1/2024

International Security and Defence Journal

European
Security
& Defence

## **Britain's Heavy Armour Programmes**

- Future AFV Design
- Active Protection Systems
- Add-on Armour Packages

- The 6×6 AFV Market
- Radiation Detection
- Iran's Interest in the Caucasus



## Politics · Armed Forces · Procurement · Technology

## DREAM TEAM IS NOW ON THE FIELD

#### KORHAN 35 MM WEAPON SYSTEM

35 MM MULTI ROLE WEAPON SYSTEM | HUNTER KILLER CAPABILITY | C4I INTEGRATION PROGRAMMABLE AIRBURST AMMUNITION | REMOTE CONTROLLED & STABILIZED ACTIVE PROTECTION | DIGITAL COMMUNICATION & TARGET IDENTIFICATION





**TECHNOLOGY SERVING PEOPLE & PLANET** 

## Word from the Editor



## **Breaking the stalemate**

For the overwhelming majority of the war in Ukraine, the highly capable air defences of both sides have greatly limited the employment and usefulness of manned combat aircraft of all types. In cases where aircraft were used, pilots typically stuck to low altitudes to avoid being detected and engaged, or relied on long-range standoff weapons to avoid becoming a target for surface-to-air missiles. The absence of reliable air support has turned the war into a slow-paced attritional slog reliant on large quantities of artillery munitions, UAVs, and loitering munitions. Yet this battlefield factor will only remain as long as air defence munition supplies allow, and here is where the situation appears to be slowly turning against Ukraine.

To provide a sense of the scale of Ukraine's task, leaked US intelligence documents from March 2023 estimated that Ukraine's combined SHORAD/MRAD/LRAD missile expenditure figures stood at around 486 missiles per month (or 5,832 per year). Note that this does not include MANPADS and VSHORAD missile expenditure, which was around 340 per month. Today, the numbers required are probably somewhat different, as Russia has expended a large portion of its guided missile and loitering munition stockpile. However, Russia has already greatly ramped up its UAV and loitering munition production over 2023, and with Russia's 2024 defence budget set to be its highest ever, it is reasonable to expect a significant ramping up in the production of ballistic and cruise missiles over the course of the year. Ukraine will therefore need to scale its air defence capabilities to match this growing threat, but this may be quite difficult to achieve in practice.

Back in early 2023, Ukraine still had stocks of its Soviet legacy missiles, but according to the aforementioned leaked US documents, most of these were predicted to run out by May 2023. This seems to have been largely borne out in reality, with Ukrainian interception reports crediting fewer and fewer interceptions to Soviet legacy GBAD systems as 2023 dragged on, while reports of interceptions by Western GBAD systems became much more common. At the start of 2024, it is probably fair to say that Ukraine's GBAD is now functionally Western. The key SHORAD/MRAD/LRAD systems and munitions known to be in service with Ukraine are summarised in the table below:

System	Missile(s)	Missile production status
IRIS-T SLS	IRIS-T	In production
IRIS-T SLM	IRIS-T SL	In production
NASAMS	AIM-120 AMRAAM (variants not confirmed) AMRAAM-ER AIM-9X	In production (all)
PATRIOT	PAC-3 CRI PAC-2 GEM-T	In production (all) – however possibly low-rate due to scaling-up of PAC-3 MSE production
Spada 2000	Aspide 2000	Production status uncertain (possibly low-rate production)
Crotale NG	VT1	Production status uncertain (possibly low-rate production)
SAMP/T	Aster-15 Aster-30	In production (all)
I-HAWK	MIM-23 (variants not confirmed)	No longer in production
Buk 'FrankenSAM'	RIM-7P/AIM-7	Production status uncertain (possibly low-rate production)
'Ground-launched ASRAAM'	ASRAAM	In production

While Ukraine currently operates a broad range of Western systems, over time Ukraine's GBAD is likely to coalesce around a smaller range of in-production systems as stocks of Western legacy missiles run out, and Ukraine's reliance on in-production Western SAMs increases. The most likely candidates here are NASAMS, PATRIOT, and IRIS-T SLS/SLM, since they are already in Ukrainian service, and the missiles used by these systems are produced in greater quantity than many of their competitors. These may be joined by other modern Western missile types, albeit likely in smaller quantities.

However, at the same time, many Western countries are looking to modernise and replenish their stocks of these same missiles, potentially putting future Ukrainian SAM procurement priorities in a state of de facto competition with allied procurement programmes.

This risks creating a bottleneck in supply, and it is not immediately clear how Ukraine could address this. If left unchecked, Ukraine's SAM depletion could gradually lead to the dangerous scenario of Russia achieving air superiority. Even if this superiority only begins as localised to certain regions or small portions of the front, it could nonetheless still spell disaster for Ukraine, and radically change the state of the war. As such, ensuring a reliable SAM supply is among Ukraine's highest priorities for the year ahead.

#### **Mark Cazalet**

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#### Pentagon leads mission to protect shipping in the Red Sea

(hum) Following the recent attacks by Houthi rebels on merchant ships in the Red Sea, the United States and nine other countries formed a military coalition on 18 December 2023 under the title Operation 'Prosperity Guardian' to protect international shipping in the region and secure freedom of navigation.

In addition to the US, Bahrain, France, Italy, Canada, the Netherlands, Norway, the Seychelles, Spain and the United Kingdom are also taking part.

Under the initiative some countries will carry out joint patrols, while others will provide intelligence support in the southern Red Sea and the Gulf of Aden.



The background to this is the repeated attacks by the Houthi militia in Yemen on ships in the Red Sea, particularly during their passage through the Bab al-Mandeb strait.

The Houthi militia has repeatedly declared that it will target all ships in the Red Sea that can be linked to Israel in any way, regardless of their nationality, "if Gaza does not receive the food and medicine it needs".

On 19 November 2023 a group of Houthi militia kidnapped the car transporter Galaxy Leader (flag state Bahamas) and is holding it hostage. It now serves as an attraction for Yemeni tourists and influencers. On 11 December the tanker Strinda was hit by a Houthi missile, although the attack did not cause any major damage or casualties. Units of the French Navy, the Royal Navy and the US Navy have repeatedly fended off attacks by unmanned aerial vehicles (UAVs) bearing explosives in recent days. USS Carney (DDG 64), an Arleigh Burke-class destroyer, intercepted a swarm of 14 UAVs launched from Yemen on 16 December.

In a press release on the morning of 19 December the Pentagon summarised that "the Houthis have conducted over 100 unmanned aerial system (UAS) and ballistic missile attacks on 10 commercial vessels involving more than 35 different nations".

According to information ESD has received from German shipping circles, the situation in the Red Sea is becoming increasingly acute. Ships are being hit by speedboats or approached by helicopters, as occurred with Galaxy Leader. The shipping companies Maersk and Hapag Lloyd are refraining from sailing in the Red Sea after attacks on their ships and other companies are following their example.

The Red Sea is an important shipping route, with 10-15% of world trade passing through the waterway. In other words, around fifty large merchant ships would typically pass every day through the Bab-al-Mandeb, the strait at the southern entrance to the Red Sea, on their way to the Suez Canal.

The alternative route via the Cape of Good Hope on the southern tip of Africa requires a much longer transit time, with a ship travelling at 18 knots from Shanghai to Rotterdam, for example, taking eight days longer to complete its trip.

As a consequence of the repeated attacks the British oil company BP announced on 18 December that it was cancelling all voyages through the Red Sea: a decision also announced by four other major shipping companies around the same time, including the Danish company Maersk and the German shipping company Hapag-Lloyd.

The US-led operation announced by Defence Secretary Lloyd Austin is to operate under the umbrella of the Combined Maritime Forces and Task Force 153. With the establishment of the multinational security initiative Washington is taking the initiative and trying to make up ground. While the US Biden administration has made efforts to counter instability in the Middle East by developing a regional security architecture based on greater co-operation between Israel and the Gulf states, that initiative have been undermined by the war in Gaza prompted by the Hamas attack on Israel on 7 October 2023.

## UK MoD cancels Morpheus EvO comms system contract

(pf) The UK Ministry of Defence (MoD) stands accused of wasting more taxpayers' money after conceding that it has abandoned a key strand of the struggling GBP 3.2 Bn (EUR 3.73 Bn) Morpheus programme. The failure also threatens to stymie the British Army's future digitalisation efforts.

Part of the UK's overarching Land Environment Tactical Communication & Information Systems (LETacCIS) programme, Morpheus is intended to deliver the next generation of tactical communication and information systems (TacCIS) to British forces operating in a land environment.

In order to replace the current Bowman communication system with a future open



information architecture solution, thus preventing 'vendor lock-in' and giving the MoD more flexibility for future acquisitions, in April 2017 the LETacCIS programme awarded a GBP 330 M Evolve to Open (EvO) Transition Partner (TP) contract to General Dynamics Mission Systems (UK). This work was intended to deliver a lab-tested design in December 2020 and an initial operating capability (IOC) by 2025, but the project failed to deliver.

In a statement to the House of Commons on 14 December 2023 the defence procurement minister, James Cartlidge, wrote, "We have been open that progress on the Morpheus project has fallen short of what was expected and since December 2020 we have been working closely with General Dynamics to agree the best way ahead. The MoD can today confirm that, as a result of these discussions, this contract has now been concluded."

On 5 December 2023, in answering written questions from Shadow Defence Secretary John Healey, Cartlidge stated that, as of 27 November 2023, the Morpheus project had already cost the MoD around GBP 690 M and that, despite this outlay, the IOC for the Evolve to Open system was yet to be defined.

However, the failure of the EvO contract will inflict additional and expensive penalties. Writing on X/Twitter on 15 December, military analyst Francis Tusa pointed out that the current Bowman communication system will not only have to go through more updates, but will now probably have to be initially fitted to the British Army's future armoured vehicles – such as the Ajax reconnaissance vehicle, Challenger 3 main battle tank and Boxer Mechanised Infantry Vehicle – instead of the next-generation radios they should have received under Morpheus.

In his 14 December statement to the House Cartlidge said the MoD "will continue to work with General Dynamics to ensure they

## blackned Enables Software-defined Defence



In September 2023, blackned, a leading military IT specialist from Germany, presented its TACTICAL CORE solution for critical communication and data exchange at DSEI in London. The software portfolio connects the forces involved on the battlefield to form an extremely effective digital network that enables the fast and secure exchange of information.

The German Federal Office for Information Security (BSI) has approved TACTICAL CORE for data transmission up to the "NATO Restricted" level, thus guaranteeing secure and authorised communication.

Direct and secure communication is crucial, especially at the tactical level. The blackned platform provides a digital network for the exchange of information - from brigade level downwards. The solution ensures effective interoperability with existing digital and analogue radio technologies as well as the integration of new devices, even in complex overall networks.

TACTICAL CORE is based on various IT solutions from blackned: The XONITOR software acts as a monitoring and management tool, RIDUX ensures a reliable and efficient data and communication infrastructure, and the patented "MeshFlow" enables seamless connectivity even in dynamic scenarios.

On the battlefield, at tactical level and in operational command centers, a large number of different systems still operate in all armed forces today - a major problem for the interaction and exchange of data. Analogue radios in the tactical frequency spectrum need to communicate with digital devices such as smartphones, systems with different designs need to exchange data with each other, and end devices need to read and analyze information from non-system sensors. This is only possible if an interoperable IT network serves as the basis in which devices from different manufacturers and technologies can communicate with each other and exchange data.

According to an analysis by the International Institute for Strategic Studies in February 2023, software also plays a key role in the required increase

in performance of armed forces. Technological progress and therefore superiority on the battlefield is achieved more quickly with software-centric systems. The transition to software-defined defence enables armed forces to conduct data-centric warfare based on machine learning and artificial intelligence in order to manage complex data streams in real time across different systems and platforms. Software emerges as a crucial component for the effectiveness of military platforms, enabling flexible and seamless networking, as well as providing interfaces for upcoming technologies to control and shape the battlefield

The TACTICAL CORE communication and data platform from blackned with XONITOR and RIDUX adapts existing systems and devices up to the brigade level. This creates a highly secure, dynamic and self-organizing communication structure that ensures a common situational picture in real time at all levels. "Our TACTICAL CORE is a fast and efficient option for digitizing national and multinational armed forces and is therefore an essential step on the way to software-defined defence," says Timo Haas, CEO and founder of blackned.



Timo Haas, CEO and founder of blackned



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#### European Security Spotlight Defence

deliver the planned update to sustain the in-service Bowman system, ensuring we continue to meet all our operational requirements".

He added that the MoD "is now proactively reconsidering the requirements that the Morpheus project is due to deliver, which we expect to conclude in the Spring."

#### China's third carrier conducting dead-load launch testing of its catapult

(pf) Video imagery has emerged showing that Fujian, China's first Type 003-class aircraft carrier, has been conducting deadload launch testing of its electromagnetic catapult.

A video clip originally loaded onto the Chinese social media channel Weibo on 26 November 2023 shows an aerial view of the carrier with a heavy splash off its bow made by the launching of a test sled from its catapult, which is a Chinese version of the Electromagnetic Aircraft Launch System (EMALS) used initially by the US Navy carrier USS Gerald R Ford.

*Fujian* was launched on 17 June 2022 and is currently being fitted out at Jiangnan Shipyard on Changxing Island, adjacent to the city of Shanghai. As explained by the Eurasia Naval Insight vlog on YouTube, Jiangnan Shipyard is on the flightpath of passenger aircraft coming in to land at Shanghai International Airport, which allows Chinese naval enthusiasts to keep track of progress there. The dead-load launch testing is an essential phase in the commissioning of the electromagnetic catapult on *Fujian* before it is tested with real shipborne fighter aircraft.

China's previous two aircraft carriers, *Liaon-ing* and *Shandong*, have 'ski-ramp' decks rather than catapults for take-offs, as Liaoning began its life as a Soviet-designed Kuznetsov-class aircraft carrier and Shandong, as China's first domestically produced carrier, was built to the same design.

Credit: via Weibo



Carriers with catapult-assisted take-off but arrested recovery (CATOBAR) systems can launch fighters with heavier payloads or larger aircraft types such as airborne early warning and control platforms like the US E-2 Hawkeye.

Before USS *Gerald R Ford* was commissioned on 22 July 2017 all previous US carriers were fitted with steam catapults, but China has opted to immediately adopt electromagnetic launch technology in its first indigenously designed aircraft carrier.

Although steam catapult systems on carriers have been very reliable, systems like EMALS are more efficient, take up less space and offer greater load control. That said, the reliability of EMALS and the Advanced Arresting Gear (AAG) system on USS *Gerald R Ford* have been disappointing in their initial years of operation.

A June 2022 report by the US Government Accountability Office stated that the US Navy "continues to struggle with the reliability of the electromagnetic aircraft launch system and advanced arresting gear needed to meet requirements to rapidly deploy aircraft" and indicated that the navy did not expect EMALS and AAG to reach their full reliability goals until the 2030s.

It will therefore be interesting to see how long it takes China to perfect its own versions of those systems.

## ■ IDF knew of Hamas battle plan a year before attack

(pf) It has emerged that the Israel Defense Forces (IDF) were in possession of a 40-page blueprint for a major assault on Israel more than a year before Hamas initiated its deadly attack on 7 October 2023, *The New York Times* (NYT) reported on 30 November 2023.

The Hamas battle plan, codenamed 'Jericho Wall' by the IDF, included a rocket bombardment of Israel and the use of unmanned aerial vehicles (UAVs) to disable the IDF's surveillance capabilities along its border fence with the Gaza Strip prior to a widespread invasion of southern Israel and IDF bases there.

Also discounted a month before the attack was evidence of Hamas training specific to the attack, including Hamas social media postings showing its fighters using explosives to breach the border fence before sweeping through it on pick-up trucks to attack a full-scale replica of an Israeli town, the *NYT* reported.

Another 2016 IDF memo obtained by the *NYT* showed that Hamas intended to take hostages back to Gaza.

On 7 October around 3,000 Hamas militants invaded southern Israel in an operation that closely followed the 'Jericho Wall' blueprint,



killing around 1,200 Israelis and abducting around 240 hostages back to Gaza.

According to the *NYT* reporting, in July 2023 a female analyst within an IDF signals intelligence unit warned that what she was witnessing was a narrowing of the gap between the 'Jericho Wall plan and what Hamas was actually capable of conducting. However, senior Israeli intelligence officials pushed back against this assertion, still regarding 'Jericho Wall' as an aspirational plan that was unlikely to materialise in the near term.

One tactic that Hamas did not apparently adopt during its attack was the widespread use of 'suicide drones', despite Hamas propaganda videos showing dozens of what have been described as Iranian-inspired tactical fixed-wing UAVs being used in training. While these may have been stockpiled for future use, it is also possible that these systems were not deemed particularly effective and that their use might have indicated to the IDF that an unprecedented offensive was unfolding.

However, one UAV type that was, indeed, used to significant effect – and foreshadowing in 'Jericho Wall' – were the multi-rotor UAVs that Hamas used to destroy IDF surveillance towers along the Gaza border fence where Hamas broke through. These systems, which were used to drop RPG rounds on the towers, appear to be Matrice 600 rotary-wing UAVs manufactured by Chinese company DJI. These systems, which are typically used for aerial photography, are widely available on the commercial market. They can carry a payload of up to 6 kg and can be purchased for around EUR 6,000.

#### B-21 Raider, USAF's next-generation stealth bomber, takes to the air

(pf) The B-21 Raider, the next-generation strategic bomber of the US Air Force (USAF), made its maiden flight on 10 November 2023. Although no official acknowledgements of the flight were released by the USAF or the aircraft's manufacturer, Northrop Grumman, in the days following the event, video footage of the first B-21 taking to the skies out of Air Force Plant 42 in Palmdale, California, was posted on X (formerly Twitter) by various sources showing the B-21 airborne and accompanied by an F-16 chase plane. The B-21 could be seen flying with its landing gear unretracted, with a test instrumentation boom protruding to the left of its nose, and was reported to have flown for around 90 minutes.

A flying wing design similar to but smaller than the Northrop Grumman B-2 Spirit stealth bomber, the B-21 is billed as the world's first sixth-generation aircraft. Northrop Grumman received a contract to develop the aircraft in October 2015: an award that was protested by losing bidders Boeing and Lockheed Martin but confirmed in October 2016.



Northrop Grumman revealed the first B-21 to the world at Palmdale on 2 December 2022 and announced that the aircraft had commenced engine runs as part of its ground test programme on 12 September 2023.

The B-21 will initially replace the Boeing B-1B Lancer and B-2A Spirit bomber fleets in USAF service, while the oldest airframes in the USAF's Global Strike Command, its fleet of B-52H Stratofortresses, are being re-engined to remain in service as missile carriers alongside the future Raider fleet.

The USAF describes the B-21 as a dualcapable penetrating strike stealth bomber capable of delivering both conventional and nuclear munitions" that "will play a critical role in ensuring America's enduring airpower capability".

Its development furthers a strategic air capability that is a key area where the US military still has a significant overmatch in relation to its adversaries. While both China and Russia also operate strategic bomber fleets, neither has a low-observable aircraft anything like the B-2 or B-21.

Around 100 B-21s are expected to be procured, with the USAF stating on its website that the type is expected to become operational in the mid-2020s.

#### Mojave becomes largest UAV launched from a Royal Navy carrier

(pf) A General Atomics Aeronautical Systems Inc (GA-ASI) Mojave has become the largest uncrewed aerial vehicle (UAV) ever to be launched from a UK Royal Navy aircraft carrier.



Controlled from aboard the carrier, the Mojave took off from the deck of the carrier HMS Prince of Wales on 15 November 2023 while the ship was on exercise off the US East Coast. It then flew circuits and approaches before eventually landing back onto the carrier.

The GA-ASI Mojave – which is 9 m long, has a wingspan of 17 m and weighs more than 1.5 tonnes when fully loaded – is a short take-off and landing (STOL) UAV demonstrator originally developed to prove STOL operations at unprepared landing sites.

While the Mojave shares common systems and components with GA-ASI's MQ-1C Gray Eagle UAV, a STOL wing-set option is being planned for GA-ASI's larger, more capable MQ-9B aircraft, which – as well as the SkyGuardian and SeaGuardian UAVs – includes the new Protector RG Mk 1 cur-

rently being delivered to the UK Royal Air Force (RAF) for entry into service next year. An MQ-9B STOL variant is being considered by the Royal Navy and other navies that operate aircraft from large flat-deck warships without catapults and arresting gear. "The Moiave trial is a European first - the first time that a remotely piloted air system of this size has operated to and from an aircraft carrier outside of the United States," said Rear Admiral James Parkin, Royal Navy Director Develop, whose team planned the trial. "The success of this trial heralds a new dawn in how we conduct maritime aviation and is another exciting step in the evolution of the Royal Navy's carrier strike group into a mixed crewed and uncrewed fighting force." Meanwhile, an RAF Protector RG Mk 1 took to the UK skies for the first time in a flight out of RAF Waddington on 17 November. In flying a series of circuits around RAF Waddington, it became the largest and most advanced UAV flown in UK airspace.

The first of 16 Protectors procured for RAF service, the UAV arrived at the Lincolnshire air base in September and is undergoing a series of rigorous trials and tests before entering the RAF fleet.

The other 15 Protectors are arriving in a phased delivery over the coming years, with all aircraft expected to be delivered and in service by July 2025.

#### UK, Italy and Japan sign landmark treaty advancing the Global Combat Air Programme

(pf) The United Kingdom, Italy and Japan signed an international treaty on 14 December 2023 that marks a key stage of the landmark Global Combat Air Programme (GCAP).

GCAP, which merges the UK-initiated Tempest programme with Japan's effort to develop a next-generation fighter, aims to produce a sixth-generation fighter that will take to the skies by 2035.



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It was also decided under the treaty that the headquarters of the programme will be based in the UK, while the first CEO for the programme will come from Japan. Meanwhile, a new joint business construct will be headquartered in the UK that will oversee support and timely delivery of the programme, with the first head of this organisation coming from Italy.

UK Defence Secretary Grant Shapps met with his Japanese and Italian counterparts, Minister Minoru Kihara and Minister Guido Crosetto, in Tokyo to sign the treaty, which comes a year after the formal launch of GCAP and "highlights the positive progress in the development of this next-generation fighter jet" the UK Ministry of Defence (MoD) stated in a press release.

The joint development phase of the programme is due to launch in 2025.

Within the UK, the GCAP effort is being led by BAE Systems in close partnership with Rolls-Royce, Leonardo UK and MBDA UK. Together, they are working closely with lead companies from Japan and Italy, chiefly Mitsubishi Heavy Industries and Leonardo respectively, to progress the design and development of the aircraft.

"Our world-leading combat aircraft programme aims to be crucial to global security and we continue to make hugely positive progress toward delivery of the new jets to our respective air forces in 2035," Shapps was quoted as saying by the MoD. "The UK-based headquarters will also see us make important decisions collaboratively and at pace, working with our close partners Italy and Japan, and our impressive defence industries, to deliver an outstanding aircraft."

#### Hungary signs deal with Rheinmetall to develop Panther KF51 MBT

(pf) The Hungarian government has signed an EUR 288 M contract with Rheinmetall to develop the Panther KF51 main battle tank (MBT) through to production maturity, Rheinmetall announced on 15 December 2023.

A demonstrator vehicle will be constructed and qualified, paving the way to fullscale production.

Under the contract, which was recently signed in Zalaegerszeg, Hungary, Rheinmetall is co-operating with the stateowned Hungarian holding company N7, which also holds a 49% stake in the joint venture Rheinmetall Hungary.

Hungarian Prime Minister Victor Orban first indicated that Hungary would join the

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development of the KF51 in August 2023. The German government, meanwhile, is focused on developing the Main Ground Combat System as the Bundeswehr's next MBT in a joint programme with France.

"We're delighted to have reached another important milestone on the path to producing next-generation fighting vehicles in Hungary," Armin Papperger, Rheinmetall's CEO, was quoted as saying in a company press release. "The Panther KF51 is the world's most advanced main battle tank. It sets a new standard for the combat effectiveness of mechanised formations, while delivering a high degree of future adaptability. At the same time, in our accustomed manner, we'll be empowering our local



Joint Venture Rheinmetall Hungary and further strengthen the national defenceindustrial capabilities of our partners."

Rheinmetall first publicly presented the Panther KF51 at the 2022 Eurosatory defence exhibition in Paris. Unlike the system demonstrator unveiled at Eurosatory, which was armed with a 130 mm Rheinmetall Rh-130 L/51 smoothbore gun, the Panther KF51 EVO (as Rheinmetall is calling this latest iteration) will be armed with Rheinmetall's tried-and-tested L55A1 120 mm smoothbore gun, giving commonality with the latest variants of the Leopard 2 MBT. This includes the 44 Leopard 2A7+HU MBTs ordered by Hungary in December 2018, the first of which was delivered in August 2023.

# NATO selects E-7A Wedgetail to succeed its E-3A AWACS aircraft

(pf) NATO announced on 15 November 2023 that it has selected the Boeing E-7A Wedgetail airborne early warning and control (AEW&C) aircraft as its next-generation command-and-control aircraft.

The alliance intends to buy six E-7As via the US Foreign Military Sales (FMS) mechanism to replace its 14 E-3A Sentry Airborne Warning and Control System (AWACS) aircraft, which are scheduled to retire around 2035.

Production of the six new E-7As is set to begin in the coming years, with the first aircraft expected to achieve an initial operational capability by 2031.



The NATO E-7As are expected to operate out of Geilenkirchen Air Base in Germany, where the current AWACS fleet is hosted, and could also operate from several forward locations across Europe.

Acquisition of the six E-7As is billed by the NATO Support and Procurement Agency (NSPA) as fulfilling an "initial Alliance Future Surveillance and Control (iAFSC) capability", with other platforms - including space and maritime intelligence, surveillance and reconnaissance assets as well as the already-operational Northrop Grumman R-Q4D uncrewed aerial vehicles of the Alliance Ground Surveillance (AGS) system – used to deliver a full replacement of the current fleet of 14 AWACS aircraft. NATO originally acquired 18 E-3As from 1982, but one was lost in a crash in 1996 and three were retired in 2015, 2017 and 2018

The E-7A features as its primary mission system the Northrop Grumman Multi-role Electronically Scanned Array (MESA) radar located on a dorsal fin on top of its fuselage. This provides 360° surveillance capability without the need to rotate, as with the E-3s' rotodome-housed AN/APY-1/2 passive electronically scanned-array radars. The other main contender vying for the NATO AWACS replacement programme was the Saab GlobalEye system, which is mounted on a Bombardier Global 6000/6500 long-range business jet airframe.

As well as the US Air Force, the E-7A has already been selected by Australia, Turkey, South Korea and the United Kingdom.

#### Sweden signs DCA with US, facilitating substantive US military presence

(pf) As final approval for Sweden to join NATO nears, the country has signed a Defence Cooperation Agreement (DCA) with



the United States that fosters closer military ties and agrees the conditions for US forces using military facilities in Sweden. The DCA was signed on 5 December 2023 by Swedish Defence Minister Pål Jonson and US Defense Secretary Lloyd J Austin III during a visit by Jonson to the Pentagon. "The DCA is an important step in deepened military co-operation with the US. It strengthens both Sweden's and its neighbouring countries' regional security by conveying the engagement and actual presence of the US," the Swedish Ministry of Defence (MoD) stated in a 6 December press release.

The US Department of Defense has previously concluded DCAs with several European countries such as neighbouring Norway. DCA negotiations are also ongoing with Denmark and have recently been concluded with Finland.

However, the DCA agree with Sweden is particularly extensive. In all it authorises a US presence at no less than 17 Swedish military sites: the regimental area and exercise area facilities at Berga, Boden, Kristinehamn and Visby; the regimental area and air base at Halmstad; the air bases at Luleå, Ronneby, Såtenäs and Uppsala; the airport and test range at Vidsel; the military camp and exercise areas at Älvdalen, Kiruna, Kvarn, Östersund and Ravlunda; the regimental area at Revingehed; and the exercise area and harbour at Härnösand.

In order for the DCA to enter into force, the Riksdag (the Swedish legislature) must approve it and adopt the legislative amendments needed to implement it. "Consideration in the Riksdag, followed by

entry into force, should be possible in 2024," the Swedish MoD said on its website. The DCA, in combination with Sweden's accession into NATO, ends a 200-yearold policy of military non-alignment by

old policy of military non-alignment by Sweden. Although elements within the country had always advocated closer relations with NATO, the Russian invasion of Ukraine in February 2022 spurred Stockholm into full-on NATO membership.

## South Korea becomes first Asian customer for the Embraer C-390

(pf) South Korea's Defense Acquisition Program Administration (DAPA) has declared the Embraer C-390 Millennium as



the winner of its Large Transport Aircraft (LTA) II requirement to provide the Republic of Korea Air Force (ROKAF) with a new military transport aircraft fleet, Embraer announced on 4 December 20023. The win makes South Korea Embraer's first C-390 Millennium customer in Asia. The value of the contract, which was not disclosed, will be included in Embraer's backlog in the fourth quarter of 2023. Under the signed deal Embraer will provide an undisclosed number of C-390 Millennium

aircraft specially configured to meet ROKAF requirements, as well as services and support, including training, ground support equipment and spare parts. Embraer will also provide a comprehensive consortium and offset package, including a significant amount of C-390 Millennium parts to be locally manufactured by South Korean partner companies and the development of a local maintenance, repair and overhaul (MRO) provider. South Korea is the seventh nation to select the C-390 after Brazil, Portugal, Hungary, the Netherlands, Austria and the Czech Republic.

Since entering operation with the Brazilian Air Force in 2019, and most recently with the Portuguese Air Force in 2023, the C-390 "has proven its capacity, reliability, and performance", Embraer stated. The company asserts that the fleet of C-390s currently in operation has accumulated more than 10,800 flight hours, demonstrating operational availability rates of around 80% and mission completion rates above 99%.

#### Bundeswehr places largest ever order for the H145M

(pf) The German Bundeswehr has signed a contract with Airbus Helicopters for up to 82 H145M multi-role helicopters, Airbus announced on 14 December 2023.



The deal, which covers 62 firm orders plus 20 options, is the largest order ever placed for the H145M and consequently the largest for the Airbus HForce weapon management system it carries. The contract also includes seven years of support and services, ensuring optimal entry into service.

Most of the purchased aircraft, 57, will go to the German Army, while the Luftwaffe's special forces will receive five.





"We are proud that the Bundeswehr has decided to order up to 82 H145M helicopters", Bruno Even, CEO of Airbus Helicopters, was quoted as saying in a company press release. "The H145M is a robust multi-role helicopter and the German Air Force has gained a significant amount of operational experience with its H145M LUH Special Operations Forces (SOF) fleet. We will ensure that the Bundeswehr receives the helicopters in accordance with the very ambitious delivery schedule, which includes first deliveries in 2024 less than a year after contract signature."

Offering a broad range of mission capabilities, the H145M can be reconfigured within minutes from a light attack role with axial ballistic and guided weapons and a state-of-the-art self-protection system into a special operations version including fast rappelling equipment, according to Airbus. The aircraft's mission packages also include hoisting and external cargo capabilities. Additionally, the new German H145M includes options for upgraded datalinks and communication systems as well as future missions, such as manned-unmanned teaming operations. The basic version of the ordered H145Ms will be equipped with fixed provisions, including Airbus' HForce weapon management system. This allows the Bundeswehr to train its pilots on the same type of helicopter that is used for operations and combat. Costly type transfers are eliminated and the highest level of professionalisation will be achieved.

The H145M is the military version of the civilian twin-engined H145 light helicopter. The global H145 fleet has now accumulated more than seven million flight hours. The type is used by armed forces and law enforcement agencies around the world, including the Bundeswehr, which already operates 16 H145M LUH SOF and eight H145 LUH SAR (search-and-rescue) helicopters.

#### First steel cut on Germany's future F126 multi-purpose frigates

(pf/hum) The first steel was cut on 5 December 2023 on the F126 programme to supply the German Navy with a new class of multi-purpose frigates.

The main contractor, Dutch shipbuilder Damen Naval, and its project partner, Germany's NVL (Naval Vessels Lürssen) Group, invited more than 200 guests to attend the steel-cutting ceremony, which took place at NVL Group's Peene shipyard in Wolgast, Germany. "We are proud to be able to start cutting steel entirely on schedule on 5 December," Damen Shipyards Group CEO Arnout Damen was quoted as saying in a company press release. "We were able to complete the development phase in record time: something that is partly due to the excellent co-operation with BAAINBw (Germany's Federal Office of Bundeswehr Equipment, Information Technology and In-Service Support), the [German] Navy and the other German authorities.



BAAINBw awarded the construction contract for four F126 frigates to Damen Naval as main contractor, together with subcontractors Blohm+Voss (part of NVL Group) and Thales, in June 2020. The F126 programme is the largest shipbuilding project in the history of the modern German Navy and the contract includes an option for two more frigates.

The awarding of a German Navy frigate contract to a foreign shipyard caused some degree of heated debate in the country. Damen thus tried to take the wind out of its critics' sails by promising to keep a high proportion of the project's added value in Germany.

"Together with its German partner Blohm+Voss, DSNS [Damen Schelde Naval Shipbuilding] will realise the project in such a way that around 80% of the total investment will remain in Germany as added value," the Dutch shipbuilder announced when the contract was signed. As a result the ships will be built entirely in Germany at shipyards in Wolgast, Kiel and Hamburg. The steelwork and preassembly for the stern will take place at the Peene shipyard in Wolgast. The foreship will be built in Kiel, where it will be assembled with the stern and towed by sea to Blohm+Voss in Hamburg. Final outfitting, commissioning, testing and delivery, as well as outfitting of the onboard systems, will take place at Blohm+Voss in Hamburg. Delivery of the first ship is scheduled for 2028.

#### ■ Kongsberg to lead development of NSM successor for Norway and Germany

(pf) The Norwegian government has announced it is starting the development of the next-generation naval strike missile in co-operation with Germany with Kongsberg Defence & Aerospace as the lead industrial partner, the Norwegian company reported on 24 November 2023.

Having developed the current Naval Strike Missile (NSM), Kongsberg will take the lead role in developing the new weapon, which will complement the NSM, the Norwegian Ministry of Defence said in a statement. The new missile will be known as the SuperSonic Strike Missile (3SM) Tyrfing and is scheduled to be ready in 2035.

The Norwegian and German governments first declared that a new anti-ship missile would become a collaborative project in 2021, with the missile set to arm naval vessels in both countries. The Norwegian government is proposing to initiate and complete the initial design phase of the 3SM Tyrfing project before returning to the Norwegian Parliament to recommend the project is continued.



"The development of Norwegian missiles is a success story. The Norwegian defence industry, with Kongsberg at the forefront, has unique expertise and produces worldclass missiles," Norwegian Defence Minister Bjørn Arild Gram was quoted as saying in a Kongsberg press release. "The project will continue to extend this strategically important expertise so we can continue to develop missiles that are attractive to other NATO countries and close allies." Today's NSM, which has anti-ship and

Today's NSM, which has anti-ship and land attack capabilities, was developed in the early 2000s and delivered to the Norwegian armed forces from 2011 to 2015. Today, the missile has been selected by 13 countries, while an air-launched version, the Joint Strike Missile, is set to arm the F-35 Joint Strike Fighters of a number of air forces.

