# ESD

EUROPEAN SECURITY & DEFENCE



09 25

# Partner Belgrade Special Issue


4 191497 419904 09

19,90 €

D 14974 E

There's a new game-changing combination for air dominance:

# MQ-9B+AEW

Now available with MQ-9B, the world's most operationally ready and long-endurance UAS, is a whole new approach to airborne early warning (AEW) that's revolutionizing ISR. Spanning MQ-9B's acclaimed SkyGuardian®, SeaGuardian®, and Short Takeoff and Landing (STOL) configurations, our multi-role, multi-domain MQ-9B AEW solution significantly extends the range of existing AEW fleets to provide a powerful and persistent defense against evolving threats at a fraction of the cost of manned platforms while keeping human crews safe. Deployable anywhere from traditional airfields to naval carrier decks to shorter land-based runways, MQ-9B AEW is changing the game in air dominance, putting it within reach – at sea, over land, and everywhere in between.

GENERAL ATOMICS
AERONAUTICAL

# Russia-Ukraine: Is a diplomatic solution on the horizon?

Following the 15 August 2025 Alaska meeting between Presidents Vladimir Putin and Donald Trump, and the 18 August meeting in Washington between Presidents Trump and Zelenskyy, along with several European leaders, the prospect of a diplomatically negotiated end to the Russo-Ukrainian War is back on the agenda. Over the course of three and a half years of fighting, the two sides have been down this road several times before, and got nowhere. Is this time any different? Maybe.

While little of substantive detail was initially revealed during the Trump-Putin Alaska meeting, perhaps the most notable takeaway came a couple of days afterward, on 17 August, when US Envoy Steve Witkoff stated that Putin was prepared to concede on security guarantees for Ukraine. According to Witkoff, "We were able to win the following concession: That the United States could offer Article 5-like protection". Assuming Witkoff's understanding of the Russian position is accurate, this would indeed represent a major breakthrough. Yet there appear to be two key conditions associated with this, according to a Trump post on Truth Social.

The first is understood to be that Ukraine formally cede Crimea. While likely to prove a painful symbolic issue for Ukraine, the country was highly unlikely to regain the peninsula Russia annexed in 2014, and it is fair to say that this condition largely makes de jure a reality which already existed de facto. Consequently, this is unlikely to represent a hill to die on for Ukraine's negotiators.

The second condition is understood to be that Ukraine formally promise to give up its NATO accession aspirations. Based on Witkoff's comment, the thinking may be that in place of NATO membership, Ukraine instead agrees to an "Article 5-like" bilateral security arrangement with the US. This one may be quite difficult for Ukraine to accept, as it would effectively leave their security at the mercy of the US' leadership. Compared to the real Article 5, an "Article 5-like" bilateral guarantee would be far more prone to abuse of power and rent-seeking behaviour – both of which are a credible risk given the US President's transactional tendencies. Lest it be forgotten, Trump's administration effectively coerced Ukraine into agreeing to a minerals deal, by making further support conditional upon Ukraine signing. Under the terms of the deal signed on 30 April 2025, the US is to receive 50% of revenues from new licenses undertaken by extractive industries in Ukraine. While potential land swaps have also been floated by Witkoff, little hard detail is available at the moment. Without knowing exactly what Russia will concede, the conditions put forward by Trump look to favour Russia's position, insofar as they largely fulfil Russia's strategic goal of keeping Ukraine out of NATO, and legitimise at least some of its prior annexations. Should these conditions prove untenable for Ukraine, is there a third way? A brief glance at the alternatives suggests most may be worse, not least because many roads lead back to Trump, in one way or another.

While Ukraine has proven its ability to slow the Russian advance to a crawl, doing so depends entirely on the continued supply of military aid and intelligence support. Right now the US appears to be the only actor capable of meeting the requirements. Trump seems set on adding a peace deal between Russia and Ukraine to his presidential legacy, and has not been shy about pressuring Ukraine very publicly. As such, the idea that Ukraine could wait him out until January 2029, hoping for a friendlier president to enter the White House, seems far-fetched at best. If Ukraine is not seen to play ball by Trump's rules, he will likely suspend aid again, or take other measures to pressure Ukraine back to the negotiating table. Going more than three years without US support is not an option for Ukraine.

Could Europe stand up to Trump on this issue, and pressure him to commit to unconditional support? Probably not, given that most European leaders have thus far proven quite reluctant to challenge Trump directly, with some even going out of their way to kowtow to him. Hoping that Europe will grow a spine therefore feels like waiting for Godot. Could Europe at least replace US military aid? Europe has certainly improved its military production capacity since 2022, but all evidence suggests it still falls far short of being able to fully shoulder the US' burden – financial or industrial. Moreover, many key systems operated by Ukraine, such as PATRIOT, would necessarily remain reliant on the US. On top of this, Europe would likely find it difficult to substitute the US' intelligence sharing, especially in the space domain, where Europe possesses a fraction of the US' remote sensing capability.

In sum, short of the collapse of the Russian economy and their forces' unilateral withdrawal, a Trump-negotiated peace process, difficult to stomach as it may be, may represent Ukraine's only realistic route to securing peace with its sovereignty intact. In the current political environment, it is difficult to see what other viable choice exists.

**Mark Cazalet**

# Contents

## Armament & Technology

[Diehl Defence]





## Industry & Markets

[Russian MoD]



## Voices from Industry



## Columns

## Masthead

**ESD [European Security & Defence]**
Issue 9/2025, September 2025,
ISSN 1617-7983
www.euro-sd.com

**Published by**
Mittler Report Verlag GmbH
A TAMM Media Group company

**Contact Details**
Mittler Report Verlag GmbH
Beethovenallee 21, 53173 Bonn, Germany
Phone: +49 228 35 00 870
info@mittler-report.de, www.mittler-report.de
**Managing Director:** Peter Tamm
**Publishing Director:** Sylvia Fuhlisch

**Editorial Team**
**Publisher and Editor-at-Large:** Stephen Barnard (sb)
**Editor-in-Chief:** Mark Cazalet (mc)
**News Editor:** Peter Felstead (pf)
**Editorial Support:** Thomas Liebe (tl)

**Subject Matter & Regional Correspondents**
**CBRN:** Dan Kaszeta (dk)
**Denmark:** J. Bo Leimand (jbl)
**Electronic Warfare:** Dr Thomas Withington (tw)
**Germany:** Gerhard Heiming (gh)
**Infantry Weapons & Industry:** David Saw (ds)
**Land Warfare:** Sam Cranny-Evans (sce)
**Naval Industry:** Conrad Waters (cw)
**Naval Warfare:** Dr Lee Willett (lw)
**Training & Simulation:** Dr Trevor Nash (tn)
**Trucks & Utility Vehicles:** Shaun Connors (sc)
**UK:** Tim Guest (tg)
**Ukraine:** Alex Horobets (ah)
**USA:** Sidney Dean (sd)
**Photography:** Neil Grundy (RecoMonkey)

**Layout & Production**
**Layout:** AnKo MedienDesign GmbH, Germany
**Production:** Birograf Comp d.o.o.
Atanasija Pulje 22, 11070 Beograd Zemun, Srbija

**Advertising Sales & Business Development**
**Adrian Kunze**, Phone: +49 228 35 00 867, a.kunze@mittler-report.de
**Michael Menzer**, Phone: +49 228 35 00 866
Mobile: +49 151 15293872, m.menzer@mittler-report.de
**Markus Wenzel**, Phone: +49 40 70 70 80 226, m.wenzel@mittler-report.de
**Stephen Barnard**, Phone: +49 228 35 00 886
Mobile: +44 7984 033154, s.barnard@mittler-report.de
**Stephen Elliott**, Phone: +49 228 35 00 872
Mobile: +49 1590 173 0346, s.elliott@mittler-report.de

**Administration & Exhibition Management**
**Lead Administrator:** Renate Herrmanns

**Subscription/Reader Service**
Mittler Report Verlag GmbH
Beethovenallee 21, 53173 Bonn, Germany
Phone: +49 0228 3500888, Email: abo@mittler-report.de


**Cover Photo:** A Yugoimport Nora NG 155 mm self-propelled howitzer firing. [Yugoimport]

Annual subscription rate: €123.80 incl. postage Reduced annual subscription rate for distribution in Germany: €103.80 incl. postage



## Index of Advertisers

## Australian DoD selects Japanese Mogami class as its future general-purpose frigate

(pf) The Australian Department of Defence (DoD) announced on 5 August 2025 that it has selected an upgraded version of the Japanese Mogami-class frigate as the preferred platform for the Royal Australian Navy's (RAN's) future fleet of 11 general-purpose frigates to be procured under Project Sea 3000.

It is the first time the Australian DoD has selected a major Japanese weapon system and the first time Japan has exported such a platform.

The deal for the 11 frigates is understood to be worth AUD 10 billion (EUR 5.59 billion). The Australian DoD will now conduct detailed negotiations with the Japanese government and Mitsubishi Heavy Industries (MHI), which builds the Mogami class, with a view to agreeing a firm contract in early 2026.

"Following a rigorous and competitive tender process, Mitsubishi Heavy Industries' Mogami-class frigate was assessed as best able to quickly meet the capability requirements and strategic needs of the Australian Defence Force (ADF)," the Australian DoD stated.

The Mogami-class design had been competing against a bid by Germany's Thyssenkrupp Marine Systems, which had offered its Meko A-200 frigate design.

**[Australian DoD]**

Beyond the Mogami class' overall capabilities, key factors in the design being selected were a lower cost over the life of the programme and the ability of MHI to ensure the ships are rapidly delivered, with Australian Minister for Defence Industry Pat Conroy stating, "This decision comes months ahead of schedule, reinforcing our commitment to deliver of capability at speed and at a lower overall cost to taxpayers. It makes good on our commitment to deliver four times as many warships in the next 10 years compared to the plan inherited by the former Coalition government."

The Australian government under Prime Minister Anthony Albanese wants the first general-purpose frigate to be delivered to Australia in 2029 and to enter service in 2030, with the third entering service in 2034. In order to make this happen the first three ships will be built in Japan, with production then transferring to Austal in Western Australia.

Along with the six Hunter-class heavy frigates being built for the RAN by BAE Systems Australia, the 11 upgraded Mogami-class general-purpose frigates will replace the RAN's Anzac-class frigates, the first of which entered service in May 1996. Seven of the original eight Anzac-class ships currently remain in service.

The RAN will this be replacing an original fleet of eight Anzac-class frigates with 17 new frigates overall.

"Today, we are taking another step towards delivering a much larger and more lethal navy, with stealth frigates that will reassure our allies and deter our adversaries," Conroy stated. "The upgraded Mogami class frigate is the best option for our navy, boosting its capability to put to sea. It will take our general-purpose frigates from being able to fire 32 air defence missiles to 128 missiles, giving our sailors the cutting edge weapons and combat systems they need to prevail in an increasingly complex environment."

Australian Deputy Prime Minister Richard Marles stated, "The upgraded Mogami-class frigate will help secure our maritime trade routes and our northern approaches as part of a larger and more lethal naval surface combatant fleet."

The upgraded Mogami-class frigate offers a range of up to 10,000 nautical miles (18,520 km). Its weapon suite includes a 32-cell vertical launch system that can launch both surface-to-air missiles and anti-ship missiles.

Ever since the Second World War Japan had followed a self-imposed ban on the export of major military hardware and had only exported smaller platforms such as patrol boats, but this policy was relaxed on 1 April 2014 by the Japanese prime minister at the time, Shinzo Abe.

Japanese law has allowed co-operative development, facilitating, for example, the country's involvement in the US-led F-35 Joint Strike Fighter programme and more recently the UK-Italian-Japanese Global Combat Air Programme (GCAP).

Australia's selection of the upgraded Mogami class frigate, however, indicates not only the growing strategic co-operation between Australia and Japan, but potentially the Japanese defence industry's emergence onto the world stage as a significant player in the global defence market.

## PURL funding for Ukraine starts to flow from European NATO countries

(pf) Denmark, Norway and Sweden confirmed on 5 August 2025 that they would fund a USD 500 million (EUR 430 million) package of equipment and munitions for Ukraine sourced from the United States under NATO's newly launched Prioritised Ukraine Requirements List (PURL) initiative.

The announcement swiftly followed the unveiling of the first package of artillery and ammunition worth more than USD 500 million on 4 August 2025 funded by the Netherlands. Together the contributions are valued at over USD 1 billion and represent the first two tranches of regular deliveries to Ukraine under the alliance's PURL initiative.

# AT-7000 Series

## Multifunctional Communications & SIGINT Antenna System

**AEROMARITIMEs AT-7000 Series Multifunctional Communications & SIGINT Antenna System for submarines was developed to meet both the multifunctional communications and signal intelligence requirements to detect and evaluate communicative (COMINT) and non-communicative (ELINT) signals. The AT-7000 series antenna has the same form and fit factors as its predecessor, the AT-4000 Series.**

The emerging communication technologies in the civilian sector provide an opportunity for the naval industry to expand military communication needs and new combat requirements as they are available in the market, technically mature and affordable. While communication technologies such as VHF, UHF, etc. remain an essential part of naval military communication, other technologies such as 2G, 4G, 5G, WLAN, etc. can expand the scope of naval military communication services.

Certain naval communication systems already include the tactical private 4G LTE communication network to achieve sufficient throughput for reliable data collection in real time and over long distances (1). The attractiveness and high efficiency of 5G technology make it necessary to consider the implementation of civilian standards in the military domain. Since the direct use of civilian standards in military systems cannot simply be adopted due to various premises, the civilian 5G standard is currently being evaluated for its usability in military applications (2). In addition, 5G NTN (Non-Terrestrial Networks) is also being developed as a future communication technology. 2G technology can be retained as a backup solution for military naval communication systems. WLAN technology can be used to set up tactical private ad hoc networks (3).

In addition to the need for mobile communications, navies around the world also need signal intelligence systems to combat all modern threats, e.g. to detect and neutralize drones.

To enable all these functions, navies around the world prefer a powerful, compact all-in-one multifunction and signal intelligence antenna and antenna subsystems, especially for submarines, due to limited space.

The AT-4000 multifunctional communications antenna system for submarines is one of the best-selling antennas that Aeromaritime Systembau GmbH has supplied to various navies around the world over the last 40 years. It includes VLF/HF-Rx, VHF, UHF, IFF, Link-16 and L-Band SatCom functionalities. The AT-4000 antenna system was developed as a communications antenna and is not intended for signal intelligence. As a consequence, a new antenna system has been developed that is suitable for both the signal intelligence and military naval communications, including the communication technologies mentioned above.

The AT-7000 series antenna system consists of the antenna itself, a communication interface (COM-IF), a SIGINT interface (SIGINT-IF) module that can be connected to most third-party signal analyzers

[AEROMARITIME]

& recording systems, and the Aeromaritime's Radio Frequency Distribution Unit RFDU.

As a multifunctional communications antenna, the AT-7000 covers VHF-LoS, UHF-LoS, IFF, Link-16 and L-band services, with Inmarsat-C and Iridium being the most popular L-band services. In addition, the AT-7000 also provides 2G, 4G and 5G cellular- and WLAN services. It has receive-only functionality for VLF and HF bands.

In signal intelligence mode, the AT-7000 captures electromagnetic signals from its environment in the range from 10 kHz to 6 GHz and evaluates the captured signals in the signal analyzer and recording system after passing through various interfaces.

The communications interface (COM-IF) module serves as an interface between the AT-7000 antenna and various communication radio devices. The main functions of the COM-IF include supplying the electronic components in the COM-IF itself and the antenna with DC power and control signals, switching between different communication paths, and filtering. The COM-IF also provides an interface to the signal intelligence interface (SIGINT-IF) module which performs filtering and multiplexing of signals received via various antenna elements and provides an interface to the signal analyzer and recorder system.

The Radio Frequency Distribution Unit (RFDU) is an optional component of the AT-7000 antenna system. If a communication system contains more than one VHF LoS, UHF LoS and GPS antenna, these multiple antennas can be easily and efficiently connected to the corresponding radios using the RFDU unit.

The Signal Analyzer & Recorder system evaluates the signals detected by the AT-7000 antenna. Although the Signal Analyzer & Recorder system is a central component of the signal evaluation, it is not offered by Aeromaritime Systembau GmbH. There are several signal analyzer & recorder systems on the market and the AT-7000 antenna system is compatible with most of them.

References:
1. https://www.linkedin.com/pulse/how-private-4g-lte-solved-communications-issues-dcns-kareen-frascaria
2. Zmysłowski, Dariusz, et al. "Naval use cases of 5G technology." TransNav: International Journal on Marine Navigation and Safety of Sea Transportation 17.3 (2023).
3. https://atos.net/wp-content/uploads/2019/02/atos-airlynx-tactical-private-lte-network-brochure.pdf

**Contact:**
AEROMARITIME Systembau GmbH
Ludwig-Erhard-Str. 16
D-85375 Neufahrn, Germany
+49-8165 - 6171 - 0
www.aeromaritime.de
info@aeromaritime.de

The PURL mechanism allows European NATO countries and Canada to regularly fund the delivery of US-sourced weapons and technology through voluntary contributions. It was established following an agreement made by NATO Secretary General Mark Rutte and US President Donald Trump at the White House on 14 July 2025. Within the PURL framework a prioritised list of weapons and ammunition will be created based on Ukraine's requests, approved by NATO's Supreme Allied Commander Europe (SACEUR).

[NATO]

The NATO secretary general stated on 4 August, "I commend The Netherlands for taking the lead and turning this initiative into concrete support on the ground, building on the steps taken last week by Germany to deliver more PATRIOT systems to Ukraine."

The following day he stated, "Since the earliest days of Russia's full-scale invasion, Denmark, Norway and Sweden have been steadfast in their support for Ukraine. I commend these Allies for their quick efforts to get this initiative off the ground. This latest round of funding will deliver life-saving equipment and critical supplies to the front line, strengthening Ukraine's hand and helping them deter aggression as they pursue lasting peace."

## UK and Türkiye sign MoU on export of Typhoons, bringing deal closer

(pf) The governments of the United Kingdom and Türkiye signed a memorandum of understanding (MoU) at the IDEF 2025 defence exhibition in Istanbul on 23 July that brings a sale of Eurofighter Typhoons to Turkey a significant step closer.


[BAE Systems]

The MoU was signed at IDEF 2025 by UK Defence Secretary John Healey and Turkish Defence Minister Yaşar Güler. Negotiations on the potential deal, which would be the first export order the UK has secured for the Eurofighter consortium since 2017, will now continue over the coming weeks.

Final production of Typhoons bound for Türkiye under a future deal would see final production take place at BAE Systems' site in Warton, Lancashire.

While Turkey has expressed an interest in acquiring 40 Typhoons for some time, the previous government in Germany, as one of the Eurofighter nations along with the UK, Spain and Italy, had resisted such a sale. However, the current German government, which came to power in February 2025, gave a green light for the exporting of Typhoons to Türkiye on 23 July following a positive decision by its Federal Security Council.

Speaking after the signing of the MoU in Istanbul, Healey stated, "Today's agreement is a big step towards Türkiye buying UK Typhoon fighter jets. It shows this government's determination to secure new defence deals, building on our relationships abroad to deliver for British working people. Equipping Türkiye with Typhoons would strengthen NATO's collective defence and boost both our countries' industrial bases by securing thousands of skilled jobs across the UK for years to come."

The UK Ministry of Defence (MoD) has taken on more responsibility for defence exports since 31 July 2025 under an initiative outlined in the UK Strategic Defence Review, published on 2 June 2025, to drive potential UK defence exports and enhance the country's economic growth. The SDR initiative moved responsibility for defence exports from the Department for Business and Trade, making the UK MoD the lead for securing deals for military equipment with UK allies.

## Germany to supply Ukraine with two additional PATRIOT launchers

(pf) The German Federal Ministry of Defence announced on 1 August 2025 that in the following days it will deliver two additional PATRIOT air defence system launchers to Ukraine, with complete system elements to follow in the next two to three months.

In return, an agreement has been reached with the US Department of Defense (DoD) that Germany will be the first nation to receive newly produced, latest-generation PATRIOT systems at an accelerated pace, with the financing for these provided by Germany.

The move is a result of the US President Donald Trump announcing on 14 July 2025 that the United States would approve the transfer of both defensive and offensive weapons to Ukraine as long as NATO nations paid for them.

"Germany has always been willing to provide PATRIOT system components in support of Ukraine," stated German Defence Minister Boris Pistorius. "The prerequisite was that the US manufacturer would deliver new PATRIOT systems to us as quickly as possible so we can continue to meet our NATO obligations. That commitment from the US side has been secured."

[Bundeswehr]

"Highly efficient air defence systems like the PATRIOT system are in short supply, and the production of some components takes years. Germany has already delivered three systems to Ukraine, which play an important role in Ukraine's air defence," the German Federal Ministry of Defence stated.

"With the solution now agreed upon, Germany is taking the lead to quickly meet Ukraine's currently very urgent needs. We are once again taking the lead and are combining this delivery with an appeal to our partners to promptly provide additional systems," the ministry added.

In recent weeks Russia has intensified its aerial attacks on Ukrainian cities with both missiles and bomb-laden unmanned aerial vehicles (UAVs). On 31 July, for example, an aerial attack on Kyiv killed at least 31 people and injured around 159. That attack involved more than 300 UAVs and eight cruise missiles, according to Ukraine's air force.

## Hyundai Rotem agrees sale of second tranche of K2 MBTs to Poland

(pf) South Korea's Hyundai Rotem has secured a major deal to supply a second tranche of 180 K2 Black Panther main battle tanks (MBTs) to Poland, South Korea's Defense Acquisition Program Administration (DAPA) announced on 2 July 2025.

[US Army]

Polish Defense Minister Władysław Kosiniak-Kamysz confirmed the news via his X social media account, stating on 2 July, "We have completed negotiations for the delivery of 180 tanks, 80 support vehicles, and we will sign contracts for a comprehensive package that has never been implemented before as part of K2 tank agreements.

"This is an extremely complex process due, among other things, to technology transfer and the localisation of production," Kosiniak-Kamysz added. "As a result, 60 tanks will be manufactured in Poland, and the main partner in carrying out this task will be the Polish company Bumar Łabędy."

The specific size of the contract will be disclosed at a later date, DAPA said in a statement, but Yonhap News Agency has reported that the deal to supply 180 K2 MBTs is likely to be worth about USD 6.5 billion (EUR 5.53 billion).

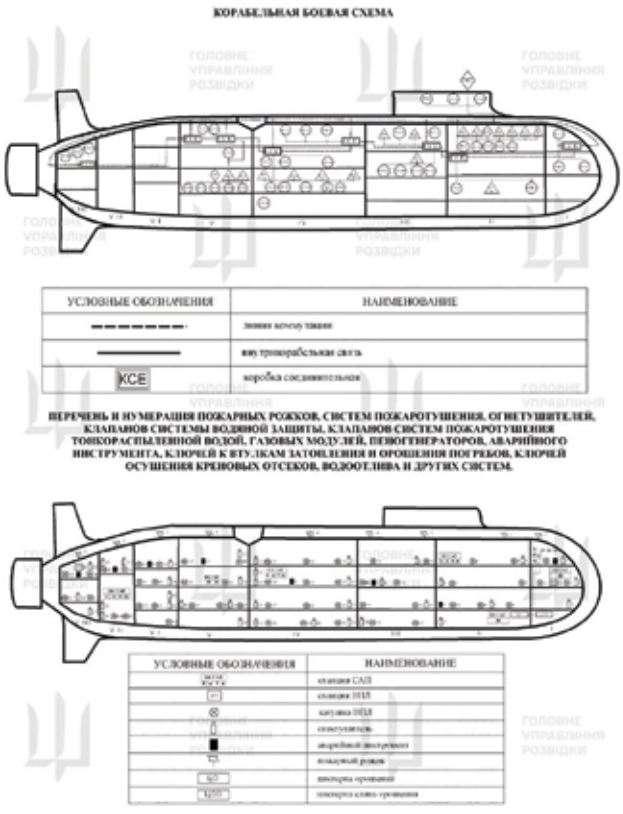
Poland initially signed a major USD 22 billion framework arms agreement with South Korea in August 2022, under which were purchased 180 K2 MBTs, 212 K9 self-propelled howitzers, 48 FA-50 fighters and 218 Chunmoo multiple rocket launchers (MRLs) (with another 72 MRLs bought in April 2024).

According to reporting by *The Korea Times*, negotiations for a follow-up deal had been underway but were delayed by political turmoil in South Korea following former president Yoon Suk Yeol's short-lived martial law declaration in December 2024, as well as disagreements between the two sides over contract terms.

## Ukrainian intelligence specialists obtain secret details of Russia's latest SSBN

(pf) The Ukrainian Ministry of Defence's Main Directorate of Intelligence (GUR) asserted on 3 August 2025 that its intelligence specialists have obtained top secret documentation related to Russia's latest nuclear-powered ballistic missile submarine (SSBN).

The Project 955A Borey-A-class SSBN *Knyaz Pozharsky* (K-555) was commissioned into the Russian Navy's Northern Fleet as part of the 31st Submarine Division on 24 July 2025, in a ceremony at the Sevmash shipyard in Severodvinsk overseen by Russian President Vladimir Putin.




[GUR]

Publishing detailed documents to back up its claim, the GUR said it had obtained numerous details relating to the operation of *Knyaz Pozharsky* (and by extension its seven Project 955/955A sister boats), including:

- name lists of the submarine crew, including data on positions, qualifications and level of physical training;
- combat instructions for the crew;
- the combat scheme of the ship, as well as schemes of systems to ensure the survivability and organisational structure of the crew;
- crew regulations in cabins and cockpits, instructions for transferring wounded and cargo, procedures for towing and other job instructions;
- engineering documentation, in particular a report on the investigation of a deformed radio beacon indicating the members of the commission and enterprises that participated in the investigation;
- an extract from the submarine's schedule book: a "voluminous document [that] regulates the daily combat and everyday work of the vessel".

"The Project 955A Borei-A submarines are a key element of the Kremlin's so-called nuclear triad," the GUR noted. "The submarines have 16 launch pods for R-30 Bulava-30 intercontinental ballistic missiles, each of which can carry up to 10 warheads."

The GUR added that the information obtained by its intelligence officers "allows us to identify the features and technical limitations of not only the *Prince Pozharsky*, but also other Project 955A submarines, which are critically important for supporting the imperial myth of the aggressor state of Russia."

Russia's Borei-class SSBNs, which are 170 m long and displace 23,621 tonnes submerged, are the first Russian nuclear submarines to use a pump-jet propulsion system, leading a report by the Russian state news service TASS to claim that their noise level is five times lower compared to Russia's third-generation Akula-class nuclear-powered attack submarines, which first entered service in 1986.

## CCG cutter inadvertently rams Chinese destroyer in South China Sea incident

(pf) Two Chinese naval vessels, a China Coast Guard (CCG) cutter and a People's Liberation Army Navy (PLAN) Type 052D-class guided missile destroyer, collided on 11 August 2025 in a bizarre incident involving a Philippine Coast Guard vessel in the South China Sea near Scarborough Shoal.

Footage of the incident filmed from Philippine Coast Guard (PCG) patrol vessel BRP *Suluan* (MRRV-4406) shows the vessel being pursued by CCG cutter 3104 as it attempts to water cannon the Philippine vessel. The PLAN Type 052D-class destroyer *Guilin* (164) then cuts across the stern of BRP *Suluan*, leading the CCG cutter to ram head on into the PLAN destroyer.

While the Chinese destroyer appeared to suffer moderate gouging on its port side, several metres of the CCG cutter's bow section were entirely stoved in.

BRP *Suluan*, along with sister vessel BRP *Teresa Magbanua* (MRRV-9701), had at the time been escorting Philippine fishing vessels in support of the Kadiwa Operation: a Philippine government-led initiative designed to support and empower fishing communities in the country's western exclusive economic zone (EEZ).

In response to the incident the Philippine Department of National Defense described the Chinese actions as "atrocious and inane behaviour" and pledged its support for the Philippine Coast Guard personnel operating in the South China Sea.

[Philippine Coast Guard]

This was not the only incident of Chinese vessels harassing Philippine shipping as Beijing pushes to expand a claimed exclusion zone in the region. While Scarborough Shoal is a maritime feature located within Manila's EEZ, China also claims the feature under its ten-dash line assertion, which claims most of the South China Sea: a claim that has been rejected by a United Nations Law of the Sea tribunal.

However, China up to now has typically pressed its claims using CCG vessels, so this latest incident involving a PLAN destroyer could potentially signal an escalation.

## Denmark to be become fourth European operator of the MQ-9B SkyGuardian

(pf) Denmark is buying four MQ-9B SkyGuardian unmanned aerial vehicles (UAVs), manufacturuer General Atomics Aeronautical Systems Inc (GA-ASI) announced on 23 July 2025.


[GA-ASI]

The purchase, which includes three Certified Ground Control Stations, was aided and supported by the NATO Support and Procurement Agency (NSPA), which has added the MQ-9B to its portfolio of defence systems to contract on behalf of European nations with the goal of enhancing interoperability while facilitating training and joint operations.

Denmark thus joins a growing list of European countries that have selected the MQ-9B. The platform provides pole-to-pole satellite control as well as de-icing capabilities that enable missions in the harsh conditions of the Arctic in support of Denmark and its NATO allies. Additionally, the MQ-9B's in-house-developed detect-and-avoid System allows the MQ-9B to fly in unsegregated airspace for domestic civilian operations, making it highly versatile for operations from Denmark.

On 29 April 2025 the MQ-9B (in the form of the Royal Air Force Protector RG Mk1 UAV) became the first large UAV to obtain a Military Type Certificate (MTC) from the UK's Military Aviation Authority, certifying its safe operation without geographic restrictions, including over populous areas.

