ESD

EUROPEAN SECURITY & DEFENCE

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The Future of Minefield Breaching

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[MRV]

Dear readers,

This is the first issue of *ESD* in the new year 2026.

It is becoming apparent that this will be an important, perhaps even disruptive year in terms of security policy.

More than ever, *ESD*, as one of the leading international defence and security magazines, must provide expert coverage of developments.

So with issue 3/2026, which we are already preparing, a new editor-in-chief will take over the editorial management of *ESD*.

Mr David Saw has many years of experience and comprehensive expertise as an editor-in-chief, excellent international contacts in the defence and security sector, and a convincing and promising vision for the further development of *ESD*.

David Saw ensured a seamless transition in January and will take over the position of editor-in-chief in full from February.

We look forward to working with David Saw and are confident that together we can further expand the relevance of our title.

In this context, I would like to express my sincere thanks to the previous editor-in-chief Mark Cazalet and news editor Peter Felstead, for their hard work and great commitment. They have left us with a strong basis to build a bigger and better *ESD*, one that fully reflects the dynamism of the European defence environment.

Amidst all these changes, you can rely on one thing: we will continue to provide high-quality, well-researched reporting for defence professionals in Europe.

For your continued trust I would like to express my sincere thanks.

Sincerely,

Peter Tamm
Publisher and CEO Mittler Report Verlag

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Cover Photo: Arkansas Army National Guard Soldiers with the 1036th Engineer Company, from Jonesboro, Arkansas, detonate an M58 Mine Clearing Line Charge (MICLIC) at the National Training Center (NTC), Fort Irwin, California, on 16 August 2015. [US ARNG/Maj Wayne Clyne]

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NATO allies look to new Arctic mission to head off Trump's threats to annex Greenland

(pf) A number of NATO countries, understood to be led by Germany, are to propose a new joint NATO mission called 'Arctic Sentry' to monitor and protect security interests in the Arctic region in a bid to head off the US Trump Administration's desire to annex Greenland.

This mission concept, first reported by Bloomberg on 11 January 2026, could potentially take its blueprint from NATO's 'Baltic Sentry' mission, which was initiated in January 2025 enhance NATO's military presence in the Baltic Sea and improve the allies' ability to respond to suspected Russian attacks on critical underwater infrastructure.

[Crown Copyright]

While US President Donald Trump had previously talked about buying or otherwise acquiring Greenland during his first presidential term, his administration's return to the concept – and in particular the refusal by Trump and some of his advisors to rule out using US military force to acquire the territory – is causing renewed consternation at NATO.

A hostile US annexing of Greenland, most alarmingly, would raise the bizarre and ominous prospect of Denmark having to invoke NATO's Article 5 mutual defence contingency against the alliance's most powerful member.

The NATO 'Baltic Sentry' proposal would serve to take the wind out of Trump's argument that Greenland needs to be secured against the threat from Russia and China and that only the United States can do this – hence the need to take over the territory.

Some within the Trump Administration, such as White House Deputy Chief of Staff for Policy Stephen Miller, have even questioned Denmark's provenance over Greenland, whereas in reality the territory has been associated with both Denmark and Norway since 986 AD – almost 800 years prior to the existence of the United States – while Greenland came under full Danish control in 1814.

Notwithstanding NATO's 'Arctic Sentry' proposal, Trump's purported justifications for needing to acquire Greenland for security reasons make little sense. In 1951 the United States and Denmark signed a defence agreement in relation to the territory allowing the US government "to improve and generally to fit the area for military use" and to "construct, install, maintain, and operate facilities and equipment" there. While there are currently only around 150 US military personnel stationed in Greenland, at Pituffik Space Base, under the agreement with Denmark there is no effectively no limit to the number of US military personnel that can be deployed there.

Moreover, Trump's assertion that Greenland is under threat from Russia and China is entirely at odds with how Trump has previously regarded Russia, since he has previously acquiesced in relations with Moscow, at times siding with Russia over Ukraine and infamously choosing during a July 2018 summit in Helsinki to believe Russian President Vladimir Putin over his own intelligence agencies when Putin denied Russian interference in the 2016 US presidential election.

Meanwhile, the political leaders of Denmark and Greenland are clearly running short of patience regarding Trump's avarice.

Danish Prime Minister Mette Frederiksen stated at a political rally on 11 January, "We are at a crossroads, and this is a fateful moment. What is at stake is bigger than what the eye can see, because if what we experience from the Americans is that they are actually turning their backs on the western alliance, that they are turning their backs on our NATO co-operation by threatening an ally, which we have not experienced before, then everything will stop."

Frederiksen has previously rejected Trump outright, telling him that Greenland is not for sale and that any idea of annexation is "absurd".

On 12 January Greenland's prime minister, Jens-Frederik Nielsen, stated on his Facebook page that "it is important to be absolutely clear: Greenland is part of the Kingdom of Denmark and part of NATO through the Commonwealth. This means that our security and defence belong in NATO. That is a fundamental and firm line."

In the US, even Republican politicians have broken ranks with Trump over the Greenland issue.

"This is appalling," Republican Representative for Nebraska Don Bacon told CNN on 6 January. "Greenland is a NATO ally. Denmark is one of our best friends ... so the way we're treating them is really demeaning and it has no upside."

Referring to the Trump Administration's Greenland rhetoric as one of the "silliest things" to come out of the White House over the past year, Bacon urged his fellow Republicans to join him in taking a stand. "I hope other Republicans line up behind me and make it clear to the White House this is wrong," he said.

After the stunning success of 'Absolute Resolve', what next for the US and Venezuela?

(pf) In his first major act of 2026 US President Donald Trump followed through on his threat to intervene in Venezuela by green-lighting Operation 'Absolute Resolve', which on 3 January led to the successful capture and rendition back to the United States of Venezuelan President Nicolás Maduro and his wife Cilia Adela Flores, both of whom face charges of narco-terrorism and drug trafficking.

However, the big question that remains is: what now?

Operation 'Absolute Resolve', which was months in preparation, was by any measure a stunning success militarily. Using more than 150 aircraft – including an RQ-170 Sentinel low-observable reconnaissance drone to monitor Maduro's movements, strike aircraft to neutralise Venezuelan air defence assets and command-and-control nodes, EA-18G Growler electronic attack aircraft to jam radars and communications, and MH-60M Black Hawk helicopters to carry elite Delta Force special operations forces – the raid was able to successfully apprehend Maduro and his wife at his fortress-like compound at Fuerte Tiuna in Caracas and spirit them away to the amphibious assault ship USS *Iwo Jima* off the Venezuelan coast. Only a handful of US service personnel were injured in the operation, with no fatalities, and, while a US helicopter sustained hits from ground fire, it was able to continue flying.

On the Venezuelan side, meanwhile, around 80 were killed, including 32 military and intelligence personnel from Venezuelan ally Cuba, which provided a substantial part of Maduro's security detail.
Ironically, it was Cuban soil on which Maduro was initially to set foot, as he and his wife were first taken to the US military's Naval Station Guantanamo Bay on the southeastern coast of Cuba before being transferred to a US federal detention centre in New York.

[White House]

After Trump announced from his Mar-a-Lago residence in Palm Beach, Florida, on 3 January that the raid had successfully taken place earlier that day, there was pushback from Democrats and even some Republicans over the operation taking place without Congress being notified. Trump Administration officials countered this by stating that the operation could not be compromised with the potential for any of the plans to be leaked, but in any case, as a specific joint military and law enforcement mission rather than a full-blown military intervention, Operation 'Absolute Resolve' did not require Congressional approval.

However, greater concern is coming from US politicians and allies over what will come next in Venezuela, while some politicians in US-allied countries, such as Dame Emily Thornberry in the UK, who is chair of the Commons Foreign Affairs Committee, have claimed the US raid to seize Maduro breached international law.

Some politicians beyond the US have claimed that actions such as Operation 'Absolute Resolve' could embolden other countries to mount similar adventures, yet it is worth remembering that Russian President Vladimir Putin needed no such excuse to annex Crimea in 2014 and launch an all-out invasion of Ukraine in 2022.

Trump initially claimed during his press conference at Mar-a-Lago, "We have a group of people running [Venezuela] until such a time it can be put back on track, make a lot of money for [Venezuelans] … give people a great way of life, and also [reimburse the] people in our country who were forced out of Venezuela."

However, it is unclear how the US government could exert any direct control in Caracas.

Trump added that, while it was his understanding that Venezuelan Vice President Delcy Rodriguez was "just sworn in" to the Venezuelan presidency following Maduro's rendition to the US (she has been made acting president), he believed Rodriguez seemed willing to work with the US.

"[Secretary of State] Marco [Rubio] is working on that directly," he said. "He just had a conversation with [Rodriguez], and she's essentially willing to do what we think is necessary to make Venezuela great again."

However, Rodriguez has held several positions in Venezuela's socialist governments, both throughout the Maduro presidency and even during the regime of his predecessor Hugo Chávez, whose presidency made Venezuela a prominent US adversary in Latin America. It is therefore perhaps a little surprising to see the Trump Administration endorse her potential as an ally so readily.

In Venezuela's 2024 presidential election the opposition leader Edmundo González was widely seen as the legitimate winner of a contest stolen by Maduro. Opposition leader María Corina Machado, who was barred from running in that election and recently won a Nobel Peace Prize for her struggles against the Maduro regime, has called for González to be recognised as the rightful leader of Venezuela. However, despite the success of Operation 'Absolute Resolve' – or maybe even because of it, given the danger of tarnishing such an obvious 'win' – the Trump Administration appears to have no immediate appetite for facilitating a Venezuelan government that truly represents the will of its people, which is perhaps not surprising; nation building – as the US found out in Iraq and Afghanistan – is hard and requires boots on the ground for longer than the duration of a special forces raid. If Acting President Rodriguez remains compliant enough and the Venezuelan opposition not sufficiently galvanised, that could be as far as 'regime change' in Venezuela will go.

Meanwhile, one potential positive result for the US from Operation 'Absolute Resolve' that might require very little effort could be economic pressure being heaped on the communist government in Cuba, which lies just 90 miles (145 km) south of Key West in Florida. While Cuba has ties with both Russia and China, Venezuela and its oil riches became a major benefactor of the government in Havana from the Chávez presidency onward. Given that Cuba's struggling controlled economy already suffers from frequent national power outages, the loss

of free Venezuelan oil could have significant economic or even political consequences unless Beijing or Moscow are prepared to step in.
As an exercise in wielding US influence and flexing US military muscle in Latin America, Operation 'Absolute Resolve' can be seen as a clear indicator that the Trump Administration's 'Monroe Doctrine 2.0' to exert US hegemony in the Western hemisphere – or Donroe Doctrine, as Trump is now calling it – is more than just talk.

Indeed, as Trump asserted at his post-raid press conference, "American dominance in the western hemisphere will never be questioned again."

It will then have come with some ongoing consternation for Denmark when Trump told reporters on Air Force One on 4 January, "We need Greenland. ... We need Greenland from the standpoint of national security, and Denmark is not going to be able to do it."

"You know what Denmark did recently to boost up security in Greenland? They added one more dog sled. It's true. They thought that was a great move," Trump added.

That remark, inevitably, was a falsehood. In October 2025, for example, the Danish government committed DKK 27.4 billion (EUR 3.67 billion) to boosting its military presence in the High North, following initiatives announced in January 2025 valued at around DKK 14.6 billion (EUR 1.96 billion).

Spanish DGAM orders 100 helicopters from Airbus and NHIndustries

(pf) The Spanish Ministry of Defence's Directorate General for Armament and Material (DGAM) has placed orders for a total of 100 helicopters from both Airbus Helicopters and NHIndustries: the joint venture in which Airbus combines with Leonardo and GKN Fokker to produce the NH90 helicopter.

[NHIndustries]

The contracts, announced by Airbus on 18 December 2025, represent the largest helicopter purchase by the DGAM and cover four different types for the three branches of the Spanish armed forces:

- 13 H135s: 12 helicopters for the Spanish Air and Space Force and one for the Spanish Navy. These will be used for advanced pilot training, light utility and observation missions;
- 50 H145Ms: all of these are for the Spanish Army, with their missions covering military pilot training, light attack (equipped with Airbus's HForce weapon systems fit), light utility and disaster relief;
- six H175Ms: these super-medium utility helicopters will be for the Spanish Air and Space Force and will be used for governmental missions, including the transport of authorities, replacing obsolete fleets from Wing 48;
- 31 NH90s in the Tactical Transport Helicopter (TTH) configuration: 13 for the Spanish Army, 12 for the Spanish Air and Space Force, and six for the Spanish Navy. These will conduct tactical transport, manoeuvre and special operations missions, as well as completing the navy's amphibious warfare fleet.

In addition to strengthening the current industrial capabilities of Airbus Helicopters in Spain, the major helicopter procurement is expected to have a direct impact on the creation of highly qualified jobs, estimated at more than 300 direct positions over the next three years. The industrial footprint in Albacete will continue to grow with a new military helicopter customisation centre and an international training centre for H145M pilots and technicians, Airbus stated, adding that the developments will further supplement the ongoing construction of facilities dedicated to the mid-life upgrade of the Airbus Tiger attack helicopter.

As well as representing a bonanza order for Airbus Helicopters, the order for 31 NH90s continues a run of positive recent news for NHIndustries and cements its position as the largest rotorcraft joint venture in the world. On 12 December NHIndustries announced that the Greek Ministry of Defence had signed up for a follow-on support contract for the Hellenic Army's fleet of NH90s, while on 16 December the first of 31 NH90 Sea Tigers was handed over to the German Navy.

As Spain has previously ordered 45 NH90s, the latest order will make Spain one of the largest NH90 operators. Spain is also the only NH90 operator to have introduced the NH90 to all three service arms. Deliveries under Spain's latest NH90 order are due to start in 2031, according to NHIndustries.

US president announces 'Trump-class' major surface combatants

(hum) On 21 December 2025 the US government announced the introduction of a new class of large surface combatants in a press release on navy.mil: the 'Trump class'. US President Donald Trump followed up on this a day later in a speech at his Mar-a-Lago residence in Florida, presenting the ships as the centrepiece of a 'Golden Fleet'. USS *Defiant* (BBG-1) is to be the first ship, with plans for 10–25 units. The goal: to restore visible maritime superiority over China and Russia.

Initial conceptual key points have been published on an accompanying, politically framed information page ('goldenfleet.navy.mil'). With a displacement of 30,000–40,000 tonnes, the Trump-class units would be larger than Arleigh Burke-class destroyers (9,200 tonnes) and roughly comparable to historic Iowa-class ships (45,000 tonnes fully loaded). The ships will be equipped with 120–130 VLS cells for conventional and potentially nuclear-capable hypersonic weapons (SLCM-N-like concepts), supplemented by railguns, 5-inch gun turrets, high-energy lasers and drone integration. Positioned as the 'most lethal surface combatant ever,' they are intended to take on C2 functions for manned/unmanned formations. Propulsion and protection remain vague. The announced nuclear armament would mark

[USN]

a paradigm shift: away from the 'submarine discretion' that has dominated since the 1990s toward deliberately visible nuclear deterrence.

CNN and Reuters estimate the cost at USD 5–7 billion (EUR 4.24-5.93 billion) per unit. Keel laying is projected for 2028/29 at the earliest, with commissioning in 2035+, depending on the FY2027 budget and Congress.

Navy Secretary John Phelan is pushing for open competition among shipyards such as Huntington Ingalls and General Dynamics in order to scale construction cost-effectively and avoid delays such as those experienced with the Littoral Combat Ship and Constellation class. President Trump is sharply criticising defence contractors for chronic cost overruns and production backlogs, demanding accountability and threatening penalties.

Overall, the Trump class represents less a consistent fleet concept than a strategic experiment under increasingly challenging conditions. In presidential communications, it is framed as the building block of a so-called 'Golden Navy' – a political narrative that emphasises visible strength without yet providing operational or financial resilience. In fact, the platform combines nuclear deterrence, firepower, air defence and command in a highly visible unit – in a security policy environment that is characterised by interconnectedness, vulnerability and industrial bottlenecks.

Whether this will result in operational substance or primarily a symbolic flagship project will be decided not in announcements, but in the budget, in industry and in operational performance. The first reliable test will be the FY2027 defence budget.

Beyond the purely maritime dimension, the Trump class also signals a deliberate shift in US sea power projection. The possible deployment of nuclear-capable weapons on surface ships increases their military relevance – but also their target priority and escalation potential in high-intensity peer conflicts. Visibility explicitly becomes part of the deterrence logic here, with correspondingly increased risks.

There is also an industrial and supply-side dimension. A resource-intensive flagship programme such as the Trump class is likely to tie up considerable development, integration and production capacities in sensor technology, effectors, software and system integration, especially where US approval and update cycles apply. In an already-tense US defence environment, this can lead to prioritisation conflicts that extend beyond national programmes.

Bundeswehr places order with PSM for 200 more Puma IFVs

(pf) Germany's Bundeswehr has commissioned Projekt System & Management (PSM), a joint venture between Rheinmetall and KNDS Deutschland (KNDS), to supply 200 additional Puma infantry fighting vehicles (IFVs), the companies announced on 19 December 2025.

The corresponding amendment to the existing framework contract has now been signed at the Federal Office for Equipment, Information Technology and In-Service Support of the Bundeswehr (BAAINBw) in Koblenz, with the contract taking legal effect in January 2026.

The total gross value of the procurement is EUR 4.2 billion, of which KNDS will receive EUR 2.1 billion while EUR 2.1 billion will go to the Rheinmetall subsidiary Rheinmetall Landsysteme. Both companies are implementing the project as subcontractors.

The first vehicles are scheduled for delivery in mid-2028.

[PSM]

The BAAINBw awarded PSM the original framework contract for the delivery of Puma IFVs in May 2023, placing an initial order for 50 S1-standard vehicles upon signing the contract. This contract has now been enlarged. In addition to the IVFs ordered to date, the contract also includes the procurement of corresponding protection modules and storage containers. Furthermore, a contract amendment for S2-standard IFVs is planned for mid-2026. The aim is to eliminate obsolescence and implement additional capabilities such as drone defence, based on the turret of the Jackal armoured vehicle (which uses the Boxer 8×8 platform to mount a Puma turret).

The Bundeswehr operates the Puma IFV as the primary weapon platform of its armoured infantry and has 350 of the type in active service.

Between 2023 and 2024 the BAAINBw commissioned the comprehensive modernisation of 297 of the Bundeswehr's Puma IFVs to the S1 series standard. This retrofit, which will be completed in 2029, includes the integration of high-resolution day and night vision camera systems, the multi-role light guided missile system (MELLS in German) and digital radio equipment.

US Navy selects Ingalls Shipbuilding to build its future small surface combatant

(pf) The US Navy has selected the Ingalls Shipbuilding division of Huntington Ingalls Industries to design and build its future small surface combatant.

The plan was announced by the US Navy on 19 December 2025 and in a video presentation on the X social media channel by US Secretary of the Navy John C Phelan and US Chief of Naval Operations Admiral Darryl Caudle. It comes in the wake of the US Navy terminating its troubled Constellation-class frigate programme on 25 November 2025 with the first two ships still under construction by Fincantieri Marinette Marine (FMM) in Wisconsin, with Phelan saying at the time that a "key factor in this decision is the need to grow the fleet faster to meet tomorrow's threats".

"To deliver at speed and scale I've directed the acquisition of a new frigate class based on HII's Legend-class National Security Cutter design: a proven, American-built ship that has been protecting US interests at home and abroad," said Phelan on 19 December. "We will deliver on a wartime footing and we will unleash the American industrial base to do it."

[US Navy]

Adm Caudle stated, "Recent operations from the Red Sea to the Caribbean make the requirement undeniable: our small surface combatant inventory is a third of what we need. We need more capable blue-water small combatants to close the gap and keep our DDGs [guided missile destroyers] focused on the high-end fight."

Called the FF(X), the new small surface combatant is to be designed as a highly adaptable vessel. While its primary mission will be surface warfare, its ability to carry modular payloads and command unmanned systems will allow it to execute a broad spectrum of operations, making it ready for the challenges of the modern maritime environment.

"Small surface combatants have always been essential to the fleet, handling a wide range of missions where a large warship isn't required," the US Navy stated. "The FF(X) will continue this vital role and will take on more routine operations, enhancing the fleet's operational flexibility, adaptability and mission readiness."

"The frigate will follow the same proven approach we've used with the Arleigh Burke destroyers: building it smart from the start, then upgrading it in steps over time as the threat and technology evolve," Adm Caudle explained.

"We've also been clear-eyed about what happens in conflict. Other countries will always prioritise their own fleets, not US ships that depend on foreign industry. That's why this is an American design, backed by American workers, American suppliers and an established logistics and maintenance network."

"The president and Sec War [Secretary of War] have signed off on this as part of the Golden Fleet [strategy]," said Phelan. "Our goal is clear: launch the first hull in the water in 2028. To expand capacity and production across our maritime industrial base we will acquire these ships using a lead yard and competitive follow-on strategy for multi-yard construction.

"Shipyards will be measured against one outcome: delivering combat power to the fleet as fast as possible."

Rheinmetall to supply Lynx IFVs to Ukraine in deal financed by German government

(pf) Rheinmetall announced on 12 January 2026 that it is supplying Ukraine with additional systems for national defence, including the country's first Lynx KF41 infantry fighting vehicles (IFVs) as early as the beginning of 2026.

A contract to this effect, Rheinmetall stated, was signed in December 2025. The order value for the first five IFVs is in the mid double-digit-million-euro range, with the systems being financed by the German government.

The decision in favour of the Lynx KF41 was made after extensive testing of the next-generation IFV, Rheinmetall noted. The vehicles bound for Ukraine will feature the two-man Lance turret, which is typically armed with a Rheinmetall MK30-2/ABM 30 mm automatic cannon and co-axial 7.62 mm light machine gun, and be configured specifically for Ukraine's armed forces. The next step is to procure additional batches, which Rheinmetall says will include production in Ukraine.

The Lynx is currently only in operational service in Hungary, which has ordered 218 IFVs and received its first example in October 2022. The Hungarian Defence Forces (HDF) then received the first of 172 domestically produced Lynx KF41s on 24 July 2024. The KF41 entering operational service in Ukraine will therefore see the IFV's first use in combat.

[Rheinmetall]

EDGE and Indra to set up joint venture focused on producing loitering munitions

(pf) Emirati defence technology house EDGE and Spanish technology and defence company Indra have agreed to establish a new defence manufacturing joint venture in Spain focused on the development, production, and lifecycle support of loitering munitions and smart weapons for Spanish and European defence programmes, the two companies announced on 13 January 2026.

[Indra]

The agreement was signed by Hamad Al Marar, managing director and CEO of EDGE Group, and José Vicente de Los Mozos, CEO of Indra Group.

Subject to the approval of the EDGE and Indra boards, the new joint venture will be established in Spain as a dedicated manufacturing entity. It will draw on EDGE's expertise in loitering munitions and smart weapons to support manufacturing, assembly, and lifecycle activities for Spanish and European defence programmes. Loitering munition systems would be produced in the province of León at a new manufacturing facility developed by Indra, which will invest an estimated EUR 15-20 million.

This approach, the companies said in a joint press release, ensures that advanced systems are produced in country, aligned with European sovereignty requirements, and available at scale to meet rapidly increasing demand across the European defence market. The initiative reflects the shared commitment of Indra and EDGE to building sovereign and export-ready industrial capabilities in Europe, combining advanced weapons technology with established European-scale manufacturing and programme execution capacity.

"Establishing this joint venture with Indra in Spain marks a decisive step in EDGE's expansion into Europe," Al Marar was quoted as saying. "By developing loitering munition capabilities in Spain, we are enabling in-country manufacturing and responding directly to the scale and urgency of European defence requirements while building long-term industrial capability with a trusted partner."

"Through this initiative, Indra takes a decisive step in its ambition to become a European reference in the drone industry," added De Los Mozos. "The development of capacities enables us to rapidly respond to the needs of the loitering munition market: a segment of strong attractiveness experiencing accelerated growth."

FNSS appoints Selim Baybaş as CEO and board member

(pf) Selim Baybaş has been appointed as CEO and Member of the Board of Directors of FNSS Savunma Sistemleri as of 1 January 2026, the company announced a few days later.

He succeeds Kadir Nail Kurt, who stepped down on 1 January after 18 years of leadership at the company.

Baybaş brings more than 27 years of senior executive experience to leading FNSS, having held strategic roles at DaimlerChrysler, Sabancı Holding, İnci Holding, Doğan Holding and Nurol Holding (which owns FNSS). Most recently, between 2019 and 2025, he served as CEO and Member of the Board of Directors of Nurol Teknoloji, where he led the company's growth through new investments and strategic partnerships. Under his leadership Nurol Teknoloji achieved a comprehensive transformation across R&D, innovation, operational efficiency, sales, sustainable profitability and exports, strengthening its position as a leading brand in its field.

In 2023, the establishment of Nurol Technology USA and the acquisition of Germany-based ceramic powder manufacturer IndustrieKeramik Hochrhein (IKH) marked a key step in the company's strategic growth and enabled its vertical integration strategy. During this period, Nurol Teknoloji contributed critical capabilities to the Turkish defence industry by advancing next-generation armour systems based on high-performance ballistic ceramics.