## Firms & Faces

#### BAE Systems, Babcock and RBSL team to pursue UK MFP requirement

(pf) BAE Systems, Babcock International Group and Rheinmetall BAE Systems Land (RBSL) are joining forces to offer the Archer wheeled selfpropelled howitzer (SPH) to the UK Ministry of Defence (MoD) for its 155 mm Mobile Fires Platform (MFP) requirement, the companies announced on 11 December 2023.



Under their teaming, named the Archer Artillery Alliance, BAE Systems will provide the weapon and gun control system, as well as setting up and managing an assembly, integration and test facility; Babcock will hold responsibility for the consolidation of the superstructure and ammunition resupply system; and RBSL will be the UK lead for providing the SPH's RMMV HX 8×8 truck chassis and preparing the cabin for integration with the Archer artillery system.

As an interim MFP solution the UK MoD agreed in March 2023 to buy 14 ex-Swedish Archers, which use a Volvo 6×6 all-terrain chassis but have been upgraded to a UK specification by BAE Systems Bofors. It was announced on 6 October that the first of these had been delivered to the British Army.

However, prior to that the longer-term MFP programme called for a full operating capability of 116 SPHs by 2032. Despite its interim Archer acquisition, the British Army has not stipulated whether its ultimate MFP platform should be tracked or wheeled. Also in contention for the requirement, for example, are the South Korean Hanwha K9 Thunder tracked SPH and the KMW Remote Controlled Howitzer 155 (RCH 155) mounted on the rear of the Artec Boxer 8×8 multi-role armoured vehicle, which has already been selected as the British Army's future Mechanised Infantry Vehicle. The MFP requirement will replace the British Army's fleet of tracked AS90 155 mm SPHs.

#### Chris Calio to succeed Greg Hayes as CEO of RTX (pf) RTX President and Chief Operating Officer Christopher T Calio

is to succeed Gregory

J Hayes as the company's CEO at the 2024 RTX Annual Shareowners Meeting scheduled for 2 May 2024, the company announced on 14 December 2023.

While Hayes will continue to serve as executive chairman of RTX, Calio was also appointed to the company's board of directors on 14 December.

"Today's announcement reflects the Board's deliberate, disciplined succession planning process," said Hayes. "Chris has a deep understanding of the industry, our customers' needs and our operations. I have every confidence in his ability to lead RTX and drive the company's long-term success."

As president and chief operating officer of RTX, Calio oversees the company's three business units, as well as its functions for technology, engineering, enterprise services, digital, operations, quality, supply chain, and environment, health and safety.

In 2023 Calio oversaw the realignment of RTX from four to three business segments: Collins Aerospace, Pratt & Whitney and Raytheon. Prior to his current role, Calio was president of Pratt & Whitney, where he led the business that designs, manufactures and services aircraft engines and auxiliary power units. He joined the company in 2005 and held various leadership roles and drove significant transformational change throughout his tenure.

Hayes, meanwhile, was elected chairman of the board in 2021. He had a nearly 21-year career at United Technologies Corporation, holding several senior leadership roles across finance, corporate strategy and business development, culminating with his appointment as CEO in 2014 and chairman in 2016. As CEO, Hayes led the reshaping of UTC from industrial conglomerate to a focused aerospace company. Beginning with the divestiture of Sikorsky Aircraft in 2015 and the acquisition of Rockwell Collins in 2018, Hayes continued to focus the business with the spin-offs of Otis Elevator Company and Carrier Corporation in 2020. Hayes then led the merger of UTC's remaining aerospace businesses, Pratt & Whitney and Collins Aerospace Systems, with Raytheon Company to form RTX in April 2020.

#### Rafael Advanced Defense Systems appoints new CEO

(pf) Rafael Advanced Defense Systems Ltd announced on 6 December 2023 the appointment of Yoav Turgeman as the company's new CEO.

He will succeed Major General (ret) Yoav Har-Even, who served as the company CEO for more than eight years, although Har-Even has agreed to extend his tenure at the board's request due to the ongoing operations against Hamas following its 7 October 2023 attack on Israel (which Israelis call the 'Swords of Iron' war).

The appointment is pending approval from the appointments committee, the Israeli minister of defence, and the Regional Cooperation Minister responsible for government companies.

"This strategic decision was made by the board of directors, who, in a unanimous choice, selected Mr Turgeman based on the recommendation of the search committee," the company noted in a press release. "The selection process adhered to the rigorous standards for CEO appointments in government-owned entities."

Turgeman served in various command and staff roles in the Israeli Navy for 25 years, retiring as a colonel. Following his military service Turgeman entered the aerospace industry, initially heading the Arrow missile defence programme at Israel Aerospace Industries (IAI) and later managing the MLM facility of IAI's Systems Missiles & Space Group. Since 2018 he has been serving as the CEO of IAI radar systems subsidiary Elta Systems.

#### Embraer and SAMI sign MoU to further aerospace and defence co-operation

(pf) Brazil's Embraer signed a memorandum of understanding (MoU) with Saudi Arabian state-owned defence concern SAMI on 29 November 2023 to establish aerospace cooperation with a particular focus on defence. The agreement is geared towards expanding the operational footprint of both companies in Saudi Arabia while promoting the capabilities of Embraer's C-390 Millennium transport aircraft and delivering support to the Saudi Ministry of Defense.

Under the MoU SAMI and Embraer will work to establish a comprehensive maintenance capability for the Embraer aircraft in the Kingdom. Additionally, both companies will explore the establishment of a regional maintenance, repair and overhaul (MRO) hub and final assembly line for the Embraer C-390, as well as a mission system integration facility in the Kingdom.

Furthermore, SAMI and Embraer will engage in training activities, enabling the opening of new opportunities for both companies across the aerospace sector in the Kingdom and the wider Middle Eastern region.



# Another new dawn beckons for UK heavy armour

#### **Peter Felstead**

UK procurement for its heavier armoured formations has not been a happy experience in recent decades, but the British Army now has a plan – another one – intended to deliver the land-based fighting capability it requires.

On 9 March 2021 a UK House of Commons Defence Committee (HCDC) report was published that focused on the British Army's armoured vehicle capability. It did not make pleasant reading.

"The recent history of the British Army's armoured fighting vehicle (AFV) capability is deplorable," the report stated in its opening summary. "Since the end of the Cold War in the late 1980s, the army's AFV fleets have been characterised by increasing obsolescence and decreasing numbers. In 1990 the UK had around 1,200 main battle tanks in its inventory, today has 227, and those that remain are in urgent need of modernisation."

The HCDC report added, "We are astonished that between 1997 and late 2020 (with the exception of a small number of armoured engineering and Viking protected mobility vehicles) the Department has not delivered a single new armoured vehicle from the core procurement programme into operational service with the army."

While it would be easy to blame a broken procurement system within the UK Ministry of Defence (MoD) – and, like the HCDC, many have – it should also be remembered that UK land systems procurement over the last 30-plus years has been pulled from pillar to post by the constantly changing nature of land warfare faced by the British Army.

#### The peace dividend

Just prior to the end of the Cold War, the British Army fielded four armoured divisions and more than 6,200 armoured vehicles. At its heavier end, according to the 1998/89 edition of the IISS' *The Military Balance*, the army's combat fleet included around 300 Challenger 1 and 870 Chieftain main battle tanks (MBTs), 1,061 variants of the Combat Vehicle Reconnaissance (Tracked) (CVR(T)) family and 150 Warrior infantry fighting vehicles (IFVs), of which 789 were ultimately received between 1987 and 1995.



Ajax and Boxer on the British Army's training area at Bovington Camp, Dorset, on 18 March 2021. These two vehicles, alongside the Challenger 3 MBT, will provide the core of the British Army's heavier armoured formations under its Future Soldier plans.

At the end of the 1980s the British Army's Future Family of Light Armoured Vehicles (FFLAV) study sought to inform what should replace the CVR(T) family and other vehicles such as the tracked FV432 armoured personnel carrier. This led to two initiatives – the Tactical Reconnaissance Armoured Combat Equipment Requirement (TRACER) and a project to deliver a Multi Role Armoured Vehicle (MRAV) – that showed promise but ultimately went nowhere before being cancelled.

However, by the early 1990s the UK government, along with other NATO nations, was looking to deliver a post-Cold War 'peace dividend' – meaning sizeable cuts in military spending – as reflected in its 1990 'Options for Change' initiative.

Following this, and in light of the army's engagement in the Bosnian War from 1992 to 1995, it was determined that light/medium-weight armour, which could readily be deployed from C-130 transport aircraft to conduct 'international police actions', was what the army required. A requirement for a fleet of AFVs to fulfil such an expeditionary role was then encapsulated within the UK's 1997 Strategic Defence Review. Emerging from this mindset came the illfated Future Rapid Effect System (FRES) programme, which came to epitomise the combination of deficient procurement and adverse circumstance that blew the British Army's AFV plans so far off course.

#### FRES

Work on the FRES requirement was initiated in 2001 when what was then Alvis Vickers was commissioned by the UK MoD to carry out concept work. However, by the time the MoD had announced a twovear Initial Assessment Phase (IAP) for the FRES programme in 2004, the British Army was already facing adversity on battlefields that looked nothing like the Balkans. As the counter-insurgency campaigns in Afghanistan and Iraq increasingly presented the improvised explosive device (IED) as the single greatest threat to British service personnel, the classic 'iron triangle' of AFV design the balance between firepower, protection and mobility - swung away from mobility in favour of protection; the notion of deploying armoured vehicles from a C-130 was exposed as a pipe dream.

The FRES programme was originally expected to deliver 3.000 AFVs in 16 different roles, essentially split into two main types, the wheeled Utility Variant (UV) and tracked Specialist Variant (SV) families, but the plans to execute the programme were caught between delivering on the requirement and actually making the acquisition happen. By 2004 the FRES programme was deemed complicated enough for a 'Systems House' to be required to oversee the programme, with the consultancy Atkins Defence appointed to that role in November of that year. Beginning in February 2005 Atkins awarded, following an open competition, nine Technology Demonstrator Programme (TDP) contracts to UK and international defence companies to "derisk, through rigorous testing, the potential technologies for FRES".

Complicating things further a system-of-systems integrator was then deemed necessary: a contract that went to a Thales/Boeing team in January 2008. Yet already by mid-2007, in order to expedite the procurement, the FRES UV requirement was effectively coming down to a straight shoot-out between three contenders. On 7 June 2007 the then head of the UK MoD's Defence Equipment & Support (DE&S) organisation, Lord Dravson, announced that these contenders would be the Boxer, produced by the Dutch-German Artec consortium; the Piranha Evolution, designed by Swiss firm Mowag and presented by local partner General Dynamics UK (GDUK); and the Véhicule Blindé de Combat d'Infanterie (VBCI) produced by France's Nexter.

On 31 July 2007 Lord Drayson told an audience gathered at the British Army's Bovington training area in Dorset to view the FRES UV contenders, "What I want is to shock you how quickly this gets done." He also conceded that, in light of the imperative for more protection, the FRES UV's air-transportability requirement had moved from the C-130 to the larger A400M.

Lord Drayson, however, was to be denied his optimistic ambitions. No doubt frustrated at his inability to effect an actual procurement, he resigned from his post in November 2007 to concentrate instead on his passion for motor racing. Although the Piranha V was provisionally selected for a FRES UV contract on 8 May 2008, its preferred bidder status was subsequently rescinded that December, with the MoD and GDUK unable to agree commercial terms for the future of the programme. At that point FRES UV was effectively dead.

#### More defence reviews

The 2010 and 2015 Strategic Defence and Security Reviews (SDSRs) sought to take in the lessons from the counter-insurgency

campaigns in Afghanistan and Irag. Meanwhile, the Army 2020 restructuring plan of the British Army, announced in mid-2012, proposed a Reaction Force, an Adaptable Force and a supporting Force Troops Command: a structure that was designed to fully integrate the army's regulars and reserves (which critics would claim was effectively papering over the cracks of a force reduction). However, Army 2020 did not last long before, under the 2015 SDSR and Army 2020 Refine plan, further revisions were made and the concept of medium-weight Strike Brigades was introduced. While the army was still determining how these formations would work, further changes to the UK military's structure came with the March 2021 Integrated Review, which was itself refreshed in 2023.

future armoured fighting vehicles.

As part of the 2021 Integrated Review the army announced a transformation plan called Future Soldier, intended to maintain the ability to engage in high-end conflict, including through leading contributions to NATO's warfighting capabilities, while also competing successfully in the 'grey zone' between peace and war.

#### **Future Soldier**

Under the British Army's current Future Soldier plans, billed as its most radical transformation in 20 years, the army says it will field a modernised, digitally networked warfighting division by 2030 in combination with a number of brigade combat teams (BCTs), designed as self-sufficient tactical formations that provide more options for decision makers. As the army itself describes them, "BCTs integrate the full range of capabilities but at the lowest possible level, including artillery, uncrewed aerial systems, cyber [capabilities], air defence, engineers, signals and logistical support". The army will also field the following formations:

- a Global Response Force (GRF) built around 16 Assault Brigade and 1st Aviation BCT (but reinforced with an additional infantry battalion, combat engineer squadron, Apache and Chinook helicopters, an artillery battery and close support logistics squadron);
- a new Army Special Operations Brigade established on 31 August 2021 that includes a new Ranger Regiment;
- 11th Security Force Assistance Brigade (SFAB), which will be persistently engaged across the globe to operate with conventional partners in permissive environments.
- The British Army's Field Army under Future Soldier will thus include:
- 1st (UK) Division, including 7th Light Mechanised BCT, 4th Light BCT, 11th SFAB, 19th Brigade (to command and force generate the Army Reserve combat units), 8 Engineer Brigade, 102 Operational Sustainment Brigade and 1st Division information manoeuvre units;
- 3rd (UK) Division, including 12th Armoured BCT, 20th Armoured BCT, 1st Deep Recce Strike BCT, 7 Air Defence Group, 25 (Close Support) Engineer Group, 101 Operational Sustainment Brigade, 3rd Division information manoeuvre units and 7 Signals Group;
- 6th (UK) Division, including Army Special Operations Brigade and the 77th Brigade, which is a combined regular



RAF A400M Atlas C.1. By the Mid-2007, it had become clear that a larger

aircraft than the C-130 would be required to transport the UK's planned



An Ajax vehicle being put through its paces at Kirkcudbright Ranges in Scotland in June 2023. Full operating capability for the British Army's Ajax vehicles is now slated to be achieved between October 2028 and September 2029.

and reserve unit focusing on non-lethal engagement, information activities and outreach;

 Field Army Troops, including 16 Air Assault Brigade; Intelligence, Surveillance and Reconnaissance Group; 2nd Medical Group, Cyber and Electro Magnetic Activities Effects Group; and the Land Warfare Centre.

A senior British Army source told ESD on 4 December 2023, "Defence is committed to ensuring that the army is combat credible, structured to meet its core purpose – being ready to fight and win wars on land – provide utility and credibility to NATO as a leading European ally, while still being able to operate globally in support of the United Kingdom's interests."

Focusing on the main warfighting division, the key platforms that will deliver the British Army's combat power will be the Rheinmetall BAE Systems Ltd (RBSL) Challenger 3 main battle tank (MBT), the Ajax family of tracked AFVs being produced by GDUK and the Boxer 8×8 multi-role armoured vehicle produced by the Artec joint venture formed by Krauss-Maffei Wegmann and Rheinmetall Landsysteme, along with long-range precision fires capabilities, Boeing AH-64E Apache Guardian attack helicopters and uncrewed aerial systems.

#### Ajax

Scout SV – what is now Ajax – emerged, Phoenix-like, from the embers of the FRES programme, with the MoD opting to concentrate its efforts on the tracked SV side of the FRES equation. GDUK was originally awarded a fixed-price GBP 500 million (EUR 571 million) contract for the demonstration and gualification phase of the Scout SV programme in July 2010. The company was then awarded a GBP 3.5 billion contract in September 2014 to deliver 589 Scout SVs to the British Army from 2017. At the time the British Army expected to equip the first squadron with the vehicles by mid-2019 and have an equipped brigade ready to deploy by 2020. The 589 Ajax AFVs are divided into what became seven variants: 245 turreted reconnaissance, surveillance and joint fire control vehicles armed with the CT40 40 mm automatic cannon and 7.62 mm coaxial machine gun (with these three types known as Ajax variants); 93 Ares armoured personnel carrier variants; 112 Athena command-and-control variants: 34 Ares formation reconnaissance overwatch variants; 51 Argus engineer reconnaissance variants; 38 Atlas armoured recovery vehicles; and 50 Apollo repair vehicles. All non-turreted Ajax variants will have a remote weapon station (RWS) capable of mounting a 7.62 mm or 12.7 mm machine gun or a 40 mm grenade launcher.

A key attribute of the Ajax reconnaissance variants will be an advanced all-weather intelligence, surveillance, target acquisition and recognition (ISTAR) sensor suite, including primary and secondary sighting systems provided by Thales UK; the primary sight can be replaced by an RWS where the operation dictates. Ajax's open digital architecture, meanwhile, will mean it has the capacity to evolve through the integration of emerging technologies. In June 2021, as Ajax development progressed, it emerged that issues with excessive vibration and noise had led to trials of Ajax variants being halted from November 2020 to March 2021. A statement by the UK National Audit Office in March 2022 referred to 136 issues with the Ajax programme and noted that the UK MoD's original capability requirements for Ajax were highly specified, "making Ajax more complex than other armoured vehicles".

GDUK has studiously kept its own counsel with regard to the issues with Ajax. Although many of the issues identified with the vehicle could be put down to the usual developmental challenges encountered with producing a new AFV, ESD understands that the numerous additional requirements requested from the UK MoD did not help the situation.

However, following a 22 February 2023 visit by then UK defence secretary Ben Wallace to Bovington Camp in Dorset, where he was shown an Ajax vehicle being put through its paces, Wallace said of the programme, "We think the remedies are in place, we are now going through the normal trials.... I am confident we have turned the corner on this troubled programme." Wallace added at the time that the aim was for Ajax vehicles to be active in military units soon after the test programme is completed in about 16 months (then circa July 2024). Full operating capability (FOC) for the Ajax vehicles is slated to be achieved between October 2028 and September 2029, according to an MoD statement in March 2023.

#### **Boxer**

Boxer's selection to fulfil the British Army's Mechanised Infantry Vehicle (MIV) requirement is effectively third time lucky in terms of this vehicle entering British Army service.

The UK had initially agreed to join France and Germany in jointly developing a Multi-Role Armoured Vehicle (MRAV) in 1996. However, France left the programme in 1999 to pursue its own VBCI programme, the Netherlands joined the programme in February 2001, and then the UK MoD announced it would withdraw from the programme in July 2003 to focus on FRES.

Boxer then made a brief appearance for the FRES 'Trials of Truth' in mid-2007 before again disappearing from the scene. In September 2015, however, General Sir Nick Carter, the British Army's Chief of the General Staff, announced at the DSEI defence exhibition in London that the army was back in the market for an armoured 8×8. This Mechanised Infantry Vehicle, the

general said, would operate alongside the Scout SV (renamed Ajax at that year's DSEI) in the British Army's future medium-weight Strike Brigades.

The UK MoD announced that it was rejoining the Boxer programme in March 2018, indicating that, having considered other 8×8 options, it had selected the Boxer to fulfil its MIV requirement rather than run another lengthy competition.

Meanwhile, Rheinmetall and KMW, as the partners of the Artec consortium, arranged for their UK-based subsidiaries, RBSL in Telford and WFEL in Stockport respectively, to take up Boxer production after the initial tranche of vehicles was delivered from Germany.

In November 2019 the UK MoD initially ordered 523 Boxers in four variants: infantry carrier, specialist carrier, command post vehicle and ambulance, with the latter having a raised roof to afford greater internal volume. In April 2022, however, the UK added a further 100 Boxers to its order for a total of 623 vehicles.

While the first 117 UK Boxers are being manufactured in Germany, UK production by RBSL and WFEL began in early 2023. Boxers bound for the British Army will be the latest A3 variants, which weigh 41



From the left: the Boxer, Piranha Evolution and VBCI contenders for the British Army's FRES UV requirement on Salisbury Plain, Dorset, in July 2007. While the FRES UV programme ultimately went nowhere, Boxer would return as the British Army's Mechanised Infantry Vehicle.

tonnes and feature an uprated MTU 8V 199 TE21 powerpack delivering 600 kW (804.6 hp): an improvement of 90 kW (120.7 hp) compared to previous variants of the vehicle.

Although the army will be receiving its Boxers as its fleet of Warrior IFVs go out of service from around 2025, the Warrior Capability Sustainment Programme having been cancelled in 2021, the two vehicles

are not directly analogous. As well as being tracked, for example, the Warrior IFV is armed with a 30 mm RARDEN cannon, while the UK Boxers will feature a Thales UK-supplied Protector RS4 remote weapon station (RWS) armed with a 12.7 mm heavy machine gun. Thales UK's GBP180 million subcontract for the RWSs also includes provision of the Acusonic shot detection system.

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A Boxer MIV undergoing trials at Millbrook Proving Ground, Bedfordshire, in July 2023. The British Army's Boxers are expected to enter service from 2025.

Boxer is thus not a direct replacement for Warrior, the IFV role of which is to deliver infantry mass onto or as close as physically possible to an enemy objective, while also possessing the weaponry to provide meaningful direct fire support.

One key feature of Boxer, not previously possessed in a British Army AFV, is that it is truly modular in nature; the vehicle's common drive platform can accept various interchangeable mission modules on its rear according to operational requirements. This means, for example, that an infantry carrier variant can be transformed with an hour under field conditions into any one of a number of different variants. Time will tell whether, beyond its initial procurement, the British Army – and indeed the other current and future Boxer users (Australia, Germany, Lithuania, the Netherlands and Ukraine) – can make full use of this novel capability.

Some sources have suggested that Artec, in facilitating so many permutations of Boxer, is building up logistical issues that will complicate the fielding of the vehicle. Artec executives have responded that, instead, they are more closely delivering precisely what their clients have asked for.

UK Boxer MIVs began industry trials at the UK's Milbrook Proving Ground in July 2023 and are expected to enter service from 2025.



An early version of a Challenger 3 prototype, photographed in April 2021. The first Challenger 3 prototypes are likely to be delivered to the British Army in early 2024.

#### **Challenger 3**

Unlike Ajax and Boxer, the Challenger 3 MBT is a direct upgrade of its predecessor, the in-service Challenger 2, with the programme previously starting as the Challenger 2 Life Extension Programme. The UK MoD awarded RBSL a GBP 800 million contract on 7 May 2021 to upgrade 148 Challenger 2s to the Challenger 3 configuration. On paper the British Army's Challenger 2 fleet stood at 227 tanks, but in March 2023 it was disclosed that only 157 Challenger 2s were available for operations, with the remainder having been cannibalised to support the rest of the fleet, while in January 2023 the UK government declared that it would send 14 Challenger 2s from the operational fleet to Ukraine. It can therefore be assumed that a number of Challenger 2s that are not operational will ultimately be used for the Challenger 3 upgrade programme.

Most notable among the Challenger 3's upgrades is the replacement of the Challenger 2's rifled 120 mm L30A1 main gun, which uses two-piece ammunition (sometimes referred to as three-piece ammunitions – somewhat erroneously since the vent tube is typically considered a part of the firing mechanism rather than the round itself), with Rheinmetall's 120 mm L55A1 smoothbore weapon, which uses one-piece ammunition. This gun, which will be housed in an all-new turret, will bring significant ammunition commonality with many UK allies operating the German Leopard 2 MBT.

As the senior army source noted to ESD, "Over 20 nations, including all of the UK's principal NATO allies, currently use 120 mm smoothbore guns, so we will have greatly improved interoperability with our allies.

"The new ammunition natures for CR3 are more capable than the existing ones and will make our tanks more lethal," the army source added. "The new Enhanced Kinetic Energy (EKE) ammunition and multipurpose round with point impact, delayed detonation and air-burst capability will be more lethal and flexible in use than their predecessors."

On 27 April 2023 DE&S announced that Germany and the UK will work together on the next phase of development for advanced armour-piercing tank ammunition for the Challenger 3 and Leopard 2 MBTs.

The Challenger 3 will also have new sighting systems to replace the Challenger 2's single thermal imager: two independent thermal imagers for the commander and gunner, an automatic target tracking system with widearea search and assisted-target-detection capabilities, and a new driver's sight with front and rear thermal imaging cameras. Regarding protection the Challenger will feature advanced armour, a laser warning system and the Trophy active protection system (APS). Trophy's Israeli manufacturer, Rafael Advanced Defense Systems, was awarded a GBP 20 million contract in July 2023 for long-lead items as the programme moves to the demonstration phase in 2024, having completed assessment phase trials on a Challenger 3-representative platform. "The Trophy APS is a big leap in the survivability of our vehicles," said the army source. "The system has been repeatedly proven to be effective against the rapidly proliferating threat of anti-armour weapons, which are a ubiguitous presence on the modern battlefield."

The Challenger 3 will also feature an opensystem vehicle architecture compared to the Challenger 2's closed vehicle architecture, along with new digital crew stations.

Mobility-wise the tank will feature thirdgeneration hydro-pneumatic suspension system to replace the Challenger 2's second-generation hydro-pneumatic suspension, certain upgrades to the engine with improved cooling, and is expected to have a reduced through-life cost as a result of these improvements. So far, however, no significant upgrading of the tank's powerpack is planned or likely, since this is not funded and presents a considerable technical challenge to retrofit.

All of the Challenger 3's upgrades are expected to come with a weight penalty of around one tonne, according to RBSL literature, raising the tank's weight to 66 tonnes, although this is not thought to include the weight of adding the Trophy system and an 'operationalised' tank is likely to weigh more through add-ons, such as an appliqué armour package.

In February 2023 the UK MoD announced it had approved the critical design review (CDR) for the Challenger 3 ahead of schedule. The first Challenger 3 prototypes are likely to be delivered to the British Army in early 2024.

#### **Future Soldier, future tactics**

The UK's nascent armour tactics will fit within the Future Soldier plans to combine reconnaissance and long-range precision strike and, as put in the summer 2023 edition of The British Army Review, lead to the "removal of the formation boundary between sensor-decider-effector" to effect the army's "first multi-domain recce-strike complex". This construct, as evidenced by the British Army forming the 1st Deep Recce Strike BCT in July 2022, is focused on "exploiting greater ranges and integrating capabilities from multiple domains to con-



A Warrior IFV exercising on Salisbury Plain in October 2023. According to the British Army, "an appropriate number of Warrior AFVs will remain in service until new concepts and capabilities are introduced into service throughout the decade".

verge effect against the enemy with superior tempo and in ever greater depth". Viewed in this context, it can be seen how Aiax – which is a 42-tonne vehicle compared to the eight-tonne Scimitar CVR(T) variant is a central component of the army's Future Soldier concept. As the army source told ESD, "The central Ajax platform is both a sophisticated sensor and a highly lethal effector in one package. The vehicle can operate in all weathers, 24 hours a day, providing an ISTAR capability that significantly improves the ability to take decisive action. Ajax's lethality, survivability and integral sensors are exponentially enhanced by its ability to connect cross-domain and with other army platforms, in which capacity it will be a net contributor to the multi-domain enterprise." Regarding Boxer, the army source told ESD that, as an infantry carrying - rather than fighting - vehicle, its role "is to rapidly transport infantry soldiers, at reach, to and around the battlefield, enabling them to conduct a range of dismounted infantry tasks, such as patrols, clearing complex terrain, raids or to occupy defensive positions". The Challenger 3 will naturally retain its MBT role as the UK's ultimate beast of the battlefield, while being more lethal, more protected, though not necessarily more mobile, than its predecessor.

Meanwhile, an upgrade to the army's Warrior IFV fleet announced on November 2023, involving the installation of a rear safety camera on 359 vehicles, indicated that the Warrior fleet will see extended service beyond its previously-scheduled retirement in 2025.

Regarding this the army source told ESD, "An appropriate number of Warrior AFVs will remain in service until new concepts and capabilities are introduced into service throughout the decade, ensuring operational requirements continue to be met. We will not provide information on the number of Warrior platforms that will remain available for operational deployments, as its disclosure would, or would be likely to, prejudice the capability, effectiveness, or security of the armed forces."

The source added that Warrior "will leave service this decade and the first Boxer vehicles will enter initial service from 2025. There are no plans to extend Warrior to 2030."

#### A new horizon

So yet another new dawn beckons for the UK's armoured formations, yet inevitably the vagaries of military geopolitics are not done with complicating matters and the lessons from the War in Ukraine, where significant types of medium and heavy armour have been deployed, will need to be accommodated.

The senior army spokesperson told ESD, "The conflict in Ukraine has provided a generational opportunity for us to test and adjust our understanding and approach to current and future war. Lessons from the battlefield have highlighted that data and lethality are central to modern warfare, but it has also shown that attrition remains a constant in the land domain."

With respect to key principles driving the Army's approach, the spokesperson concluded, "Modern warfare demands combat credibility and scale in warfighting forces, as well as the ability to rapidly generate sufficient capacity in both people and equipment to continue the fight. These remain core elements of both our approach to modernisation and the Future Soldier plan."

# Horizon scanning: the future requirements of AFV design

#### Sam Cranny-Evans

Looking out over the next decade, this article aims to identify some of the key trends and requirements which we are likely to see emerge in armoured fighting vehicles (AFVs) of the 2030s and beyond. While predicting the future can often be challenging, examining current trends in industry and on the battlefield can provide a number of useful clues as to the direction future AFV design may take.

he future requirements of armoured fighting vehicle (AFV) design in the next decade will differ from the past 108 years in three key ways. Artificial intelligence (AI) will become a valuable tool to overcome the challenges of dispersion and improve target engagement. Its use will likely grow in tandem with more advanced mission systems that are designed to bring closer coordination between front line units from the air to the sea. Together, they will drive a greater need for edge computing power. The second will be a requirement for a survivability matrix; a combination of protective systems designed from the outset around a variety of threats. Matrices will move away from the traditional front-loading of armour towards affording the vehicle 360° protection from all but the most capable forms of lethality. The third is that future growth will be built into the AFV with software as much as hardware. Software updates will provide more than the reduction in memory and changes to various apps that smartphone users are probably familiar with; it will be able to deliver fundamentally new capabilities, provided that the first point was properly addressed at the outset

How then, will these changes come about? Why aren't the next pages filled with comparisons of internal combustion engines against hybrids or conventional large calibre armaments to electromagnetic railguns? The answer to the second point is relatively

#### Author

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Current conventional lethality is sufficient for the battlefield, and it seems unlikely that this will change to the extent that new types of weapon are required.

simple. From a lethality standpoint, there are few targets on the battlefield that cannot be decisively engaged with the current arsenal of weaponry carried by AFVs. For main battle tanks, the 120 mm or 125 mm gun remains capable and very lethal. There is always scope for additional lethality against heavily armoured targets, but if that really becomes necessary, the Rheinmetall 130 mm gun or the Nexter Ascalon 140 mm designs will likely address the shortfall for Western nations.

For infantry fighting vehicles (IFV), the 30 mm cannon remains a formidable weapon that is difficult to defend against without driving vehicle weight up. If a 30 mm cannon is no longer sufficient, the readily-available 40 mm cannons on the market provide a marked increase in lethality without changing manufacturing requirements or – in the case of the  $40 \times 180$  mm 'Super Forty' cartridge – the internal layout of the turret. There are lethality gains left on the table in Russia, China and Europe. Russia has developed the 2A91 57 mm cannon

that arms its Derivatsiya-PVO air defence vehicle. The UK and France have developed the CT40 cased telescoped weapon system, which arms the EBRC Jaguar and Ajax reconnaissance vehicles. China has a similar development underway, although it has so far only known to have been demonstrated in a static firing position. All of these weapons would be capable of engaging almost any current non-MBT AFV from the front and defeating them at 1,000 m. They would also represent a significant challenge for an MBT from the side.

I know; railguns are exciting, as is Electrothermal-chemical (ETC) technology and the many other options touted as a replacement for conventional munitions. However, the truth is that these systems are fraught with developmental risk. Whilst they may offer lethality increases, they do so with an increase in the likelihood that a programme will fail or be delayed. Few defence departments have the stomach for this in the current climate when the available conventional weapons already meet most needs, and an increase in calibre can meet those that exceed current capabilities. This was true when Professor Ogorkiewicz discussed these technologies in his 2016 book *Tanks: 100 years of evolution*, and it is true now.

What about mobility? There are exciting possibilities for growth in composite rubber track (CRT) technology, especially if tracks can be produced that will bear MBT-like weights. Benefits include reduced road noise and increased speed, greater track life, reduced weight compared with steel tracks, and lower vibration. These are all good things and will improve the performance and use of tracked AFVs. However, CRTs will be hard-pressed to fundamentally alter AFV mobility off-road. There are efforts underway to explore hybrid electric drives for AFVs that will provide the power for energy-hungry computers and mission systems as well as reducing environmental impact. However, as is the case with CRTs, it is hard to see a way for a hybrid or even fully electric drive train to dramatically alter mobility performance. That is not to say that electrified drive trains will not be elements of future AFV requirements, simply that the onus will be on those manufacturers to prove that these systems can meet



US troops tested ATLAS (Advanced Targeting and Lethality Aided System) during Project Convergence in 2022. It used AI to enhance target detection rates and accuracy at greater ranges than the typical crew was capable of.

the mobility standards set by combustion engines. That said, some form of hybrid drive train will most likely be included in all future Western AFV designs as there is political impetus to do so.

A relatively reserved assessment of the prospects for AFV mobility is also necessary because much of a vehicle's ability to move over any terrain is shaped by physics and the interaction of a tyre or track with soil, rock, sand, or road. The heavier the vehicle, the more difficult it will be to guarantee mobility on wet soil, or in a town with weak and dilapidated infrastructure. There is very little that can be done to alter this from a drive train or track perspective when so much is decided by a vehicle's weight and size.





#### A shift in mindset?

What will drive the AFV design requirements of the next two decades? With the exception of countering IEDs in Irag and Afghanistan, many western AFV developments since 1990 have been capability-, as opposed to threat-driven. Manufacturers made suggestions for vehicle designs based on what was technically possible, and what the user thought they might want or need. This attitude is shifting to focus more on the threats that an armed force must counter, in part because those threats have changed significantly. Take ATGMs as an example; they were relatively rare until the Syrian Civil war started in 2011 and Iran, Russia, and the US began arming their preferred allies in the region with some of their best weapons. The weapons found their way into use with ISIS, and now the Houthis in Yemen are experienced users, as are Hezbollah and Hamas. ATGMs are here to stay and pose a considerable threat to current and future AFVs.

The use of small drones in combat has evolved, again since around 2011. Their use in Ukraine has brought drones into the limelight, but they were used extensively in Iraq and Syria by ISIS. The ability of small drones to damage AFVs at the asymmetric end of combat must also be considered alongside the lethality of loitering munitions such as Russia's Lancet-3M and armed drones carrying ATGMs at the peer-conflict end. A small drone modified to carry a grenade or fly an RPG warhead into a vehicle is limited by its own payload. Weapons developed by states typically carry warheads that approach the capabilities of an ATGM, making them a more potent if less common threat.

Outside of these technological threats, there is the very real prospect of state-on-state conflict. European states must consider how they will deter Russia. The US must prepare its armed forces to counter China and what role its AFVs will be required to play in the Indo-Pacific. It appears that many NATO states have lost their appetite for wars of choice in the Iraq/Afghanistan vein. However, if the current fleets of AFVs are indicative of service life, then AFVs designed in the next decade or two, should expect to serve into - or close to - the next century. Because of this, urban warfare against an asymmetric opponent is almost a certainty.