"It's been a very productive year for our MQ-9B platforms," GA-ASI President David R Alexander was quoted as saying in a company press release. "First, we earned MTC and now we've added Denmark to the UK, Belgium and Poland as MQ-9B customers in Europe. I believe the extensive waters of the North Sea, Norwegian Sea and Baltic Sea of the Nordic countries make the MQ-9B a very effective tool for national maritime surveillance and security."

## GMARS launcher conducts first live firing, proving its capability to launch GMLRS rounds

(pf) Lockheed Martin and Rheinmetall, as partners in the Global Mobile Artillery Rocket System (GMARS) programme, have successfully conducted the first live firing of the GMARS launcher, demonstrating its capability to launch Guided Multiple Launch Rocket System (GMLRS) rockets, Lockheed Martin announced on 4 August 2025.
GMLRS rounds are launched by the M270 MLRSs and M142 High Mobility Artillery Rocket Systems (HIMARS) of the US and various allied forces worldwide, reinforcing interoperability and supporting joint operations.
The live-fire demonstration, held recently at White Sands Missile Range in New Mexico, marked a significant milestone in the GMARS development programme, which aims to provide military customers with a highly mobile, survivable and versatile long-range precision fires capability tailored to and interoperable with existing allied platforms. The launcher can be armed with an enhanced loadout of two Army Tactical Missile System (ATACMS) rounds, four Precision Strike Missiles (PrSMs), 12 standard-range GMLRS rounds or 12 Extended-Range (ER) GMLRS rounds.

[US Army]

The GMARS launcher, based on the Rheinmetall HX vehicle series, offers a high degree of interoperability and interchangeability with fielded M270A2 and HIMARS launchers, making it an ideal solution for military forces operating in Europe, Lockheed Martin noted. The system's ability to launch current and future long-range and extended-long-range rocket fire missions provides a significant advantage on the modern battlefield, the company added.

The GMARS programme is a result of a partnership between Rheinmetall and Lockheed Martin that began in 2023, with the two companies combining their individual strengths to provide a launcher built for NATO allies that maximises combat-proven HIMARS and M270 components. GMARS provides the same munition capacity as the tracked M270 system on a wheeled platform, with opportunity to integrate allied nations' platforms and munitions.

## Denmark finalises integration into CAVS programme and orders 129 vehicles

(pf) Denmark has now completed its integration into the Common Armoured Vehicle System (CAVS) programme by signing the three remaining agreements and ordering 129 Patria 6×6-based CAVS armoured vehicles, Patria announced on 14 July.

[Patria]

It was announced that Denmark had joined the CAVS programme – joining Finland, Latvia, Sweden and Germany – on 1 April 2025 by signing its Technical Arrangement, but Denmark has now also signed the programme's R&D Agreement, the Frame Agreement and Life Cycle Management Agreement.

The first Danish CAVS vehicles will be delivered in 2025.
Within the CAVS programme the 6×6 armoured vehicle system development is led by Patria. The supply of vehicles to the

CAVS partner nations is conducted by utilising the nations' local industrial capabilities, with every new nation inherently reinforcing the security of supply for the whole collaboration system.

Patria has already received orders for nearly 1,000 Patria 6×6 vehicles and has delivered more than 200 under the CAVS programme, which is open to countries with similar AFV requirements by mutual consent of the participating countries.

## Royal Navy accepts into service new autonomous minesweeping system

(pf) The UK Royal Navy (RN) has accepted into service three sets of autonomous minesweeping systems, known as SWEEP, that allow it to safely clear sea lanes and defeat modern mine threats using unmanned platforms, the navy announced on 4 July 2025.

The SWEEP system – effectively the RN's first uncrewed minesweeper – was designed by Dorset-based TKMS Atlas UK (formerly Atlas Elektronik UK) under a GBP 25 million contract announced on 19 January 2021.

Each SWEEP system comprises an autonomous surface vessel that tows a sensor unit behind it. The unit uses magnetic, acoustic and electric technology to identify and neutralise

[Crown Copyright]

different types of sea mines. The system is controlled by a portable command centre that can be based at sea or on land.

SWEEP's 'sense and avoid' capability works together with other similar autonomous systems, such as the Maritime Mine Counter Measures (MMCM) system and SeaCat uncrewed underwater vehicles, to sustain freedom of manoeuvre for RN and allied vessels.

The RN received its first serial-production MMCM system – an advanced suite of technologies designed to locate, classify and neutralise naval mines, operated either autonomously or via remote control – in February 2025.

## Baykar completes acquisition of Italy's Piaggio Aerospace

(pf) Turkish unmanned aerial vehicle (UAV) specialist Baykar officially completed its acquisition of Italy's Piaggio Aerospace on 30 June 2025 with a signing ceremony in Rome.

The transaction, initiated by the Ministry of Enterprises and Made in Italy *(Ministero delle imprese e del made in Italy)* on 27 December 2024, has now closed with 'Golden Power' approval from the Italian Prime Minister's Office.

**[Baykar]**

The signing ceremony was attended by Minister of Enterprises and Made in Italy Adolfo Urso; Baykar CEO Haluk Bayraktar; and the Extraordinary Commissioners of Piaggio Aerospace – Carmelo Cosentino, Vincenzo Nicastro, and Gianpaolo Davide Rossetti.

Speaking at the signing ceremony, Urso highlighted the deal's importance for his country, stating, "With this operation we are safeguarding a strategic industrial asset for the country and laying the foundation for a concrete relaunch of the Italian aerospace sector. Piaggio Aerospace can once again play a leading role thanks to a solid industrial plan, new investments, and the enhancement of local expertise. This result demonstrates how the State, through the extraordinary administration and the Golden Power tool, can protect industrial sovereignty while attracting high-quality international investment."

Selçuk Bayraktar, Baykar chairman and CTO, stated of the acquisition, "It is a great honour for us to take responsibility for the future of Piaggio Aerospace: a symbol of Italian innovation and excellence. Our goal is to revitalise this historic brand by investing in its civil aviation capabilities, expanding production of the P.180 Avanti EVO [executive light transport aircraft], and enhancing [Piaggio's] role as a centre of excellence for aircraft and engine maintenance in Europe. We are committed to long-term growth, high-quality employment, and deepening industrial co-operation between Türkiye and Italy."

The acquisition represents a significant part of the broader industrial co-operation between Türkiye and Italy, including Baykar's joint venture with Leonardo to develop UAVs. Going forward, Baykar aims to stabilise the Piaggio and make the necessary strategic investments for its growth by developing a comprehensive industrial plan.

As well as reintroducing the legendary P.180 Avanti EVO to the global market with upgraded technological capabilities, the development plan for Piaggio also calls for producing Baykar's Bayraktar Akinci and Bayraktar TB2 unmanned combat air vehicles (UCAVs) at Piaggio's facilities to meet worldwide demand, and establishing a Europe-wide centre of excellence in aircraft and engine maintenance.

## Leonardo to acquire Iveco Group's defence business for EUR 1.7 billion

(pf) Leonardo announced on 30 July 2025 that it has signed an agreement to acquire the Iveco Group's Defence division for a total enterprise value of EUR 1.7 billion, with the transaction financed through available cash resources.

Iveco Group's Defence business includes both Iveco Defence Vehicles (IDV), which produces special-purpose protected vehicles, and Astra, which produces heavy-duty trucks for extreme off-road conditions.

"This strategic acquisition marks a significant step in Leonardo's plan to strengthen its role as a leading, fully integrated original equipment manufacturer (OEM) in the land defence domain," Leonardo stated. "The acquisition further enhances the group's comprehensive portfolio of solutions for defence and security, covering both tracked and wheeled platforms."

**[IDV]**

The acquisition will also boost joint commercial positioning, leveraging the complementary nature of the two companies' sales networks and the ability to offer integrated solutions in high-potential markets.

"The acquisition of Iveco Defence represents a key milestone in the execution of our inorganic growth strategy and supports the full implementation of our Industrial Plan," Leonardo CEO and General Manager Roberto Cingolani was quoted as saying in a Leonardo press release. "This transaction reinforces Leonardo's position as a reference player in the European land defence market: a segment expected to experience sustained growth in the coming years."

The closing of the transaction is expected in the first quarter of 2026, subject to regulatory approvals.

The integration of Leonardo's electronic systems – including a complete suite of combat electronics sensors and next-generation turrets – with Iveco's range of military vehicles "will ensure the utmost effectiveness of the proposed operational solutions", stated Leonardo, adding that the highly specialised know-how in the two

companies' respective verticals, combined with robust logistics and manufacturing capabilities, "will drive greater operational efficiency and accelerate joint technological development, while also creating new opportunities for professional skill development and talent enhancement".

Leonardo, in collaboration with its partner Rheinmetall, will also evaluate potential opportunities in the heavy vehicle sector in relation to the Iveco acquisition. The two companies announced the creation of Leonardo Rheinmetall Military Vehicles (LRMV) in October 2024, although this joint venture is primarily focused on heavy tracked armoured vehicles.

## Air Marshal Harv Smyth, former combat pilot, to be UK's new Chief of the Air Staff

(pf) Royal Air Force (RAF) Air Marshal Harv Smyth, a former combat pilot on multiple aircraft types who has also led UK space commands, has been appointed as Chief of the Air Staff (CAS) and Aide-de-Camp to His Majesty in the rank of air chief marshal, the RAF announced on 16 July 2025.

AM Smyth took up his CAS post in August 2025, succeeding Air Chief Marshal Sir Rich Knighton, who is being promoted to Chief of the Defence Staff: a role he is taking up in September 2025.

The Chief of the Air Staff is responsible for the strategic planning and delivery of all RAF operations, people and capability. The position is accountable to the UK defence secretary for the fighting effectiveness, efficiency and morale of the RAF as well as the service's development and sustainment.

Joining the RAF in 1991 as a direct entrant, AM Smyth then spent 15 years as a frontline Harrier pilot and weapons instructor, which included flying hundreds of operational missions over Bosnia, Kosovo, Serbia, Iraq and Afghanistan.

Through his subsequent career and increasingly senior appointments, AM Smyth retrained as a Tornado pilot and then as a Typhoon pilot.

[Crown Copyright]

Promoted to air marshal in 2022, AM Smyth was appointed as the RAF's Deputy Commander (Operations): a role that was transitioned to become the UK Air and Space Commander in 2023, responsible for all RAF air and space operations globally.

In April 2024 AM Smyth became the first RAF officer to hold the role of Deputy Chief of Defence Staff (Military Strategy and Operations), responsible for the provision of military advice to senior leadership across government including the UK prime minister, the development of UK military strategy and its integration with partners across government and allies, and the commissioning of UK military operations at home and across the globe.

# Desolate skies: Why GBAD matters

Mark Cazalet

**While drones, tanks, and artillery have grabbed headlines, Ukraine's ground-based air defence (GBAD) has quietly achieved something remarkable: keeping Russian air power mostly out of the fight for over three years. Ukraine's experience in this sphere offers vital lessons for the future security of European NATO members.**

Looking around at the bulk of NATO armed forces over the last few decades, a visible trend is the relative age and small numbers of GBAD systems in operation with many Allies. Concerns over this have been voiced at the highest levels, as during a 9 June 2025 speech at Chatham House, in which NATO Secretary General Mark Rutte stated that NATO needs "a 400% increase in air and missile defence".

IRIS-T SLM key system components viewed from above, consisting of the command post (left), transporter, erector, launcher (TEL; middle), and radar (right). This system forms the MRAD component of ESSI. [Diehl Defence]

AUTHOR

**Mark Cazalet** is the Editor-in-Chief of ESD. Previously, he worked for Janes as a Senior Analyst on the Land Warfare Team, and Editor of the Janes Artillery and Air Defence, and Janes Firepower, Survivability and Mobility yearbooks. Prior to that he worked at the International Institute for Strategic Studies (IISS), contributing to The Military Balance.

Neglecting GBAD has been a fairly long-running trend among many NATO Allies since the end of the Cold War, but it was not a particularly concerning capability gap during the era of the Global War on Terror, given the lack of aerial capability from the opponents of the time. Even the US could be credibly accused of slacking during this era, with its army broadly relying on PATRIOT for long-range air defence (LRAD), the Stinger-armed AN/TWQ-1 Avenger for very/short-range air defence (V/SHORAD), and the 20 mm Gatling cannon-armed Land Phalanx Weapon System for point defence of US bases, pretty much entirely in the counter-rocket, artillery, and mortar (C-RAM) role. There was little to speak of in the way of medium-range air defence (MRAD) during this period, with I-HAWK being retired, while initiatives such as SLAMRAAM were cancelled, and NASAMS was procured only in small quantities to defend government buildings in Washington DC; though on the other hand, this period also saw the original PAC-3 (now more commonly referred to as PAC-3 CRI) come to fruition.

Granted, in the US' case these gaps represented little in the way of meaningful weakness when considering that the country had, and continues to operate the two largest air forces in the world – the USAF and the US Navy. The same, however, cannot be said for its NATO Allies. Consequently, GBAD has represented a capability gap that European NATO members have begun scrambling to fix since Russia commenced its full-scale invasion of Ukraine on 24 February 2022.

In this vein, perhaps the most relevant current example of attempting GBAD procurement at scale is the German-led European Sky Shield Initiative (ESSI), which presently comprises 24 members. What is notable about ESSI is that the effort aims to steer users toward a procuring multiple systems with the goal of ensuring a multi-layer GBAD capability. The effort envisions Skyranger 30 in the VSHORAD role, IRIS-T SLM in the MRAD role, PATRIOT in the LRAD role, and Arrow-3 in the dedicated ballistic missile defence (BMD) role; all of which are systems Germany has selected for its own requirements. While this list lacks a 'true' dedicated SHORAD system, which should arguably also be part of any multi-layer system, the ESSI shopping list nonetheless covers most of the key areas. German industry stands to win significantly from this initiative, with the VSHORAD and MRAD components both

# TAURUS KEPD 350

PERFORMANCE MATTERS!

## SECURITY. SURVIVABILITY. PRECISION. EFFECT

### // AT A GLANCE

- Operational Range > 500 km
- High survivability for the aircraftcrew and the missile
- Undetected because of lowest flight altitude in terrain following flight
- Unmatched penetration capability
- Precise & jamming resistantnavigation
- GPS independent
- Navigation: INS, GPS, IIR seeker & radar altimeter
- Subsonic speed, highly manoeuvrable
- Weight: 1,400 kg
- Layer-counting & programmable fuze
- Warhead: 480 kg Pre-charge & penetrator
- Modular concept

TAURUS SYSTEMS GmbH

using German-origin systems, and may also benefit somewhat from the LRAD side, given that Germany plans to domestically produce PAC-2 GEM-T missiles for PATRIOT.

The move represents a significant tonal shift for Europe, whose GBAD purchases pre-Russo-Ukrainian War often consisted of low-quantity purchases to paper over the cracks, without the impetus to drive procurement of a proper, modern multi-layer air defence network. By now, it should be especially obvious to Europe that simply purchasing a couple of MRAD batteries and calling it a day is deeply insufficient. To understand why, one need only look to Ukraine.

## Ukraine: Exemplifying the value of GBAD

The Russo-Ukrainian War represents an interesting and fairly unique case study in how near-peer/peer warfare looks when both sides field large, multi-layered air defence networks. At the opening phase of the war, Ukraine operated a significantly smaller and less modern air force compared to Russia, so consequently, a greater share of the task of contesting the Russian Aerospace Forces' (VKS') power would need to fall on GBAD systems. In many ways Ukraine's Soviet legacy helped it here, as the Soviet armed forces operated a very large and diverse fleet of GBAD systems covering many range and altitude bands, of which Ukraine inherited a substantial portion. Many of these older systems remained sufficiently effective against 4th-gen fighters, and were key to Ukraine preventing Russia from attaining air superiority in the opening phase of the 2022 invasion, as well as keeping Ukraine's airspace contested in the months and years that followed.

The effect over time was that these GBAD systems effectively prevented Russia from using its fast jets to full effect, largely forcing them to operate at very low altitudes for pop-up attacks, or employing less plentiful guided munitions from standoff distances. Initially, the latter typically comprised air-launched cruise missiles (ALCMs), and was later supplemented by gravity bombs fitted with UMPK glide/guidance kits. Alongside these, Russia also introduced the massed one-way attack (OWA) drones such as Shahed/Geran, and others, along with decoys into its aerial threat mix.

**Pictured: a 5P85SM TEL from the S-300PM system. Despite being relatively old, many legacy SAM systems such as the S-300P family, nonetheless proved themselves to be a serious danger for 4th-Gen fighter aircraft. [RecoMonkey]**

As Ukraine burned through its legacy missile stocks, and acquired new systems and munitions from allies, its GBAD gradually Westernised, with the country now operating a large and diverse mix of US and European designs, along with some hybrid oddities such as the Buk 'FrankenSAM' using RIM-7/AIM-7 missiles. While such systems were often effective, Ukraine's reliance on Western munitions introduced a vulnerability in supply – with perhaps the most concerning moments for the Ukrainian frontlines coming around February 2024, during which Ukraine's surface-to-air missile (SAM) depletion reached critical levels. In this window, some signs of limited, localised air superiority for the VKS rapidly began to emerge, with Russian President Vladimir Putin claiming "thousands of sorties" in the operation which culminated with the fall of Avdiivka on 17 February 2024. This window was not to last, as US Congress managed to pass a long-awaited USD 60.8 billion aid package on 20 April 2024. These deliveries saw a replenishment of Ukraine's SAM stocks, and consequently the ended the brief window in which the VKS had enjoyed localised air superiority.

In short, Ukraine has demonstrated the extent to which GBAD can influence the battlefield. While of course air-to-air exchanges have taken place, and manned aviation on both sides has played a role in air defence, it has not been the prime driver of the trends seen. With neither side able to employ air power in the typical desired fashion (persistent medium-altitude flight in close proximity to enemy positions, with emphasis on ground attack), the nature of the fighting was forced to become relatively static, positional, and attritional – an environment in which both artillery and small drones thrive. Both sides have nonetheless attempted to find alternative ways to employ their available air power, but GBAD has continued to prevent air power on either side from playing a decisive role.

All told, it would probably not be much of an exaggeration to argue that Ukraine's GBAD hindered the success of Russia's invasion more than any other single factor, due to its compounding shaping effects on the rest of the battlefield. While there are a number of shaping effects at work on the battlefield, artillery being an oft-cited example, this author would argue that there is a hierarchy of shaping effects. In the case of artillery – it is able to exert the shaping effects it does primarily due to the absence of persistent air power which under other circumstances could have located and destroyed it. Much the same could be said of drones; to my mind it is doubtful that this war would have seen the rise of small drones if Russian airborne ELINT and strike assets were free to roam Ukraine's skies, dropping KAB-250s on any emission signature even remotely resembling a drone ground control station. More to the point, in such a scenario, the war would likely have been over long before a domestic drone industry could arise.

## How applicable are these lessons to NATO?

So, what can NATO members learn from the battlefield influence of GBAD in the Russo-Ukrainian War? As ever, one should be cautious about applying lessons from this war, as many observed operational realities exist due to Ukraine's unique circumstances vis-à-vis Russia, and may not necessarily apply in other scenarios, such as a hypothetical full-scale conflict between Russia and NATO. The latter is precisely the scenario the current wave of modernisation and rearmament is geared toward readying the Alliance for.

**A Ukrainian Su-27P; the country operated an estimated 34 Su-27 aircraft prior to Russia's full-scale invasion. These were less capable than their equivalents operated by Russia. [RecoMonkey]**

With that in mind, are large fleets of GBAD systems as necessary for NATO as for Ukraine? Arguably less so. For starters, air superiority over Russia was never a realistic goal for Ukraine, whose pre-war fast jet fleet largely comprised small-medium numbers of older Soviet-era 3rd/4th-gen aircraft. As such, GBAD had to shoulder the burden of keeping Russian aircraft at bay. By contrast, many NATO members operate significantly more modern, capable, and in some cases larger fighter fleets. As such, attaining air superiority should be a far more realistic goal for NATO than for Ukraine, and indeed would probably represent the Alliance's best chance for ending a war with Russia quickly. Consequently, given NATO's vastly superior air forces relative to Ukraine's, it is fair to question the likelihood that GBAD would play an equally-important role in the aforementioned scenario. In a time of budgetary pressures, it may therefore seem tempting to save on GBAD to free up funding elsewhere. Yet, as tempting as that route may be, there remain many good reasons for NATO members to invest in their GBAD capabilities.

To begin with, some context. Despite Russia's often poor tactical performance in Ukraine, and the superiority of NATO's air forces, the survival of sufficient numbers of NATO fast jets for long enough to attain air superiority in a full-scale conflict with Russia should not be taken for granted. In a scenario where it is fighting NATO, Russia would be expected to invest considerable resources into destroying the Allies' fast jet fleets on the ground, such as via ballistic and cruise missile strikes, along with using its GBAD and aviation to attrit NATO aircraft as they ventured into defended airspace to perform offensive counter-air, and suppression/destruction of enemy air defence (SEAD/DEAD). Alongside this, Russia would be expected to continue employing massed low-cost long-range precision strike means, such as OWA drones, against both military targets, as well as strategically-vital industrial and energy infrastructure. In this kind of environment, GBAD would provide a relatively low-risk form of persistent protection for strategic assets and ground formations.

First, the mere presence of larger numbers of GBAD systems, particularly long-range air defence (LRAD) systems such as PATRIOT, would restrict the freedom with which Russia's own air forces could operate in-theatre, likely forcing the VKS to either stay further back from the front lines, or dedicate more intelligence, surveillance, and reconnaissance (ISR) and strike assets to hunting down GBAD. This would also come at a time where they would be in very high demand for other tasks, such as locating key command and control (C2) nodes, or defensive counter-air. Likewise, the presence of GBAD could provoke the expenditure of precious high-performance munitions, either to ensure high-value targets were struck, or against the GBAD system itself.

Second, large fleets of GBAD systems would give Allies greater scope to devote fewer fast jets to the defensive counter-air role. This should not be understated – even leaving aside the cost asymmetries of using the likes of F-35 to down Shahed/Geran series OWA drones or Kalibr cruise missiles, dedicating a sizeable portion of the Allied fast jet fleet to conduct large-scale defensive counter-air also imposes an opportunity cost, insofar as these aircraft will not be usable for offensive action at the same time. Ultimately, the success of NATO attaining air superiority will hinge on the number of aircraft it is able to dedicate to offensive counter-air and SEAD/DEAD.

**Russia is mass-producing Geran series OWA drones at an estimated rate in the thousands per month, with ambitions to scale this to 1,000 per day. Even if their wartime production is disrupted, their current estimated industrial output compared to observed expenditure suggests they likely have a not inconsiderable stockpile available. [TV Zvezda]**

Third, there is a need for redundancy in case of losses. As seen in Ukraine, GBAD on both sides has suffered significant attrition, especially during the highest-intensity phase in the opening weeks of Russia's full-scale invasion. Ukraine's Western-built systems have thus far suffered fewer losses, however these have mostly seen action during portions of the war where hostile SEAD/DEAD was less of a risk, and Ukraine has also been more conservative with their positioning than with its Soviet legacy systems. That said, even Western systems have suffered losses during the relatively static phases of the war; most notably, Ukraine was visually confirmed to have lost part of a PATRIOT battery to a 9M723 Iskander-M strike in March 2024. What re-

mains true for both sides, is that the relatively large GBAD fleets they started with meant they could absorb said losses without the situation turning truly catastrophic. Many NATO armies at present lack this level of redundant capability, meaning that any system losses risk leaving persistent gaps.

Fourth, there are some targets that fighter aircraft are simply unsuited to engaging – a case in point being ballistic missiles. At present, there is no real alternative to using ground- or sea-based systems for the ballistic missile defence (BMD) role. While not all GBAD is suited to the role, with SRBM interception typically being the domain of specialised LRAD systems, many V/SHORAD and MRAD systems nonetheless provide a level of capability against lower-tier threats such as artillery rockets or various types of precision-guided munitions, against which employing aircraft would be impractical, even though they may technically possess the requisite capability to engage such targets.

Fifth and finally, even when going up against an opponent with good SEAD/DEAD capabilities, there are a number of characteristics of GBAD systems which can make them a thorny problem to deal with effectively.

- GBAD systems can be difficult to locate, meaning an opponent needs to invest significantly in ISR to do so reliably, and often at considerable operational depths, particularly in a large theatre.
- Even when located, GBAD systems can often protect themselves against the very weapons which would typically be used to engage them. In the case of LRAD systems, these will often have V/SHORAD or MRAD systems protecting them.
- Even when engaged, GBAD systems represent quite complex targets, since they tend to operate as dispersed systems of systems comprising multiple vehicles. The system can usually keep functioning if a launch vehicle is destroyed, making total defeat of a GBAD system quite difficult. Furthermore, due to advances in networking technologies, some GBAD systems are now capable of using an allied asset's radar picture for target tracking and even fire control, making even the loss of a GBAD system's primary radar somewhat less of a dire prospect than in years past.
- GBAD systems exist primarily to protect other assets, so even in when they are successfully defeated, as long as the critical object or formation they are protecting survives long enough to achieve strategically-important effects, the GBAD has done its job.

**A 9A317M transporter, erector, launcher, and radar (TELAR) vehicle from the Buk-M3 LRAD system. A less-discussed trend during the war in Ukraine has been the entry into service of more modern and capable air defence systems. [RecoMonkey]**

In sum, large numbers of dispersed modern GBAD systems represent a genuine headache for even a well-equipped air force to deal with, and can exert considerable shaping effects on the battlefield over time if they are allowed to operate unopposed.

## Doing things properly

When it comes to fielding a meaningful GBAD capability, there is a right way and a wrong way to do things. Perhaps the best exemplar of the former is Poland, which is currently in the process of procuring the following:

- 8 PATRIOT batteries, each comprising eight launchers (64 total) armed with PAC-3 MSE missiles (Range: ~120 km), under the Wisła programme. Deliveries to be completed in 2029.
- 23 EMADS (Narew) batteries, each comprising six launchers (138 total) armed with CAMM-ER missiles (Range: >45 km), under the Narew programme. Deliveries to be completed in 2035.
- 2 EMADS (Mała Narew) batteries, each comprising six launchers (12 total), armed with CAMM missiles (Range: >25 km), under the Mała Narew programme. Deliveries completed in 2023. It is unclear whether or not these will eventually be folded into Pilica+ batteries.
- 22 Pilica+ batteries, each comprising six SPAAGMs (132 total) armed with both twin-23 mm cannons and Piorun missiles (Range: 6.5 km); additionally each battery receives two separate launchers (44 total) armed with CAMM missiles (Range: >25 km), under the Pilica+ programme. Deliveries to be completed in 2029.
- 79 Poprad launch vehicles (split between eight formations and a training school), armed with either Grom (Range: 5.5 km) or Piorun missiles (Range: 6.5 km). Deliveries completed in 2021.
- Collaboration between MBDA and PGZ in the development of the CAMM-MR missile, purportedly slated to have a range of approximately 100 km. Planned to eventually enter service with Poland on both land and naval platforms.

As things currently stand, in 2035 Poland will possess probably the largest, and one of the most modern GBAD system fleets among all European NATO Allies. The fleet will be capable of combating a wide variety of threats, including small drones, cruise missiles and PGMs, modern fast jets, and SRBMs. This represents a remarkable turnaround in a relatively short span of time, especially considering the Polish Army had previously not procured any new GBAD systems, aside from man-portable air defence systems (MANPADS), since the Cold War.

Moreover, in a synergistic move Poland has opted for a common C2 system for its PATRIOT and its Narew batteries in the form of IBCS. This not only provides it with a modern, capable C2 system, but one which has already been integrated with F-35, which Poland is also procuring. This would in principle enable targeting data sharing across PATRIOT, Narew, and F-35. The most likely envisioned use cases would include, for instance, using F-35 radar data to enable PATRIOT and Narew batteries to conduct engagements below their own ground-based radar horizon, as may be required against very low-flying threats such as cruise missiles. This data-sharing capability would also enable redundancy in case of a ground-based radar being jammed or lost.

# Next-Generation Energy Storage for Modular Military Power Supply

## ESM hybrid brings the "Modular Grid" system to market readiness

Modern armed forces face a complex challenge: the power requirements of military systems have increased significantly. Air defense radar systems require continuous power for command posts and launcher modules. Electronic warfare, reconnaissance, and communications systems further drive up consumption. Added to this are basic operational requirements: quarters must be heated and illuminated; medical facilities supplied with life-saving equipment. What is routine in garrison becomes a critical logistical challenge in deployment.

VINCORION's Modular Grid technology provides flexible solutions to these power challenges. "The true innovation lies not in the technology alone, but in the operational advantages it creates," explains Sascha Brüning, Vice President Business Development & Sales at VINCORION. "Close collaboration with users and procurement agencies has provided valuable operational insights."

**Battery Storage as Key to Efficiency** Central to this innovation is the ESM hybrid energy storage module, which works in conjunction with PGM low emissions generators. The intelligent battery storage systems with 28 kilowatt-hour capacity from Futavis (part of Deutz) enable diesel generators to operate at optimal efficiency while handling peak loads. The ESM is available in configurations ranging from one 28-kW battery to nine batteries.

Thanks to an integrated ventilation system for heating and cooling, the energy storage units operate reliably in a temperature range from minus 32 to plus 55 degrees Celsius. In many deployment scenarios, the generator can be completely shut down while the storage handles base load requirements. In combined PGM and ESM operations, fuel savings of up to 33 percent are achievable. This not only reduces consumption but also minimizes acoustic and thermal signatures.

**System Scalability and Integration** Daniel Zeitler, Head of Product Management at VINCORION, outlines the system's development stages: "In 2023, we first introduced the Modular Grid concept, 2024 saw our first new PGM 50 kW generator, and now in 2025, we're presenting the new ESM hybrid battery storage with innovative energy management. The system's modular design enables it to integrate virtually any energy source – from conventional generators to solar arrays and fuel cells."