[FNSS]

Commenting on the CEO transition at FNSS, Nurol Holding Vice Chairman of the Board Oğuz Çarmıklı underlined the company's global growth and transformation-oriented management approach. "This change is an integral part of FNSS's long-term strategy, which focuses on strengthening its global presence, accelerating digital transformation and expanding its product portfolio," said Çarmıklı. "Selim Baybaş, who has taken over the leadership at FNSS, has already made significant contributions to our group's sustainable growth goals through his strong leadership vision, global experience and transformation-driven management approach, and we believe he will take this contribution even further in his new role. We congratulate him and wish him every success. We also extend our sincere thanks to Nail Kurt, a valued member of the Nurol Holding family for 38 years and the leader of FNSS for 18 years, for his highly valuable contributions."

Into the breach: The future of minefield breaching

Jim Backhouse

Most of the world's largest militaries rely on small fleets of specialised systems to breach defended minefields as quickly and as safely as possible. This article examines how these breaching systems are evolving in response to challenges to their survivability and concerns over their affordability and availability.

Breaching an enemy minefield is a complex, time consuming, and extremely hazardous operation. Unlike other mine clearance operations, the engineers responsible for opening a breach not only face the dangers inherent in neutralising mines, but are likely to also be exposed to hostile fire from the defender. Worse still, breaching is very much a time-sensitive operation; if not carried out quickly, it deprives the rest of the attacking force of its momentum and flexibility of manoeuvre. Consequently, militaries have developed specialised breaching systems designed to make this difficult operation faster and safer. However, as these systems have evolved, so too have the means available to defend against a breach. Nowhere is this more apparent than in the war in Ukraine, where efforts by Russian and Ukrainian forces to breach minefields have floundered against defences laden with sensors and precision-strike systems, many of which are based on inexpensive, commercial-off-the-shelf (COTS) unmanned aerial vehicles (UAVs). This proliferation of sensors and fires is undermining the survivability of the current generation of expensive, niche breaching systems, indicating that cheaper or more survivable solutions will need to be developed.

Layers upon layers

Breaching systems must be able to contend with a widening array of threats, chief among which are the mines themselves. These can be separated into two main categories: anti-personnel (AP) mines designed to maim or kill enemy personnel, and anti-tank (AT) mines designed to immobilise or destroy enemy vehicles. Both types can either be laid on the surface or buried underground, with surface-laid mines much faster to emplace but also far easier to detect and clear than buried mines. A variety of fuzes are also available to activate the mines, ranging from simple pressure-activated mechanisms that detonate the mine's explosive payload when an enemy soldier or vehicles pass over it, to sensor-activated fuzes that can autonomously detect and attack their targets at a greater stand-off range. Although mines can be employed individually, they are at their most effective when several of them are laid across a large area in a minefield. This is because outside of the physical and psychological impact of directly injuring, damaging, or destroying their unfortunate targets, the primary purpose of a minefield is to slow down an attacking force and limit its freedom of manoeuvre by either forcing it to clear a path through the minefield or avoid it altogether. Both courses of action can lead to an attacking force being 'canalised' into narrower, predictable routes of advance. This multiplies the effectiveness of a defender's supporting fires, since they can concentrate their attention on a smaller target area.

In April 2025, Pearson Engineering and the UK MoD unveiled the Weevil, a remotely-operated unmanned breaching system based on a legacy Warrior armoured vehicle hull. [Crown copyright 2025]

Based on these characteristics, systems developed to breach minefields typically employ mechanical or explosive means (or a combination of both) that can clear a lane through a minefield wide enough for a column of vehicles to pass through. The most common mechanical means are mine ploughs that can be fitted to the front of armoured vehicles. These can be set to scoop up and displace surface-laid or buried mines as the host vehicle moves forwards, depositing them in piles next to the lane. Other common means of mechanical mine clearance include mine rollers and flails. The former consist of a framework mounted on front of a vehicle with several heavy-duty rollers that detonate the mines ahead of the host vehicle, neutralising them as a danger for any vehicles follow-

An M1150 Assault Breacher Vehicle using a MICLIC in training at the National Training Center (NTC) in Fort Irwin California, on 12 June 2019. [US ARNG/Capt Gregory Walsh]

ing them in the same lane. Flails work on a similar principle, but instead of rollers, the framework contains a rotating drum with heavy chains that beat the ground in front of the host vehicle, detonating mines in their path. Vehicles equipped with mechanical mine clearance systems may sometimes also carry a magnetic signature duplicator, which generates a magnetic field to detonate magnetic mines at a safe distance from the vehicle.

Whereas these mechanical means require a system to manoeuvre inside the minefield, explosive means can be deployed at greater range. These can include conventional artillery shells or thermobaric weapons, but their most common manifestation is the mine-clearing line charge (MICLIC). Such systems consist of a flexible tube containing explosives that is connected to a rocket launching system mounted on an armoured breaching vehicle or a dedicated trailer. After the launcher is manoeuvred in front of the minefield, the rocket is launched over the minefield, causing the flexible tube attached to it to unfurl itself on top of the minefield. The explosive inside the tube is then detonated, with the blast wave causing pressure-sensitive mines in its vicinity to detonate, thus clearing a lane through the minefield. It is important to note that neither mechanical nor explosive systems are 100% reliable, as some mines may be missed by mechanical systems or have countermeasures in their fuzes that are designed to prevent them from being detonated by explosive means.

Minefields can also be layered with other obstacles to make it harder for breaching systems to approach them. These include anti-tank ditches, networks of barbed wire, metal or concrete obstacles such as 'Czech hedgehogs' or 'dragon's teeth', and fortified emplacements. Should the defender have sufficient time to prepare, the depth of a minefield can also be expanded beyond its doctrinal limit, with some Russian minefields encountered by Ukrainian forces being between two and four times their doctrinal depth. This complicates both mechanical and explosive means of breaching, as mechanical systems will take longer to clear a lane and MICLICs may require multiple launches if minefield depth exceeds the length of the charge.

However, the most effective counter-breaching approach is to defend the minefield with supporting fires, such as artillery, main battle tanks (MBTs), or anti-tank guided missile (ATGM) launchers. These can strike breaching systems and vehicles or personnel attempting to transit cleared lanes, inflicting attrition on the attacking force. The proliferation of cheap UAVs used for sensing and precision strikes has exacerbated this threat, especially when breaching is attempted in daylight and clear weather, where UAVs can operate with fewer restrictions. Not only can UAVs multiply the number of sensors available to an attacker to detect and identify breaching systems, but they can also be used to damage or destroy them for the fraction of a cost of a typical ATGM or precision-guided munition. This expansion of the fires threat is likely to have major ramifications for the effectiveness of any breaching systems that are only available in limited numbers.

Up close and personal: Armoured breaching vehicles

Leaving aside MICLIC launchers, armoured breaching vehicles (ABVs) are the most common type of specialised breaching system in service. These are designed to make breaching operations safer, by providing protection to their crews, and faster, by integrating mechanical and/or explosive means of

Rheinmetall's Keiler NG can carry a mine plough mounted on the front of the hull and two launchers for the Plofadder MICLIC system mounted in boxes on top of the hull rear. [Rheinmetall]

breaching minefields. Unveiled at Eurosatory in June 2024, Rheinmetall's Keiler Next Generation (NG) is a typical example of these platforms. Like most armoured breaching vehicles, it is based on the hull of an in-service MBT (in this case the Leopard 2). This ensures that it has a similar level of mobility and protection to the armoured units that it is supporting, as well as sufficient payload and power to support its specialised breaching and engineering systems. Furthermore, using an existing platform increases commonality across platform types, reducing operating costs and simplifying maintenance and training compared to operating a bespoke vehicle. The Keiler NG is equipped with both mechanical and explosive means of mine disposal, as well as a magnetic signature duplicator. This includes a Full Width Mine Plough (FWMP) from Pearson Engineering that can clear a 250 m long, 4.2 m wide lane per minute and two Plofadder 160AT Mk II MICLIC launchers from Denel that can each clear a 160 m long, 9 m wide lane. As with many other armoured breaching vehicles, the Keiler NG also has a crane which it can use to exchange the FWMP for other front-end equipment (FEE) or to remove obstacles. This allows it to double as a general purpose armoured engineering vehicle, which is likely to be attractive to militaries that cannot afford to operate multiple types of specialised fleets.

Despite their heavy armour, ABVs still put valuable personnel in harm's way. This is compounded by the fact that these vehicles are large, conspicuous, priority targets for enemy fires. As demonstrated in Ukraine's failed counteroffensive in summer 2023, ABVs can be rapidly identified and targeted by UAVs, allowing the defender to neutralise them far more quickly than exclusively relying on fires assets with more limited availability, such as artillery. If an ABV is destroyed or damaged, it can create even more problems for the attacker and increase the exposure of the remaining ABVs. For example, if an ABV is damaged or destroyed while clearing a lane, it will have to be recovered or moved out of the way, putting more personnel and platforms at risk. While this issue with survivability is not unique to ABVs, it is particularly problematic for them because these systems are expensive, niche assets that are in high demand and short supply. Consequently, most militaries cannot afford to lose many of these vehicles, nor they can they concentrate them in sufficient numbers to offset the growing availability of sensors and precision strike systems available to the defenders.

Rheinmetall has proposed several development pathways for its Keiler NG that could partially address some of these problems. As a new platform, the Keiler NG has been designed with sufficient excess payload and power to allow the integration of an active protection system (APS). With the software in many hard-kill APSs now being modified to defend against strike UAVs and loitering munitions, the next generation of ABVs could be fielded with some organic protection against ATGMs, loitering munitions, and strike UAVs. However, this will increase the cost of ABVs, making it even more difficult to procure these systems in numbers that are sufficient to meet demand. Another development intended to offset the vulnerability of ABVs is to make them optionally manned. By removing the valuable, highly-trained crew from the vehicle, the cost of losing an ABV is reduced. This could mean that they can be used with less caution, potentially enabling faster breaching operations. However, for optionally-manned operations to be viable, the crew will need to have a wired or radio-control system that can function in a contested electromagnetic (EM) environment, otherwise it will not be possible to rely on this capability in a high-intensity war. Furthermore, making a system optionally manned does not change the fact that the system itself will be an expensive, niche asset the user cannot afford to lose in large numbers.

One means of overcoming this cost spiral may be to proliferate breaching capabilities across a greater number of platforms. In this way, militaries will be less reliant on a stretched fleet of specialised ABVs and the defending enemy will find it harder to prevent a breach. As it stands, many MBTs already have the provision for mounting mine ploughs or mine rollers on the front of their hull, as do some wheeled vehicles like the US Army's Stryker 8×8. At Eurosatory in June 2022, Pearson Engineering presented its Vector mine plough. Unlike other mine ploughs designed for heavy tracked vehicles with a high tractive effort, Vector is specifically designed for lighter wheeled vehicles so that formations equipped with such platforms can independently breach minefields.

Pearson Engineering developed the Vector mine plough to allow lighter wheeled vehicles (such as this Patria AMV) to clear minefields independently. [Pearson Engineering]

By purchasing more of these systems and ensuring that more of the force is trained in their operation, militaries could multiply their breaching capacity at a much lower cost. This greater flexibility could also prove useful in tackling the types of surface-laid mines that can be deposited by artillery, manned aircraft, and even UAVs behind an advancing force, freeing ABVs to concentrate their attention on the more difficult obstacles. Once again though, using other armoured vehicles for breaching will require a willingness to put personnel and expensive platforms in a particularly dangerous position and will therefore result in high levels of attrition. Moreover, adding more mine clearance systems to a unit's inventory places more stress on logistics, as means to carry and store these extra mechanical mine clearance systems will need to be provided.

Out of harm's way: Unmanned breaching systems

Considering the difficulties in designing cost-effective and survivable manned ABVs, more attention is being given to developing unmanned breaching systems based on unmanned ground vehicles (UGVs). These offer two main advantages over manned platforms. Firstly, as they are designed to be remotely operated, the crew is less exposed to risk. Secondly, since there is no need to protect the crew, a UGV can be smaller, lighter, and therefore cheaper than a manned system. This means that they could potentially be employed in far greater numbers for a comparable level of investment, perhaps even being treated as expendable platforms rather than high-value specialised assets.

UGVs are already employed to clear minefields away from the frontlines, and experimentation with unmanned breaching systems is increasing. During Eurosatory in June 2024, Pearson Engineering unveiled its Robotic Combat Vehicle-Pioneer (RCV-Pioneer). Taking the form of a kit designed to be integrated on any type of UGV with sufficient payload, the RCV-Pioneer leverages technology developed for the Vector mine plough to allow UGVs with lower tractive effort to clear surface-laid and buried mines. As with manned ABVs, the kit can be dismounted from the vehicle within 30 minutes and swapped for a different payload, so that the same UGV can support multiple mission types. UGVs can also be adapted to carry MICLIC launchers, with one such system demonstrated during the US Army's Project Convergence – Capstone 5 experiment held between March and April 2025. Militaries have also experimented with converting surplus armoured vehicles into unmanned ABVs. This is being pursued by the British Army's Project Attila, which published a tender in August 2025 for the conversion of six Warrior infantry fighting vehicles into Weevil optionally-manned ABVs equipped with FEE for mounting mine ploughs. Comparable efforts have been undertaken in the US, where an M113 armoured personnel carrier was reportedly converted into the optionally-manned Outlaw Breaching Vehicle with a MICLIC launcher for as little as USD 50,000.

Yet for all their theoretical advantages, there are several practical obstacles standing in the way of the adoption of UGVs for breaching. The most significant of these is maintaining control of the system in an environment where the EM spectrum is likely to be highly contested. Unless they employ a tethered connection to their operator, which could be cut by enemy fires, UGV operators must rely on having a secure connection to a datalink on the UGV to control the system. With these being vulnerable to jamming, the attacking force could find itself unable to use its breaching systems, especially as enemy electronic warfare (EW) efforts are likely to be focused on areas being subjected to breaching operations. The EM signature generated by large-scale use of unmanned systems also makes the force vulnerable to detection and targeting by enemy fires, and renders it more difficult for the attacker to gain the element of surprise. Concentrating breaching UGVs in one place could thus decrease the survivability of friendly forces (including the UGV operators) if the defender can mass their EW and precision strike systems against EM 'hotspots'. UGV operators may also find it increasingly difficult to maintain situational awareness during breaching operations, as the cameras that they rely on to navigate the vehicle could not only become obscured by any dust kicked up during ploughing or flailing, but they could also be damaged by shrapnel from enemy fires or any mines detonated during the breaching operation.

The US Army demonstrated a UGV equipped with an M58 MICLIC launcher during Project Convergence-Capstone 5 in March 2025. [US Army/Sgt Marita Schwab]

Working at arm's length: Artillery as a breaching tool

While ABVs and UGVs require specialised personnel and platforms to be directly exposed to the danger of mine blasts and hostile fires, it is possible to open a breach using artillery. This is not a novel approach; using artillery bombardments to open a passage through minefields was commonplace as early as the First World War. Artillery shells can destroy mines in a variety of ways: by directly impacting them, by detonating them with their explosive energy, or by impacting them with shrapnel, particularly if the artillery shell's fuzes are set to detonate them at the optimum height. Compared to using specialised tools, this approach has the advantage that it uses existing systems. It is also faster than massing specialised breaching systems, increasing the chance that the defender will be taken by surprise. Moreover, even though directing artillery to fire in support of a breaching operation will expose the artillery to counterbattery fire, the standoff range means that they will be less exposed to shorter-range, cheaper precision strike systems such as small strike UAVs.

Nevertheless, using artillery for breaching also comes with drawbacks. Unless more expensive precision-guided munitions are used, clearing a minefield to a standard that is sufficient will require vast expenditure of ammunition, a commodity that is already in short supply in many of NATO's militaries. It may also be more unreliable and less readily available than dedicated breaching systems, as artillery systems will be in demand for other fire missions. With large-calibre artillery being an expensive asset and likely to remain in high demand, it is doubtful that it will be able to replace dedicated breaching systems.

However, shorter-range artillery such as mortars could be more suitably employed for breaching. An iteration of this approach is being explored by the US Army's XM123 Ground Obstacle Breaching and Lane Neutralization (GOBLN) system that is designed to replace the M58 MICLIC launcher during the 2030 fiscal year. In its experimental iteration, the GOBLN comprises three elements: a detection system represented by a FLIR Systems R80D Skyraider UAV fitted with an optoelectronic infrared (IR) sight and an automatic target recognition system that can detect surface-laid and partially-buried mines [Note: the eventual goal also includes detection of buried mines, and in this vein, the US Army has expressed interest in exploring technologies such as ground penetrating radar (GPR) to detect buried threats] and upload their coordinates onto a digital map, a fire control system that can compute firing solutions for destroying detected minefields, and an effector based on the 81 mm Automated Direct/Indirect Mortar (ADIM).

In a typical operation, the Skyraider UAV will fly over suspected minefields and detect any mines. This data will then be passed to the FCS, which will compute a firing solution for the effector that can then neutralise the identified mines. According to official specifications published by the US Army, the system should be able to operate at a standoff range of more than 1 km and clear a lane 150 m long with a single fire mission. Its effectors could be mounted on different types of platform including the XM30 Mechanized Infantry Combat Vehicle, the Armored Multipurpose Vehicle (AMPV), and Robotic Combat Vehicles (RCVs), potentially allowing breaching capabilities to be distributed across more the force. However, the XM123 GOBLN's reliance on UAVs to precisely detect mines will render it vulnerable to EW in the same way as UGV-based breaching systems, and will also limit its application in challenging weather. Moreover, it is unclear if and how the mortar bomb's effector will be able to neutralise buried mines, however, the US Army has also expressed interest in exploring solutions such as UAV-delivered munitions, and guided munitions, which may hold more promise here.

Exploring all paths: The future of minefield breaching

All of these developments are aimed at addressing the two fundamental issues facing minefield breaching systems. First, they have become more vulnerable due to the increasingly widespread use of UAVs for sensing and precision strike, which provides the defender with cheaper and more widely available means to identify and disable or destroy them. Second, breaching systems are expensive and are therefore limited in number, meaning that an attacker cannot afford to lose very many of them. This means that breaching systems will either need to become more survivable, or cheaper and more plentiful. In theory, using UGVs for breaching could mitigate the cost problem and obviate vulnerability concerns, but issues with their reliability in a contested EW environment means that they have yet to prove trustworthy enough to take on such a valuable role. This indicates that the transition to unmanned breaching systems is likely to be more gradual, perhaps involving a mix of optionally-manned conventional breaching platforms equipped with defensive measures for countering UAVs and paired with UGV wingmen to provide greater mass and redundancy, plus a greater reliance on standoff systems like the US Army's GOBLN that reduce the number of personnel in harm's way.

The XM123 GOBLN demonstrator uses an 81 mm ADIM mortar mounted on an HMMWV to neutralise mines. [Sean Mazza]

Countering the drone threat to heavy armour

Alexey Tarasov

The mass employment of unmanned aerial vehicles (UAVs) in armed conflicts over the past decade has initiated numerous debates on the current state and future development of armoured vehicles, as well as on the employment of armoured forces – their structure and role on future battlefields. While these debates are far from concluded, the broader discussion has moved away from oversimplified statements, toward more detailed and sober assessments and analysis. The major question, however, remains: How can armoured forces counter the drone threat to heavy armour today?

An upgraded BREM-1M armoured recovery vehicle, featuring a new explosive reactive armour (ERA) layout, anti-drone protection, and electronic warfare jammers. Note the towing coupler attached to the dozer blade, which allows the crew to recover damaged vehicles without leaving their own vehicle. [Alexey Tarasov]

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Controversy and consensus

Before diving into the analysis of this matter, it is important to note that armoured forces and heavy armoured vehicles have proven indispensable in all recent armed conflicts since 2020, despite the changing and increasingly hostile conditions on the battlefield. Armoured forces continue to play a critical role in modern ground warfare, while many militaries across the globe plan to expand and further develop this branch of service. The tank is not dead, and armoured forces are not going to go extinct in the near future.

Undoubtedly, armoured forces and armoured fighting vehicles (AFVs) have to adapt to the new combat environment – technically, tactically, and doctrinally. However, this has been a normal part of their evolution since the beginning of the 20th century.

Moreover, the contemporary 'drone scare' – a widespread mindset today – has historical analogues. In the late 1930s, based on an assessment of the experience of the Spanish Civil War, Soviet military leadership concluded that strong anti-tank defences and masses of small-calibre anti-tank artillery had rendered the use of large armoured formations impossible. In the 1960s and 1970s, the proliferation of anti-tank guided missiles (ATGMs) gave rise to the view that heavy armoured vehicles would become obsolete due to the development of guided weapons. In the 2010s, some politicians and military thinkers questioned the value and relevance of the armoured branch, arguing that the geostrategic environment had changed, making "the prospects for another head-on clash of large mechanised land armies seem less likely", as stated by then-US Secretary of Defense Robert M. Gates in a 25 February 2011 speech at West Point.

Today, proponents of the idea that developments in UAV technology, loitering munitions, and anti-tank weapons have 'changed the nature of ground combat', rendering armoured vehicles ineffective and obsolete, largely follow the same path by drawing generalised conclusions based on incomplete, misinterpreted, and difficult-to-verify information.

Against this background, the critical issue is not whether armoured forces remain relevant, but how the drone threat should be correctly assessed in order to distinguish genuine technical and operational challenges from overstated conclusions and to develop comprehensive anti-drone solutions.

A T-80BVM tank featuring an array of anti-drone protection measures, including passive barriers, ERA, and electronic warfare jammers. [Alexey Tarasov]

Beyond the buzzwords: evaluating the drone threat

For a correct assessment, two key aspects should be examined: the true scale and nature of the threat, and the actual effectiveness of small drones in the anti-tank role. It is important to note, however, that the assessment of these aspects can be challenging for several reasons.

First, there are currently no reliable and publicly availablestatistics that allow for a comprehensive analysis of the effectiveness of small drones against all types of targets, including heavy armoured vehicles. As a result, the primary source for this kind of analysis remains aggregated open-source data, combined with imagery analysis. While this combination may be applicable under certain conditions, it also has a number of significant flaws. For instance, many conclusions are drawn from combat footage of first-person view (FPV) drone strikes during the Russo–Ukrainian conflict. However, the vast majority of documented strikes only demonstrate that the drone reached its target, with the post-impact results often remaining unclear. Very few recordings include a battle damage assessment (BDA), and even fewer clearly show the aftermath of the strike.

In an interview published in December 2024, Ukrainian drone commander Robert Brovdi (callsign "Madyar") provided statistics on the effectiveness of FPV drones: *"The effectiveness rate across different units varies between 20 and 40 percent. I am not referring to cases in which a drone merely reached the area and produced unclear or unconfirmed effects. Only cases in which the drone reached the target, successfully struck it, and the result was recorded should be included in the statistics."*

In other words, only two to four out of ten drones actually affect the target, in addition to an unknown number that fail to reach it for various reasons, such as weather, electronic or mechanical failures, enemy countermeasures, or piloting errors, to name but a few. Some specialists, however, consider the 20–40% rate to be inflated, suggesting that a more realistic figure may be below 20% even under favourable conditions. Given that the majority of drones used in the anti-tank role in Ukraine rely on commercial components never designed for harsh and unpredictable battlefield conditions, the latter assessment sounds reasonable.

Second, available data indicate that strike UAVs and loitering munitions rarely cause irrecoverable damage to heavy armoured vehicles on their own; rather, it is the combination of multiple assets that does so. In a very typical scenario, a heavy AFV – such as a tank or engineering vehicle – could be damaged or immobilised by ATGMs, artillery fire, or landmines, after which drones finish off the abandoned vehicle. While the vehicle will likely be destroyed eventually, analysing scenarios like this adds little to the question of AFV protection. Even the best-protected vehicle could be destroyed if its electrical system – powering the active protection system or electronic warfare jammers – is disabled, allowing a drone to strike through an open hatch, thereby bypassing passive armour.

Third, there is often no way to determine which asset caused the critical damage by analysing combat footage alone. The most reliable method of assessing the damage remains the examination of the damaged and destroyed AFVs on the ground.

As a result, evaluating the true effectiveness of drones against AFVs, including heavy armoured vehicles, remains difficult. What is more certain is that drones and loitering munitions have added to, rather than replaced, the established array of threats to heavy armour, such as ATGMs, guided artillery munitions, and mines, among others.

Nevertheless, their increasing presence on the battlefield, combined with the pace of their evolution, necessitates adaptation by armoured forces not only in technological terms, but also tactically and doctrinally, in order to counter this evolving challenge.

Solutions at the platform level

The question of countering the drone threat could be split into two major directions: first, the protection of individual armoured vehicles; and second, collective defence of armoured units and formations.

In terms of individual AFV protection, rapid evolution is evident. Over the last four years, a number of notable changes have been introduced, some of which have become new standards widely employed by militaries around the world.

Overhead/top attack protection. First introduced by the Russian Army in June–August 2021, this type of tank turret protection has evolved and proven its utility. By 2026, it had entered experimentation or seen combat use in more than 20 countries, including China, India, Japan, Poland, France, Israel, and Taiwan, among others. In turn, the US Department of Defense's budget estimates for Fiscal Year (FY) 2026 include a request to fund the procurement of four Armoured Brigade Combat Team sets of a Top attack protection capability. Top attack protection is described as *"a passive add-on armour that is placed over crew compartments and hatches to mitigate damage from overhead threats,"* making it highly likely that the US Army has also joined this group.

A Leopard 2A8 at its roll-out ceremony in Munich, on 19 November 2025. The new model, equipped with the Trophy APS, is being produced for the German and Norwegian Armed Forces. [KNDS]

The design of top-attack protection continues to evolve, with newer variants being introduced into service and tested in combat. Russia, and apparently Ukraine, make widespread use of complex, multi-layered variants incorporating explosive reactive armour (ERA), nets, slat armour, and rubber-polymer screens. Notably, Russian industry has been offering serially-produced top-attack protection for heavy armoured vehicles since at least October 2023. While Ukrainian mechanised forces have also employed standardised variants of top-attack protection, the extent to which these are serially-produced or ad-hoc field upgrades based on a common design remains unclear.