Overall, the AFV designs of the future must contend with a greater variety of threats than ever. On the one hand designers will need to revisit Cold War threats such as top attack sensor fuzed munitions, or extensive minefields with high density mine patterns, as well as the immense challenge of stopping the APF-SDS rounds fired by Russian and Chinese guns. On the other hand, those same vehicles will have to be capable of resisting the effects of ATGMs that are more accurate and lethal than ever, and the omnipresent threat of small drones carrying explosives and munitions against the traditionally vulnerable upper arc of an AFV. They will be required to do all of this and more in urban environments, which increase the need for 360° passive armour. Additionally, those designers will be addressing all of this inside the same constraints as the designers of the many World War II tanks; protection, mobility, and firepower. Each adjustment to one of these elements will have an impact on another. However, in line with the changing threat landscape





The IDF is the most successful and widespread adopter of APS. Its armour is also reflective of the shape of future AFV design requirements.

there are emerging technologies that will enable designers to address these threats without building a modern-day equivalent of Nazi Germany's Maus.

#### A survivability matrix

This connects neatly with the first element of future AFV requirements that is almost certain to reflect a real change and growth from past design requirements and that is the survivability matrix. Future AFV reguirements will require the combination of passive and reactive armour in many cases, with an active protection system (APS) capable of data sharing with other vehicles, upper-hemisphere protection, and a mission system suite that boosts situational awareness. Combining all of these protective systems into a single matrix will provide greater survivability against ATGMs and shoulder-fired anti-tank weapons as well as drone-delivered munitions. Furthermore, it will extend protection through vehicles automatically supporting each other and enabling engagements to take place at greater range.

Many vehicles are fitted with an APS, from the Trophy that protects Merkava Mk 4 to the Abrams M1A2 SEP v3, to the Rheinmetall StrikeShield that can be fitted to vehicles such as Boxer, which uses effectors located around the vehicle that are integrated into passive armour blocks. Following tests, the US Army also plans to equip a brigade of Bradley IFVs with the Elbit Iron Fist Light Decoupled APS by 2025.

However, in most cases the APS is retrofitted to these platforms with knock-on effects for its balance or the turret drives. There are also compatibility issues that result from the interception efficiency of the APS. If the projectile creates by-products (such as fragments) upon interception, the vehicle requires a certain level of base armour to withstand and absorb those by-products. If the armour is too light, then the projectile may still have an impact upon the vehicle and crew. This could be accounted for in the design of the vehicle by installing the APS as part of the vehicle's construction from the start. Hanwha took this approach in the design of its Redback IFV that was selected by Australia for its Land 400 Phase 3 programme in 2023.

A built-in APS allows other design decisions that can improve protection. For example, if the efficiency and magazine depth of the APS are considered sufficient, a manufacturer can choose to design the vehicle armour only around kinetic energy threats. At present, most AFVs must balance kinetic energy (KE) threats such as armour pierc-



This image portrays sensor fusion on a Typhoon. Note how multiple sensor feeds covering different parts of the spectrum are consolidated into a set number of tracks represented by the green triangles. This form of sensor fusion technology is equally valuable to land forces operating in dispersed environments.

ing fin stabilised discarding sabot rounds (APFSDS) with chemical energy threats otherwise known as high explosive antitank (HEAT) or shaped charge threats. Theoretically, both defeat a vehicle using kinetic energy, and both derive their kinetic energy from a chemical energy source, but HEAT rounds generate that energy at the point of activation. It is possible to balance the armour of a vehicle to withstand both. but not optimal. For example, explosive reactive armour (ERA) designed to counter HEAT projectiles will employ a thinner flyer plate that disrupts and destabilises the jet. The same armour designed for a large calibre APFSDS will need to employ a much heavier and thicker flyer plate that transfers stress to the projectile, as well as moving additional armour into its path.

So, if an APS can be considered sufficiently capable to defend against HEAT threats, the armour of choice could be focused on KE and optimised to defend against it. Or, if an APS can successfully intercept an APFSDS round, as demonstrated by Elbit with their Iron Fist Light Kinetic in 2020, the passive armour could be reallocated to provide greater protection to all sides of the vehicle and improve its survivability in urban environments. This design approach could serve to drive vehicle weights down, or return designs to weights that are more easily supported. One further element to

consider is the role of modular APSs. The UK's DSTL is exploring this through the Modular Integrated Protection System architecture, which is designed to demonstrate the ability of proven technologies and capabilities to be integrated into an APS. It includes software and hardware, and the programme is exploring the possibility of sensor fusion and data sharing between APSs. If successfully developed, this could provide vehicles with an element of upperhemisphere protection from drones and munitions. Sensor fusion and data sharing between platforms might even allow for a greater warning time of an approaching drone or loitering munition.

## What of artificial intelligence?

At a conference in 2023, one US attendee told this author, 'Your senior officers seem to sprinkle AI over everything like it will fix all of their problems.' He was not wrong in his assessment, discussion of the role of AI in defence often lacks any real-world explanation of how it can help. For AFVs there is one clear use case that is already viable, but will become more so in the near future, and that is sensor fusion. Sensor fusion is not the latest buzzword, it is a real thing that is already practised by commercial companies. The most prominent use case is in driverless vehicles, which must fuse data from LIDAR, cameras, and radars to form a single unified image of the environment around the vehicle so that its computers can make better decisions. The use case for AFVs is much the same, however, humans are required to make the decisions.

A driving factor in this development is the role of dispersion in modern warfare. From Afghanistan to Ukraine, armed forces are being dispersed over much larger areas than they would normally contest. It is not uncommon to see Ukrainian trenches defended by two or three personnel, for instance. The dispersion and distance between units generates a demand for more ISR assets so that the dispersed units can understand the world around them and the space between them and their nearest friendly unit. However, this in turn leads to many different pictures of the battlefield and difficulty in sharing that data between units

Sensor fusion enabled by AI could help address this need in future AFVs. Sensor fusion algorithms work by taking data processed on one sensor – on a drone for example – and sending it to another platform. This is known as decentralised sensor fusion and requires additional computing power deployed to edge platforms. Furthermore, providing an AFV with its own edge computer capable of running sensor fusion AI of-



The Ajax was built to include software-defined upgrades. GDLS announced that it was seeking such upgrades in 2020.

fers future benefits; AI can be used to track objects and their trajectory to provide more accurate fire control solutions.

Put simply, sensor fusion at the edge of the battlefield would enable one vehicle to detect a tank moving across the front and pass data about that vehicle to another platform that cannot see it. Upon detecting that tank the second vehicle's computers would recognise the vehicle and update its situational awareness to reflect it as the same vehicle. In current environments it is not uncommon for one tank observed by two different vehicles to be reported as two tanks, for example. This appears to be the goal of the Thales Combat Digital Platform, which uses AI to fuse data inputs from a variety of sensors and present it to all echelons.

Theoretically, this concept could be taken further to allow platforms across domains to cooperate and share data. It was taken to an extreme by the US Army under Project Convergence; one trial involved spacebased sensors providing targeting data to a modified howitzer through AI-enabled data centres. In other trials, AI has helped coordinate air defence engagements between ground-based Patriot batteries and F-35s. The US developments in the field of AI as a tool to improve data sharing between disparate platforms and improve target engagements is indicative of what might be possible for future AFV designs. However, it is essential that sufficient computing power that is built for AI is a part of future AFV requirements, otherwise this potential will not be realised.

#### Software defined defence

Most modern combat systems are already heavily dependent on software, 80% of the F-22's functions are performed by software, for instance. The F-22 entered service in 2000, so why is software referenced here as an element in future AFV design requirements? Firstly, AI requires software, it pro-

am



The Type X shown here is an unmanned combat vehicle. Many feel that this represents the future of land warfare. Others disagree. Either way, the design requirements when it comes to computing power are similar to those of manned platforms.

vides the user interface that the operator interacts with and is a significant part of how effectively an algorithm can be used. Secondly, many subsystems within the defence world are also software defined, from engines to sights. This is driven in no small part by the world's shift towards software defined systems as a whole; this article was written on a software defined network infrastructure. Many people now carry watches that are software defined, instead of the mechanical mechanisms that have made watches work for the past century.

Often these software systems fail to offer a new capability. A digital heating system is marginally more convenient than a conventional thermostat, but it ultimately turns the heating on and off, sometimes remotely. However in AFVs, it would be possible to build new capabilities into a platform through software updates. For instance, a link between the vehicle's battle management system and a supporting drone could be created, allowing the vehicle crew to benefit from the drone's enhanced viewpoint. Expanding this concept, software is essential to the networked systems of systems envisaged by most Western forces. It was key to the air defence and indirect fires examples in the previous section. Through application programming interfaces (APIs) different platforms can be connected and empowered with AI and greater computing power to share and understand more data than ever. Again, APIs are not new, APIs in AFVs are not entirely new. However, harnessing the growth and miniaturisation of computing power, along with relatively recent developments in neural networks and AI provide new opportunities to AFV designers. The requirement for AFV designers is that a vehicle should have a genuinely open system architecture with customer-defined and owned APIs.

This allows any selected company to develop software to upgrade the vehicle's systems. The possibilities are considerable; a vehicle could be purchased in a relatively simple configuration, with automated target detection added at a later date when it is considered sufficiently evolved by the user. New types of vehicles and drones could be introduced into service and connected to the AFV fleet through software. A vehicle's targeting algorithms could be updated to allow for engaging a new type of target or responding to changes in target behaviour. General Dynamics UK had embraced this concept with Ajax in 2019, however, the ensuing challenges with the vehicle's maturation has obscured this.

Nevertheless, a move towards software defined AFVs is underway. Together with AI, software is critical to concepts such as manned-unmanned teaming that the US and others have identified as definitive in future warfare. Consider, for example, the impact that a completely autonomous drone providing target data to a fleet of AFVs and supporting fire assets could have.

#### In sum

You may realise that much of what has been discussed above is already emerging within the current generation of AFVs. The AbramsX is slated to carry AI-enabled command and control (C2), an unmanned turret, and the ability to deploy and operate drones. The KNDS Main Ground Combat System pursues similar concepts, and even the Russian T-14 Armata claimed to have many of these capabilities. There are inservice vehicles with these capabilities so, how are they the requirements of future AFV designs? Put simply, the three requirements identified here represent the author's assessment of what will be definitive, as opposed to marginal, in their ability to improve combat outcomes.

Bigger guns and more advanced ammunition can be fitted to AFVs, but the capacity to do so is finite. A 140 mm gun has been fitted

and test-fired on a Leclerc hull, but the video footage of it firing does not suggest that it is necessarily an optional solution. A 130 mm gun is more viable, but as stated above, the current lethality of AFVs is guite considerable and already addresses most threats. Equally, mobility is undergoing some modernisation through hybrid propulsion and smaller powerpacks delivering like-for-like capability at a smaller footprint and total weight. This allows reductions in vehicle weight and armoured volume, but does not change the properties of soil. It might lead to an MBT with improved off-road mobility compared with the 70-tonne monster it replaced, but it will not lead to fundamentally new off-road performance that cannot already be achieved by something akin to a CV90.

However, a survivability matrix that is built from the ground up to be modular and include an APS will greatly enhance the ability of an AFV to survive and fight in future wars. Enhanced with AI and advanced sights, the crew will theoretically be able to understand their environment to a greater extent than any of their predecessors whilst sharing their understanding with a network of other platforms that is only limited by the range and bandwidth of its communications network, and the computing power that they carry. All of these elements combined would potentially represent a significant shift in how AFVs fight, and the impact that they can have on a battlespace.

There is one final element to address, which is the question of unmanned elements: unmanned turrets, unmanned ground vehicles, and so on. These have not been addressed as separate entities because it is not possible to have an autonomous unmanned ground vehicle without AI and enormous computing power. While they may be considered 'expendable', the cost of developing these platforms to a standard where a Western force would be content to deploy them is likely such that they will be similarly protected to their crewed partners.

So, in sum, these are the three areas that this author believes will represent a fundamental shift in how AFVs are designed and how they operate. Everything else is of course important; you can't have a tank without tracks and a big gun, no matter what some might think. Yet in the quest to attain an advantage over opponents, and competitor manufacturers, it will be the designs that harness AI, software, and layered survivability matrices to the fullest extent that gain the edge.

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# Assessing armoured vehicle requirements for strategic power projection

#### **David Saw**

Armoured vehicle design is based on the so called 'iron triangle' of firepower, protection and mobility. The most successful vehicles are those that achieve the best balance between these three criteria. Other factors come into play though, including the operational doctrine of the operator driving the specifications of the vehicle, the tasks that the vehicle is expected to perform and the industrial capabilities of the user in terms of design, development, manufacturing and long-term support.

Dut simply, designing an armoured vehicle is a complicated process and despite armoured vehicles being designed and developed for over 100 years, the possibility of failure remains ever present. Not every country can call on an indigenous armoured vehicle design, development and manufacturing base. In these conditions, the country needs to acquire its armour from foreign suppliers and then look to adapt it to meet its needs. Obviously, in an ideal world, an army would prefer to obtain a vehicle perfectly adapted to meet its operational needs from in-country suppliers; in this environment, long-term support and vehicle upgrade possibilities would be implicit. However, being realistic means looking for practical solutions in terms of armour acquisition.

#### **Acquiring capability**

Australia provides an excellent example of meeting armoured vehicle capabilities by acquiring foreign vehicles, while at the same time making the establishment of an indigenous industrial capability for the manufacture and support components of the acquisition programme. Under the LAND 400 Phase 2 programme, Australia signed a contract with Rheinmetall in August 2018 to acquire 211 Boxer armoured vehicles. A key element of the contract was the establishment of the Military Vehicle Centre of Excellence (MILVEHCOE) in Ipswich, Queensland, in partnership with the Queensland State Government. MILVE-HCOE would 'finalise' the 25 Block 1 Boxer vehicles supplied from Germany prior to delivery to the Australian Army; it would then be responsible for the manufacture and delivery of 186 Block 2 Boxer vehicles, as well as long-term Boxer support.

LAND 400 was an extremely ambitious programme; the Phase 2 Boxer acquisition



This image shows one of Australia's first batch of Boxers in the Combat Reconnaissance Vehicle (CRV) variant, fitted with the Rheinmetall Lance 1.0 turret, and armed with the MK3-2/ABM 30 mm automatic cannon.

was followed by the Phase 3 part of the programme, which covered the replacement of the M113AS3/AS4 APC and its variants, with a modern infantry fighting vehicle (IFV). The same logic applied in this acquisition, with local manufacture and support being a key element of the programme. Originally the intention had been to acquire up to 450 IFVs, as well as 17 manoeuvre support vehicles (MSV), the latter being a combat engineering vehicle based on the selected IFV's base platform. Subsequently, the Australian Army looked to expand the scope of the programme with the acquisition of mortar carriers, mortar ammunition carriers and logistics vehicles, again based on the IFV design.

Unfortunately for the Australian Army, as it was looking to bring its LAND 400 Phase 3 to a conclusion, the Australian economy took a downturn, putting pressure on the defence budget. A new government instituted a 'Defence Strategic Review (DSR),' which recommended that the LAND 400 Phase 3 acquisition be dramatically reduced to 129 IFVs. Hanwha Defense Australia (HDA) and their AS21 Redback IFV were selected for the programme, with the vehicle to be manufactured by HDA at their local facility in Geelong, Victoria. This facility is also responsible for the manufacture of 30 AS9 Huntsman self-propelled artillery systems and 15 AS10 armoured ammunition resupply vehicles being acquired under the LAND 8116 Protected Mobile Fires programme.

The LAND 400 armoured vehicle acquisition programmes represented a major capability gain for the Australian Army. They also have an important strategic element; deployment across the Australian landmass covers strategic distances and often over complex terrain and in areas with limited transport infrastructure. The DSR referenced the requirement for littoral manoeuvre operations by the Australian Army; implicit in this is the requirement to deploy beyond Australia, a clear endorsement of strategic power projection. LAND 400 is an example of how existing armoured vehicles can be specified by export customers for requirements that include a strategic power projection element.

Adapting existing vehicles to meet national operational requirements is the path that most nations will have to follow, but not everybody will be able or willing to include an armoured vehicle industrialisation element for local manufacture and support as Australia has done. For many, it is a matter of operating within available budgets, or perhaps deciding that strategic power projection is and will remain far beyond national capabilities. If a requirement to deploy strategically did emerge, in those circumstances it would be necessary to piggyback on the capabilities of allied or friendly nations for transport to the area of operations and subsequent support. Such situations are certainly common for smaller European nations that look to participate or are, perhaps, leaning towards participating in international operations for peacekeeping/peace-making missions.

#### **Operational requirements**

The requirements for designing an armoured vehicle are predicated on the operational environment that those specifying the system anticipate fighting within and the doctrine that they intend to employ in combat operations. Matters would be very simple indeed if an armoured vehicle was to be used solely in a limited geographically defined area with relatively benign environmental factors to be considered. Sadly for those looking for simple solutions, the majority of armoured vehicles today should be able to operate in the widest possible spectrum of geographical and climatic conditions.

Another set of factors come into play when looking at the operational requirements to cope with anticipated threat levels. With armoured vehicles, if peer or near-peer level opponents are to be confronted, this represents a key factor in how a vehicle's firepower, protection and mobility characteristics are balanced. Moreover, the threat never remains static, hence the need for a growth margin in the vehicle design to accommodate upgrades, such as additional protection and the implications that might have on other vehicle characteristics such as mobility.

To further complicate matters, the need to operate in unexpected environments against constantly-evolving threats presents new challenges in armoured vehicle design. For the majority of the past 20 years, Western militaries have found themselves embroiled in asymmetric conflicts from Africa, to the Middle East and to South Asia. Initially, it was assumed that these conflicts were essentially counter-insurgency campaigns, something that was familiar to these militaries in the post-1945 era. In these circumstances, existing armoured vehicles were seen as adequate, with an emphasis on light armour, as the threats were not deemed sufficient to warrant heavier protection.

Of course, Western militaries soon discovered that they were not dealing with the post-colonial insurgencies of yore, as the threat was far greater and opponents far better-equipped than anticipated. Operations in Iraq and Afghanistan demonstrated that insurgents had access to light anti-armour weapons, mines and the ability to construct increasingly sophisticated improvised explosive devices (IEDs). This

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A Bundeswehr Wiesel 1 TOW vehicle launches a missile during a live firing exercise. In the final analysis, light armour is the only choice for truly rapid intervention over strategic distances using airlift. But, will these light vehicles have enough protection and firepower to survive once they arrive?

gallery of threats guickly rendered much of the light armour considered adequate for counter-insurgency missions dangerously redundant. In turn, this created a demand for more effectively protected vehicles, eventually leading, amongst other things, to the widespread adoption of a new vehicle category - the mine resistant ambush protected (MRAP) armoured vehicle.

The asymmetric conflicts in Irag and Afghanistan also saw major developments in vehicle protection of in-service armour; the evolution of the British Army Warrior IFV in this context is noteworthy. The

Credit: Crown Copyright



In 2011, the British Army fielded the TES(H) (Theatre Entry Standard - Herrick) upgrade of the Warrior IFV with major protection enhancements for Afghanistan, bringing vehicle weight to near 40 tonnes. Shown here are, much lighter, standard configuration Warriors training in Germany during Exercise Iron Storm 2023.

Warrior entered service with the British Army in 1986, and at that time its vehicle weight was some 25 tonnes, with the armour designed to survive 155 mm artillery fragments and 14.5 mm AP rounds. Warrior first saw combat in January 1991 as a part of Operation Granby to liberate Kuwait, with vehicle protection increased by the addition of an appliqué armour package developed by Vickers Defence Systems which was installed on-site in the Middle East.

Warrior's protection would grow dramatically in the 2000s to meet threats encountered in Iraq (Operation Telic) and then in Afghanistan (Operation Herrick). In late 2007, Warrior IFVs in Iraq had the WRAP 2 armour package fitted with the installation conducted in Kuwait; this consisted of explosive reactive armour (ERA), slat armour and ECM equipment amongst other additions. Warrior IFVs arrived in Afghanistan in 2007 and their protection levels were incrementally upgraded beyond WRAP 2 standards to meet evolving threat levels. The downside of this was increased vehicle weight and this started to impinge on vehicle mobility. This set the scene for what might be described as the 'ultimate' Afghanistan Warrior upgrade.

This new upgrade programme was known as Theatre Entry Standard - Herrick TES(H),

with 70 Warrior vehicles going through the upgrade process. The objective was to improve protection, restore mobility and increase reliability. As previously noted, Warrior originally weighed in at roughly 25 tonnes, with the first raft of protection upgrades seeing a weight increase to 30 tonnes and by the time TES(H) came on the scene, Warrior was a nearly 40-tonne vehicle. Mobility enhancements included suspension and ride-height modifications, final drive changes and improved brakes, modular armour additions, air conditioning and numerous other changes.

The TES(H) Warrior performed well in Afghanistan, with the only downside being the question of weight. The modular armour package in TES(H) could be downscaled to reduce weight, but there were risks involved in reducing protection. Deploying a TES(H) specified Warrior in a hurry over strategiclevel distances was also difficult, as the only British military asset capable of lifting it was a C-17 transport aircraft. If the British Army found itself looking to deploy a reasonable force with armour and heavy weapons capabilities over a significant distance, such a force would quickly deplete British strategic air transport capabilities.

#### **Deployability** and pre-positioning

Ultimately, the issue of deploying armour over strategic distances is down to the time available and the amount of weight to be moved. Other issues need to be taken into account if light armour is to be made easier to move, but if it is overmatched by the threat it is going to meet once deployed, there is little point in moving it at all. To



Two Stryker armoured vehicles of 1st Stryker Brigade Combat Team, 4th Infantry Division, loaded on to a US Air Force C-17 transport aircraft on a lift from Colorado to the National Training Center in Fort Irwin, California. US strategic airlift capabilities are unparalleled, as other nations have to cope with significant lift limitations.

develop a vehicle capable of being used as a part of strategic power projection will still require that the classic compromise between firepower, protection and mobility is successfully achieved. However, designing a successful vehicle that meets all desired operational criteria in a weight and dimensionally restricted package will always be incredibly difficult.

There are other options to provide strategic power projection possibilities for armour and these are well proven. A case in point is the US Army Prepositioning Strategy and Prepositioning of Materiel Configured in

Unit Sets (POMCUS) programme, more recently referred to as Army Prepositioned Stocks (APS). During the Cold War, the US Army would need to rapidly reinforce its forces in Germany and this could not be achieved by shipping troops and equipment from the US. Instead, the US and other NATO members paid for the establishment of POMCUS sites where divisional sets of equipment could be kept in controlled storage conditions, with personnel on-site to conduct equipment maintenance for the equipment to be kept in battleready condition. All that was needed was





British Army armoured vehicles await loading on a commercial Ro-Ro ferry at the Sea Mounting Centre, Marchwood, in southern England on their way to a major NATO exercise in Estonia. This sealift crosses the Channel, followed by land transportation to Estonia is not exactly rapid deployment.

to fly the personnel from the US to operate the equipment. The utility of POMCUS was proven by the annual US Army Return of Forces to Germany (REFORGER) exercises. During Operations Desert Shield and Desert Storm in 1990/91, equipment from POMCUS locations was transported by air and sea to the Middle East and prepared for combat operations. In the aftermath of the first Gulf War, the US Army established POMCUS, by that point known as APS, in Kuwait and Qatar to support future combat operations. These APS sites played a critical role as US forces returned to the Middle East in 2003 for Operation Iragi Freedom. Post-2003 equipment at these APS sites was used later to support combat operations in both Iraq and Afahanistan.

Having equipment stockpiles in the potential area of operations and using that equipment in periodic reinforcement exercises, demonstrates ongoing commitment to security in a region, as well as providing the basis for a rapid response to a crisis situation. Having heavy equipment at hand for large-scale, ground combat operations (LSGCO) also acts as a deterrent. Placing APS locations in Europe, the Middle East and Asia arguably provides a far more robust structure for strategic power projection instead of relying on shipping personnel and equipment over strategic distances via airlift or sealift.

The APS strategy is not without its faults, as there is always the danger that equipment in store will be used to equip new units and will never be replaced at the APS, something that has already occurred. Organisational and budgetary issues have also impacted the utility of the APS strategy; examples of this are maintenance being deferred leading to equipment unserviceability at APS sites and consequently not being fit for issue. If sites are kept properly stocked and managed, the APS concept remains one of the most logical solutions to provide the basis for strategic power projection.

#### **Systemic issues**

In the final analysis, there are still guestions that need answering regarding the movement of armour and ground forces across strategic distances in pursuit of power projection objectives. These include the distance to be covered and the speed needed for the planned movement. Then comes the crux of the matter which relates to the opponent to be deterred or fought and their level of threat. If the threat environment features potentially confronting a peer or near-peer competitor in a high-intensity conventional conflict environment, then heavy armour, artillery and other highend capabilities are needed. That means undertaking a major logistics challenge in delivering heavy equipment in a timely manner to where it is needed and in fighting shape on arrival. Beyond that is the need to sustain operations, another equally burdensome logistics challenge. Within Europe, strategic movement of armour from the western to the eastern boundary of NATO will inevitably make heavy use of railway transport. European armies have planned on using rail transport for major troop and materiel movements since the middle of the 19th century. The challenges involved and the requirements for successful utilisation are well known, although railways remain vulnerable to disruption by both covert and overt means.

For strategic-level movements of heavy forces further afield, it is a matter of sealift. Organic military sealift assets are massively reduced compared to those of the Cold War era, as it is now a matter of acquiring commercial shipping assets such as car carriers and large 'roll-on, rolloff' (Ro-Ro) ferries to move heavy units. Obtaining suitable commercial vessels, having them move to the appropriate ports, correctly loading the vessels, arranging movement instructions and timetables, plus providing a suitable escort to the destination port all takes time, with more time required to unload, organise and then begin movement to operational locations. Sealift is still responsible for the majority of world trade and there is no substitute for sealift in moving bulk cargo, but this is not a rapid response option in terms of power projection.

This brings us to airlift, which is clearly the optimum response if rapid power projection over strategic distances is required. The problem here as far as Europe is concerned is that they are limited in terms of suitable military airlift assets, with the Boeing C-17 and Airbus A400M being the most useful options. For larger loads, it comes down to utilising the few commercial An-124 aircraft in Europe though Russian-owned aircraft of this type are obviously out of the question, or looking to US support in the form of C-5 missions. Currently, Europe possesses enough available military airlift capacity to rapidly move a tripwire force with some light armour to act as a deterrent, secure ground locations, such as a port, to await the arrival of the main force by sea for example. However, a tripwire force would be extremely vulnerable until reinforced.

If there is a requirement to have a power projection capability that can rapidly move a viable force over strategic distances, then there needs to be a rethink of what kind of armour capability is essential to cope with the majority of threat scenarios. While it would be attractive to rapidly move top-of-the-range 60-70 tonne tanks in serious numbers along with all their required support, as well as IFVs, artillery systems and other assets to deter or project power, it is just not possible under current circumstances.



Formerly called the Mobile Protected Firepower system, the M10 Booker is a 38-tonne vehicle designed to provide a mobile direct fire support capability. Built by General Dynamics Land Systems (GDLS), some 500 vehicles are required by the US Army.

#### The future

Looking ahead, technology may yet provide crucial answers to in terms of providing a viable armour solution to support strategic power projection requirements. The true next generation of tanks is characterised by solutions such as the proposed Franco-German Main Ground Combat System (MGCS) which is now scheduled to enter service at some point between 2040 and 2045. A number of future concepts have been discussed in the context of MGCS. which include unmanned ground vehicles (UGV) and autonomous systems operating as part of a constellation or 'system of systems'. Other developments include looking to fire support vehicles lighter than tanks. A notable recent example is the M10 Booker, selected under the US Army's Mobile Protected Firepower (MPF) programme, which

promises to provide much-needed capability while being more suited to rapidly deploy to remote locations than its heavier counterparts.

Looking beyond the aforementioned programmes, technologies such as UGVs, autonomous systems and secure operational networks provide the basis for the development of lightweight armour solutions that could be rapidly transported by air to potential zones of conflict at strategic distances. Suitably-equipped UGVs and autonomous systems interlinked with robust command and control systems could potentially have the capability to deter or confront hostile heavy forces. Such a capability could also have the ability to hold ground until the main operational force arrives by sea.

The future course for armoured systems to meet the requirements of strategic power protection is more capability,

though with much less weight. This will potentially allow more armoured systems to be deployed, thereby reducing risk in conventional, asymmetric, peacekeeping and peace-making mission environments. UGVs and autonomous systems can provide the solution for more capability at lower weight, with the added bonus that they could offer a reduced need for personnel to be deployed in hazardous situations.

In the meantime, until technology alleviates the weight versus capability problems, mission planners should be very careful in assessing the operational environment that armour is committed to if power projection missions are undertaken. The human cost of the erroneous assumption that light armour was perfectly adequate to deal with the threats encountered in Afghanistan should never be repeated.



## Active protection systems: an overview

#### Sidney E. Dean

Armed forces continue to pursue active protection systems (APSs) capable of effectively defeating anti-armour weaponry. As many different designs have completed their development, the current APS market offers users more options than ever before.

he high numbers of damaged or destroyed armoured vehicles suffered by the warring parties in the Ukraine War underscores the urgent need for improved vehicle protection. Adding more and better armour is one possible approach, but the increased weight and bulk invariably interfere with mobility and add stress to the chassis and drivetrain. For years, users and industry have pursued APSs as an alternative or adjunct to additional armour. Like armour, APSs are intended to protect the vehicle on which they are mounted. although protection of nearby vehicles is being examined as a further capability enhancement. Unlike armour, however, they are designed to intercept or divert incoming anti-tank ordnance before impact – a so-called 'left of boom' approach.

APSs are generally divided into two categories: hard-kill and soft-kill. The majority of APSs are hard-kill systems. These typically work by using an explosive effector to defeat the incoming anti-tank projectile, detonating in close proximity to it in order to destroy or deflect it, and thereby minimising its effect on the protected vehicle. This can be achieved in several ways.

One common approach for hard-kill APSs is to use one or more rotating launchers armed with small interceptor grenades on the host vehicle, which launching a projectile at the incoming threats to defeat it at a distance from the vehicle. Examples of this type of APS include the Elbit Systems Iron Fist and the Aselsan Akkor. Another approach is to use distributed static effectors all around the vehicle, which detonate to defeat the threat when it is very close to the vehicle. Examples of this type include Mikrotek Zaslon (along with the Aselsan Pulat based on the Zaslon design) and the Rheinmetall Strikeshield. This latter approach relies more on passive armour to absorb residual blast and fragmentation, however, it can be particularly advantageous in urban or forest environments with limited line-of-sight to conduct interceptions further from the vehicle.

Soft-kill APSs utilise a variety of methods to divert an incoming missile from its target without actually intercepting the weapon. These can be as simple as deploying a smoke screen, to jamming semi-automatic command to line-of-sight (SACLOS) guided projectiles. More complex approaches utilise electronic warfare (EW) technology to disrupt radar-based seekers, or laser 'dazzlers' to blind optically-guided munitions.

## North American developments

The US armed forces have displayed great interest in acquiring APSs for their various armoured vehicles, most notably the M1 Abrams main battle tank (MBT), the M2 Bradley infantry fighting vehicle (IFV) and Stryker infantry carrier vehicle (ICV) families. However, very few US firms are developing their own active protection systems. This was not always the case – during the early-mid 2000s, interesting efforts such as Raytheon's 'Quick Kill' and US branch of BAE Systems 'IAAPS' and 'CICM' APSs, among various others, were in development. However, ultimately none of these designs progressed to entering service. As such, most APS solutions now under consideration by the Pentagon are foreign designs, such as Rafael's Trophy system, which is being integrated onto the Abrams MBT by Leonardo DRS.

#### Artis – Iron Curtain

One exception to the foreign technology trend is Virginia-based Artis LLC, which began developing the Iron Curtain APS in 2004. This distributed hard-kill system was tested on the M-ATV MRAP and the Humvee, and was provisionally selected as an interim solution for the Stryker in 2016. However, the Army dropped it from consideration in August 2018 following evaluation trials on the Stryker. According to Army statements at the time, the Iron Curtain was generally considered viable and was able to hit its targets, but lacked adequate maturity; the service was unwilling to invest the time and resources necessary to bring it up to speed. A 2019 Army statement clarified that the system remains a viable option for future consideration.



In the meantime, the firm has pursued an upgraded version dubbed the Improved Iron Curtain or I2C, which offers enhanced performance while reducing size, weight, power consumption and cost (SWAP-C). The modular, shelf-like components can be mounted on any vehicle frame, as well as on buildings or other infrastructure, to provide protection from top- and side-attack. The system is effective against rocket propelled grenades (RPGs) and anti-tank guided missiles (ATGMs). I2C detects incoming projectiles via radar and initiates the countermeasure when the threat is only centimetres from the vehicle. The system includes both upward-firing and downward-firing effectors, an arrangement which allows for protecting against both direct-fire projectiles as well as some types of top-attack projectiles. By engaging the threat at a very short distance from the vehicle, this arrangement also reduces the risk of injury to dismounted personnel or civilians who could otherwise be in the line



Concept of the US Army's future MAPS/Vehicle Protection System mounted on a Bradley IFV.

of fire. The system is also intended to deflagrate rather than detonate the warhead of incoming shaped charge threats, to further reduce the risk of collateral injuries.

#### Lockheed Martin – MAPS

Artis states that the I2C is compatible with the modular active protection system (MAPS) being developed by Lockheed Martin Missiles and Fire Control as part of the US Army's overarching future vehicle protection system (VPS). MAPS is conceived as an open architecture system with a common controller to be mounted on various combat vehicles. It will be capable of simultaneously integrating various hardand soft-kill countermeasure technologies, including the interim measures such as Trophy and Iron Fist currently being pursued. It is designed to adapt over time in order to accommodate vehicle development as well as incorporate new defensive technologies as they mature.

As described by Lockheed Martin, the firm's MAPS base kit integrates sensors and countermeasures in an open, common framework to detect, track, classify and defeat existing and emerging threats such as RPGs and ATGMs. The open and scalable architecture provides the ability to exchange individual components of a vehicle protection system rather than replace an entire configuration. This will enable faster and cheaper upgrades by replacing only those elements which need to be exchanged in order to counter new threats. The open architecture will permit interfacing components from various developers without proprietary restrictions. The MAPS common controller, with its high-speed processor and the associated software (which identifies the incoming threat and selects the optimal countermeasure) form the heart of the system. Acquisition and tracking sensors, as well as active countermeasures, interface with the controller. The precise configuration – including the type, number and arrangement of sensors and effectors – will be optimised for each vehicle type.

Development of MAPS began in 2014. Following successful live-fire tests, in February 2021 the US Army awarded Lockheed Martin a three-year, USD 30 million contract to integrate and test the MAPS kit on four classes of combat vehicles: the Abrams MBT, the Bradley IFV, the Armoured Multi-Purpose Vehicle, and the Stryker. The contract also covers developing base kit support beyond APS, such as underbelly blast protection. The integration and test phase is expected to be followed by a production decision. A precise timeframe for serial fielding of the operational system has not been announced.

#### **European manufacturers**

Several European firms have presented APSs which are either operational or in advanced stages of development.