▲ Sascha Brüning [VINCORION]

▲ Daniel Zeitler [VINCORION]

The advantages are evident in operational scalability. The different power classes of the PGM series with 20-, 50-, and 200-kW units can be combined with corresponding ESM modules and expanded according to mission requirements. A unified interface controls all components and automatically determines optimal energy distribution.

**Long-term Support Guaranteed** Beyond technology, VINCORION provides comprehensive lifecycle support. The company has invested in new testing and maintenance facilities. "We've built a new multi-generator test stand and invested systematically in our PCB manufacturing capabilities," reports Brüning. "This enables reliable repairs and significantly reduces turnaround time."

VINCORION maintains spare parts inventory and technical expertise for up to 30 years. Specialists from German facilities in Wedel, Altenstadt, and Essen support not only current systems but also legacy platforms – crucial for obsolescence management.

*Visit VINCORION at DSEI London, September 9-12, or RÜ.NET in Koblenz, September 3-4 – and experience advanced military power supply solutions.*

defense@vincorion.com

VINCORION

▼ The animation illustrates how PGM low emissions generators could appear in operational use. [VINCORION]

**A TEL from Poland's Mała Narew system, using the same UK-designed CAMM missiles as the British Army's Sky Sabre system. The CAMM family will form the backbone of Poland's future MRAD capability. [Polish MND]**

By contrast, the British Army is a notable example of chronic under-investment in GBAD, especially relative to the country's technological and economic potential. As with many countries, the UK's GBAD acquisitions were fairly limited in the decades following the Cold War, with the primary system for 27 years being Rapier FSC, a SHORAD system which served from 1995 until its retirement in January 2022. Rapier was formally replaced in service by Sky Sabre, which is the service name for the UK's specific configuration of EMADS, equipped with CAMM missiles. Although often referred to as SHORAD, it would more accurately be described as sitting at the lower end of the MRAD band. While Sky Sabre is a modern, capable system which represents a substantial improvement over the old Rapier FSC system, the UK's overall GBAD picture nonetheless does not look particularly rosy. The two key problems here concern quantity and diversity.

At present, 16th Regiment Royal Artillery is understood to operate just four Sky Sabre batteries, each with three launchers (for a total of 12). On the V/SHORAD front, IISS' The Military Balance 2025 publication cites a figure of 38 FV4333 Stormer vehicles in service with the UK, which can be armed with Starstreak (Range: 5.5 km) or LMM missiles (Range: 8 km). Aside from some MANPADS, that is effectively the sum total of the British Army's GBAD at present. Based on a rough calculation, the British Army's current capability results in a theoretical maximum defended footprint similar to just the organic GBAD available to two Russian tank divisions. While this is admittedly a somewhat flippant example, as different systems have varying typical deployment distances between launchers and command posts which can influence the real defended footprint greatly, it nonetheless serves as a rough litmus test of capability. All told, things could be better.

Regarding diversity, the Army currently fields only V/SHORAD and MRAD systems; it has neither LRAD, nor BMD capability. As things stand, this leaves the UK with no answer to the likes of 9M723 Iskander-M or Kh-47M2 Kinzhal, both of which have been commonly used by Russia in Ukraine. Through the Royal Navy's Type 45 Destroyers, the UK does have Aster-30 missiles, which in theory would be capable of dealing with the aforementioned threats – although reports from Ukraine

**A 9P78-1 TEL of the Iskander-M system, with two 9M723 SRBMs shown raised to the launch position. At present, specialised GBAD is the only realistic solution to such threats in the context of a land war. [RecoMonkey]**

in early 2025 suggested otherwise. In any case, being ship-based, these would be of limited utility in the context of a land war occurring deep into the European continent. As things currently stand, the UK's main options for force protection in a NATO-Russia scenario would seem to comprise: relying on Allied GBAD to plug the Army's gaps, and/or dedicating at least some of its fast jets to a defensive role. Thus far, the MoD has signalled it is pursuing the latter approach in the 2025 Strategic Defence Review, stating: "The RAF combat air force provides the core of UK IAMD 'effect' capability, with Typhoon and F-35 providing the UK and NATO with air defence against air and cruise missile attack."

Filling the gaps in the UK's GBAD would require substantial investment, but there have been some small signs that the MoD intends to consider the issue more seriously. Among these is the UK-led DIAMOND initiative, which according to an MoD statement aims "to integrate NATO's missile defences, while also pledging to develop new long-range, cutting-edge missiles, improving the Alliance's collective air defence and offering opportunities to the UK defence industry". However, until hard figures are revealed by the MoD in its 2025 'Defence Investment Plan', slated for publication at some point in the autumn, it is difficult to assess the extent of the UK's ambitions in this field.

## An oppressive layer

In general, it is fair to say that GBAD has not enjoyed quite the same level of attention or credit for its role in the Russo-Ukrainian War as many other weapons. This was especially the case during the first two years, where the main references to it consisted of mocking calls of 'what air defence is doing?' on social media.

Some of this was due to poor public understanding of GBAD. Strikes on positions happen, so people assume air defence doesn't work. GBAD system components get destroyed, so people assume they're useless. Few confirmed kills are posted on social media, so people assume targets aren't being intercepted. Additionally, there's the problem of attrition inflation in the public imagination – mainstream press are used to dealing with single-vehicle systems such as tanks, whereas many GBAD systems are multi-vehicle systems. The result has been that media will be far more likely to report something like 'two S-400 systems destroyed' rather than the more accurate 'two 5P85TM launchers destroyed' – which would be just a portion of an S-400 battery. This isn't helped by the myriad variations in air defence system sizes among different systems and users, with terms such as 'fire unit', 'battery', to the Russian 'divizion' and 'polkovoi komplekt' – all of which can be confusing.

Attitudes did start to change somewhat as the war dragged on, especially as Ukraine's air defenders began to regularly post regular interception reports on social media, and increasing insight into the nature of the fighting began to drip-feed into public discourse. However, perceptions of GBAD's importance are difficult to shift, and fundamentally this comes down to GBAD being a low-propaganda value weapon, unsuited to the information war for several reasons.

For starters, given the massive area in which aerial targets could fall after being downed, many GBAD successes become confirmed only much later, such as when one side captures an area where an aircraft wreckage landed – yet this could take weeks, months, years, or in some cases might never happen. Such was the case with Bayraktar TB2 – the flurry of TB2 strikes published to social media led to it being hailed as a wonder weapon in the public imagination, even having a song written about it. However, the reality on the ground looked quite different – by the fourth week of Russia's 2022 invasion, new clips of TB2 strikes had dried up almost entirely. Then, only many weeks later as Russian ground forces gained ground in some sectors, they began posting photos of TB2 wreckages they had found to social media. Since the opening weeks, there have been only a small handful of new clips of TB2 strikes, broadly restricted to portions of the Black Sea.

Next, aside from some very kinds of short-range engagements such as those against small drones, most engagements (especially those against the highest-value targets) will tend to happen beyond visual ranges, sometimes even beyond the range of a system's optoelectronic sights (if present), meaning they can only be seen on radar. Simply put, video footage of a track on a radar screen losing altitude doesn't make for compelling sharable social media content in quite the same visceral manner as a first-person view (FPV) drone strike.

**A selection of copter-type small drones of various weight classes in use with Ukraine. Along much of the front line, this is effectively what air power has been reduced to. [Ukrainian MoD]**

Yet the effects of air defence in the Russo-Ukrainian War become fairly evident when looking for notable absences on the wider battlefield. Are fast jets regularly flying at medium-high altitudes close to the front lines? Are drones in the medium-altitude long-endurance (MALE) or similar class being observed in use? Are deployments via parachute being carried out? Are attack helicopters being used in offensive operations? After the high-intensity opening phase of fighting, the answer to all of these broadly became no. In this capacity, GBAD has served as an invisible, oppressive layer hanging over the battlefield in Ukraine, greatly limiting the utility of manned aviation for over three years. Within this kind of environment, both sides began to understand that regular flight along the frontline would only be possible by going small, cheap, and unmanned.

# Trade-offs in air defence system design

Dr Sidharth Kaushal

**As modern warfare increasingly features overlapping missile, drone, and cruise missile threats, air defence planners face critical decisions about whether to optimise systems against specific threats or pursue costly multifunctional capabilities. Recent conflicts from Ukraine to the Middle East reveal how these choices can determine mission success or failure.**

The design of air defence networks in a context where a number of overlapping threats will characterise the operating environment will pose a number of considerations as planners and defence industrial specialists attempt to balance the imperatives of managing the problems of mass and complexity. Among these are the questions of to what extent capabilities should be optimised against particular parts of the threat spectrum as opposed to being multirole and the trade-offs between coverage and magazine depth. In addition, the ways in which the demand for a broader range of sensors must be managed will pose its own challenges.

## Optimisation or multifunctionality?

The choice regarding whether to build systems that are optimised against parts of the threat spectrum or not is one of considerable strategic importance, particularly in a context where multiple threat types converge. To build solutions weighted against individual parts of the threat spectrum is to risk having multiple lines of effort, each of which is poorly-resourced. Equally, the desire for multifunctionality can result in systems which are functional against many threats but perform sub-optimally against parts of the threat spectrum.

One solution might be to build systems biased towards a particular threat type. This does not mean exclusive focus, but relative weighting. The case of the Iranian attacks on Israel over the course of 2024 and 2025 are instructive in this respect. In April 2024, Iran commenced an attack which was in many respects a defence PowerPoint diagram come to life, combining unmanned aerial vehicles (UAVs), cruise missiles and ballistic missiles. The challenge that this posed, however, was that rather than reinforcing one another, the different elements of the threat spectrum undermined each other. Shahed one-way attack (OWA) UAVs provided Israeli air defenders with nine hours of warning, which in turn eliminated any hope of operational surprise when Iran's ballistic missiles were launched. It is perhaps unsurprising, then, that during its attacks in both October 2024 and July 2025 Iran opted for purely ballistic attacks (UAVs were used in July 2025, but there was no attempt to coordinate them with ballistic missiles and they had very limited utility).


**A Shahed 136 OWA UAV on display. Iran's decision to add such threats into the mix for its April 2024 attacks proved less effective than it might have hoped. This was partially due to their launch increasing the warning time, but also because the air defence means to deal with Shahed tend to be much simpler than those required to deal with ballistic missiles, meaning there was no real synergy between the two to overwhelming a particular class of defensive system. [FARS Media Corporation/Behrouz Ahmadi, via Wikimedia Commons (CC-BY-4.0)]**

Particularly at medium and intermediate ranges, some capabilities are considerably more concerning than others. Cruise and ballistic missiles which have the payloads to destroy high-value targets and the penetrating capacity to leak through air defences in meaningful numbers pose a considerably more potent threat than UAVs. Moreover, while there are opportunities to use the two threat types in mutually-reinforcing ways (for example using ballistic missiles with submunitions to trap aircraft for a follow-on salvo of cruise missiles), the differences in speed makes convergent attack unlikely. Such would likely characterise Chinese attacks on US airbases in the Pacific. Instead, one capability is often likely to act as a breaching capability and force multiplier for the other. For example, if Iranian ballistic missiles had proven more effective at shutting down bases such

AUTHOR

**Dr Sidharth Kaushal** is a Senior Research Fellow at the military sciences team within the Royal United Services Institute (RUSI). His specialisms include Sea Power and Integrated Air and Missile Defence.

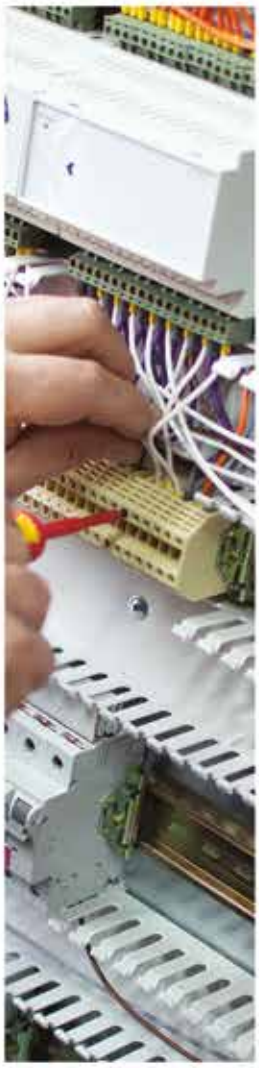
# PIEK

YOUR KNOWLEDGE PROVIDER FOR THE ELECTRONICS INDUSTRY

## TRAINING COURSES

FOR THE ELECTRONICS MANUFACTURING INDUSTRY

| PB DESIGN | PB FABRICATION | PB ASSEMBLY | PB REPAIR AND REWORK | CABLE AND WIRING TECHNIQUES | SPECIAL TRAINING PROGRAMS |
|---|---|---|---|---|---|



## QUALITY

IPC® ACCREDITED TRAINING PARTNER

PIEKTRAINING.COM

as Nevatim in October 2024 and July 2025, arguably cruise missile salvos would have proven more effective against a reduced defensive counter-air (DCA) challenge.

When one enjoys the advantage of medium to intermediate ranges from an opponent, then, it is arguably useful to optimise against specific high-value threat types even to the partial exclusion of others. For example, the Russian system as constituted has a specific focus on big-wing enablers such as tankers and airborne early warning and control (AEW&C) aircraft (against which the 40N6 of the S-400 was optimised), as well as on cruise missiles, which are to be engaged both by surface-to-air missiles (SAMs) and by aircraft such as the MIG-31BM, which was equipped with a Zaslon radar purpose built for this role – something which was arguably well-suited to Russia's pre-war needs.

## Operating without depth

The erosion of a nation's strategic depth, however, can change this dynamic considerably since the range of threats which can strike a target increases exponentially.

Again, the Russian case is illustrative, particularly in light of the change in Russia's borders with NATO after 2022. The changing boundaries of the Alliance makes it possible to strike operationally or strategically significant targets with missiles which might have previously been considered tactical. From Finland, for example, a short-range ballistic missile (SRBM) such as the PrSM can reach a number of targets that the Russians would dub 'strategic', such as Severomorsk and Olenya Guba. Many of these systems can be launched from otherwise 'tactical' systems, such as M142 HIMARS and M270 MLRS.

The challenge Russia will face is not that it cannot defeat each threat type. In the ballistic missile defence (BMD) role, systems such as the S-300V can engage tactical ballistic missiles (TBMs) and SRBMs, while S-500, although notionally optimised for engaging medium-range ballistic missiles (MRBMs) and intermediate-range ballistic missiles (IRBMs), can also play a supporting role against lower-tier threats through its sensor coverage, or the provision of lower-tier interceptors. Meanwhile air-breathing threats can be engaged by Tor, Buk, S-300V4, S-400, among others. Similarly, systems such as Tor and Pantsir can play a counter- rocket, artillery and mortar (C-RAM) and counter-precision-guided munition (C-PGM) role. However, each individual system is vulnerable to the threats against which it is not optimised. For example, despite the 9M96M missile (now more typically employed on the S-350, but can also be used with S-400 if required) being of utility against tactical ballistic targets, it does not have a hit-to-kill warhead or a Ka-band seeker. This could either reflect a design focus on air breathing targets or potentially that the Elbrus-800 computer on S-400 is marginally too slow to enable hit-to-kill solutions (something which is often compensated for with seeker frequencies that enable wider sweeps but preclude hit-to-kill solutions). In either instance, the effective operation of an S-400 against a large number of tactical threats becomes dependant on the availability of ballistic missile defence (BMD) capable systems, increasing the cost and complexity of the air defence in an area but also forcing geographical clustering to enable mutual reinforcement.

The changing dynamic has also turned Russia's BMD strategy inside-out. Systems such as the S-500 and A-235 were procured with a view to defence against more limited numbers of IRBMs and intercontinental ballistic missiles (ICBMs). As more nations field SRBMs like PrSM, Russia will have a choice to make. It can deploy the S-500 against SRBMs (albeit almost certainly using interceptors other than the 77N-6 which is a high endoatmospheric capability). However, if employing the S-500 against lower-tier threats such as TBMs/SRBMs, it will necessarily have lower coverage compared to when it is configured against the MRBM/IRBM threats it was primarily designed for – due to the shorter-range missiles' lower apogee. Additionally, this would impose a degree of resource strain, since the limited numbers

**Russia operates a diverse array of air defence systems, providing coverage against a variety of threat types. The 9A331M transporter, launcher, and radar (TLAR) shown here is part of the Tor-M2 system, optimised for short-range air defence (SHORAD) against air-breathing threats, along with and the C-RAM/C-PGM roles. [RecoMonkey]**

A 9A83M transporter, erector, launcher, and radar (TELAR) of the S-300V4 system. The continuous wave illumination radar for the track-via-missile (TVM) guidance system can be seen folded over the rear deck, under the missile containers. [RecoMonkey]

of S-500 will be needed to defend key strategic targets against intermediate-range targets like submarine-launched ballistic missiles (SLBMs). Moreover, close to the front the S-500 is vulnerable to a range of air-breathing threats, necessitating the use of 'gate guardian' systems to protect it. The system itself is expected to carry a range of interceptors but dedicating launchers to shorter-ranged interceptors would limit its capacity against those parts of the threat spectrum which only it can defend against. Alternatively, Russia can turn to systems such as the S-300V4, but the X-band semi-active radar homing (SARH) seeker on the 9M82 likely provides limited granularity (which is traded for range) and a lower integration rate for returns, which potentially explains the modest claim of 0.5 probability of kill (Pk) against TBMs. This does not mean that defence becomes impossible, but the need to layer capabilities likely makes it more spatially concentrated.

This conundrum is not necessarily a uniquely Russian challenge and it raises two possibilities. The first is that forces, particularly in the land environment, will have to cluster in ever narrower areas both to enable mutual reinforcement of air defence system types, but also to allow for shorter-range air and ballistic missile defence systems which can be used in larger numbers, to be better leveraged given the limited coverage of these systems. Consequentially, both covered areas and the portion of a military force which is usable (in terms of having sufficient air cover to muster for an attack) will be relatively small at any given time and hard choices between the defence of frontlines and rear areas will have to be made.

## Integration as an enabler for optimisation

An intermediate point between these two positions might suggest that the answer to the question of whether to optimise or aim for a balanced and integrated system (with consequentially limited coverage) is a function of one's ability to offset elements of the threat through means other than active defence. Integration in its broadest sense – the use of passive defence and offence in tandem with active defence – may thus be the determinant of one's ability to optimise.

It is of some note that the fact that Israel found itself facing a purely MRBM threat was a function of its previous success against Hezbollah, which removed the latter's rocket, artillery, and mortar (RAM) and TBM/SRBM threats from the mix to a considerable extent. Although despite this, Hezbollah did destroy or damage elements of the Israeli air defence system with capabilities such as Spike derivatives on several occasions. In effect, optimising the offence against a particular part of the threat spectrum (RAM and TBMs from Lebanon) narrowed the air defence challenge down to what in effect amounted to BMD.

In other circumstances, the situation may be reversed and longer-range threats may be more easily eliminated by means other than defence. In Europe, for example, Russia is likely to have a limited number of launchers for IRBMs such as Oreshnik for some time, incentivising 'left-of-launch' solutions.

Other elements of the threat spectrum may be better managed through passive defensive solutions including camouflage and hardening – something particularly true of many UAVs, which have small payloads and limited sensor loadouts. This is also true of older cruise missiles, many of which can be diverted off course by capabilities comparable to the digital radio frequency memory (DFRM) decoys used on naval vessels.

To the extent that an air defence system can be optimised against a threat type, it can more efficiently provide coverage over a wider area for longer (simply because of the efficiencies that focusing time and resources on a simplified problem creates). This will in turn depend on other parts of missile defence including suppression and passive defence.

# Countering small drones: A big challenge

Doug Richardson

**What began as a commercial technology is in the process of transforming the modern battlefield. As drone technology proliferates, and production scales toward the millions of units annually, the urgent question facing militaries is not whether they can afford sophisticated counter-drone systems, but whether they can afford not to deploy them.**

While the funeral in Vatican City of Pope Francis on 26 April 2025 involved many traditional features, such as Swiss Guards dressed in their traditional Renaissance-style tricoloured uniforms, and armed with swords and halberds, it introduced one defensive measure never before seen at a papal funeral – soldiers from the Italian special forces armed not with rifles or other small arms, but with infantry-portable anti-drone weapons. Although a 'no-fly' zone had been imposed over the entire area of Rome and the Vatican in order to keep the sky clear of unauthorised aircraft and helicopters, the security forces were ready to deal with pilotless intruders.

Although no drones disturbed the funeral, small drones with multiple rotors and ranges of up to around 10 km have changed the nature of front-line combat. They are already reported to be responsible for around two-thirds of the total combat casualties suffered by both sides in the current conflict between Russia and Ukraine.

Both countries are understood to be using around 10,000 drones each month. Given that Ukraine's target for drone production through 2025 is 4.5 million, and Russia is reported to be planning to produce between 3–4 million, the rate of drone use seems set to increase, perhaps by an order of magnitude or more.

## Radio links versus jammers

One inherent problem in creating effective anti-drone defences is that the process is largely reactive. Drones and drone tactics continue to evolve, particularly during conflicts, and upgrading of defences is the inevitable response to this.

AUTHOR

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

Known as first-person view (FPV) drones, the most common variant harassing Russian and Ukrainian front-line forces over the last year or so are typically controlled in real time via a video feed sent via a radio link to the operator who can use electronic goggles to display imagery from the drone's onboard camera, and use commands sent by radio to steer the aerial vehicle. Since these two-way radio communications can be jammed, many drone systems use frequency-hopping to try to maintain the two-way linkup.

**Developed by the Australian company Droneshield. the Dronegun Tactical uses·directional antennas to deliver RF energy intended to disrupt control, video, and navigation signals across multiple frequency bands, and to prevent the target from using satellite navigation. [Droneshield]**

Jamming of the radio signals passing between the drone and its operator was a viable solution for dealing with first-generation threats. Jammers transmit a large amount of radio frequency (RF) energy towards the drone. This can disrupt the commands being sent to the drone, and video signal being transmitted back to the controller. They can also be used to jam any on-board GPS system that the drone may be using for navigation.

While anti-drone jammers are available in fixed-site and vehicle-mounted configurations, as the hardware being used to protect the Papal funeral in April 2025 showed, RF jammers are also widely available in man-portable form.

Early drone jammers operated on specific frequencies known to used by commercial drones. More modern systems use improved RF detection subsystems capable of precisely iden-

# UNMANNED REVOLUTION

www.wbgroup.com

WB GROUP

tifying the specific frequencies used by their target, tailoring the jamming to match the threat, while minimising the risk of interference with friendly RF-based systems. However, RF jammers require regular updates in order to cope with changes on the download and control frequencies being used.

By the end of 2024, more than 70% of the radio-controlled FPV drones being used by Russia and Ukraine were being successfully countered by jamming, even though newer types of Ukrainian drone operating at many different frequencies had made Russian jamming operations increasingly difficult.

## The fibre-optic revolution

Fibre-optic drones get around the jamming problem by carrying a storage spool and a dispensing system for a long optical fibre. Since all communications between the drone and its operator are transmitted through the fibre rather than via radio links, these drones are more difficult to detect, and immune to effects of defensive jammers. Fibre-optic technology offers much higher bandwidth than is possible using RF links, so delivers higher-quality imagery to the operator.

▲ A Ukrainian drone manoeuvres after launch to demonstrate the release of its trailing optical fibre. [Ukrainian MoD]

The weight of the fibre-optic storage spool and the dispensing system reduces the operational payload of a drone. Maximum range is limited by the total length of fibre being carried, and currently sits at around 10–20 km. While the presence of the fibre does place limits on the degree to which the drone can be manoeuvred, it does allow flight at much lower altitudes than are required in order to maintain radio links. Additionally, as long as the fibre is unbroken, the drone could be landed to await the arrival of a suitable target – thereby permitting ambush-type attacks.

If the use of fibre-optic drones destroys a large portion of the enemy's RF jamming systems, this can restore the viability of radio-controlled drones, which are less expensive than their fibre-optic guided counterparts.

## Protective netting

According to a recently-published US Army document, gunfire is seen as a potential counter to hostile drones flying close to a tank. The proposed procedure for a training exercise 'React to Unmanned Aircraft System While Mounted – Platoon' calls for tanks threatened by a hostile UAV to "engage with all machine guns or 120 mm canister rounds". US tanks have no fire-control system able to target such threats, but the document recommends that when faced with a crossing fixed-wing threat, gunfire be aimed "one-half football field in front of nose", while an approaching quad-copter be tackled by aiming slightly above its fuselage.

Such a simplistic approach has not found favour with other armies. Recent conflicts have seen tanks equipped with protective screening intended to detonate incoming warheads. In its most basic form, these are mounted above the turret in order to counter attacks from above, but drones are now able to fly at very low altitude when attacking, and recent imagery has shown some Russian tanks totally enveloped by protective screens.

Armoured fighting vehicles (AFVs) and other vehicles on the move behind the front line are potential targets for attack, as are groups of soldiers. In 2023, Russia was reported to be using lamp posts to support panels of netting stretched across major roads around Bakhmut. These panels seemed to be repurposed camouflage netting, and were intended to counter drones attempting at fly at shallow approach angles while chasing and attacking vehicles. Likewise, Ukraine has also taken a similar approach, by hanging fishing nets above commonly-used roads. This thin netting is often difficult to detect on an FPV's camera, and make it likely that FPVs diving targets on these roads would find themselves immobilised in the process, their propellers snagged in the netting.

▼ A Ukrainian 'drone tunnel' in Donetsk Oblast. Such is the density of FPV drone threats that both sides have opted for covering up commonly used routes with anti-drone netting. [jana_skhidna X Account]

In mid-2024, the Russian TASS news agency recorded that the vehicle routes in the Kupyansk area of the front line were being fitted with protective nets made from plastic and fabric mesh held in position by wooden poles positioned along the route. If the netting is installed both overhead and on both sides of the road, the result is the creation of what is intended to be an anti-drone tunnel.

In February 2025, a 2 km tunnel of nets was reported to have been installed near Chasiv Yar in the Donetsk region. These road-protection schemes are reported to be effective, but involve a significant investment in man-hours both to install the supports and netting, and then to maintain them. It remains to be seen for how long such protective nets will remain a practical solution.

## Small SAMs for the anti-drone role

One early attempt to create a low-cost surface-to-air missile (SAM) able to engage small UAVs was the Raytheon Coyote. This was originally developed in piston-engined form, incorporating folding wings, and stored in a pneumatic box launcher. It formed part of the ground-based air defence (GBAD) counter-UAV system developed for the US Marine Corps. This teamed the missile with an RPS-42 S-band radar, a Modi electronic warfare (EW) system, and visual sensors. In this initial form, Coyote was 600 mm long, had a 1.47 m wingspan, weighed 5.9 kg, and was armed with a 1.8 kg warhead.

Selected by the US Army for use in the counter-UAV role, the Coyote Block 1B version was equipped with a RF seeker and a proximity-fuzed warhead, and operated in conjunction with Raytheon's Ku-band Radio Frequency System (KuRFS) radar. To increase the missile's speed and maximum range, Raytheon then developed the Block 2 variant. Launched by a rocket booster and powered by a small turbojet engine, this had a flight endurance of up to 4 minutes, giving a range of 10-15 km, and the ability to re-attack a target in the event of an initial miss.

In February 2021, Raytheon was awarded a US Navy contract to develop what was originally known as Coyote Block 3, but was later given the designation Coyote Launched Effect Short Range (Coyote LE SR). Compatible with a TOW missile launcher, this version has no wings or strakes, but features three rear-mounted pop-out grid fins.

Aside from the more common explosive payloads, non-kinetic options are also becoming available. In this vein, in August 2021, Raytheon announced that during an air-intercept test, a Coyote Block 3NK (non-kinetic) missile launched from a US Army Fixed Site-Low, Slow, Small UAV Integrated Defeat System (FS-LIDS) had used its non-kinetic warhead to defeat a swarm of ten drones.

The palletised FS-LIDS is one of two configurations of the Raytheon's LIDS family, the other being the Mobile-Low, Slow, Small UAV Integrated Defeat System (M-LIDS) variant. Both integrate Raytheon's KuRFS radar and Coyote missiles with Northrop Grumman's Forward Area Air Defense Command and Control system (FAADC2) and the Counter-Small UAV Electronic Warfare System Direction Finding (CUAEWS DF) direction finding and electronic warfare (EW) system made by Syracuse Research Corporation.

M-LIDS Increment 2 comprises a pair of Oshkosh M-ATV 4×4 protected patrol vehicles, one of which is fitted with a Moog Reconfigurable Integrated-weapons Platform (RIwP) remote turret, armed with a launcher housing two Coyote munitions, and the XM914E1 30 mm automatic cannon; while the second vehicle is equipped with the CUAEWS DF, along with a remote weapon station (RWS) fitted with a M2 12.7 mm heavy machine gun (HMG), paired with the Ballistic Low Altitude Drone Engagement system (BLADE) specialised C-UAV sight. Two key capability differences between the two configurations include the fact that M-LIDS has both cannon-based and HMG-based effectors while FS-LIDS lacks these, and that FS-LIDS' Coyote launcher houses four rounds, while the M-LIDS' launcher houses two.

In 2019, the USAF revealed that its BAE Systems AGR-20 Advanced Precision Kill Weapon System II (APKWS II) air-to-ground 70 mm guided rocket had been successfully tested in the air-to-air role. In late 2023, the service announced the

▼ **A US Army Bradley Fighting Vehicle launches a Coyote LE SR during Project Convergence-Capstone 5 (PC-C5) at Fort Irwin, California, on 12 March 2025. [US Army/Sgt Marita Schwab]**

▼ **Raytheon's palletised FS-LIDS launches the company's Coyote Block 2 missile. [Raytheon]**

impending delivery of a new APKWS II proximity-fuzed warhead intended for use against drones. Early in 2025, the USAF reported that the APKWS II had been successfully used by F-16 fighters to engage hostile drones launched by Ansar Allah (Houthi) militia forces in Yemen. In this role, the APKWS II had served as a low-cost alternative to the AIM-9X Sidewinder.