Explosive reactive armour. New configurations have been introduced, with ERA now covering larger areas and is combined with other forms of passive protection, including slat armour, polymer nets, and various types of screens.

Electronic Warfare (EW) jammers. So far, the primary operators of anti-drone electronic countermeasure systems have been Russia and Ukraine. However, other nations have also begun experimenting in this field. In December 2025, it became known that the M1E3 – a prototype of a new main battle tank for the US Army – will likely incorporate an electronic warfare (EW) system intended to jam and/or spoof drone command and/or guidance systems. Meanwhile, Russia and Ukraine continue to improve their EW jammers used with heavy armoured vehicles, expanding their capabilities and the range of frequencies across which these systems are able to disrupt UAVs. An important detail is that Russia's Uralvagonzavod (UVZ) now includes EW jammers as part of the standard factory-installed package of additional protection for MBTs.

Active Protection Systems (APS). As more countries accept these systems into service and additional integrations enter the market, active protection systems are gradually becoming a 'must-have' capability. Notably, a growing number of systems in service and integrations is likely to make APS more affordable, which in turn may stimulate further procurement. In this sense, a 'democratisation of active protection systems' is taking place.

The technology is also maturing and adapting to new requirements. In October 2024, Rafael unveiled an upgrade to the Trophy APS, adding the capability to counter some forms of top-attack munitions, including drones. Another APS – Iron Fist by Elbit Systems – continues to evolve and has also been upgraded to counter some forms of UAVs and loitering munition threats, as noted on the developer's website. The Iron Fist APS has been selected to upgrade the US Army's Bradley M2A4E1

A T-72B3A at UVZ's trials site. The new modification features a combination of Kontakt-1, Kontakt-5 and Relikt ERA, electronic warfare jammers, anti-drone protection measures such as overhead protection, netting and rubber-polymer screens, along with an upgraded version of the Arena-M APS. [UVZ]

A full-scale mock-up of the Bullfrog RWS fitted to an M1 Abrams tank. [Allen Control Systems]

Infantry Fighting Vehicles (IFVs). In January 2026, the company was awarded USD 150 million in contracts with BAE Systems Hägglunds for the integration of Iron Fist into CV90 IFVs operated by seven European NATO member countries, with three additional operators planned.

Meanwhile, Russia's Uralvagonzavod has apparently completed field trials of its Arena-M APS. In January 2026, industry sources reported on a new modification of the T-72, designated the T-72B3A, equipped with an updated version of the Arena-M APS. A military acceptance officer at the UVZ plant stated that a new counter-UAV (C-UAV) operating mode was added to the Arena-M in 2025.

Historically, a tank modification receives a new designation only after testing and acceptance trials. This suggests that during 2025, the T-72B3M equipped with an upgraded version of Arena-M was tested – possibly even field-tested in Ukraine – and has now entered serial production. Arena-M is also expected to be integrated with T-90M tanks.

Remote weapon stations (RWSs) with a counter-unmanned aerial vehicle (C-UAV) capability. This is an emerging sector offering flexible and cost-effective solutions based on existing technologies and components. Significant advantages of adding C-UAV capability to remote weapon stations (RWSs) include rapid deployment and a lower cost-per-kill ratio compared to missile systems.

Over the past few years, major manufacturers of RWSs have stepped forward with C-UAV solutions based on their products, including Kongsberg, EOS Defense Systems, and Moog Inc., among others.

Some militaries have begun experimenting with RWS featuring C-UAV capability tailored for heavy AFV anti-drone protection. In November 2025, Allen Control Systems reported that the US Army was testing its Bullfrog autonomous weapon station on M1 Abrams MBTs and M2 Bradley IFVs.

Elsewhere, Russia's Okhotnik RWS, developed by Elektromashina (part of UVZ), has been adapted to the C-UAV role, as the manufacturer reported in 2025. While the Okhotnik remote weapon station has been tested on the BT-3F IFV and the Typhoon-K MRAP, it remains unclear whether it has been tested on any Russian MBTs.

Lighter tank designs. At least two major next-generation MBT programmes continue to evolve: the Franco-German MGCS and the American M1E3. Despite obvious conceptual differences, both platforms share common ground in their requirement for reduced weight – less than 50 tonnes for MGCS and under 60 tonnes for the next-generation Abrams tank.

Among the main reasons for this requirement were the need to reduce the visual signature, improve deployability, and lower maintenance and transportation burdens, but more importantly, to retain growth margins for future development and the integration of subsystems, as well as additional protection against both current and emerging threats.

A CV90 IFV fitted with an Iron Fist APS and camouflage netting. [BAE Systems]

Enhancing armoured vehicles survivability has become, therefore, a key focus over the last years. At the individual level, since 2023 a range of protective measures has been introduced to improve overall survivability, with several of them specifically developed to counter the drone threat.

Today, these measures are employed across all types of armoured vehicles, including heavy ones, either individually or in various combinations, depending on mission requirements and threat assessments. Such measures include:

- Additional passive protection kits. Some of them have entered serial production and continue to be upgraded;

- New-generation ERA, employing updated layouts that provide broader coverage from all aspects;
- Slat and net armour, as well as other physical barriers;
- Rubber–polymer screens;
- Serially produced electronic warfare systems and jammers;
- Signature-reduction measures, including thermal camouflage kits and camouflage nets;
- Smoke- and aerosol-based countermeasures;
- Active protection systems.

But is this sufficient? While these measures significantly enhance individual vehicle survivability, they are not a definitive solution. Beyond this point, new tactical approaches and collective protection measures come into play.

Unit-level counter-drone solutions

Even the most sophisticated, multi-layered defensive system of an AFV can be overwhelmed by saturation from multiple threats; for example, even the most modern and heavily protected tank may be destroyed if an adversary has the opportunity to concentrate its fire assets on a single target.

The arithmetic is simple: if one side (for instance, the defending side) is able to generate greater firepower against a smaller number of enemy targets, those targets are likely to be damaged or destroyed, regardless of how heavily protected they are.

The complex problem of countering the drone threat to armoured vehicles requires an equally comprehensive solution at the level of units, formations, and doctrine.

An indication of how the Russian Army has adapted to the drone threat can be drawn from an interview with Bekhan Ozdoev. When asked how armoured vehicles can be protected against FPV drones, he answered: *"Despite the importance of protecting combat vehicles, the key point is not to rely exclusively on passive protection. The primary approach is to counter the very essence of the threat. This includes destroying drones in the air; intercepting reconnaissance drones, which serve as the enemy's 'eyes'; suppressing UAV communication links; striking UAV command-and-control nodes; destroying drone production facilities in the enemy's rear; and disrupting the logistical supply chains that support these systems."*

Some analysts compare the modern 'drone revolution' to the proliferation of machine guns during the First World War, which brought overwhelming firepower down to the tactical level. If this historical analogy is applied to the contemporary drone threat, the drones themselves become the 'bullets', while the true source of the threat lies with tactical UAV operator teams. While one cannot deflect all the bullets, one could potentially defeat the shooters. This is precisely what Ozdoev advocates when he argues for the destruction of UAV command-and-control nodes, supply chains, and the operators themselves.

By destroying UAV C2 nodes and operators, an attacker disrupts the reconnaissance-strike network – an approach roughly analogous to artillery practices that emerged in 1917–1918, which emphasised the neutralisation of artillery forward observers and machine-gun nests to degrade the enemy's defensive system ahead of infantry assaults. Once the reconnaissance-strike network has been degraded, a combined-arms assault – integrating armour, air and artillery strikes, EW countermeasures, and layered air defence down to the tactical level – significantly increases the probability of success.

Similar approaches to addressing the drone threat can be observed across Western armed forces. In the United States, for example, some analysts have argued that the Army should prioritise integrated counter-drone air-defence systems, EW, and deception capabilities, to neutralise an adversary's unmanned systems. At the doctrinal level, efforts must focus on developing concepts and doctrine that ensure effective manoeuvre in environments dominated by persistent drone presence.

Closing thoughts

Individual AFV protection continues to evolve, and heavy armour is adapting accordingly, demonstrating that drone proliferation neither restricts manoeuvre nor diminishes the importance of heavily protected vehicles.

Armoured units and formations must adjust their tactics and organisation to operate effectively in drone-rich environments. However, translating battlefield experience into doctrine and coherent operational concepts inevitably takes time. Overall, armoured forces and heavy armoured vehicles remain the primary strike power of any major land army and, based on current trends, are likely to retain this role well into the coming decades.

An M2A4E1 Bradley IFV fitted with the Iron Fist APS. [US Army]

Advances in chemical protective clothing technology

Dan Kaszeta

Chemical weapons remain a persistent threat, but advances in protective clothing are changing the calculus of CBRN warfare. This piece explores how new fabric technologies are making suits lighter, safer, and more effective.

Chemical, biological, radiological, and nuclear (CBRN) hazards drive the development of defensive countermeasures such as protective masks or medical treatment. In the area of protective clothing, the aspect of the CBRN threat that drives the entire segment is the chemical weapons threat. Generally speaking, gamma rays pass right through CBRN suits anyway, and radioactive particles and biological aerosols are far easier to mitigate than nerve agents and blister agents. So, what we are really talking about with 'CBRN suits' is chemical warfare protective clothing.

One of the reasons chemical warfare is not more widespread on the battlefield is that it is a category of warfare whose effects can be minimised with training and equipment. The offensive chemical weapons arms race that occurred in the First World War was quickly accompanied by a parallel arms race in defensive technology. The bulk of chemical warfare fatalities in that war occurred in the armies that were slow in fielding effective gas masks, namely Russia and Italy. This set a pattern that was repeated in later conflicts such as the China-Japan front in the Second World War, the Italian invasion of Ethiopia, and the Iran-Iraq war. The side in the conflict that fielded more and better protective clothing and respiratory protection tended to have far fewer chemical casualties.

During most of the Cold War, both Soviet and Western chemical warfare and chemical defence doctrine acknowledged that chemical weapons had decreased in their ability to cause immediate casualties among trained and well-equipped troops, due to protective clothing, respiratory protection, detection, and decontamination. Much emphasis was rightly placed on the fact that use of chemical warfare agents, particularly persistent liquid agents like Mustard and VX, would drive intensive use of chemical protective clothing and thus degrade the enemy's operations due to the cumbersome nature of the clothing.

Rubberised suits, like this US Army M3 suit ensemble, were used for decades but cause a lot of heat stress to the wearer. [US Army]

AUTHOR

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While the First World War is now beyond memory and the chemical defensive doctrine of the Cold War is now, increasingly, the province of aged commentators like this correspondent, the fundamental reality remains true. Chemical protective clothing and respiratory protection erodes the lethality of chemical warfare. But the corollary is also true; the prospect of spending days or weeks in chemical protective posture erodes every aspect of military operations and increases casualties from accidents and heat injury. For this reason, it is worth looking at the history of chemical protective clothing and how we got to where we are today.

Wax capes and rubber suits

Chemical protective clothing as a component of protective equipment, as opposed to merely gas masks, arises from the end of the First World War. In effect, the first few generations of chemical warfare agents in that gruesome war were things like chlorine and phosgene, which are almost entirely respiratory threats defeated by a good respirator. This started to change with the advent of blister agents, such as sulphur mustard, also known as 'yperite' or misleadingly as 'mustard gas'

in the last year of the war. Mustard, and other chemicals like lewisite, were active through the skin as much or even more than through the lungs.

For basically 50 years after the advent of the blister agents and their even more dangerous counterparts, nerve agents, which were also active through skin content, protective clothing to protect against them was fairly unsophisticated. Generally speaking, protective clothing was rubber or rubberised cloth for specialist chemical troops, with wax-impregnated uniforms and capes for normal soldiers. For example, the US Army fielded both wax-impregnated uniforms for front line soldiers during key offensive operations such as the D-Day invasion and also had numerous Chemical Warfare Service units whose job would be to treat literally millions of uniforms with wax should chemical warfare break out. These wax-impregnated uniforms and capes were, by no means, completely effective but were meant to mitigate possible mass casualty events stemming from the use of blister agents.

Eventually, by the 1960s and 1970s, as the Cold War became entrenched, chemical protective clothing could be broadly categorised into non-permeable and permeable suits. Non-permeable suits do what they say on the label. They form a barrier between inside and outside. First made of rubber or rubberised material, they have long proven problematic due to heat stress to the wearer. If troops wore them for any extended period of time, there would be a serious amount of heat casualties in all but the coldest weather, and the chemical warfare agents that need the most skin protection are far less effective in colder weather anyway. The Soviet-era OZK suit is still very much in use in Russia and some other ex-Soviet states. In the West, non-permeable suits are more the province of civil-sector emergency responders, where more advanced materials made by companies like DuPont and Trelleborg are used to make partially-encapsulating and totally-encapsulating suits for hazardous materials incidents, which often deal with substances far more physically corrosive than chemical warfare agents. In addition, such incident response rarely requires a technician to wear a suit for more than about an hour at a stretch, as opposed to days or weeks.

Permeable suits arose in NATO militaries as a way to have chemical warfare protection that lasted a long time in the field and allowed the wearer to operate for a long time without falling over from heat injuries. A permeable suit would have to let some moisture out and let some of the external hazards in, but if made correctly a suit could have one of more layers of material that would absorb or adsorb the chemical warfare agent. In effect, such a suit would be a bit like a protective mask filter.

Earlier generations of permeable suits included the US Chemical Protective Overgarment CPOG (late 1960s onward) and Battle Dress Overgarment BDO (late 1980s), as well as the UK Mk II and Mk III suits. Other NATO countries had similar designs, although some also used US suits. Individual designs varied, but the CPOG and BDO were (and still are, in some places) typical examples. They had a fabric outer layer, usually with some waterproofing, and a polyurethane or similar foam inner layer that contained charcoal powder. These suits were infamous for leaching powder onto the wearer. The BDO was nominally good for three weeks of continuous wear before disposal.

The 1990s saw a generation shift to lighter, more effective suits. Several technical approaches were used. Small carbon spheres in the fabric, impregnated carbon fabric, and activated carbon fabric all used more sophisticated forms of carbon adsorption than the bulk charcoal of the older suits. By using carbon more efficiently, these suits are lighter and thinner than the charcoal suits. A carbon sphere fabric was adopted by the US Department of Defense to make the Joint Service Lightweight Integrated Suit Technology protective ensemble. The US government spent hundreds of millions of dollars on procuring these new suits, with 96 million USD spent in Fiscal Year 2003 alone.

Two US Army soldiers wearing JSLIST suits using carbon sphere technology. [US Army/Spc Sean Harding]

The new carbon sphere suits, both the US JSLIST suits and numerous other very similar products around the world reaped significant benefits over older technology. A higher level of protection was afforded by a thinner and lighter suit that gave significantly less heat burden. In addition, the suits could be laundered several times and had a functional lifetime at least twice, if not longer, than older charcoal suits. While CBRN suits have never been popular with troops, these newer ones were widely regarded as superior. Although they are more expensive than older charcoal suits, the incremental expense was partially offset by the improvements to service lifetime, bulk, and weight.

The new frontier

One obvious problem with porous, breathable suits is that they retain the chemical hazards within them. Even if the chemical warfare agents are absorbed or adsorbed into charcoal or

Heathcoat Fabrics' factory in Tiverton, Devon, UK. [Heathcoat Fabrics]

carbon spheres, the used suit becomes hazardous waste. What do you do with it? What if the actual fabric of the suit could react with chemical warfare agents and, instead of merely containing the threat, actually cause some reaction that would neutralise the threat? A decade ago, this would have sounded either like fiction or unrealistically expensive to this correspondent.

This is where Heathcoat Fabrics, a centuries-old textile company in Tiverton, UK comes into the equation. This correspondent visited the factory in October 2025 to look into their relatively new chemical defensive clothing technology. Heathcoat has migrated from a traditional English textile weaver into a modern high-tech textile operation employing five hundred or so employees. Their work has spawned a new generation of protective clothing technology.

The new frontier is a chemical compound called zirconium hydroxide, a chemical with non-CBRN industry applications up until recent years. A number of published studies and several patents show that zirconium hydroxide in powder form can degrade the major liquid chemical warfare agents, such as nerve agents and sulphur mustard. The zirconium hydroxide readily adsorbs these agents and reacts with them to neutralise them.

Heathcoat takes the theoretical properties of the zirconium hydroxide and applies them to clothing. Using a proprietary process that has its roots in making the previous generation carbon sphere fabrics, Heathcoat can bond zirconium hydroxide to a layer of fabric. This zirconium hydroxide fabric can then be stitched into a suit, or used on its own as a decontamination mitt, which may well feature in future articles on the subject of decontamination. Heathcoat refers to this as its 'NeutraliZr' product line (a portmanteau of 'neutraliser' and the chemical symbol for zirconium).

A chemical protective suit with zirconium hydroxide provides significant advantages over previous generations of CBRN fabrics. The various activated carbon fabric of the previous generation suits used toxic and environmentally concerning PFAS (so-called per- and polyfluoroalkyl substances) in their manufacturing process. These 'forever chemicals' are of necessary concern to environmentalists, the public, and regulators; as such, manufacturers would do well to find ways to avoid them. The zirconium hydroxide fabric avoids PFAS and leads to a less environmentally troublesome manufacturing process. Depending on how much of the zirconium hydroxide is incorporated in the fabric, suits that provide a higher degree of protection than even the best activated carbon fabric suit are theoretically feasible. Shelf life is excellent, as is launderability of the suits. Because the suits themselves act to decontaminate adsorbed chemical warfare agents, used suits are less of an environmental hazard than previous generations. None of the world's major militaries has seriously addressed what to do with the potential waste stream of thousands of contaminated suits, leading to off-piste discussions about dumps and burn pits reminiscent of the negligence noted in a previous article [See: 'Toxic legacies of warfare: Burn pits and other health hazards' in ESD 07/08-25].

One downside is that these suits are somewhat more expensive than previous generations. Understandably, Heathcoat would not tell this correspondent how much they pay for their zirconium, but open-source research online does show a significant price differential over activated carbon. Some of the price differential with the newer generation of suits would be compensated for by gains in shelf life and longer service lifetimes.

Protective suit incorporating Heathcoat Fabrics zirconium hydroxide fabric. Also note the prototype decontamination mitt made from the same material. [Heathcoat Fabrics]

Heathcoat Fabrics, it should be noted, does not make chemical protective suits but supplies such manufacturers. Observers of the CBRN industry would do well to watch both Heathcoat and its customers, as this correspondent has not seen such a step change in the CBRN industry in well over a decade.

It is worth noting that there is a rival technology to zirconium hydroxide. So-called 'Metal Organic Frameworks' (MOFs) have appeared frequently in the technical literature with claims and properties not dissimilar to zirconium hydroxide. MOFs have been clearly demonstrated to react with the nerve and blister agents that are the main threat driving the CBRN protective clothing market. These properties have been known for some years now. Of considerable interest is an article in the *Journal of the American Chemical Societ*y in December 2019 by a team principally affiliated with Northwestern University (Chicago, USA) and the US Army. (*J. Am. Chem. Soc.* 2019, 141, 51, 20016–20021 for those interested.) This article specifically talks about incorporating MOFs into textile fibres for detoxifying nerve agents.

MOFs could, all other factors being equal, give Heathcoat and the zirconium hydroxide some competition. But it seems all other factors are not equal. MOFs, or at least the ones discussed seriously so far, all seem to be considerably more expensive than zirconium hydroxide. There may well be a place for MOFs in chemical warfare protection or decontamination, but barring a radical improvement in their costs, it seems unlikely at this point that a rival suit could be commercially competitive.

It would be remiss to not point out the dark side of the equation. All of these suits are still permeable. Something small enough could theoretically work their way through any of these types of suits. As noted in a previous article [See: 'Nanotechnology: Threats and prospects in the CBRN sector' in *ESD* 09-2025], nanoparticles could encapsulate some chemical or biological threats. A small enough nanoparticle could insinuate itself through all of these permeable suits. In which case, we are back to impermeable suits. At this point, this is merely hypothetical.

The future

As mentioned above, the type of step-change represented by zirconium hydroxide does not come along very often in CBRN defence technology and its significance should be noted. The logical end-state in CBRN protective clothing is a regular combat duty uniform which is, by means of its fabrics, also a chemical protective suit. We are not quite there yet, but things like zirconium hydroxide and MOFs are a step in that direction.

The rate at which newer suit technologies displace the older ones has always varied. We can expect older technologies to remain in use for a long time as some countries under-invest in CBRN defence, often for reasonable prioritisation of scarce defence resources. However, after a quarter century of, dare one say it, boring gradual change, the chemical protective fabric segment of the industry has now become much more interesting.

Goodbye SCAF? Is this the end of the road for the Franco-German-Spanish fighter dream?

Jon Lake

Behind polite diplomatic language and official commitments to partnership, the SCAF fighter programme is unravelling. A German union has declared they won't work with France's Dassault, while Germany and Spain have been exploring alternative partners such as Sweden. France now appears increasingly ready to walk away. Welcome to Europe's most dysfunctional defence collaboration programme.

The Franco-German-Spanish SCAF/FCAS/NGWS air dominance system of systems is teetering on the brink of cancellation, amid an apparent inability by the partners to agree workshare and leadership responsibilities – especially on the NGF manned fighter. [Dassault]

By the middle of 2025, there were signs that the Franco-German-Spanish sixth-generation fighter programme was teetering on the brink of cancellation, though officially, the partners were still working towards launching 'Phase Two'. This was intended to include the production of the New Generation Fighter (NGF) combat aircraft demonstrator.

AUTHOR

Passionate about aviation and flying, **Jon Lake** grew up around aeroplanes, learned to glide before he could drive, learned to fly with the University of London Air Squadron, and has been in aviation publishing since 1984.

In September 2025, the French Ministry of the Armed Forces announced that it was "fully committed with its German and Spanish counterparts to reaching a mutually acceptable solution [to Phase Two] by the end of the year". This seemed to signal that public disagreements aired by Dassault and Airbus at the Paris Air Show had been solved, and that the 'end of year' milestone was within reach.

As the year came to an end however, it was clear that the deadline would be missed, and that the two sides were further apart than ever.

A convoluted history

The SCAF (Système de Combat Aérien du Futur) programme was launched industrially by a Franco-German (Dassault/Airbus-led) consortium in 2018, joined later by Spain in 2019. SCAF was intended to offer a family of systems (sometimes also known as the Next-Generation Weapon System or NGWS), with an NGF as 'Pillar 1' of seven development pillars which also included unmanned collaborative combat aircraft (or remote carriers), engine technology, simulation, sensors, and stealth, and a 'combat cloud' linking a wider system of systems.

The SCAF/FCAS family of systems includes the NGF manned fighter, an array of unmanned effectors and adjuncts (known as Remote Carriers) together with a Combat Cloud. [Airbus]

SCAF/FCAS forms part of a wider NGWS system of systems that will draw together systems in all domains – including other fighters, tankers, ISR aircraft and UCAVs in the air domain. [Airbus]

SCAF is known by a variety of acronyms, with France favouring the Système de Combat Aérien du Futur (SCAF) designation, while Airbus uses the alternative FCAS (Future Combat Air System). For its part, Germany uses Zukünftiges Luftkampfsystem (ENG: Future air combat system) while Spain uses Futuro Sistema Aéreo de Combate (FSAC).

An initial EUR 65 million, 18 month initial framework (Phase 1A) contract was finally signed on 12 February 2020, delayed by a German requirement for approval by the Bundestag's Budget Committee. The Phase 1A agreement supported early research and conceptual studies, and was intended to develop the system architecture and explore key technology areas (including fighter and unmanned platform design, and the combat cloud). Specific roles and responsibilities were assigned to the French and German partner companies, with Spanish workshare being left for the Phase 1B contract, which was finalised on 17 May 2021.

Phase 1B covered the design of the NGF and Remote Carrier airframes and systems (as well as demonstrators for both), integration and test strategies, a simulation environment, and the initial production strategy. Phase 1B was expected to take about 3.5 years to complete, with an NGF demonstrator originally supposed to be ready to fly by the summer of 2026. This subsequently slipped to (the as yet unsigned) Phase 2, and a first flight is now tentatively slated for 2029.

According to the agreement, Dassault would serve as prime contractor for NGF, with Airbus serving as its main partner, and Indra Sistemas was assigned as the Spanish industrial partner.

Airbus was to be the prime contractor leading the development of accompanying remote carrier vehicles (with MBDA its main partner) and was to be prime contractor responsible for the broader system's supporting combat cloud, with Thales as main partner and with Rohde & Schwarz providing the artificial intelligence (AI)-enabled combat cloud backbone. The combat cloud will be a multiply redundant, mesh-based, heterogeneous network that avoids critical single points of failure, and that will be resistant to jamming, and dynamic cybersecurity threats. It will enable secure, real-time data sharing and collaboration between manned and unmanned systems across all domains.