#### **Rheinmetall – StrikeShield**

StrikeShield is the newest iteration of Rheinmetall's established advanced modular armor protection – active defense system (AMAP-ADS) family. The Strike-Shield system completed more than 900 successful intercept tests before serial production began in September 2021. The modular, scalable system can be applied to vehicles of nearly every weight class, including 4×4s, transport trucks, IFVs and MBTs. System weights range



The StrikeShield APS tested on a Leopard 2 MBT. The blast directly on the turret is the detonation of the StrikeShield effector (an intact charge is visible adjacent to the blast site). The second, lower blast is the destruction of the ATGM warhead.

from 100 kg to 1 tonne, depending on the configuration. The distributed APS consists of multiple radars, optical sensors, and effectors per protected vehicle. The precise number and ratio of the components varies with the vehicle and the level of protection desired by the user.

According to Rheinmetall, the system is optimised for simultaneous intercept of multiple RPGs and ATGMs, including some top-attack munitions and "certain types of IED". The reaction time between detection and engagement of incoming ordnance is 560 microseconds; Rheinmetall describes this as the shortest reaction time of any APS in ambush and multi-attack scenarios. Incoming missiles are engaged within close proximity to the protected vehicle. Instead of launching projectiles, the StrikeShield uses a directed blast to degrade or destroy the incoming warhead, with residual blast energy and fragmentation from the warhead absorbed by the vehicle's passive armour.

One special advantage of StrikeShield is the extremely small electromagnetic signature of the low-power radar sensors. This decreases the risk of detection of the radars – and the vehicle – by hostile electronic intelligence (ELINT) assets. According to Rheinmetall, some currently deployed APS radars can be detected from a distance of 21.5 km, while StrikeShield's low emissions limit the detection range down to roughly 350 m (at -60 dBm sensitivity) for tactical level ELINT assets, or 6 km (at -95 dBm sensitivity) for more powerful strategic-level ELINT assets.

The hard-kill StrikeShield system can be combined with Rheinmetall's Rapid Obscuring System (ROSY) soft-kill obscurant smoke solution (which can defeat munitions guided by TV or infrared homing, and semi-active laser (SAL) guidance systems) for an integrated protection solution. In addition to the standard variant of Strikeshield. Rheinmetall has also devised a hvbrid StrikeShield system which integrates active protection and passive armour. In this configuration, the APS components are embedded between the outer and inner tiles of the passive spaced armour, while radar and optronic sensors are placed between the tiles. This affords the active components a degree of protection from small arms fire and shell fragments. These hybrid tiles are lighter in weight than typical passive armour plates, but offer protection against a greater range of threats due to the APS component. The first procurement contract was issued in May 2021 by Hungary, which ordered 209 sets of the hybrid protection kit to be mounted on its Lynx IFVs.

#### **Hensoldt MUSS**

In contrast to StrikeShield, the multifunctional self-protection system (MUSS) produced by Hensoldt is a soft-kill APS. With 350 units delivered to the German Bundeswehr for deployment on Puma IFVs, MUSS is one of the few soft-kill APS to be operational on a larger scale. In 2021, Hensoldt announced development of the next-generation system, MUSS 2.0, which will introduce new sensors and enhanced processing power to detect and overcome current and emerging threats. MUSS is

#### **Thales – Diamant**

Thales Group is developing a new distributed hard-kill APS called Diamant which is currently undergoing testing by the French defence ministry's procurement agency, Direction Générale de l'Armement (DGA). The evaluation is being conducted under the French MoD's Protection Multi Effets Terrestre Unifiée (PROMETEUS) programme to develop an ASP for the future Scorpion combat vehicle series. A Griffon Véhicule Blindé Multi-Rôle (VBMR) multirole armoured vehicle is serving as the test platform.



The Hensoldt MUSS soft-kill APS mounted on a Puma IFV.

designed to protect medium-weight and heavy armoured vehicles including self-propelled artillery, IFVs and MBTs; the system weighs up to 170 kg, considerably less than most hard-kill systems on such vehicles. The layered MUSS APS is effective against both SACLOS and SAL guided munitions.

The system has multiple components geared to deal with various threats. Each vehicle is equipped with a central electronic control unit and four passive sensor heads. Each sensor head contains both an infrared (IR) based ATGM warning sensor (with a range of several kilometres) and a laser warning sensor; MUSS does not employ radar. Countermeasures controlled by the central unit include an infrared (IR) jammer mounted high on the vehicle to ensure 360° coverage, and an adjustable smoke and pyrotechnic ammunition dispenser, all intended to either break a targeting lock or divert incoming munitions.

Enhancements introduced through the 2.0 upgrade include enhanced laser detection capability in the presence of obscurants and of low-energy laser threats; expansion of the threat detection portfolio to now include RPGs, tracer ammunition, muzzle flash, and kinetic energy munitions; multi-threat capability and threat prioritisation; and a more favourable space, weight and power (SWAP) ratio which will make the system viable for smaller vehicles. Future enhancements are likely to include laser dazzlers. The Diamant APS uses four frequencymodulated continuous wave (FMCW) radar sensors mounted on the corners of the vehicle roof, and a number of effector modules mounted on frames around the perimeter of the vehicle roof and bonnet (22 interceptors as configured on the Griffon). Incoming projectiles are detected at close range, and engaged by a directed effector when they are in close proximity to the vehicle. The reaction time to initiate an intercept is less than 0.1 seconds. The system works by launching a directional blast into the path of the threat. To date, the system has intercepted RPGs and ATGMs with the Griffon test platform driving at speeds up to 70 kmh.

#### Middle Eastern systems

#### Rafael - Trophy

The Trophy system produced by Rafael Advanced Defense Systems is arguably the most well-known APS in the world. In service with the Israeli Defense Forces (IDF) since 2009, its effectiveness in combat was proven in 2011. It has now accrued over 1 million operating hours, with 1,800 units delivered or under contract.

Rafael's APS is currently offered in two variants. Trophy HV (heavy vehicle) is based on the original system, designed for mediumto-heavy armoured vehicles such as MBTs and 8×8 or tracked IFVs. The full system

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weighs 820 kg, with a 0.69 m<sup>3</sup> footprint on the vehicle. Trophy VPS, the lighter variant, is currently in the final stages of development following field testing in Israel and overseas. Configured for medium to light armoured vehicles, it is 40% lighter than the original variant, but provides the same level of protection. VPS is designed to integrate additional technology in the future. Trophy uses a relatively unique effector among APSs, using a flat plate effector containing multiple small explosively formed penetrators (EFPs). This plate is



Trophy APS on a US Army Abrams MBT.

detonated, which effectively launches the small EFPs into the path of the incoming munition, in a similar pattern to a shotgun blast. This is designed to destroy the threat at some distance from the vehicle (potentially at a range of 10 m or more). It offers 360° protection against multiple and nearsimultaneous attack by RPGs, rockets, AT-GMs, and high explosive anti-tank (HEAT) rounds. The system's radar (optionally augmented by optronic sensors) detects and tracks the incoming threats while the control element computes a fire solution. If tracking determines a missile will miss the protected vehicle, Trophy will not fire in order to preserve effectors. IR countermeasures can be integrated into Trophy to provide a soft-kill option.

The complete Trophy system combines the APS with a hostile fire detection (HFD) system to enable the crew to rapidly locate and neutralise threat sources. The HFD system is networked, providing the threat location to the protected vehicle's battle management system, which can respond with onboard weapons or pass the data to other networked platforms, enabling other friendly vehicles to engage the threat. On IFVs, the Trophy can be integrated with the Samson 30 remote weapon station, which can be slewed to engage detected enemy firing positions with the 30 mm gun, coaxial machine guns, or Spike ATGMs.

Rafael's partner Leonardo DRS supports testing and export of the APS. In January 2021, Leonardo completed delivery of four brigade-sets to the US Army, to equip 400 Abrams M1A2 SEPv2 and SEPv3 MBTs. That same year, the British Army announced plans to equip the Challenger 3 MBT with Trophy (delivery 2027-2030). In 2022, the EuroTrophy joint venture was founded by General Dynamics European Land Systems, Krauss-Maffei Wegmann and Rafael. In September 2023, Rafael announced that Trophy would be the baseline APS on the new Leopard 2A8 which, to date, is on order by the German and Norwegian armed forces. South Korea has also opted for Trophy as an option for variants of the K2 Black Panther MBT.

#### **Elbit Systems - Iron Fist**

Another internationally successful Israeli APS is the Iron Fist, produced by Elbit Systems. The system is available in two configurations. According to Elbit, the Iron Fist Light Decoupled (IFLD) variant is designed for light to medium IFVs as well as logistics vehicles and 4 × 4 tactical vehicles; it is capable of defeating RPGs, rockets, recoilless rifle rounds, as well as ATGMs. The Iron Fist Light Kinetic (IFLK) is intended for MBTs and heavy IFVs; it defeats rockets, ATGMs, recoilless rifle munitions, as well as HEAT rounds, armour-piercing fin-stabilised discarding sabot (APFSDS) rounds, and even loitering munitions, (provided these are not diving on their target at too steep an angle). The effectors are carried in double-barreled launchers capable of traverse and elevation, with most configurations using two launchers to provide 360° coverage. Iron Fist employs a grenade-type effector which explodes in close proximity to the threat projectile in order to defeat it. In the case of APFSDS rounds, the interceptor's blast introduces a degree of yaw onto the projectile, forcing it to impact the vehicle at a less-effective angle, losing much of its penetrative capability in the process. An optional soft-kill anti-ATGM laser jammer can be integrated with the interceptor system. Threat detection and tracking are achieved through independently operating radar and passive IR sensors, with a detection range of 1.5 km.

Iron Fist has been selected for the IDF's Eitan IFV, D9 armoured bulldozer, and the turreted variant of the Namer IFV. BAE Systems Hägglunds has integrated Iron Fist on the CV90 armoured combat vehicle. Both the Dutch and the Czech armies have opted to include the system on their CV90 fleets, while the Australian army has selected it for their Boxer 8×8 combat reconnaissance vehicle (CRV). The US Army completed testing of the IFLD on the Bradley IFV in late-2022, and plans to equip a brigade's worth of vehicles with the system by 2025. For the latter project Elbit has partnered with General Dynamics – Ordnance and Tactical Systems (GD – OTS).

#### Advantage multitasking

New anti-armour threats are evolving, including armed unmanned aerial vehicles (UAVs) and loitering munitions capable of top-attack. Ground- and air-launched AT-GMs with greater range and speeds (potentially even hypersonic) are being developed. Saturation attacks by comparatively low-cost weapons threaten to overwhelm defences or simply run out hard-kill APS magazines. In the long run, one-size-fits-all solutions to vehicle defence will be inadequate. The trend towards hybrid APSs is already recognisable, integrating hard- and soft-kill techniques or linking APS sensors with offensive weapons in order to destroy enemy firing positions rather than gamble on the ability to intercept the next ATGM, and the next one after that. While any functioning APS provides a vital extra layer of survivability to a combat vehicle, the future will belong to systems that simultaneously provide multiple different means of defence.



Twin Iron Fist launchers atop an unmanned Elbit UTM30MK2 turret
## It's all a matter of perception – vehicle optronics and situational awareness in tomorrow's battlespace

### **Tim Mahon**

Although the main battle tank has (arguably) not been entirely dislodged from its position as 'Queen of the Battlefield', the requirements of modern ground conflict have changed – immeasurably so – in the last two decades.

The exponential increase in the development of lighter, more specialised armoured platforms – manned, unmanned, tracked, wheeled, of all shapes, sizes and configurations – coupled with rapid advances in the capabilities brought by advancing technologies, have resulted in a new breed of armoured fighting vehicles. Something that remains common to all, unsurprisingly, is the imperative for excellent (and instant) situational awareness (SA), in a wide range of terrains and environments, including the increasingly significant electromagnetic spectrum.

Psychologists consider that situational awareness consists of three distinct elements: understanding; assessment; and decision-making. That is an entirely adequate definition from which to consider what is happening in enhancing, improving and facilitating efficient SA in today's and tomorrow's armoured vehicle fleets. These three elements reflect the logic of the Observe, Orient, Decide, Act (OODA) loop, which still lies at the heart of many of the techniques, tactics and procedures embraced by operational concepts across multiple nations. Fundamentally, the need to understand the environment in which the subject vehicle is operating is a fundamental precursor to the crew (or remote operator) being able to take effective action in time for it to be of use. Ukraine, Syria, Libya and the Sahel, for example, clearly show the synergies deriving from superior SA.

### <u>Author</u>

An award-winning author, editor and consultant, **Tim Mahon** has a career in defence and aerospace spanning four decades. He is currently Publishing Director, Counter-UAS at Unmanned Publications



This image of the Boxer CRV – Rheinmetall's winning bid for the Australian Combat Reconnaissance Vehicle programme – amply demonstrates the extent to which a vehicle's profile can be significantly increased by the number of sensor-related additions, principally roof-mounted.

This explains the huge increase in developments on the part of industry, constantly seeking solutions that better address the changing requirements of operators.

Those requirement changes are driven by many factors: discretion (the need for lowemission sensors); timely information (the imperative for real-time data and near realtime analysis); flexibility (an ability to discriminate difficult, often concealed targets at close and distant ranges); size, weight and power consumption optimisation; and intuitive, easily assimilated interfaces and data outputs. Users require SA assets that simultaneously provide accurate, reliable data, preferably with decision options, and are soldier-poof. In fact, the complex web of requirements and aspirations for SA on the battlefield, in the 'urban canyon' or in counter-insurgency operations can be broken down into three abilities: capability, affordability and interoperability.

### Capability

Different approaches to providing SA capability can be seen in any cursory trawl through the relevant press or social media postings, whether emanating from observers of current operations, armchair generals or professionals. Some of the makeshift solutions seen in Ukraine recently verge on the bizarre - though many of them actually seem to work! Users contemplating upgrading legacy platforms or equipping future vehicles are often presented with a bewildering array of options, ranging from simple standalone sensors offering multiple options for range, spectrum and output, to fullyintegrated systems that take every possible aspect of the vehicle's sensor capability and make it a holistic, intrinsically easily absorbed construct that takes the operator directly into response mode.



The upgrade of the Challenger 2 to Challenger 3 configuration, managed by Rheinmetall BAE Land Systems (RBSL), features a radical departure in new sensor and situational awareness capability, resulting in some pundits suggesting this is a new vehicle with entirely new capabilities.

The latter approach is the one taken by any number of current projects in the armoured vehicle sphere. Here we encounter the first inescapable truth – that talking about vehicular SA in isolation is possible only to a limited degree; the ubiguitous nature of sensors and their fundamental contribution to every aspect of a combat vehicle's operations - survivability, firepower, mobility and combat effectiveness - coupled with the proliferation of other onboard systems demanding rapid data processing and analysis, means that an integrated system will, potentially, have greater utility than a host of disparate systems, no matter how great their utility.

That is the approach taken by, for example, the British Army's Challenger 3 upgrade, which enhances and changes the vehicle's SA capability radically. It is also reflected in the Israeli Carmel programme, which aims to provide a smaller than usual crew with swiftly gathered, processed and parsed data. It will be interesting to note, when the dust of current operations settles, what lessons the IDF will have learned from trialling early iterations of this technology in combat conditions. Larger-scale, integrated solutions have also been proposed by companies of the size and broad-spectrum capabilities of BAE Systems and Hensoldt, for example, with the latter's Local Situational Awareness System (LSAS) offering a relatively painless entry to integrated SA. That approach, however, does not necessarily suit every existing or emerging requirement. Taking a dispassionate look at some of the vehicles now being fielded, developed and proposed, one cannot help but wonder whether the plethora of (mostly) roof-mounted sensors – visual, thermal, acoustic - necessarily contributes to an op-

timised capability. Low observability is still a critically important (and often underrated) component of survivability – hence the passion for sensors that exhibit the lowest possible emissions – and adding height and rectilinear profiles to a vehicle can somewhat thwart such an ambition.

### Affordability

Practical considerations aside, there is another significant driver influencing the manner in which procurers and suppliers are approaching the issue of next-generation SA capabilities: the effect of increasingly stressed budgets. Both the so-called 'Peace Dividend' and the apparent commitment to significantly higher defence spending that started after Russia's annexation of Crimea have more or less evaporated - despite a brief fillip caused by Putin's 24 February 2022 invasion. The reality is that national governments - even in economies that are still more or less centrally controlled, such as China – are finding it increasingly difficult to come up with the sums required for development, manufacture and deployment of adequate solutions, in time and at scale. The pressures that treasury departments exert on those responsible for developing and acquiring capability mean that choices have to be made. Choices that, again inevitably, frequently favour the more obvious aspects of combat capability, such as more firepower or better armour, than what the bureaucracy might well see as the 'intangible benefit' of better SA. The inability of the uniformed services to convince the relevant organs of government of the real nature of those benefits means that the soldiers suffer.

The problem is that an integrated system one that can almost instantaneously meld sensor-derived data into a simple decision matrix for the vehicle crew – is currently an expensive system. Many of the countries now pursuing upgrades and new equipment programmes, therefore, are seeking more affordable approaches to the conundrum. Which is where the age-old argument about sourcing once more rears its head: is it better to go with a solution from a tried and tested contractor, whose size and sometimes ponderous processes mean their systems frequently carry a higher-thanexpected price tag? Or better to seek a more innovative and often more graceful solution from a smaller, less well-known vendor, while simultaneously doing everything possible to sensibly mitigate the risk?



Working closely with the IDF, Nir-Or has developed an AI-based SA system that offers 360° coverage and will integrate combat, navigation and electronic warfare sensors, hard-kill self-protection sensors and offboard sensor feeds, having trialled the system on a number of IDF vehicles.

There is no easy answer. The comfort of a solution from 'a usual suspect' as opposed to a higher-risk one from a smaller, more agile alternative should not be too easily dismissed. Even when integration problems occur with adding an additional or replacement sensor to an existing vehicle backbone, finding workarounds can both resolve a utility issue and invigorate the industrial or military personnel developing the solution. Luckily, there is an alternative approach; one that has been around since the beginning of this century.

The Modular Open Systems Approach (MOSA), already mandated for a wide range of requirements by the US Department of Defense, and its corollary, the Sensor Open Systems Architecture (SOSA) aim to provide an environment in which proprietary interfaces and architectures become a thing of the past. In theory, this will enable smaller, agile concerns to develop and offer innovative solutions that will fit seamlessly into an existing architecture, thus avoiding expensive 'tweaking' to fit the application. The idea is simple, the implementation, sadly, not so much. Recently heard after a briefing was the question: "What is a MOSA, and where do I get one"? More education and a more constructive dialogue is required, but it seems likely that will only happen over a considerable period of time. Admittedly, initiatives such as the British-originated General Vehicle Architecture (GVA) concept, which subsequently became the NATO GVA, are starting to make a difference, but there is still a long way to go. Meanwhile, the third factor needs addressing.

### Interoperability

A guick survey of the armed forces and security forces in Europe reveals over 120 different types of armoured vehicle with more on the way as the unmanned ground vehicle community matures. Leaving aside the issue of different variants of a baseline platform and looking at the average number of sensors equipping a single platform, means there could be up to several hundred different sensors operating in a European joint force. As was the case with dismounted operations in Afghanistan, the inability of different units to communicate with each other because of national differences in equipment or software led to inefficiencies at best and actual casualties at worst.

There are multiple initiatives seeking to address this issue at different levels of the supply chain. At the component level, 
 The world of security and utility vehicles. exemplified here by the

The world of security and utility vehicles, exemplified here by the Otokar Cobra II 4x4, is filled with platforms exhibiting multiple sensor fits ranging from remote-controlled weapon stations to driver and commander vision systems, sighting systems and in some cases acoustic sensors, all of which contribute to enhanced situational awareness.

as just one example, several years have been spent in harmonising laser emissions and making laser devices common with respect to operations, interfaces, maintenance, etc. This is already the case in the training and simulation community and there are laudable efforts within the sensor community too. Currently, these are focused on avionics systems, but their applicability to the ground environment where the scale of issue is normally far higher – is becoming more and more obvious to influential players. One cannot help but wonder, however, how we might best achieve the fundamental shift in thinking required in order to achieve something useful in time for it to be so.

### Challenges

That change in thinking applies to almost every aspect of modern combat. Increasingly, pundits are talking about another Revolution in Military Affairs, brought about by the technology-wrought changes in combat capability and the increasingly wide swathe of missions the armed and security services find themselves tasked with. Recent and current operations prove beyond a doubt that existing modi operandi will not suffice or, at least, will not provide the tactical or operational advantage sought. Therefore changes need to be made, which will require re-evaluating every aspect of the manoeuvre force, at the very least, with situational awareness being equally as important as firepower, mobility and survivability.

It is also worth reflecting that, as the complexity of data handling, processing and dissemination increases, so too does the cognitive load on the operator. Although there are huge strides being made in the direction of making that complexity transparent to the user, our training and support systems continue to lag behind. There is strong evidence that the mode of thinking in the personnel of today's and tomorrow's forces is subtly different from that exhibited by the previous generation, hence the extensive use of games technology in today's training solutions. That recognition needs to be reinforced at every level of the military machine and kept in mind as new SA systems are defined, developed and deployed.

Perhaps the biggest issue, however - and the one that will cause the greatest debate, argument and controversy - centres on scale and speed. In every environment, from discussions of airborne sensors in Ukraine to the US's ability to provide adequate counter-drone coverage for manoeuvre forces and critical infrastructure, a major challenge identified is being able to develop, test, procure, manufacture and issue equipment at scale and in a sensible timescale. For the vehicular SA community, failure to do so will result in rapidly degrading capability, huge wastage of resources and higher risk of damage, ineffectiveness and casualties. The moving finger has already written - we just need the wit do read it, understand it and do something about it. This need not be too difficult. After all, it's really only a matter of perception.

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## The 6×6 armoured vehicle market

### **David Saw**

The wheeled armoured vehicle sector provides potential customers with a wealth of choices for virtually all conceivable requirements.

he vehicle range includes variants in 4×4, 6×6 and 8×8 configuration. Selecting the appropriate vehicle solution is dictated by the mission(s) that are to be carried out, the operational environment, and the weight category of the vehicle; this is governed by the mobility required versus the protection needed, in addition to the firepower solutions considered to be essential. A margin for growth should also be included in order to accommodate new equipment and protection fits. These elements should be factored into the overall vehicle package that the operator can maintain and support through the service life of the vehicle. And all of this needs to be at an affordable cost for the operator.

If affordability is important and mission criteria can still be met, the acquisition of a 4×4 protected vehicle solution is perfectly appropriate. The Turkish defence industry has developed a complete range of wheeled armoured vehicle solutions and has been very successful in export markets. In South America, 20 Cobra II 4×4 systems and more recently, 15 Ural 4×4 vehicles, designed for internal security applications, were delivered to Ecuador by Turkish defence firm Otokar. As an aside, it appears that Otokar supplied Ukraine with at least 20 Cobra II vehicles in the second quarter of 2023.

Another Turkish armoured vehicle company, Nurol Makina, achieved an important breakthrough into the European NATO marketplace with the decision by Hungary to acquire the Ejder Yalçin 4×4 tactical armoured vehicle, known as the Gidrán in Hungarian service. Since 2021, Hungary has received some 50 Gidrán vehicles out of an original acquisition objective of 300 units. At the end of October 2023, Hungary and Nurol Makina signed a Memorandum of Understanding covering the local production of the Gidrán in Hungary, with the implication that a substantial number of vehicles, potentially more than the original programme objective, could be acquired.

These contracts illustrate that the Turkish defence industry has the capability to be competitive at the 4×4 end of the wheeled armour marketplace. A new contract from another European NATO country, in this



In October 2023, Estonia announced it would acquire new 4×4 armoured vehicles from Nurol Makina and 6×6 vehicles from Otokar, which was awarded a EUR 130 million contract for their ARMA 6×6 vehicle. According to Otokar, ARMA is already in service with five different nations.

case Estonia, indicates that Turkish industry is also competitive in the 6×6 vehicle sector. In October 2023, the Estonian Centre for Defence Investments (ECDI) announced that it had awarded contracts to Nurol Makina and Otokar for 4×4 and 6×6 armoured vehicles. The contract value was EUR 200 million and includes vehicles, documentation, training, special tools and spares. In total, 230 armoured vehicles will be acquired, plus four more for the Explosive Ordnance Disposal Centre of the Estonian Rescue Board.

According to the ECDI, the two Turkish companies were selected after evaluating proposals from nine different companies from six different countries. First vehicle deliveries will take place in 2024 and all deliveries will be complete by 2025. ECDI notes that contract validity is for 10 years, and this could potentially cover the acquisition of more vehicles and spare parts if required. Nurol Makina will supply their EWS 4×4 vehicle to Estonia; the vehicle is available in nine separate variants and an extended wheelbase variant is available in the form of the NMS EWB 4x4. Otokar disclosed that the contract value of their sale to Estonia was EUR 130 million and that this covered the acquisition of the ARMA 6×6 vehicle. The ARMA is a modular system that can be configured for multiple mission requirements, such as standard APC, IFV with a turret-mounted 25 mm cannon, fire support variant with a 90 mm cannon and a variant for explosive ordnance disposal (EOD). According to Otokar, five different countries already operate the ARMA. Both the EWS and the ARMA in Estonian service will be equipped with a single 12.7  $\times$  99 mm NATO M2 heavy machine gun.

### **International choices**

Estonia's decision to meet its 4×4 and 6×6 wheeled armour needs with Turkish vehicles is significant, as is the decision by Hungary to opt for Turkish 4×4 vehicles and to manufacture them under licence. All of this proves that the level of competition for wheeled armour orders in Europe is intense and that European manufacturers are not guaranteed success in what should be relatively approachable markets. Broaden the focus to global markets and even there, the level of competition has considerably increased in recent years. The fact of the matter is that there are a number of credible armoured vehicle designs ready to meet any requirements that might emerge.

There is undoubtedly an abundance of  $4\times4$  wheeled armour options; equally, there is plenty of choice when  $6\times6$  vehicles are evaluated. For example, the  $6\times6$  VBTP-MR Guarani from Brazil, based on an lveco design, benefits from large Brazilian



A French Army Jaguar 6×6 on the training area at Mailly-le-Camp; the first 10 Jaguars became operational in December 2021. In total, the French Army will acquire 300 by 2030. This 25-tonne vehicle has exceptional firepower characteristics.

orders and has started to achieve export success. Another option for a 6×6 solution comes from Hyundai Rotem in the Republic of Korea (ROK). The company won the competition to provide the ROK Army with new 8×8 (K808) and a 6×6 (K806) wheeled armoured vehicles; once again, an existing domestic order base strengthens the ability to compete in the export market.

Indonesia has its own 6×6 solution in the form of the PT Pindad Anoa; this vehicle is clearly influenced by the French Arquus Véhicule de l'avant blindé (VAB) and it even uses the Arquus VAB Mk3 driveline. Primarily aimed at meeting the needs of the Indonesian military, the Anoa has also been offered to meet a 6×6 vehicle requirement in Malaysia. France has always been a strong supporter of the 6×6 format and there are numerous solutions on offer to meet both domestic programme requirements and export opportunities.

The Arguus VAB has been extremely successful in export markets over the years and the latest version, the VAB Mk3, is aimed at export markets where the requirement is to replace older generation 8×8 vehicles such as the BTR-60/BTR-70 and BTR-80. A high-performance 6×6 vehicle can easily replace these old 8×8 types and offer far higher operational performance levels. Customers with older generation VAB vehicles can opt to upgrade their existing fleets, for example Qatar established a VAB rebuild facility, improving protection and other characteristics, and boosting automotive performance via the installation of the VAB Mk3 driveline. Another French 6×6 solution comes from KNDS with development of the TITUS, a new range of vehicles based on a Tatra truck chassis. The vehicle can be used for both military and paramilitary applications. Thus far, the main customer is Czechia which has some 62 vehicles in service.

The French Army has long been persuaded of the utility of wheeled armoured vehicle solutions and one of the leaders in this field was Panhard (now part of Arguus), which produced the 4×4 AML family of vehicles in the 1960s. By the time production ended in the late 1980s. thousands of vehicles had been produced for export customers in Africa, the Middle East and South America, with the French Army reportedly acquiring some 900. When the French Army sought a replacement, they opted for a 6×6 vehicle that was more heavily armoured for reconnaissance and combat missions. This resulted in the AMX-10RC, with the French Army taking 300, Morocco 108 and Qatar 12; subsequently, French vehicles were upgraded to the AMX-10RCR configuration. France has donated AMX-10RC/RCR vehicles to Ukraine and will gradually retire the vehicle as it is replaced by the new Jaguar vehicle.

While the AMX-10RC met the majority of French Army needs, it was too heavy to support intervention operations in Francophone Africa, where French troops and equipment needed to be deployed rapidly. This saw the French Army turn to Panhard, and their successor to the AML, the ERC-90 Sagaie, a 6×6 vehicle mounting a 90 mm gun. The Sagaie will also be replaced by the Jaguar. The new wheeled vehicles being acquired under the French Army Scorpion programme include the Véhicule Blindé multi-rôle léger (VBMR-L) Serval, a 4×4 system supplied by KNDS and Texelis, with 978 vehicles due to be acquired by 2035. An additional 1,060 Serval vehicles are due to be acquired under the Véhicule léger tactique polyvalent protégé programme. It is the 6×6 vehicles in the Scorpion programme that are of interest in this article; these two vehicles are the Véhicule blindé multi-rôles (VBMR) Griffon and the Engin blindé de reconnaissance et de combat (EBRC) Jaguar.

According to the Direction générale de l'armement (DGA), the French defence acquisition authority, the French Army received 16 Griffon vehicles in October 2023, 13 of which were troop transport variants and three were command post variants. The programme schedule is that 887 Griffons will have been delivered by the end of 2025. As of end October 2023, the French Army had received 443 Griffon VTT troop transports, 79 Griffon EPC command variants and 11 Griffon VOA artillery observation variants. Another variant of the Griffon for the French Army is the Mortier embargué pour l'appui au contact (MEPAC) mortar carrier armed with a 120 mm Thales 2R2M mortar. 54 of which are on order. Belgium is the first export customer for the Griffon and also for the Jaguar, with their Capacités Motorisée (CaMo) programme for the Belgian Land Component. Under CaMo, Belgium has ordered 60 Jaguars and 382 Griffons, as well as two batteries of the MEPAC mortar vehicle.

As previously noted, the EBRC Jaguar is replacing the AMX-10RC/RCR and the ERC-90 Sagaie, as well as the anti-tank variant of the VAB with HOT missiles in the French Army. Jaguar is a 25-tonne vehicle, with a three-person crew; in total. 300 Jaquars are to be acquired by 2030. Particularly impressive is the firepower available to this vehicle  $\neg$ - the turret mounts a CTA International CT40 40 mm cannon, and also mounts two MBDA Akeron-MP anti-tank missiles with a 7.62 mm machine gun in a Hornet remote weapon station on the turret roof; the Hornet is also a standard fit on Griffon vehicles

### **Multinational progress**

Patria in Finland has built a significant presence in both the 6×6 and 8×8 wheeled armour sectors. Their 8×8 AMV has been particularly successful, with substantial numbers built under licence in

Poland as the KTO Rosomak. Ukraine will order an initial batch of 100 Rosomak vehicles, and intends to purchase 100 more. South Africa also produces the AMV under licence, with other AMV customers including Finland, Croatia, Slovakia, Sweden and the United Arab Emirates (UAE). In December 2022, the AMV XP was selected by the Japan Ground Self-Defense Force (JGSDF) for the wheeled armoured personnel carrier (WAPC) requirement to replace the existing Type 96 8×8 vehicle in JGSDF service. At the end of August 2023, Patria signed a licence production agreement with Japan Steel Works (JSW) to produce the AMV XP in Japan.

Prior to the AMV, Patria was best known from the 1980s onwards for its 6×6 vehicles such as the XA vehicle family in the XA-180/XA-185/XA-186/XA-188 and XA-200 variants. The first customer was Finland, with seven countries also adopting the vehicles, which were highly valued in peacekeeping operations. Patria has since carried out service life extension programmes on Finnish and Swedish XA vehicles.

More recently, Patria decided to build a successor 6×6 vehicle, building on what they had learnt from the XA and the AMV, resulting in the Common Armoured Vehicle System (CAVS). This provided the basis for a multinational programme, as in January 2020 Finland and Latvia agreed to define a new 6×6 vehicle, which was the CAVS, with Patria as prime contractor. In August 2021, the CAVS programme entered the acquisition phase, with Latvia placing orders for more than 200 vehicles with first deliveries taking place in October 2021. All of the CAVS vehicles will be built by Patria in Hämeenlinna, Finland with Finland signing a Letter of Intent to cover



The Véhicule blindé multi-rôles (VBMR) Griffon will play a key role in the French Army Scorpion vehicle programme. As of October 2023, the French Army had received 533 Griffons in three different variants; 887 Griffon are due to be delivered by end-2023. Belgium has ordered 382 Griffons.

the acquisition of 160 CAVS vehicles. In January 2022, Finland ordered three preseries CAVS vehicles for test and evaluation purposes; these were delivered in mid-2022.

Filename: Patria CAVS Sweden

Caption: Sweden received its first Pansarterrängbil 300 Common Armoured Vehicle System (CAVS) vehicles from Patria in October 2023. CAVS is a fournation programme involving Finland, Latvia, Sweden and most recently Germany. Existing orders cover more than 300 vehicles, with many hundreds more required. Credit: Patria

At the end of 2021, Sweden announced that it was joining the CAVS programme, and in June 2022 the Swedish defence materiel administration (FMV), the Ministry of Defence of Finland, the Ministry of Defence of Latvia and Patria signed





Sweden received its first Pansarterrängbil 300 Common Armoured Vehicle System (CAVS) vehicles from Patria in October 2023. CAVS is a four-nation programme involving Finland, Latvia, Sweden and most recently Germany. Existing orders cover more than 300 vehicles, with many hundreds more required.

an agreement under which Sweden would join the CAVS R&D programme. Germany signed a Statement of Intent in June 2022 to join the CAVS programme, then in April 2023 they officially joined the programme. April 2023 also saw the Swedish FMV sign for 20 CAVS vehicles, to be known as the Pansarterrängbil 300 in Swedish service; the eventual requirement will be for 'several hundred' vehicles.

In June 2023, the Finnish Defence Forces Logistics Command signed an agreement with Patria covering the acquisition of a first batch of 91 CAVS vehicles, with the option of a further 70. Finally, the first vehicles for Sweden were handed over at the Ground Combat School in Kvarn on 26 October 2023.

From the starting point in 2020, CAVS has evolved into a four-nation multinational programme, which unlike most multinational programmes seems to be exceedingly well managed, as demonstrated by how rapidly vehicles are delivered. With the benefit of a strong order base from the four partners, CAVS provides the basis to be both price and performance competitive in international  $6 \times 6$  wheeled armour markets.

The wheeled armoured vehicle market remains incredibly competitive in the 4×4, 6×6 and 8×8 sectors. Supplier diversity is the name of the game here, as multiple suppliers from multiple countries have numerous vehicle solutions available to meet virtually any conceivable requirement. In investigating the validity of this range of vehicle solutions, it is, inevitably, up to the customer to make the right choice.



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## Add-on armour systems

### Sidney E. Dean and Mark Cazalet

On the modern battlefield, extra protection for armoured vehicles is increasingly in demand with high-performance organic armour and active protection systems comprising two vital elements. Add-on armour is a vital third element of a comprehensive protection package for armoured fighting vehicles (AFV) and armoured support vehicles.