Laser-guided 70 mm rockets also form the armament of L3Harris Technologies' Vehicle Agnostic Modular Palletized ISR Rocket Equipment (VAMPIRE), a modular system able to arm light tactical vehicles or even non-tactical vehicles. Based on a pallet that can be installed in about two hours on any vehicle with a cargo bed, it combines a mast-mounted WESCAM MX-10D RSTA independent stabilised sighting system with a launcher for APKWS or other laser-guided munitions. Developed and field-tested in 2021, this surface-to-air system underwent further tests in the following year, and a batch of 14 were delivered to Ukraine by mid-2023.

## Even smaller and cheaper SAMs

Many small drones of the sort being widely used in the Russo-Ukrainian war would not make suitable targets for SAM defences on technical or cost grounds. Even engagements by cannon-based defences may prove surprisingly expensive if long bursts are fired. If SAMs are ever going to become a widely-deployed counter to swarms of drones, they would have to be cheap enough to be mass-produced at a unit cost similar to that of their target. Although such a goal may seem impractical, several companies not currently associated with missile development and manufacture seem determined to attempt it.

The Latvian company Frankenburg Technologies has set itself the goal of developing "missile systems that are ten times more affordable, a hundred times faster to produce, and in quantities far exceeding current industry capabilities". In December 2024, it announced a plan to start testing of hardware in Ukraine during 2025. No technical details of the hardware have been published other than a maximum engagement height of 2,000 m. A photograph of what seems to be a test launch shows a wingless missile with cruciform tail fins, but other photographs released by the company show a model with cruciform wings and tail fins, and indicate a length of less than 1 m. A predicted unit cost of around USD 2,000 is in a similar price category as many of the drones it is intended to counter.

In March 2025, the Swedish company Nordic Air Defence (NAD) announced the development of the Kreuger 100 anti-drone missile. Compatible with handheld or mobile launchers, it uses what the company describes as battery-powered pulsed propulsion, and is guided by an infrared (IR) seeker, which according to the company is built from "commercially available components", and "designed to function effectively in various weather conditions, day or night". Currently the missile flies at speeds of up to 270 km/h, but significantly higher speeds are expected from a planned military variant. It is understood to lack a warhead, however this has not been confirmed.

## Drone versus drone

An alternative to these proposed missiles is already in service in the form of interceptor drones. Guided by real-time data from ground-based radar or optronic systems, these take direct physical action such as detonating a warhead, colliding with the intruding drone, or delivering some form of disabling payload such as a net.

Ukraine is already using Win_Hit interceptor drones developed by Ukrainian company ODIN to engage Russian Shahed/Geran and Gerbera long-range one-way attack (OWA) drones. Win_Hit is vertically launched and powered by four propellers mounted at the tip of the drone's cruciform wings. Once launched, it has an endurance of 7–10 minutes, and cruises at 200–220 km/h, transitioning to 280–300 km/h during its final attack.

**This screengrab shows a test launch of the Mark I anti-drone missile being developed by Latvian company Frankenburg Technologies. This version, featuring cruciform wings and tail fins, is more likely to be representative of the eventual production model than the wingless configuration which has also been shown in company graphics. [Frankenburg Technologies]**

**The vertically launched ODIN Win_Hit interceptor drone is already in Ukrainian service. [ODIN]**

# YOUR SHIELD IN THE AIR

ANTIDOT 2-U
100/110/120

ANTIDOT 2-U 200

ANTIDOT 2-U/S 100

aselsan 50 years

On 3 July 2025, Ukraine and the US company Swift Beat signed a memorandum covering drone production. Swift Beat is to expand its production capacity, and give priority to supplying Ukraine with drones under what was described as "special terms and at cost price". In addition to interceptor drones, the agreement also covers quadcopters for reconnaissance, surveillance, and fire-adjustment, as well as "medium-class strike drones for engaging enemy targets". The US company had already conducted drone tests on Ukrainian territory.

Elsewhere, following an initial series of trials conducted in Israel during October 2024, around 20 counter-drone technologies underwent operational trials testing by the Israel Ministry of Defense (IMOD) Directorate of Defense Research & Development (DDR&D) in February 2025. While some involved gun systems, solutions using interceptor drones were demonstrated by Israeli companies, Airobotics, Elbit Systems, Elisra, Israel Aerospace Industries, Rafael Advanced Defense Systems, Robotican, and Xtend.

## Directed-energy weapons

The US Army's Directed Energy Maneuver-Short Range Air Defense System (DE M-SHORAD) is based on the General Dynamics Land Systems (GDLS) Stryker wheeled infantry combat vehicle, and is armed with a high-energy laser (HEL) and radar system configured by Leonardo DRS. This includes a 50 kW class laser intended to melt the plastic or metal structure of a hostile drone, damage its optical sensors, cause it to catch fire, or even to prematurely detonate the explosive payload.

During a meeting held in June 2025 to review Russia's planned state armament programme for 2027–2036, President Putin declared that the country needed "new approaches and non-standard solutions" to the problem of countering drones. Within days, officials revealed that eight HELs of varying power levels had recently been tested. These included mobile units and higher-powered stationary systems, and the trials were expected to allow the start of serial production and subsequent deployment.

In the spring of 2025, Russia's TASS news agency reported the development of a "laser rifle" able to attack hostile drones at a range of up to 500 m. Based on Ytterbium-laser technology, the hardware was tripod-mounted, and connected by cable to a separate power supply. According to TASS, a similar weapon was already in Ukrainian service. However, the only laser weapon that Ukraine has revealed so far is the Tryzub (ENG: Trident). A video released in April 2025 showed what was probably a trials version installed on a mounting carried in the rear of a vehicle. According to Col Vadym Sukharevskyi, commander of Ukraine's Unmanned Systems Forces, Tryzub can engage fixed-wing aircraft, helicopters, and large reconnaissance drones at ranges of up to 5 km, or tactical strike drones and cruise missiles at up to 3 km.

High-power microwave (HPM) devices are another form of directed-energy weapon (DEW), and are intended to generate an electromagnetic pulse (EMP) powerful enough disrupt or destroy the electronic circuitry in drones by inducing damaging levels of voltage and current. In April 2025, the UK MoD announced that during the largest counter-drone swarm exercise the British Army had conducted to date, soldiers had successfully tracked, targeted and defeated swarms of drones using a newly developed system dubbed 'RF DEW'. This used high-frequency radio energy to disrupt or damage critical electronic components inside the drones, causing them to malfunction or crash. Installed on a truck, the system is intended to defeat airborne targets at ranges of up to 1 km, and become an effective counter to UAVs that cannot be countered by electronic warfare. According to the MoD, the estimated cost of each shot of RF energy was about GBP 0.10.

## Last-ditch defence

Today's Russian and Ukrainian front-line soldier knows that while newspaper articles and defence magazines may talk of next-generation lightweight SAM systems, and of DEWs based on HELs or HPMs, these are unlikely to become available in large numbers deployed close to his current position. Meanwhile, the soldier lives under skies swarming with hostile drones – knowing that if a drone just spotted by a comrade has locked onto him, his life expectancy could be dramatically shortened. Inevitably, front-line soldiers facing frequent drone attack would like to see some form of anti-drone defence deployed at platoon level, or even made available to every soldier.

One potential candidate is a shotgun, which can be effective against all types of small UAV, including these guided by fibre-optics. Ukrainian and Russian forces are reported to be using shotguns as last-ditch anti-UAV weapons, and manufacturers in other countries are developing anti-drone shotgun rounds, and even offering specialised shotguns.

**During a trial conducted early in 2025, the UK-developed RF DEW system used high-powered RF energy to defeat a swarm attack by drones. [Crown Copyright 2024]**

**Benelli's M4 A.I. Drone Guardian shotgun features a long choke to allow drone engagements out to 100 m, with the manufacturer citing optimal effectiveness from 0 to 50 m. [Benelli]**

Italian firearm manufacturer Benelli Arm's M4 gas-operated 12-gauge weapon is already in service by the US as the M1014 Joint Service Combat Shotgun, by the UK as the L128A1, and by at least 14 other countries. The manufacturer has now developed the M4 A.I. Drone Guardian variant. This features a long choke inside the barrel which is intended to enhance the ability to hit drones at greater distances that are possible with the standard barrel.

Swedish ammunition manufacturer Norma offers the AD-LER, a 12-gauge shotgun cartridge that releases a payload of 2.7 mm No 6 tungsten shot at a velocity of 405 m/sec and a maximum effective range of 100 m. According to the company, the shot has a "high impact force against drones and other small aerial targets".

Payloads intended to end a drone's flight by tangling with or even damaging its rotor blades can be fired from shotguns or various forms of hand-held, shoulder-launched, or turret-mounted launcher. They can also be launched from a defensive drone, or hung below the latter and manoeuvred into contact with the target.

Florida-based company ALS has developed the ALS12SKY-Mi5, a 12-gauge anti-drone round intended for use against commercially-available drones used for illegal or military purposes. The payload has a velocity of 251 m/sec when fired, and a maximum effective range of about 90 m. It takes the form of five tethered segments which separate by centrifugal force in order to create what the company describes as a 'capture net' about 1.5 m in diameter.

Russia's Tekhkrym company is developing an anti-drone shotgun cartridge that fires a Kevlar net instead of traditional shot. Reported to be still under development in 2024, this will create a fully-deployed net at a range of about 30 m.

The smallest and most man-portable net-launcher is probably the hand-held Mitla developed by Ukrainian company Teneta. This single-use launcher is only 200 mm long and 40 mm in diameter, and weighs 365 g. A built-in 7.62 mm pyrotechnic cartridge provides the propulsive force for the net, which measures 3.5 x 3.5 m when fully expanded. Due to the force of the recoil, users are advised to hold the device with both hands when firing. Since the maximum range is only 25 m, this is very much a 'last ditch' weapon for an individual soldier who finds himself under attack.

Russian company Ingra has developed the Rosyanka adaptor that converts a standard GP-25 Kostyor 40 mm under-barrel grenade launcher mounted on AKM and AK-74 assault rifles into a single-shot 12-gauge shotgun with a reported range of 15–30 m. In 2024, Ingra claimed that testing of the Rosyanka adaptor had been completed, and that a pre-production batch was being manufactured. However, given that not all Russian infantrymen are equipped with the GP-25, the scale of any deployment of the Rosyanka will be limited, while its tactical

**A cluster of barrels (probably intended to fire shotgun ammunition) and a row of rifles form the armament what is probably a Russian improvised anti-drone vehicle, but there is no sign of an optical sight or other aiming system. [Russian MoD]**

**When mounted on a rifle, Israel's SMASH 2000L fire control system is intended to give the front-line soldier the ability to engage incoming UAVs.**

effectiveness will be restricted by a slow reloading process that requires the device to be removed from the grenade launcher, the spent cartridge case extracted, a new cartridge loaded, and the adaptor reinstalled into the grenade launcher. Shotgun-type weapons and machine guns have formed the armament of several Russian improvised anti-drone vehicles first seen in 2024. The ZVeraBoi incorporates a turret fitted with two 7.62 × 54 mm PKT machine guns, a six-barrel array intended to fire shotgun-style cartridges, and a thermal imaging sight. A second turret is armed an array of with six coaxial AK-12 5.45×39 mm assault rifles.

In late 2024, video sequences released by the Russian defence ministry showed a counter-drone vehicle armed with a cluster of 24 barrels that may be intended to fire shotgun-like ammunition, as well as six AK-series infantry rifles positioned on a single mount. Both of these multi-barrel systems are steerable, but it is not clear how they are aimed. Another Russian short-range anti-drone weapon created for use on a vehicle features a tripod-based mounting carrying a four-barrel Yakushev-Borzov YakB-12.7 rotary machine gun, a thermal-imaging camera, and probably a laser rangefinder.

Ukrainian defence forces have used FPV drones armed with shotguns to attack enemy UAVs. The Ukrainian company Varta has developed DroneHunter, a payload that can be used to arm small drones, allowing them to engage small and medium-sized opponents. It weighs 2.3 kg, and consists of two 12-gauge barrels able to fire electrically initiated anti-drone charges with a range of 5-20 m. Its recoil-suppression system is based on the principle of simultaneous counterfire. A similar system based on four 12-gauge barrels and able to fire more powerful ammunition with a maximum range of 50 m was reported to be under development in mid-2025. The first application of the twin-barrelled system was the Chief-1 UAV, which Ukrainian Ministry of Defence cleared for operational use in June 2025.

## Rifle fire versus drone

In June 2024 Ukraine released a video showing how a Yak-52 training aircraft could be used in the anti-UAV role by carrying a marksman close enough to a UAV to allow the latter to be engaged by rifle fire. However, full-automatic rifle fire from soldiers on the ground will rarely be effective against UAVs if standard ammunition is used.

Ukraine has developed a 5.56 mm calibre anti-drone round which is now in front-line use. Known informally as the Horoshok, it is reported to fire five sub-projectiles rather than a solid bullet. These are reported to have an initial velocity of more than 800 m/s, higher than that of the pellets released by anti-drone shotgun cartridges. Yet to have a realistic chance of downing a drone, the soldier must fire a burst of between five and rounds while continuing to track the target. Maximum range is reported to be around 50 m.

The soldier can rapidly reconfigure his personal weapon for use against drone targets, but the Horoshok cannot be fired while the weapon is fitted a suppressor or some types of flash hider. These rounds are reported to be already in service with some Ukrainian units, but production is expected to ramp up to allow more widespread deployment.

Postings on Russia's Telegram chat service in 2024 have shown attempts by Russian soldiers to improvise anti-drone payloads for the standard 5.45x39 mm rifle cartridge. One example showed how the standard projectile could be removed from the cartridge and replaced by a series of seven ball-bearings contained in a plastic shrink-wrapped sleeve. This improvised payload is smaller in diameter than the original projectile, so will have a low accuracy when fired, while the effect that ball bearings and the remains of the plastic shrink wrap will have on the barrel of the rifle are unlikely to be good.

An alternative approach is to add a sophisticated fire-control system to a rifle used to fire standard ammunition. The Israeli company Smart Shooter won a contract from the US Army to supply their Smash 2000L optical system for small arms and rifles to the US Army. It is intended to team artificial intelligence and assisted-vision technologies to allow individual soldiers to accurately engage moving targets including small drones. Smash 2000L uses image processing to recognise the target, predict its movements, and remain locked on the target despite its subsequent movements, and changes of position by the user. Maximum effective range is 250 m by day, and 100 m at night. The potential of giving the individual soldier the ability to engage small drones has not gone unnoticed by other nations, and the Israeli system can be integrated into any type of assault rifle. The British Army has procured a version of the system for use on its SA80A3 rifle.

## Coping with the evolving threat

As the deployment of front-line anti-drone systems increases, the greater the training problem. Ukraine reports that a growing number of its soldiers need to be trained in their use. At first, their success rate may be low, but as individual soldiers gain experience, the number of weapons or rounds fired in order to obtain a 'kill' declines significantly. However, there are only a limited number of Ukrainian training establishments, so experienced front-line units are often tasked with providing 'on the job' training for inexperienced arrivals.

Some observers have likened the current conflict between Russia and Ukraine to the trench warfare of 1914–18, with the large-scale use of drones representing the present-day equivalent to the massed machine-gun fire which caused so many casualties on both sides more than a century ago. Yet just as workable tactical solutions had to be developed to cope with the machine gun, the same will probably apply to drones. What that solution will be has yet to be found. To adapt the words of a reportedly traditional Chinese curse, we live in interesting times.

FN

**VISIT US AT DSEI UK**
9-12 SEPT - HALL N10 - BOOTH 115

OVER
**135**
YEARS
OF GLOBAL EXPERTISE

**50**
YEARS
OF MANUFACTURING IN THE UK

**fnherstal.com**
**fnuk.co.uk**

**Design** differently.

# Ground-based DEWs: From science fiction to operational deployment

Sidney E. Dean

**On 13 November 1973, an MQM-33B aerial target drone 3.6 m long was shot down by a 100 kW class Carbon dioxide laser over Kirtland Air Force Base, New Mexico. A half century later, laser weapons finally had their combat debut.**

In late May 2025, reports surfaced on pro-Russian *Telegram* channels stating that the Russian military was deploying a Chinese-built laser weapon against Ukrainian drones. To date, these claims have not been confirmed by either Moscow or Beijing. In contrast, there is more certainty regarding the 28 May 2025 Israeli government announcement that laser weapon systems developed by Rafael Advanced Defence Systems successfully downed "dozens" of aerial drones launched by Hezbollah from Lebanese territory at the beginning of October 2024. Rafael's chairman, Yuval Steinitz, stated that Israel had become the "first country in the world to transform high-power laser technology into a fully operational system and to execute actual combat interceptions".

**Rafael's Lite Beam system is a 10 kW class HEL designed to be compatible with even relatively small land platforms, such as the Joint Light Tactical Vehicle (JLTV). [Rafael]**

This begs the question: why did 51 years pass between the 1973 Kirtland AFB demonstration and the first operational deployment of an offensive or interceptor laser? The short answer is that the technology of the 1970s – and 1980s and 1990s – was insufficient to realise the ambitions of either the United States or any other military. It was not until the early 2000s that the Zeus-HLONS (Zeus-HMMWV, Laser Ordnance Neutralization System) was deployed to Afghanistan and Iraq. Despite still being developmental, and having no more than 2 kW output, the vehicle-mounted system succeeded in destroying hundreds of mines and roadside bombs. However, the static targets provided comparatively little challenge. Fielding directed energy weapons (DEWs) which were both battlefield practical and possessed sufficient precision and power to engage and neutralise moving targets would take another two decades.

AUTHOR

**Sidney E. Dean** is a freelance writer and editor specialising in strategic studies, military technology and military history. He serves as North America correspondent for ESD and other Mittler Report Verlag publications.

## Major challenges

While various different technologies fall under the category of DEW, the two types of weapons currently being pursued are high-energy laser (HEL) and high-power microwave (HPM) weapons. Near-term ambitions centre around counter-unmanned aerial vehicles (C-UAV), as well as counter rocket, artillery and mortar (C-RAM) applications. With further development, armed forces hope to eventually expand DEW capabilities to include downing cruise missiles, ballistic missiles and manned aircraft. While research and development is ongoing for ground-based, ship-based, and even airborne DEW systems, this article will focus on fixed and mobile ground-based technology.

Fielding effective directed energy weapons faces several challenges. HELs in particular rely on generating and maintaining a sufficiently powerful and coherent beam, and keeping that beam on a moving target for sufficient time to either disable sensors (if pursuing the less-lethal option), or burn through the target's skin to destroy vital components. Improvements in optics, computing power and artificial intelligence are making significant progress with regard to beam coherence and targeting capabilities.

However, power and cooling demands remain significant challenges for both HELs and HPMs, especially for mobile weapon systems. While industry and the military frequently cite DEWs as possessing 'infinite magazine depth' as a major advantage over conventional projectile weapons, in practice tactical DEWs still have a limited combat endurance. Most vehicle engines and diesel-powered field generators do not produce sufficient continuous power to directly feed energy weapons (especially at higher power levels). More commonly, they charge batteries which in turn power the weapons, either directly or via Supercapacitors. When the batteries are drained, they must be recharged before the weapons can resume firing. DEWs deployed to protect fixed or relocatable sites can alternately be powered directly from the electric grid, promising greater endurance.

Independent of energy supply, DEWs' operational endurance is limited by their thermal management capacity. Both HELs and HPMs both quickly generate massive amounts of heat which, if not managed correctly, degrades performance and can damage vital working components. Both weapon types typically require substantial cooling-off intervals after relatively brief (compared to projectile weapons) sustained firing. Here again, DEWs operating from fixed locations (and indeed on naval vessels) can be provided with larger and more powerful cooling systems than those operating from tactical vehicles. Indeed; for land vehicles, these cooling systems will represent a further burden on available power, as well as available volume and weight.

Further complicating matters is the issue of increasing effective range – simply put, to make HELs and HPMs able to engage targets beyond very short ranges, significantly more power is needed. This in turn makes it more of a challenge to meet system power supply and cooling requirements, and so requires more onboard volume and weight dedicated to the DEW. Additionally, in the case of HPMs, the powerful signals they emit make them highly vulnerable to discovery by hostile electronic intelligence (ELINT) systems.

The challenges have not deterred the armed forces of many nations from systematically pursuing the technology. This persistence is beginning to pay off, with development projects in the United States, Europe and Israel showing significant progress recently.

## United States

The United States Army and US Air Force (USAF) are pursuing multiple DEW programmes, several of which are considered high priority. These include:

**DE-M-SHORAD**

The Stryker-mounted Directed Energy Maneuver Short-Range Air Defense (DE-M-SHORAD) system is intended to augment the in-service gun- and missile-armed Sgt Stout M-SHORAD vehicles escorting manoeuvre forces.

The Army intends to deploy DE-M-SHORAD against Group 1-3 UAVs and in the C-RAM role; Department of Defense (DoD) documents also mention a potential capability to combat helicopters and low-flying fixed-wing aircraft, although this would be considerably more challenging given the typically greater ranges which would be required for engaging these latter target types.

In 2023, four prototypes (developed by Kord Industries as lead integrator) were assigned to an Army Air Defence Artillery platoon for evaluation. The prototypes' primary weapon is a scalable RTX-designed 50 kW class laser powered by Lithium-Nickel-Cobalt-Aluminium oxide (Li-NCA) batteries charged by diesel generators aboard the vehicle. The platoon deployed to Iraq in 2024 for operational evaluation, but the results were below expectations. The Army's Rapid Capabilities and Critical Technologies Office (RCCTO) postponed DE-M-SHORAD's transition to a programme of record, and issued new prototype contracts.

▲ The DE M-SHORAD prototype in February 2024 in Huntsville, Alabama. [US Army]

In June 2025, the Army conducted an exercise at Fort Sill, pitting prototype DE weapons, including a DE M-SHORAD system, against a swarm of Group 1-3 UAS. The Army's 27 June 2025 press release stated that data from these tests will shape future HEL development and procurement. The statement also stressed that short-range directed energy systems are intended to augment, not replace, kinetic weapon systems.

**IFPC-HEL/IFPC-HPM**

The indirect fire protection capability (IFPC) is a vehicle-mounted system designed to protect high-value fixed and relocatable sites against UAVs, RAM threats and cruise missiles. In addition to kinetic weapon systems, an IFPC-HEL variant and an IFPC-HPM variant were planned. In 2023, the RCCTO awarded Lockheed Martin a contract to deliver vehicle-mounted 300 kW class laser weapon systems prototypes by October 2025. However, the Congressional Research Service notes that future funding for IFPC-HEL is eliminated from the Army's budget plans starting in

FY2026, effectively freezing the programme; the impact of this on the IFPC-HPM remains to be seen, as the two types were to be used in tandem.

Meanwhile, Epirus provided the RCCTO with four transportable IFPC-HPM prototypes in FY 2024. According to Epirus, New Equipment Training (NET) and Engineering Developmental Testing (EDT) by the Army validated the HPM system's effectiveness against drones and drone swarms in a series of increasingly complex flight patterns. Epirus has stated that their HPM system functions differently to many others, using long pulses (circa 1 ms) to cause more sustained interference within circuitry, as opposed to the more typical approach employing very short pulses (circa 10 ns) at very high peak power.

Furthermore, on 17 July 2025, the RCCTO placed an order worth USD 43.5 million for two Integrated Fires Protection Capability High-Power Microwave (IFPC-HPM) Generation II (GEN II) systems. According to Epirus, these models are more capable than the GEN I models initially procured; in a press release the company stated: "*The IFPC-HPM GEN II systems are expected to more than double the maximum effective range of GEN I systems, increase power by a projected 30 percent and feature the inclusion of high-density batteries for prolonged operating times and decreased external power requirements, extra-long pulse widths for maximizing energy output for target defeat, high-duty burst mode for faster multitarget engagement, advanced waveform and polarization techniques for increased lethality against a broader set of targets of interest and Soldier usability enhancements.*"

**Open architecture HEL**

The IFPC-HEL funding change notwithstanding, the Army underscores its enduring commitment to fielding HELs. In March 2025, Huntington Ingalls Industries (HII) announced an RCCTO award to develop and test an open architecture HEL weapon system prototype to acquire, track and destroy Group 1-3 UAVs. It will be suitable for both fixed-site defence and integration onto vehicles. The open architecture will permit exchange of subsystems and software as the weapon evolves. According to HII, the RCCTO award is expected to ultimately culminate in a transition to the US Army's Program Executive Office for Missiles and Space. "As part of this process, HII's prototype HEL will undergo field testing to evaluate its safety and operational suitability. Upon successful demonstration, the system is expected to transition into low-rate initial production," according to the company's press release.

**High-power microwave weapons**

The USAF is focusing more closely on developing HPMs suitable for defence of fixed or semi-fixed installations such as air bases. In December 2022, the Air Force Research Laboratory (AFRL) opened the 1,100 m2 High-Power Electromagnetic Effects and Modeling Facility at Kirtland AFB. According to the AFRL press release, the facility will be used for planning, developing, prototyping, testing and deploying high-powered radio/microwave frequency weapons systems.

**THOR/Mjölnir**

Even prior to opening the centralised lab, the USAF has experimented with several HPM designs and prototypes. These include the Tactical High-Power Operational Responder (THOR) technology demonstrator developed by the AFRL in conjunction with Leidos and BAE Systems. The entire weapon system fits inside a 6-m ISO container, topped by the emitter antenna mounted on a fast-moving gimbal. THOR is powered directly from the electric grid, operating (as expressed by the AFRL) "from a wall plug. (...) A target is identified, the silent weapon discharges in a nanosecond and the impact is instantaneous." Evaluation began in 2018, and following a successful 12-month overseas field operation assessment, testing culminated in April 2023 with the defeat of a mock swarm attack at Kirtland AFB.

A follow-up system designated Mjölnir (named for the mythological Thor's hammer) is being developed by Leidos under a 2022 contract. Building on THOR's capabilities, the new prototype is expected to achieve greater capability, reliability, and manufacturing readiness. "Mjölnir will focus on creating a detailed blueprint for all future [C-UAV] HPM systems with enhanced range and technology for detecting and tracking UAVs," said Adrian Lucero, THOR programme manager at AFRL's Directed Energy Directorate, in February 2022. Like THOR, it is conceived for comparatively close-range defence against Class 1 and 2 UAVs.

**CHIMERA**

In contrast, the Counter-Electronic High-Power Microwave Extended-Range Air Base Defense (CHIMERA) is designed to engage medium- to long-range targets.

**Air Force Research Laboratory researchers making final touches on the CHIMERA equipment prior to conducting system tests. Beam width on HPMs can generally be scaled to match the threat scenario. [AFRL]**

AFRL awarded the development contract to Raytheon Missiles and Defense in October 2020. In January 2024, a successful three-week field test was conducted during which CHIMERA applied directed energy to multiple static target variations, and acquired and tracked aerial targets through their entire flight path. According to Raytheon, the system wields more power than other HPMs designed to defeat airborne threats (as indeed it would need to, in order to engage such targets at longer ranges). Unclassified public information regarding CHIMERA remains limited.

PHOTONIS
EXOSENS GROUP


**DSEI UK**
**EXOSENS BOOTH N8-245**

exosens.com

## Europe

Numerous multinational (European Union) and national-level DEW research, development and testing programmes are underway in Europe.

**TALOS-TVVO**
The Tactical Advanced Laser Optical Systems: Technologies for High Power Laser, Vulnerability study, Vignette development and Operational Study (TALOS-TVVO) is funded by the European Defence Fund. Launched in December 2024 and running for 36 months, some 21 firms and institutes from eight EU nations are involved, including CILAS (as project coordinator), Leonardo and Rheinmetall. The goal is to enable development of fully European and sovereign 100 kW class laser weapons by 2030. To this end, the project will work to mature critical technologies and subsystems, ensure an adequate European industrial base and supply chain for HEL production, and build demonstrators. The programme intends to coordinate with national MoDs to permit TALOS-TVVO technologies to flow into national HEL programmes; technologies are to be flexible enough to satisfy different end-user requirements.

**PESCO DES**
The EU's Directed Energy Systems (DES) project was officially approved on 27 May 2025 under the EU's Permanent Structured Cooperation (PESCO) initiative framework and is set to run from 2025 to 2029. The project aims to develop modular and scalable DEWs that can be mounted on any mobile platform. The primary focus is on Short- and Very-Short-Range Air Defense (SHORAD/VSHORAD) capabilities for the CUAV and CRAM mission as well as defence against loitering munitions and cruise missiles. The DES initiative will integrate scalable high-energy laser technology (10–100 kW power) into military vehicles and will feature an advanced command and control (C2) system, incorporating threat evaluation, sensing, and weapon assignment tools. Precision, engagement speed, adequate 'magazine depth' and low-collateral potential are key requirements. The project is led by Italy, with Spain as a key partner; major industry partners include Leonardo and MBDA.

**DragonFire**
At the national level, Britain has been making notable advances toward fielding a HEL weapon. Overall the MoD plans to invest GBP 1 billion for DEW programmes over the next five years as part of a spending package announced in June 2025, building on years of previous research and development.

The MoD's Defence Science and Technology Laboratory (Dstl) awarded the DragonFire HEL technology demonstrator contract in 2017. The system was designed by MBDA as lead contractor, with Leonardo providing the beam director and QinetiQ the laser source. A series of incremental tests led to the UK's first high-powered long range laser trial in 2022, during which DragonFire was successfully tested against static targets (including mortar bombs) at up to 3.4 km range. In late 2023, the HEL defeated the first aerial targets. According to a June 2025 statement by Dstl, recent successful testing includes over 300 firings of the DragonFire demonstrator and 30 drone defeats. Precise performance parameters remain classified, but the MoD states that DragonFire can engage with any visible target with "pinpoint accuracy, [...] leading to structural failure or more impactful results if the warhead is targeted". On 2 June 2025 the MoD announced plans to arm the Royal Navy's Type 45 destroyer with DragonFire. By contrast, the current Army-tested demonstrators will not enter service, but provide crucial insights for future DEW development.