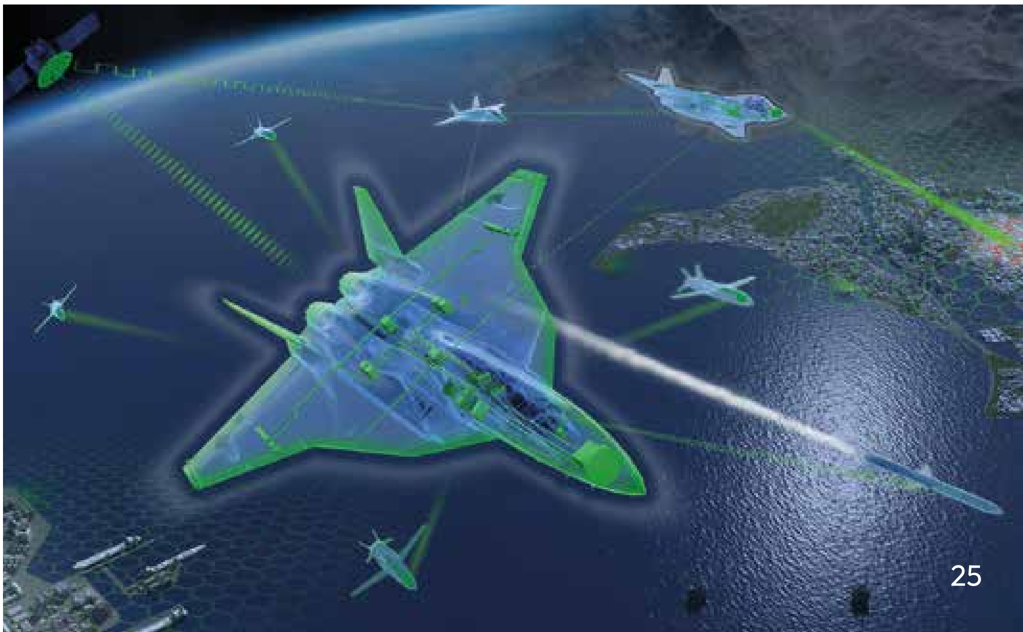
Safran was assigned to be prime contractor for the engine, with MTU as the main partner, while MBDA and Thales were made responsible for weapons and sensors, respectively. Prime contractors for each pillar were notionally selected on a 'best athlete' basis, though this has proved controversial, and there have been accusations that the French side tried to seize control across all of the pillars. They were prevented from doing so due to the way the programme had been structured, and how agreed principles of industrial co-operation had been established. These included joint decision making, clear governance and transparent ways of working.

The lack of effective cooperation is shown by the fact that both Dassault and Airbus have continued to show two quite different concepts since the beginning, perhaps indicating a lack of agreement on a single configuration.

The first NGF CGI renders were released by Airbus, and showed a twin-engined cranked Delta aircraft with widely spaced tailfins, this seemed to be a two-seater. Airbus have continued to show CGIs and models based on this configuration.

Dassault then unveiled a small-scale model of its NGF concept at the Euronaval show in October 2018. The concept was a stealthy, twin-engined, tailless delta aircraft, which Dassault Aviation CEO Eric Trappier described as being "more ambitious than the F-35".

The Airbus NGF concept is frequently shown as being a large, two-seat aircraft, with widely spaced twin tailfins and a distinctive wing planform. [Airbus]



Early Dassault NGF concepts were tail-less 'cranked Deltas', with an apparent emphasis on low observability. This one was unveiled in model form at the 2018 Euronaval exhibition. [Dassault]

A new full-scale mock-up was unveiled at the Paris Air Show in June 2019. This had a completely new (and rather more conservative) configuration when compared to the earlier Euronaval concept and featured an arrow wing, a butterfly tail, and forward swept intakes.

In November 2023, Major General Jean-Luc Moritz, who leads the French segment of the programme, said that a down-selection process was underway, and said that he expected two designs to be chosen by mid-2024 and with the choice of a single final configuration anticipated by March 2025.

The different configurations shown by Dassault and Airbus reflect the different national requirements for the manned NGF. All three NGWS partners wanted the aircraft to be capable of operating in a traditional fighter role, projecting air dominance and surviving in heavily contested future threat environments. But they also saw the NGF manned platform as a 'command fighter' that would control unmanned adjuncts and effectors and other combat aircraft, employing AI and datalink technologies to allow pilots to perform battle management functions.

The Dassault NGF evolved into a more conventional design, with a lambda wing and widely spaced, highly canted tailfins. [Dassault]

Growing friction

Yet while the NGF would be a Eurofighter replacement for Germany and Spain, augmented (in the German case) by F-35As in the strike and interdiction roles, France needed the aircraft to be carrier-capable, and optimised for the nuclear strike role. Quite apart from these differences in requirements, tensions have been brewing at the heart of SCAF/FCAS and NGF.

Dassault's actions have suggested it wants to lead rather than be an equal partner in a Eurofighter GmbH-style Joint Venture. Dassault's expectation that it should have 'design leadership' in collaborative programmes derailed the company's planned participation in the multinational Eurofighter (then the Future European Fighter Aircraft) programme, and has mitigated against further participation in collaborative manned combat air platform programmes.

When the Phase 1B agreement was reached, it was decided that the demonstrator aircraft would be built by Dassault in France, triggering an early row between Airbus and Dassault. Dassault's Éric Trappier said that the company that designed the aircraft should also design the flight controls, to the fury of Michael Schoellhorn, Chief Executive of Airbus Defence and Space, who pointed out that Airbus was the main partner on the flight controls and stealth, and not Dassault's supplier.

Schoellhorn was clearly irked that Dassault had declared itself to be the "'best athlete' by asserting that we, Airbus, know nothing about the flight controls of fighter aircraft". He noted, "That is not only untrue but contributes to undermining the spirit of co-operation and mutual respect."

Friction has not been limited to the NGF manned fighter pillar of SCAF. The NGWS system of systems will see the use of unmanned adjuncts (known as Remote Carriers within the NGWS programme) accompanying and supporting the manned aircraft. These will use 'swarming and teaming' tactics alongside AI to create unpredictability for the adversary.

The Dassault NGF mock up enjoyed pride of place in the Dassault static display at the Paris Air Salon in 2019 and 2023, displayed with models of the MBDA and Airbus Remote Carrier designs. [Dassault]

Two classes of Remote Carriers are being developed with MBDA leading the development of smaller, cheaper expendable remote carriers (ERCs) as part of FCAS Phase 2. They bring a range of different effects to the battlespace, including kinetic and non-kinetic effectors, electronic warfare (EW) capabilities, offboard sensors, and communications relay. These ERCs will have an operational flight endurance of about an hour, and will enjoy fighter-like performance and manoeuvrability, allowing them to 'keep up' with NGF manned aircraft – or to serve as realistic decoys. They will also be cheap enough to be used to saturate enemy defences, delivering much-needed, low-cost, combat mass.

There will also be a class of larger, though more expensive recoverable remote carriers (RRCs), for which Airbus is the prime contractor. Airbus revealed a full-scale concept model of its Wingman unmanned combat aerial vehicle (UCAV) at the International Aerospace Exhibition (ILA) in Berlin in June 2024.

Despite Airbus' UCAV unveiling, Dassault decided to unveil a new UCAV, clearly based on their earlier nEUROn design, at the Paris Air Show in 2025. Dassault's Trappier said that the new UCAV would not form part of FCAS "for the moment," but the new drone effectively seemed to represent a competitor for (or alternative to) the new Airbus-led RRC.

One industry insider observed that: "Dassault's definition of a collaborative partnership is one in which Dassault decides the direction and gets the workshare and intellectual property, while its partners sit back and pay the bills, gratefully accepting any crumbs that fall from the table." Another observed that SCAF was: "the least harmonious collaborative combat air

At the Paris Air Show 2025, the NGF mock-up was relocated around the corner from the main Dassault static display, which was dominated by the Rafale (foreground) and a new UCAS (middle) based on the nEUROn demonstrator. The nose of the NGF model (background) can just be seen 'peeking' out behind the UCAS model. [Dassault]

programme in history. We have three national partners bickering over who gets to do what, and two of those partners have taken arguing to the level of being an Olympic sport."

Reports that France was seeking an 80% workshare on the NGF led Germany to fear that it would have to give up too much sovereignty and independence and would end up effectively financing what would be a French project with German money. But for Dassault's Trappier, the SCAF/NGF programme lacked "one true leader" but instead had "three 'co-co-co's." Trappier asked: "How can I have leadership when I have someone in front of me who weighs twice as much? We are not capable of distributing the work according to what we think. We have to compromise, negotiate constantly."

German Defence Minister Boris Pistorius observed that: "What's important for the two of us is that the projects represent German-French co-operation and partnership, they don't represent national egotism."

Head of airpower at Airbus Defence and Space Jean-Brice Dumont, said: "We don't challenge that there is an appointed leader for the fighter programme: That leader is named Dassault." But Dumont also said that other partners deserve a fair share, and that the partnership "doesn't have to become toxic".

While French Minister of the Armed Forces, Sébastien Lecornu, promised to address the subject of governance with his German and Spanish counterparts, and to encourage dialogue between Guillaume Faury (president of Airbus, representing the interests of Germany and Spain), and Éric Trappier, Trappier himself has suggested that Dassault Aviation could withdraw from the SCAF programme altogether, and 'go it alone'.

In an article written for the Royal Aeronautical Society's magazine, Aerospace, author Bill Sweetman postulated that Dassault Aviation could abandon SCAF to concentrate on the Rafale (which is enjoying something of a resurgence in sales), and whose F5 version is expressly linked to the company's new UCAV programme. Sweetman assessed that this is felt to be "an affordable approach that will beat the threat well into the 2040s". He also highlighted that the company might struggle to execute the NGF (and its associated demonstrator), given the need to resource Rafale F4 fielding and F5 development, as well as the new UCAV, and the Falcon 10X business jet.

The French company's enthusiasm for SCAF/NGF may have been further dimmed by concerns about exportability (with misgivings about Germany's position on exports to some countries, and with concerns that the NGF may be too large and too costly for many potential customers). There may also be a worry that timescales will mean that NGF will arrive on the market long after its main competitors. Trappier has said that: "With the delays, it's already too late for 2040. We're more likely headed for the 2050s." He subsequently gave a more optimistic estimate of "sometime between 2042 and 2044."

For the 2025 Paris Air Show, the NGF full-scale model was moved from its usual prominent position in the Dassault coral, its place being taken by a static display of the Rafale F5 and the new UCAV, while the company's stand in the exhibition halls saw the single small NGF model relegated to the third row of an array of company products, behind 14 Rafales and an array of Falcon biz jets. Even Dassault company graphics seemed to de-emphasise or demote the NGF, while highlighting Rafale, Falcon 10X and the new UCAV.

German and Spanish support for the SCAF programme has also seemingly eroded in recent years and months. But in September 2025, German Chancellor Friedrich Merz and Spanish Prime Minister Pedro Sanchez met in Madrid and expressed their wish for the programme to move forward with urgency.

Dassault seems to be concentrating its efforts on the Rafale F5 and unmanned adjuncts, 'all-French' products that require no cooperation with European partners, and whose profits will remain with French companies. A Rafale is seen here banking away from the nEUROn technology demonstrator. [Dassault]

Éric Trappier (left) of Dassault and Airbus' Dirk Hoke (right) at the 2019 FCAS signing ceremony. Early harmony soon evaporated. [Dassault]

Sanchez highlighted existing agreements, which, he said all three countries must respect, noting that Spain wanted FCAS "to come to fruition under the conditions originally agreed upon by the three partner countries".

Merz said that: *"We are both in discussions with the French government, and we both want to find a solution as soon as possible, by the end of 2025. We are both aware that we need such a project. But things cannot continue as they are now. We share the same opinion: the current situation is not satisfactory. We are not moving forward with this project."*

Behind the scenes, Bloomberg reported that Germany was exploring options to develop the NGF without France if Dassault Aviation continued to insist on having a controlling role. Options under consideration included Germany and Spain moving ahead and developing the FCAS and NGF without French participation, or replacing Dassault with new partners. There have also been reports of German overtures to join the Anglo-Italian-Japanese GCAP project, and of talks with Sweden's Saab.

Pressure to abandon the original trinational SCAF/NGWS programme came to a head in December 2025. On 8 December, Juergen Kerner, deputy chief of the German industrial union IG Metall (representing Airbus workers in Germany) and Thomas Pretzl (Chairman of the General Works Council at Airbus Defence and Space) wrote to German Defence Minister Boris Pistorius and Finance Minister Lars Klingbeil, warning that they would stop co-operating on the programme if Dassault remained involved. "We no longer trust Dassault," they said, alleging that the French company had "completely disqualified itself as a reliable partner".

"We are happy to collaborate with French businesses but not with Dassault," the letter stated. "We stand by European co-operation and the Franco-German friendship. But Dassault is trampling over both for selfish reasons."

The labour bosses called for a "smart repositioning of FCAS" which it said should take the form of a two-fighter aircraft solution. The German Aerospace Industries Association (BDLI) has also advocated for a system of systems with "two high-performance next-generation aircraft".

Volker Mayer-Lay, Air Force spokesperson on the parliamentary defence committee for Chancellor Merz's conservative party, also called for a split with France, pointing out that French military requirements for FCAS were very different from those of Germany or Spain. France "needs a system designed for nuclear deterrence, including the use of aircraft carriers and the specific integration of delivery systems", Mayer-Lay argued, while "France and Germany don't necessarily need the same aircraft."

Mayer-Lay suggested that France should build its own manned fighter, while Germany and Spain seek new partners for a separate aircraft. He also suggested that other elements of the FCAS system of systems (most notably the integrated computer data combat cloud, and some effectors and adjuncts) could still be shared between the two platforms. This division, he said, "would allow us to better meet national military needs and overcome obstacles to industrial cooperation."

On 2 January 2026, a German chancellery spokesperson confirmed that there had been a further postponement of the final decision on Phase 2 of the FCAS programme, originally due by the end of August 2025, and then by the end of that year. "Contrary to the original plan, a final decision on the continuation of the FCAS project has not yet been made at the end of the year."

The delay was attributed to "the extensive Franco-German agenda in foreign and security policy issues, which has not yet made it possible to deal with the issue of a joint fighter aircraft at the level of the President and the Federal Chancellor."

The spokesperson could not give a new date for a decision, and did not comment on reports that the delay was actually mainly due to arguments about what share of the project would be given to Dassault, Airbus, and Indra.

Some observers see these latest developments as indicating that SCAF is effectively dead in the water, while others take a more optimistic view. They reason that a SCAF family of systems could include both a high-end sixth-generation combat air platform focused on air dominance and a cheaper tactical fighter that could provide a useful alternative to, and replacement for the F-35. The usefulness of the F-35A is increasingly coming under question in the light of the US 'pivot' away from Europe, NATO, and the rules-based order which has long underpinned European security. Many believe that the F-35 is too vulnerable to any withdrawal of US support, sustainment, logistics and mission data, and that Europe's defence budgets would be better spent locally, rather than in the USA.

Counter-UAV procurement in the Middle East

Sidney E. Dean

Throughout the Middle East, governments and armed forces are improving their ability to counter the unmanned aerial vehicle (UAV) threat to military and civilian targets. Counter-UAV systems of various types are being procured from domestic and foreign sources.

Rafael's Iron Beam HEL weapon system. [Israeli MoD]

The threat posed by unmanned aerial vehicles throughout the Middle East is strong and still increasing. Operators range from terrorist and insurgent groups to nation states. Technologically they span the gamut from comparatively simple 'garage-workshop' systems to mass-produced long-range strike weapons such as Iran's Shahed one-way attack (OWA) drone family. In addition to military and government targets, significant civilian infrastructure targets – including oil fields, pipelines, refineries and terminals – need to be defended. Conventional weapons, including standard air defence systems, are not optimally suited for the counter UAV mission. Regional governments are procuring dedicated counter-UAV (C-UAV) systems from domestic, local and overseas suppliers to meet the threat. A few exemplary acquisition projects are discussed below.

Contracts with regional suppliers

Israel

With its well-developed national defence industry, Israel mostly procures through domestic suppliers. While Tel Aviv tends to maintain confidentiality regarding procurement contracts, details of some major programmes are available. This holds for the high-powered Iron Beam laser defence system developed by Rafael Advanced Defence Systems, in partnership with Elbit Systems, for the Israeli Defense Forces (IDF). While this family of complementary laser weapons includes mobile and naval variants, the flagship element is the Iron Beam high-energy laser (HEL) which features a 450 mm aperture and incorporates a 100 kW laser module developed by Elbit. Iron Beam is a trailer-mounted semi-mobile weapon for fixed-site short-range defence against UAVs as well as short-range rockets, artillery shells and mortars. It provides a further layer to the missile interceptors of the Iron Dome air defence system, helping preserve missiles for more complex threats. The IDF plans to integrate the Iron Beam into the Iron Dome system to enhance its multi-tier air and missile defence capability.

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HEL prototypes were successfully deployed in October 2024 to defend Israeli airspace against Hezbollah drones launched from Lebanon, while roll-out of Iron Beam continued. The MoD and Rafael declared the Iron Beam system operational on 17 September 2025 after completion of multi-week final tests. The official MoD statement of 17 September declared that "first systems [are] set to be integrated into the IDF air defence arrays by year-end." Brig Gen (Ret.) Dr Daniel Gold, head of the MoD's Directorate of Defence Research & Development (DDR&D), confirmed in late November that initial operational capability would be delivered to the IDF on 30 December 2025.

Current procurement of Iron Beam systems, as well as the Iron Dome and David's Sling systems, are financed through a USD 8.7 billion military aid package for Israel which was approved by US Congress in April 2024. Of that figure, USD 5.2 billion is dedicated to strengthening Israeli air defences; within the air defence package, USD 1.2 bn was explicitly earmarked for procurement of Iron Beam batteries. An initial set of procurement contracts were finalised by the MoD with Rafael and Elbit in October 2024, with a total value in excess of USD 500 million; in a 28 October 2024 release Elbit Systems announced that USD 200 million of the contract award would go to Elbit for the high-power laser component of the procured units.

While the IDF has not revealed specific end-state numbers (or cost) for the Iron Beam component of the air defence system, the 17 September 2025 announcement revealed that deployment of a full series of batteries would begin within months, with deployment ultimately planned nationwide at scale. MoD Director-General Amir Baram said that the news regarding Iron Beam was only the foundation stone to start the acquisition process. He was seconded by the DDR&D's Brig Gen Yehuda Elmakayes who revealed that the Knesset had approved sufficient funds in 2023 to finance as many Iron Beam batteries as would be needed during the early deployment phase. According to Israeli press reports, the fielding of the Iron Beam batteries is expected to proceed through 2026.

UAE

The Abu Dhabi-based Edge Group has emerged as a leading developer and manufacturer of defence technology, with clients in the Middle East and globally; during the November 2025 Dubai Airshow alone the firm announced new sales valued at USD 7 billion, including 21 major contracts. The United Arab Emirates armed forces are among the Edge Group's frequent clients across the defence technology spectrum.

The mobile Skyshield system provides automated 360° detect and defeat capabilities for anti-drone protection. [Edge Group]

In January 2024, Edge's subsidiary SIGN4L – which focuses on electronic warfare and intelligence applications – announced a major contract to supply several, multi-layered counter UAV systems to the UAE Ministry of Defence. The contract, which was revealed during the Unmanned Systems Exhibition and Conference (UMEX) 2024 in Abu Dhabi, covers delivery of both the Skyshield C-UAV and the Navcontrol-G jamming systems. According to the firm's press release, these "provide a high degree of situational awareness and soft-kill capabilities against unmanned aerial threats, enabling the comprehensive protection of critical infrastructure and border integrity."

Skyshield is available in fixed and vehicle-mounted configurations; the pickup truck mounted QD (Quick Deployment) variant was chosen by the MoD. All integrate an X-band radar, optronic sensors and direction finders to detect and classify UAV threats. They rely on jamming and spoofing to interfere with drone control and global navigation satellite system (GNSS) navigation frequencies. According to Edge, the system jams the full GNSS spectrum as well as drone command and control channels, with an effective range of up to 10 km against unprotected GNSS platforms.

The Navcontrol-G employs GNSS jamming and spoofing to misdirect UAVs to simulate a contradictory alternative path, guiding incoming UAVs away from their intended targets. The radar-assisted system is effective against unprotected GNSS navigation systems at ranges up to 50 km. As a stationary and line-of-sight dependent system, Navcontrol-G is most suitable for the border protection mission as well as for defence of high-value facilities.

As is frequently the case with Edge Group sales, the contract value, number of contracted units and per unit cost were not disclosed publicly; various defence outlets have described the procurement as a significant acquisition, despite the lack of details from the vendor or the MoD.

Contracts with external suppliers

United States

RTX has secured a USD 1 billion contract to supply the Fixed Site – Low, Slow, Small UAS Integrated Defeat System (FS-LIDS) to Qatar. The contract was negotiated as a Foreign Military Sales agreement with Qatar, and was announced in May 2025 by the US government. FS-LIDS is produced by RTX's Raytheon unit in cooperation with SRC Inc. and Northrop Grumman. The stationary FS-LIDS (and its

Qatar's 2025 order is the first export sale for Raytheon's FS-LIDS C-UAV system. [Raytheon]

The verification model of the Boxer-mounted Skyranger 30 configuration during trials with the German armed forces in Spring 2025. [Rheinmetall]

mobile counterpart M-LIDS, which is not part of this procurement contract) are designed to detect, track and neutralise low-flying small UAVs, whether operating singly or as a swarm. The system integrates radar, high-powered optronic/infrared sensors, an electronic warfare component to disrupt communications between drones and operators, and the jet-powered Raytheon Coyote Block 2 UAV as a kinetic interceptor.

The procurement contract covers ten FS-LIDS systems including launchers, sensors, and the forward area air defence command and control system, as well as 200 Coyote 2 interceptors. It also includes associated support services including training, logistical and technical support, spare parts, and software support. The purchase will allow for layered defence at fixed-site locations (whether government or infrastructure) and provide real-time situational awareness and threat response.

Qatar's original request for the system was approved by the US in late 2022. Contract negotiations, Qatari requirement refinements, and budget approvals took up another two years before the actual order was signed. To date, no details regarding the timeline for contract fulfilment have been released. However, the 29 November 2022 Defense Security Cooperation Agency (DSCA) press release regarding the procurement stated that implementation of the proposed sale would require the assignment of five additional US Government and 15 US contractor representatives to Qatar for a duration of five years to support fielding, training, and sustainment activities.

France
On 21 November 2025, MBDA announced the firm's first contract for the Sky Warden C-UAV system. To date, the customer has only been identified as a 'Middle Eastern' nation. The Sky Warden, which falls within the specific portfolio of MBDA France, was presented publicly in 2022. It is a multi-layer system that protects an area from UAVs ranging from micro-drones to class 2 drones and loitering munitions. A variety of non-kinetic and kinetic effectors are available for integration. These include: omnidirectional and directional jammers; machine guns; the Cilas Helma-P laser which provides scalable effects ranging from optical jamming to destruction; the MBDA HTK (Hit-to-Kill) interceptor drone designed to destroy micro- and mini-UAVs through kinetic impact; and Mistral 3 very short range air defence (VSHORAD) infrared-guided missiles. Multiple sensors including radars, cameras and radio frequency finders provide multidimensional real-time detection and targeting capability. Sky Warden can be configured as a fixed installation or vehicle mounted for mobile operations, and integrates into wider defence networks via tactical datalink.

While confidentiality regarding the client's identity is a frequent prerequisite for Middle Eastern procurement contracts, this inevitably opens the door to speculation. Given the capabilities profile of the system and the different threat scenarios facing nations of the region, likely candidates for the contract could include Saudi Arabia and the UAE, both of which are interested in adding high-powered short range air (including drone) defence to their multilayered architectures. While the UAV threat is pervasive throughout the region, the two nations face particularly active pressure on oil industry infrastructure as well as airports and military installations from various militia groups, including the Houthis. Both nations would also be the best situated to finance the purchase of high-end and high-priced technology.

Germany
While there have been no contract announcements to date, Saudi Arabia is reportedly evaluating Rheinmetall Air Defence AG kinetic C-UAV systems to counter existing and future threats. Various defence media analyses indicate that Saudi Arabia is predominately interested in the Skyranger 30 system. Skyranger 30 is conceived as a modular unmanned turret housing a 30×173 mm automatic cannon, sensors, and optional missile launchers (including MBDA's newly developed DefendAir drone defence missile), with integration of a HEL also being explored. Skyranger is typically offered on the Boxer 8×8 platform, though the manufacturer also offers mounting on various other wheeled and tracked platforms). It is also offered in a static palletized configuration, under the 'Skynex' name.

The Revolver Gun Mk3 is an automatic cannon capable of firing Rheinmetall's Advanced Hit Efficiency And Destruction (AHEAD) munition with an estimated range of up to 3,000 m. The programmable airburst round releases a cloud of tungsten sub-projectiles just ahead of the target position, making the system particularly suitable for neutralizing UAVs, including smaller models, as well as for the counter-rocket, artillery, and mortar (C-RAM) role.

The Beirut-based Tactical Report (TR) service, which produces private intelligence reports and market analyses regarding Middle Eastern defence issues, has repeatedly discussed Saudi interest in Rheinmetall C-UAV systems. On 12 November 2025, the report reiterated ongoing Saudi-German talks and continued Saudi interest in the Skyranger 30. In that context the report referenced a delegation of the Saudi Arabia Military Industries (SAMI) Land Systems division which visited the Rheinmetall facility in Kassel, Germany. Notably, the Kassel facility is being expanded and upgraded to become Rheinmetall's hub for Boxer production. An inspection of this particular location by SAMI – which is wholly owned subsidiary of Saudi Arabia's Public Investment Fund (PIF) – would be consistent with a Saudi interest in the Skyranger 30 system to serve as a mobile, networked short- and very-short range C-UAV capability to defend a multitude of military, government, transportation and infrastructure targets.

Depending on the number of systems acquired, the Skyranger 30 could also escort manoeuvre forces in the C-UAV and V/SHORAD role. Should agreement be reached, a contract would be quite lucrative. In 2024 the German armed forces placed an order for one Boxer-based verification model and 18 production model Skyranger 30 vehicles with a total value of EUR 595 million.