Add-on armour has the advantage of being modular, allowing the user to configure the extra protection according to operational requirements, the known vulnerabilities of the base-armour, and the carriage capabilities of the vehicle. In some operational environments, a minimum amount of additional armour will be mounted to defend against a particular weapon threat (and minimise impact on vehicle manoeuvrability), while in other high-threat scenarios the maximum possible panoply might be applied. Commonly used materials include hardened steel, ceramic armour, and multicomponent composites. Various types of add-on armour are available, providing a wide spectrum of options to the user.

### Appliqué plate and spaced armour

The simplest appliqué armour consists of at least one layer of (usually hardened steel or ceramic) plates attached to the vehicle's organic armour. A composite material absorber layer can be placed between the organic armour surface and the appliqué plate in order to absorb fragments of the warhead or plate. When two appliqué plates are positioned over one another with a space in between, the configuration is designated as spaced armour. The plates may be applied at a vertical angle to take up less volume, or at a sloped angle for enhanced protection.

These systems tend to be lighter in weight compared to other add-on options, which makes them suitable for smaller vehicles such as armoured 4×4s. Britain's Air Sea Land Group (ASL) offers a line of appliqué solutions primarily for lighter vehicles. ASL's Assero-A single-plate armour provides STANAG level 2-4 protection; the ceramic or steel strikeface can shatter incoming projectiles, and is coupled with a composite absorber to neutralise fragments. The modular and scalable ASSERO-M system comes in three variants offering additional



M19 ARAT 1 ERA tiles on an M1 Abrams tank.

degrees of protection against threats including improvised explosive devices (IEDs), RPGs and 30 mm rounds. ASSERO-M configurations can include single and multilayered ballistic plates and boxes ranging from 20 mm to 350 mm thickness.

Denmark's Composhield also offers flexible options for up-armouring vehicles such as 4×4s and logistics trucks. The scalable system can provide ballistic protection up to STANAG level 5 against direct fire as well as blast and fragmentation. This includes defence against explosively formed projectiles (EFP), as well as IEDs. The ceramic-polymer composite armour plates are engineered to withstand heavier impact and energy release than traditional steel armour; this enhanced structural integrity ensures the ability of each plate to survive multiple impacts without breaking up. The firm offers customised solutions, enabling users to choose the amount and distribution of coverage.

### **Explosive reactive armour**

Explosive reactive armour (ERA) consists of an explosive charge sandwiched between steel or ceramic armour plates. When a projectile pierces the outermost armour plate and strikes the explosive filler, the explosive detonates, forcing the two plates apart. In the case of high explosive anti-tank (HEAT) jets, the rapid movement of the plates and imparts powerful stresses onto the shaped charge jet, disrupting the jet and making it



Logistics vehicles protected by Composhield composite add-on armour plates.



Soldiers attach M19 ARAT 1 tiles to an M1A2 SEP v2 tank at the Grafenwöhr Training Area, Germany.

lose coherence, thereby leading to a large reduction in penetrating power.

In the case of an armour-piercing fin-stabilised discarding sabot (APFSDS) round. movement of the plates can likewise lead to massive stresses being imparted onto the projectile potentially bending or fracturing it, and additionally, the ERA can also impart a small degree of yaw onto the projectile, forcing it to strike the main armour at a slightly less-optimal angle and thereby reducing penetrating power further. However, defeating APFSDS projectiles typically requires use of heavier plates, along with a slightly greater quantity of explosive filler to effectively impart the necessary energy onto the penetrator, and many early ERA designs lacked these.

ERA is widely used as add-on protection, most commonly by Russia and former Warsaw Pact countries, as well as China, but has also seen increased adoption by western countries over recent decades. A notable western example is the US Army's Abrams reactive armour tile (ARAT) system designed for the M1A2 Abrams main battle tank (MBT).

The US Army introduced the M19 ARAT 1 in 2006 and it is still utilised on the M1A2 Abrams. The M19 is produced for the Army by Ensign-Bickford Aerospace and Defense (EBAD). It consists of 62 flat ERA tile cassettes, each weighing 29.5 kg. The cassettes themselves consist of a layer of explosive material between two metal plates. The tiles are attached on pre-installed racks on either side of the MBT, positioned to cover the turret, hull and tracks from RPG and ATGM strikes.

In 2008, the M19 was augmented by the M32 ARAT 2 system, also developed by EBAD. The ARAT 2 is mounted over the ARAT 1 system, effectively doubling the protection. The M32 tiles are rectangular, but curve towards the centre, resembling terracotta roof tiles. This curved shape means that the faces of the tiles will always be at a slight angle in azimuth relative to any inbound projectile, which improves their capability to reduce the penetration of many common threats. Unlike the M19, the M32 ERA tiles can also be angled facing slightly downward in elevation during the mounting procedure, which further improves performance by making it less likely that a projectile could strike the plate at a perpendicular angle relative to the plate position.

The ARAT system is primarily intended to defeating shaped charge projectiles but could also be expected to degrade the penetrating capability of APFSDS projectiles at least partially. By contrast, Rafael's Armour Shield KE system revealed in 2021, is designed specifically to be capable of defeating APFSDS penetrators, with Rafael's tests revealing it is capable of reducing the penetrative power of an APFSDS projectile by approximately 50%. It is also capable of working against HEAT projectiles and explosively-formed penetrators (EFPs), but is less effective against tandem-HEAT warheads, which are typically used by modern anti-tank guided missiles (ATGMs). The system's modules weigh 350-750 kg per m2 of covered surface, with turret-mounted modules being the heaviest. Armour Shield KE utilises lowexplosive charges to provide a multi-hit capability, which allows a module to operate as ERA over multiple hits, rather than all of the explosive content being expended after the first hit, as is more typical for ERA.

The fact that most ERA modules can only function once is a notable disadvantage of most ERA designs, since it leaves a potential vulnerable spot for the enemy to target with repeat attacks. Moreover, modern tandem-HEAT warheads are usually designed to initiate ERA with a small initial 'precursor' warhead, leaving the main armour vulnerable to the primary warhead. Layering the modular armour – either with two ERA sets such as ARAT 1 and 2, or by adding a non-explosive plate or block behind the ERA – is often used to mitigate against this vulnerability.

### Non-energetic reactive armour

Non-energetic reactive armour (NERA), also (alternately non-explosive reactive ar-



An M1A2 SEPv2 MBT with M32 ARAT 2 explosive reactive armour.

mour; NxRA) substitutes ERA's explosive charge with an inert elastic substance, often a type of elastomer. As with ERA, the basic principle is to dissipate the energy of the attack to minimise the impact on the actual vehicle and preserve its base armour. As a HEAT warhead or APFSDS projectile impacts penetrates the module, it causes the elastic layer to bulge rapidly in response, pushing the two plates apart. In principle NERA operates along the same principles as ERA, albeit at lower energies, due to explosives containing more energy than an elastomer layer can provide. Unlike ERA, however, NERA modules have an inherent multi-hit capability, since there is no explosive content to be used up. This should also translates into improved performance against tandem-HEAT warheads than some ERA designs.

These advantages aside, NERA performance is widely considered less effective than ERA. Additionally, it is important to note that ERA and NERA typically do not completely neutralise the HEAT jet or APF-SDS penetrator entirely – rather they typically reduce penetrative power to a level the vehicle's passive armour is able to cope with, so a base level of armour is required to absorb any residual penetration from the projectile. For this reason, ERA and NERA are typically not used on lighter vehicles, since they often lack the required level of base passive armour.

### Bar/slat/cage armour

Slat or bar armour is composed of a grid of rigid metal (usually steel or aluminium) bars mounted to protect vital or vulnerable areas of the armoured vehicle. It is sometimes referred to as 'cage armour', particularly when it encloses the entire vehicle. Alongside the commonly-seen aluminium and steel bars, this armour can also take the form of wire or aramid netting, and sometimes even weighted chains – although the implementation can vary, the operating principles for these armour types is the same.

Contrary to popular belief, this type of armour does not work against all shaped charge weapons. In fact, it only works against munitions which use a doubleskinned nose as the conductive path for the piezoelectric fuzing system. In practice, this typically refers to the PG-7V (used by the RPG-7), PG-9V (used by the SPG-9), and PG-15V (used by the BMP-1's 2A28 Grom launcher) families of munitions, along with their many clones and derivatives. These families of weapons have been near-ubiquitous on many battlefields around the world, and bar armour provides a simple

A British Army Buffalo engineering vehicle with bar armour in Afghanistan.

and very cost-effective solution to reducing the threat posed by this class of munitions. Bar armour can work to reduce the effectiveness of the aforementioned class of munitions in a number of ways. The primary design intent is that due to the warhead being wider than the bars, the two 'skins' of the warhead are forced together when the projectile passes between the bars. However, both 'skins' are conductive, and so when they are forced together, they form a short circuit, thereby preventing the electrical detonation signal from the front fuze component (assuming it has functioned as intended) from reaching the rear fuze component.

The above represents a 'best case' scenario, and in reality the battlefield is a messy and often chaotic place. As such, there are various other means by which bar armour can hinder the aforementioned class of munitions from functioning properly. One possibility is that the shaped charge liner is deformed upon impact, thereby preventing optimal jet formation if it does detonate, which in turn results in reduced penetration. Another phenomenon which can occur is impact-induced deflagration of the explosive charge, which can prevent or hinder jet formation. There are also some rare occasions where the projectile has been reported to have been caught by the bars and remained stuck in place, unexploded, as the target vehicle continued with its day. However, if the crew are unlucky enough for the projectile to impact a solid surface first instead of passing between the bars, for instance striking one of the bars or the frame, then this form of protection will not work as intended, and the warhead can be expected to detonate normally.

Among bar armour's advantages, is that it can be mounted on almost any size vehicle including HMMWVs. While its weight can be detrimental to some smaller vehicles, it is lighter than other add-on armour options; for larger or heavier vehicles, this makes it a viable adjunct in addition to other appliqués, maximising protection in high-threat environments. It is also consid-



The L-ROD bar armour package mounted on a South African RG-31 Nyala protected patrol vehicle.

erably cheaper than most other protective systems. Ad hoc bar armour can even be assembled from scrap metal 'on demand' by deployed soldiers, as demonstrated during the early phase of the post-invasion insurgency in Iraq. On the other hand, the typical mounting distance away from the vehicle's hull can impede manoeuvrability, especially in constrained terrain such as narrow streets. Additionally, in some cases, bar armour must be removed before a vehicle can be airlifted. BAE Systems has marketed the L-ROD bar armour system since 2009. Made of aluminium, the armour is lightweight while offering the same level of protection from RPGs as afforded by steel bar armour. The modular kit can be configured for any vehicle type. The system can also be installed and maintained in the field with no welding or drilling required. Vitally, hinged doors are set into the armour grid to permit unimpeded egress from the vehicle.

### Tank kits

Several preconfigured kits are available which combine various types of add-on armour optimised to support one another, ensuring that no gaps in coverage remain. Users can also choose to apply only selected elements of the kit when the full panoply is not required. One example is the British Army's theatre entry standard or TES kit, devised for the Challenger 2 MBT and presented to the public in 2016. The primary purpose of the TES is to shield the tank from the threat posed by IEDs and ATGMs. To maximise protection, the kit provides three different add-on solutions, namely ERA, passive appliqué armour, and bar armour. Depending on the tactical situation, the unit can deploy one, two or all three simultaneously.

When fully outfitted, the tank's organic Dorchester composite armour is augmented by layers of armour blocks along both flanks and the turret (protecting both the crew compartment and ammunition magazine), with bar armour providing further protection, especially at the rear section of the hull and the rear portion of the turret. While useful under any circumstance, the extra protection is especially vital for operations in urban terrain and similarly constrained environments in which close-range ambushes with anti-tank weapons are a possibility. The Israeli Defense Force's Merkava MBTs also feature a highly modular all-around set of augmented protection, beginning with the Mk 3 variant, carried over to the current Mk 4 and Mk 4 Barak. The add-on armour is mounted in pre-existing retainers, enabling efficient addition, subtraction, or replacement of armour blocks in the field. This also facilitates keeping the system up to date by easily substituting newly developed materials.

The appliqué kit consists primarily of passive ceramic composite armour alongside the chassis and turret (giving the turret a sloped appearance), and also atop the engine compartment and turret. Bar



A Merkava Mk 4 MBT.

armour augmented by chain-and-ball armour is attached at the (more thinly protected) rear of the tank to detonate warheads before they reach the organic armour. The Merkava Mk 4 is one of the few MBTs which can also be equipped with a modular belly plate to improve protection against IEDs. The V-shaped underbelly module is composed of ceramic composite material. Additionally, low intensity conflict (LIC) or urban warfare configurations of the Merkava are provided with steel mesh around vulnerable points such as sensors, exhaust ports and ventilators to prevent attackers moving from cover to attach explosive charges. Recently, a so-called 'cope cage' or overhead bar armour grille has also been observed atop the Merkava turret to defend against top-down attacks.

#### Future option: electric armour

An alternative concept for countering shaped charges and potential APFSDS rounds is electric armour (also known as electromagnetic reactive armour). It consists of two or more conductive metal plates separated by a non-conductive buffer or a layer of air. One of the plates is kept very highly charged through a supercapacitor, while the other plate serves as the ground path. When a shaped charge jet passes through both plates, it effectively completes the circuit between the charged plate and the ground plate, resulting in a large amount of energy being dumped into the jet at once, disturbing and dispersing the jet in the process of the current moving from charged to ground plate. This effect is also understood to be capable of disturbing APFSDS penetrators, and reducing their penetrative capability, but the extent of this reduction is unclear.

As with ERA, electric armour needs to be coupled with some base passive armour, since the incoming projectile will retain some residual penetrative capability which needs to be absorbed. Electromagnetic armour systems should weigh less than traditional ERA, reducing the burden on the vehicle or enabling protection of lighter weight vehicles such as armoured personnel carriers. The reduced weight is also conducive to covering all vehicle surfaces, affording protection against top-down attacks.

Although several nations, including the US and the UK, have experimented with the concept for nearly two decades, operational electromagnetic reactive armour systems have yet to be introduced as some issues remain. One problem is that commonplace threats such as tandem-HEAT warheads would continue to pose a threat to vehicles using this form of protection. Although the power draw of electric armour has been reported be relatively low, nonetheless, modern vehicles already have large power demands from their mission systems which may reduce the viability of electric armour. As future armoured vehicles with greater onboard energy generation capacity enter service, electric armour may become more operationally viable, providing another option for modular vehicle protection.

## Radiation detection: the current state of the art

#### Dan Kaszeta

For several decades, much of the emphasis within CBRN detection has been most about chemical warfare detection, with occasional blips in biological detection. Radiation detection often gets treated at best as a settled issue and solved problem. After all, we have been able to detect, measure, and identify radiation rather a lot easier than we can do the same for chemicals and biological materials. At worst, radiation detection is considered a backwater in military affairs, with nuclear threats being relegated to the distant past of the Cold War.

The military radiation detection market has moved slowly in recent decades, and has done so on the back of broader developments in customs, border protection, and general antiterrorism measures. The last great emergence of perceived radiological threats that affected the radiation detection market was the collapse of the Soviet Union and the feared (and in retrospect largely non-existent) flooding of the world's commercial and transportation channels with Soviet-origin radioactive materials. A general boost to antiterrorism spending after 9/11 floated the radiation detection market a bit as well.

Some militaries have now re-discovered the 'RN' in CBRN, though. This phenomenon is not so much the emergence of a new threat environment, but a rediscovery that old threats are not going away. Not to put too fine a point on it, but the war in Ukraine involves a combatant (Russia) that still fields tactical nuclear weapons for battlefield use. Furthermore, this conflict occurs upon terrain that includes both older and newer nuclear power plants as well as significant land areas contaminated by the 1986 Chernobyl nuclear accident.

Various nations have let radiological capabilities atrophy somewhat, while others, such as Poland, kept their eye more firmly on the ball. For example, Poland has wanted neutron detection in main battle tanks (MBTs) at a point when others scratched their heads and wondered why. For the

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USAF 1st Lt. Santino Cozza and Airman 1st Class Jonathan Domingues, 19th Operational Medical Readiness Squadron bioenvironmental engineers, monitor the nose radome with a Victoreen 451P radiation detector during radiological aircraft recovery training at Little Rock Air Force Base, Arkansas, 24 October 2019.

curious, small battlefield nuclear weapons create rather more mayhem with neutrons, as a proportion of their harm, than larger ones. Due to the current threat environment, it is worth dusting off the topic and reviewing where these technologies are and what products are available.

### **Back to basics**

Readers of this magazine can probably be forgiven for not paying close attention to radiation detection technology or how it works. A bit of a primer is probably needed, and this correspondent is happy to oblige, and apologises in advance for a few simplifications. This whole particular area is concerned about 'ionising radiation' as opposed to 'non-ionising radiation'. Both are all around us every day, but non-ionising radiation includes such examples as radio waves that carry audio, video, and data signals, microwaves that cook for us or provide radar imaging, and light such as visible, Ultraviolet (UV), and Infrared (IR). As anyone who has had a sunburn can attest, non-ionising radiation can damage us, however, ionising radiation is what we are referring to in military and security circles. As its name suggests, ionising radiation imparts an electrical charge and ionises matter. This is biologically damaging in ways that are more serious than non-ionising radiation. Broadly speaking, ionising radiation comes from fission, fusion, the decay of radioactive isotopes of matter, and a few other sources such as x-ray machines. We are bathed in cosmic ionising radiation that

largely comes from the fusion of hydrogen that fuels the sun. We also have a fair bit of radiation coming at us from the earth itself, from naturally occurring radioactive materi-

als in trace quantities in various minerals. Ionising radiation can be in the form of alpha particles, beta particles, gamma rays, and x-rays. As the name implies, the alpha and beta are actually physical particles. An alpha particle contains two protons and two neutrons (essentially a Helium-4 nucleus), and is positively charged. A beta particle is an electron, and so is negatively charged. Gamma rays and x-rays are photons, which means they are pure energy and have no mass or charge. From a detection and measurement standpoint, the latter two are identical, only their origin differs. There's also the odd subcategory of neutrons. Neutrons, singular particles that are neither positive nor negative are occasionally omitted by some radioactive sources. They can be highly destructive.

The way these different types of radiation interact with matter differs somewhat, so no one single technical approach can give us all of the information we may want or need. Radiation sensors can be made for various purposes. Detection sensors tell you whether radiation is present and may be useful for finding radiation sources. Measurement devices provide some sort of quantitative output, in terms of dose rate, such as 'counts per minute' or 'Rads per hour' somewhat analogous to a speedometer. There is an esoteric variety of units used to measure and describe radiation, but this is somewhat beyond the scope of this article.

Another category, dosimeters, work like an odometer, an provide an accumulated reading of how much radiation has been absorbed over a period of time. So-called 'isotopic identifiers' try to not just detect and measure radioactivity, they try to analyse the exact nature of the radiation in order to make a calculated estimate of what type of source may have emitted it. Each of these tasks are different and often require separate instruments. Indeed, few do all of them in one device. It should be noted that naturally background radiation is always present, so this can complicate all of these tasks.

#### Military and security roles and missions

Military roles for radiation detection include a variety of missions. First there is the need for monitoring to detect whether there is a radiation hazard present, as opposed to merely natural background radiation. If radiation is present, surveying equipment or terrain to find out where contamination is specifically present may be necessary. Is a road safe to use? Is this tank contaminated? Such instrumentation can also aid decontamination by providing some degree of quality control in decontamination processes. Did we clean up the tank properly? Dosimetry, the measurement of accumulated radiation absorbed by individuals, can protect the health of personnel by ensuring that nobody exceeds an unsafe dose. Has this platoon been over-exposed? All of these use cases amount to commanders making decisions about whether a particular location or situation is safe or unsafe or if a particular bit of equipment or infrastructure is 'clean' or 'dirty'. The environmental demands and rigors of combat often dictate product design for ruggedness, but the actual innards are the same.

In the security sector, there are additional, complex tasks and missions. Detection of hidden radioactive materials in baggage, vehicles, or cargo is a core customs and border protection issue. Security and antiterrorism personnel conducting detection missions in urban areas and near civilian populations will be confronted with a





USAF Staff Sgt Ismael Zayas Ramos, 100th Civil Engineer Squadron emergency management training NCO in charge operates radiation detection equipment during an Aircraft Radiological Recovery Plan training event at Royal Air Force Mildenhall, UK, 11 May 2023.

bewildering array of annoying false alerts from medical procedures, building materials, and industrial sources. Isotopic identification is often needed to tell if detected radiation is benign (like Potassium-40 which is a natural radiation source found in bananas) or malicious, such as a stolen Caesium-137 medical device. The previous two decades have seen a proliferation of specialty devices for the homeland security market.

### **Technology overview**

All of these missions can be accomplished with scientific instrumentation. A simple way of describing radiation detection, measurement, and identification instrumentation is that science found ways of making objects that interact with radiation in ways that can be measured by electronics. It is a Hollywood trope that radiation detectors are all 'Geiger counters'. This is not true, but some really are. The Geiger-Müller tube is a venerable technology in this field. It is a gas-filled tube which reacts to incoming radiation and detects the ionisation caused by particles or rays passing through the tube. The number of such ionising events can be used to estimate the amount of radiation. Other types of gas-filled tubes or chambers are also used, using similar principles. These are often rather inexpensive devices, and they remain very much in use in use, either on their own or bundled with other technologies. If you are looking to wave a device over a floor and look for where some radioactive dust has been tracked, for example. a 'Geiger Counter' may be your best bet for economy and speed.





Radiation detection has come a long way from 1960s Geiger Counters.

Another class of device are known as scintillators. A variety of materials, principally Polyvinyl Toluene, a plastic, Caesium Iodide (CsI), lanthanum Bromide (LaBr3) and Sodium Iodide (NaI) are in this category. They give out flashes of visible light when radiation interacts with them. In particular, NaI can also measure other characteristics of the radiation and give some clues as to the identity of the substance emitting the radioactivity. Thus, NaI devices are sometimes useful for identification as well as detection.

A further category is composed of semiconductor devices. These substances react electrically when exposed to radiation. Like scintillators, there are a range of these materials ranging from relatively simple to quite expensive and complex. Cadmium-Zinc-Telluride (CdZnTe or CZT) is a midrange option and used in some detectors. The high end of this market is chilled Germanium. These instruments are expensive, and the Germanium needs to be cooled to very low temperatures, which used to require liquid nitrogen. However, these are the very best portable isotope identification instruments available.

Dosimetry can use a few other technologies, not all of which work in real time. The simplest dosimeters are film badges and pocket ion chambers, which have not changed in decades. Thermoluminescent dosimetry (TLD) is widely used, but needs a dedicated device to read a dosimeter after the fact. It should be noted that many detection instruments have the capability to work as a de facto dosimeter and do some calculations to approximate an acquired dose over time. Some 'personal electronic dosimeters' using Geiger-Müller tubes are now actually quite good. Others are more approximate.

Alpha and neutron detection are somewhat more difficult disciplines, are less necessary in field environments, and require specialist instrumentation. Alpha detection often uses traditional Geiger-Müller tubes, but with a fragile thin membrane. As such, they are easily broken in the field. Neutron detection traditionally used Helium-3, but a worldwide shortage of that material has necessitated new approaches to neutron detection, and Lithium-6 is now being used in this role.

### **Products and market players**

Unlike some types of military technology, the military radiological market is broadly supported by a wider market. The nuclear power industry, border protection, and medical sectors have demands for products that do more or less the same thing as military detectors. In most parts of the world, these markets are significantly larger than the military market. Almost universally, the manufacturers make radiation products for the broader markets as well. Often the key distinguishing feature between a military and a civil product is 'ruggedisation'.

The radiation detection market has long been a space full of specialist SME manufacturers with a handful of products and technologies. While a number of these firms still exist, recent decades have seen mergers and acquisitions. Often, this means that radiation detection product lines are a small percentage of a corporate giant's turnover. Teledyne FLIR (USA) and Thermo Fisher Scientific (USA) stand as key examples of such market players. They are world leaders in radiation detection, but these firms are leaders in a lot of areas. Canberra, long a name in the field, is now part of Mirion, yet another global firm in the field. Ortec, leader in Germanium isotope identifiers, is a branch of Ametek (USA), the electronics firm. Ludlum (USA) continues to be a name of note. Bubble Technology (Canada) works in neutron detection. Svmetrica (UK), Tracerco (UK), Ultra Energy (UK), H3D Gamma (USA), PHDS (USA), Nuvia Group (UK), Radiation Solutions (Canada) and others have diverse product offerings. Argon (UK) holds a special place as well, not as a manufacturer, but as a training and simulation firm that can adapt others' products for use in training environments.

### **New frontiers**

There are dozens of new products in this area, but many of them represent incremental improvements over existing systems. Compared to the rather nebulous offerings in biological detection and the growing pains of chemical detection, it might seem that radiation detection is more settled. Is there room for innovation and improvement? A casual glance around the exhibition floors at trade shows demonstrates that there certainly are new developments.

One remarkable development from a procurement perspective is that the US military finally adopted a new radiation detector, replacing the 35-year-old AN/ PDR-77 and AN/VDR-2 radiation detectors. D-Tect Systems, a Utah-based division of Ludlum, is producing the "Radiological Detection System" for US DoD requirements. A 'Milestone C' decision

on this system, was reached in the summer of 2023, finally moving procurement and deployment forward. The system is modular; a user-friendly base unit, with basic beta and gamma capability can be augmented with a number of different external probes, covering numerous specialty detection tasks, such as alpha or neutron detection. This development is big news due to the volume required - it has been reported that at least 50,000 units will be procured over the next decade or so. That counts as a truly large order in this sector. Economies of scale may make this product more affordable in other markets in time.

In terms of broader technical developments, there have been developments what we can loosely term the front end (the bit of the detector that interacts with the radiation) and the back end (the processing of the data) of radiation detection systems. In terms of "front end", germanium-based instruments that do not need liquid gases to chill them are getting smaller and cheaper. Devices that function as "gamma cameras" are becoming more affordable. A gamma camera combines high-resolution radiation detection with imaging technology so that you actually "look" at the world

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D-Tect's Radiological Detection System is being procured in high volume for the US DoD.

through the eyes of the detector and see where the radiation source is located. These have been around for some time, but have been large and very expensive. Such systems are getting smaller and cheaper, albeit in relative terms – they still cost as much as a new car.

PHDS, a Tennessee-based company combines both Germanium spectroscopy and imaging. Their GeGI instrument, weighing in at less than 7 kg and is mechanically chilled. It not only accurately identifies gamma-emitting radioactive isotopes within a few seconds, it overlays the radiation detection output onto a 60-degree field of view and works out to about 50 meters. If the source is under the seat of a car, it appears on the screen exactly there. There are numerous operational scenarios, where this capability may come in useful, particularly in situations responding to alerts from cheaper and more widely proliferated sensors. Make no mistake, this is a premium product, but one that gives PHDS's more firmly established competitors like ORTEC something to worry about.

From the perspective of 'back end' improvements, basically every manufacturer has benefited from miniaturisation and computing improvements. A good bit of scintillator material is only as good as the electronic components and algorithms interpreting the information coming out of the detection materials. One example of a manufacturer that seems to be doing this well is Symetrica (US/UK). Their Verifinder product line is gaining a lot of traction among security and defence clients who need isotope identification. Part of their success seems to be excellent software and algorithms embedded in the kit. Identifying multiple radiations sources correctly and quickly amidst not just background radiation but also the complexities of a high-radiation environment during an incident is a perplexing mathematical problem. Symetrica appears to have done well with this task and has excellent algorithms to guickly sort through the issues. This is not to say that Symetrica isn't doing well with the 'front end' as well. They are addressing neutron detection by using Lithium-6 based detection. It is also clear that their systems are useable in a wide variety of opera-



*Symetrica's Verifinder isotope identification equipment has been trialled with military users in several countries.* 

tional conditions, with a -20°C to + 50°C operating temperature, which is very impressive in this sector. Tellingly, some vendors' literature does not give operating temperature ranges, and it seems logical that users may have to do some extra work to get accurate information out of scintillator crystals and semiconductors at low and high temperatures.

Truly different approaches have been rare in recent decades in this field. However, a US-based start-up firm, CODEAC Solutions, has come up with a very new approach to surface contamination detection. Examining surfaces for radiological contamination has long been a core mission for radiation detection instruments. CODEAC approaches the issue from a totally different perspective. The primary surface contaminants of concern in a radiological environment are a fairly narrow number of isotopes. How about detecting them chemically instead of radiologically? CODEAC's surface wipes change colour in the presence of cobalt, uranium, plutonium, and a few other elements. They use the chemical properties, not the radiological properties, of these elements to detect the presence of hazards. For many applications, this may be far easier than electronic methods. Interestingly, this could also have environmental health implications in detection of (relatively unradioactive) depleted Uranium.

### The way forward

Where is the future in all of this? The equipment can get better, cheaper, easier to use, and more accurate. In recent years, this has had to do with both improvements in materials science (i.e., better ways to make and use materials that are responsive to ionising radiation) and electronics improvements, such as smaller hardware and better software. Both aspects can take advantage of improvements from other sectors of industry. Equipment that is smaller and cheaper will also be easier to field on a more widespread basis. This should make it easier to have more sensors across military units, and not just segregated to specialist teams. It is possible to find some prospects for convergence. The digital camera in a smartphone contains a semiconductor that is not actually bad at detecting gamma rays. There are even apps that do this now. Will the next generation of radiation detection actually just be an app that resides on a smart device that every soldier has on their belt? This author can think of ways that this could happen inside a decade.



Viewpoint from **Kyiv** 



## Assessing the fighting

### **Alex Horobets**

n late 2023, the war in Ukraine once again captured international headlines. However, unfortunately, this is connected not with the much-sought de-occupation of large swathes of Ukrainian territory or a Ukrainian breakthrough toward the Sea of Azov, but with assessments of the current results of the Ukrainian counter-offensive, the battlefield situation, and issues with the allocation of new packages of military assistance to Kyiv. Little attention is paid to how Russia can take advantage of these circumstances, and not only regarding Ukraine.

In sum, the Ukrainian counteroffensive did yield some positive results, but no strategic shifts were observed despite high expectations. Those expectations, however, mostly came from the general public and Ukraine's allies. Kyiv did regain some of its territories and reopened maritime commercial routes. The Ukrainian army took down a large number of Russian military personnel and destroyed plenty of weapons systems, ranging from tanks and artillery to aircraft. A new threat has also emerged for the Russians when the Ukrainians launched a series of smaller-scale amphibious landings onto the eastern bank of the Dnipro river in Kherson region, which looms over the North of the occupied Crimean Peninsula. Among the reasons why Ukraine could not attain greater results are limited arms supplies, the lack of air support, and a very stretched front line.

At the moment, the war is heading toward a positional phase, where the front line typically moves only slightly, while any significant advance implies great sacrifices. As President Volodymyr Zelensky said on 1 December 2023, Ukraine has entered a new stage of war, which is about a transition to defence and an increased application of unmanned aerial vehicles and anti-tank systems. This also means that in the near future, we are unlikely to see any news of the liberation of vast areas, as was the case in 2022, and the warring parties will typically be fighting for minimal gains, of some hundreds of meters or a few kilometres at a time.

These are exactly the conditions that are favourable for Russia to exploit war fatigue in Ukraine and the West to its advantage. Even if neither side achieves large-scale goals during the winter campaign, Russia still has the advantage of greater mobilisation resources and transfer of its larger economy to a military footing. In the next three years, almost a third of the Russian Federation's budget will be used to maintain the army and the defence industry. Yet even these steps may not be sufficient for Vladimir Putin to achieve his ultimate goals.

Therefore, the Kremlin is employing all possible resources. In particular, as stated by Ukraine's defence intelligence, Russia injected a staggering USD 1.5 Billion into a new round of an anti-Ukrainian propaganda campaigns, which is a record amount since 2014. Through such efforts, Moscow is trying to create a split in Ukrainian society. A lot of effort goes into exerting influence on individual politicians in several countries to ensure that military and financial assistance to Ukraine is curbed.

However, fairly realistic assessments of the current situation are coming from the United States and NATO. US State Department spokesman Daniel Isaac stated that the results of Ukraine's counteroffensive should not in any way affect the level of US military assistance. Although by the end of the year the White House had spent almost all the funds previously allocated for Ukraine assistance, and the issue of providing further funding has become bogged down in Congress.

In turn, NATO Secretary General Jens Stoltenberg called on NATO member states to boost ammunition production, since the ongoing war in Ukraine is a war of attrition, a battle for efficiency and logistics that also tests the defence capabilities of the Alliance.

Under these circumstances, Ukraine is looking at a fairly challenging year ahead. Although presidential elections are scheduled in Russia for March 17, 2024, it does not seem that Vladimir Putin expects to have ended the war by then. Moreover, he appears to be bracing for a long war, but this does not rule out the possibility that he will need some smaller-scale 'victories' before the elections to use in his Presidential campaign. It is possible that this is why the Russian army launched offensive operations in several sectors in eastern Ukraine.

Under such conditions, the Ukrainian political and military leadership should demonstrate cohesion. On the other hand, assistance from Western allies must continue. After all, as has happened before, sensing the West's weakness in terms of supporting Ukraine, the Kremlin may start destabilising other regions that are sensitive for NATO, and not only on its eastern flank, but also in other parts of the world.

# MEDEVAC – keeping the wounded alive

### **Tim Guest**

The efficient medical evacuation (MEDEVAC) of wounded soldiers from the battlefield follows a planned pathway involving trained personnel using the latest available equipment and medical procedures.

Battlefield wounds often present medi-cal professionals with the most complex injuries encountered. A soldier may be wounded in the remotest of locations, 🗒 making it all the more urgent for an efficient MEDEVAC to be set in motion as soon after the wound has been sustained as possible – at the point of injury (POI) – to ensure the best possible chance for survival. This article provides a brief overview of the ground-based MEDEVAC chain used by NATO nations. It includes a look at some of the latest medical devices and interventions that currently equip many of the field ambulances and various medical treatment facilities (MTFs), casualty staging units (CSUs) and other locations along the tactical ME-DEVAC path, and includes a look at blood loss and haemostatics.

### **MEDEVAC** in NATO

Within NATO, the Joint Medical Evacuation Concept provides a doctrine for the medical evacuation of casualties within a NATO operational scenario. This encompasses best practices of member states and provides Alliance combatants, as well as other friendly forces operating alongside NATO, with a 'continuity-of-care' pathway involving medically-trained personnel, dedicated resources, equipment and latest treatments designed to keep the patient alive throughout the MEDEVAC process, and before strategic repatriation becomes possible. This joint concept is outlined by Colonel Dr. Ingo Hartenstein in his paper, 'Medical Evacuation Policies in NATO'. which is referred to in this section to provide an overview of the various stages in an allied MEDEVAC chain of events.

The Hartenstein paper emphasises the need for as common and predictable a system as possible to avoid chaos and ensure

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A Humvee ambulance during the US Army's Best Medic Competition at Fort Hood, Texas, 27 January 2022. MEDEVAC among NATO members follows a 'continuity-of-care' pathway involving medically-trained personnel, dedicated resources and equipment designed to be familiar to all.

that casualties suffered in the operational battlespace, can be evacuated along a 'common and predictable' system – even under extreme conditions – and, as far as the operational situation allows. MEDEVAC is a pre-planned process, tracked at every stage and with dedicated resources, equipment, ambulances and trained medical personnel. It differs from CASEVAC, which unfolds without such resources and relies on untrained, or basically trained individuals using improvised methods of transport and non-dedicated vehicles to evacuate a patient as rapidly from the battlefield and out of harm's way as possible, often with no medical equipment other than individual first aid kits (IFAKs).