**Land LDEW Demonstrator**
Another ongoing UK MoD programme is the 'Land LDEW' (Laser Directed Energy Weapon) Demonstrator programme, an advanced capability demonstrator initiative designed to explore and accelerate the integration of DEWs onto land platforms.

During this programme, British Army air defence personnel evaluated the Raytheon High-Energy Laser Weapon System, mounting it on a Wolfhound armoured vehicle. In early November 2024, the

▲ The British military's advanced capability laser demonstrator mounted on a Wolfhound tactical vehicle. [UK MoD]

system engaged and destroyed multiple UAVs in midair at varying altitudes, distances and speeds. This constituted the first such test of a HEL from a British armoured vehicle (the DragonFire tests were conducted from fixed test platforms). As noted by the MoD, "putting the demonstrator in the hands of the Army early will help inform future requirements and reduces the risks associated with future DEW acquisition. The intent is not to simply introduce these systems into service, but to use the demonstrators as building blocks for laser weapon capability in the UK."

On 13 June 2025, the UK MoD put out a preliminary market engagement notice soliciting industry proposals for a HEL system capable of destroying small UAVs at ranges of over 1 km, with a declared budget of GBP 20 million for purchasing "multiple systems", and with envisioned contract period of 1 August 2025 to 31 March 2026.

**RapidDestroyer**
The UK's Dstl is also testing an HPM for the C-UAV mission. The system has previously been referred to as 'RFDEW' (Radio Frequency Directed Energy Weapon) under Dstl's Project Ealing, but has since been designated 'RapidDestroyer' by Thales UK, the lead developer under Team Hersa (which also includes QinetiQ, Teledyne e2v and Horiba Mirais).

Like other HPM weapons, RapidDestroyer promises to be especially valuable against drone swarms by virtue of being able to generate a wide beam to engage multiple targets simultaneously, though it can also generate a narrow beam to engage individual targets. Both the UK MoD and Thales announced on 17 April 2025 that the system had successfully concluded the largest counter-drone swarm exercise the British Army had conducted to date. During the experiment, the Army brought down two swarms of drones in a single engagement; across the complete testing cycle more than 100 drones were tracked, engaged and defeated by RapidDestroyer. "With improvements on range and power, which could come with further development, this would be a great asset to Layered Air Defence," said Royal Artillery Sgt Mayers after participating in the experiment.

▲ The 'RapidDestroyer' HPM system on an RMMV HX60 4×4 truck platform during British Army trials. [UK MoD]

The electromagnetic pulses emitted by RapidDestroyer disrupt or damage critical electronic components inside drones, causing them to crash or malfunction. According to the UK MoD, the system currently has a range of up to 1 km against small UAV-type targets.

## Israel

According to the Israeli MoD, the laser DEW systems deployed at the country's northern border in 2024 were related, but not identical to, the Magen Or ('Shield of Light'; better known internationally as 'Iron Beam') system, which the Israel Defense Forces plan to introduce operationally by the end of 2025. The 100 kW class Iron Beam system is designed to intercept UAVs, RAM threats, and cruise missiles at ranges of up to 10 km (roughly the same as early versions of Iron Dome). The semi-mobile containerised weapon system can be deployed to defend military installations, high-value infrastructure or civilian population centres. The system operator controls the weapon remotely via datalink. As described by Rafael, high-performance beam directors and adaptive optics permit persistent focus of the beam on one coin-sized spot on the target, resulting in target neutralisation within seconds. Rapid retargeting capability neutralises swarm attacks.

Rafael is also developing a mobile variant 'Iron Beam-M', a truck or armoured-vehicle mounted system utilising a 50 kW laser, with a range of "several kilometres". Suitable as a stand-alone weapon or integration into a layered air defence network, the Iron Beam-M can accompany manoeuvre forces or be deployed to protect fixed sites against UAVs and loitering munitions. Power for beam generation and for cooling is provided by a battery storage bank that is charged periodically by an onboard generator.

Rounding out the Rafael L-DEW family is the Lite-Beam, a 10 kW class system which can engage low-flying aerial targets as well as ground targets. It is designed to neutralise swarms of

▼ Iron Beam HEL shown during testing. [Israeli MoD]

up to ten targets at ranges up to 3 km. The lightweight weapon can be integrated aboard a wide range of tactical vehicles including 4×4, 6×6, 8×8 and tracked armoured fighting vehicles. This versatility makes it highly suitable for rapid relocation as needed.

## Finding their niche

While not a panacea, DEWs – whether HELs or HPMs – have great promise as one component of layered air and missile defence networks defending both fixed installations and manoeuvre forces. The growing diversity of aerial threats requires an equally diverse set of scalable countermeasures. Both lasers and microwaves travel at the speed of light, hypothetically making them more responsive than kinetic munitions (depending on the 'dwell time' on target). DEWs are particularly suited to defeating small to medium UAVs and swarm attacks which could either overwhelm, or would be uneconomical to engage with traditional cannon-or missile-based air-defence systems. Engineers and military planners presume that upscaled DEWs, such as lasers in the 500 kW to MW range, could defeat cruise or even ballistic missiles. Integration into air defence command and control systems, refining targeting systems, and overcoming thermal management and power supply challenges will determine if and when DEWs can unleash their full potential on the future battlefield.

# Dual-use offensive/defensive interceptors: Panacea or chimera?

Dr Sidharth Kaushal

**Western militaries face an acute shortage of complex weapons while confronting numerically superior adversaries. Multifunctional interceptors offer an appealing solution – yet the reality of engineering missiles to excel in multiple roles proves more challenging than theory suggests.**

The question of whether complex weapons should become more multifunctional is a subject of considerable discussion. In the US, the SM-6 missile, which can act as both a surface-to-air missile (SAM) as well as a land-attack and anti-ship capability, represents an exemplar of this design philosophy in action. In Ukraine, the Russia's ability to use SAM systems as a crude form of rocket artillery has also been demonstrated. A focus on multifunctionality has also characterised the design of the Anglo-French Future Cruise/Anti-Ship Weapon (FC/ASW) which will apparently be capable of engaging naval vessels, land targets and high-value aerial targets.

At one level, this is understandable. Complex weapons pipelines are highly strained throughout the West, and the ability to get more functionality out of any given system represents a partial solution to this challenge. It is also the case that the capacity to integrate offence and defence represents a means of mitigating the challenge of adversary mass, which is an acute problem for Western forces and their Allied across multiple theatres. A number of sensors already support offence-defence integration, with examples including the AN/MPQ-64 radar which forms part of a Patriot battery. The radar is capable of calculating the launch position of a target such as a tactical ballistic missile based on its trajectory. It would stand to reason, then, that multifunctional interceptors should complement the inherent versatility of many sensors.

**An SM-6 missile is launched from the USS *John Paul Jones* (DDG 53) during Flight Test Standard Missile-27 Event 2 (FTM-27 E2) on 29 August 2017. [MDA/Latonja Martin]**

While there is much to be said for this argument, there are significant design trade-offs which multifunctionality imposes on the design of a missile. These trade-offs do not mean that versatility loses all value, but they provide reasons for planners to think carefully about when and where they seek to integrate functions on a single missile and what the price they pay for doing so is.

AUTHOR

**Dr Sidharth Kaushal** is a Senior Research Fellow at the military sciences team within the Royal United Services Institute (RUSI). His specialisms include Sea Power and Integrated Air and Missile Defence.

## Multifunctionality in the maritime domain

The maritime domain represents an area where there has been considerable progress in the fielding of dual-use interceptors, with the US Navy's SM-6 representing a leader in the class. The SM-6 Block 1B can be employed against air breathing targets, ballistic missiles, surface vessels and ground targets. During the Valiant Shield Exercise in June 2022, the SM-6 was employed in a ship sinking exercise (SINKEX) involving a decommissioned frigate.

While this multifunctionality is impressive, it comes at a price. In a rather literal sense, the SM-6 is one of the most expensive SAMs on the planet with an estimated unit cost of USD 10 million based on the prices for missiles delivered in FY24. In addition, there are fundamental design differences between SAMs and anti-ship missiles. The propulsion system for a SAM is typically a solid

RECOMONKEY

Combat ID & Photography

| | |
|---|---|
| Combat ID | Training & assistance for all levels, including Instructors.<br>Practical advice for training delivery & assessment.<br>Full audits of image libraries to check accuracy.<br>Verification of 3D Imagery for training systems & gaming. |
| Photography | Extensive searchable image Database split into intuitive groupings.<br>Regularly updated and checked by competent and current subject matter experts. |


www.RecoMonkey.com mail@recomonkey.com

/groups/recomonkey/ /recomonkey/ /RecoMonkey /@recomonkey895

rocket motor, which enables the missile to close the distance with fast-moving targets rapidly. By contrast, cruise missiles are typically jet powered which provides them with greater manoeuvrability (albeit typically at lower speeds) and the ability to fly low to evade shipboard air defences. If employed in an anti-ship role, a missile like the SM-6 would likely have to fly on a high-altitude trajectory which would make it independently vulnerable to on board air defences on a well-defended vessel.

There is something to be said, however, for the potential use of a missile such as an SM-6 as part of a larger salvo involving anti-ship cruise missiles. A number of operational analyses conducted by China's People's Liberation Army (PLA) examining the conditions for the defeat of an Aegis-equipped destroyer such as the *Arleigh Burke* class suggest that the convergent use of a ballistic missile and a number of anti-ship cruise missiles might be sufficient to saturate the vessel's onboard radar. In principle, an SM-6 acting as a ballistic target could play a similar role. However, it is unclear whether or not a similar role could also be played by a purpose-designed ballistic missile such as China's ship-launched YJ-21, arguably at a lower cost with greater effectiveness. True, a ballistic missile requires certain enabling features on a vessel such as the capacity to cold-launch missiles, as well as large diameter vertical launch system (VLS). However, the dimensions of an SM-6 do not vary drastically from those of many short-range ballistic missiles (SRBMs) such as PRSM; indeed SM-6's booster diameter is wider than PRsM's diameter.

Second, the warheads on SAM systems are typically poorly-optimised for the defeat of larger vessels and this is true of the SM-6 which appears to employ a blast fragmentation warhead across different categories. Moreover, the warhead is necessarily light to provide the missile with the kinematics needed to engage airborne targets. As such, the functionality of SM-6 against larger vessels remains an open question, with some analyses suggesting it has limited utility against larger vessels (something which would seem to be validated by the fact that it was one of a number of missiles used against a single frigate type target in the Valiant Shield SINKEX).

It should be noted, however, that warhead size is not the best predictor of a missile's lethality against a surface vessel, with kinetic energy on impact typically correlating more closely with the number of missiles on target needed to mission kill or sink a vessel. Even so, however, a blast fragmentation warhead represents a poor tool with which to inflict structural damage on a vessel.

**Artist's impression of the two effectors being developed under FC/ASW. These comprise the ramjet-powered supersonic cruise missile known as RJ10 (top), and the low-observable turbojet-powered subsonic cruise missile TP15 (bottom). [MBDA]**

Arguably, multifunctionality might be achieved with a different warhead type such as a hit-to-kill warhead which could be employed against both air-breathing and ballistic targets, as well as high-value surface vessels. A missile with sufficient kinetic energy could in theory achieve lethal effects against a large vessel with even a relatively small warhead. This having been said, much is likely to depend on factors such as whether a missile penetrated a vital part of a vessel. More importantly, however, a SAM used on a ballistic trajectory will provide considerably less range than a comparably-sized cruise missile.

This raises the question of how missiles such as the supersonic, ramjet-powered RJ10 being developed for FC/ASW would be intended to operate, since as a cruise missile, it uses air-breathing propulsion, and thus does not follow the same design principles as the SM-6. If the RJ10 model is used against high-value targets such as bombers, the missile may have to keep pace with potentially supersonic, albeit relatively large, targets. Its ramjet engine should in principle enable supersonic flight at relatively high altitudes – for example Russia's P-800 Oniks anti-ship cruise missile (ASCM) has a flight ceiling of 14 km (roughly the service ceiling of a Tu-22M bomber).

However, complexity arises when designing a payload for two very different tasks. If one equips a missile like RJ10 with a large unitary warhead, such as the 300 kg warhead of a P-800 Oniks, or the 453 kg warhead of LRASM, then it is less useful as SAM given the negative impact of a large warhead on manoeuvrability. A smaller blast fragmentation warhead like the roughly 64 kg of the SM-6 warhead would allow for better functionality as a SAM, but at a cost in terms of anti-surface warfare utility. It could be argued that since kinetic energy is the best predictor of anti-ship lethality, this is an acceptable trade-off. This is particularly true given that in the European theatre most Russian targets are likely to be small surface vessels (with size being the other predictor of how many missiles are needed to sink a ship). However, while justifiable, this choice would necessarily entail trade-offs.

Finally, in addition to the complex dynamics associated with missile design, the matter of command and control (C2) bears considering. If air warfare officers and surface warfare officers are employing the same capabilities, there will be a pull on shared resources. Principle warfare officers can mediate these trade-offs, but multifunctionality makes it more difficult for each group of officers to anticipate precisely which resources will be at their disposal.

## The land operating environment

Arguably in the land environment there are stronger incentives to employ dual-use missiles. This stems from the fact that many plausible targets for dual-capable missiles, such as tactical ballistic missile launchers and multiple launch rocket systems (MLRSs) are not large robust targets such as ships and can be destroyed with relatively small payloads. Indeed, evidence from Israel suggests that kinetic hit-to-kill warheads can inflict considerable damage on many types of launchers. While it might be argued that there are a number of launch systems in the land environment which can engage high-value targets, including assets supporting from the air, it must be noted that doctrinally defined tasks such as suppression of enemy air defences (SEAD) will absorb the majority of the strike capacity in both the land and air domains in a number of theatres,

including Europe. The suppression of the enemy air and missile threat might, then, benefit from the presence of dual-capable missiles, which can be employed by air defenders without a requirement for support from other arms and echelons.

The use of dual-capable interceptors in the land operating environment is not without its own imposed costs. For example, active radar seekers are unlikely to be of utility against ground targets unless they employ especially small wavelengths. Even then, it is likely that a second mode of inference such as infrared (IR) seekers would be required to cross-reference target types – adding cost and weight to a missile. Alternatively, cueing could be provided from offboard by air assets redirecting missiles towards targets. This would require a network architecture comparable to the US Navy's Naval Integrated Fire Control-Counter Air (NIFC-CA), as well as a mechanism for moving data using low-latency bearers. Equally, however, counterbattery attacks do not need to be perfect to deter the use of a tactical ballistic missile (TBM), for example, as they need to be prompt and have a sufficient chance of damaging impact – something which dual-capable missiles could achieve. Moreover, the development of low-payload effectors which can strike soft skinned targets (as well as supporting air defence) could also enable other parts of a strike campaign.

## Closing thoughts

While there are arguably advantages to the use of dual-capable effectors, their development and fielding is by no means simple. Particularly in the maritime domain, even limited multifunctionality arguably imposes cost in excess of the value generated. In the land environment, there is somewhat more purchase for dual-capable effectors, albeit with some latent system engineering problems remaining to be resolved.

USS *Savannah* (LCS 28) launches an SM-6 missile during a demonstration of a containerised launch system, in the Eastern Pacific Ocean, on 24 October 2023. This was understood to be a developmental version of what would later become the US Army's Typhon ground-based launch system for SM-6 and Tomahawk missiles. [US Navy]

# Serbia's Defence Industry: Achievements, Future Prospects, and Lessons Learned from the War in Ukraine

**Dr Nenad Miloradović**

Dr Nenad Miloradović, Serbia's Assistant Minister of Defence for Materiel Resources. [Serbian MoD]

In recent years, the war in Ukraine has dominated global geopolitical and security discourse. At the time of writing, a major diplomatic initiative – spearheaded by the world's leading powers – offers a potential pathway toward resolution. Yet, should diplomacy fail, the risk remains that the conflict could devolve into a protracted stalemate or escalate into something even more catastrophic. However imperfect or controversial, a diplomatic settlement would be vastly preferable – for the belligerents, their backers, and the broader international community. While future crises stemming from unresolved or "frozen" conflicts – so familiar to the Balkans – are always a possibility, they pale in comparison to the existential danger posed by unchecked escalation.

Regardless of how the Ukrainian conflict ultimately concludes, its repercussions are already shaping global defence postures. Across Europe and beyond, surging defence budgets, expanded production capacities, and continent-wide rearmament are now underway. The objective is clear: to achieve full readiness for a potential peer-to-peer conflict in Europe by the end of the decade.

## Serbia's Defence Industry Strategy

Serbia is a militarily neutral country. Consequently, the capabilities of the Serbian Armed Forces (SAF) must be developed to align with the evolving European battlespace, to the maximum extent possible, ensuring the nation's independence and territorial integrity in what promises to be an unpredictable and unstable period ahead.

Historically, a strong defence-industrial base has underpinned Serbia's independence and neutrality, serving as a cornerstone of its defence strategy for nearly two centuries. For this reason, Serbia has invested in its defence industry almost continuously over the same period. The Serbian Ministry of Defence (S-MoD) plans and executes activities related to the industry's development. Its primary tools for achieving SAF capabilities and strategic goals include seven military technical institutions embedded within the S-MoD/SAF structure. At the forefront is the Military Technical Institute (MTI), Serbia's spearhead for defence R&D; Yugoimport SDPR, the country's most prominent producer of Armaments and Military Equipment (AME); and the Serbian Defence Industry Group (SDIG), a consortium of 17 state-owned factories.

The ongoing Defence Industrial Growth Plan (DIGP) aims to upgrade and modernise production lines in key defence technologies across these government-owned entities, while also enhancing the capacity of smaller, privately owned licensed AME producers (around 60 companies). In parallel, it fosters a growing ecosystem of SMEs, techno-parks, and university laboratories. The DIGP further emphasises partnerships with global defence companies for joint AME development and production in Serbia. Several collaborations with major European defence technology firms are already in motion, with more expected to follow.

## Key Areas of Serbian AME Development and Production: Status and Prospects

**Ammunition**

Serbia's defence industry boasts a long tradition of ammunition production across all calibres and standards, both NATO and Soviet. This includes small arms, medium calibre rounds, artillery shells, tank ammunition, rockets, mortar bombs, grenades, guided anti-tank and air defence missiles, as well as guided and unguided airborne munitions. Increasingly, ammunition is also being designed for drones and unmanned aerial systems.


NORA B-52 NG SPH. [Yugoimport]

The industry is supported by Serbian manufacturers of energetic and pyrotechnic materials, which produce explosives, propellants, and rocket fuels renowned worldwide for their quality and competitiveness. Alongside these, Serbia produces the full spectrum of mechanical and electronic components – fuses, guidance blocks, seekers, and both metal and composite parts – enabling the development of new generations of "smart munitions" with enhanced precision, range, and lethality.

**Artillery (Long-Range Precision Strike)**
The SDI has developed a comprehensive portfolio of conventional and rocket artillery systems. Foremost among these is the NORA B-52, a 155mm wheeled self-propelled howitzer (SPH) with a range exceeding 40 km. Already in SAF service and exported to partners in Europe, Africa, and Asia, the latest M21 version features increased automation, improved accuracy, and extended range. Versions with ranges beyond 70 km are currently under development.

Rocket artillery programmes include three classes of modular multi-tube launchers – Morava, Oganj M18/24, and Tamnava – mounted on Serbian-built cross-country trucks (4×4, 6×6, 8×8). Highly mobile and digitised, these systems integrate modern fire-control architecture supported by mobile or UAV-based ISTAR assets. Capable of firing a full range of legacy rockets as well as modern guided munitions (122mm, 128mm, 262mm) with ranges of 40–70 km, they offer exceptional survivability and lethality on the modern battlefield.

**Armoured Vehicles and Protected Mobility Systems**
The SDI currently produces five types of wheeled armoured vehicles in multiple variants, with improved models in development. Two are based on monocoque steel armoured hulls with the latest Western suspensions, engines, and transmissions: the LAZAR L3/M 8×8 fighting vehicle, armed with a 30mm RCWS, and the MILOS/M 4×4 APC with 12.7mm/20mm RCWS.

Three additional vehicle types – M21 MRAP 6×6, BOV 4×4, and NTV/Hajduk 4×4 – serve in reconnaissance, command, and heavy-weapon carrier roles. All meet the latest standards of ballistic and mine protection while providing high mobility across rugged terrain.

**Mechanised Forces Equipment**
Two major upgrade programmes are underway: the M-84 AS-2 main battle tank and the M-80 AB1/2 IFV. Both platforms have been enhanced with next-generation armour (passive and reactive), battle management systems (BMS), counter-drone jammers, and, in future, active protection systems (APS). Their mobility has been significantly boosted with upgraded powerpacks and suspensions. Firepower has also been modernised with thermal imagers, advanced fire-control systems, and new-generation AP and smart munitions.


**Soldier Systems**
To meet SAF's requirement of increasing infantry firepower by 30%, the SDI has introduced a new generation of weaponry, night vision, communication systems, protective gear, and camouflage equipment.

The backbone is the MAP M-16 modular rifle family (rifle, carbine, LMG, sniper variant), capable of firing both 6.5mm Grendel and 7.62mm rounds. It integrates Serbian-made optics such as the NT35 thermal sight and ON4x32 day sight. Infantry squads are quipped with RBG grenade launchers (40x46mm and 40x51mm, range up to 800m). Sniper teams now field the M07 rifle (338 Lapua Magnum) and the DP12 anti-materiel rifle (12.7mm). Plans are in place to replace the M-84 GPMG with a new model chambered in .338 Norma Magnum.

**Short-Range Air Defence and Counter-Drone Systems**
The SAF's primary counter-drone and SHORAD platform is the PASARS M16, a hybrid self-propelled gun-missile system. The latest V4 version integrates a 40mm automatic cannon firing air-burst munitions, SHORAD missiles (MISTRAL, S2MA, RLN-IC), an AESA radar, a counter-drone jammer, an optoelectronic fire-control system, and full integration into higher-echelon air-defence networks – all mounted on a modern wheeled armoured platform.

**Drones and Unmanned Systems**
Serbia has developed two generations of Mali Milos tracked unmanned combat vehicles, as well as a logistic support vehicle. These are in service with SAF special and reconnaissance units, offering high mobility, strong protection, and silent movement thanks to electric propulsion.

In the aerial domain, Serbia has fielded three ISTAR/combat UAVs: VRABAC (40 km), SENKA (60 km), and Pegasus MALE (200 km), each capable of carrying reconnaissance payloads and launching guided or unguided munitions.

Loitering munitions under development include OSICA (25 km/2.5 kg warhead), STRŠLJEN (40 km/5 kg warhead), and GAVRAN (100 km/10 kg warhead). Additionally, SAF infantry and special forces are increasingly equipped with KOMARAC FPV attack drones (1-3 variants), including fibre-optic guided versions.

## Conclusion

What is already clear is that Europe – and much of the world – is rearming at speed, moving toward new generations of weaponry, from unmanned systems to modernised legacy platforms, while dramatically expanding industrial capacity. This momentum is likely to accelerate through the end of this decade and beyond. In this process, Serbia cannot – and must not – fall behind.

MILOS 2 4×4 armoured tactical vehicle. [Yugoimport]

# Assessing Serbia's ground forces procurement efforts

Chris Mulvihill

**Serbia has undertaken a sustained effort to modernise its land forces, balancing legacy Yugoslav-era weapons with new domestic developments and selective foreign acquisitions.**

As a diplomatically neutral state in a region increasingly integrated into Western-aligned political and military structures, Serbia faces growing pressure to maintain sovereign and credible defence capabilities, having faced painful consequences from the conflicts of the 1990s – most notably the de-facto independence of Kosovo. This pressure has only intensified with the recent Joint Declaration on Defence Cooperation signed in Tirana in March 2025 by Albania, Croatia, and Kosovo, further highlighting Serbia's regional isolation. While Serbia's procurement is limited to air and land platforms, this article will focus solely on Serbia's land programme acquisitions which have received less comprehensive coverage in recent times. These land programmes reflect Belgrade's attempt to build a credible sovereign defence capability, deter adversaries from potentially targeting Serb territory or ethnic Serb populations, and discourage what Belgrade often views as escalatory actions by Pristina in the areas of northern Kosovo predominantly populated by ethnic Serbs.

## Serbian defence policy

Serbia has long pursued a policy of military neutrality, formally prohibiting membership in defence alliances. This places Serbia in a strategically disadvantageous position, as it cannot rely on external alliances for military defence, while the broader region is largely integrated into NATO structures and, in many instances, the EU as well.

Despite remaining outside formal military alliances, Serbia actively cooperates with several major security structures, including the Russian-led Collective Security Treaty Organization (CSTO), the EU's Common Security and Defence Policy (CSDP), and NATO. Serbia holds observer status within the CSTO and has previously participated in the annual 'Slavic Brotherhood' exercise alongside Belarus and Russia. Under the EU's CSDP, Serbia has contributed to multinational operations in the Central African Republic and Somalia, and participates in the EU's Greek-led HELBROC Battlegroup – also known as the Balkan Battlegroup – located in Larissa, Greece.

The most substantial cooperation, however, is with NATO. Beginning with the Partnership for Peace (PfP) programme and later through an Individual Partnership Action Plan (IPAP), Serbia has participated in numerous joint exercises primarily aimed at enhancing interoperability in peacekeeping operations. Apart from select engagements such as annual air defence drills with Bulgaria and the Slavic Brotherhood exercises, Serbia's defence cooperation remains largely confined to training for peacekeeping-related interoperability.

Recognising the absence of an external security guarantee, Serbia must maintain credible national defence capabilities capable of deterring external armed threats and contributing to domestic and regional stability. In 2009, Serbia re-adopted the 'total defence' concept, once practised in the former Yugoslavia. This holistic approach extends beyond the armed forces, involving civil organisations, private actors, and the general public in national defence planning. By blurring the lines between military and civilian roles, the total defence concept seeks to mobilise all sectors of society in support of territorial defence – vastly expanding the potential human resource base. However, in Serbia's case, the practical implementation of this policy remains limited. Compulsory military service was suspended in 2010, and no concrete steps have yet been taken to reinstate it.

A further part of Serbia's defence policy is the development of a domestic arms industry. While Serbia inherited a substantial defence industry from the former Yugosla-

**Exercise Platinum Wolf 25 hosted in Serbia, supported by the United States European Command, saw 11 countries participating in training to improve interoperability in peacekeeping operations. [Serbian MoD]**

via, this industry was not designed to function independently and was deeply integrated across various republics of Yugoslavia. The breakup of Yugoslavia and ensuing conflicts effectively dismantled these supply chains, leading to the collapse of many defence enterprises. Serbia was not immune to this disruption but has made considerable efforts to rebuild specific sectors to enable the domestic design and production of defence materiel.

Serbia's leading defence enterprises are predominantly state-owned. Among Serbia's predominant activities include the manufacture of ammunition across all calibres and the production of land-based platforms. In addition to manufacturing, Serbia retains a moderate capacity to service and upgrade Yugoslav-era platforms. Amid heightened global tensions, the Serbian defence industry has capitalised on rising international military spending. In 2023 alone, defence exports exceeded USD 1.6 billion. While this represents a valuable revenue stream, Serbian-manufactured equipment has occasionally appeared in conflict zones, potentially undermining Serbia's declared neutrality. Most notably, reports in May 2025 alleging Ukrainian use of Serbian-supplied ammunition prompted diplomatic inquiries from Moscow, following allegations from the SVR (Russia's Foreign Intelligence Service), although no retaliatory measures were ever announced by Russia. In late June 2025, Serbian President Aleksandar Vučić declared that Serbia had halted all exports of arms and ammunition for the time being, citing national security and economic interests.

Serbia will likely continue investing in domestic defence production to meet its national security needs while seeking to expand its export footprint. The long-term ambition looks to penetrate higher-value and more prestigious international markets, enhancing the reputation and competitiveness of Serbia's defence industry.

## Main battle tanks

The Serbian Army's main battle tank (MBT) fleet has undergone notable modernisation and expansion over the past decade. In 2006, Serbia possessed a relatively large but outdated tank force comprising 204 M-84s, 28 M-84As, 61 T-72Ms, and an unspecified number of T-55s. Serbia gradually retired the T-55s from active service by 2010, leaving the M-84s and T-72s as the core of the tank fleet.

In 2020, Serbia began receiving newer T-72B1MS 'White Eagle' tanks, with delivery of the entire batch of 30 understood to have been completed in 2021. Today, the Serbian Army maintains four tank battalions, each subordinated to one of its four brigades. All but one of these battalions are equipped exclusively with M-84 tanks. The exception is the 46th Tank Battalion of the 4th Brigade, which fields one company (typically 13 vehicles) equipped with T-72B1MS tanks. Additionally, a separate T-72B1MS battalion is controlled directly by the Army Command, rather than being integrated into a brigade. This latter case illustrates the support Serbia has received from Russia in recent years.

Aside from this one-off Russian donation, Serbia has not actively pursued foreign acquisitions to complement or replace its legacy MBT fleet. Instead, the focus has been on upgrading existing in-service platforms. While there was discussion in the mid-2010s about initiating a domestic tank design, this ambition is widely regarded as unfeasible, due to the high costs involved and a lack of the technical and industrial base required to develop such a complex system. Although the M-84 is a Yugoslav-developed platform, its final assembly line was located in present-day Croatia, and its components were sourced from all across the former federation. Consequently, Serbia did not inherit the complete infrastructure or expertise necessary to start full-scale MBT production.

This has not deterred efforts to modernise the M-84 fleet domestically. Several previous upgrade attempts were either export-oriented or failed to gain traction. Notable examples include the M-84AB1, which bore a strong visual resemblance to the Russian T-90S, and the M-84M, which was mainly focused on explosive reactive armour (ERA) application. However, it was not until 2020 that a domestic upgrade programme gained official backing from the Serbian Ministry of Defence (MoD).