Joint ventures

European and American technology remains of interest to Middle Eastern nations. However, long-term interests favour solutions that support not only the region's security but also the local economy and labour sectors. The UAE, in particular, has been pursuing production and joint venture agreements with foreign defence firms.

A recent example is Raytheon's establishment of an assembly facility for Coyote counter-UAV interceptors in the Tawazun Industrial Park in Abu Dhabi. Raytheon Emirates signed an initial Memorandum of Understanding with five UAE defence industry partners on 20 February 2023. The formal term sheet between the firm and the Tawazun Council was signed on 21 April 2025. The Council is an independent UAE government entity that works closely with the MoD to enhance defence capabilities, including through defence industry development.

The 2,000 m^2 production, assembly and precision testing facility was formally inaugurated on 21 May 2025. Raytheon Emirates' local partner Edge Group's EPI has already begun manufacturing prototype components as an initial step toward industrial readiness. Speaking at the ceremony, Matar Ali Al Romaithi, Sector Chief of Defence & Security Industrial Affairs (DSIA) at Tawazun Council, said: "This facility marks a strategic milestone in the UAE's vision to establish an advanced defence industrial base. The partnership stems from the objectives of Tawazun Economic Programme to foster collaboration with international partners to transfer knowledge and advanced technologies to the UAE's defence and security industrial sector. [...] It also reinforces the UAE's position as a regional hub for advanced defence industries and strengthens its drive towards industrial self-reliance and technological excellence."

Such joint ventures are likely to increase over the next few years. They allow foreign partners to enjoy increased access to local markets, while the host nations enhance prestige, keep a share of the procurement funds at home – satisfying industry and labour – and open up opportunities to become regional and global exporters in their own right.

Raytheon inaugurated the production and assembly facility to manufacture the Coyote counter drone interceptor at Tawazun Industrial Park, Abu Dhabi, on 15 May 2025. [Tawazun Council]

Developments in European mortar turrets

Tim Guest

An evolving demand for turreted, self-propelled (SP) mortar systems, has seen interest bolstered further in recent years by the geopolitics of the moment and changing battlefield threats experienced in Ukraine, with systems developed and emerging from European and allied defence manufacturers garnering interest, even from the US Army.

Raison d'être

The vulnerability of traditional infantry mortar crews, manually handling their weapons into and out of action under the constant threat of counter-battery detection and fire, as well as crews manning unprotected, vehicle-borne systems, is a problem nowhere more acutely and recently apparent, than on the battlefields of Ukraine. Weapon-locating and counter-battery radars of growing sophistication – alongside sound-ranging systems and reconnaissance drones – pose a constant threat. They can rapidly detect and geolocate the origin of mortar fire, feeding coordinates to fire-direction assets and often triggering swift counter-battery strikes. Transitioning in and out of action is a relatively slow process for a typical mortar section, and the fact that they operate much closer to the front than their artillery counterparts, also means the sensor-to-shooter response time, for any counter-battery fire heading their way will be shorter. Not to mention the threat from first-person view (FPV) drones.

A Polish M120 Rak vehicle firing during the Anakonda 23 exercise at Nowa Deba Training Area, Poland, 5 May 2023. SP mortar systems offer mobility, protection, and networked indirect firepower, while also able to conduct direct-fire missions when in close contact with enemy forces. [US Army/Pfc Jason Klaer]

As a result, mortar crews in Ukraine operating turreted SP mortar systems supplied by allied nations have expressed positive feedback about the performance and protection such systems provide. This, in turn, is driving continued growth in the market for turreted SP mortars. Mobile and responsive, these systems offer crew protection, with a sophisticated fire control system (FCS), networked into a wider tactical indirect fire support ecosystem. They combine high rates of fire, precision and new munitions with, in some cases, the ability to fire on the move. 'Shoot-and-scoot' tactics and armoured protection are no longer the preserve of just latest SP artillery; the mortars, too, can now evade those weapon-locating radars, be gone from their firing positions before the enemy has a chance to locate them, and be safe from small arms and shrapnel.

Scene set, this article takes two particular turreted mortar systems, which have emerged from European industry players in recent years, and which are playing a part in major vehicle programmes.

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M120 Rak: Polish prowess, Ukrainian usage

Produced by Huta Stalowa Wola (HSW), Poland's 120 mm turreted SP mortar system, the M120 Rak, plays a key role in Poland's artillery modernisation, having entered production soon after the country's Ministry of Defence (MoD) placed a definitive order for 64 of the wheeled, M120K versions on 28 April 2016. The platform, mounted on the wheeled Rosomak 8×8 armoured personnel carrier (APC) version of the system, itself based on the Patria Armoured Modular Vehicle (AMV) 8×8 design built under licence, first entered service by the end of 2017, achieving the system's initial operational capability; follow-on contracts in succeeding years have brought the total number of vehicles eventually to be procured to 122. By 2023, a 40 vehicle mix of Rak mortar carriers with a handful of command vehicles had entered service with Poland's Armed Forces. In a follow-on timeframe, a tracked variant, the M120G, with an upgraded M120 Rak mortar turret mounted on HSW's Borsuk platform, appeared as a technology demonstrator at the MSPO 2024 defence exhibition in Kielce, in September 2024, (a previous light tracked vehicle demonstrator appeared at an earlier incarnation of the same show in 2021, when the Rak turret was mounted on the HSW Opal light tracked platform). Nevertheless, wheeled or tracked, the standard breech-loading Rak mortar system is said to have a sustained rate of fire of 6-8 rds/min, largely enabled through the use of its automatic loader. From receipt of fire mission orders, the mortar can be ready to fire in 30 seconds, with the Rak turret having a full, 360° traverse capability, and -3° to +80° elevation capability. The mortar has a maximum range of some 10–12 km, using standard HE ammunition and the platform is able to accommodate 46 rounds (of which 20 are ready rounds), although storage capacity depends on ammunition type.

It is worth noting that upgrades on the M120G Borsuk tracked variant at MSPO 2024 included a new autoloader enabling an improved sustained rate of fire reported to be 10–12 rds/min, and a maximum rate of fire, reportedly, of 15 rds/min. In addition, the variant has a modified, lower-profile turret with a longer smoothbore barrel offering improved maximum range of some 13 km. The M120G also has improved armour with better ballistic protection, as well as an active protection system against larger-calibre rounds. The variant was also equipped with an integrated drone to provide recon, target detection/identification, and impact assessments following a fire mission.

An impending improvement to the platform's mobility may result following the November 2025 announcement, that HSW signed an MoU with US military vehicle automatic transmission maker, Allison Transmission, for the design and production, under licence, of latest gearboxes. These will be incorporated into the powertrains of HSW's combat vehicle range, with HSW's management board president, Marek Karabuła, saying the agreement would give HSW access to latest technologies "that will be used in vehicles such as Borsuk, and in future projects based on tracked and wheeled platforms".

Rak in Ukraine

Despite still building up its own numbers of the system, in April 2023, under a military aid package, Poland agreed to supply Ukraine with 24 of its relatively newly received, wheeled SP 120 mm M120 Rak systems, together with 12 fire control command

M120K RAK SP mortar 2019 serial production systems on the Nowa Deba training ground with Polish Armed Forces. [Jarosław Wolski, via Wikimedia Commons, CC-BY-SA 4.0]

post vehicles. Delivered by Q3 2023, the mortars entered service with the 44th Separate Mechanised Brigade and were deployed operationally almost immediately. Feedback by Ukrainian Forces in spring 2024, extolled the wheeled systems' ability to 'shoot and scoot', confirmed its 30-second 'TTBR' (time to be ready), as well as the effectiveness of the autoloading system in helping crews achieve high sustained rates of fire using standard NATO 120 mm munitions against targets out to ranges between 10–12 km; 'at least' one wheeled Rak M120 had, however, been destroyed by that time.

Other than Poland and Ukraine, no other nations have yet become operators of the M120 Rak, despite its being actively marketed by HSW at overseas trade fairs, like the 2024 editions of the World Defense Show in Riyadh and Eurosatory in Paris. That said, overseas interest in the system is reported to have increased since the unveiling of various 2024 upgrades, including possible interest from the US Army in the Rak turret for its five-variant Armoured Multi-Purpose Vehicle (AMPV) programme, although a new mortar variant prototype for that programme is currently testing the Patria/Kongsberg NEMO 120 mm turreted mortar system.

NEMO: Finnish firepower, US interest

This brings us nicely to the US AMPV programme, well underway and set to replace the M113 family of vehicles within the US Army's Armoured Brigade Combat Teams (ABCTs), over the next 20 years. Comprising five new variants, including an SP mortar carrier, more than 3,000 of the new vehicles are now on order following a recent additional 240 vehicle request. What proportion of the total fleet will eventually be mortar carriers is unknown at this time. What we do know is that AMPV fleet vehicle variants – general purpose, mortar carrier, mission command, medical treatment, and medical evacuation – will account for some 30% of the vehicles in each of the US Army's 16 current ABCTs (which includes five National Guard combat teams). The intention is for all AMPVs, including the mortar carrier, to operate alongside other armoured fighting vehicles (AFVs) in the ABCTs, including M1 Abrams MBTs and M2 Bradley IFVs. Full-rate production of the AMPV fleet was awarded to BAE Systems by the US Army in August 2023.
The AMPV mortar carrier variant, of which 386 are planned, is based on the US Army's legacy 120 mm mortar system; the carrier, designated the M1287 Mortar Carrier, was expected to use the M121 mortar system with the M95 mortar FCS, with two vehicle crew and two mortar crew. However, in 2024, BAE Systems introduced a new top-plate system, the External Mission Equipment Package (ExMEP), which enabled a range of different turret types to be easily installed on the core platform. In the case of the MC, the company developed a prototype, unveiled in late 2024, with the ExMEP-equipped AMPV platform fitted with a Patria NEMO 120 mm remote turreted mortar system. The Pentagon and Patria had already been undertaking a Cooperative Research and Development Agreement since 2020 to explore how NEMO might be used with certain US Army vehicle platforms.

This development, according to BAE Systems, resulted from a rapid collaborative technology investment effort between itself, Kongsberg/Patria, and the US Army, to prove the versatility of the ExMEP-equipped AMPV platform in enabling incorporation of many different turret types, not just the NEMO mortar system.

At the time, AMPV programme director at BAE Systems, Bill Sheehy said, "The AMPV turreted mortar prototype was born from a capability discussion we had with the army in 2022, the same year ExMEP was conceptualised with industry partners, and we look forward to its evaluation." The company said that using ExMEP enabled rapid integration of the NEMO 120 mm turreted mortar system, which offers both indirect, as well as direct-fire support across multi-mission scenarios.

Since its first appearance late 2024, the AMPV NEMO mortar carrier prototype has undergone several months of rigorous field trials and live firings during 2024/2025 to gauge user feedback, including at Fort Moore in Georgia. Next, let's take a closer look at the NEMO in a European context.

The US Army's AMPV programme is replacing the army's fleet of M113s with five variant vehicles. The mortar carrier variant prototype, pictured, is outfitted with the Patria NEMO 120 mm remote turreted mortar system. [BAE Systems]

Patria's CAVS NEMO mortar carrier combines the company's 6×6 vehicle, mounted with its NEMO 120 mm turreted mortar system, seen here firing in direct-fire mode. [Patria]

NEMO

Patria's NEMO 120 mm turreted mortar has already entered service with three countries (Saudi Arabia, Slovenia, and the UAE) and is on order with three others (Germany, Hungary, and Sweden) aboard a number of land and naval base platforms. However, a significant recent development is the NEMO's inclusion for the mortar carrier variant of the Patria 6×6 – the platform being procured under the multinational Common Armoured Vehicle System (CAVS) programme, whose members include Denmark, Finland, Germany, Latvia, Norway, Sweden, and the UK. The primary variants offered under CAVS include: armoured personnel carrier (APC), command and control (C2) command post vehicle, logistics/support vehicle, engineer vehicle, MEDEVAC vehicle, and the NEMO-turret-equipped self-propelled mortar. Thus far, Germany is the sole CAVS member confirmed to have purchased the NEMO mortar carrier variant of the Patria 6×6, with 69 units on order. However, combined member orders for all CAVS variants now total over 2,000 units, with 250 already delivered and quantities increasing regularly, and with such a large user base, further procurement of the mortar variant appears likely.

The NEMO turret itself is a 120 mm mortar system designed for indirect fire support, but with a direct-fire capability; its breech-loading mechanism and stabilised turret enable it to fire at the low-elevation angles required for direct-fire engagements, for which it also has a laser rangefinder and day/thermal imaging cameras.

NEMO is also capable of multiple rounds simultaneous impact (MRSI) fire missions, during which up to five mortar rounds can be fired, so that the rounds land on an area target almost simultaneously, and with under four seconds between each impact. It can also conduct multiple targets simultaneous impact (MTSI) fire missions, in which up to five bombs are fired at nearby individual target coordinates, so that the rounds land on their targets almost simultaneously. MRSI/MTSI fire missions are possible at ranges between 1 km to 6.5 km. Both direct and indirect fire missions can be conducted either while the vehicle is stationary or on the move.

With a crew of two or three, the NEMO RC turret weighs 1,900 kg and has a full 360° traverse, with an elevation range from -3° of depression, to +85° elevation. The turret has an electrical laying system, but with manual back-up, if necessary. It has a 3 m, 120 mm smoothbore barrel, notionally a semi-automatic loading system (albeit a 2025 Patria NEMO brochure made reference to an automatic loading system, suggesting this is now also offered), again with manual back-up, and a soft, hydro-pneumatic recoil system. The platform can carry 50–60 rounds of ammunition, while the mortar itself can fire all NATO standard, smoothbore, 120 mm rounds, as well as certain precision-guided munitions. The turret is also offered with smoke grenade launchers for protection and an integrated remote weapon station as a secondary armament.

According to the manufacturer, based on user feedback and trials, NEMO can be ready to conduct a fire mission within 25 seconds of receiving orders; its FCS enables sensor-to-shooter operations, receiving fire support plans and fire missions from the fire direction centre via the wider tactical data network into the onboard C2 systems. Its 'shoot-and-scoot' capabilities include being able to fire on the move; it can fire the first three rounds of a fire mission in 15 seconds, but has a sustained rate of fire of 6 rds/min, thereafter, and a maximum rate of fire of 10 rds/min. Depending on ammunition type, NEMO can hit targets over 10 km away.

Protected patrol vehicles: A brief survey

Sidney E. Dean

Protected patrol vehicles (PPVs) are military workhorses, serving in a wide variety of combat and support roles. The following is a selected overview of currently marketed systems, presented by region.

Demonstration of the JLTV A2 for the UK MoD in October 2025. [AM General]

Protected Patrol Vehicles form a diverse category comprised of a wide variety of platforms. Most of those currently being built are 4×4 or 6×6 vehicles. By definition, PPVs are 'protected,' that is to say armoured, with organic armour packages varying from light to heavy depending on user priorities and mission profiles. That being said, modern PPVs tend to place a higher premium on mobility and signature management than armour. Modularity is also a significant attribute, with most PPVs having access to a suite of appliqué armour, weapons, sensors and other mission systems which can be configured to meet the mission requirements and the operational environment.

USA

The United States Army and US Marine Corps (USMC) began procurement of the 4×4 Joint Light Tactical Vehicle (JLTV) with the award of a Low-Rate Initial Production (LRIP) contract to Oshkosh Defense in August 2015. Full-rate production (FRP) of Oshkosh's A1 variant was approved in June 2019. The base vehicle is 6.2 m long with a GVW of circa 10,200 kg. The basic protection level of STANAG 4569 Level 1 can be enhanced with modular armour kits. As of mid-2025, Oshkosh had delivered circa 22,000 JLTVs to the US armed forces and another 1,600 to allied and partner nations.

In 2022, the Pentagon re-competed the JLTV programme, and awarded a follow-on contract to AM General in February 2023, ending Oshkosh's role as prime builder effective 2025. As with the JLTV A1, the new A2 variant was designed to balance mine/blast protection with high off-road mobility. Like the A1, it can be fielded in general purpose, heavy guns carrier, and close combat weapon carrier tactical configurations or as a utility vehicle. Despite the obvious similarities, the A2 variant incorporates more than 270 engineering changes over the A1, including improved suspension, electrical power generation, and digital backbone integration.

The LRIP of AM General's JLTV A2 variant began in February 2025. However, in a surprise move the US Army announced on 1 May 2025 that it would cease procurement of JLTVs in accordance with a directive by Defense Secretary Peter Hegseth to "end procurement of obsolete systems, and cancel or scale back ineffective or redundant programs, including [excess ground vehicles]".

The decision has largely been attributed to the Pentagon's shift away from counter-insurgency operations in favour of a 'pivot' to the Info-Pacific region and a corresponding re-orientation to lighter, less protected but more mobile vehicles. Army Chief of Staff Gen Randy George compared the JLTV to a "complete shell," adding that "the problem with some of those vehicles, too, is they're not very mobile. They get stuck. When you get stuck, you're also a target." Ironically, George's statement stands in stark contrast to a statement by the Pentagon's Defense Security Cooperation Agency (DSCA) in a 2 September 2025 arms sale notification to the US Senate. The document describes the JLTV as "an optimal choice for a spectrum of light tactical vehicle missions anywhere in the world. All JLTV mission variants include a strong balance of protection, manoeuvrability, speed, reliability, and combat service support capability that far surpasses any similar vehicle in its weight class today."

Unlike the Army, the USMC remains committed to procuring the JLTV, whereby Marine Corps Commandant Gen Eric Smith has cautioned that the Army's cancellation will raise unit costs, which could force the Marines to reduce their acquisition target. The Corps' continued interest in the JLTV is notable as that service is also currently returning to its emphasis on mobility, and is preparing specifically for littoral and island hopping missions in the Indo-Pacific theatre.

Despite the Army's about-face, both Oshkosh and AM General continue to produce their respective variants for the export market, emphasising customisation to meet diverse customers'

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needs. Exports will be fulfilled through both direct commercial sales as well as through government-brokered Foreign Military Sales (FMS).

In April 2025, Oshkosh netted a contract to supply 150 Dutch Expeditionary Patrol Vehicles (DXPV), a specialised JLTV variant tailored for littoral and multi terrain operations, to the Netherlands Marine Corps; this follows several FMS contracts to other nations which were announced in 2023.

On 2 September 2025, the DSCA informed the US Senate that Canada plans to acquire 60 JLTV A2 vehicles, presenting the first foreign sale for AM General's variant. On 8 October 2025, the firm announced that it would partner with British defence contractor Marshall Land Systems to compete for the upcoming United Kingdom Land Mobility Programme (LMP) solicitation; AM General simultaneously announced that it had hosted a capabilities demonstration of its light tactical vehicle portfolio (including the JLTV A2) for the UK MoD at the UTAC Millbrook Proving Grounds.

France

The Serval 4×4 Véhicule Blindé Multi-Rôle Léger (VBMR-L, light multirole armoured vehicle) entered service with the French Army in 2022. It is produced jointly by lead contractor KMDS France (formerly Nexter) which manufactures the armoured hull and integrates mission systems, and Texelis Defense (currently being acquired by KNDS) which supplies the rolling chassis, driveline, and suspension systems. The 6.5 m long vehicle has a combat weight of 15-17 tonnes depending on configuration. It can be transported by air (A400M or larger), rail or ship, and has a road range of 600 km.

The base variant fits a two person crew plus eight dismounts (2+8). Modular architecture permits the Serval to eventually be configured as 31 variants or subvariants, allowing the vehicle type to cover the complete set of missions and functions that might be encountered during operations. These include reconnaissance, command and control, troop transport, fire support and logistic support missions. Advanced digital communications systems and enhanced battlefield connectivity guarantee full interoperability with other armoured platforms.

A remote-controlled weapons station (RCWS) can mount either a 12.7 mm heavy machine gun (HMG) or 7.62 mm machine gun

The Serval PPV in French Army service with winter camouflage scheme. [Armée de Terre]

(MG) or a 40 mm automatic grenade launcher (AGL) for fire support or self-defence; a secondary 5.56 mm or 7.62 mm MG is standard. A notable recent version is the LAD counter-drone configuration, equipped with radar, direction finder and ARX30 turret armed with a 30M781MPG automatic cannon chambered in 30×113 mm, and capable of firing airburst munitions.

The Serval protection suite includes base armour against ballistic, mine and IED threats; protection can be enhanced through optional ballistic armour kits. Other survivability systems include a 360° situational awareness suite, CRBN protection (optional), a Thales BARAGE radiofrequency jammer, and a Strike Launch Alert (SLA) detector combining acoustic, optical, and infrared sensors to detect muzzle flashes, missile launches, or incoming rounds.

The Serval has already been deployed on peacekeeping missions in Africa, as well as for multinational exercises within Europe. France plans to acquire about 2,000 Serval vehicles by 2035. The vehicle is also available for export.

Germany

KNDS Deutschland's Dingo protected transport vehicle family has served with the German armed forces since 2000. Five other NATO nations and several other military forces also utilise Dingo vehicles, making a total of 1,200 currently in service. The protected vehicle is used for personnel transport and convoy operations as well as patrol, reconnaissance, and command missions. Specialised variants, including ambulance and battlefield repair vehicle, are also in use. All versions of the Dingo are known for a high level of protection as well as robust all-terrain performance.

The newest iteration is the Dingo 3. Its passive armour package provides protection against small arms and shrapnel, as well as mines and improvised explosive devices (IEDs). NBC protection is also offered. The protected core of the vehicle is formed by the armoured steel safety cell outfitted with side doors and an electrically driven rear ramp. The Dingo 3 is available in the 4×4 and the 6×6 troop carrier core configurations, and the 6×6 ambulance. The 4×4 and standard 6×6 accommodate a variety of RCWS including one proprietary to KNDS. The flexible layout permits customising the rear or crew compartment with mission-specific equipment kits depending on end-user requirements.
The 4×4 is oriented toward multifaceted mission profiles and extreme terrain conditions, with a road range of over 800 km. It is based on the militarised Unimog 14.5 chassis. The 6.6 m long vehicle has a maximum permissible weight of 14.8 tonnes (including a 3 tonne payload capacity), up from a 13.1 tonne GVW with the Dingo 2 4×4. The vehicle accommodates a two-person crew in the cab plus up to eight dismounts in the rear or crew compartment (2+8), with a passage connecting the two spaces. Alternate configuration options include NBC reconnaissance or mobile command post. The new vehicle can accept up to 2 tonnes of equipment, up from 1.5 tonnes for the equivalent Dingo 2.

Other improvements compared to Dingo 2 include a new drivetrain with a high-torque 6-cylinder turbo diesel engine, automatic transmission and automatic central tyre inflation system (CTIS), significantly increased electric power (11.2 kW) to support future installation of new mission systems, and a stronger air conditioning system (16 kW cooling power). The driver's instrument panel has been modernised, including addition of a driver information system.

The Dingo 3 in the 4×4 and 6×6 variants. [KNDS]

A variety of weapons can be carried on the optional roof-mounted remote weapon station (RWS). The vehicle itself can be configured for a number of roles including general patrol, reconnaissance, surveillance, SHORAD and ambulance configurations.

The 6×6 variant of the Dingo 3 based on the Unimog FGA 20 is 8.05 m long with a maximum permissible weight of 20 tonnes including 5 tonnes of payload, of which 3.5 tonnes can be used for equipment. With a crew compartment volume of 17 m^3, the vehicle is capable of accommodating the crew plus ten dismounts (2+10) making it suited to the troop carrier role; however it is also modular and adaptable to numerous mission profiles including patrol, reconnaissance, command, maintenance, recovery or radar carrier vehicle or ambulance.

Switzerland

Mowag (now owned by General Dynamics European Land Systems or GDELS) introduced the Eagle family of vehicles (FoV) in 1992. The latest generation, the Eagle V, was presented in 2010. It is the first Eagle PPV to be built in both a 4×4 and 6×6 chassis. The 5.4-m-long 4×4 variant has a maximum weight of 11.5 tonnes including a 3.5 tonne payload capacity; it seats four including the commander and driver (2+2), and can accommodate a temporary fifth seat. The 6.9 m 6×6 vehicle has a maximum weight of 17 tonnes including up to 5 tonnes of payload; depending on configuration, it accommodates 12 including the commander and driver (2+10).

Both Eagle V variants use the de Dion suspension which enhances off-road mobility and stability. Like the Dingo, the Eagle focuses the primary protection around the crewed areas of the vehicle. A double-V shaped floor and internal decoupling measures maximise integrated mine protection. The vehicle's ballistic STANAG 4569 Level 1 protection can be increased up to Level 3 via optional kit armour and can be augmented by counter-RPG measures; additional protection options include NBC filtration, automatic fire suppression, and a shielded engine compartment.

The Eagle V 4×4 all-weather, all-terrain PPV. [GDELS-Mowag]

Serbia

The BOV M16 Miloš 4×4 multipurpose armoured vehicle is designed and manufactured by Yugoimport. Production has been ongoing since 2017. The Miloš entered service with the Serbian armed forces in 2019, and is utilised for a wide variety of missions including patrol, reconnaissance, anti-terrorist operations, special operations force support, and anti-tank operations. The independent suspension system ensures high mobility in multiple terrains.

The 5.45 m long vehicle has a maximum weight of 14 tonnes. The 6.5 m3 crew compartment accommodates up to eight soldiers including the commander and driver (2+6). Four are seated in the forward section of the vehicle and disembark via four standard doors, while four additional personnel are seated in the rear and deploy via a hydraulic ramp or inbuilt rear door.