Hartenstein's paper explains the three ME-DEVAC categories used by NATO, while acknowledging that "individual nations may choose to describe their MEDEVAC activity in different ways, but we must remem-



A team of British Army medical personnel treat a simulated casualty in the resuscitation bay within the field hospital during a training scenario on Ex Iron Titan on 2 October 2023. The further up the MEDEVAC path a patient is transferred, the more advanced the care and equipment becomes.

Credit:

ber that NATO must provide the common framework, that can be appreciated and contributed towards by all NATO national elements".

The first category described is Forward ME-DEVAC, which begins at the POI, "to the initial MTF", where the first "opportunity for resuscitative intervention" is present. Hartenstein notes that the movement of casualties in Forward MEDEVAC is mainly conducted by ground-based ambulance fleets, although airborne assets can also be employed at this stage. It is in the dedicated wheeled and tracked ambulance fleets and at the MTFs that some of the latest medical equipment and procedures can be brought to bear on life-threatening wounds, thereby improving chances of survival.

The next category outlined in Hartenstein's paper is Tactical MEDEVAC, which he describes as the "coordinated transfer of patients within the Joint Operational Area, between available MTFs. The aim of the movement is to advance the casualty to greater care levels to meet the needs of the patient, with the ultimate aim of achieving transfer of the patient to the CSUs and into the final category of MEDEVAC, Strategic MEDEVAC".

This third and final stage, which will be touched upon only briefly in this article, aims to deliver the patient to advanced and intensive medical care facilities, typically in the casualty's home country. The transportation means involved depend on available assets for evacuation and may include dedicated ground ambulances, rail cars, as well as airborne assets, depending on distances and numbers of wounded to be transferred.

### POI to survival – transport, devices, interventions

Within the defence industry, Rheinmetall produces an armoured field ambulance version of its high-roofed Fuchs armoured transport, unveiled in 2021 (see ESD October 2021). Able to transport four casualties, two lying down and two seated, the ambulance is equipped with intensive care and patient monitoring equipment.

Another ambulance maker is Marshall Land Systems, which has developed several vehicles over the years for NATO members including the UK, Sweden and The Netherlands; one of its most recent is a reconfigurable, Boxer-based, armoured ambulance for The Royal Netherlands Army. With deliveries continuing throughout 2024, the German Bundeswehr's ambulance corps is receiving 80 highly protected Eagle 6×6 vehicles from General Dynamics European Land Systems (GDELS) over a period of

The armoured field ambulance version of Rheinmetall's high-roofed Fuchs armoured transport was unveiled in 2021 and can carry four casualties, two lying down and two seated, with the ambulance equipped with intensive care and patient monitoring equipment.

three years following a contract of USD 159 million awarded in 2020 by the German procurement agency, BAAINBw. In a statement at the time, GDELS said the vehicle was selected under the medium protected ambulance vehicle programme (mittleres geschütztes Ambulanzfahrzeug), and closes the gap between the user's light and heavy ambulance vehicle fleets.

It is on board the ambulances produced by a wide variety of makers, as well as in the MTFs and CSUs along the way, that the latest medical equipment from companies such as Philips, Promoteq, Ortus Technology (Corpuls and Weinmann), Safeguard Medical/Combat Medical, Zoll, (all represented in the Medical Hub at DSEI 2023), play an ever increasing role in aiding the survival of casualties throughout the ME-DEVAC process.

Philips, for example, offers an array of solutions; Paul Cropper, the company's global head military and disaster relief, told ESD during last year's DSEI, that the company provides effective end-to-end support for casualties along the MEDE-VAC pathway. As part of its offer, the company provides lightweight, rugged medic packs with equipment to support triage, diagnose and treat the wounded on the ground and at various stages during evacuation, including its IntelliVue X3 and Tempus Pro units for the monitoring of vital signs, and its HeartStart FR3 (weighing 1.3 kg), professional-grade automated external defibrillator (AED), which has been tested to military standards and certified by the US Army. When it comes to casualties requiring ventilator support, the company's Trilogy Portable life support ventilators, weighing only 5.6 kg, can provide several hours of life-saving ventilation while transporting patients from POI to MTFs, CSUs and beyond. Philips has also developed a lightweight, portable ultrasound device, displayed at DSEI, for use at any stage of MEDEVAC.



Corpuls modular patient monitor and defibrillator.

Another industry player with a similar array of end-to-end solutions is Zoll, with automated CPR systems, defibrillators, ventilators and more. Its business development manager of military sales, Maxine Bowley, told ESD at DSEI that the company collaborates closely with its military customers in the development of its medical equipment for military use, thereby ensuring they meet the extreme demands of the MEDE-VAC chain of events. Equipment such as its EMV+ portable ventilator, which is suited for use on board ground-based field ambulances of all descriptions, as well as airborne assets, is just one of the devices offered.

### **Bleeding and clotting**

Probably the most common cause of death following an initial wound is blood loss. According to trauma specialists in the military medical field, haemorrhage is responsible for the "vast majority of potentially survivable deaths in combat casualties", with most fatalities taking place pre-hospitalisation. Leading academics and surgeons in military medicine have agreed in recent years in a wide range of papers on this subject that improving the availability and use of "advanced bleeding control" systems in combat scenarios and throughout the ME-DEVAC pathway, will help improve survival rates for those with even the most complex injuries.

the more sophisticated the resources and medical bag contents become. That said, the key pieces of equipment within an IFAK will also be present further up the chain." Berrow continued, "Celox also supplies chest seals to treat penetrating chest trauma. There are three leading causes of preventable deaths, i.e. when appropriate treatment is delayed; the first is major haemorrhage accounting for about 80%; the next is a compromised airway; and the third is a penetrating chest trauma, or pneumothorax, basically a hole in the chest causing a collapsed lung, or pressure buildup – tension pneumothorax – compressing other vital organs and vessels. This is where the chest seal, like our Foxseal chest seal provides an occlusive dressing with a one-





The gauze-based Celox Rapid haemostat takes about one minute to take effect. The company supplies about 80% of NATO forces with its haemostatic products and has been the supplier of choice to the British Armed Forces since 2006.

One leading specialist in the haemostat field is Celox Medical, whose global product and business development manager, Tim Berrow, spoke with ESD about its solutions and the important role haemostats play from POI along the MEDEVAC chain. The company's gauze-based Celox Rapid haemostat, for example, takes about one minute to take effect compared with its granule-based haemostats, which can take up to five minutes.

According to Berrow, "Generally, any combatants will be issued with an IFAK containing various components such as haemostats, tourniquets, chest seals, etc, and in the phases of care, such as care under fire where a soldier has suffered a wound resulting in catastrophic bleeding, the Celox haemostat would be used as close to the POI as possible, possibly with the soldier using it on themselves, or a first-line medic using the individual patient's own IFAK contents to apply the haemostat. They will then enter the tactical field care phase, with the casualty being moved from the battlefield into a dedicated ambulance in the case of MEDEVAC, equipped with more comprehensive medical kits and equipment – the further up the chain you go

way vent/valve, enabling air to leave the chest, but preventing any from entering. Such a device will be in IFAKs, as well as aboard dedicated field ambulances."

### Historical perspective, new development

Offering background and a historical perspective on battlefield bleeding, Sir Keith Porter, Senior Medical Advisor at Cambcol and a senior trauma surgeon at Birmingham's Royal Centre for Defence Medicine, told ESD that, "War over millennia has driven advances in care, most significantly during the Afghanistan campaign." He said the 15th century saw the introduction of ligatures to stop blood loss and in the Napoleonic Wars, the introduction of patient Triage, (French: to sort), and 'flying ambulances' - horse-drawn carts to evacuate the most seriously injured soldiers to nearby field hospitals where rapid amputation was the only option for those with severe limb injuries.

By the end of World War I, Porter said blood transfusion was possible, with World War II seeing increased use of blood for transfusion and the introduction of antibiotics,



Clotta used to secure haemostatic in a patient receiving emergency surgery for head trauma in Ukraine.

although many troops still died of blood loss in the field. "Both the Korean and Vietnam Wars saw more rapid evacuation of the injured and the introduction of forward surgical capability in clearing stations and field hospitals," Sir Keith said, "where, despite these advances, haemorrhage was a common cause of death and preventable deaths." He added that the index injury during the war in Afghanistan was caused by improvised explosive devices resulting in catastrophic limb and pelvic injuries, as well as torso and head trauma. "Without the use of tourniquets and haemostatic dressings, many more lives would have been lost due to blood loss."

Porter also noted that haemostatic dressings have historically functioned as a 'bung' with no intrinsic blood-clotting capability. "What is required is a product that has the ability to up-regulate the natural clotting process and be easy to use and produce consistent results." At this point, he told ESD about Cambcol's new Clotta haemostat, which, he said, "provides all of these actions and also has anti-bacterial properties, which reduce potential infection risk, particularly when there are extended casualty evacuation times to definitive care." He said the new product has the potential for use in all grades of external and internal bleedina.

It is worth noting that with the Russian invasion of Ukraine in February 2022, urgent medical requirements saw the Clotta haemostat released for early export through ProTrainings Europe in April of that year, specifically to aid Ukraine. The company said in a statement at the time that the product would be available soon in the UK, but that stocks were ready for immediate dispatch to Ukraine and other countries that allow "unlicensed haemostatic dressings".

Providing more detail, Cambcol's CEO, Jonathan Fitton told ESD that, "Clotta is a collagen-based haemostatic dressing, which uses an innovative formulation to stimulate and enhance natural clotting responses to stop bleeding quickly, unlike the 'jellified bung' methods that are very common within this category. It will stop and clot arterial bleeding, right down to minor everyday cuts and scrapes. It is a Class III medical device, due to its invasive use and the fact that it is composed of material of avian animal origin as the source of collagen."

Fitton continued, "Unlike the standard livetissue model of a 45-second bleed, Clotta has been used successfully on immediate application following complete severance of the femoral vessels. Data collected so far also shows significant wound healing acceleration; it can also be used in extremes of weather conditions and in both hypo and hyperthermic patients."

Regarding the product's use in Ukraine, Fitton added, "it is already being used in Ukraine via charities under a special waiver".

### **MEDEVAC** from Ukraine

Staying with Ukraine, strategic MEDE-VAC is currently being conducted 'out' of the country by rail and ambulance into a MEDEVAC hub based in the Polish city of Rzeszów, near the Ukrainian border, and from there by airborne assets to other overseas facilities. According to reports, as of August 2023 more than 2,350 Ukrainian military and civilian patients suffering from serious war wounds, as well as other critical ailments, had been evacuated to hospitals in 21 European countries since the initiation of the EU Civil Protection Mechanism, set in motion in March 2022. With fully trained medical personnel and latest equipment and best-practice treatments, the Polish MEDEVAC hub, acting in the role of a NATO-like CSU, provides patients with sustaining and stabilising care and support before transfer to other overseas facilities, with flights provided by Norway twice a week

The World Health Organization (WHO) announced in March 2022 that it had donated four additional ambulances for MEDEVAC and repatriation operations from Ukraine to Poland, enabling the Humanosh Foundation to deploy these assets and reinforce MEDEVAC convoys for the Ukrainian Armed Forces, providing evacuation and life-sustaining treatment, transporting critically ill patients from medical facilities across Ukraine to the Medevac Hub in Poland. In a statement, WHO said the ambulances are equipped to transport four patients and include: oxygen tanks, defibrillators, portable ventilators and other equipment. In July 2023, it was announced that the EU and WHO were joining forces to strengthen MEDEVAC operations for Ukraine.

### **Final word**

It is clear that wounded soldiers today stand a far greater chance of survival thanks to the availability of previously unavailable advanced medical equipment and treatment that can be administered close to the POI. Certainly, no soldier wants to end up in need of urgent MEDEVAC, but it must be some consolation to know that the modern MEDEVAC system comprising the latest treatments and medical technology is available, thereby ensuring each and every wounded combatant has the best possible chance of survival under almost any circumstance.



## **Their Dark Materials**

### **Thomas Withington**

A new software tool could help locate individuals suspected of war crimes in Ukraine via posts that they may make to the Telegram social media application.

You may not be familiar with Telegram. Neither is your correspondent who equates the name with a form of retro telecommunications which largely fell into disuse in the 1990s. The growth of the internet was largely responsible for the demise of this form of written communications. Nonetheless, the name is back with a vengeance following the launch of the Telegram Messenger service in August 2013.

Telegram was developed by Nikolai and Pavel Valervevich Durov, Russian-born computer programmers, mathematicians and entrepreneurs. Telegram provides encrypted instant messaging, much like WhatsApp and Signal. Social networking features are also included in the software application. One of Telegram's achievements is that it has become the most popular messaging service in Russia. MegaFon is the country's second largest cellphone operator. In March 2022, the company said that Telegram had surpassed WhatsApp as Russia's most popular messaging service. This growth could have been artificially created by several factors: Firstly, in October 2022, the Russian government added Meta, owner of Facebook and Instagram, to its list of violent and extremist organisations. In March 2022, Facebook and Instagram were banned by the Russian government over accusations of 'Russophobia', according to media reports.

Given the apparent popularity of Telegram in Russia, manufactured or otherwise, it is no surprise that the messaging service is playing an important role in the ongoing war in Ukraine. A report by Time magazine in March 2022 called Telegram "an instrumental tool for both governments and a hub of information for citizens on both sides." The report continued that it is not only the Russian

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Ukraine's President Volodymyr Zelenskiy is seen here during a visit to the city of Bucha, just to the northwest of Kyiv. Photographic and video evidence emerged of war crimes following Russian forces' occupation of the city and their withdrawal on 1 April 2022.

military, its government and sympathisers who are using the application – Ukraine's government and sympathisers are also enthusiastic users.

This is not the first time Telegram has found itself in the middle of a warzone. Social media sites such as Twitter (now X), Facebook and YouTube have come under popular and political pressure to curb extremist content. From 2014, these companies began cracking down on content provided by the Islamic State of Iraq and Syria and its followers. Violent content otherwise destined for these sites has now migrated to Telegram where controls are lax to the point of non-existent. Likewise, crackpot conspiracy theorists have found a haven on Telegram as established social media sites have paid closer attention to their ramblings. Telegram seems to have become something of a digital 'Wild West' - a place where anything can be posted, and anything qoes.

Like every conflict since the advent of the newspaper in the late 17th Century, the conflict in Ukraine is being fought in the information space as an adjunct to the battlefield. Both Russia and Ukraine fight to dominate the information, and hence the cognitive, space with their narratives. Telegram has also become an intelligence tool. Smartphone footage of Russian Army vehicles moving through the streets of an occupied Ukrainian city will indicate where those vehicles are to anyone familiar with the surroundings. The person posting may even add comments about where the vehicles are, and this may be done in near real-time. To preserve security during the Second World War, the American government warned the US public that 'loose lips sink ships'. Eight decades later, indiscretions on social media can be just as dangerous. Today, loose tweets flatten streets.

### **Finding the perpetrators**

As the article in Time notes, Russia's government has been an enthusiastic user of Telegram. The application has become a useful vehicle for propagating Moscow's disinformation, and sympathetic narratives. Although Telegram banned accounts owned by Russia's state media, alternative channels have sprung up. These claim to be providing objective, facts-based reporting when in reality they are anything but. As the report continues, 'The War on Fakes' Telegram channel regularly churns out Russian dezinformatsiya (disinformation). Telegram has also become a home for far darker materials including footage of potential war crimes. in which 298 passengers and crew were killed on 17 July 2014 when their Boeing 777-200ER airliner was shot down over Ukraine. The aircraft was destroyed by a 9K37M1 Buk-M1 (NATO reporting name: SA-11 Gadfly) medium-range surface-toair missile system belonging to the Russian Army. On 17 November 2023 Igor Girkin and Sergey Dubinskiy, both officers in Russia's FSB foreign intelligence ser-



Telegram has emerged as one of the most important social media software applications in the ongoing war in Ukraine. Developed by two Russian-born programmers, it is extensively used by both sides.

Russian combatants fighting in Ukraine have allegedly uploaded pictures of such atrocities to the platform.

It may be possible to use open-source intelligence techniques to determine where these acts took place and to identify those who may have been responsible. The first challenge is ascertaining when the acts occurred. Determining time and date may be possible from the Telegram post itself, or by correlating when it was reported to have taken place via third parties or via reports from the victim's associates. Alleged perpetrators may be identified by cross-referencing timelines with information on military units in the area at the time. For example, the Ukraine Conflict Monitor provides an accurate chronicle of Russia's order-ofbattle in Ukraine.

There is an imperative to determine the identity of the individuals responsible for possible war crimes which can be a laborious, if not impossible task, using open sources. The work of the Bellingcat investigative journalism organisation helped determine those responsible for the loss of Malaysian Airlines Flight MH17, vice, and Leonid Kharchenko, a Russian separatist, were convicted in absentia of mass murder.

Tracking down individuals like Messrs. Dubinsky, Girkin and Kharchenko takes time and painstaking work. Fortunately researchers at the Centre for Information Resilience (CIR), a human rights non-governmental organisation, have devised a way by which Telegram users can be geolocated. CIR's approach uses the Python programming language. Python was used to create a dedicated script which can extract the geographical coordinates of the devices participating in a Telegram channel. As well as geolocation details, the script can discern the identity of user, the date the post was made, the content of the message and any media that was posted such as still photos or video. CIR researchers have included step-by-step details on how to use this script with Telegram. Instructions are sufficiently clear so that even a non-specialist or someone with only a basic grasp of computing can follow them. Once all these steps have been followed it is possible to visualise the locations of the Telegram users via Google Earth.

It is therefore now possible to see in an instant where the locations of the devices using Telegram are on any specific day. The benefits of such technology are obvious. Suppose a squad of Russian troops have filmed or photographed themselves performing extrajudicial killings of Ukrainian soldiers or civilians. They may have decided to upload this imagery to Telegram to share and boast with their friends. Perhaps they are sharing the imagery with an extreme rightwing Russian nationalist channel? Using CIR's Python script it could be possible to determine when and where these photographs or video footage was filmed. It is highly likely that individuals may not be using Telegram under their own names. Instead, they may have adopted a nom de guerre or other nickname. Getting these latter details are vitally important. Even nicknames can help lead investigators to someone's identity which maybe discernible from other sources online.

### The double-edged sword

CIR researchers declined to answer questions directed to them regarding their Telegram research tool. Nonetheless, it is clear this Python-based script has significant utility. As well as aiding war crime investigators it could be useful in helping journalists debunk dubious government claims or propaganda. Nonetheless, a note of caution should be sounded. CIR researchers revealed this tool to the world via a LinkedIn post. The danger is that it could be leveraged for nefarious purposes too. Those with hostile intent could also use these techniques to determine the location and identity of any telegram users, malicious or not. Ukrainians under Russian occupation sharing details of human rights abuses could likewise risk geolocation. Individuals outside Ukraine using Telegram could be at risk should these tools be used nefariously. Like many emerging technologies, its impact can be double-edged.

The ongoing war in Ukraine is arguably the first conflict in which social media and social networks have played such an important role. Their importance highlights the fact that the information space, including the cyber domain, has now become a space for exploitation. Software apps such as Telegram are making their presence felt, but so will the techniques devised by CIR to geolocate users. These kinds of tools could likewise prove particularly important in the aftermath of the conflict, when the reckoning for war crimes begins.

## Texelis unveils the Celeris mobility system concept

### **David Saw**

Texelis has recently unveiled its 'Celeris' 4×4 mobility system concept. Effectively this is a range of kitbased chassis and driveline packages being offered to vehicle manufacturers, in order to simplify the development of new 4×4 platforms. In addition to the chassis and driveline, the Celeris offer also includes Texelis' assistance with integration of hulls and key vehicle electronic components.

French company Texelis is a mobility systems provider operating in both the commercial and defence sectors. The company's main commercial activity is in the rail/transport sector, providing axles and driveline systems for metro and tram systems. Their products can be found on metro systems in Paris, Canada, Chile, Mexico and Switzerland. While their tram and automated people mover systems are widely used internationally, it is the defence sector that represents the most important part of Texelis' business, and it is this sector that is set for significant growth.

In terms of defence, Texelis has participated in a number of major programmes in export markets; for example, the company supplied some 6,000 axles to Mack trucks in support of a Canadian Armed Forces programme to acquire 1,535 trucks. Yugoimport SDPR in Serbia has selected Texelis as the supplier for a range of wheeled armoured vehicle programmes. The Miloš 4×4 multirole tactical vehicle (combat weight 14 tonnes) uses Texelis T700 axles, while the larger Miloš 2 4×4 multirole tactical vehicle (combat weight 18 tonnes) uses T750 axles. Texelis T900 axles and other systems are also used on the Lazar 3 8×8 vehicle and the Lazar 3M 8×8 which is equipped with a 32V01 remote control weapon station (RCWS) mounting a 30 mm 2A42 cannon and a 7.62 mm PKTM (6P7K) machine gun.

The decisive moment for the company's ambitions in the defence sector came in 2018 when the French defence procurement agency, Direction générale de l'armement (DGA), selected both Texelis and Nexter for the Véhicule Blindé Multi-Rôle Léger (VBMR-L) Serval 4×4 armoured vehicle programme. Serval was acquired under the French Army's Scorpion programme for a new generation of wheeled armoured vehicles; according to the DGA, there are four main Serval variants: Véhicule



Texelis have been a major mobility systems supplier to wheeled armour programmes by Yugoimport SDPR in Serbia. These programmes include the Miloš 4x4 Multirole Tactical Vehicle, the Miloš 2 4x4 Multirole Tactical Vehicle, the Lazar 3 8x8 vehicle (shown here) and the Lazar 3M 8x8 vehicle.

de Patrouille Blindée (armoured patrol vehicle), Nœud de Communication Tactique (signals vehicle), Surveillance Acquisition Renseignement et Reconnaissance (surveillance, target acquisition, intelligence and reconnaissance) and Guerre Electronique (electronic warfare).

In February 2017, Texelis and Nexter signed a contract to work together on the Serval programme; Texelis would supply the mobility solution, while Nexter would provide the vehicle body, integrate the two elements and deliver the complete vehicle to the French customer. For Serval, Texelis supplies Nexter with the mobility solution in a number of different kits. These include: an independent suspension system, engine, gearbox, structure for batteries, protected fuel tank, alternator, automatic pre-heating, winch and subframe. First Serval deliveries to the French Army were in 2022, with 978 vehicles due to be acquired by 2035. Under the related Véhicule Léger Tactique Polyvalent Protégé (VLTP-P) programme, an additional 1,060 Servals are due to be acquired.

### **Moving forwards**

The Serval programme provides Texelis with years of long-term production work and an ongoing support business across the more than 30-year lifespan of the vehicle. This solid business base set Texelis to thinking about how they could further develop their position in the global armoured vehicle marketplace. One certainty was immediately obvious; there was an ongoing military demand for protected mobility. In parallel, there was also a demand in many nations to develop a national defence industrial capability in key areas, such as protected mobility. Another aspect was that specialist vehicle developers/manufacturers were also looking to have modern protected mobility solutions that could be applied to military, paramilitary and law enforcement fields.

Developing a wheeled armoured vehicle is a complicated business with high levels of risk involved, as evidenced by the substantial number of underperforming armoured vehicles globally. In the context of a 4×4 armoured vehicle, one possibility to mitigate risk in the development process would be to base the vehicle on a commercial 4×4 chassis. Superficially this is an attractive option; the mobility system is procured and the vehicle body is then developed to meet the operational requirement within the weight constraints of the overall design, allowing a margin for further weight growth. Another attraction of basing a design on a commercial chassis is that it should be more affordable than developing a military specification mobility system.

However, utilising a commercial vehicle chassis as the basis for a 4×4 armoured vehicle actually adds risk to a military vehicle programme. First and foremost, commercial systems are not designed to military specifications. The sort of operational environments and terrain challenges that armoured vehicles are likely to operate within are far more demanding than the relatively benign situations facing commercial vehicles. Though a vehicle manufacturer claims a certain vehicle has a high-level of off-road performance, this does not automatically equate to acceptable performance for a military vehicle.

With a military vehicle, the operator must look at a system in terms of Through Life Capability Management (TLCM), the objective being to keep the vehicle operationally viable and sustainable through its service life, which could mean 30 years or more. The problem with adopting a commercial mobility system is that their product lifecycles are generally much less than 30 years. Another aspect is that commercial manufacturers change and evolve their vehicles through their design lives. This potentially means that the initially contracted mobility solution might not exist a few years later. This adds substantial risk to the long-term supportability of a system.

The other option is to design and develop a complete mobility system as a part of the vehicle design process. This approach is attractive since the vehicle can be designed taking into account a full military TLCM strategy, though more risk is added to the development programme, with the inevitably higher costs associated with this solution.

Taking these issues into account, Texelis concluded that they had the solution to the problem. The Serval programme had proven that they could develop a bespoke full military specification mobility system for a  $4\times4$  armoured vehicle. This would provide the basis for Texelis to develop a range of mobility system solutions for customers looking to develop their own  $4\times4$  armoured vehicles. This would therefore offer the customer reduced risk in developing a vehicle and through working with a contractor that understood TLCM, they would be confident of support throughout the entire service life of the vehicle.

### **The Celeris solution**

The end result is the Celeris system, which Texelis characterises as a turnkey armoured vehicle mobility system. In a 4×4 vehicle application, the Celeris system weighs 4.5 tonnes, which includes tyres, which will support a vehicle with a gross vehicle weight of between 13 and 18 tonnes. The baseline Celeris configuration comes in the form of 12 kits; these contain elements such as axles or powerpack for example. To support the widest possible range of vehicle applications, there are 30 optional kits





Texelis provides the mobility solution for the new French Army Véhicule Blindé Multi-Rôle Léger (VBMR-L) Serval 4x4 armoured vehicle being acquired under the Scorpion vehicle programme. By 2035, 978 Servals will have been delivered, with 1,060 to be acquired under the related Véhicule Léger Tactique Polyvalent Protégé (VLTP-P) programme.

allowing a potential user to optimise Celeris for their individual operational and performance requirements. Key system elements include a driveline consisting of a Cummins ISL9 Euro 3 diesel engine producing 279.6 kW (375 hp) and an Allison 3200SP automatic transmission – also present are Texelis T750 axles.

Celeris offers countries, or original equipment manufacturers (OEM), a multitude of options to move forward in developing and fielding a 4×4 armoured vehicle. The fact that a flexible set of mobility system options are available means that the development time for a new 4×4 vehicle can be shortened and the level of risk significantly reduced. Additionally, the Celeris system is flexible enough to allow the user to add their own components into the architecture of the system.

Another advantage implicit in adopting the Celeris system as an armoured vehicle mobility solution is that Texelis is prepared to work with the customer, assisting with systems integration and design questions through the development





Building on experience gained with the Serval programme, Texelis can now offer Celeris, a complete mobility solution for 4x4 armoured vehicles. Featuring a Cummins engine and Allison transmission, Celeris provides a de-risked solution for those seeking to develop 4x4 protected vehicle platforms.

of vehicle prototypes and the construction of the initial series of vehicles. In this respect, Texelis becomes a partner in the TLCM process of the vehicle, working together in the design, development, fielding and support of the vehicle throughout its service life. Celeris customers can therefore directly benefit from the practical experience gained by Texelis throughout all stages of the French Army Serval programme.

The current state of play with Celeris is that a launch customer has been selected, though at this stage, the OEM in question remains unspecified for contractual reasons. Texelis is also said to be in discussions with a number of potential clients in both Europe and Asia interested in the Celeris approach. This is particularly true in countries looking to establish their own wheeled armoured vehicle design, development and manufacturing capability. Allowing an OEM, or country, to mitigate risk in an armoured vehicle programme by

risk in an armoured vehicle programme by adopting a properly defined and supported mobility solution makes sense. For Texelis, the Celeris system will act as the catalyst to transform and grow their defence business in European and international markets. There is more though, the current 4×4 version of Celeris is only a starting point – much more is to come. Texelis is due to unveil further Celeris developments optimised for both 6×6 and 8×8 armoured vehicles. This will open up a potentially massive market for Texelis and could lead to major changes within the international wheeled armoured vehicle marketplace.



### Viewpoint from London





## Britain's 'mini-pivot' Eastwards

### **Tim Mahon**

Despite concerns over the potential for resumed continental warfare prompted by the Russo-Ukraine conflict and Putin's increasingly bizarre behaviour, and over and above the apprehension over a broader conflict erupting in the Middle East, those who plan and implement Britain's foreign policy and security strategies currently spend much of their time looking much further East of Suez. Not to put too fine a point on it – and with more than a passing nod to the influence of the soi-disant special relationship with Washington – Whitehall's primary cause of dyspepsia, increasingly, is the People's Republic of China.

Those digestive rumblings are caused, in the main, by an inability to fathom China's strategies or to determine its objectives with any accuracy. Coupled with London's need to find and cement a more visible role in the post-Brexit geopolitical world – hence a 'mini-pivot' towards the Asia-Pacific and Indian Ocean regions – this leads to a heightened sense of concern that there appears to be an inexorable descent towards armed conflict at an indeterminate but gradually approaching point.

China does little to defuse such concerns: indeed, some believe it actively fosters them in order to fuel instability, insecurity and dissent among its potential adversaries. Beijing has watched, with interest and, one presumes, considerable amusement, the posturing of Western governments vis-à-vis the Ukraine conflict, noting that robust statements of support tend to evaporate over time and that only a select few nations steadfastly maintain a flow of materiel and pragmatic aid: others tend increasingly to limit themselves to rhetoric. Yet it has telegraphed little of its real intent, which is what drives professional China-watchers to the brink of desperation when it comes to substantive analysis.

US Defense Secretary Lloyd Austin describes China as America's 'pacing threat,' meaning it is the only nation that can credibly challenge the United States economically, technologically, politically and militarily. Those assumptions bear careful examination. For example, the continuing journey towards a true 'blue water' Chinese navy, while impressive, has been marred by indications of systemic failure and hiccups in capability or technology insertion. In the past forty years, according to US analysts, the People's Liberation Army (PLA) – the armed force of the Republic – has been decreased at least three times. The most recent reduction, in 2018, brought the total number

of troops under arms to two million and significantly reduced China's militia forces.

Simultaneously, however, strenuous efforts have been made to improve the capabilities of equipment, to retire outdated weapon systems, to improve training and readiness and to prepare the force for modern combat scenarios. Those two million men and women are better armed, better supported and, perhaps, better motivated than they have been for decades. The question in Western minds, of course, is – what will Beijing do with them?

The principal fear among hawks on both sides of the Atlantic is that China intends an invasion of Taiwan. Regular and increasingly large airborne incursions into Taiwanese-claimed airspace, aggressive naval exercises in close proximity to the island republic and unceasing rhetorical sallies against Taipei's policies are all indicative, so the theory goes, of a real intent to 'walk the walk' and 'make two Chinas one.' Reality is, perhaps, slightly different. Well-placed academics and journalists around the world, some with decades of observing and living in China and the region, believe Beijing will continue to test the waters, will continue to make 'noises off' to test the intent, resolve and will of potential adversaries in the West, and will continue to bring its forces into a state in which it could legitimately contemplate such a conflict. Yet actual combat would not be engaged until Beijing truly believes it can win the conflict in a reasonable timescale and at a containable, acceptable cost. That time is not vet.

Meanwhile, Britain continues to struggle to find the middle road in asserting freedom of navigation, continues to highlight China's internal issues on the global stage (much to Beijing's chagrin) and continues to support laudable regional initiatives such as AUKUS, in which it is pivotal. One thing that Britain's policy planners will need constantly to remind themselves of, however, is that the Chinese leadership think, plan and act in a timeframe vastly more extended than that which Western polities have become accustomed to. Unconcerned with the exigencies and uncertainties of the next electoral cycle – these planning timescales can often literally span a generation or more.

Complacency is unwarranted. So, too, is panic. Constructive engagement continues to be the sensible route forward, if not the only viable one.

## Mobile test systems for combat vehicles

#### **Gerhard Heiming**

Global military deployments often require repair of heavy combat vehicles close to deployment locations, far away from fixed infrastructure and peacetime-equipped workshops. Mobile test systems can provide support in assessing damage and confirming the success of repairs carried out in the field.

Modern combat vehicle engines are characterised by high power density, and use electronic control units to ensure optimum operation under all environmental conditions. This makes it possible to analyse faults and thus control maintenance in a targeted manner, even in the field. However, due to their complexity, analysing faults and targeted control of repairs can be both timeconsuming and difficult.

Mobile test systems offer a solution here, as they can be transported where required and operated in the field at manageable cost. Based on 60 years of testing experience in the production of transmissions for heavy combat vehicles, Renk Group has developed a mobile variant of its stationary test systems.

Renk Group subsidiary Renk Test System GmbH (RTS) has been working on mobile test benches since 2022 following a customer enquiry, resulting in two development directions. The first is a roller test bench for complete vehicles. The second is a mobile load test system for engines. These are due to be presented at the International Armoured Vehicle (IAV) 2024 conference in London. The next development steps planned are test solutions for suspension elements, drivetrains, and turret drives.

### Mobile test systems

A mobile test system consists of dynamometers in containers, a container with cooling and supply equipment, and a container with the control station. The system is transported on two trucks: an all-terrain tractor with a low-bed semitrailer for the dynamometers and the control station, and an off-road truck for the supply container. The components are handled using standard logistics equipment when setting up the test equipment. Dynamometers are at the heart of the system, used to simulate the driving resistance. The test bench uses the complete vehicle power pack for the test and drive power is provided by the engine, allowing the engines to be tested under realistic load conditions. The brakes used are eddy current brakes. The mobile system does not require any infrastructure or access to an external electrical grid, it is designed to be self-sufficient.

### **Testing**

The power pack, consisting of the engine, gearbox, and cooling unit, is installed on the mobile test bench for fault analysis. This field testing capability can allow significant time savings for frontline units – without a mobile test system, the entire power pack would need to be replaced and transported to a regional depot or control centre work-





CG graphical representation of a Renk mobile dynamometer solution. The graphic shows two containerized dynamometers on the flatbed trailer, with the power pack being tested in the middle. By the trailer are the control station and the cooling container.

### Renk supplies transmission test rigs for the CH-53K

The US Navy has awarded the American Renk subsidiary, Renk Systems Corp, a contract for the development, manufacture and installation of three transmission test rigs for the CH-53K heavy-lift transport helicopter. According to a statement from the US Department of Defense, the delivery of one test stand each for the main gearbox and the intermediate gearboxes in the tail and front of the helicopter has been agreed.

Following installation, the contract also includes calibration of the test rigs, accompanying logistics, maintenance and operational support, as well as spare parts. The scope of delivery also includes technical manuals and operating instructions in addition to associated data sets for the operation of the test stands with the CH-53K units. The order is valued at USD 49 million (approximately EUR 45 million).

The test rigs are developed and manufactured in Germany by Renk Test System GmbH in accordance with US requirements. The work is scheduled for completion in November 2025.

The US Marine Corps (USMC) has a requirement for 200 CH-53Ks, and since the USMC's first aircraft was handed over in May 2018, a double-digit number of helicopters have been delivered. On 21 December 2022, the US Navy approved series production of the CH-53K, thereby increasing the production rate to 20 aircraft per year. Israel is the only foreign customer to date, with 18 helicopters on order.

shops for minor repairs. For major repairs, the power pack is transported to the manufacturer for repair – typically either directly to the manufacturer or a contracted local repair centre with the appropriate equipment. After the test bench run, a decision is made as to whether the entire power pack or just individual components need to be repaired. The test bench enables identification of defective components, which can then be replaced, and the engine re-tested to ensure it is functioning correctly. This means that only the defective component(s) need to be sent to the manufacturer, instead of the complete power pack.