The M-84AS1 (2017) was unveiled at the Partner 2017 defence exhibition in Belgrade. Developed by the Military Technical Institute (MTI) in Belgrade, this vehicle introduced significant enhancements in protection and situational awareness, but the design continued to evolve. By 2020, a revised variant appeared, referred to as the M-84AS1 (2020), as well as the very similar-looking but more refined M-84AS2.

In terms of recognition, the M-84AS2 appears very similar to M-84AS1 (2020), with the main visual differences being the M-84AS2's full ERA coverage on the glacis, more steeply-sloped ERA arrangement on the turret cheeks, laser warning receivers (LWRs) on the turret sides, a taller commander cupola to reduce blind spots caused by roof-mounted ERA, revised panoramic sight for the commander, and the presence of mudguards above the toe plate to prevent fouling of the headlights and driver periscope.

**The T-72B1MS is currently the most modern main battle tank in active service with the Serbian Army. It has Kontakt-1 explosive reactive armour across the hull and turret, a PKP-72 independent panoramic day/thermal sight for the commander, and a Sosna-U day/thermal sight for the gunner. In addition, it also possesses an auxiliary power unit and a remote weapon station armed with a Kord 12.7 mm heavy machine gun for the commander. [Serbian MoD]**

Both the AS1 (2020) and AS2 models were seen on exercises, and undergoing trials in the early 2020s, but the latter design appears to have been favoured. According to Serbian sources, the M-84AS2 upgrade is being rolled out gradually. As of 2024, around 20 units were believed to have entered service, with at least nine displayed during the Zastava 2024 event at Batajnica air base. It remains unclear whether this modernisation will be extended across the entire M-84 fleet or confined to select battalions.

**The M-84AS2 is a comprehensive upgrade of the M-84 platform, and sees lethality, protection, and situational awareness improvements. [Chris Mulvihill]**

The M-84AS1 (mod. 2020) and M-84AS2 reportedly feature a new domestically-developed ERA package applied to the glacis, hull sides, and turret front, sides, and roof. Additionally, both feature a remote weapon station (RWS) armed with a 12.7 mm heavy machine gun (HMG), along with a day/thermal sight, and a 360° panoramic camera suite integrated onto an updated meteorological sensor. Interestingly, although an early AS2 prototype displayed in 2021 was fitted with the Safran PASEO commander's panoramic sight (and prior to that 2020, an AS2 seen on the 'Support 2020' exercise used a different model), more recent presentations – such as at Partner 2023 and the Zastava 2024 display in late 2024 – omitted this feature. This is probably a cost-saving measure, since the commander already has an RWS, which can serve as a panoramic sight. The gunner is believed to use a domestically produced DNNS-2TI thermal sight, while the driver also gained a thermal camera. The AS2 retains the Soviet-era V-46-6 engine, upgraded to 840 hp. With a combat weight of approximately 46.5 tonnes, this yields a power-to-weight ratio of around 18.1 hp/tonne, which is modest by contemporary MBT standards.

The upgrade's export potential hinges on its applicability to the broader userbase of the T-72. With Russia currently constrained in its ability to offer comprehensive support to these countries, Serbia could potentially leverage its experience with the M-84AS2 to market upgrade solutions abroad, providing a valuable capability within the MBT upgrade market.

## Infantry fighting vehicles

As with its main battle tank fleet, Serbia retains a fleet of Yugoslav-era infantry fighting vehicles (IFVs), namely the BVP M-80 series. The first serious attempt to modernise this platform came in the early-2000s with the BVP M-80A/98. The programme saw little success, and development was effectively paused until 2016.

The BVP M-80AB1 (2016), initially unveiled in 2016, was developed by the Military Technical Institute (MTI) and built upon the M-80A/98 concept. Its most significant improvement was the addition of appliqué armour across the hull. According to MTI, the latter upgrade enables the vehicle to withstand 30 mm projectiles on the frontal arc and 14.5 mm fire on the sides, a substantial enhancement given the modest baseline protection of the original M-80. It was provided with an M91 E-I single-person turret armed with a Zastava M86 30 × 210B automatic cannon. In 2021, a modified version was presented, the BVP M-80AB1 (2021). Following further development and refinement, during which another version was seen in 2020, the final variants were revealed at the Partner 2023 defence exhibition in the form of the BVP M-80AB1 (2023) and the BVP M-80AB2 variant. The former was fitted with the Yugoimport RCWS 20 remote turret, armed with a Zastava M55 20 × 110 mm automatic cannon.

**The BVP M-80AB1 has seen several iterations, but this appears to be the latest of its kind, showcased at Partner 2023 in Belgrade. Aside from the substantial appliqué armour coverage, its most notable differences are a redesigned headlight assembly and crew compartment that also includes a rear ramp. It also integrates an unmanned turret armed with a 20 mm automatic cannon, with the addition of a 7.62 mm co-axial machine gun, a 30 mm automatic grenade launcher, and a pair of Malyutka anti-tank guided missiles. [Chris Mulvihill]**

The second variant shown, the M-80AB2, shares the same hull structure and armour package as the AB1 but incorporates a manned turret fitted with a 30 × 173 mm M12 cannon, a NATO-standard evolution of Zastava's M86 design. It also features an upgraded anti-tank guided missile (ATGM) system based on the domestic Malyutka platform, supporting the Malyutka 2T, 2F, and 2TS variants, also developed by MTI. At the Zastava 2024 event, only one M-80AB2 was presented, compared to up to 13 examples of the M-80AB1 (2023).

It remains unclear which of these variants will be adopted as the standard for upgrading the existing M-80A fleet. The greater numbers of the M-80AB1 present at Zastava 2024 suggests a preference for the unmanned turret variant, which continues to employ the older 20 mm M55 cannon used on the original M-80A. It is possible that development is underway to adapt the unmanned turret to support the newer 30 mm cannon, or possibly that the Serbian Army is content to retain the M55 for the foreseeable future given the likely abundance of domestically-made 20 mm ammunition. While no definitive decision has been announced, the M-80AB1 currently appears to be the leading candidate for at least a partial modernisation of the M-80A fleet.

## Armoured personnel carriers

Serbia has achieved notable success in developing a domestic line of wheeled armoured personnel carriers (APCs) that are entirely new designs, rather than modernisations of legacy Yugoslav-era platforms. This progress is exemplified by the Lazar family of 8×8 APCs. Since the launch of the Lazar 1 project in 2008, the series has undergone several iterations, culminating in the more refined Lazar 3, which has been adopted by the Serbian Army and has also secured export orders.

**The Lazar 3 with the 30/2 mm RWS. While this particular manifestation is not in service, it showcases the interest Yugoimport SDPR has invested into developing a plethora of variants based on the Lazar chassis, both for domestic and export opportunities. [Chris Mulvihill]**


he Lazar 3 is believed to have entered service in 2017 in the APC role with the Serbian Army, with smaller procurement by the Serbian Gendarmerie. The vehicle accommodates a crew of three and nine dismounts, for a total of 12 personnel. It has a maximum weight of 28 tonnes, a top speed of 110 km/h, and can ford water obstacles up to 1.6 m deep, although it is not amphibious. The chassis is reportedly built around the T900 axle set, developed by Timoney Technology and manufactured by Texelis.

As of 2025, the Lazar 3 remains the only vehicle in the family operational with the Serbian Army, with approximately 80 vehicles in service out of a total order of 125. The exact breakdown of variants ordered has not been publicly disclosed.

However, known configurations include a base APC variant fitted with an M15 remote weapon station (RWS) armed with a 12.7 mm HMG, a version with the Kerber unmanned turret armed with three 20 mm cannons, an ambulance variant, and an anti-tank guided missile (ATGM) carrier.

Yugoimport, the primary contractor for the Lazar family, has also developed the Lazar 3M – a variant fitted with the Russian 30 mm 32V01 turret. This model omits the small side windows and firing ports found on the Lazar 3, presumably to improve protection. A heavier APC variant is also in development under the name Lazanski, which has been displayed with a mock-up of the Russian AU-220M 'Kinzhal' unmanned turret armed with a 57 mm cannon. However, given both the Lazar 3M and Lazanski rely on Russian-supplied weapon systems, their viability may be in question due to ongoing difficulties in securing and delivering Russian defence products.

In a surprising development, Serbia has also procured surplus Hungarian BTR-80A vehicles, with estimates ranging from 50 to 70 units. The rationale behind this acquisition remains unclear. Hungary has already begun phasing out its BTR-80 fleet, suggesting that Serbia may have acquired the vehicles at favourable rates. It is also possible that production rates for the Lazar 3 have fallen short of expectations, necessitating an interim solution. Alternatively, the deal may reflect deepening bilateral defence cooperation in the region, following the signing in Belgrade of a Strategic Defence Cooperation Plan between Serbia and Hungary in April 2025; this was seemingly a reaction to the defence cooperation pact formed by Albania, Croatia, and Kosovo the month before.

## Protected mobility vehicles

Alongside the Lazar family of armoured personnel carriers, Serbia has also developed and produced its own protected mobility vehicle, the BOV M16 Miloš, which is employed as a general-purpose patrol vehicle and in a number of specialised variants. Like the Lazar, the Miloš uses a Texelis-manufactured axle set, the T700, reflecting continued reliance on key foreign subcomponents within Serbia's defence industrial base.

**The Miloš is another relatively successful platform, given it has been exported to Cyprus and Senegal. In addition to a patrol role, Yugoimport markets other variants including command, ATGM carrier, artillery reconnaissance, and ambulance variants. [Yugoimport]**

Yugoimport has also unveiled the Miloš 2, although its only notable distinction from the baseline variant appears to be the integration of the same 20 mm M55 unmanned turret found on the BVP M-80AB1 (2023). The vehicle has a maximum weight of 18 tonnes and accommodates up to 10 personnel, including both crew and dismounts. At least 30 baseline Miloš vehicles are known to be in service with the Serbian Army, in addition to an undisclosed number operated by the Gendarmerie. In January 2024, President Vučić announced an order for an additional 112 Miloš vehicles. If fulfilled, this would bring the total fleet to approximately 142 units. The breakdown of the ordered variants has not been publicly disclosed.

**The Nora B52 NG can be differentiated by its base platform, now using a MAN-based truck, whereas previously the system relied on a KamAZ truck. [Yugoimport]**

Beyond its domestic developments, Serbia has also benefitted from foreign military assistance, notably from Russia, which donated 30 BRDM-2MSs alongside the T-72B1MS tanks. These armoured reconnaissance vehicles serve within the Army's dedicated reconnaissance battalion. While the BRDM-2MS is still a relatively limited platform, it offers significantly greater utility and survivability than the older BRDM-2 models in use by Serbia.

Serbia has also expanded its inventory of High Mobility Multipurpose Wheeled Vehicles (HMMWVs), having originally received 47 units as US donations between 2012 and 2017. To augment this fleet, Serbia placed an order for up to 118 additional vehicles, with at least 66 known to have been delivered by 2023. The rationale behind this procurement appears to be an effort to expand the pool of interoperable vehicles for deployment in multinational peacekeeping operations. However, Serbia has also deployed UN-marked Miloš vehicles as part of its contribution to the United Nations Interim Force in Lebanon (UNIFIL), indicating that local designs are also used for expeditionary roles. The additional HMMWV acquisition may therefore also reflect limited annual production capacity of the Miloš rather than a purely tactical preference.

## Tube and rocket artillery

One area in which Serbia has retained significant expertise from the former Yugoslavia is the design and production of artillery and rocket systems. This tradition continues today, with Serbia actively developing such systems for both domestic use and export markets. Recent procurements in this sector include updated variants of the 155 mm Nora B52 truck-mounted howitzer and the reported acquisition of the Israeli Precise and Universal Launching System (PULS) rocket artillery system.

Until the more recent Nora B52 M21 and Nora B52 NG variants, both of which were based on a MAN 8×8 truck platform, the system was mounted on a KamAZ platform – the latter may become increasingly difficult to procure and export due to geopolitical constraints. As a result, Yugoimport may shift entirely to using the MAN truck platform, even for domestic service. The Nora B-52 NG weighs up to 40 tonnes and is armed with a 155 mm L52 main gun. The gun uses an automatic loading system, allowing a maximum firing rate of four rounds per minute. The vehicle carries 30 rounds in the autoloader, with an additional six stored on the vehicle. In 2021, former Defence Minister Nebojša Stefanović confirmed that six additional systems had been ordered, supplementing the 12 already in service at that time. However, rising costs and continued reliance on imported components, particularly the chassis, may limit broader production and procurement for domestic use.

While the Nora B52 represents the modern element of Serbia's self-propelled artillery fleet, the legacy 2S1 Gvozdika remains in service as a secondary platform. A domestic modernisation package developed by the Military Technical Institute (MTI) and implemented by Srboauto has extended the vehicle's operational life. Upgrades include a new fire-control system, a 7.62 mm machine gun mounted for the commander, and a thermal imaging camera for the driver. These enhancements will support the continued use of the 2S1 Gvozdika in the near term.

In the rocket artillery domain, Serbia has reportedly signed a contract with Israel's Elbit Systems for the acquisition of the PULS. While Elbit's official press release in November 2024 referred only to an "unnamed European customer", President Vučić hinted at a press conference later that month that Serbia may have been the buyer. The exact configuration of the PULS variant destined for Serbia has not been disclosed. The modular PULS launcher can launch a range of rocket types with varying calibres and ranges – from shorter-range 122 mm rockets to long-range 370 mm Predator Hawk tactical ballistic missiles (TBMs) with a range of 300 km. As the PULS is capable of launching 122 mm rockets, it remains to be seen whether Serbian-manufactured munitions can be integrated into the system, potentially expanding domestic industry involvement and reducing long-term logistical reliance on imports.

## Air defence

Serbia's air defence network has undergone significant investment over recent years, marked by the acquisition of foreign systems and sensors, as well as efforts to develop indigenous short-range air defence (SHORAD) capabilities. While Serbia continues to rely heavily on legacy Soviet-era platforms, its procurement strategy has increasingly pivoted toward Chinese systems, as Russian hardware has become difficult to acquire. As a result, Serbia has become the first European operator of both the FK-3 (the export variant of the HQ-22) and the HQ-17AE systems. Concurrently, domestic projects such as the PASARS-16 and the newly unveiled Harpas self-propelled anti-air gun and missile (SPAAGM) systems remain ongoing.

The FK-3 had its first components delivered in early 2022, air-lifted to Serbia by Chinese Y-20 heavy transport aircraft – a rare deployment of the Chinese People's Liberation Army Air Force (PLAAF) to Europe. A medium- to long-range system-of-systems, the FK-3 complements Serbia's legacy S-125M and 2K12M2 Kub systems and is likely to form the long-range backbone of Serbia's air defence network. With an advertised maximum engagement range of 100 km, the FK-3 is roughly analogous in range capability to older variants of the S-300P series, having comparable missile characteristics. FK-3 reportedly achieved full operational capability in early-2025 and is assigned to the 2nd Air Defence Missile Battalion, which is tasked with the defence of Belgrade. The system's entry into service may allow for the eventual retirement of the static S-125M.

**First revealed in June 2024, the HQ-17AE is Serbia's second purchase of Chinese air defence equipment, just two years after the FK-3 purchase. Each transporter launcher and radar (TLAR) vehicle can hold up to eight missiles and, according to a Serbian MoD specification board for the HQ-17AE, has a maximum engagement range and altitude of 15 km and 8 km, respectively. [Serbian MoD]**

In a surprising move, Serbia also procured the HQ-17AE, a wheeled variant of the HQ-17, itself derived from the Russian Tor-M1 system. The acquisition, revealed in 2024, was even more unexpected than the FK-3 deal. Previously, in 2019, Serbia had acquired the Pantsir-S1, and by late 2021, expressed interest in the Pantsir-S1M. However, logistics and political constraints – specifically the inability to deliver Russian systems through NATO airspace – likely rendered this impossible. In that context, the HQ-17AE perhaps offered an alternative system for SHORAD that would not have entailed the same difficulty and consequences that would have emerged from purchasing a Russian system.

On the domestic front, Serbia continues to develop the PASARS-16, a 6×6 truck-mounted SPAAGM platform armed with a single licensed-produced 40 mm L/70 Bofors cannon. While previously it had a notable absence of any radar systems, the model showcased at Partner 2023 did have RADA Electronic Industries' multi-mission hemispheric radars, possibly for target detection. This cannon is reportedly capable of firing programmable ammunition, possibly BAE Systems' 3P rounds. The variant presented at Partner 2023 showcased a broad weapons suite mounted on a manned turret. This included a jamming system, two man-portable air defence systems (MANPADS), including the locally-produced Strela-2M and the newly acquired Mistral 3 ER, and two extended-ranged Malyutka ATGMs for defence against ground targets.

Complementing this is the Harpas, a tracked SPAAGM unveiled at Partner 2023, developed on an M-84 MBT chassis. It serves as Serbia's attempt at a domestic analogue to the 2K22 Tunguska, providing a combined gun/missile air defence system with mobility suited for armoured brigades. The Harpas uses twin 40 mm Bofors cannons to deliver a higher rate of fire than the PASARS and incorporates up to four short-range missiles, notionally these would be Serbia's RLN-RF and RLN-TK missiles. The RLN-RF uses a thermal seeker, while the RLN-TK is guided by a semi-active radar homing (SARH) seeker, with both reportedly offering engagement ranges of up to 12 km – far exceeding the effective range of the onboard cannons. For target detection, the Harpas is equipped with the Thales GS-40, a modification of Weibel's Xenta-M X-band radar system. Whether this platform will progress beyond the prototype stage remains to be seen, but it reflects Serbia's ambition to develop a mobile, domestically produced SHORAD capability that can support its manoeuvre forces.

**The Harpas tracked SPAAGM was unveiled at the Partner 2023 exhibition in Belgrade. In the example shown, the vehicle is equipped with two each of the RLN-RF and RLN-TK missiles. [Mark Cazalet]**

## Closing thoughts

Serbia's procurement efforts reflect a deliberate attempt to modernise its armed forces and build up a larger pool of domestic expertise and manufacturing capability, all while also having to navigate its relations between East and West. Though constrained by budgetary and geopolitical limits, Belgrade has revitalised domestic industrial capacity in several key sectors, particularly in wheeled armoured vehicles and artillery. Meanwhile, legacy Cold War-era equipment continues to be upgraded and retained where feasible. The result is an eclectic, but increasingly capable force structure designed to meet Serbia's unique security requirements in the immediate region, where many of its neighbouring states are often smaller in size and lack many of the capabilities the Serbian armed forces have built up since the collapse of Yugoslavia. As regional dynamics evolve, diplomatic pressures may test the sustainability and coherence of its procurement choices in the future.

# The continuing evolution of tube artillery

Alex Tarasov

**The experience of modern warfare has underlined the importance of tube artillery. While debates about its employment and future continue, a clear consensus has emerged: tube artillery remains relevant on the modern battlefield – and it continues to evolve.**

Modern warfare is being fundamentally reshaped by the experience of the Russo-Ukrainian War, widely regarded as the largest artillery war since World War II. This conflict has reintroduced large-scale, high-intensity combat to the forefront of military thinking and has underscored the enduring importance of conventional capabilities – especially classic tube artillery, including towed and self-propelled systems, as well as mortars. Before beginning any discussion about the capabilities of tube artillery on today's battlefield, several important considerations must be highlighted.

The 8×8 variant of the CAESAR SPH on display at the Eurosatory 2024 exhibition. [Tank Encyclopedia, courtesy photo]

- First, the experience of the ongoing conflict in Ukraine should not be regarded as universally applicable. While it offers many valuable insights, the conflict has been shaped by a range of political, geographical, and military factors that make its overall environment unique. The specific conditions of the Russo-Ukrainian war may not be replicated in future conflicts.
- Second, tube artillery has one of the longest life cycles of any land-based weapon system, with service lives of over 40–50 years being common. While both sides have deployed some newer systems, the majority of artillery systems used in Ukraine date back to the Cold War era or even earlier.
- Third, multiple factors influence the performance of artillery, including technological, tactical, organisational, and industrial aspects, to name a few. These factors, individually or in combination, can significantly enhance the effectiveness of both modern and legacy systems.

AUTHOR

**Alexey Tarasov** is a land warfare expert specialising in Europe, Russia, and armoured vehicles. He has contributed to ESD, Shephard News, along with other publications, and has authored several books.

What are the most important changes that have been implemented by 2025, and what developments are likely to be introduced in the near future?

## Automating the artillery: UAVs and C2 systems

The mass adoption of tactical reconnaissance unmanned aerial vehicles (UAVs) and their integration into artillery units at all levels can be considered one of the most influential changes of the past decade. While less-capable UAVs have been available since the Cold War and even earlier, what we can think of as truly modern UAVs began to trickle into service in the 1990s and 2000s in limited numbers. This increased somewhat throughout the 2010s, however large-scale adoption has only occurred since the beginning of the 2020s.

The Russian Army provides a clear example of the significant progress made in this field. In 2018, it operated more than 1,800 UAVs of various types, mostly fixed-wing UAVs such as the Orlan-10, Tachyon, Eleron-3, and similar models. Contrast this to 2023, when the Russian Army had received over 140,000 UAVs of all types that year alone, with further plans to increase production output tenfold in 2024, according to a speech by President Vladimir Putin at the Military-Industrial Committee in September 2024.

# 105 LG

## The best 105mm for airmobile operations

- Lightest 105mm
- Set into action by a crew of 3
- Highest rate of fire
- and other characteristics...

knds.com

KNDS

Importantly, the quantitative growth has been accompanied by the wider integration of intelligence, surveillance, and reconnaissance (ISR) UAVs into the organisational structure of the army, including artillery units and formations. For example, in 2024–2025, reconnaissance-strike UAV battalions were integrated into the organisational structure of artillery brigades within the Russian Ground Forces.

Another crucial enhancement is the development and introduction of automated fire control systems (FCSs) into artillery units. Combined with organic strike and ISR UAV capabilities, this has allowed for a significant increase in effectiveness at the brigade level, as well as at lower echelons, down to the battery or platoon level.

The synergistic effect of these innovations can be demonstrated by the following case. In May 2023, the Russian Army deployed artillery units equipped with integrated strike and ISR UAVs, as well as the cross-service information exchange system (abbreviated as 'МСИО' in Russian; ENG: MSIO). Analysis of their actions showed that the average duration of the 'detect–decide–engage' cycle was reduced down to around 4-6 minutes, with an ammunition expenditure of 2-5 rounds per target. By comparison, in 2017, the average counterfire time (from target acquisition to shot) 'across a wide variety of US and multinational allied units' hovered around 12 minutes, according to a 2018 article in the US Army's *Fires* magazine. Similar processes could be observed in other militaries, including those of Ukraine and China, with other nations closely following in their footsteps through their own programmes and experimentation.

## Mobility

Brigadier General Rory Crooks, director of the Army Futures Command Long-Range Precision Fires Cross-Functional Team, has identified three fundamental problems facing US artillery: range, capacity, and survivability based on mobility.

Indeed, the latest transformations in warfare have once again highlighted the importance of survivability for tube artillery – and mobility is one potential solution. While wheeled self-propelled howitzers (SPHs) have certain disadvantages compared to tracked platforms, such as poorer off-road performance, they offer significant advantages, including lower production and maintenance costs, greater operational mobility and being typically easier to deploy by air, as well as a reduced logistical footprint.

The last five years have seen a surge in interest in wheeled SPHs systems, with many systems at various stages of development or already adopted into service. Numerous examples exist today. The British Army has transitioned from the tracked AS90 platform to the wheeled Archer SPH, with the prospect of procuring the Boxer platform-based RCH 155 SPH. Russia has completed development and entered serial production of at least two variants of the Malva wheeled SPH: one equipped with the 2A64, a 152 mm L47 howitzer, and the other armed with the longer-range 2A37, a 152 mm L54 howitzer. Meanwhile, Ukraine has accepted into service and significantly expanded production of the wheeled 2S22 Bohdana SPH. Based on battlefield experience, this system has undergone incremental upgrades since 2018, when the experimental prototype was introduced. Notably, prior to the war in Ukraine, neither country had wheeled SPHs in service, and the need for this class of artillery remained in question.

Today, the market for wheeled SPHs offers a wide range of options on different platforms, ranging from 4×4 (mostly used for mortars) to 6×6, 8×8, and even 10×10 configurations, examples of the latter including the Piranha HMC AGM and the Israeli SIGMA 155. Further development of wheeled systems is likely in the near future, with the next logical step in their evolution being modularity, allowing a system to be mounted on any wheeled platform on the market, depending on the operator's needs and requirements. While mobility increases survivability on its own, tube artillery requires greater protection against emerging threats.

## Survivability

The modern battlefield is characterised by several factors, including the expansion of combat zones, increased counter-battery response speed, and the proliferation of reconnaissance assets and new threats such as loitering munitions and one-way attack (OWA) drones.

These factors have translated into a number of tactical and technical requirements aimed at increasing the survivability of self-propelled and towed artillery. In short, this can be summarised as: unprotected vehicles should receive protection, while protected vehicles should be upgraded with additional countermeasures against a range of threats.

**A 2S43 Malva SPH at the Armiya 2024 exhibition. This variant is armed with the 2A64, a 152 mm L47 gun previously used on the 2S19 Msta-S SPH. [Alexey Tarasov]**

**The new variant of Malva shown during the Victory Day Parade rehearsal in Moscow, in May 2025. This variant of the Malva SPH is armed with the 2A37, a 152 mm L54 gun previously used on the 2S5 Giatsint-S SPH. [Alexey Tarasov]**

Examples include Russian and Ukrainian SPHs equipped with standard protection kits, including slat or net armour screens covering vulnerable areas, electronic warfare (EW) systems, and camouflage systems designed to reduce visual, thermal, and electromagnetic signatures. Protected cabs have become a standard feature on wheeled SPHs and multiple launch rocket systems (MLRS), while add-on armour kits have been introduced for previously unprotected vehicles.

Another example is a standard additional armour kit for the Msta-S series tracked howitzers, developed and fielded in 2024. Notably, recently released US Department of Defense documents on the Fiscal Year 2026 Budget Estimates mention a vehicle protection suite (VPS) programme that will "evaluate, mature, and integrate onto multiple combat and tactical vehicles combinations of active, reactive, and passive protection capabilities." Among other measures, the document refers to signature management and passive add-on armour for top-attack protection (presumably against bomblets). While the description does not specify which vehicles will be involved or what the final variants of protection systems will look like, it is possible that the US Army's M109A6 SPGs may also receive additional protection.

Further improvements in this area would likely include advanced camouflage technologies allowing for better concealment and signature management, explosive reactive armour (ERA) or non-explosive reactive armour (NERA) kits for SPHs, and soft-kill active protection systems. Another possible enhancement could be the integration of remote weapon stations (RWSs) with a counter-UAV capability.

## Range, precision and firepower

The requirement for longer range is now considered essential. It has emerged in response to the expansion of the battle zone to beyond 30 km, where an artillery system faces increased risk of detection and may encounter multiple threats – ranging from counterbattery fire to loitering munitions and tactical UAVs.

On the other hand, it is understood that long-range missiles or precision-guided rounds may not always be available, nor effective due to electronic warfare (EW) countermeasures and air defence systems deployed by the adversary. At the same time, the need to strike high-value targets (HVTs) in the enemy's depth remains, while the number and dispersion of these targets has increased.

KNDS expects that within ten years, most ammunition stockpiles will consist of rounds compatible with 155 mm L52 guns; these are able to be fired at charge 6, while rounds developed for L39 guns are limited to charge 5 within L52 guns. Accordingly, tube artillery fleets are likely to include more SPHs with L52, or possibly even longer-range, guns.

These developments come at a price. Long-range tube artillery requires more powerful charges, and their frequent use accelerates barrel wear. Transitioning artillery fleets to L52 guns will require stable mass production of barrels, large stockpiles of replacements, and deployed repair and maintenance units. In 2024, the US Army cancelled the L58 Extended Range Cannon Artillery (ERCA) programme; one of the reasons for this decision

▲ **A screengrab from Russian MoD footage showing a Msta-S SPH equipped with part of an additional protection kit, which includes an anti-drone cage around the turret, supplemented with camouflage netting. [Russian MoD]**

was the excessive barrel wear observed during testing. An even more long-range and ambitious programme – the US Army's Strategic Long Range Cannon (SLRC) – was halted in 2022.

Another aspect of the issue is munitions. Until recent years, it was widely accepted that precision-guided artillery rounds were a cost-effective solution compared to traditional unguided rounds. However, many of these conclusions were based on experiences of the low-intensity conflicts against sub-peer adversaries, where artillery was typically employed in relatively small numbers from static firebases – often to deliver precision-guided munitions.

The experience of the war in Ukraine against a peer adversary has demonstrated that precision-guided rounds can be spoofed by Russian EW, while stockpiles of such munitions were clearly inadequate for a large-scale conflict. In other words, a combination of mass (unguided) munitions and precision guided weapons is needed for modern peer conflict, while domestic industry must be prepared to deliver both guided and unguided munitions in sufficient quantities at affordable prices.

▼ **A range of artillery ammunition and modular charges from Nexter (now KNDS France) on display at EDEX 2021. The KATANA round is visible in the top left. [Alexey Tarasov]**

Future developments in the area of munitions will likely involve greater efforts toward guided rounds that are less susceptible to EW jamming – such as KNDS France's KATANA round, which is equipped with a GNSS/INS guidance system.

Another possible direction for increasing the performance of tube artillery is the development of artillery-launched drones.

A Chinese tube-launched system named Tianyan (ENG: 'Sky Eye') was recently tested, successfully completing five live-fire trials. While this design is still in the development stage, the capabilities it may eventually offer could further expand the capabilities of tube artillery in future operations.