The hull is made of armoured sheet steel and offers STANAG 4569 Level 3 ballistic protection on the front and Level 2 on the other sides. Mine protection reaches STANAG 4569 Levels 2a and 2b.

Serbian armed forces exercise with a Milosh BOV 16 PPV. [Yugoimport]

The BOV M16 can be equipped with a remote or manually controlled weapon station capable of mounting a variety of weapons including a 12.7 mm HMG or a M134D minigun. Alternately, anti-tank guided missiles (ATGM) and very short-range air defence (VSHORAD) missiles can be mounted.

The Miloš 2 entered service in 2023. The 6.5 m long variant has a maximum weight of 18 tonnes. It is armed with the 1,000 kg Kerber RWS, developed by Yugoimport and designed for carriage by light- to medium-armoured vehicles. The Kerber is provided with day and thermal optronic sights and a fire control system, and armed with three 20 mm automatic cannons chambered in 20 × 110 mm, providing the vehicle with a high-volume firepower

A convoy of Vuran multi-purpose armoured vehicles, with the general patrol vehicle in the lead, followed by the mortar carrier and the armoured multiple rocket launcher vehicle. [BMC]

capability against ground, air, and maritime threats. With procurement by the Serbian armed forces continuing, this vehicle is also offered for export.

Türkiye

BMC Otomotiv Sanayi ve Ticaret A.Ş. produces the Vuran series of 4×4 PPVs. The baseline Vuran 4×4 personnel carrier variant is referred to as the 'MPAV' (Multi-Purpose Armoured Vehicle). The 6.22 m long PPV has a GVW of 19.1 tonnes can be deployed as a general patrol vehicle seating nine personnel including the commander and driver (2+7). The mission profile also includes area or point reconnaissance, point defence, and convoy escort. An optional roof-mounted RWS can be armed according to the user's requirements. In addition to the patrol vehicle, specialised Vuran can be configured as a 120 mm mortar carrier or armed with a 107 mm multiple rocket launcher. The Vuran entered service with the Turkish armed forces in 2019, and has since been exported to seven additional countries.

The Vuran can operate in weather conditions between -32° and +49° and in high humidity. Off-road performance includes the ability to navigate 60% gradients and 30% side slopes. Ground clearance of 400 mm and fording capability of 800 mm translate to excellent manoeuvrability in difficult terrain. Standard equipment includes a fire suppression system, air conditioning, an arctic kit, run flat tyres and a central tyre inflation system, a self-recovery winch, jammer, gunshot detection system and front and rear cameras. RPG and CBRN protection are optional. The unibody, armoured cabin and shock-absorbing seats provide ballistic, mine and IED protection. BMC further cites compliance with DIN EN1522-1063 ballistic protection standards.

UAE

The Edge Group's subsidiary Nimr Automotive LLC produces several lines of protected patrol vehicles ranging from light to heavy. The 4×4 Ajban 440A protected light tactical patrol vehicle was introduced as a derivative of earlier Ajban logistics and support vehicles. In 2021, Nimr launched the second generation Ajban light PPV line, designated Ajban Mk2. Despite the continuity of the name, the Mk2 features substantial changes, with significantly enhanced payload, ballistic and mine protection.

The Mk2 series is currently marketed in three configurations: the 442A, the 432AU, and the 452A. The vehicles features a V-hull structure for enhanced blast resistance, and a fully armoured monocoque cabin for effective protection from ballistic threats. A floating floor further enhances vehicle integrity and crew safety against under-vehicle blast. Critical ballistic protection for the engine is optional, as are sealed fuel tanks and an automatic fire-extinguishing system. Situational awareness and navigation are enhanced through front and rear external cameras. Weapons options include a roof-mounted weapon ring to accommodate a machine gun or grenade launcher. Gun ports in the cabin permit the crew to deploy small arms fire under armour. The interior layout facilitates integrating command, control and communication systems tailored to mission requirements.

The smallest and lightest configuration is the 442A; this 5.8 m long vehicle has a GVW of 14.5 tonnes and a 4,000 kg payload. It is designed for four soldiers (2+2 seating) but can accommodate a fifth. The mission profile encompasses general patrol including reconnaissance, surveillance, and light combat. The 432AU is somewhat larger than the 442A, and mostly intended for utility roles, although it can be configured as a mortar carrier.

Nimr introduced the enhanced Ajban 452A in 2025. Capacity has been expanded to 11 crew (2+9), with a 3,500 kg payload capacity and a GVW of 16 tonnes. It retains the common 4×4 chassis and modularity of the Mk2 generation. Dimensions (length 6.050 m, width 2.51 m, height 2.695 m, wheelbase 3.5 m) are slightly larger than the 442A, but still compact considering the fact that the vehicle's capacity bridges into roles often filled by 6×6 platforms. In addition to patrol and personnel transport, specialised configuration options include command and control vehicle, artillery observation or ambulance. The 452A, which is still classified as a light tactical patrol vehicle, features an armoured hull with a V-shaped design for enhanced underbody blast resistance. NBC protection and smoke grenade launchers round out the protective package.

A premium on flexibility

In the past, PPVs were often developed with a premium placed on armour and other protective attributes at the expense of mobility. Early MRAPs for example, were deliberately designed with a high ground clearance to better survive mines and IEDs, but this higher centre of gravity increased the risk of rollover on uneven terrain. Current design philosophy is oriented toward a more even balance between firepower, survivability, mobility, and cost.

The Ajban 452A expands the capacity and capability profile of Nimr's light PPV family. [Edge Group]

CBRN defence issues in law enforcement and counterterrorism

Dan Kaszeta

Defence against chemical, biological, radiological, and nuclear (CBRN) hazards has spent decades as, principally, a military discipline. Great effort has gone into developing an industry devoted to protecting military personnel from CBRN hazards. However, CBRN threats are, in recent decades, just as relevant in a civil protection and law enforcement context. CBRN terrorism, as well as accidents and disasters that cause the spread of hazardous materials, drives the need for some level of CBRN readiness in police and security services.

Existing PPE for the emergency services is usually designed to a very high (and very expensive) occupational safety and health standard. [US ANG/MSgt Michael Matkin]

CBRN defence has over a century of being considered as subject in the military sphere of influence. Civil protection or civil defence has largely been considered a secondary area of concern. Even when it has been considered in a civil context, law enforcement and criminal investigation agencies have often been regarded as secondary players after fire, rescue, and emergency medical services. There was a lot of concern in the late 1990s after several incidents in Japan involving nerve agents, which drew a lot of broader concern to CBRN counterterrorism. But, again, much of this concern and effort fell upon fire and rescue services more than police services.

This correspondent, who owes much of his career to the post-Tokyo rise of CBRN antiterrorism, witnessed the spectacle of US Army Chemical Corps soldiers trying to teach military CBRN defence, verbatim from US military doctrine, to American firefighters and paramedics. My own take is that the effort went down poorly, needlessly sacrificed some good will, and resulted in little actual improvement to public safety. The general lesson learned by many was that you cannot simply take military CBRN defence, paint it blue, and give it to police. Yet it precisely this that the CBRN defence industry sometimes attempts to do.

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Key differences

In order to understand this subject, we must comprehend the numerous major and minor differences between military CBRN defence and the policing and security services sector. First, there is the issue of organisational responsibility. In a civilian environment, CBRN incidents are far less common than but often very similar to accidents involving hazardous materials. Dealing with hazardous materials accidents in commerce, industry, transportation, and scientific situations is usually the province of firefighters, with police as only a supporting role.

Law enforcement and firefighters work in a civilian environment, which takes a different approach to risk management than the military. This translates into a number of legal, regulatory, and practical differences in things like procedures and equipment. Personal protective equipment (PPE) for civil-sector use has to adopt an occupational health and safety approach, mandated by laws and requiring tests and certifications for equipment. This approach, which takes a stronger view towards reduction of possible harm, results in PPE that is heavier, hotter, more expensive, and ultimately more protective than comparable military kit. Furthermore, civil hazardous materials hazards provide a broader spectrum of threats and conditions than military CBRN agents. Compare a military gas mask with a firefighter's breathing apparatus and compare a military CBRN suit to a Hazmat technician's suit, and you will see what I mean. Military CBRN equipment makes design compromises that favour operational endurance (such as spending a day or a week in CBRN kit instead of an hour), logistical simplicity, and the ability to conduct warfighting over survivability. Military CBRN kit has never been designed to negate 100% of a particular hazard. Such an attitude does not work in a regulated civilian workplace and leads to a situation wherein it may actually not be legal for a police officer to be issued with a military CBRN mask.

Operational deficits and how to fill them

Where does one start? At the beginning of a rational process, it is necessary for governments to either define or refine what it is that they expect police and other law enforcement agencies to actually do in the event of CBRN terrorism or a hazardous materials release. These two threats are necessarily combined because CBRN terrorism may present itself under the guise of a hazardous materials incident. A rational analysis of the mission can be translated into tasks that police are expected to accomplish in a CBRN situation. A set of tasks then drives the training and equipment needed. Indeed, training and equipment are co-dependent, as CBRN response is an equipment-intensive sector and much CBRN training is, in fact, equipment-oriented. But fixing the operational deficits in capability requires an earnest effort to analyse just what it is you expect your people to do.

It is actually quite important that the process be followed in the correct order. All too often, an emergency services department or agency gets this process backwards. There have been many instances of a police department being sold a particular bit of equipment, only to be following by the spectacle of working out a mission for it and how to train people on its use. This correspondent, more than once, was tasked with developing training classes for equipment based on the fact that management liked a particular sales pitch but had not actually figured out what to do with the equipment.

In most places, the details of the output of a mission analysis may vary considerably. However, in practice, these efforts broadly settle into two categories: offensive and defensive missions and tasks. Offensive tasks will require deliberate entry into a hazardous environment, and will likely include things like raiding a suspected laboratory or storage location, body retrieval, and collecting evidence after an incident. These will likely be the domain of specialist teams. Defensive tasks and missions will be things like supporting corridors and perimeters around incident sites and the ability to immediately protect oneself while retreating from an incident to a safe distance.

A mission analysis effort will run up against the issue of interagency cooperation and coordination, and fall afoul of tensions and rivalries. The general practice around the world is that firefighting services (or more rarely a dedicated civil protection service, such as the Singapore Civil Defence Force) tend to deal with industrial and transportation accidents involving hazardous materials. But as pointed out above, a CBRN incident often presents the same way. By necessity, police will have to work with firefighters. Firefighter training facilities will be better equipped and trained to conduct basic CBRN training. In many places, ancient rivalries exist and interagency cooperation is poor. Fixing these parochial issues is important to addressing CBRN threats in the civilian environment. Unfortunately, the track record in this area varies from excellent to abysmal around the world. We need only look at the sad spectacle of New York City police officers and firefighters getting into fights with each other at the World Trade Center site in November 2001 to see that such rivalries exist.

PPE and procedures in the emergency services are often driven by hazardous material incidents and may need adaptation. [US Department of Energy]

Fixing both the capability deficit and interagency coordination problems has, in fact, a common solution. Training, exercises, joint procedures, and personnel exchange are all very useful. Every task, mission, and piece of equipment identified will take training in order to perform. Such training will be more effective if it is joint, and ambulance service and fire crews are alongside for much of it. Indeed, it may be the fire training academy in a particular locale that is already best suited. Exercises help people find ways to work together in an environment that is less stressful than actual incidents, but in many places, it is rare for police, fire/rescue, and emergency medical personnel to hold exercises jointly.

All of this takes resources. Time, labour, and money are required to sort out the mess, and not every department will have the requisite resources. The sad reality of CBRN planning and response is that, all too often, things are done in haste and panic after an incident. A modest capability before an incident is inevitably superior to the combination of no capability before the incident and ample capability three years later due to learning a harsh lesson.

Finding pockets of existing competence and building upon them is one way to build capability. A systematic analysis of the actual mission requirements for CBRN response by law enforcement yields a set of tasks, skills, and required equipment that is actually very similar to that need for two types of niche law enforcement teams that already exist in places. Specialist investigators that pursue environmental crimes and specialist teams that conduct raids and high-risk searches on clandestine drug laboratories both have a lot of what it needed for CBRN response. In some places, such teams are scarce or non-existent, but where they exist, they can be the seed for future growth. What if a police department has a clandestine narcotics laboratory enforcement team that is capable of raiding a fentanyl or methamphetamine laboratory without causing death, injury, or environmental disaster? That is, in fact, a de facto CBRN response team, given its already existing equipment and mission, and it will need only minor adjustment.

Often the largest CBRN-related deficit in law enforcement is the issue of forensics. Collecting, storing, and analysis of evidence from a possible CBRN-related crime scene is likely to be necessary to discover the perpetrators, identify the causative agent (which, in turn is useful for medical treatment and recovery of the affected area), and prosecution of offences. It would be a political catastrophe anywhere a terrorist group escaped arrest, avoided prosecution, or was acquitted at trial due to lack of evidence or evidence being tainted. [Note: This subject is much more heavily explored in 'CBRN forensics: Proving an incident occurred and proving who did it', published in ESD 02-2025.]

The issue of equipment needs three things. It needs resources, principally funds. But spending money on the wrong things does not help capability or capacity. The correct equipment items need to actually be available for procurement. For industry to develop equipment actual suited to this market segment, two things need to happen. Occupational safety and health regulators that govern PPE need to lean a bit towards emergency responder use cases in the understanding that there are emergency situations which are not the same as a normal workplace that uses industrial hazards.

On the other side of the equation, manufacturers need to do more than just paint the products blue and slap a 'for police use' decal on them. There needs to be a better understanding that CBRN incidents in the urban environment are not necessarily the same as military use cases on the battlefield. In the US and Western European CBRN markets, there has been some progress on both of these fronts, but it has been glacial and practitioners have long been having to make improvisations. Much of the equipment used early on for clandestine lab raids or environmental investigations, mentioned above, was improvised and adapted from other sources. Use of military equipment can be a useful stop-gap, but needs to be used with caution. Also, there are certainly legal and political issues with militarisation of policing and blurring the lines between the military and civilian police in many countries. But there is actually a lot of improvement in CBRN technology in recent decades and police CBRN protective clothing, for example, does not have any technical reason to need to look like military CBRN protective clothing.

One area of particular concern, however, is detection equipment. CBRN detection has improved greatly in recent decades and several articles over the last decade in this publication have attempted to survey these developments. However, the fundamental reality is that urban environments, which is where policing tends to be concentrated, has a wide variety of background interference that can give a lot of false positives on CBRN detection equipment. The operational penalties for false alarms in a civilian environment are different than in a military environment. If an artillery battery has to put on masks for an hour while an alert from a chemical detector is investigated, of course there is some operational penalty and degradation of performance. But in a modern military this is, to some extent, 'baked in' and it is better to have that false alert than lose some soldier's lives. But false positives in civilian environments can get buildings evacuated, cause widespread disruption, or get someone arrested wrongly because a chemical detector alerted to dry cleaning fluid or a leaking fire extinguisher or some similar scenario. Your correspondent does

Evidence collection in CBRN situations will require special training and equipment. [US Army/Capt Molly A Treece]

Specialist law enforcement CBRN equipment has existed for some time, but has usually been the product of liaison between a specific agency and a manufacturer. [US Department of Homeland Security]

not see widespread adoption of chemical detection equipment in routing policing any time soon due to inherent limitations in design and the engineering trade-offs that have been made in chemical detection. On the other hand, there are numerous useful examples of radiation detection being used in policing and law enforcement, particular in customs and border protection scenarios.

Closing thoughts

If modern society wants to protect its citizens and safeguard its critical infrastructure, then the issue of CBRN response to policing needs to be seriously addressed. Relegating the CBRN protection mission solely to the military may work in some places, but generally speaking, modern democratic societies can and should do better, and military forces are often quartered far away from much of the likely civilian populace and infrastructure that would be most likely involved in terror incidents. The gulf between military and law enforcement CBRN response is not insurmountable, and a systematic analysis can address this gulf. Indeed, in many places, significant process has been made. None of this progress will be fairly evaluated without having been challenged, and we hope such challenges are rare.

Northern European seabed operations underline the Alliance's collective approach to CUI security

Dr Lee Willett

The northern Euro-Atlantic theatre is today a stage on which maritime asymmetric activities are involving and impacting non-state, state, and multinational actors. The underwater domain remains a particular area of state-based strategic contest because it remains opaque, cloaking submarine and, increasingly, uncrewed platform operations. In a significant Euro-Atlantic security shift, asymmetric activities and capabilities are bringing physical and strategic vulnerability to critical undersea infrastructure (CUI). This threat may have been underlined in late 2025, following concerns that a CUI incident in the Gulf of Finland may have involved a rogue commercial ship deliberately dragging its anchor across the seabed.

NATO ships from SNMCMG1 sail in the Baltic Sea in November 2025. NATO's SNMG1 and SNMCMG1 task groups have been the at-sea 'hub' around which national and NATO responses to the Northern European CUI risk have been built. [Dr Lee Willett]

Senior NATO military leaders began warning about increasing underwater threats as far back as 2016. However, the CUI issue burst into European and international political and public consciousness in September 2022, when the Nordstream gas pipelines in the Baltic Sea suffered explosive ruptures. The Baltic became a global CUI security focus when three incidents of damage between October 2023 and December 2024 raised questions in NATO political and public debates over whether such incidents were attributable to rogue ships intentionally dragging their anchors at distance and speed across known CUI sites.

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The Baltic incidents were not the only examples of suspicious damage to northern European CUI. In November 2021, sensor cables in a civilian-run environmental monitoring network off Norway's Lofoten peninsula, were damaged; in January 2022, data cables connecting the SvalSat satellite station on Norway's Svalbard Island to the Norwegian mainland also were damaged. These incidents occurred at either end of the Bear Gap, a maritime chokepoint through which underwater traffic transiting between the Barents and Norwegian seas must pass.

The increased CUI threat is reflected in NATO's Allied Maritime Strategy (AMS). The first version (published, 2011) bracketed CUI protection within wider maritime security challenges to sea lines of communication (SLOCs). However, by the time the second version appeared (October 2025), the CUI threat profile had been elevated significantly not just by the Baltic incidents but because of greater state-based threats to maritime security as a whole, including to freedom of navigation, access at and from the sea, and strategically important SLOCs now recognised as including CUI.

CUI security's central role in NATO maritime thinking is illustrated in how the risk was described in the latest AMS version. "By increasing maritime readiness, situational awareness, posture and mass, while enhancing existing capabilities with emerging technologies, NATO will have the maritime power required to assure maritime access, uphold freedom of navigation, safeguard vital SLOCs, protect critical infrastructure, and prevail in conflict," the AMS said. Securing CUI is seen as flowing directly from enhancing NATO's overall operational output.

Allied power

The Baltic incidents affected CUI connecting NATO states region-wide. Countries conducted national responses, alongside myriad examples of collective response.

Following the 26 September 2022 Nordstream explosions, Denmark, Germany, The Netherlands, Norway, and the UK surveyed collectively over 8,000 km of CUI in their national territorial waters, using uncrewed underwater vehicles (UUVs) supplied particularly by Norwegian industry.

Post-Nordstream too, six countries – Denmark, Germany, Finland, The Netherlands, Norway, and Sweden – established (under an existing naval capability cooperation framework) The Netherlands-hosted Seabed Security Experimentation Centre (SeaSEC), harnessing commercial and defence uncrewed capabilities to (SeaSEC said) 'do something' quickly about the threat.

In the wake of the 2023-24 Baltic incidents, the UK-led, 10-country Joint Expeditionary Force (JEF) – established previously to provide maritime and wider joint capacity to support NATO through deterring sub-conflict threshold threats in Northern Europe – established its 'Nordic Warden' CUI security operation, conducting various deployments since June 2024 to bring presence across an area encompassing the Barents to the Baltic seas.

NATO responded too, establishing in January 2025 its 'Baltic Sentry' maritime presence, surveillance, and deterrence activity. Led at sea by NATO's Allied Maritime Command (MARCOM) and its standing naval forces (SNFs), 'Baltic Sentry' is now a core component of NATO's wider enhanced vigilance activity (EVA) output across the region.

These and other responses illustrate the national power NATO and its member states can harness collectively in crisis response, working as an alliance or as multinational 'spokes' around the NATO 'hub'. Such collective capacity and capability is where NATO has significant advantage over potential adversaries.

Regarding a challenge like CUI security, each NATO member state and its commercial industry hold significant information on the status of national CUI networks. Building CUI security through sharing and layering data to generate information superiority demonstrates how NATO could enhance its outputs and advantages through further integrating information and operations.

CUI security is a multi-stakeholder issue, combining government agencies (including those covering the maritime domain), the armed forces, and industry. For NATO countries, responding quickly to the threat means working closely with industry.

Commercial industry is changing its CUI security and resilience perspective. Recognising the threat, it understands the need for network security and repair capacity – not just to maintain operational-level supply for its customers, but to reduce strategic-level vulnerability for the countries concerned. Companies working in seabed infrastructure lay, monitor, repair, and replace it.

However, industry's contribution relates to more than just CUI information and security. Norway's commercial offshore sector operates a collective pool of over 600 remote-controlled and autonomous UUVs. The sensing mass within such pools can help bolster deterrence effect.

Integrating industry

Norway's geostrategic position – and CUI incident background – is a useful illustration of the national and multinational approaches NATO countries take in securing CUI. Its underwater geography also underlines the broad nature of the CUI threat.

Norway's government, military, and industry stakeholders are closely integrated in deterring threats to CUI. Here, the air force and coast guard work to secure an offshore commercial installation, during a multinational 'Nordic Warden' deployment. [Norwegian Armed Forces]

Talking to *DefenceIQ's* 'Seabed Security' conference in Tróia, Portugal in September, Commodore Kyrre Haugen – the Royal Norwegian Navy's (RNoN's) Commander Norwegian Fleet – explained the varying geophysical challenges countries and their CUI stakeholders must consider.

Norway's exclusive economic zone (EEZ) includes shallow waters under 100 m deep, where CUI can be accessed by underway maritime shipping, Cdre Haugen explained. In EEZ waters 100–1,000 m deep, CUI is at damage risk from fishing trawlers, he added: while commercial activity is not usually present beyond 1,000 m, specialist equipment (like that built for research or military activity) can provide access.

In vessel terms, the CUI threat comes in these and other forms. Merchant ships, fishing vessels, and submarines can all deploy UUVs, for example. Responding to the broad threat means government agency and organisation, industry, and armed forces integration – the latter including integrating naval, air, and space domains, to harness surveillance and wider maritime situational awareness (MSA) sensing presence.

Norway's CUI stakeholders interact regularly, including conducting tabletop exercises and through industry actors' own operations centres, via which they can integrate with the RNoN's maritime operations centre (MOC) to share and access information, Cdre Haugen explained.

While Norwegian industry's UUV fleet offers significant surveillance and MSA capability and capacity the RNoN can draw on, the navy is building its own presence. "We are developing and growing capacity on the seabed, by introducing a fleet of uncrewed systems, which we can use for surveillance and to investigate what is going on in different areas," the Cdre said. "So far, the RNoN has improved its ocean-going autonomous UUV capabilities, using a container-based system that can be deployed from several ships in the fleet."

Noting too that adversaries' uncrewed systems provide surveillance and sabotage threats against CUI, "The most important thing is to be able to deny deniability," said Cdre Haugen. "We need a combination of all layers – space, cyber, surface, and sub-surface, combined with proper intelligence gathering – to be in the right place, at the right time, with the right capacities to deny deniability when there are threats to our CUI."

Industry is strengthening its own capacity to support the response. Here, Cdre Haugen explained, contributing to common MSA is the key driver, with industry fitting sensors to offshore platforms and integrating these and other sensors (for example, radars fitted on rigs or helicopters) into the wider CUI and MSA networks.

Adding capacity

When the Norwegian and Nordstream incidents occurred, Finland and Sweden were not NATO states. Russia's invasion of Ukraine in February 2022 precipitated their membership, formalising what had been close, long-standing, strategic-level partnering with NATO and its members.

The later, 2023–24 Baltic incidents occurred around the time Finland and Sweden became members (April 2023 and March 2024, respectively). What their membership added in the Baltic CUI context was significant understanding of the region's naval environment, especially underwater, plus substantial MSA capacity and capability. The potential benefit Finland and Sweden offer here is augmenting deterrence through attribution, assisted by their knowledge of local shipping. Both countries also have proven records of maritime security information-sharing across national stakeholders.

Regarding information sharing to enable attribution, navies contribute through integrating surveillance pictures. "We are able to support CUI protection with our sea surveillance capabilities. That is the baseline operation: make sure we know every merchant ship that operates in the region," Rear Admiral Tuomas Tiilikainen, Commander Finnish Navy, told *ESD* in December.

Such information is shared with stakeholders including the Finnish Border Guard. "We work very closely with the Border Guard: we share the same situational awareness, and the Border Guard has some unique authorities and capabilities

The Royal Norwegian Navy has developed a containerised UUV capability for supporting CUI security. The capability can be deployed across various Norwegian ships. [Norwegian Armed Forces]

The mine-hunter FNS *Katanpää* is the latest in a line of Finnish Navy ships to have deployed into NATO's standing naval forces, including to support 'Baltic Sentry'. [Finnish Navy]

because they are 'police': they have the constabulary authority," Rear Adm Tiilikainen explained. "We share information, we share resources, and we plan in advance for using the resources so we have maritime presence in key areas '24/7, 365'." For incident response during peacetime, the Border Guard leads with the navy in support, the admiral added.

While the region's national stakeholders already have integrated relationships, NATO adds value in building and sharing the integrated MSA picture. "NATO's contribution is information sharing, giving us a 'heads up' on vessels of interest entering the Baltic Sea basin," said Rear Adm Tiilikainen, noting that such advanced information can include concerns over suspicious behaviours or previous visits to ports of interest.