Once the defective components have been repaired, power pack repair can be completed in the operator's country. The final functional and acceptance test can again be carried out on the mobile

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test stand. This ensures that only a fully functional power pack is reinstalled in the combat vehicle.

### **Operational benefits**

With a mobile test stand permitting monitoring and testing of components in the field, logisticians have a tool capable of increasing the operational availability of combat vehicles. By regularly running test procedures according to manufacturer specifications, repairs and maintenance can be performed more rapidly, thereby increasing operational availability.

Precise fault analysis and repairing or replacing only the defective components allows the user to quickly restore vehicles to operational readiness. Additionally, this reduces the amount of equipment required to be transported to the manufacturer, which saves on logistics costs and frees up transport capacity.

#### **Further steps**

Renk RTS is due to present the mobile test stand at the IAV 2024 conference, and discuss the solution with potential users in a workshop session. The concept will then be developed to completion and offered as a modular solution on the market.

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# **Turret options for modern AFVs**

### **Chris Mulvihill**

Turrets are central to armoured fighting vehicle (AFV) design and house many of the most important subsystems on any platform. These can include the main armament, sensors, fire control systems, and protection systems. The choice of turret can affect greatly what a system can or cannot do.

The market for standalone turrets provides potential users with many options to select from, with many having similar characteristics. Standalone turret choices range from those housing the 12.7 mm heavy machine gun, up to those armed with a 120 mm smoothbore gun. This article will examine the wide variety of turrets, including both largeand medium-calibre turrets, and explore common types of configurations that industry offers.

### A natural convergence

The term 'AFV' covers a large variety of vehicle types, many from which have evolved their capabilities and roles significantly over the past 70 years. Examples include main battle tanks (MBTs), infantry fighting vehicles (IFVs), armoured personnel carriers (APCs), among other specialised vehicle-types. An AFV is principle any type of vehicle that is armoured from the design stage and has the ability to engage in a variety of combat and combat support roles.

The majority of AFVs that possess an armament greater than that of a light 5.56 mm or general purpose 7.62 mm machine gun will almost always possess a turret mounted above the hull. The usage of turrets as the main structural element housing the vehicle's armaments began in 1918 with the arrival of the Renault FT. This truly revolutionary design ended the initial experiments with mounting multiple cannons onto tanks using sponsons protruding from the hull's sides, as can be seen on the British series of tanks during WWI. Similarly, while casemate designs were used during WWII for tank destroyer designs and by a limited number of designs during the Cold War such as the West German Kanonenjagdpanzer or Sweden's Stridsvagn 103 (Stank), a consensus emerged that the use of a turret housing the main armament and accompanying subsystems is the most effective design.

With the emergence of the APC and IFV post-war, turrets have also been utilised



The Yugoimport Lazanski 8×8 wheeled IFV with the AU-220M turret, armed with a 57 mm automatic cannon. Recent years have seen very large-calibre cannons mounted on proposed IFV designs.

to arm these classes of vehicles with machine gun or medium-calibre cannon armaments, often being small-sized turrets with some even being operated by a single crewman. Given that both the APC and IFV are not equipped with heavy and bulky large-calibre guns, such as those used by tanks, these classes of vehicles have been the first to undergo the evolution of turrets from manned and mechanically-operated to unmanned and automated. Additionally, the continuing need to increase the lethality of AFVs means that both contemporary APCs and IFVs are now often equipped with 30 mm cannons. This looks set to increase further, with new cannon designs of 40 mm, 50, mm emerging, and the Russians reviving the 57 mm cannon for use on the AU-220M turret.

With an increase in automation, the expansion of situational awareness sensors and technologies, and the availability of higher calibre weapon systems, the options for turrets for modern AFVs can appear endless, with a wide array of manufacturers globally who market standalone turrets to retrofit legacy fleets or for new-build AFVs.

### Contemporary turret development

Turrets for AFVs have undergone a gradual evolution in their attributes throughout the last half-century and have attained considerable advances in firepower, protection, and situational awareness. One of the most notable developments in turret design has been the adoption of an autoloader for the main armament. This has produced two major advantages over AFVs without autoloaders - a decrease in the required size and weight of turrets, and removing the need for a loader crewman. For military planners, this can make a huge difference in manpower requirements for armoured formations by reducing the crew needed to operate a tank by a quarter.

A significant advance in the construction of turrets has also improved the protection of modern turret. This is a result of a gradual transition from cast to welded turrets. Cast turrets and hulls had been the norm up to and around the late-Cold War. Welded turrets have been found to be slightly lighter than a cast turret of equivalent protection rating, at the cost being more labour-intensive to mass-produce. The transition to welded turrets has been marked by turrets with typically flatter surfaces than their curvier cast turret counterparts. Flatter surfaces, have in turn made it easier to mount appliqué armour packages, and explosive reactive armour (ERA) tiles. Today, most recently produced tanks have welded turrets built on a steel base, with composite modular armour packages often built onto the steel at production. The usage of composite materials was a significant advancement as it could offer better protective capabilities at a lower mass or size relative to older rolled homogenous armour (RHA). Composite armour was first applied to tanks and has also been used during the construction of turrets, beginning with the T-64.

Turrets for lighter AFVs like APCs and IFVs have not seen a wide-application of such protection measures due to an arguably more significant advancement - automation. With the removal of the loader in place of the autoloader, and the electrification of formerly mechanical interfaces and key subsystems for the commander and gunner, the natural progression was to remove the remaining two crewmen from the turret altogether. A turret no longer needs to have the physical presence of the two crewmen needed to operate, and this allowed the reallocation of protection and weight towards the hull. This has led to a further reduction in the volume and weight of a turret by removing the turret basket, as well as allowing designers to isolate the turret from the hull by using a non-hullpenetrating design.

Accompanying the emergence of unmanned turrets, the quantity and quality of sensors that allow greater situational awareness has increased on modern turrets. Turrets would previously have a limited number of periscopes, a gunner's sight with a possible backup, sometimes an independent sight for the commander, and allowed the commander to emerge from his hatch, albeit at the cost of partially emerging from the armour protection of the turret. As optical sights became gradually replaced with optronic sights and the connection to vision systems no longer went through a physical optical connection but through an electric cable, the possibilities of for equipping the crew with a vast array of sophisticated visual sensors has increased.

### Large-calibre gun turrets

Turrets can vary in attributes but a distinction between turret options can be found between the few that are marketed with large-calibre guns versus the plethora of medium-calibre turret options. While excep-



General Dynamics Land Systems unveiled their AbramsX technology demonstrator in October 2022, during the AUSA exhibition. Elements of this demonstrator including the unmanned turret are widely expected to make their way into the planned M1E3 Abrams variant.

tions exist, in general tank turrets are typically those that wield a large-calibre guns, most commonly ranging from 100 mm to 125 mm guns. They are also still manned by crew members within the turret, although some future tank designs are showing a shift towards unmanned tank turrets. Similarly, the autoloader has not been embraced by all tank designs at the moment, but with several next-gen tank designs using unmanned turrets as well as larger and heavier munitions, their adoption would necessitate the use of autoloaders.

Unlike other AFVs, MBTs are typically equipped with the same turret that they left the factory with. While there are exceptions to this – for instance in one Cold War project, an M60 Patton was tested with a Leopard 2 turret, however, in general these projects were rarely progressed beyond a prototype vehicle. However, there appears to be some opportunity for 're-turreting' MBTs when the costs and delivery times of most military equipment is now at a relative high due largely to the ongoing conflict in Ukraine and increased demand for a wide range of military equipment.

### Hitfact MkII 105/120mm

A recent example has emerged from Greece in late November, with a meeting between the Greek general staff and representatives of Leonardo S.p.A., who have meant to present their proposals for modernising Greece's significant but antiquated Leopard 1A5 fleet. One proposal reportedly under consideration is to upgrade Greece's Leopard 1A5 tanks with the Hitfact Mk2 105/120mm turret. The Hitfact MkI owes its lineage to the MkI variant, used on the Centauro 120 trials vehicle. Efforts have been made with the updated MkII for a pitch towards retrofitting older MBTs as well as some 8×8 wheeled vehicles.

The turret can be armed with a 105 mm L52 rifled gun, the same calibre of the original gun on the Leopard 1, or with a low-recoil 120 mm L45 gun. The Hitfact can be manned by two crew thanks to its autoloader that carries 12 rounds of ammunition, regardless of whether the turret is armed with the 105 or 120 mm. The option for a three-person crew with manual loading is also offered. This turret would allow the Leopard 1 to use the 120 mm gun, allowing compatibility with Greece's Leopard 2 fleet. It would also allow the tank to receive a modern fire-control system (FCS) with stabilised sights, meteorological sensors, a ballistic computer and automatic target tracking. In addition, the turret can be equipped with a battle management system (BMS), which provides a variety of means to improve coordination with friendly forces.

Overall, the turret offers a substantial firepower and mission systems upgrade for legacy MBTs such as Leopard 1A5. Ad-



The Hitfact MkII 120 mm is most commonly seen on the B2 Centauro mobile fire-support vehicle. It is equipped with a low-recoil variation of the 120 mm smoothbore gun.

ditionally, the 120 mm configuration has been selected for use on Italy's Centauro II fire support vehicle, demonstrating the viability of this armament on an 8×8 platform.

### Cockerill 3105 & CSE 90LP

Belgium-based John Cockerill also offers a comparable product, in the form of the Cockerill 3105. The two-person turret houses a 105 mm rifled gun coupled to an autoloader that stores 12-16 rounds, depending on the configuration. The turret has been seen on a Leopard 1 at Eurosatory 2022, demonstrating its viability on the platform. Modifications required the installation of a turret ring adapter as well as integrating the turret with the Leopard 1's electrical supply. As with the Hitfact, the key advantage a turret like this could provide to legacy MBTs is a suite of modern mission systems, along with a reduction in weight and crew. The 3105 has also entered service on the FNSS/PT Pindad Harimau tracked fire support vehicle (FSV) for Indonesia, and the GDLS-Canada LAV-700 FSV for Saudi Arabia. Other platforms the turret has been mounted on for testing include the GDLS-Canada LAV-III, Hanwha K-21, and the Otokar Tulpar.

John Cockerill also offers the CSE 90LP twoperson turret, which is armed with a 90 mm rifled gun. The turret offers a baseline protection rating of STANAG 4569 Level 1, but has proven light enough to have been trusted on smaller vehicles such as the Akrep II 4×4. It has one of the most varied applications of the turrets listed so far, having been integrated and tested on all types of vehicles from a Ukrainian BTR-3 8×8, to the M1117 Guardian 4×4. Setups such as these enable relatively light vehicles to provide meaningful mobile fire support for infantry.

### **Medium-calibre turrets**

Options for medium-calibre turrets are far greater in variety than large-calibre turrets. In some respects, this is due to the fact that most land armies maintain their direct fire large-calibre armaments on their MBTs, without requiring a similar capability mounted on IFV or APC platform. Medium-calibre turrets are also easier to manufacture, given that they are by nature lighter due to using a smaller armament system and corresponding lighter ammunition. They are also never as heavily protected as MBT turrets, as they are not expected to engage MBTs.

The proliferation of medium-calibre turret offers has provided manufacturers of APCs and IFVs the option of forgoing development of a proprietary turret, and instead work with industrial partners and customers to select a turret solution from the wide range of options. Shown below is a table with a selection of medium-calibre turret products that are sold as a standalone product, along with some key characteris-

Turret	Country of origin	Manned/ Unmanned	Main arma- ment calibre (mm)	ATGM
32V01	Russia	Unmanned	30	No
AMICT	South Africa	Manned	30	No
AU-220M	Russia	Unmanned	57	No
Berezhok	Russia	Manned	30	Yes
Cockerill 1030	Belgium	Unmanned	30	No
Cockerill 3030	Belgium	Both available	30	No
Guardian 30	Spain	Unmanned	30, 40	Yes
Hitfist	Italy	Manned	25, 30, 40	No
Hitfist UL	Italy	Unmanned	30	No
LANCE	Germany	Both available	30	Yes
Mizrak	Turkey	Unmanned	30	Yes
Nefer	Turkey	Unmanned	25, 30	No
Protector RT60	Norway	Unmanned	30, 40	Yes
RIwP	USA	Unmanned	12.7, 25, 30	Yes
Samson 30	Israel	Unmanned	30, 40	Yes
T40 CTA	France	Both available	40	Yes
ZSSW-30	Poland	Unmanned	30	Yes

Note: All information derived from open sources. The above is a selection rather than an exhaustive list of all medium-calibre turrets available.

tics. Following this, a selection of varying types of turrets will be explored to highlight the common differences of those available on the market today.

### **ZSSW-30**

The ZSSW-30 is a Polish turret which was indigenously-developed by a consortium comprising Huta Stalowa Wola (HSW) and WB Group. Poland is looking to integrate the turret on its first indigenous IFV, the Borsuk, as well as some of its Rosomak 8x8 vehicles. In addition to Borsuk and Rosomak, Hanwha has also offered Poland the option to mount this turret on the AS21 Redback IFV, should Poland select the vehicle.

The ZSSW-30 is to be armed with a 30 mm Mk44/S Bushmaster II chambered in the 30 × 173 mm cartridge. The turret is also equipped with a pod-mounted pair of Spike-LR II ATGMs, enabling the crew to engage armoured targets out to a range of 5.5 km, and a UKM-2000C 7.62 mm machine gun. The FCS was developed by WB group, and includes a meteorological sensor, ballistic computer, and stabilised independent sights for the gunner and commander with day and thermal channels. The latter enables the crew to carry out hunter-killer engagements. An obscurant smoke-based soft-kill active protection system (APS) is also included, comprising laser warning receivers (LWRs) linked to smoke dischargers. When the LWRs detect a laser illumination threat, they can activate the smoke grenade launchers, creating a bank of multispectral obscurant that can hinder enemy targeting, and obscure the vehicle from infrared homing ATGMs.

### **T40 CTA**

The French T40 CTA will likely be the only in-service turret armed with the CT40, a 40 mm cased telescoped cannon, until the UK's Ajax reconnaissance vehicle enters service later in the decade. The turret is offered in both manned and unmanned configurations, with the former being selected for the EBRC Jaguar reconnaissance vehicle chosen by France and Belgium, and the latter demonstrated on the developmental VBCI-2 8×8.

Perhaps the most noteworthy feature of this turret is its main armament – the CT40, which possesses several unique features. Cased telescoped ammunition is a design wherein the projectile is encased completely within the cartridge, as opposed to conventional 'bottle shaped' ammunition, which have the projectile protruding from the top of the cartridge. Cased telescoped ammunition is typically slightly wider than an equivalent conventional munition, but is significantly shorter. This provides volume savings which allow higher number of rounds to be carried than with equivalent performance conventional munitions.

The CT40 also offers interesting ammunition natures, such as the Kinetic Energy Airburst (KE-AB) round, a programmable airburst munition that unleashes a payload of tungsten pellets with a directional effect. This round is designed to engage low-flying aerial targets at a range of up to 3,500 m. The General-Purpose Round Point Detonation Tracer (GPR-PD-T) round is intended for engaging structures and light armoured vehicles. It is capable of penetrating up to 210 mm of concrete, or 15 mm of RHA equivalent at 1,000 m. The cannon not only provides longrange firepower, but its range of ammunition natures as well as its ammunition handling and feed system allow the operators of the T40 CTA turret to take multiple ammunition natures in their loadout, as opposed to the more typical limit of two ammunition natures for dual-feed cannons.

For engaging armoured targets, the turret is equipped with a pop-up launcher for ATGMs, with known options including the MBDA Akeron-MP ATGM. The turret also has a comprehensive sensor suite, given that it is designed to be mounted on a reconnaissance vehicle. The FCS includes independent sights with day and thermal channels for the gunner and commander, enabling hunter-killer engagements, as well as a meterological sensor and ballistic computer. Additionally, the turret can also be equipped with a passive acoustic gunshot detection sensor for rapidly locating the source of incoming fire.

#### **RwIP**

RwIP turret is perhaps the closest solution towards a universal user-configurable turret design - capable of being outfitted to engage both ground- and air-targets if the armament is configured so. The RwIP perhaps leads the growing trend of 'modularity', with the ability to pick and choose many characteristics desired for a platform. The RwIP is not laid out like other unmanned turrets. It more closely resembles a skeleton frame onto which various weapons can be integrated, including machine guns, automatic grenade launchers, an automatic cannon, rockets, ATGMs, or MANPADS, even both of the latter simultaneously. The RwIP is one of very few turrets that offers the ability to also include MANPADS without having to lose its primary direct fire armament. This allows for providing manoeuvre units with organic SHORAD capabilities without sacrificing as



The Borsuk is Poland's first domestically-designed IFV and it is armed with a local ZSSW-30 turret.



The Jaguar provides heavy firepower for a 6×6 with a 40 mm CTA cannon. This cannon will also be shared with the British Ajax.

much in the way of direct fire capability. The RwIP can be armed with a large array of weaponry, ranging from machines guns such as the 12.7 mm M2 Browning up to the M230LF or 30 mm XM813 cannon. Although the turret is unmanned, its protection rating can be optionally increased through add-on armour options, depending on user requirements. The turret is typically shown with a single optronic sight for the gunner, however, an independent sight for the commander can be optionally added. It is currently in service with the US Army on the Stryker M-SHORAD variant.

### An abundance of choice

Turrets on AFVs have been around for over a century and continue to evolve with new capabilities that improve a system's protection and lethality in the field. Sensor and vision systems equipment have undergone electrification, allowing unmanned operation of the turret. This allows the crew to reside in the hull, saving both weight and volume on armouring the turret. This in turn has follow-on benefits for vehicle transportability and tactical mobility.

Large-calibre turrets, can provide newbuild vehicles with direct-fire large-calibre guns and also be used to retrofit legacy MBTs. The latter could prove to be a relatively financially sensible solution for forces that lack the funds to procure new MBT fleets but may have legacy vehicles that would greatly benefit from modernisation. Medium-calibre turrets covers a huge variety of designs with a broad range of manufacturers around the globe. The sheer range of modern turret options available for AFVs allows users to obtain sophisticated combat capabilities while also offering the chance to reduce turret volume, at a lower weight penalty than many of their forebears.

### SECURITY POLICY

## Examining the French Military Programming Act 2024–2030

### Jean François Auran

The 'loi de programmation militaire' (LPM) is a French institution. This document is discussed at length and represents the Government's commitment to providing the military with sufficient resources for the future. LPM 24–30 will allow the French military to significantly increase its budget, reaching EUR 413.3 billion over the next seven years. Despite this considerable funding, several programmes will experience staggered delivery or a reduction in scope.

According to the Ministry of Armed Forces, in the context of technological breakthroughs, rearmament, and explicit contention of international legal principles, the 2024–2030 LPM aims to build a revitalised Armed Forces model. It also represents a political and military transformation project in the service of French sovereignty, seeking to protect its strategic autonomy.

### Parliamentary control will be strengthened

The LPM arrived before the Assemblée Nationale on 22 May 2023 for the initial text to be amended by members of parliament (MPs). A total of 1,700 amendments were tabled before a vote was scheduled for 6 June. The Senate then scrutinised 288 amendments and after weeks of debate, the French Parliament adopted the 2024-2030 LPM on 13 July. The text provides EUR 413.3 billion for defence and a slight increase in personnel. The LPM was promulgated on 1 August 2023 and published in the 'Journal Officiel' the following day. The allocated amount is 40% higher than the previous 2019–2025 LPM at EUR 295 billion. With this act, parliamentary control is reinforced because both assemblies have determined that the objectives must be updated by the end of 2027, and the Government must provide annual progress updates. The 2027 revision must be preceded by a Revue Nationale Stratégique (RNS) and will lead to adopting a law and not a debate followed by a vote, as happened in 2021.

### <u>Author</u>

Jean François Auran is a retired French Armed Forces officer and a Defence and Security Analyst.



The Aviation Légère de l'Armée de Terre (ALAT) will receive NH90, including a version for Special Forces units. ALAT will transfer its Caracal helicopters to the Air Force.

#### A significant budgetary effort

The LPM sets the annual budget amount for the next seven years. It is, therefore, a financial commitment that the Government makes towards citizens. The text provides an increase of EUR 3.1 billion in 2024, an additional EUR 3 billion annually from 2025 to 2027, and finally EUR 4.3 billion annually from 2028. The budget will, therefore, reach a total of EUR 68.9 billion in 2030. The defence budget will therefore be increased to 2% of GDP between 2025 and 2027. According to the previous LPM, the defence budget was due to reach this symbolic figure in 2025. The military programming does not include the budgets dedicated to military support for Ukraine or the financing of the service national universel (SNU), which receives other funding. The LPM will make it possible to reach the figure of 275,000 personnel within the Ministry of the Armed Forces and 80,000 reservists by 2030. The text also acknowledges the end of large-scale operations in Africa and the ongoing reflections on Operation Sentinel's continuation. The budget dedicated to the OPEX/MISSINT will plummet from EUR 1.2 billion to EUR 750 million annually.

### Strengthening the coherence of military forces

The LPM specifies the priorities from 2024 to 2030 and intends to remedy weaknesses highlighted by the conflict in Ukraine. The Ministry of the Armed Forces insists that the LPM is consistent between all components of military capabilities. For this coherence, manufacturers will spread out deliveries regarding several significant programmes for the benefit of ammunition, stocks of



Deliveries of armoured vehicles from the Scorpion program will be slowed down compared to the previous LPM.

spare parts for better maintenance, operational preparation, or the launch of innovative programmes whose needs have arisen from the Ukrainian conflict and other geopolitical tensions. Equipment such as aircraft, armoured vehicles or ships represent EUR 268 billion, and EUR 10 billion will be injected into technological innovation to support all these new developments.

#### Constant effort on nuclear power

Nuclear deterrence alone will consume 13% of the funds since it is a question of modernising both the carrier platforms and missiles. It will consist of constructing a new class of nuclear SSBNs (nuclear powered ballistic missile submarines), called SNLE 3G, for the third generation

to replace, from 2035, the Triomphant class currently in service. The M51.3 missile should be delivered in 2025 and is due to equip future submersibles. This missile will have an increased range of some hundreds of kilometres. It incorporates the characteristics of the M51.2 with an improved third stage, aiming to increase the maximum range and guarantee the penetration of opposing anti-missile defences circa 2030. France conducted the first M51.3 missile test on 18 November 2023 from a land test site. During this period, the airborne component of the French nuclear deterrent. which relies on the Strategic Air Forces (FAS) and the Nuclear Naval Air Force (FANu), should be equipped with modernised ASMPA-R airborne nuclear



The navy will receive three FDIs during the 2024-2030 period. Pictured is the first of them, Admiral Ronarc'h, at the Naval Group shipyard in Lorient.

missiles, while the ASMPA-R's successor, the fourth-generation ASN4G missile is due to be test launched.

### Strengthening permanent protective postures

The LPM will make it possible to consolidate all permanent protection postures. The permanent air security posture (posture Permanente de sûreté-air) will be extended to the fight against drones and very high altitude threats. Maritime safeguarding and even the contribution of the armed forces to specific public service missions (safeguarding, helping populations, supporting other administrations) will be reinforced. The text will also strengthen the permanent posture dedicated to influence, established as a strategic function, and information warfare. Overseas territories will be one of the priorities, and the forces de souveraineté will benefit from a general effort to improve capabilities (protection, intervention and support, infrastructure). They will constitute a first reinforced level immediately available in terms of presence. protection, and humanitarian action, to discourage any attempt at destabilisation or attack. The reinforcement will result in permanently basing A400M aircraft, with more than EUR 800 million to be spent on the military infrastructure of overseas territories; approximately 65 Serval armoured personnel carriers and six medium helicopters will be supplied as part of a capacity improvement effort for the forces stationed in these areas.

### Better-trained conventional assets

The Army will receive 2,300 new armoured vehicles over the period in question, which is 30% less than planned. Out of the 300 expected, 100 Jaguar reconnaissance and combat vehicles (EBRC) will be delivered after 2030. The Army will be losing infantry soldiers, but the positions will be transferred to emerging functions such as cyber combatants or drone operators.

Rocket artillery will receive special attention, with the reconstitution of the Lance Roquette Unitaire (LRU) fleet. The LPM project plans to acquire at least 13 new systems before 2030 and 13 more by 2035. The solution chosen could be French or European, benefitting from Safran, Ariane Group and MBDA's expertise. The Army, beyond the equipment, is seeking to preserve its adaptability and manoeuvre capability.

According to observers, the Marine Nationale (French Navy, also known as 'La Royale') seems to be the winner of this LPM. During his parliamentary hearing, the Navy Chief



Design work on the next-generation aircraft carrier will continue during the LPM. Its construction is also due to be launched.

of Staff (CEMM) did not hesitate to enumerate the lengthy list of future challenges such as the rise of piracy, the plundering of fishing resources and the spectacular development of the navies of other countries, including Turkey and China. He explained that the picture was gloomy, and that the Navy's current resources must be improved. The fleet will, therefore, be modernised by 2030 but not to the extent expected. The main disappointment comes from the reduced number of Frégates de défense et d'intervention (FDI) due to be delivered. The three vessels will be the Admiral Ronarc'h, due to enter service in 2024, the Admiral Louzeau in 2026, and the Castex in 2030. The FDI delivery schedule is deliberately spread out to allow construction of units for export. Three force supply vessels (BRF), part of the Vulcano class logistics support ship programme, will replace the Durance class tanker. One ship will enter service in 2024, and two others in 2025 and 2027. La Royale will have seven offshore patrollers (PH), replacing the old A69 Aviso vessels. At the end of November 2023, the

Directorate General of Armaments ordered seven offshore patrol vessels (OPVs) for EUR 900 million. These OPVs should have a displacement of 2,000 tonnes, be 90 m in length, and be fitted with at least one 40 mm RapidFire cannon in addition to having the capacity to deploy a helicopter and/or an onboard UAV. Ten vessels are expected to be in service by 2035, with a first delivery planned for 2026.

The Barracuda nuclear attack submarine class also continues to be included in this programming law. Five other submarines will enter service by 2030, as the Suffren is already operational. Included in the 2024–2030 LPM, the construction of the new aircraft carrier is now secured after it took 20 years to reach a decision. The porte-avions de nouvelle generation (PANg) aircraft carriers are scheduled to be ordered during fiscal year 2025. Studies for constructing a second aircraft carrier will be launched, with a decision expected in 2028.

The Air and Space Force (AAE) will continue homogenising its entire aviation capability around the Rafale fighter and strengthen





The Air Force will move to a full Rafale fleet even if it will take longer than originally planned.

its strategic transport fleet. In 2030, the Air Force will have 137 Rafale aircraft and 35 A400M transport aircraft, compared to the initial target of 185 Rafales and 50 A400Ms. Finally, by 2030, AAE will receive its first Eurodrone system out of six systems to be acquired so far. France's action in space will be reinforced with spatial observation, signals intelligence (SIGINT) satellites, and increased exo-atmospheric monitoring capabilities. The objective is to detect a suspicious or aggressive act in space and to protect critical assets through active defence, particularly in low orbit. Special Operations Command, whose role is essential in the event of a hybrid conflict, will be allocated EUR 2 billion over the planned period. The funds will modernise their tactical transport aircraft, and the force will receive Caïman SOF helicopters, more durable drones, and submarine insertion assets.

In summary, these forces will not be more numerous, but they should be bettertrained. Operational preparation will be qualitatively strengthened to consolidate necessary skills for short-term and future engagements. The ORION 2023 exercise was one of the first milestones in creating a simulated hybrid theatre which saw a blend of pure simulation with a combined battle group command post and a brigade, taking place in Mailly-le-Camp and, simultaneously, a LIVEX for a division. The Chief of the Defence Staff has planned another exercise of this magnitude for 2026.

More than EUR 16 billion is to be provided by the LPM to purchase ammunition of various kinds, whether it be MICA, Aster 15, and Aster 30 surface-to-air missiles, or artillery weapons such as 155 mm shells or long-range rockets. The country's manufacturers have been asked to increase their output; KNDS is currently able to produce six Caesar howitzers monthly, with shell production reaching 1,500 units per month. While it might not seem like much, there has been an uptick.

#### Involving the civilian sector

The Government hopes to mobilise all of the country's active forces, including the defence industry, with President Macron calling for a switch to a war economy. State orders are increasing and the sector is suffering from difficulties in financing. The Government has therefore decided to use one of the most popular savings accounts, the Livret A, for the financing needs of small- and medium-sized companies in the sector. France can also rely on its ability to develop new capabilities in cyber defence, mainly while covering disruptive technologies. According to the LPM, the Direction Générale de la Sécuri-


Space is a key dimension of interest with new satellites, command and defence capabilities.

té Extérieure (DGSE) must be the technological vehicle for the entire intelligence community. The intelligence organisation must be competent everywhere: in analysis, large, shared programs, foreign languages, cyber, etc. A centre of excellence will also be established to structure, around the École Polytechnique, content, methods, and academic teams to benefit the cyber missions entrusted to the Ministry of the Armed Forces.

#### A mixed reception

Defence specialists have welcomed the LPM albeit with a certain reluctance. The Government's initial text was amended, particularly in the Senate, where rightwing parties hold the majority. While significant work has been done to make the text more coherent, securing resources was a vital issue. Indeed, if budgetary appropriations finance EUR 400 billion, EUR 13.3 billion will be financed by extrabudgetary resources whose origin was not 100% assured. In the event of insuffi-

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cient funding, additional credits will have to be allocated in the finance law. The LPM's detractors believe that a large part of the allocated resources will be used to pay for orders or parts of some orders from previous years. Therefore, the actual room for manoeuvre is less than EUR 100 billion.

It is clear that the country is making significant financial efforts to ensure the population's security and safeguard its land, sea, and air domains. There is no point in buying hundreds of cannons if no technological superiority guarantees mastery of new conflict areas: space, the seabed, the informational field, cyber, etc. France, the world's secondlargest exclusive economic zone reguires a more capable naval force as neighbouring Pacific nations build up their fleets. Therefore, the Navy came away a relative winner in the budget decision. Nevertheless, the law may still be impacted by the 2027 presidential and parliamentary elections, where the new president, as well as the new majority, could well question the choices made.

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#### NATO's role in contemporary global security dynamics: beyond adaptability and resilience

#### Andreea Stoian Karadeli

Throughout its seven-decade history, NATO has demonstrated adaptability and resilience in overcoming diverse challenges as an international entity due to the shared values among its member states. Beyond its initial military alliance role, NATO now prioritises multilateral cooperation and adopts a multifaceted approach to tackle complex contemporary challenges. But today's fast-changing geopolitical landscape requires the Organisation to redesign its tools and capabilities to develop a comprehensive proactive security strategy.

ATO confronts a rapidly-evolving and intricate security landscape that demands capabilities beyond just adaptability and resilience. External challenges that no longer fit the pattern of traditional threats leaving complex transboundary challenges intertwine with internal factors, including strained trans-Atlantic relations, perceived value disparities, and escalating tensions between members, all of which threaten the Alliance's cohesion. Divergent perceptions of threats among Allies contribute to NATO assuming different roles for different members. Historical discord has at times been part of NATO's norm, but constructive diplomacy often emerged from such differences. But this is no longer the case, as today's geopolitical situation calls for unity and common action.

This analysis discusses NATO's developing role in the constantly changing global dynamics, underlying the imperative to reassess its strategy and enhance innovation, agility, and the cultivation of multi-

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NATO Secretary General Jens Stoltenberg opens a session during the meeting of Defence Ministers at NATO Headquarters, Brussels, Belgium, 12 February 2020. The North Atlantic Council meets periodically throughout the year at different levels of governance and coordination; the event brings together defence ministers from all NATO states to discuss the Alliance's future.

domain capabilities. It will do so while engaging proactively in international security to prove its continued relevance in the coming decades.

#### **Historical background**

Established in 1949, NATO constituted a component of a more comprehensive initiative aimed at fulfilling three objectives: deterring Soviet expansionism, preventing the resurgence of nationalist militarism in Europe by maintaining a robust North American presence on the continent, and fostering the process of political integration within Europe. The Alliance has been a pivotal force in global security, navigating through distinctive periods influenced by dynamic geopolitical shifts and the strategic objectives of its principal member, the United States. NATO's evolution has unfolded across four discernible periods— the tension-filled Cold War epoch; the uncertainty of the post-Cold War era; the war against terrorism phase; and the contemporary stage characterised by the complexities of Great Power competition, notably with the inclusion of China. NATO has demonstrated its adaptability since the Cold War era, transitioning its focus to international stabilisation and peace-supporting missions after the Cold War ended. Significantly, this included military operations in the aftermath of the 2001 terrorist attacks in the United States, culminating in the activation of Article 5 of the Alliance's 'Collective Defence' commitment. The illegal annexation of Crimea by Russia in 2014 marked a return to great power rivalry and forceinduced border changes in Europe. Confronting Russian revisionism, NATO has reoriented towards collective defence while addressing persistent threats, such as regional instability and the proliferation of violent extremist organisations. Nevertheless, the past decade has posed a complex variety of global and regional threats emerge, such as the rise of Daesh in Syria and Irag, the COVID pandemic, the Russia-Ukraine war and, most recently, the Israel-Hamas war. All those challenges have one common trait: they transcend traditional boundaries and reguire a multidimensional response.

In response, NATO initiated various programmes to enhance capabilities, with its members reaffirming decisions at summits in 2014, 2016, and 2019, with the latter ratifying a new NATO Military Strateqy. Concurrently, a reflection process – NATO 2030 – was initiated to enhance

the Alliance's political strength, with recommendations provided at the 2021 NATO Summit. While the NATO 2030 Agenda can be described as one of the first signs of proactive capability development undertaken by the Organisation, the results of the process, as reflected in the 2022 Strategic Concept, might prove an enhanced capacity to respond to the developing transboundary threats, but it is far from a pre-emptive approach. Historically, NATO's mission expanded beyond regional defence to encompass international stabilisation, peace-supporting missions, and counter-terrorism efforts. Furthermore, the Alliance has recognised and engaged with persistent global challenges, such as instability in the Middle East and North Africa, as well as the spread of violent extremist organisations. In addition to traditional military challenges, NATO has expanded its scope to address emerging threats such as cybersecurity, disinformation campaigns, the weaponisation of new technologies, and cognitive warfare.

Acknowledging progress made up to the most recent Strategic Concept, defined by adaptability and resilience, the current security landscape calls for a rapid change of perspective, beyond the political and military divide, transcending the classical domains and physical boundaries. The developing strategy should not be static, but rather flexible and fluid, serving as a foundation for proactive action, as requested by the evolving map of complex challenges.

#### The nexus of internal and external security threats

Internally, NATO cohesion and effectiveness have been facing growing threats such as: divergent national interests, defence spending disparities, political instability, erosion of trust, political (dis)unity for decision-making, technology gaps, enlargement issues, and operational coordination.