The combination of requirements for greater mobility and enhanced firepower may also lead to the broader implementation of innovative fire modes, such as multiple round simultaneous impact (MRSI) and fire-on-the-move capability – aligning with the evolving threat landscape and the operational demands of the modern battlefield.

## Final thoughts: Finding the balance

Over the last few decades, the evolution of artillery has been heavily influenced by major shifts in doctrinal thinking, driven by global changes in the military, political, and economic environment. Following the end of the Cold War and the dissolution of the USSR, future warfare – particularly as envisioned by NATO countries – was seen as a series of high-speed encounters conducted by small professional armies using long-range precision weapons, while large-scale conventional conflict was considered unlikely. Within this paradigm, tube artillery was regarded as a secondary and often unnecessary tool, compared to the air force or long-range rocket artillery.

Today, large-scale conventional conflict with a peer or near-peer adversary is once again a reality. The relevance of tube artillery on the modern battlefield has been reaffirmed by the experience of combat in the Russo-Ukrainian War. This renewed focus has prompted significant research and development in the field, with numerous innovations introduced to align tube artillery with the requirements of modern warfare.

At the same time, many longstanding debates have been settled. Discussions such as 'tracked versus wheeled platforms' or 'precision fires versus massed fires' have largely concluded with a common understanding: a modern army needs a substantial amount of artillery, and it must also have all the necessary tools in its toolbox. The question is how to find the right mix of systems, effectors, and capabilities that will enable forces to operate effectively on the battlefields of today and tomorrow.

# Marketing Report: WEIBEL

Napoleon said: "God is on the side with the best artillery". Applying a filter with the experiences from the last two year's war in Ukraine, it could be rephrased to "God is on the side with the most effective artillery" – and why is that?

Mass still matters, but when artillery units are running short on ammunition, more effective use of available ammunition is paramount.

What has become clear is that the ability to focus precise and accurate fires from indirectly firing weapons on the prioritized targets will make a difference. Coupled with the ability to shoot-and-scoot, precision and accuracy will dominate the battlefield – ensuring survivability from counter battery fires, loitering ammunition and drones – while suppressing or even destroying enemy forces.

In the past, there has been a move from lighter artillery to heavier, complex self-propelled howitzers. However, over the last years the trend has changed. The heaviness of an indirect firing platform is not the only parameter making indirect firing weapons the "King of the Battlefield". An emergence of lighter and more mobile howitzers of all calibers and autonomous heavy mortars has seen the light of day. "Below" the 52 cal. (+) howitzers is a layer of lighter indirect firing weapons based on 105mm guns and heavy 120mm mortars for the clos-in battlefield.

Traditionally the light guns would have longer range than heavy mortars, but mortar systems in general are better suited for fighting in built up areas due to their high trajectory. With new propellants and longer and heavier tubes, the gap between the two is closing.

Enabling those systems with the full technical enhancement package of heavier artillery will make them "just as lethal" as the heavier systems, and in some instances, the lightness will make them faster i.e. less vulnerable and help reduce the strain on the logistic trains.

A key component of enabling rapid and precise fires whether on various types of howitzers or heavy mortars is 1; digitization of fire control, 2; utilizing meteorology data and finally 3; updating base line firing tables with accurate and current muzzle velocity data. These three parameters were already found in a US DARPA study on improving accuracy of mortars from 2005. And to be correct, the third factor was recommended to be solved through "lot firing tables", to be more specific than "type firing tables". However building a firing table

**[DALO]**

**[KNDS]**

needs the use of 800-1000 rounds, which may not be the best use of the ammunition during "ammunition famine". The question then is; how to obtain more effective fires without unnecessarily depleting scarce ammunition resources?

For the third element (muzzle velocity data), Weibel's muzzle velocity radars of the 700-series provides new and legacy weapons with an easily integrated muzzle velocity radar system, from which data can be used by the fire control system to correct the platform's fires. From first round fired, the muzzle velocity data will make reducing unwanted dispersion possible, thus the desired effect is achieved faster and with fewer rounds fired.

On modern lightweight and mobile artillery systems, the MVR is e.g. integrated on the AMG Hawkeye lightweight howitzer. Based on the Hummer CT-2 platform, this systems plays on its high mobility and fast deployment, and through that, it's a system designed specifically for "shoot-and-scoot" mission, making use of fire optimization tools extremely important.

The radar does not only see usage on artillery howitzers, the Danish Army are the first in the world to permanently mount muzzle velocity radars onto their Cardom 10 120 mm mortars, installed onto the Piranha V platform. As mentioned; with modern propellants, longer tubes and thus increased range, modern autonomous mortars close in on the performance of light artillery. Hence the need for better control over ballistics, which propels the requirement for digitization and the use of MVRs, which not so many years ago was considered irrelevant. In short: The more knowledge about your muzzle velocity an indirect firing platform can get, the more effective it will be in consuming the available ammunition resources.

No matter the indirect fires platform, artillery or mortars, the use of digitization, meteorology and muzzle velocity data in an integrated system will improve and expedite the delivery of effects. Which close the circle: The favor is the side with the most effectively used artillery – and mortars.

Weibel's muzzle velocity radar systems are used on more than 4000 howitzers worldwide in some 30 countries.

1 Some may argue that mortars are not artillery, but they do deliver indirect fire and are subject to the same impact dispersion issues as artillery, hence they are included here.

# Europe's dash to procure rocket artillery

Tim Guest

**Rocket artillery systems have been employed extensively by both sides during the ongoing Russian war against Ukraine. As a result, Kyiv's European/NATO Allies are now investing heavily and apace in their own long-neglected, rocket-artillery inventories.**

Pictured: Dutch Army PULS validation test firings, July 2025. Several European NATO armies are racing to build their rocket-artillery inventories after years of complacency and in the face of old dangers having returned to the continent. Achieving this quickly means systems from various suppliers are being procured across the Alliance. [Dutch MoD]

In part, the latest wave of procurement is due to various users having supplied launchers and ammunition to Ukraine over the past few years, leaving various stocks depleted and in need of replenishment. In addition, Europe has begun to realise that it needs to depend less on the US for its future security and more on its own resources, equipment, and supply chains. As far as rocket artillery is concerned, the war in Ukraine has also underlined the urgent need for European nations, several of which are immediate Russian neighbours, to increase their longer-range, surface-to-surface, precision-strike, indirect-fire capabilities; traditional tube artillery, no matter how sophisticated and large-calibre the gun, while still of crucial importance, simply does not meet the longer-range requirements of the modern battlefield.

Emerging from this overview, are developments towards indigenous European rocket artillery solutions and industrial capabilities, as well as overseas procurements of new systems from the likes of Israel and South Korea by several European nations, and the continued adoption of latest rocket artillery from the US.

This article takes a look at just some of the recent and ongoing procurements and developments set to bolster rocket-artillery inventories and capabilities across European NATO Alliance member states. A look at the part the war in Ukraine has played as a catalyst to such procurements sets the scene.

## Ukraine war has upped the ante

From the US-made M142 High Mobility Artillery Rocket System (HIMARS) and M270 multiple launch rocket system (MLRS), to Czech-made RM-70 MLRS, and more, Ukraine's Armed Forces, in their defence against their Russian invaders, have been using a variety of rocket artillery platforms in longer-range engagements, out to around 80 km, since the early months after the initial invasion. They knew they needed such systems and made numerous requests for them from allied nations. And while not acquired, for the most part, through typical commercial channels, it's worth knowing which systems have been provided, in what numbers, and by whom, because many of those donor nations are now procuring new weapon platforms to replace and bolster their own stocks.

One source of such details, the Kiel Institute for the World Economy, has kept a track of government-to-government materiel transfers/donations from 41 countries, which have donated weapons and assistance to Ukraine since the start of the war, or immediately before. In the case of rocket artillery, according to the institute's Ukraine Support Tracker's data, systems supplied between late January 2022 and 30 March 2025, is summarised in the table below.

AUTHOR

**Tim Guest** is a long-time defence and aerospace journalist, UK Correspondent for ESD, and a former officer in the British Armed Forces.

TABLE 1

**Rocket artillery supplied to Ukraine (January 2022 – March 2025)**

| Country | Equipment | Quantity |
|---|---|---|
| Czech Republic | RM-70 | 12 |
| France | M270 MLRS | 4 |
| Germany | MARS II/MLRS Evolution | 5 |
| Germany | M142 HIMARS | 3 |
| Italy | M270 MLRS | 2 |
| Norway | M270 MLRS | 11 |
| Poland | BM-21 Grad | >30 |
| UK | M270 MLRS | 6 |
| USA | M142 HIMARS | 41 |

Note:
a) Data sourced from Kiel IFW's Ukraine support tracker, aside from Poland.
b) Poland figures sourced from the Office of the President of Poland.

The HIMARS platforms supplied by the US, for example, were requested in early discussions between Ukraine with the Biden Administration, and have been highly effective in engaging and hitting targets at ranges out to 84 km using guided rockets, as have the M270 MLRS; both platforms have been able to use a unitary-warhead variant of the 227 mm guided multiple launch rocket system (GMLRS) M31A1 (unitary warhead) and M30A1 (alternative warhead) rockets. These use a combination of global navigation satellite system (GNSS) and inertial navigation system (INS) guidance for accuracy to engage targets anywhere between 15 km and 84 km distant; they're designed for precision strikes on point targets using a high-explosive fragmentation (HE-FRAG) warhead, and can be set for either impact or air-burst fuzing modes.

Ukraine was also on the lookout, early on, for M270 MLRS. Indeed, the UK's announcement to gift six M270 MLRSs was made back at the start of June 2022, and was a decision, as confirmed by the UK MoD, co-ordinated closely with the US' decision to gift the single-pod, wheeled HIMARS. The UK said at the time that M31A1 munitions would also be supplied at scale together with the six weapon platforms. It also confirmed that the decision to supply these M270 MLRS had been taken by the then UK Minister of Defence, Ben Wallace, following specific requests for the system from Ukrainian Forces, who'd said they needed the longer-range precision weapons to defend against Russia's heavy rocket artillery, which they'd previously experienced during the devastating counter-battery artillery engagements in the eastern Donbas during 2014. Before the six MLRS launchers were sent, Ukrainian troops were trained in their operation at the UK at the Royal School of Artillery on Salisbury Plain.

Among the growing number of urgent new orders for rocket artillery across NATO's European members, tried and tested US stalwart HIMARS, continues to be in huge demand. However, that demand has squeezed supply timelines, resulting in several nations looking elsewhere, to ensure they have a suitable rocket artillery system of some kind, in place, as fast as possible. So, even as Lockheed Martin is addressing increased demand for HIMARS by upping annual launcher production rates in 2025, according to the International Institute for Strategic Studies (IISS), from 60 to 96 units, (though Lockheed Martin recently said it had "doubled" its production, without specifying the final number), together with the company's target to "increase GMLRS production capacity to 14,000 per year in 2025" (from its rate of 10,000 in 2024, and 6,000 in 2023), other makers beginning to take up the slack to meet Europe's needs in the coming years. These include Israel with Elbit's PULS MRL, and South Korea with Hanwha Aerospace's K239 Chunmoo MRL.

## The Baltics, Scandinavia, and Italy opt for US systems

All three Baltic states, Estonia, Latvia, and Lithuania, have elected to adopt HIMARS, together with GMLRS rockets to enhance their deep-strike capabilities as part of a joint force development project. This joint force collaboration was formalised in Riga, Latvia, in January 2024, when the three nations' ministers of defence signed an agreement of mutual intent to develop their new HIMARS capabilities, collectively.

As for procurements, at the end of April 2025, the Estonian Defence Forces took delivery of six new HIMARS MLRS, which arrived at the Ämari Air Base, following three-and-a-half years to procure the systems and train the soldiers to operate them. It's one of Estonia's largest weapons' acquisitions and the director general of the Estonian Centre for Defence Investments (ECDI), Magnus-Valdemar Saar, said, "HIMARS is a joint force development project among the three Baltic states... the same systems will soon be delivered to our neighbours, Latvia and Lithuania, representing a major leap in the region's defence capabilities, enabling rapid strike effects deep into enemy territory." He added that while defence procurement cooperation among the Baltic States was close, joint programmes of this scale, which has involved the US and Lockheed Martin, were rare. The ECDI's Strategic Category Manager (armaments), Ramil Lipp, added that

An M270 MLRS conducting a launch at the Grafenwöhr training area in Germany. [PEO Missiles & Space]

An Estonian Defense Forces M142 HIMARS launches a training rocket during a live-fire exercise in Undva, Estonia, on 11 July 2025. [US Army/SSgt Rose Di Trolio]

the original December 2022 contract, signed with the US Defence Security Cooperation Agency (DSCA), includes rockets of various range capabilities, as well as communications, training, logistics, and full lifecycle support.

With the arrival of the new systems, Hanno Pevkur, Estonian Minister of Defence, said that the US had financed the procurement and the US Army's Victory training unit, already stationed in-country, had already trained Estonian troops to use HIMARS prior to the new systems arriving. The first live-firing and division-level exercises have already been taking place this summer, 2025. The US funding for Estonia's HIMARS is understood to be part of a broader security assistance package intended to strengthen the defensive capabilities of NATO's eastern flank.

Neighbouring Latvia, meanwhile, signed its agreement with the US at the end of December 2023 to similarly purchase six HIMARS launchers, together with ammunition of various kinds and ancillary equipment. Its decision to procure the system was a direct result of the system's use in Ukraine, according to the Latvian MoD. In the deal worth USD 179.8 million, Army Tactical Missile Systems (ATACMS) tactical ballistic missiles (TBMs) are also part of the package. This munition which will enhance Latvia's deep-fire capabilities out to some 300 km. Latvian Defence Minister, Andris Sprūds, said the acquisition underpinned the country's strategic partnership with the US, as well as helping to bolster NATO's collective defence. US Ambassador to Latvia, Christopher Robinson, added that the new systems would be crucial in 'deterring aggression' and sending a clear signal that, "the US and Latvia will stand by [their] joint commitment to defend every square inch of NATO's territory". Delivery of the six systems and ammunition is slated to begin in 2027, although Latvia's Armed Forces will be trained in their use prior to delivery. It is also worth noting that in Latvia's approved 2025 defence budget, EUR 52.84 million have been allocated to indirect fire support capabilities, including for long-range rocket systems.

It was, however, Lithuania, which was the first Baltic states to sign up for HIMARS, back in December 2022. This followed the November 2022 green-lighting of the potential acquisition by the US Department of State, as a potential FMS. As well as eight launchers with live and dummy ammunition, together with different ammunition pods, including pods for ATACMS, full training, maintenance equipment and support services, and more, were all itemised at that November 2022 stage. However, the Lithuanian MoD also said that the USD 495 million deal also included systems integration and connection with NATO's integrated air and missile defence system (NATINAMDS). Lithuania's Minister of National Defence, Arvydas Anušauskas, said at the time, that with its Latvian and Estonian allies also looking to acquire HIMARS, this would "unquestionably lead to the capability becoming a substantial boost to the defence of not just Lithuania, but the entire region". Just one month later, in mid-December 2022, Mr Anušauskas and then-US Secretary of Defence, Lloyd Austin, signed Lithuania's M142 HIMARS contract for the eight launchers and ancillaries, with first deliveries slated for 2025.

A USMC M142 HIMARS loads onto a USMC C-130 Hercules cargo aircraft to conduct a High Mobility Artillery Rocket System Rapid Infiltration (HIRAIN) during Exercise Baltic Operations 25 (BALTOPS 25), at Klaipeda, Lithuania, on 18 June 2025. [USMC/LCpl Van Hoang]

MITTLER REPORT

# 21st Life Cycle Management in NATO Conference and Exhibition

## 20/21 January 2026

### Holiday Inn Brussels Airport



Impressions from the LCM Conference 2025

# Cooperating for Capability

## Life Cycle Management – The Key Enabler from Investment to Combat Power

The Life Cycle Management in NATO Conference and Exhibition is organised by Mittler Report Verlag GmbH in cooperation with the NATO Life Cycle Management Group (LCMG) and supported by the NATO Industrial Advisory Group's (NIAG) Industrial Interface Group (NIIG).

Experts from NATO, armed forces and industry share how Life Cycle Management turns investments into real combat power. Discover practical solutions, new partnerships and lessons learned. Meet decision-makers and expand your network. A focused exhibition presents innovations and capabilities to ensure sustained operational strength.

**Information & Tickets**

MITTLER REPORT **mittler-report.de/events/lcm**

Norway is one Scandinavian HIMARS adopter, which received initial approval from the US State Department in August 2024 to acquire 16 M142 HIMARS launchers together with associated ancillary equipment. This included a range of pods for various rocket munitions, including for ATACMS TBMs; the acquisition, will be conducted as a foreign military sale (FMS), and is valued at around USD 580 million.

Finland, on the other hand, is undertaking an extensive upgrade and refurbishment programme of its M270 MLRS platforms instead of new procurement, as announced in December 2023. Conducted by maker Lockheed Martin, the programme will ensure the resulting M270A2s are almost brand-new systems, so they remain effective and in operation through 2050. They'll have a new common fire control system, shared with HIMARS, thereby enabling interoperability in several areas, including the ability to use a wider range of latest munitions, such as Lockheed Martin's new Precision Strike Missile (PrSM) and extended-range (ER) GMLRS. The upgraded platform will also have a new 600 hp engine and new transmission, together with a new armoured cab offering additional crew protection against mines and IEDs.

For its part at NATO's southern extremities, Italy began the year by announcing the acquisition of 14 M142 HIMARS launchers in January 2025, completing the Directorate of Land Armaments' (Terrarm) overall procurement of 21 HIMARS for the Italian Army under the terms of an FMS with the US, valued at around USD 400 million. As with other such deals, training and specialist technical support to guide the systems into service are included, as well as additional equipment, including an M31A2 GMLRS unitary pod with an insensitive munitions compliant propulsion system. Discussions on the acquisition began with the US in late 2023/early-2024, and bringing it into Italian service complies with the Italian Army's Operational Concept 2020-2035 plan, as well as with enabling capabilities for the army outlined in its 'Army 4.0' paper. These capabilities include such things as mobility and extended range, as well as accuracy to enable deep, precision fires, all contributing to greater operational flexibility. The new systems will eventually operate alongside 21 upgraded Italian M270A1 MLRS, which can also use/share GMLRS rocket supplies.

## Poland's powerful preparations

Not one to shirk its own and Alliance collective responsibilities, in August 2023 Poland took delivery of the first three of 290 South Korean K239 Chunmoo MRLs currently on order. Poland's initial end-2022 contract with Hanwha Aerospace was for 218 systems, and a follow-on USD 1.6 billion contract in April 2024 was for 72 Chunmoo systems, together with an unspecified 'thousands' number of guided tactical missiles. According to Poland's IAR news agency, 12 of the 72 launchers in the 2024 contract will be made in South Korea, with the remaining 60 to be built in Poland, with deliveries slated for a 2026-2029 timeframe.

Designated Homar-K in Poland, the K239 systems are being integrated with Jelcz 8×8 trucks and will incorporate Polish Topaz combat management systems. The Homar-K platforms will operate alongside the Army's existing HIMARS platforms, and will be able to launch a variety of munitions, including CGR-080 239 mm guided rockets with a range of 80 km, and 600 mm CTM-290 tactical ballistic missiles (TBMs) with a range of 290 km.

▲ **Pictured: Poland's Homar-K conducting its first live firing. Poland will eventually have an inventory of 290 K239 Chunmoo MRLs. [Polish Armed Forces]**

However, taking this major procurement to the next level and aiming to create a domestic rocket-artillery capability, Poland's largest private defence company, WB Group, signed an agreement with Hanwha in April 2025 to create a guided missile joint venture (JV) in the country. The new JV – formed to produce guided munitions for the Homar-K MRL – will be majority-owned by Hanwha Aerospace (51%), with the remaining 49% held by the WB Group subsidiary, WB Electronics. The facility will eventually produce the 80 km range, GNSS/INS guided CGR-080 rockets for the Homar-K. The JV will also jointly market its product portfolio to other European nations. Indeed, as part of a bigger picture, not only does this JV agreement bolster the Korean company's long-term commitment to playing a key part in the modernisation of Poland's defence industry, but also gives it strategic-partnering potential with other European NATO members.

## Europe's increasing PULS rate

Spreading the load to meet demand and adding to the mix of rocket artillery among European NATO states is Elbit Systems' Precise and Universal Launch System (PULS). The Israeli system has so far been adopted by several European nations, includ-

ing Denmark, Germany, The Netherlands, and Spain. And while these nations are not on NATO's immediate eastern flank, they are moving ahead with rocket artillery procurements as fast as possible, having seen the critical role such systems are playing in Ukraine, and to bolster their own precision deep-fire capabilities, urgently. Let's now take a look at aspects of some of these procurements.

**The RNA has recently, mid-2025, taken delivery of the first of its 20 PULS launchers. Pictured: Rear view of PULS pods during Dutch Army test firings, July 2025. [Dutch MoD]**

According to the IISS, the Royal Netherlands Army (RNA), had been on track to acquire HIMARS as its latest rocket artillery asset, but due to demand for that system outstripping timely supply, as well as other differentiators such as PULS' greater ammunition capacity (depending on munition) compared to HIMARS, the Israeli system was chosen by the Dutch. Accordingly, mid-May 2023, a USD 305 million contract was awarded to Elbit Systems to supply 20 PULS artillery rocket systems to the RNA over a five-year period, from first deliveries in 2025, to 2030. The RNS's new launchers, which have already begun arriving, are mounted on the COMMIT 8×8 truck platform. The contract also includes rockets and missiles of various calibres and range capabilities, as well as maintenance support services and full end-user training. According to Elbit, the system has an open architecture to support growth, legacy C4i systems integration, as well as being able to accommodate bespoke customer needs. The munitions being supplied to the RNA include Accular guided rockets (122 mm variant has a range of 35 km, while 160 mm variant has a 40 km range), EXTRA 306 mm guided rockets with a range of 150 km, and Predator Hawk TBMs with a range of 300 km; all use GNSS/INS guidance.

Having recently taken delivery of its first PULS launchers mid-2025, the RNA conducted successful live-fire, precision-strike validation tests over 8-9 July 2025, at the Afsluitdijk coastal training ground, during which 16 rockets were fired at specific coordinates out to sea. The results proved the system's accuracy, with all projectiles landing within their designated target areas, as well as confirming operator certification requirements.

As for Germany's USD 57 million PULS deal, or, rather, 'EuroPULS', this was announced in February 2025 as having been "carried out through agreements between the Dutch, Israeli and German Governments". KNDS and Elbit Systems actually signed a teaming agreement in September 2023 to formalise and implement their strategic cooperation to further all aspects of the EuroPULS, next-generation, rocket artillery system concept.

To deliver the new contract, Elbit is working with KNDS Deutschland on various system adaptations for the German end-user, including the integration of domestic C4i equipment, as well as command and weapons control systems, and full in-service support. The launchers will eventually undergo test and evaluation with German procurement agency, BAAINBw, as well as associated technical test centres, in order to attain approval for in-service use with the German Armed Forces. CEO of KNDS Deutschland, Ralf Ketzel, said, "The cooperation between Elbit Systems and KNDS Deutschland marks a milestone in the development of a European indirect fire system for rockets. As the OEM for European land systems, such as the Leopard 2 and PzH 2000, KNDS will ensure that the PULS systems become the EuroPULS."

Yehuda Vered, General Manager of Elbit Systems Land, concluded that the German acquisition and arrangement "paves the way for future orders of the EuroPULS configuration". It is worth noting that, as well as its open architecture, the EuroPULS MRL can operate using third-party rockets from other manufacturers, such as Lockheed Martin.
As for Spain's USD 700 million PULS deal – PULS is designated SILAM with the Spanish Forces – the collaboration involves technology transfer to enable participating Spanish companies, Escribano Mechanical & Engineering and Rheinmetall Expal Munitions, to manufacture the launchers and munitions, respectively, in Spain.

Finally, on 1 April 2025, Elbit announced having been awarded a USD 130 million contract by an unnamed "European customer" for artillery rockets, and slated to be delivered over an unspecified three-year period. The contract included a variety of munitions, from training rockets to the Accular 122 mm variant rocket, the EXTRA rocket, as well as the Predator Hawk TBM. The wording of the Elbit press release seemed to suggest that these would be going to an existing European PULS operator.

## Preparing for the future

The above is just a snapshot of some of the latest procurements of rocket artillery by several European NATO member states, who've been watching events in Ukraine closely. Over the past three years, they seem to have woken up to the importance of rocket artillery on today's battlefields, the need for longer-range precision fires, and the urgency of restocking depleted inventories. At the same time, they are acquiring new systems with improved capabilities, accuracy and lethality, while also working to collaborate more efficiently and effectively with Allies – driven by a shared sense of urgency in preparing for an uncertain and potentially perilous future.

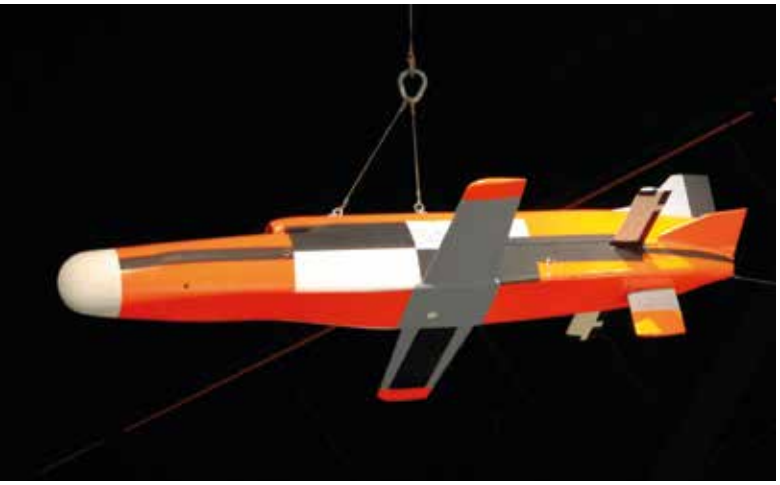
# Loitering munitions: Production scaling kicks into higher gear

Sidney E. Dean

**Demand for loitering munitions is growing exponentially. Industry is challenged to scale up production capacity to adjust to the changing operational realities.**

Loitering munitions (LMs) combine the capabilities of a small drone and a guided missile. They are designed to remain over a target area for short-to-extended periods, identify and verify targets using onboard sensors, then transition to attack mode, executing precision strikes by impacting the target.

The concept can be traced to the 1980s, originally in the form of loitering missiles. Early models include the air-launched AGM-136 Tacit Rainbow loitering anti-radiation missile, developed by Northrop (now Northrop Grumman) along with Texas Instruments and Boeing, but cancelled by the US Department of Defense (DoD) in 1991 before it could enter production. The IAI Harpy, developed by Israel Aerospace Industries (IAI) and thought to have been first deployed in 1991, is generally considered the first operational drone-based LM. These early LMs were configured for the Suppression of Enemy Air Defences (SEAD) role. Since then, the mission profile has broadened significantly, and now prominently includes (among others) anti-personnel, anti-vehicle and anti-armour attacks.



▲ Northrop AGM-136A Tacit Rainbow on display in the Cold War Gallery at the National Museum of the US Air Force in Dayton, Ohio. [USAF]

AUTHOR

**Sidney E. Dean** is a freelance writer and editor specialising in strategic studies, military technology and military history. He serves as North America correspondent for ESD and other Mittler Report Verlag publications.

LMs fill a capabilities niche between artillery and missiles, providing additional options and, depending on operational scenarios, potential advantages over other munitions. The most obvious advantage is the extended dwell time over the target zone, increasing the search window for hidden targets, permitting attacks against targets of opportunity, and the ability to analyse and prioritise targets before attacking. Unlike tube or traditional rocket artillery, LMs' sensors allow them to discriminate between and verify individual targets, increasing precision and reducing the risk of collateral damage. Furthermore, given the two-way data link between UAV and operator, these sensors also provide the LM a secondary or alternate capability as reconnaissance and surveillance aircraft, and can provide immediate feedback about mission success. Also unlike shells and rockets, LM operators can divert the munition to different targets or fully abort the mission. Unlike either artillery or missiles, many LM classes can be recalled, recovered and reused if no target is found. Finally, LMs can be deployed by tactical vehicles and dismounted infantry, providing small units with beyond-line-of-sight (BLOS) precision-attack capability without the need to call in and wait for artillery strikes. Aside from these tactical considerations, LMs are often lower cost than missiles; as one example, the US Congressional Research Service in 2023 cited a unit cost of USD 6,000 for the Switchblade 300 tube-launched LM.

## Proving grounds

LMs have been used increasingly in recent conflicts, including the 2020 Second Nagorno-Karabakh War (during which Azerbaijan launched numerous IAI Harpy and other LMs to significantly degrade Armenian air defences and armour) and the Syrian Civil War of 2016–2021 (during which the US supplied the Syrian Democratic Forces with circa 150 Switchblade series LMs).

The battlefield role of LMs jumped exponentially after the Russia's full-scale invasion of Ukraine in 2022. Precise numbers of LMs deployed in the Ukraine war are difficult to verify, but there are estimates by reliable sources. Russian materiel loss tracking website *lostarmour.info* stated a figure of over 3,500 confirmed Lancet strikes as of early August 2025. Ukraine also quickly adopted LMs, using both western-supplied and domestically developed systems. Here, too, precise figures are largely classified. In October 2023, the vice president of US-based AeroVironment Inc. confirmed that his company had delivered "a very large number" of Switchblade 300 LMs to Ukraine, and was transitioning deliveries to the more powerful Switchblade 600. In 2024, AeroVironment went a step further, partnering with a Ukrainian firm for local manufacture of the Switchblade 600. In December 2024, Forbes magazine revealed that Florida-based Aevex Aerospace had delivered 5,000 Phoenix

Ghost LMs to Ukraine up to that point, at a production tempo that peaked at roughly 230 units per month. The firm itself describes the Phoenix Ghost family as the "Nr. 1 US Government provided loitering munition to support the conflict in Ukraine." Poland's WB Group, which had a pre-war contract to sell 1,000 Warmate LMs to Ukraine, supported Kyiv's war effort with an undisclosed number of systems. Ukraine's domestic efforts included developing their own LMs. In summer 2024, Ukraine's Digital Transformation Ministry confirmed that multiple companies were mass-producing such 'Lancet analogues'.