The MARCOM-based NATO Maritime Centre for the Security of CUI (NMCSCUI), established as the Alliance's maritime operational-level information-sharing 'hub', brings particular impact as an Alliance navies' asset. NMCSCUI can play a central role in harmonising processes for sharing contacts of interest and for incident response, said Rear Adm Tiilikainen. NMCSCUI has played an increasing role in supporting 'Baltic Sentry', too.

The Finnish Navy has contributed to 'Baltic Sentry' in several ways. Most recently, between August and November, the navy's mine-hunting vessel FNS *Katanpää* joined MARCOM's Standing NATO Mine Counter Measures Group 1 (SNMCMG1) SNF. Here, it has learned much about national and NATO contributions to CUI security.

"From our perspective, 'Baltic Sentry' is a success story. It was launched swiftly and decisively, and it really showed NATO's commitment and dedication to protect CUI," said Rear Adm Tiilikainen. Such effect relates not only to NATO's SNFs at sea, but to the building and sharing of MSA between the navies and their MOCs to generate a comprehensive understanding of rogue shipping movements and potential emerging threats, he added.

Moreover, the admiral continued, "'Baltic Sentry' has been a platform upon which we have been able to train and execute comprehensive presence in the region, not only for our navies but the maritime patrol aircraft and [other] assets." Such training and operating includes encompassing key maritime areas, surveilling contacts of interests, building awareness to ensure no surprises occur, and enhancing attribution capacity. "So, in that sense, coordination, situational awareness, and C2 have been tested during 'Baltic Sentry', and to me it's been a success story," Rear Adm Tiilikainen said.

One development the Finnish and Swedish navies recognise when it comes to supporting NATO operations – particularly during times of tension, and potentially during times of crisis and conflict – is the requirement for sustained operational capability including for the CUI task. This has already been evident in their support of NATO's Baltic EVA requirements, especially 'Baltic Sentry', and in their capacity to provide MSA.

When non-aligned, Sweden would have used its navy in conflict for high-end warfighting over a short, intense period to allow full, joint force mobilisation. As illustrated by 'Baltic Sentry' – now underway for a year – NATO operations are usually more sustained. 'Baltic Sentry' has been led by the MARCOM SNF Standing NATO Maritime Group 1 (SNMG1). The Royal Swedish Navy (RSwN) was one of the first navies to add a ship to SNMG1 during the operation: HSwMS Visby joined briefly in January 2025, also becoming the first RSwN ship to operate under NATO command.

"'Baltic Sentry' is not a two-week job .... It's still ongoing," Rear Admiral Johan Norlén, Sweden's Chief of Navy, told *ESD* in October. "If that is some sort of description of the peacetime we have right now – peace, or slight crisis – then you need persistent ISR [intelligence, surveillance, and reconnaissance] operations." Here, the high-end technology the RSwN has been developing brings impact, the Chief explained. "We have, for instance, autonomous vehicles in every aspect – underneath the surface, on the surface, and in the air – that will enable us to complement crewed ships during that time so we can maintain operations for a much longer period than we used to."

Generating sustained operations – something central to the CUI task – is a daily focus for the navy, Rear Adm Norlén said. The RSwN's MSA capability – again, crucial to CUI security – brings wider operational benefit for NATO, he added. "The baseline for every operation in this area and one of the major things we bring to the NATO table is that we have really good surveillance operations, '24/7, 365', and consequently MSA that is really good – especially together with Finland." Reflecting the requirement for integrating information, Rear Adm Norlén said a key RSwN aim is enhancing its connectivity so such information can be shared wider-still with allies.

Characterising the Baltic Sea as a confined, congested, and (now) contested space, Rear Adm Norlén highlighted the challenge posed by asymmetric activities. These threats can include accidental or intentional CUI damage, GPS jamming, or ship automated identification system (AIS) spoofing. "There are a lot of hybrid operations ongoing. Hybrid operations are no less dangerous than conventional operations," the admiral said. "The only problem with hybrid operations is that attribution is the main issue."

The Baltic is a 'strategic sea' for NATO and Russia. NATO's increased presence there is due not just to deteriorating regional security, but because eight of the nine Baltic states are NATO members. Russia may see such presence as challenging its access opportunities into the North Sea for ships and trade flowing from St Petersburg and Kaliningrad.

For an issue like CUI security, any tension – like that existing around the Ukraine war – can create escalation risk. Here, the potential involvement in the Baltic CUI incidents of rogue ships linked to Russia, and the consequent need for NATO and its navies to shadow such ships, is part of that risk. "We are there. We exercise our rights to have these sea lanes open – but at the same time, we are not too provocative because we don't want to escalate anything," said Rear Adm Norlén.

Nonetheless, NATO recognises the need to maintain deterrence presence. That just one further CUI incident has occurred since the establishment of 'Baltic Sentry' points to that deterrent effect.

Lead corvette HSwMS *Visby* was the first Royal Swedish Navy vessel to deploy under NATO command, when it joined 'Baltic Sentry' in January 2025. [NATO Maritime Command]

Breaching defensive lines

Tim Guest

Planned and well-constructed defensive fortifications and lines can hold back an enemy for days, weeks, even months, or more, stalling their advance and forcing them to commit assets and men, with potential huge losses, into the fray. Breaching such defences is no easy task and tactics for doing so have evolved over a century of World Wars, and continue to evolve to this day.

Defensive fortifications outside Odesa have been heavily reinforced since the spring of 2024, overseen by Odesa's Regional Military Administration, following the injection of new funds from central government in Kyiv. The non-explosive, (i.e., not mines), defences include dragon's teeth, anti-tank ditches, concrete barriers and pillboxes. [Odesa RMA]

This article looks back briefly to WWI and WWII to understand how tactics for breaching major defensive fortifications have evolved. It then examines lessons currently being learned in Ukraine, as that nation continues to defend itself against Russian forces. In doing so, it highlights how Ukrainian forces are adapting their approach and tactics to breaching defensive lines, largely taken from NATO's playbook, in order to succeed in the face of new and latest battlefield threats.

Historical lessons

Two World Wars saw the trial-and-error emergence of new doctrine on defences and fortifications, which gave rise to some of the most elaborate defensive lines and fortifications ever constructed in wartime. In turn, defeating and overcoming them also drove new doctrine on the breaching of such defences. Built in depth, they often comprised layers of trench lines, dotted along their length with concrete pillboxes whose machine guns had interlocking arcs of fire covering every possible piece of open ground approaching such defences. Barbed wire in dense, overlapping belts, was designed to entangle, slow, and halt any attempt to penetrate the defensive line. Behind it, artillery was pre-registered on the foreground, middle ground, and rear approaches, with coordinates prepared for final protective fire (FPF) missions: a last-resort mission called only when an attacker was on the verge of breaching the final defences, and close-quarters combat loomed as the last remaining barrier to defeat. One example from history of such fortifications and scenarios was the infamous Hindenburg Line, (known as 'Siegfriedstellung' (ENG: Siegfried Position) to the Germans), in the face of which massive casualties mounted up among Allied Forces, through their repeated attempts to overwhelm the defences with massed infantry assaults, which failed at huge cost. Such futile attempts at breaching defences had repeatedly been the order of the day, in terms of doctrine, in the early stages of the war, when attempting to overcome trench fortifications and less fortified defensive lines than the Hindenburg using massed troop formations, regularly resulted in abject failure and huge losses.

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The Siegfried Line, also known as the 'Westwall' to the Germans during WWII, was their last line of defence stopping the Allies from reaching the German frontier. Pictured: In October 1944, following the dreadful Battle of Hürtgen Forest, the US Army's XIX Corps finally broke through the Siegfried Line's defences north of Aachen. [US National Archives]

It was the Hindenburg Line, however, which spurred the Allies on to develop new tactics, which they honed and employed against the defences from August to November 1918, in what became known as the Hundred Days Offensive. Rather than simply using massed infantry, Allied artillery was brought to bear along the whole line in massive bombardments. This destroyed fortifications, prevented the enemy from effective return fires, and also enabled their own infantry to advance under the protective umbrella of creeping barrages. Speed and surprise were also integrated into these new breaching tactics, as well as coordinating attacks at many different points along the defensive lines, so enemy reserves and reinforcements were spread too thinly to be able to effectively defend each locus of breaching attack. However, it was an overall emerging new approach of 'combined arms operations' together with these other changes, that enabled attacks to be driven forward, using artillery, engineers, infantry, the first tanks, as well as early aircraft and other units. These all worked in a coordinated fashion and in support of one another for the first time, helping to breach and overcome the Hindenburg Line during the war's final months.

In WWII, the Siegfried Line, as the Allies then referred to it, again came into play as a major defensive fortification, though called the 'Westwall' by the Germans. Until late 1944, the line held, before the US XIX Corps broke through its defences north of Aachen in the Battle of Hürtgen Forest with superior and concentrated forces and manpower, though not without facing intense and bloody resistance from the Germans.

Another major WWII defensive fortification was the French Maginot Line, which the defenders believed would halt the German advance to invade France. However, German forces highlighted a major method of breaching, or overcoming, such a defensive obstacle when they chose to bypass and outflank the main Maginot Line defences altogether, something the French had considered impossible. Instead, the Germans pushed their way through the almost impenetrable forests of the Ardennes in Belgium and Luxembourg, which the French had assumed would stop heavy armour in its tracks.

Another WWII example of overcoming a major defensive fortification was played out through the famous Battle of Monte Cassino in central-southern Italy. In short, the hilltop monastery above the town of Monte Cassino, was the most formidable point on the German's Gustav Line, and a crucial defensive part of their larger Winter Line, which ran from one coast of Italy to the other. Capture of the monastery was therefore deemed essential if the Allies were to advance on Rome successfully. However, some analysts look back and consider that the monastery was, perhaps, afforded more importance than Allied forces should have and, indeed, hindsight suggests the option of bypassing it altogether on the way to Rome, might well have turned out less costly. As it is, massive Allied artillery bombardments were brought to bear on the hilltop objective, along with intense tactical air support, in order suppress enemy positions before mounting infantry assaults. In the end, the monastery was totally destroyed and it took repeated efforts and four infantry assaults up the hillside before Allied success; the cost, however, was some 55,000 Allied troops either killed, wounded, or missing in comparison to 20,000 killed on the German side. As this highlights, breaching defensive fortifications and lines, unless absolutely necessary, with no alternatives, can be unacceptably costly.

Fast forward to today

Yet, despite such historical lessons, the formation of the UN and NATO soon after WWII, and a lengthy period of peace in Europe since, it seems we're almost back to square one in a wartime European scenario. NATO Allies are gearing up for a wartime footing of sorts, some building defences and fortifica-

Russian MoD footage showing M2 Bradleys and a Leopard 2A6 tank damaged or destroyed around the start of Ukraine's summer 2023 counteroffensive. Even well-equipped modern armoured formations can shatter against well-prepared defences. [Russian MoD]

tions along their borders with Russia, though others waking up at a relative snail's pace to what's needed. Meanwhile, as an ally of NATO, Ukraine is fighting the bloodiest existential war seen in Europe since 1945. Its armed forces know defensive lines and fortifications like no other European nation, how to build and what's required to breach them, including how breaching tactics have evolved.

While Russia has conducted its own breaching missions against Ukraine's extensive defences, in some cases in repeated WWI-esque, meat-grinder operations, the Ukrainians themselves have learned that to breach Russia's formidable defences, traditional combined arms operations are no longer sufficient and tactics have had to change.

Engineer assets, essential in combined arms efforts to breach defensive lines, are crucial in new tactical approaches to breaching operations. The latest solutions include such platforms as the unmanned RCV-Pioneer mine-breaching vehicle from Milrem Robotics, seen here at DSEI 2025. [Tim Guest]

The Ukrainians have understood the need for very precise reconnaissance of enemy lines and fortifications, including the use of drones and satellite imagery, to provide detailed views of Russia's complex, integrated defences and such threats as dense and often multi-layered minefields. They have also modified a combined arms approach, integrating electronic warfare (EW), intel-gathering, and agility. Evolved tactics now place an emphasis on improved application of engineer assets and skills, alongside precise synchronisation of fires of all relevant calibres – including the exploitation of any discernible enemy weaknesses using deep strike weapons – to create a breach. This is followed up rapidly by boots on the ground to exploit a breach fully, though being cognisant of continual defensive adaptations and changes to fortifications likely being made by the enemy.

Many of the tactical changes Ukraine has made to its breaching approach/doctrine were learned the hard way during their September 2023 counteroffensive in the Donetsk and Zaporizhzhia Oblasts, when application of breaching fundamentals, known as SOSRA (suppress, obscure, secure, reduce, assault) failed to achieve the desired results. Russian fortifications were so dense and extensive, with layered and interlocking minefields, trenches and other fortifications, that it made conventional attack ineffective and costly, not to mention Russian use of huge numbers of reconnaissance and strike drones to detect and target formations of troops attempting to breach their lines. In addition, Ukrainian command and control was continually disrupted by Russia's application of EW making communications with, and coordination of, its forces nigh on impossible.

Faced with a new battlefield of modern threats, Ukraine's new breaching tactics now rely on real-time recon and targeting to provide as much information as possible and help in countering any enemy drone use. A new emphasis on precision, long-range strike using drones and missiles, targeting Russian logistics hubs, resupply, and command centres, are intended to degrade their ability to sustain the forward defences the Ukrainians are trying to breach. Systems such as Ukraine's own Neptune or Flamingo FP-5 cruise missiles are key in this long-range-strike role; a new 'Long-Neptune' version of the cruise missile – introduced in August 2025 – is reported to be capable of hitting targets out to 1,000 km with a 150 kg warhead, improving on the 300 km range of its original version. Meanwhile, mass production has begun of the long-range Flamingo, which can reach targets out to 3,000 km with a 1,150 kg warhead; both are now formidable assets in Ukraine's arsenal.

While traditional combined arms alone is no longer sufficient for such a task, the Ukrainians see an 'improved' version, synchronising combined arms assets more acutely with much improved artillery, engineer, and infantry integration, as being part of the answer. During the 2023 counteroffensive, coordination and momentum of these forces was degraded and their efforts became ineffectual. In addition, of paramount importance against extensive fortifications, the Ukrainians have worked develop and field new and more rapid ways to destroy and clear paths through minefields and obstacles, for instance, by making use of unmanned systems.

Having said that, Ukraine has learned that breaching well-prepared defensive lines is not a simple task, and massing troops for assaults carries risks of detection and being targeted with strike assets. As such, over most of 2025 the Ukrainians largely fought defensive battles, with the most notable counteroffensive efforts being near Pokrovsk and Kupiansk.

Closing thoughts

The experience of Ukrainian forces during their challenging and mostly ineffective counteroffensive of 2023, opened their eyes – and the watching world and Allied militaries, who must also learn from these events – that for a breach to be successful during large-scale combat operations, forces must have the capability to conduct extensive and detailed reconnaissance of the entire expanse of the area chosen for a breach. They must also employ sufficient assault forces backed up with support and logistics to prosecute the operation to fruition, and also apply fundamental SOSRA principles bolstered by today's understanding of an evolved battlespace. Of crucial importance, engineering assets must be bolstered in number and employed in tandem, for any attempt to breach defensive lines to succeed. Attempting the breach of a major defensive line and fortifications will never be an easy task.

The challenges of last-mile logistics

Alexey Tarasov

The methods and means of conducting combat operations have changed significantly over the past decade, prompting militaries worldwide to react and adapt. Logistics, as one of the most critical components of modern warfare, has likewise undergone substantial transformation, with many changes already implemented and others still in the trial phase. Against this backdrop, so-called last-mile logistics has emerged at the forefront of both innovation and adaptation.

An unmanned ground vehicle (UGV), part of the Autonomous Last Mile suite of ground vehicles, undergoing testing at Camp Grayling, Michigan, on 28 August 2019. [US Army]

Modern military thought emphasises that last-mile logistics–the final delivery of supplies, equipment, or support to front-line or operational units–remains one of the most vulnerable and complex aspects of military sustainment.

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Defining the last mile

Official doctrines define "last mile resupply" or "last tactical mile" logistics as a part of the logistics chain physically closest to enemy forces and therefore most exposed to direct action. According to the United Kingdom's 'Autonomous Last Mile Resupply System' competition document, "*The 'last mile resupply' involves the delivery of combat supplies from the forward-most location (such as a physical base or a logistics/infantry vehicle) to personnel engaged in combat operations. Although relatively small in distance, these resupply activities are challenging as they are in an environment that is typically hostile, complex and contested. These activities need to quickly and efficiently deliver vital supplies in order to maintain operational tempo and enable successful mission outcomes.*" At the same time, the document specifies that 'last mile' is a concept rather than a fixed distance and, in some scenarios, may extend up to 30 km.

Enemy force characteristics, theatre conditions, geographical features, and socio-political factors may further add complexity to the environment in which logistics operates. Some adversaries possess a full spectrum of conventional and preci-

A convoy of optionally-manned trucks in Autonomous Leader-Follower mode navigate a roadway on Camp Grayling, Michigan, on 28 August 2019. [US Army]

sion weapon systems, while others – such as various non-state armed groups (NSAGs) – benefit from extensive local support, a network of dispersed strike nodes, and concealed communications.

The environment

While the experience of the Russo-Ukrainian conflict should not be considered universally applicable, it remains the largest, most protracted, and technologically sophisticated ground conflict of recent decades. Due to its scale and nature, it provides a vast amount of data for analysis and lessons learned.

Based on this experience, logistics in the modern combat environment are shaped by several key factors:

- The battlefield has become increasingly transparent as a result of the high density of reconnaissance and surveillance assets. Observation density increases progressively toward the line of contact;
- The combat zone and the close rear area have expanded, as have the widths of defensive sectors assigned to formations, and the defensive areas of individual units. Depending on the tactical situation, the depth of the combat zone and close rear areas may vary from a few hundred metres to several tens of kilometres;
- Ground forces operating near the combat zone function in a contested electronic warfare (EW) environment. Communications may be disrupted, intercepted, and exploited by the enemy. The density of EW assets has also increased at the tactical level;
- The density and diversity of precision-guided fires available at the tactical level have increased. Precision munitions and associated delivery systems have become increasingly affordable and, in many cases, expendable;
- The speed of reaction in 'detect-decide-engage' cycle has decreased several times, up to 4–6 minutes. According to an interview with Colonel General Andrey Mordvichev, Russian ground forces have begun employing 'micro-nodes' within their reconnaissance-fire system, enabling a streamlined decision-making process and providing tactical commanders with the capability to rapidly observe and engage identified targets. Essentially, a micro-node may consist of a single system – a mortar, artillery piece, tank, MLRS, or other fire asset – coupled with a reconnaissance unmanned aerial vehicle (UAV).

Considering the factors outlined above, armed forces now conduct operations in a highly contested, geographically extended battlespace, characterised by constrained mobility and elevated threat levels. The logical response to these challenges has been the dispersion of both combat and logistics elements. However, this dispersion has also placed additional strain on the sustainment system.

The challenges

In the modern operational environment, logistics operations–including last-mile resupply–are shaped by several key challenges.

First, the dispersion of combat elements has significantly increased the complexity of the logistics system, making it more resource- and labour-intensive. For example, whereas company-sized infantry units were previously supplied with ammunition, food, and water at a single point, logisticians are now required to divide cargo into smaller loads and deliver them across, at times, considerable distances to dispersed elements, sometimes to groups of only two or three soldiers.

Another example can be drawn from the combat experience of Ukrainian self-propelled howitzers (SPHs). To enhance survivability and avoid detection, SPHs often move without ammunition across large areas between pre-positioned firing positions where ammunition stocks are stored. From a logistical perspective, this approach differs significantly from the techniques and procedures employed during the Cold War, when an entire artillery battery or battalion could be resupplied at a single location. In the case of Ukrainian SPHs, the logistics system must now support multiple dispersed firing

MTP-A2.1 technical support vehicle based on the Ural-4320 truck with an armoured cab. This configuration has been employed in Ukraine. [Alexey Tarasov]

positions, as well as secure hide sites located beyond the reach of enemy fire assets. At the same time, movement alone cannot be regarded as a panacea. Personnel, equipment, and materials required to construct, maintain, and conceal multiple firing positions must also be delivered.

All of this requires a greater number of vehicles, more drivers or operators–where conditions permit the use of UAVs or UGVs in a logistics role–and increased effort in construction, loading, unloading, and cargo sorting.

Second, sustaining multiple dispersed positions and pre-positioned supply stocks requires increasingly complex planning and scheduling. This task becomes even more demanding when supporting a diverse mix of capabilities–for example, artillery, infantry, strike UAVs, and armour. From an administrative and data-management perspective alone, ensuring that the right supplies reach the right recipient at the right time has become a major challenge. Enemy activity further compounds this complexity.

Third, increasingly complex logistics networks generate higher requirements for protection and connectivity. Establishing and maintaining secure and resilient links between combat and sustainment elements dispersed across a wide area poses a further significant challenge.

Fourth, the character of future combat is likely to vary depending on theatre and conditions; however, a high density of reconnaissance and surveillance assets, coupled with the rapid responsiveness of enemy fire systems, is likely to become a persistent feature.

As a result, logisticians will have to adapt to multiple, and at times fundamentally different, operational scenarios – from static or semi-static attritional combat, characteristic of some sectors of the Russo-Ukrainian front, to highly fluid, fast-paced operations in the Pacific theatre, as envisioned by the US Marine Corps (USMC).

Finally, large-scale conflict with a peer or near-peer adversary remains a realistic possibility. Logisticians must account for threats and capabilities that were often overlooked during the Global War on Terrorism (GWOT) era. For example, in addition to the 'last mile', which may extend up to 30 km, modern precision weapons (such as guided rocket artillery and loitering munitions) can engage targets at ranges of 80–120 km. For this reason, some analysts argue that areas once considered safe rear echelons during the Cold War have effectively been 'functionally erased'.

Protected fuel tanker ATZ-8-4320, fitted with an armoured cab. To conceal its role and resemble a standard cargo truck, it is equipped with a canvas-covered frame. [Alexey Tarasov]

Taken together, these challenges make last-mile logistics an increasingly difficult undertaking in an unpredictable and dangerous battlespace. The increased density of intelligence, surveillance and reconnaissance (ISR) assets, combined with the expanded range and precision of enemy fires, has substantially elevated the risk to personnel, platforms, and materiel compared to conflicts of the late 20th and 21st centuries. Consequently, the 'cost of transaction' has increased significantly for 'last mile logistics'.

The responses

While many of the challenges discussed above were identified in the late 2010s, widespread changes to established logistics systems have largely been implemented only in recent years, driven primarily by the operational lessons of the conflicts in Ukraine and the Middle East.

This delay can be attributed in part to the limited experience of most armed forces with protracted, large-scale warfare, as well as the significant investments required to modernise military logistics. The emerging operational environment has imposed new requirements on combat sustainment that, in many cases, necessitate a near-complete restructuring of legacy logistics systems.

In this regard, the Russian Ground Forces – one of the few large land armies currently engaged in a protracted high-intensity conflict – provide a useful case study of institutional priorities, implemented measures, and near-term plans.

In December 2024, Russian Minister of Defence Andrey Belousov, speaking at an extended session of the Ministry of Defence Collegium, outlined several priority areas for the development of the materiel and technical support system (MTO). These included enhancing the protection of arsenals and fuel and lubricants depots located within the reach of enemy strike systems, as well as eliminating open storage sites. Additional measures included enhanced concealment, the formation of mobile air-defence groups, and the establishment of coordinated command-and-control (C2) links with air defence units.

Belousov also emphasised the need to revise existing approaches to storage and logistics organisation. Large, centralised, multi-purpose storage facilities, he argued, should be replaced by a distributed, layered network of depots, with corresponding adjustments to logistics systems and methods of cargo delivery.

According to Belousov, these tasks were largely completed during 2025. In December 2025, he announced new objectives for 2026, including the completion of a multi-layered storage system and the initiation of the first phase of digitalising inventory management processes. He also reported the widespread deployment of all-terrain vehicles and the expanded use of UAVs and UGVs in last-mile logistics operations. An analysis of these priorities highlights both concrete responses to major operational challenges and several emerging trends.

First, logistics organisation has shifted away from Cold War-era practices toward decentralisation across all levels of the sustainment system, with a transition from large, centralised storage facilities to smaller, distributed resupply nodes.

Second, force-protection measures for logistics infrastructure have expanded significantly, encompassing enhanced concealment and deception, EW measures, and the deployment of air defence systems to protect depots, routes, and critical infrastructure.

An Ulan multipurpose all-terrain vehicle, used by Russian armed forces as a frontline transport platform and for last-mile logistics. [Alexey Tarasov]

Third, new transportation solutions have been introduced at the tactical level, both manned and unmanned. Manned platforms include a wide range of all-terrain vehicles and motorcycles, while experimentation with unmanned logistics systems continues. According to Belousov, more than 12,000 tonnes of cargo were delivered by unmanned systems during 2025; however, this accounted for less than 0.2% of the approximately 8 million tonnes of materiel transported in 2024 by the Russian Material and Technical Support forces. In parallel, additional protection kits and protected logistics vehicles have entered service in the heavier platform segment.

Finally, announced efforts to digitalise logistics processes represent a critical enabling development, given the growing complexity of modern sustainment systems and the increasing requirement for accurate, timely data to support planning, coordination, and execution.

Closing thoughts

Looking ahead, last-mile logistics will increasingly be conducted in a persistently contested, transparent, and lethal battlespace. Logistics disaggregation – the dispersion of sustainment nodes, transport assets, and delivery routes – will become a defining characteristic of future combat logistics, reflecting the broader dispersion of manoeuvre forces and the transformation of the traditional views on sustainment.