Divergent national interests within NATO represent an inherent complexity that underscores the Alliance's composition of diverse members. While NATO operates under the shared principles of collective defence and mutual security, the unique geopolitical priorities, historical contexts, and domestic considerations of individual member countries often result in varying strategic perspectives. The challenge lies in reconciling these divergent national interests to maintain a cohesive and effective alliance. Effective consensus-building mechanisms and diplomatic efforts become imperative in navigating the intricacies of diverse national agendas within NATO, ensuring the Alliance's ability to address contemporary security chal-



Soldiers from the 82nd Airborne Division and 18th Airborne Corps file onto a US Air Force C-17 Globemaster III aircraft at Fort Bragg, North Carolina, February 2022. The soldiers are deploying to Eastern Europe as directed by the US Secretary of Defense to assure the United States' NATO allies and deter Russian aggression.

lenges with unity and resolve. Moreover, maintaining political unity among members is essential for NATO's effectiveness. The Alliance's decision-making processes require consensus, and internal disagreements on issues such as military interventions or strategic directions can hinder timely and decisive action. Within the same sphere of internal challenges, another relevant issue is the question of whether and how to expand the Alliance by admitting new members. Decisions regarding enlargement involve considerations of security, stability, and potential geopolitical implications.

The issue of burden-sharing – as illustrated in defence spending – has been a persistent challenge. This concern was first pointed out by former US President Donald Trump, but it still represents an internal threat to the Alliance today. Some NATO members consistently fall short of the agreed goal of allocating 2% of their GDP to defence. This not only affects the Alliance's overall military capabilities, but also creates resentment among those member countries that perceive themselves as carrying a disproportionate burden. Moreover, rapid advancements in military technology may create disparities in military capabilities among NATO members. Ensuring that all members have access to and can integrate cutting-edge technology is crucial for maintaining the Alliance's effectiveness. NATO's strength relies on the ability of its member' armed forces to operate cohesively. Achieving interoperability and seamless coordination in joint military operations represents a persistent internal challenge, given differences in military doctrines and equipment.

Political instability within member countries can also affect NATO's ability to respond cohesively to emerging threats. Changes in leadership, shifts in foreign policy priorities, or internal political conflicts may hinder the Alliance's ability to formulate and implement a unified strategy. In the same way, trust among members is crucial for the functioning of NATO. Disputes over issues such as intelligence sharing, military interventions, or diplomatic strategies can erode trust and cooperation. Building consensus becomes more difficult when there is a lack of confidence among member states. Externally, NATO is dealing with a complex set of challenges, emphasised by the 2022 Strategic Concept: Russia's aggressive actions, the global power competition – China, terrorism, regional conflict, cyber threats, hybrid warfare, emerging and disruptive technologies, proliferation of weapons of mass destruction, maritime security challenges, migration, climate change and global health emergencies.

The Russian Federation constitutes the principal and most direct threat to the security of NATO members and the overall peace and stability in the Euro-Atlantic region. Its strategic objectives encompass the establishment of spheres of influence and the exertion of direct control through methodologies such as coercion, subversion, aggression, and annexation, employing conventional, cyber, and hybrid means. Notably, Russia is actively modernising its nuclear forces and expanding its innovative and disruptive dual-capable delivery systems, concurrently engaging in coercive nuclear signalling. The explicit aim is to destabilise countries situated to the east and south of NATO member countries. Furthermore, in the High North, Russia's capacity to disrupt allied reinforcements and impede freedom of navigation across the North Atlantic poses a strategic challenge to the Alliance. Moscow's military build-up, particularly in the Baltic. Black, and Mediterranean Sea regions, in conjunction with



Lt Col Robert Cuthbertson, Commander of Hunter Army Airfield, fist-bumps a soldier assigned to Headquarters and Headquarters Battalion, 3rd Infantry Division, as he boards an airplane at Truscott Air Terminal, Hunter Army Airfield, Georgia, 5 September 2023.

its military tango with Belarus, poses a direct challenge to the security and interests of NATO member countries.

Shifts in global power dynamics and competition among major powers, including the People's Republic of China (PRC), can have implications for NATO's strategic environment. The Alliance monitors these developments and assesses their impact on security. PRC ambitions and policies pose a significant challenge to NATO's interests, security, and values. The PRC employs a comprehensive array of political, economic, and military instruments to expand its global influence and project power. However, the PRC maintains opacity regarding its strategy, intentions, and military build-up.

Malicious hybrid and cyber operations, coupled with confrontational rhetoric and disinformation, have been used by the PRC against Allied member states, posing problems for the Alliance. Additionally, the PRC has built up its control over pivotal technological and industrial sectors, critical infrastructure, as well as strategic materials and supply chains. Leveraging economic influence, the PRC has also created strategic dependencies to enhance its global influence. As a whole, the PRC's efforts have challenged the existing rules-based international order. particularly in the space, cyber, and maritime domains. Furthermore, the deepening strategic partnership between the PRC and the Russian Federation, represents a further challenge to the Alliance's core values and strategic interests.

Terrorism remains a significant concern for NATO, representing the foremost asymmetrical threat to the security of citizens and to the global state of peace and prosperity. The Alliance collaborates on counterterrorism efforts and works to address the underlying factors contributing to extremism. Terrorist organisations aim to launch or incite attacks against NATO Allies. These entities have undergone network expansion, capability enhancement, and technological investment to extend their operational scope and lethality. They often lack a centralised structure, expanding their reach. Nonstate armed groups, inclusive of transnational terrorist networks and those with state backing, persist in exploiting conflict zones and areas characterised by weak governance for the purposes of recruitment, mobilisation, and the amplification of their influence.

Ongoing conflicts, political instability, and the presence of extremist groups in several regions, and specifically in the Middle East and North Africa have im-



NATO HQ exterior, Brussels, Belgium, on 27 June 2019.

plications for NATO's security. The Alliance monitors and addresses potential spill-over effects and collaborates with partner countries in the region. NATO's southern vicinity, notably encompassing the Middle East, North Africa, and the Sahel regions, confronts interlinked challenges spanning security, demographic shifts, economic concerns, and political instabilities. These challenges are compounded by the consequences of climate change, vulnerable institutions, health crises, and food insecurity. This complex environment serves as conducive terrain for the proliferation of non-state armed entities, including terrorist organisations. Additionally, it facilitates destabilising and coercive interference by strategic competitors.

The domain of cyberspace is subject to continuous contention, where malevolent actors endeavour to disrupt critical infrastructure and government services, extract intelligence, pilfer intellectual property, and obstruct military operations. NATO faces challenges from hybrid warfare, which involves a combination of conventional military tactics, cyberattacks, disinformation campaigns, and other unconventional methods. This multifaceted approach makes it challenging to respond effectively.

The advent of emerging and disruptive technologies introduces both opportunities and potential hazards, thereby transforming the nature of conflict and elevating their strategic significance as pivotal arenas in the global competitive landscape. Technological pre-eminence remains a key contributing factor to determining success on the battlefield.

The proliferation of weapons of mass destruction remains a global concern. NATO works to prevent the spread of these weapons and address the risks associated with their potential use. The degradation of the framework governing arms control, disarmament, and nonproliferation has had adverse effects on strategic stability. The conceivable employment of chemical, biological, radiological, and nuclear materials or weaponry by antagonistic state and non-state entities against NATO continues to pose a threat to the security of the Alliance.

NATO confronts multifaceted challenges in the maritime domain, highlighting the intricate nature of contemporary security threats at sea. Foremost among these challenges is the evolving spectrum of anti-access/area denial (A2/AD) strategies employed by potential adversaries, employing advanced anti-ship capabilities to restrict NATO's maritime access. The proliferation of submarines equipped with sophisticated sensors and weaponry amplifies the submarine threat, underscoring the need for vigilant monitoring and countermeasures. Furthermore, the increasing availability of naval platforms and technologies, including unmanned systems, introduces new complexities in maritime operations. Hybrid maritime threats, combining conventional tactics with cyberattacks, pose an additional layer of vulnerability, exploiting weaknesses in communication systems and infrastructure. The persistent spectre of maritime terrorism, illegal activities such as piracy and trafficking, and resource competition further contribute to the intricacies of NATO's maritime security landscape. The Alliance works to ensure the security of sea lines of communication and maritime trade routes.

Climate change poses long-term security challenges, including resource scarcity, migration pressures, and potential geopolitical shifts. NATO recognises the security implications of climate change and works to address related risks. Climate change stands as a pivotal challenge in our era, significantly affecting allied security as a crisis and amplifying existing threats. It possesses the capacity to exacerbate conflict, fragility, and geopolitical competitions. The escalation of temperatures results in elevated sea levels, heightened occurrences of wildfires, and more frequent and intense weather events, causing disruption to our societies, jeopardising security, and posing threats to the well-being and livelihoods of our citizens. Furthermore, climate change influences the operational dynamics of our armed forces. The vulnerabilities of our infrastructure, assets, and bases are exposed to the effects of climate change, necessitating military operations in increasingly extreme climate conditions and more frequent engagement in disaster relief efforts.

Internal and external threats are interlinked, challenging the organisation in different spaces, at different levels simultaneously. In the era of interconnectivity, NATO needs a strategy that transcends a unilateral approach and provides the foundation for enhancing proactive capabilities, tackling threats on multiple domains, and enhancing its capacity to anticipate and effectively address future challenges. The Alliance's commitment to innovation, collaboration, and the continuous reassessment of its strategic objectives underscores its crucial role in navigating the complexities of contemporary global security dynamics. Over the preceding two decades, the swift advancements in space technology, cyberspace, artificial intelligence, and autonomous weapon systems have provided both state and non-state entities with novel means to exert influence and engage in unconventional warfare. The escalating threat of cyberattacks, dissemination of disinformation, and the weaponisation of emerging technologies have underscored the critical importance of cybersecurity and prompted concerns regarding the susceptibility of vital infrastructure and the resilience of societies. These developments have heightened the competition for influence, resources, and strategic advantages, fostering increased tension and rivalries.

#### The path to an evolving mission: multidimensional proactiveness

In the context of the evolving great power competitive landscape, NATO is confronted with the pivotal guestion of reassessing its role and mission. A strategic framework is indispensable for the realignment of objectives, methods, resources, and means, ensuring the cohesion of NATO, integral to its credibility in both operational and deterrent capacities. Recognising the diverse security concerns of all members emerges as a central imperative for NATO's prospective trajectory. NATO must tackle the perception of being 'many things to many people' and should concentrate on fostering a cohesive community within the Alliance

The potential of the NATO 2030 initiative to create the premises for proactiveness has led to a new Strategic Concept which, although it reiterates NATO's primary objective of collective defence, adopts a comprehensive 360° approach. The concept prioritises national and collective resilience across all core tasks, integrating technological innovation and addressing climate change, human security, and the Women, Peace, and Security (WPS) agenda. The overarching goal is to create a safer world and safeguard nations, societies, and shared values.

However, bearing in mind the complex nature of the aforementioned threats and their fast evolution, the decade-long Strategic Concept is no longer a sustainable tool for NATO. Instead, the organisation needs to redefine its mission as constantly evolving, enhancing proactive capabilities and strategies spanning all domains. In this way, NATO endeavours to both deter and overcome potential threats posed to its members, thereby ensuring the Alliance's capacity to sustain security and deliver decisive responses.

The most relevant example for NATO's evolving mission is the revised strategy for NATO's transformation, as advocated by Allied Command Transformation (ACT), which seeks to cultivate a military instrument of power characterised by a more fluid nature, as opposed to a static strategic approach. Therefore, NATO's Military Instrument of Power (MIOP) must possess inherent fluidity and flexibility, allowing it to adeptly respond to diverse contexts,

threats, and tensions. The overarching goal is to sustain a cycle encompassing strategic foresight, conceptual and doctrinal frameworks, enhanced capabilities, and human resources.

Strategic foresight plays a pivotal role in proactively identifying emerging trends, risks, and opportunities within the global security landscape. Through the analysis of geopolitical shifts, technological advancements, and societal transformations, NATO can discern potential threats, enabling the formulation of preemptive strategies. This foresight establishes a robust foundation for informed decision-making and the establishment of enduring objectives and priorities. In this virtuous cycle, concepts and doctrine assume a critical role by fostering the dissemination of best practices, fostering alignment among member states, and establishing shared norms and standards for collaborative military endeavours. Such alignment ensures interoperability, promotes cooperation, and strengthens NATO's collective defence efforts. The Alliance must consistently cultivate and enhance its military capabilities, leveraging technological innovations through investment in research and development, modernising equipment and infrastructure, and refining training and education programmes. Attracting and retaining skilled personnel while providing avenues for professional growth and advancement enables NATO to harness the expertise of its human resources, enhancing its capacity to anticipate and effectively address future challenges.

Nevertheless, NATO will realise its transformative objectives by embracing the process of digital transformation to facilitate the effective use of technology, optimise data utilisation, and cultivate collaborative endeavours encompassing academia, the private sector, as well as its members and partners. At the Madrid Summit in June 2022, heads of state and government agreed to "expedite our digital transformation." Since then, the digital progress has been accelerated by the adoption of a Digital Transformation Vision in October 2022 and a Digital Transformation Implementation Strategy in July 2023.

The challenges faced by NATO over the past decade represent a mere glimpse of the global security threats that the organisation will face in the future, emphasising the need for a fluid, comprehensive, and extensively holistic strategy which focuses on expediting interoperability, and benefits from the application of digital transformation to the development of capabilities for enhanced agility.

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#### The Bundeswehr special fund – a year and a half later

#### **Gerhard Heiming**

The Bundeswehr special fund was legally established in July 2022. In the initial economic plan, a total of 38 projects were listed in five spheres, totalling EUR 100 billion. In December 2022, a new economic plan – heavily revised following criticism – was adopted for the first time in connection with the adoption of the federal budget for financial year 2023.

he Bundeswehr special fund provides EUR 100 billion for the "financing of significant Bundeswehr equipment projects, in particular complex multi-year measures". In the first edition of their economic plan, the Federal Ministry of Defence packed the entire budget with projects without taking into account the interest to be borne by the special fund. Following criticism from the Federal Audit Office, this was taken into account when drawing up the economic plan for the 2023 budget. This reduced the available amount to EUR 92 billion and later - taking into account rising interest rates - to EUR 87 billion. As a result, numerous projects had to be removed from the economic plan. The interest burden may increase further due to the long timespans of some projects.

In December 2022, the German Bundestag's Budget Committee approved the first projects for the special fund with proposals valued at EUR 25 million, including the procurement of 35 F-35 Lightning fighter aircraft, the most expensive to date (EUR 8.3 billion) and one of the longest projects with a term until 2031. The Ministry of Defence had announced over 70 EUR 25-million proposals for 2023, some of which were for projects from the special fund. The table below lists the majority of the projects that have already been approved. At the time of writing, there remain a double-digit number of proposals left to be presented at the meetings of the Budget Committee still to take place by the end of 2023.

#### **Planning status**

Only a few of the projects in the special fund – such as the F-35 or the heavy transport helicopter (STH; Schwerer Transporthubschrauber) – are genuinely new projects. The majority are transfers from the core budget of Section 14. The arma-



The F-35A Lightning II fighter aircraft is the largest project to date in the Bundeswehr special fund.

ments investment part of the budget has been decreasing continuously since 2022. While it was still EUR 12.2 billion in 2022, the figure for 2023 fell to EUR 9.6 billion. The draft for 2024 envisages a further reduction to EUR 3.9 billion. The special fund is therefore increasingly mutating into the financing of 'normal' projects. The intended effect as a booster for the modernisation of the Bundeswehr is visibly evaporating.

At the Bundeswehr conference in November, Federal Chancellor Olaf Scholz described it as a good sign that "more than half and probably two thirds of the special fund will already be contractually committed by the end of the year."

However, the conclusion of contracts and the contractual commitment of budget funds do not lead to an immediate outflow of funds, nor an immediate inflow of equipment. It can take several years for the first weapon systems to be delivered, particularly in the case of large-scale projects. Expenditure of EUR 8.4 billion from the special fund is planned for 2023, although at the time of writing it is unclear how much of this has actually been spent. In recent years, it has been repeatedly shown that investment funds for armaments have not been fully used despite dwindling resources.

The special fund is playing an increasingly important role in achieving NATO's goal of spending 2% of gross domestic product (GDP) on defence. The Establishment Act states that this target is to be achieved with the help of the special fund over a multiyear average with a maximum of five years. In view of the stagnating defence budget of EUR 51 billion, the special fund must take on an ever-increasing share.

This is achieved by transferring numerous projects to the special fund that, accord-

ing to the law, do not belong there. For example, expenditure of EUR 19.2 billion is planned for 2024. In subsequent years, the financial injection required from the special fund to achieve the 2% target will increase because GDP is set to rise again, but the defence budget will not. It is therefore foreseeable that the special fund will soon be exhausted. Insiders expect that no more funds will be available from 2026. Almost all of the projects listed in the table will not have been completed by then, and some of them will be in the planned peak of their spending phase.

#### The future

There are two basic options to ensure that the projects continue to be financed and that the 2% target is achieved: Firstly, the Bundeswehr special fund could be increased. This would again require overarching cooperation, in which not only the governing coalition but also the opposition would have to agree on a joint approach.



The procurement of the Caracal airborne vehicle has been accelerated by the special fund.

Approved special fund proposals					
Project name	Value (EUR millions)	Project end date			
Handheld and vehicle radios	33	2024			
Airborne rescue centres	40	2024			
Interchangeable loader systems and platforms	317	2025			
Eurofighter, development of e-scan radar	84	2025			
Command and control equipment IdZ	51	2026			
Air defence system IRIS-T SLM	950	2027			
Reconnaissance and anti-submarine warfare system Poseidon	2,803	2027			
Simulator for P-8A Poseidon	180	2027			
Support services D-LBO	57	2028			
Puma infantry fighting vehicle, 2nd batch	1,500	2028			
Crypto modernization TP 2b	70	2028			
Puma infantry fighting vehicle, retrofit 1st lot	851	2029			
CATV over-snow vehicle	1,471	2030			
Caracal airborne platform	1,398	2030			
Arrow missile defence system	4,005	2030			
F-35 Lightning II fighter aircraft	8,300	2031			
Heavy transport helicopter STH	7,216	2032			
Total (EUR)	29,362	N/A			

The other option is to increase the defence budget by EUR 20–30 billion from 2026 at the latest. This increase could be prepared for now by adjusting medium-term financial planning.

Currently, a political solution seems extremely difficult with regard to either option. In addition to the security crisis arising from conflicts in Ukraine and Israel, both the climate and economic crises pose further challenges for financial planners. Additionally, their financial plans have recently been shaken by the Federal Constitutional Court, which has torn a EUR 60 billion hole in the German budget with its ruling that the Scholz Government's Second Supplementary Budget Act was unconstitutional. Federal Defence Minister Boris Pistorius has demanded that the Bundeswehr must become fit for war. In addition to a change in the mentality of German society, and well-trained, motivated personnel, the third pillar of readiness for war is modern equipment for the armed forces. The Bundeswehr special fund was intended to accelerate the modernisation of equipment, and this appears to be succeeding, albeit partially. However, the increasing dilution of the special fund and the lack of support due to the collapse of the defence budget are putting modernisation on the back burner. The Bundeswehr's equipment must be financed with a long-term perspective. This is the only way to ensure planning security for the troops and their commanders, but also for the defence industry responsible for modernising the Bundeswehr's equipment.

## Why Iran sees the Caucasus as part of the Middle East

#### Ilya Roubanis

Two exogenous events are currently reshaping the South Caucasus: the War in Ukraine and the Israel-Hamas conflict in Gaza.

he invasion of Ukraine forced Russia to re-prioritise the significance of the region, which evolved from the backwater of its 'near abroad' neo-colonial space to the main logistical hub of its war economy. Russia currently works with its historical regional foes – Iran and Turkey – in what might be

#### Iran and Regional security after Ukraine

The war in Ukraine ended what remained of the Pax Russica in the Caucasus. Russia now needs to work with its historical foes in the Caucasus, Turkey and Iran, to sustain 2024. Of equal significance is the security dimension of this partnership. Attention in western media often focuses on the delivery of Iranian Shahid loitering munitions and Mohajer drones to Russia, critical to the war effort in Ukraine. However, Iran's gains are long-term, securing access



Russian military outpost 016, near the Eastern Armenia-Azerbaijan-Iran triangle

called a Concert of Three. This Concert was moulded in Astana in 2017, when the three powers convened to determine the future of Syria without Western involvement. This exclusionary regionalisation is now enveloping the Caucasus. More recently, the web of relationships with a security bearing in Gaza now affects stability in the Caucasus: Iran, Turkey and Russia will find it more difficult to compartmentalise their security posture.

#### <u>Author</u>

**Ilya Roubanis** (PhD, EUI, Florence) is a journalist, editor, and business intelligence analyst, specialising in the South Caucasus region. Professionally, he has evolved through roles in political communication consulting, policy research, and government. As an analyst, he collaborates with think tanks and specialist journals in London, Athens, Madrid, The Hague, Tbilisi, and Prague. its war economy. Every state in the region is feeling a positive economic boost from trading with Russia. A recent report by the Asian Development Bank paints a picture of miraculous GDP growth for the Caucasus states in 2022: Armenia (12.6%), Georgia (10.2%), and Azerbaijan (4,6%). The report attributes this growth to re-exporting activity towards Russia, as well as the migration of businesses, people, and capital from Russia. A range of sources also points to Iran's geoeconomic benefits.

Tehran is central to transit trade towards Russia, and the internationally-sanctioned continuum from the Baltic Sea to the Indian Ocean presents a range of opportunities. Tehran's 'Look East' economic narrative envisions a shift from the margins of the global economy to the epicentre of a Eurasian economic regime. That is not merely 'a vision'. Russia emerged in 2022 as Iran's foremost foreign investor and trading partner, and Iran is due to accede to the Eurasian Customs Union by early to strategic Russian technology: digital surveillance and missile defence systems, attack helicopters, and fifth-generation fighter jets.

The newfound symmetry of this relationship also entails a threat. Iran can no longer count on Russia as the guarantor of the territorial status quo in the Caucasus. As the Covid-19 pandemic unfolded in September 2020, Azerbaijan launched a major offensive against Armenia. By 9 November 2020, Armenia was forced to sign a Russian-mediated ceasefire agreement, conceding the loss of territories governed by the self-proclaimed Republic of Artsakh. Azerbaijan's victory came with a caveat. The ceasefire agreement provided for the continued presence of the autonomous region linked to Armenia by the Lachin Corridor (Article 6), a transport artery linking the territory to the Republic of Armenia. The corridor was to be under the custody of a Russian peacekeeping force of just under 2,000 troops (Article 3).

This status quo held until the war in Ukraine, when Azerbaijan seized the opportunity to end Armenian self-governance in Nagorno-Karabakh altogether. In August 2022, Lachin came under the control of Azerbaijani troops, encountering no resistance from Russia. In December 2022 Baku stepped up the disruption of energy, people, and goods to Karabakh. In June 2023 the region was sealed off and in September 2023, Azerbaijani troops advanced to assert full control over the territory. The Russian peace keeping force did not intervene.

While Armenian access to the Lachin corridor eroded, Azerbaijan's President Ilham Aliyev referenced the November 2020 ceasefire agreement (Article 9) to demand a corridor linking the Republic of Azerbaijan and its exclave of Nakhchivan, known as the 'Zangezur corridor'. The ceasefire agreement envisioned entrusting the security of this notional transport artery to Russia's Border Guard Service (PB FSB). Armenia has been reluctant to implement this, but Azerbaijan has continued to press the issue via coercive means. From September to November 2021 Azerbaijani troops made inroads into sovereign Armenian territory. Later, in September 2022 Azerbaijani troops made further inroads into Armenia. coming within reach of the towns of Kapan, Goris, Vardenis, Sotk, Artanish, Jermuk, and Ishkhanasar. Yerevan triggered the collective defence clause of the Collective Security Treaty Organisation (CSTO) but neither the 4,000 FSS border guards nor the Russian military heeded the call.

Russia is effectively no longer Armenia's security guarantor, while Russian servicemen control the entire Armenia-Iran borderline. This complicates Tehran's ability to assist Armenia and fill the security vacuum left by Russia's de facto disengagement. During the Second Karabakh War in 2020, Iran became the sole reliable transit state for the movement of weapons and ammunition to Armenia. Yet in the aftermath of the Second Karabakh War, Iran has accepted the new status quo. For instance, when Azerbaijan arrested two Iranian truckers transiting via the Goris-Kapan highway in the Lachin region, Tehran ensured fines were paid and pledged to invest in an alternative transport route that bypasses Azerbaijan's sovereign territory.

Having said this, Iran has repeatedly stated that it would not tolerate Azerbaijan's control over the South of Armenia. In response to the 'Three Brothers' military drills between Turkey, Azerbaijan, and Pakistan along the Iranian border in September 2021, the IRGC conducted drills that included amphibious crossings of the Arax River, heliborne and parachute jump operations, night operations, and the simulated seizure of routes and heights controlled by a hy-



Key transport corridors transiting via Armenia, from a presentation on the Armenian Government's 'crossroads of peace' project.

pothetical enemy. Historically, Iran did not have hypothetical enemies in Russia's nearabroad. However, Tehran has drawn a red line with southern Armenia, unwilling to allow the de facto Turkish-Azerbaijani control of the Armenian borderline, creating what is in effect a cordon sanitaire between Armenia and Iran. After the Azerbaijani incursion into Armenian territory in September 2022, Iran took action by mobilising a force of 50,000 troops, opening a consulate in Kapan, and welcoming the EU observation mission in Armenia's Syunik Province, the southernmost in the country, which shares a border with Iran. With respect to acceptance of Azerbaijan's presence, Tehran's consistent message has been 'Yes to Karabakh, no to Syunik.'

#### Iran and Regional security after Gaza

Iran views Azerbaijan's positioning in South Armenia as a threat to its own national security for two reasons: firstly, due to ethnic Azerbaijani secessionism within Iran; secondly due to the perceived threat of Azerbaijani collusion with Israel. While Russia was present, there was no contradiction in the special relationship between Ankara and Baku - the 'one nation, two states' partnership – and the strategic alliance between Baku and Tel Aviv. A partnership of equals in the Caucasus now means that Tehran, Ankara, and Moscow need to build consensus between them and minimise the intervention of external actors. They agree on the latter objective, but their consensus is facing more of a challenge after Hamas' 7 October 2023 attack on Israel.

Azerbaijan's strategic relationship with Israel is often referred to as the 'iceberg relationship,' in the sense that its greatest part is hidden under the surface. The two parties cooperate on communications, energy, military procurement, reconnaissance, and intelligence gathering. Through this partnership, Israel has been keen to develop a 'go-it-alone' option to attack Iran without US support. Iran accuses Azerbaijan of providing airfields for Israeli UAVs that enable direct action within Iranian territory. By contrast, Azerbaijani diplomats are on the record denying Israel the refuelling support that would render attacks deep into Iranian territory a credible threat. Experts point to Israel's attack against nuclear installations in Isfahan in January 2023, carried out with small quadcopter drones probably smuggled via Azerbaijan. In sum, Azerbaijan is understood to either assist or merely facilitate Israeli covert action.

Azerbaijan and Israel clearly share a perception of Iran as a security threat operating through militant Shia Muslim proxies. Historically, the Republic of Azerbaijan in Tehran is referred to as 'the Republic of Baku' while Azerbaijani analysts refer to Northern Iran as 'South Azerbaijan.' This is not about two states contesting territory but a clash of worldviews. The two states compete for the hearts and minds of Turkic-speaking Shia communities in the Caucasus, pitting Shia allegiance against Turanic patriotism. The managing director of a news outlet linked to IRGC recently referred to people living "on both sides of the Aras river" as culturally Iranians. The Azerbaijani analyst Ali Hajizade has pointed to dozens of Iranian-sponsored media sources that seek to mobilise support against Azerbaijan via Shia propaganda.

Azerbaijan sees Iran as a domestic threat and vice versa Historically, Iran's response to a security threat in the region includes the instrumentalisation of Shia militancy. Israel's Foreign Minister, Eli Cohen, pointed the finger at Iran for foiled attacks against Israeli Embassies in Baku, Athens, and Nicosia. By the same token, President Ilham Aliyev pointed the finger at Iran for an attack against Azerbaijan's Embassy in Tehran and the occupation of the Azerbaijani Embassy in London. An organisation known as Hoseynun or 'Defenders of the Shrine' is making inroads into Azerbaijan's Talysh community, and is vaguely associated with the Iran-sponsored Hezbollah movement and recognised as a branch of Soleimani's 'Axis of Resistance.' For its part, Tehran is not particularly covert in its engagement with this movement - on 18 October 2023, the leader of the Hoseynun movement visited Tehran and was interviewed by their public broadcaster.

How Iran engages with the Caucasus is changing. The appointment of Ambassador Mehdi Sobhani in Yerevan in March 2023 was viewed as highly significant, both because of his former posting in Syria and his ties to the IRGC. More recently, in November 2023, the commander of the IRGC ground forces of Iran, Sardar Pakpour, was inspecting defence facilities along the Jolfa region, which borders Azerbaijan's Nakhchivan enclave, signalling this is no longer the exclusive preserve of the military. In sum, Iran is bringing to bear resources previously tested in the Levant.

In this security context, it is unclear whether Ankara and Baku share the same security priorities. While Washington speaks of Turkey as "a bulwark against Iran" (Shaheen-Romney Bipartisan Bill, July 2022) that is a fanciful proposition. Turkey's newly-appointed foreign minister. Hakan Fidan, is the former Director of the National Intelligence Organisation (MIT) that cultivated an amicable partnership with Major General Qassem Soleimani, forged during the war against ISIL in Iraq and Syria. Significantly, Ankara condemned Soleimani's assassination and finds it easier to coordinate with Tehran than its Western allies on the Kurdish question. Seeking its own ground force in Syria, Washington built a partnership with the Syrian Democratic Forces, which has fuelled a reservoir of anti-American rhetoric in Turkey. Events in Gaza have galvanised this rhetorical alignment with Tehran, particularly in the context of Turkish leadership's expressed tolerance of Hamas.

The cooperation between the Iranian Revolutionary Guards (IRGC) and Turkish businessmen in Lebanon is an uncontested real-



ity. Beyond the Levant, Iran's secret services have been given the leeway to target dissidents in Turkey. It then comes as no surprise that Israel regards Turkish intelligence and Foreign Minister Fidan as a foe, particularly as MIT has come down hard against Mossad's counter-Iranian activity in Turkey. The fact that Israel has developed a strategic partnership with the Kurds cements the 'enemy-of-my-enemy-is-my-friend' dynamic between Ankara and Tehran. In any event, Fidan visited Tehran on 1 November 2023 for consultations regarding the effect of Israel's Gaza campaign in Lebanon and Syria. In follow-up statements, the Iranian foreign minister scolded Azerbaijan's fuel exports to Israel. Clearly, the crisis in Gaza points to friction between the Concert of Three and the 'one nation, two states' dictum.

#### Iran's new security posture in the Caucasus

Iran has held its ground without adventurism in the Caucasus, which was largely recognised as a Russian sphere of influence. However, the dramatic transformation of the diplomatic and security landscape following the war in Ukraine means that Iran's security posture is under review. Moscow and Tehran now effectively form an internationally-sanctioned continuum that Ankara is well placed to exploit, reaping economic and strategic benefits in the process. Lavrov's emotive comparison of Gaza's siege with the Nazi siege of Leningrad, and Erdogan's recent proclamation that 'the end is near' for Israel suggests that the partnership with Iran is resilient. However, Turkey needs to balance this partnership with its 'one nation, two states' partnership with Azerbaijan.

It is now conceivable that the Caucasus can be enveloped in the web of conflict escalation in the Levant. Should the conflict in Gaza escalate, there could be wider mobilisation among Shia movements. To think of these developments as wholly separate and compartmentalised can be deceiving, particularly when considering not state-actors. Often, emerging militant movements claim responsibility for actions not instigated by them but loosely inspired by their ideas, in what is a well-established pattern of brand name terrorism. The storming of a passenger aircraft in Dagestan by a mob in search of Jewish Israeli passengers is a clear indication of how opportunities to exploit tension can arise. In sum, proxy movements are instrumental to, but not necessarily controlled by Iran and that is true in the Caucasus as much as the Levant. Should the conflict in Gaza spread to Lebanon, Israel may have to press its allies for every tactical advantage it can secure, not least the ability to strike strategic locations within Iran. Strategic advantage may also be gained by covert action in Iran, instrumentalising the South Azerbaijan movement. This means non-state actors can potentially trigger events that undermine security.

The perception of threat often has the same effect as covert action. Iran may believe Azerbaijan to be a threat, moving pre-emptively to build closer ties with Armenia and bolster its ties with Shia militants. Iran has already mobilised three times along its border with Armenia, which indicates that its security posture is linked to its own national security considerations both vis-à-vis Azerbaijan and Israel. In this context, it would be useful to think of the post-Soviet space in the Caucasus as having become enveloped in the geopolitical framework of Middle Eastern insecurity. Iran and Israel already do.



#### *European* European European Security & Defence

#### Exhibitions & Conferences 2024

Januar	y .	
2225.01.	IAV (International Armoured Vehicles)	London / UK
2324.01.	DWT – Prospects for the Defence Industry 2024	Bonn / Germany
2425.01.	Mobile Deployable Comms	London / UK
Februa	ry .	
0408.02.	WDS	Riyadh / Saudi Arabia
2629.02.	Enforce Tac / IWA / U.T.SEC	Nuremberg / Germany
2729.02.	Int'l Mil Helicopter	London / UK
March		
tbc	ISDEF	Tel Aviv / Israel
0405.03.	Defence Logistics CEE	London / UK
0406.03,	DIMDEX	Doha / Qatar
0506.03.	Future Indirect Fires / JMTS	Bristol / UK
1113.03.	DGI	London / UK
1113.03.	Future Soldier	Landon / UK
12:03.	Parliamentary Evening	Berlin / Germany
1214.03.	Combat Engr/Log	Warsaw / Poland
1921.03.	DWT – Applied Research for Defence and Security in Germany	Bonn / Germany
April		
0911.04.	IT <sup>2</sup> EC / UDT / MILSIM CEE	London / UK
May		
tbc.	IDEB	Bratislava / Slovakia
0608.05.	GPEC	Leipzig / Germany
0609.05.	DSA	Kuala Lumpur / Malaysia
0609.05.	SOF Week	Tampa / US
0708.05.	DWT – Multi-Domain Ops	Bonn / Germany
0709.05.	SEDEC	Ankara / Turkey
1315.05.	AOC Europe	Oslo / Norway
1416.05.	Aerospace Seville	Seville / Spain
2123.05.	CNE	Famborough / UK
2224.05.	BSDA	Bucharest / Romania
2930.05.	CADSI	Ottawa / Canada

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509.06	ILA	Berlin / Germany
7,-21.06	Eurosatory	Paris / France
627.06	AFCEA	Bonn / Germany
uly		
204.07	DCC Shrivenham	Shrivenham / UK
226.07	Farnborough	Famborough / UK
627.07	Helicopter Forum	Bückeburg / Germany
epten	ıber	
206.09	SOFEX	Aqaba / Jordan
811.09	MSPO	Kielce / Poland
325.09	. DWT – MarineWorkshop	Linstow / Germany
bc	SPIE	Berlin / Germany
bc	DVD UK	Millbrook / UK
Octob	er	
809.10	DWT – Energy Transition in the Military Context	Bonn / Germany
416.10	AUSA	Washington D. C. / US
618.10	Future Forces Forum	Prague / Czech Republic
226.10	SAHA	Istanbul / Turkey
Noven	ıber	
407.11	. Euronaval	Paris / France
811.11	Indodefence	Jakarta / Indonesia
922.11	IDEAS	Karachi / Pakistan
6.11.	Parliamentary Evening	Berlin / Germany
bc	NIDV	Rotterdam / Netherland
Decem	iber	
011.12	DWT – IT Conference	Bonn / Germany
bc	I/ITSEC	Orlando / US
bd	International Fighter	tbd





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