In this environment, a 'protected-everything' approach is likely to shape last-mile sustainment. Protection will increasingly take precedence over speed, driving the design of logistics platforms and procedures toward integrated force-protection measures, including EW, short-range air defence, signature management, and layered passive and active protection systems.

Unmanned systems will assume a growing role in last-mile resupply, but their employment is likely to complement rather than replace manned logistics. To sustain dispersed yet operationally significant formations, heavily protected logistic UGVs may emerge alongside UAVs evolving toward greater payload capacity and endurance.

Finally, as logistics networks increase in scale and complexity, the integration of artificial intelligence (AI) and machine learning (ML)-enabled tools for predictive planning, routing, and inventory management will become essential to reduce the burden on personnel and to enable resilient sustainment operations under continuous threat.

MRTO-ATB mobile repair and maintenance workshop, based on the KamAZ-6350 chassis and featuring an armoured cab. Earlier versions of this type of support vehicle were unprotected. [Alexey Tarasov]

Ukraine's industry after four years of full-scale war

Alex Horobets

Despite relentless Russian strikes on its facilities and energy infrastructure, Ukraine has nonetheless managed to massively scale up its domestic defence production over four years of war, emerging as both a technological innovator and strategic partner for European nations seeking greater military self-sufficiency.

The full-scale Russian invasion of Ukraine, launched on 24 February 2022, has exposed critical challenges across the nation's defence forces and defence industry. Both have been forced to swiftly adapt to wartime conditions by ramping up weapons production, repair, and modernisation amid sustained attacks from one-way attack (OWA) unmanned aerial vehicles (UAVs) and missiles. In the initial weeks following the Russian invasion, Ukrainian defence industry faced an existential threat, with Russian strikes focusing on core production facilities and storage sites for components and finished products. As a result, various experts at that time forecast a near-term collapse of the industry. However, after four years of military action, Ukraine not only managed to avoid this but even significantly increased production. According to Ukrainian officials, annual defence output was projected to reach USD 35 billion by the end of 2025, compared to just USD 1 billion annually before the war. At the same time, the defence sector has expanded to nearly 1,000 enterprises, roughly 80% of which are private companies, many founded since the start of the full-scale war.

A Ukrainian T-84 Oplot participating in the Strong Europe Tank Challenge on 6 June 2018. Since the outbreak of full-scale war in 2022, Ukraine's industry has become better known for producing impressive volumes of unmanned platforms than heavy armour. [US Army/Markus Rauchenberger]

AUTHOR

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Status of Ukraine's defence industry: February 2022

On the eve of Russia's invasion, Ukraine's defence industry remained a largely archaic system shaped by its Soviet past. Most production capacity depended on outdated equipment, yet this did not prevent Ukraine from maintaining a notable position in global arms markets for years. The industry was traditionally export-oriented. Although the war that began in 2014 sharply reduced export volumes, Ukraine remained among the world's nine largest arms exporters until 2016 and later consistently ranked within the top 15. Its key exports included modernised Soviet-era tanks such as the T-64BV, T-72, and T-84 Oplot; BTR-3, BTR-4, and Dozor-B armoured vehicles; aircraft engines and components; air defence systems; and marine gas turbines. At the same time, a substantial share of production capacity remained idle due to a lack of domestic orders.

State defence procurement was insufficient to sustain profitability across the sector. With most defence enterprises under state control, the industry remained heavily dependent on budget funding and lacked the flexibility needed to respond quickly to market demands. It was increasingly clear that, sooner or later, Ukraine's defence industry would need to overhaul its approach to remain competitive on global markets.

At the same time, between 2014 and 2019, Ukraine succeeded in developing a range of new weapons, including various missiles, anti-tank weapons, self-propelled howitzers, UAVs, and light armoured vehicles. In practice however, most of these projects never moved beyond the pre-serial production stage. Under these circumstances, Russia's full-scale invasion triggered a rapid and far-reaching transformation of Ukraine's defence industry.

A critical period for industry: 2022-2023

In 2022, Ukraine's defence industry shifted into emergency mobilisation mode, rapidly adapting its operations to meet the most urgent battlefield needs. Production priorities centred on critically needed weapons for the front, including drones and ammunition, alongside the repair of armoured vehicles and the accelerated introduction of new systems. These efforts were carried out in close coordination with international partners to respond to the urgent needs of the Ukrainian Armed Forces.

After February 2022, Ukraine lost a portion of its military production capacity as facilities were damaged, destroyed, or fell within Russian-occupied territory. At the same time, surviving enterprises began relocating to safer regions, a process aimed at preserving industrial continuity and sustaining output under wartime conditions.

An urgent effort to restore production facilities critical to the basic needs of the Ukrainian Armed Forces began almost immediately. In the first months of the war, the primary objective was to supply the army with at least minimal quantities of standard ammunition. In 2022, Ukraine established production of 152 mm and 122 mm artillery shells – essential for Soviet-era systems and largely unavailable from NATO stockpiles. To reduce vulnerability to missile strikes, production was dispersed across multiple locations. Ukrainian officials say industrial-scale output of these munitions was achieved by the end of 2022. In parallel, several types of ammunition, including 82 mm and 120 mm mortar rounds as well as tank shells, were produced for Ukraine at NATO-based facilities. Ukrainian enterprises also began repairing captured Russian equipment, most notably T-72 and T-80 tanks, armoured vehicles, along with BM-27 Uragan and BM-30 Smerch multiple rocket launchers (MRLs).

A pivotal moment in 2022, which shaped the character of current military operations, was the emergence of mass production of UAVs. Between 2022 and 2025, Ukrainian UAVs evolved from limited, experimental solutions into a systemic battlefield tool employed at multiple levels of military command. At the start of 2022, their use was fragmented and often depended on civilian drones adapted for military purposes.

This progress was largely driven by volunteers and small private teams. The trend gained official support in July 2022, when Ukrainian authorities launched the 'Army of Drones' programme, aimed at systematically developing the military UAV industry and supplying drones to the Armed Forces. Under the programme, Ukrainian UAV manufacturers were contracted to deliver various types of drones, provide maintenance and repairs, and train pilots. New units – companies of attack drones – were also established within the Armed Forces. These combined private and public efforts enabled a significant expansion of first-person view (FPV) drone and attack UAV capabilities in the years that followed.

Ukraine's Frontline Robotics and Germany's Quantum Systems are expanding production of the Linza bomber UAV. [Ministry of Defence of Ukraine]

Despite the organisational chaos of the war's early months, the Ukrainian defence industry succeeded in producing essential equipment for the front lines and adapting to the Armed Forces' evolving needs for new weapon systems. The period can be seen as a 'reset' for their industry: the conflict shattered old institutional patterns, allowing the most progressive sectors to thrive through a network of small and medium-sized private enterprises capable of operating even under regular missile and drone strikes.

Transformation

Between 2023 and 2025, the Ukrainian defence industry underwent a fundamental institutional and structural transformation, shifting toward a more flexible, innovation-driven model. In the summer of 2023, reforms began at Ukroboronprom, which was restructured into the JSC 'Ukrainian Defence Industry'. The reform aimed to reduce the dominance of large state-owned enterprises, transferring a substantial share of production to the private sector. It also sought to simplify investment opportunities and enable the creation of joint ventures with private and international partners.

By 2025, private companies accounted for the lion's share of Ukraine's defence production, reaching as much as 90% in certain sectors, such as FPV drone manufacturing – a dramatic shift from the pre-war period. Several institutional innovations were pivotal in this transformation. One of the most notable is Brave1, a defence technology cluster launched in April 2023 that fosters collaboration among start-ups, investors, the military, and government agencies. Since its inception, Brave1 has attracted over USD 100 million in private investment, awarded

700 grants totalling UAH 2.6 billion, and registered more than 4,800 developments from 2,300 teams.

The platform has become a central driver in moving Ukraine's defence industry from a traditional government procurement model to an 'innovation–rapid verification–contract' model, allowing military developments to be quickly tested and brought into production. Brave1 also introduced the so-called 'Amazon for War', a marketplace where the military can rapidly find and purchase equipment for the front, including drones, electronic warfare systems, ground robotics, and components. At launch, the platform featured over 1,000 solutions, with the number continuing to grow.

Various UGVs in use with the armed forces of Ukraine. [General Staff of the Armed Forces of Ukraine]

Since 2024, the Ukrainian Ministry of Defence has been implementing the 'Danish model' of financing, which allows foreign governments to provide direct funding to Ukrainian defence enterprises. Under this framework, the Ukrainian Armed Forces received approximately EUR 538 million worth of weapons in 2024. A notable example of this approach is Bohdana self-propelled artillery systems, whose production is financed under this model. The EU and nine countries have joined the initiative – Denmark, Canada, Lithuania, The Netherlands, Norway, Sweden, the United Kingdom, and the United States – funded through both domestic budgets and frozen Russian assets. The model's key advantage lies in bypassing bureaucratic hurdles, thereby accelerating the delivery of weapons to the front lines.

By 2025, another important trend had emerged: Ukraine's defence ecosystem now includes roughly 900 enterprises, of which around 100 are state-owned and 800 are private. The majority of new players are small private companies, often founded after 2022. Many began as volunteer teams or IT start-ups and, by 2025, had evolved into serial manufacturers with contracts worth hundreds of millions of dollars. This decentralisation has created fertile ground for innovation and new military developments. As Defence Minister Shmyhal noted, Ukraine is becoming a global hub for modern defence technologies and one of the most promising markets for defence investment, with the country's production capacity increasing 35-fold in three years, despite the ongoing war.

Joint production with Ukrainian partners is also underway, with investments supporting the systematic scaling of industrial capacity. Currently, 25 foreign companies – including global defence giants – are at various stages of localising production in Ukraine. For example, Rheinmetall plans to build three military plants in the country to repair equipment, manufacture ammunition, and produce anti-aircraft systems. KNDS Deutschland has officially opened a joint venture with a Ukrainian defence firm to produce and repair equipment supplied by Germany. BAE Systems also has plans to manufacture and repair military equipment in Ukraine.

Key achievements of Ukraine's defence industry

To date, enterprises within Ukraine's defence-industrial complex are producing weapons that even some of the world's largest economies do not manufacture. The industry's current focus – experiencing rapid growth and scaling – is the production of various types unmanned systems, including aerial, ground-based, and maritime. Development and improvement cycles have been significantly shortened thanks to the ability to test these systems directly in combat. UAV production now accounts for roughly one third of Ukraine's defence market, with an estimated 96% of drones used on the front lines are manufactured domestically.

According to Bloomberg, Ukraine produces approximately 4 million UAVs of various types annually, compared with roughly 100,000 in the United States. Their battlefield effectiveness has been repeatedly demonstrated: naval drones have reportedly reduced the potential of the Russian Black Sea Fleet by over 30%, and in 2025, around 4,000 drone attacks were recorded in Russia and occupied Crimea.

Mass production of drones, simplified government procedures, and the establishment of the Unmanned Systems Force are expected to drive further scaling in this sector, enhancing UAV range, payload capacity, and performance in both maritime and ground applications. A new trend has also emerged: Ukrainian unmanned technology companies are actively expanding their presence in Europe, creating joint ventures and attracting investment. Relocating some production abroad benefits both Ukrainian manufacturers and European partners. Following a series of airspace violations in Europe, NATO countries have increasingly invested in defence technologies, with Ukrainian drones becoming a benchmark for such programmes. To promote export potential, Ukrainian authorities have announced the creation of representative offices in Berlin and Copenhagen.

In 2025, alongside the rapid scaling of UAV production, Ukraine advanced the development of new long-range missiles. The Ministry of Defence made the missile programme a top priority, announcing that serial production of R-360 Neptune missiles, modernised for long-range target engagement, was underway.

Demonstration of the new version of the Neptune cruise missile to representatives of NATO member states. [Denys Shmyhal X Account]

Production also began for the Palianytsia, Ruta, and Peklo drone missiles, which have already been used in combat. Plans called for the production of approximately 3,000 Ukrainian-made missiles over the course of the year.

The main sensation of 2025 was the presentation of the FP-5 Flamingo missile from the Ukrainian company Fire Point, with a claimed range of 3,000 km and a 1 tonne warhead. Although, according to the General Staff of the Armed Forces of Ukraine, these missiles were first used in the spring of 2025, work on their development and serial production is currently ongoing. Several more missiles were also unveiled in 2025, namely an improved version of the Neptune missile with a claimed range of 1,000 km, and the cheaper and simpler Trembita, which in different versions has a range of up to 200 and up to 1,000 km. The Trembita missile's unique feature is its simple technology, making it easy to launch into mass production. If all goes well, we will likely see an increase in serial production of long-range missiles.

Closing thoughts

Over four years of full-scale war with Russia, Ukraine's defence industry has not only withstood constant missile strikes on its production facilities but has also achieved an unprecedented transformation – rising from the brink of collapse in 2022 to become one of Europe's most dynamic and innovative defence technology clusters. Annual production now reaches approximately USD 35 billion, supported by a network of 1,000 enterprises, the majority of which are privately owned. Ukraine's experience offers a valuable benchmark for European countries, positioning Kyiv not merely as an aid recipient but as a full-fledged technological and manufacturing partner in strengthening their strategic autonomy amid the long-term confrontation with Russia.

Tracing the path of Middle Eastern efforts to develop indigenous defence industries

David Saw

Building indigenous defence industries is strategically attractive but can be challenging to execute. Earlier Arab efforts, particularly Egypt's post-1950s' programmes, were ambitious but enjoyed limited success. Today, Saudi Arabia and the UAE are pursuing defence industrialisation on a far larger, and better-resourced scale. This article examines traces the path from early ambitions to the capabilities in the present day.

An M1 Abrams of the Royal Saudi Land Forces, during Exercise Eager Lion in Jordan, on 11 September 2022. While many Middle Eastern states have and continue to be dependent on foreign suppliers for their defence equipment, over the past decade, efforts have been made to change this. [US Army/Sgt Nicolas Ramshaw]

While the logic of developing an indigenous defence production capability is inescapable, the difficulty comes in developing the ability to turn intention into action. For many of the Gulf states, the circumstances were just not conducive to investing in a domestic defence industry. They did not have the appropriate resources, nor did they possess a suitable labour force; and in many cases, there was just no real requirement to build a local defence industrial capability in support of the limited military capabilities that they were able to sustain at the time.

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That is not to say that defence industrial developments were not a part of the defence picture across the broader Arab World. Egypt is the most obvious example of the development of a defence industrial capability in the Arab World with the starting point being the possession of maintenance and repair facilities from the colonial era. Egypt also had ambitions to build a highly capable defence industry. One area that was primed for development was aircraft – initially trainer aircraft and then the development of an indigenous combat aircraft. The process started in the 1950s with the production of the Czech version of the German Bücker Bü 181, piston-engined trainer, under license as the Gomhouria. The programme was a success and the aircraft was built in substantial numbers.

The next phase of aircraft development was collaboration with Spain on the Hispano HA-200, designed by Willy Messerschmitt. The aircraft was built ay Helwan in Egypt during the 1960s, with some 90 aircraft built. The HA-200 provided the basis for a much more ambitious programme, another Messerschmitt design – the Helwan HA-300. Initially this was a Hispano project to develop a light supersonic combat aircraft for the Spanish Air Force, though they abandoned the project for technical and financial reasons. At the end of the 1950s, Egypt decided to take over the programme to develop a lightweight interceptor fighter to be built at Helwan.

The Egyptian HA-300 project would also see the development of an indigenous engine based on the Brandner E-300 design of Austrian origin, which would replace the British Orpheus engine used on the original Spanish design. Work in Egypt on the HA-300 began in the early 1960s, but by 1969 the project was cancelled due to over complexity and cost. Instead, Egypt turned to the Soviet Union to meet its combat aircraft needs.

In this era, the Nasser government also looked to develop an indigenous ballistic missile capability, another ambitious and costly project reliant on foreign technical know-how that would never be completed. In the 1970s and the 1980s, Egypt would again look to develop a ballistic missile capability, based on Soviet technology and, as before, the programme failed to deliver a result. In fact, the only indigenous programme from the 1960s that delivered was the Walid, a 4×4 wheeled armoured vehicle inspired by the Soviet BTR-40 design. Over 1,000 Walid vehicles were built between the 1960s and the 1980s.

Egyptian defence industrialisation would then fade into insignificance for a number of years, before returning in a less ambitious but more logical format. Although Egypt once harboured dreams of acting as the defence industrial centre for the whole Arab World, its defence industry activities are now directed towards meeting domestic Egyptian needs, through the manufacture of a complete range of small arms of both Soviet and Western origin, grenade launchers and RPGs. There is local production of anti-tank missiles of Soviet, Chinese and Korean origin, with local artillery consisting of multiple rocket launcher systems, and there will also be local production of the Hanwha K9 self-propelled howitzer (SPH). There is extensive local production of light armoured vehicles systems and Egypt also locally assembled M1A1 Abrams tanks in large numbers. The country has extensive maintenance, repair and overhaul capabilities, as well as significant system upgrade capabilities.

Mention should also be made of Egyptian naval shipbuilding capabilities, based at the Alexandria Shipyard, where, three Naval Group Gowind 2500 corvettes have been built for the Egyptian Navy. The Alexandria Shipyard has also built a TKMS MEKO A-200EN frigate for the Egyptian Navy, which is in the process of looking to acquire a new conventional attack submarine (SSK) to replace existing submarines that have reached end of life; it is thought likely that they would look for local production of at least some of these future submarines.

Development spectrum

Egypt is a large country with a population of more than 111 million. By contrast, Jordan, with a population of a little over 11 million, has far fewer resources to play with and yet it has established a local defence industry, though admittedly on a smaller scale compared to Egypt and other regional states. In 1999, the King Abdullah Design and Development Bureau (KADDB) was established to provide equipment and related services for the Jordanian Armed Forces. KADDB was subsequently rebranded as the Jordan Design and Development Bureau (JODDB) with its objective being to develop specific solutions to meet Jordanian needs; these can range from personal equipment, to sighting systems, a recently developed counter-unmanned aerial vehicle (C-UAV) system and protected mobility, amongst other programmes.

The Egyptian Gowind 2500 corvette ENS El Fateh (971) took part in a sailing exercise with members of Standing NATO Maritime Group Two (SNMG2), on 24 August 2022. [NATO MARCOM/PO3 Ezekiel Duran]

JODDB also looks to market its expertise and systems to friendly militaries and security forces.

Bearing in mind their strategic situation, it was a logical move for both Egypt and Jordan to develop indigenous defence industries, although the development of these industries was limited by resources in terms of personnel, materiel and the financial means that could be applied to industrial development.

Others were less constrained, which is particularly true of defence industrial development in the Gulf States, and our focus will be on defence industry developments in two particular Gulf states – Saudi Arabia and the United Arab Emirates (UAE). The financial resources that these two countries have at their disposal dwarfs anything that Egypt and Jordan have access to and this is reflected in their defence industry ambitions.

The main source of revenue for Saudi Arabia comes from crude oil, oil refining, liquified natural gas (LNG) and petrochemicals. With a population of 36.5 million, the Saudi government needs to create economic opportunities for its citizens, oil and related industries cannot provide employment for all, nor can government jobs cover employment demand. Another important consideration is that the price of oil and other energy products fluctuates, meaning that over-dependence leads to vulnerability and complicates economic planning.

Some years ago, it was recognised that it was sensible to diversify the economy. There was also a process known as 'Saudisation', which sought to replace foreign workers with native Saudis. Significant investment efforts were made in education to boost the capabilities of and the possibilities available to the local workforce. Saudi Arabia is changing and there is now a modernisation agenda that seeks to start a process of transformation in the country. Aspects of this include the decision to open up the country to foreign tourism, large-scale megaprojects and offering new opportunities to private sector businesses to diversify the economy.

In May 2017, Saudi Arabian Military Industries (SAMI) was established as an enterprise owned by the Public Investment Fund of Saudi Arabia (PIF); SAMI's objective is to meet the demand that 50% of national military expenditure is spent in Saudi Arabia by 2030. SAMI aims to be one of the Top 25 defence companies in the world by 2030, part of a policy known as 'Vision 2030'.

SAMI has signed a number of cooperation agreements with foreign companies to cover programmes in Saudi Arabia, with potential partners including major US contractors, European companies and even Rosoboronexport of Russia. Turkish industry in the shape of Aselsan and unmanned aerial vehicle (UAV) manufacturer Baykar have also signed a number of Memoranda of Understanding (MoU) with SAMI. Naval shipbuilding has proven to be an area of SAMI's interest with MoUs signed with Navantia of Spain and Naval Group of France.

A pre-existing defence enterprise, the Military Industries Corporation has been folded into SAMI. This company was established in the 1950s, initially to manufacture small arms and small arms ammunition. Weapons produced under license include types from Heckler & Koch (HK) and Russia's Kalashnikov Concern. Artillery ammunition is produced including 155 mm and 105 mm rounds. A number of light armoured vehicle designs have also been produced, some of which have been exported, and various Tatra truck models are produced locally.

In 1988, the Advanced Electronics Company (AEC) was established in Saudi Arabia – among the original shareholders was BAE Systems. The company was involved in defence electronics and aerospace, including for example, the maintenance of F-15 systems for the Royal Saudi Air Force (RSAF) and the manufacture of electronic systems for other US-origin combat aircraft. In December 2020, AEC was acquired by SAMI, marking a significant step in the development of a comprehensive Saudi defence industrial capability.

Under Vision 2030, Saudi Arabia is developing a national space strategy via the Saudi Space Agency (SSA). According to the CIA World Factbook, SSA's objective is to: *"use the space sector to accelerate economic diversification, enhance scientific research and development, and raise private-sector participation in the global space industry; manufacture and operate communications, remote sensing (RS), and scientific satellites; develop a range of satellite subsystems and payload technologies."* Saudi Arabia is also credited as the main founder (in 1976) and source of funding for the Arab Satellite Communications Organisation (Arabsat).

With PIF backing, SAMI has access to the financial support necessary to continuing developing and expanding its capabilities. SAMI is obviously a major asset for Saudi defence capabilities, but its goals are ambitious. It aims to bring advanced technology into the country and develop indigenous high technology solutions, all of which will eventually raise the technology base and capabilities of the economy as a whole. SAMI also aims to play a key role in training and developing the skilled workers that Saudi Arabia will need to further develop its national economy.

The UAE solution

While the UAE's population sits at a little over 10 million, the difficulty comes from the fact that only about 12% are Emirati citizens. Where Saudi Arabia has to create job opportunities for its population, the UAE finds itself in a situation where it does not really have enough Emirati citizens to meet its military and economic objectives. In economic terms, the UAE's main revenue source is oil and oil-related products such as petrochemicals. The UAE leadership recognised many years ago that they needed to diversify their economy and they have achieved significant success in this regard.

Earlier diversification efforts involved the creation of a facility to manufacture ceramic tiles. Today, tourism provides an important source of revenue to the UAE economy and it is a major financial centre, an attractive destination for Foreign Direct Investment (FDI) and a major global transport hub via its airports and ports. For the UAE, the possession of a defence industrial capability meets strategic needs, but the high technology implicit in advanced defence, aerospace and space systems also offers economic benefits. Fortunately, the UAE has the resources to invest in defence industrial developments, with the intention of creating and sustaining a world class defence industrial capability.

A number of defence industrial enterprises had previously been created in the UAE, for example in areas such as naval shipbuilding. However, the critical development was the creation of EDGE Group in November 2019. EDGE describes itself as consolidating more than 35 corporate entities into six core clusters: Platforms & Systems, Missiles & Weapons, Space & Cyber Technologies, EDGE Commercial, Technology & Innovation, and Homeland Security. Ships, armoured vehicles, small arms, artillery ammunition, missiles and satellites are all part of EDGE's capabilities. Extensive R&D investment is available to further develop its capabilities in critical areas. Significantly, EDGE is aggressively looking to attack export markets and are present in Brazil, India, Indonesia and Vietnam amongst others.

EDGE is also signing MoUs with foreign partners in key areas. In November 2025, they signed an MoU with Hanwha Aerospace "to explore strategic defence cooperation across advanced air and missile defence, long-range precision strike, unmanned systems, and defence AI" according to the official statement. They had previously signed an MoU with Korea Aerospace Industries (KAI) to cover possible collaborative efforts. There have also been MoUs signed with Western companies, for example L3Harris, and joint venture activities with major players such as Leonardo. Edge also acquired a majority stake in Estonian unmanned ground vehicle (UGV) manufacturer Milrem in February 2023.

EDGE cannot simply be viewed as a defence industrial operation limited to meeting the needs of the UAE, its home country, as the company has a multinational footprint gained through acquisitions and is looking to further expand its international business. What is noticeable is how quickly EDGE has moved to develop advanced capabilities in such areas as air defence systems and standoff weapons. They appear to develop sophisticated solutions extremely rapidly. It is also worth noting the effort that the UAE is putting into the space sector, since they do not have a satellite launch capability, instead using launch services provided by Russia, Japan and the US. They do however, have the capability to design and build their own satellites – in August 2024, a UAE-built remote sensing/earth imaging satellite was launched by the US.

SAMI in Saudi Arabia and EDGE in the UAE were only established in 2017 and 2019 respectively, and since then both organisations have gained significant momentum. They have redefined the indigenous defence industry in the Arab World and with the financial resources available to them, there is no reason why they should not continue on a growth trajectory.

An EDGE Group Rabdan Mk2 8×8 in the armoured recovery vehicle (ARV) configuration, on display at IDEX 2025. [EDGE]

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