Beyond traditional LMs, both sides in the Russo-Ukrainian War have been heavy adopters of first-person view (FPV) drones, an improvised form of LM. Thanks to their relatively simple construction, both sides have been able to produce these in large volume, with production now in the low millions of units per year for both Russia and Ukraine.

## Surging demand in NATO

Even before the Russian invasion of Ukraine, Western nations recognized LMs' potential. Government documents confirm that US Special Operations Command (SOCOM) acquired 1,000 Switchblade 300 units between 2012 and 2020, conducting up to 400 launches in Afghanistan during that timeframe; thousands of additional Switchblades were deployed by conventional forces.

Current US Marine Corps acquisition efforts include the Organic Precision Fires – Mounted (OPF-M) programme to equip light armoured reconnaissance and amphibious units with Hero-120 LMs, and the Organic Precision Fires-Light (OPF-L) programme to provide man-portable LMs to every infantry squad, with fielding to begin in 2027. In August 2024, the US Army awarded AeroVironment a five-year indefinite-delivery, indefinite-quantity (IDIQ) USD 990 million contract for Switchblade 300 and 600 LMs. A portion of this procurement will serve the goal, confirmed by Army Vice Chief of Staff Gen. James Mingus in June 2024, of acquiring more than 1,000 Switchblades to support the Replicator Initiative. Another portion will support the Army's Low Altitude Stalking and Strike Ordnance (LASSO) project to provide Infantry Brigade Combat Teams (IBCTs) an organic BLOS precision-strike capability. The Switchblade 600 was selected as the Phase 1 effector. Procurement began in Fiscal Year 2025 with 434 All-Up Rounds (AURs), followed by a request for 294 AURs in the FY 2026 budget request. The immediate goal is to equip five IBCTs. The Army is pursuing additional capabilities to form a multi-tiered LM family-of-systems including medium- and long-range helicopter-launched effectors.

**US Soldiers assigned to 3rd Brigade, 10th Mountain Division fire a Switchblade 600 LASSO weapons system at the 7th Army Training Command's Grafenwoehr Training Area, Germany, on 25 February 2025. [US Army/K.S. Payne]**

European nations are also intensifying efforts at the national and multinational level, most notably France and Germany. France is pursuing multiple initiatives to acquire domestically produced LMs. In March 2024, Defence Minister Sébastien Lecornu announced that France planned to purchase 2,000 LMs of various classes. Among such efforts was France's Colibri programme for a UAV with a minimum 5 km range and 30 minute endurance, which culminated with the selection of the Delair/KNDS team's MV-25 OSKAR, a fixed-wing LM with a 25 km range and 45 minute endurance. Thus far the DGA is known to have contracted a batch of 100 MV-25 OSKAR LMs for Ukraine.

France's efforts on rotary-wing LM procurement have moved forward somewhat further. In July 2024, the DGA awarded Delair/KNDS team the development contract for the Munition Téléopérée – Courte Portée (ENG: Loitering Munition – Short Range), selecting the firm's MX-10 Damocles quadcopter LM design. The team managed to develop, produce and qualify the LM within a single year. The DGA's procurement contract calls for 460 units to be delivered in 2025, of which the first batch of 30 were slated to have been delivered in July 2025.

In April 2025, the German armed forces (Bundeswehr) announced procurement of "a large number" of LMs to be directly assigned to frontline units for in-depth operational evaluation. Contracts were awarded to the German start-ups Helsing SE (HX-2 'Karma') and Stark Defence GmbH (OWE-V 'Virtus'). Following evaluation in operational units, leadership will decide to either procure larger orders of the same LMs or consider acquiring alternative systems in support of the Force 2030 modernisation programme. The German MoD has not released a precise stockpile target, however, Simon Brünjes, Helsing's vice-president of sales estimated a requirement for 120,000 to ensure sufficiency for 60 days of fighting while production ramped up, or increasing to 200,000 to ensure that 120,000 could be available in case of ammunition depots being targeted.

## Industry's response

Given their extant physical infrastructure, financing and staffing, established defence companies can be expected to have an innate advantage regarding the emerging market, especially since some have already established a track record for developing and fielding LMs. The challenge will be upgrading the ability to produce en masse and for short-term, crisis-driven demand cycles.

A prime example of proven manufacturers would be Virginia-based AeroVironment (AV). Founded in 1971, AV became an early pioneer of military unmanned aircraft development;

operational introduction of the rucksack-compatible Switchblade 300 in 2012 helped make the firm a major player in the LM sector. The Switchblade 300 and 600 munitions can be launched by infantry or integrated on vehicles and special operations watercraft; they have also been test-launched from helicopters. Switchblade systems are still mostly operated by US and Ukrainian forces, but international interest is growing. To meet future demand, AV is making significant investments to expand production capacity, with perhaps the most notable example being the firm's new 19,000 m2 FreedomWerx facility in Salt Lake City, Utah, expected to begin operations in the second half of 2025.

▲ **A UVision Hero-120 launching from a Boxer armoured fighting vehicle. [Rheinmetall]**

In October 2021, Rheinmetall and Israeli firm UVision Air Ltd. announced a strategic partnership to meet sharply increased demand for remotely controlled precision munitions. Under this framework, Rheinmetall has agreed to manufacture and supply UVision's Hero LM family for the European market; the German firm is also responsible for certification of the Hero series to NATO standards. Production is being undertaken by Rheinmetall's Italian subsidiary RWM Italia. In the course of this partnership Rheinmetall has also integrated the LM with various manned and unmanned vehicles. In September 2022, the Rheinmetall/UVision partnership secured its first sale of the Hero-30 to the Italian special forces, followed in July 2023 by a 'low three-digit million-Euro range' sale to Hungary and, in September 2023, the first sale of the Hero-120 in Europe (to an undisclosed customer).

Poland's largest private defence manufacturer, WB Group, produces the Warmate family of LMs which can be equipped with various warheads depending on the mission. The flexible, swarm-capable system can be deployed by infantry or vehicles. On 15 May 2025, Poland's armament agency signed a framework agreement with the WB Group for delivery of 10,000 Warmate LMs. This is the third, and by far the largest, order placed by the Polish MoD for this weapon system since 2017. In the accompanying press release, the firm described this as the largest single signed order for LMs in the world. The contract is slated for completion in 2035. The firm is also actively marketing the Warmate for export, most recently participating in the DSEI Japan in May 2025. Foreign customers include NATO members as well as Middle Eastern and Asian nations, with South Korea placing an order for "several hundred" Warmate munitions in October 2024, according to WB Group.

While established firms enjoy innate advantages, comparatively new technologies such as LMs also provide opportunities to dynamic young firms; not 'burdened' by established procedures


▲ **On 15 May 2025, WB Group, represented by CEO Piotr Wojciechowski (left), and the Armament Agency of the Polish MoD, represented by Deputy Agency Head, Col Piotr Paluch (right, signed an agreement for the delivery of 10,000 Warmate LMs. [WB Group]**

and infrastructure, start-ups can immediately forge ahead with new production concepts that, if successful, could hypothetically transform the industry. If, that is, they can overcome such challenges as economies of scale, quickly establish an adequate physical manufacturing base, and secure reliable supply chains.

The German start-up Helsing, founded in March 2021, has lost no time establishing a market niche characterised by fast-paced weapon system development and maximum use of software-guided production processes. The firm's public statements present a vision of scalable mass production at speeds much faster than currently demonstrated by major firms. Following multiple large orders from the German government, along with 4,000 HF-1s and 6,000 HX-2 LMs for Ukraine, Helsing now describes itself as "one of the largest manufacturers of strike drones globally".

To finance its ambitious expansion plans, Helsing has raised USD 1.37 billion in investment capital in four major funding rounds between 2021 and 2025. The firm plans to estab-

lish several 'resilience factories' (RF) at different locations throughout Europe. This concept calls for decentralised mass production to ensure continuity if facilities in one allied nation are destroyed. Each RF will maintain its own localised supply chain. Helsing's production concept emphasises an artificial intelligence (AI)-supported, software-centric approach that automates and accelerates complex processes. Efficiency is enhanced by contracting with other manufacturers to produce subassemblies and components according to Helsing's specifications. The first resilience factory, RF-1, was completed in December 2024 at an undisclosed location in southern Germany. Helsing cites RF-1 as having an "initial monthly production capacity of more than 1000 HX-2s". RF-2 is currently at the planning stage, and will have a higher production capacity. The firm expects its various RFs to jointly produce tens of thousands of units monthly during a crisis. However, to date Helsing has not published a timeline regarding construction of additional RFs.

▲ RF-1, Helsing's first resilience factory, has a monthly production capacity of "more than 1,000 HX-2s". [Helsing]

## Surge capability required

Just as governments and industry have recognised the need to significantly boost artillery production, they are also systematically pursuing expansion of LM manufacturing capacity. While adequate standing arsenals must be maintained to permit rapid response to crises, a major requirement will be the ability to rapidly scale up production on demand. General Pierre Schill, Chief of Staff of the French Army, summarised the problem during an October 2024 hearing before the French National Assembly. *"The challenge for me is to have industries capable of producing the most up-to-date [LMs] possible, to have a production flow that allows training and a minimum stock, but above all to produce much more when I need it. The risk of building up stockpiles of such ammunition would be like having obsolete ammunition, so rapid is the evolution in this field."* Established firms and start-ups alike are racing to develop this capability.

# Catch the wave

Dr Thomas Withington

**European military networking has taken an important step forward with the realisation of the ESSOR suite of waveforms, some, or all, of which look likely to be adopted throughout NATO in the coming years.**

Land forces fighting together in a coalition have, in recent times, often struggled to talk to their counterparts. For example, a Canadian Army brigade might struggle to communicate with elements from the *Heer* (German Army). Should land formations need to communicate directly, voice and data traffic has often flowed upwards to reach the joint command, flowing back downwards to its intended recipients. The reason for this is comparatively simple: Land forces have lacked common, interoperable, tactical communications waveforms they can use for interforce connectivity.

Intra-force communications, where individual armies network between formations, echelons and combat arms, have been comparatively easy. Several NATO member countries employ tailored tactical waveforms to meet their specific operational needs. For instance, the French Army *(Armée de Terre)* uses the Geomux high-data-rate waveform with Thales' PR4G family of radios. The US Army and US Marine Corps, meanwhile, operate a wide range of tactical communication waveforms suited to their respective missions. The Army's TSM waveform carries secure high-data-rate voice and data traffic for instance.

A common inter-force waveform was developed in the 1980s to equip the Single Channel Ground and Airborne Radio System (SINCGARS), a revolutionary family of tactical radios and waveforms intended to provide secure and robust inter-force communications. It was adopted by the US Army and other NATO land forces. Nonetheless, some exceptions to this dearth of inter-force connectivity do exist: NATO's HAVEQUICK-I/II waveform is intended for Alliance-wide air-to-surface/surface-to-air and air-to-air communications. HAVEQUICK-I/II is a frequency-hopping waveform using a very/ultra-high frequency (UHF) waveband of 225 MHz to 400 MHz. The waveform is installed on US-supplied radios as it is covered by the US's International Traffic in Arms Regulations (ITAR). The majority of NATO's land forces have tactical radios provided by US suppliers such as L3Harris. These ITAR-controlled radios contain the HAVEQUICK-I/II waveform. The intrinsic interoperability of HAVEQUICK-I/II makes sense. A Hellenic Army Joint Terminal Air Controller (JTAC) might be coordinating a close air support (CAS) mission with a *Luftforsvaret* (Royal Norwegian Air Force) F-16 series combat aircraft. It is imperative that both the JTAC, and the Norwegian pilot, can use a common, robust and secure waveform to manage a task as complex as CAS.

AUTHOR

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

**The advent of the SINCGARS radio in the 1990s was a major step forward in fostering intra-force connectivity in the US Army, and elsewhere in NATO. However, inter-force networking for land formations has, until now, remained elusive. [US Army]**

European nations have fought in coalitions in scores of operations since the end of the Cold War. NATO efforts in the Balkans and Libya were primarily focused on air campaigns, though this was not the case in Afghanistan. There, Alliance and Allied nations deployed significant land power. Two realities highlight the imperative that European nations need robust and effective interforce communications: The first is the continent's strategic situation. Russia's initial invasion of Ukraine in 2014, and full-scale invasion eight years later, has shown that Moscow's territorial ambitions remain the greatest threat to Europe since the Cold War. Short of a complete Russian defeat in Ukraine, and her full expulsion from the territory of Ukraine, the threat posed by the muscular strategic posture of President Putin's government is unlikely to diminish. Any invasion of NATO will see European Alliance members fighting to push the aggressor back behind its borders. It is noteworthy that several European nations already comprise eight NATO battlegroups deployed in Bulgaria, Estonia, Hungary, Latvia, Lithuania, Poland, Romania and Slovakia.

## Multi-domain operations

Alongside Europe's strategic reality, NATO's membership writ large is embracing the multi-domain operations (MDO) mindset. The Alliance defines MDO as "the push for NATO to orchestrate military activities across all operating domains and environments. These actions are synchronised with non-military activities and enable the Alliance to create desired outcomes at the right time and place."

# How Next-Gen Tactical Communications Empower Autonomous Systems

Modern warfare requires real-time situational awareness, which demands broadband capabilities from communication systems. However, the requirements for communication systems are often contradictory: long range requires narrowband transmission and low frequencies, but at the same time, real-time video transmission is necessary. The rise of autonomous systems makes it even more complex, while opening the door to new tactical communications capabilities.

The war in Ukraine has shown that inexpensive, even off-the-shelf drones can destroy enemy equipment and troops. These operations require real-time, uninterrupted wireless communications, but commercial technology has its limitations: because its functionality is well understood, it is relatively easy to jam. Jamming narrows the operational area of unmanned vehicles, forcing operators dangerously close to enemy lines.

▲ **Unmanned systems must be integrated into the tactical communications and C5 systems. [Bittium]**

Manual remote control with visual line of sight or video feed is only a step toward autonomy. In the future, higher levels of autonomy could enable drone swarms to operate independently after receiving a mission. They could then rely on short-range, high-bandwidth communication within the swarm, and possibly on slow, periodic data links between the swarm and the C5 system to relay, for example, location and status information.

## Enhanced Performance Through System Integration

To transmit data like drone video to command units, unmanned systems must be integrated into the tactical communications and C5 systems. If a vehicle can carry enough payload, it can host sensors to generate and relay data through the tactical network. Communication devices may also act as relays within the network. The challenge is that small drones, especially those carrying weapons, have limited payload capacity.

This is where technology convergence becomes essential – integrating electronic warfare capabilities into communication devices. For example, a software-defined radio (SDR) could also detect jamming, determine their location, and share that data in near-real time. Fully integrated systems also allow unmanned platforms to use advanced LPD/LPI/AJ features – including frequency hopping, cognitive spectrum management, and interference mitigation.

When linked into a mobile ad hoc network (MANET), unmanned vehicles can extend both range and data transfer speed by relaying traffic between nodes. Airborne nodes are well suited for this purpose, though they are also more susceptible to jamming. On the other hand, line of sight between friendly nodes allows the use of higher frequencies and directional antennas, which improve resistance to jamming and reduce emissions toward the enemy.

## From Theory to Practice

In the European Integrated Modular Unmanned Ground System (iMUGS) project, Bittium contributed a hybrid networking concept, combining C5 tactical communications with commercial mobile networks, allowing, for example, smartphone access to services.

Bittium also introduced TAC WIN Smart Link 360 functionality to its broadband TAC WIN Waveform. With the Smart Link 360, network nodes using electronically controlled SBA antennas autonomously locate their counterparts and can track their movements. Additionally, the steering of antenna beams is synchronized with the transmission, enabling full MANET networking while still providing the benefits of directional antennas traditionally used in fixed links. This solution – providing enhanced performance, automation, and jamming resistance – works also for unmanned vehicles.

## Shaping the Battlespace of Tomorrow

Integration, autonomy, and adaptability are not just buzzwords, they are the blueprint for next-generation defense. With SDR-based solutions, Bittium is building communications systems that empower autonomous systems and secures the tactical edge.

**Meet Bittium experts at DSEI UK, stand N8-250.**

**Contact: defense@bittium.com**

Bittium

MDO can also be defined as the full inter- and intra-force connectivity of all military assets within and beyond one or several theatres of operations to enable synchronous operations at all levels of war across all domains. The goal of MDO is to facilitate faster, and better quality, decision-making than one's adversary. The logic underpinning this decision-making improvement is to ensure that blue forces remain continuously proactive. Conversely, red forces will be compelled to be continually reactive. MDO theory holds that this proactive/reactive paradigm should be a precondition for blue force victory.

## Enter ESSOR

This apparent lack of a common, secure inter-force networking waveform has concentrated minds within the European defence community and prompted the development of such a capability. Work began in 2009 on an initiative known as the European Secure Software Defined Radio (ESSOR) waveform. Prophetically, ESSOR began before the full breakdown in relations between Russia and NATO, but the effort has proven prescient. The goal foreseen for ESSOR was to develop a secure networking waveform that can be installed in a host of different tactical radios used by different nations. The ESSOR programme is managed by OCCAR (*Organisation Conjointe de Coopération en Matière d'Armement*/Joint Organisation for Armaments Cooperation), a European supranational institution which manages collaborative defence programmes across the continent. The waveform is being developed by six companies in a consortium called A4ESSOR namely Bittium, Indra, Leonardo, Radmor, Rohde & Schwarz, and Thales. The armed forces of France, Finland, Germany, Italy, Poland and Spain are slated to receive ESSOR waveforms. Funding for ESSOR is secured from member nations and OCCAR itself.

Alongside OCCAR, the ESSOR initiative is supported via a European Defence Agency (EDA) Permanent Structured Cooperation (PESCO) project. PESCO was established in December 2017 under Article 42(6) of the Lisbon Treaty—introduced in the 2007 Treaty of Lisbon—to deepen defence cooperation among EU member states. The Lisbon Treaty essentially forms the EU's constitutional basis, and lets the Union sign treaties and join international organisations as an entity. As such, PESCO projects are intended to help EU member states develop common defence capabilities collaboratively by pooling financial and intellectual capital. The ESSOR PESCO was one of the original tranches of 17 projects adopted by the European Council in March 2018.

The ESSOR effort is developing four specific waveforms that can be installed across a wide array of tactical radios, airborne transceivers and satellite communications (SATCOM) terminals. Land forces are set to use the high-data-rate waveform (HDRWF) and narrowband waveform (NBWF). Both the HDRWF and NBWF will primarily be employed for surface-to-surface communications carrying voice and data traffic. The three-dimensional waveform (3DWF) is designed for air-to-air and air-to-surface/surface-to-air traffic. Finally, the SATCOM waveform supports over-the-horizon space-based communications. Both the Finnish and French militaries are using the HDRWF operationally, ESSOR programme sources have disclosed. Moreover, both the Croatian and Irish militaries will receive the waveform by virtue of recent tactical radio acquisitions they made from Bittium and Thales respectively.

The HDRWF uses frequencies of 225 MHz to 400 MHz handling up to 1 Mbps of data with up to 200 individual radios being hosted on each HDRWF network. The NBWF uses similar V/UHF frequencies to the HDRWF, with the addition of a 30 MHz to 88 MHz VHF waveband. This waveform handles data at kilobits-per-second rates and each NBWF network hosts up to 60 users. Data rates for the 3DWF are dynamic, adjusting to prevailing electromagnetic conditions, with each network capable of hosting up to 32 users. Like all ESSOR waveforms, it incorporates robust communication and transmission security protocols.

## ESSOR for NATO

To date, the ESSOR programme has primarily been a European effort, rather than a NATO-wide initiative, led by OCCAR. Nonetheless, the situation is changing. In 2023, the HDRWF's specifications were formally enshrined in NATO's STANAG-5651. By enshrining the waveform's design criteria in this STANAG, tactical radio developers have a blueprint on the software characteristics. This is essential if their wares will need to accommodate this waveform. The HDRWF's incorporation into STANAG 5651 goes a long way to answer a longstanding NATO requirement for a wideband coalition waveform. NATO launched the Coalition Wideband Networking Waveform (COALWNW) initiative in 2009, coincidentally the same year that ESSOR got underway. COALWNW had many similar aspirations to ESSOR: It was to provide a wideband waveform that could expand and deepen multinational networking for land forces. However, COALWNW's development proceeded at a glacial pace for

**Finland's land forces, alongside those of France, are now thought to be using the ESSOR high data rate waveform operationally. Other armies are expected to implement ESSOR in their tactical communications in the coming years. [Bittium]**

# Shaping the night – How Photonis sets the standard for modern warfare

**Frédéric Guilhem, Chief Commercial Officer - Night Vision at Exosens, shares how nearly 30 years of expertise, relentless innovation, and a commitment to European sovereignty has made Photonis (The NV brand of Exosens Group) a critical partner for modern armed forces.**

▲ Frédéric Guilhem – Chief Commercial Officer (Night Vision). [Photonis]

## How has Photonis evolved to become a market leader, and what makes your solutions stand out in today's defense landscape?

Photonis is today the world leader in image intensifier tubes, the heart of any night vision device. Over nearly 30 years, we've grown from modest beginnings into a 300 million Euro business through strategic acquisitions, organic growth, and constant innovation. Our two major production sites in France and in the Netherlands each account for about half of our global output. Combined with our proven ability to deliver in times of crisis and a strong European supply chain, this enables reliable supply even during global disruptions, giving customers confidence we can deliver large quantities quickly, a decisive differentiator in today's uncertain geopolitical climate.

Our tubes are designed, manufactured and fully tested in the EU, ensuring a 100% European supply chain free from ITAR restrictions and giving customers full independence, a key advantage for European armies seeking operational autonomy.

## How have geopolitical events and evolving user doctrines changed the demand for night vision and how has Photonis responded?

Even before the war in Ukraine, we saw growing orders from NATO and allied countries. Anticipating these needs and following the huge trends, we more than doubled our European production capacity. The conflicts confirmed that night vision is no longer optional but essential: soldiers must see clearly to act decisively. Our proactive investments enable us to deliver reliably and respond quickly to urgent demands, a key strength for our customers.

Meanwhile, armies' use of night vision has evolved dramatically. Twenty years ago, many bought it without fully understanding its potential. Today, with dedicated training and mature doctrines, soldiers exploit night vision to its fullest, making it a decisive battlefield asset.

## What are your R&D priorities and how is Photonis preparing for future needs?

Relentless innovation is at the core of what sets us apart. We constantly improve tube performance, image clarity, contrast, and reduce size and weight for better comfort. Our R&D also explores digital night vision for video recording and integration with connected battlefield systems, aligning with the digitalisation of combat. Yet we keep solutions robust, intuitive, and mission-ready, earning and keeping the trust of NATO and European forces.

## What can visitors expect from Photonis at DSEI 2025, and what new applications drive your innovation?

Without revealing too much, we're preparing a breakthrough that will significantly enhance night vision, setting a new benchmark for performance. This advancement, based on years of R&D and feedback from elite units, will boost performance of NVD but more importantly reduce the workload of operators in the field, a decisive edge in modern warfare. This product will address the Tier One end users to start with: Special Forces.

## How does Photonis ensure reliable deliveries and maintain independence in a tense industrial environment, and why is night vision a necessity today?

Our strategy combines full control of core technologies with a secure double sourcing European supply chain. During the COVID crisis, we proved our resilience by avoiding delays through strong supplier relationships and buffer stocks. We're expanding capacity in Europe and setting up production in the United States to meet growing demand and support NATO and allied countries even when other suppliers fall short.

Despite being a mature technology, night vision remains irreplaceable. Unlike thermal systems that only detect heat, our tubes deliver real-time images essential for situation awareness and precise identification, a decisive tactical advantage. Combined with low operating costs and exceptional reliability, night vision remains a critical asset on today's complex battlefields. At Photonis, we aim for a simple ambition: 'one soldier, one goggle', this is our mission!

New tactical radios being supplied by Thales to equip Ireland's military will comprise the ESSOR HDRWF which will significantly improve intra- as well as inter-force networking. [Thales]

many years, and the initiative is now considered all but ended, according to NATO sources. ESSOR's adoption into STANAG-5651 effectively sees this waveform satisfy the COALWNW requirement.

In fact, the adoption of ESSOR by countries such as Ireland show that the waveform will help inter-force networking both within and beyond NATO's militaries. Although not an EU member state, the United Kingdom is a member of OCCAR. Like other NATO members, the UK's Ministry of Defence (MOD) sees the importance of the realisation of a wideband, coalition networking waveform. Although the MOD is yet to formally join ESSOR, there is substantial interest in the project. There may also be added urgency for the UK to participate in the initiative given that COALWNW is now all but dead. The UK has two choices in that she could join the programme as an industrial partner. This was the route Germany took in February 2020 which also saw Rohde & Schwarz join A4ESSOR as an industrial participant. Alternatively, the MOD could remain outside the programme but add the waveforms to UK military radios as and when they become available. This could be done via the NATO STANAGs discussed in this article. Likewise, the UK could simply have the waveforms preloaded into the future tactical radios the MOD acquires. This has been the approach that nations like Ireland and Croatia have taken.

Interestingly, other ESSOR waveforms in development maybe adopted in other NATO communications STANAGs potentially increasing the adoption of the overarching programme's output in other areas. NATO has, for all intents and purposes, satisfied its COALWNW requirement with HDRWF. Nevertheless, the Alliance is looking for a narrowband waveform to foster inter-force networking across land forces. Unsurprisingly, the NBWF appears to be in the offing to meet this demand. ESSOR officials are hopeful that the NBWF's specifications will be enshrined in the second edition of NATO's STANAG 5630, which covers narrowband waveforms for V/UHF radios. Likewise, 3DWF specifications could be enshrined in the fourth edition of NATO's STANAG-4372, which covers NATO's Second-Generation Anti-Jam Tactical UHF Radio for NATO (SATURN) waveform specifications. It is possible that the 3DWF's architecture could form the basis to support SATURN's surface-to-air/air-to-surface networking requirements. Finally, SATWF's specifications may yet be incorporated into STANAG-4681 which concerns the realisation of an integrated waveform to foster digital interoperability between UHF SATCOM terminals. Sources close to the ESSOR initiative have shared with the author that the first edition of STANAG-5630, which covers fixed frequency waveforms, has now been ratified by NATO. The second edition covering frequency-hopping waveforms is expected to be finalised in early 2026. Once the STANAG is finalised, it will then commence the process of NATO ratification. When ratified, NATO members will be able to use STANAG-5630's specifications to guide their realisation of NBWF-compatible waveforms. The sources continued that, for now, the emphasis is on completing the full ratification of STANAG-5630 and 5651.

Although a comparatively late entrant to the ESSOR programme, Germany is an active participant and the waveforms emanating from the initiative will be ported into that nation's current and future tactical communications. [Rohde & Schwarz]

## Outlook

It is entirely possible that the suite of four ESSOR waveforms are precisely the right thing at the right time. The onward march of MDO has underscored the need to significantly deepen intra- and inter-force connectivity. At the same time, the tense strategic situation in Europe today highlights the necessity for the continent's Allied forces to have unprecedented levels of deep, survivable networking. The work of ESSOR helps to answer those requirements. Meanwhile, initiatives like the HDRWF may answer existing desires within NATO for wideband coalition networking waveforms. Thus, the ratification of STANAG-5651 enshrining the HDRWF specifications will provide benefits beyond the ESSOR partner nations. This process of ratification also allows the adoption of these waveform standards by non-European NATO members. Therefore, it would not be unsurprising if Canada and the United States adopt ESSOR waveforms in the future as these nations, like other NATO members, are pledged to embrace the Alliance's MDO posture.


18-21
NOVEMBER. 2025
PARIS NORD VILLEPINTE
MILIPOL
PARIS
Milipol
PARIS
Leading Event for Homeland
Security and Safety
COMEXPOSIUM
www.milipol.com
#MilipolParis
RCS Nanterre 401 138 029 - Crédits photos : Anne

# Mapping the expansion of Russia's defence industry

Sam Cranny-Evans

**Russia's defence industry has seen a dramatic transformation since the 2008 'New Look Reforms' and especially since Moscow's full-scale invasion of Ukraine in early 2022. Once dependent on foreign machine tools and regular state orders, it is now operating under wartime conditions, massively expanding its missile, drone, and ammunition production. This article looks at how Russia has rebuilt its industrial base to sustain prolonged high-intensity warfare, and what that means for NATO and its allies.**

▲ **Two-piece 152 mm ammunition for a 2A65 Msta-B towed howitzer arranged for firing in a 2019 Russian exercise. Russia's defence industry has had to expand significantly to even partly resource the country's use of this ammunition. [Russian MoD]**

In the wake of the Cold War, Russia's defence industry contracted, as the country's arms exports fell. The Soviet Union had accounted for 40% of the world's conventional arms exports in the 1980s, and this had fallen to just 10% for Russia by 1996. At the same time, 65% of Russia's defence production was exported, with the federation's own forces decidedly deprioritised amidst the pressures of the country's economic collapse. Factories were left to decay and their staff released, no longer supported by state orders. The limited resources available to the Russian government were focused on those things that guaranteed security – the nuclear stockpile.

AUTHOR

**Sam Cranny-Evans** is a consultant and journalist based in the UK. He specialises in land warfare and the technologies shaping the way armed forces fight. Sam previously worked at Janes, and is a RUSI associate fellow.

The Russian armed forces appeared to follow the trajectory of the country's defence industry, struggling to deploy capable forces to Chechnya in 1994, and later succeeding in Georgia in 2008, but with many flaws that made clear the need for transformation. While the Russian forces were successful in Georgia, their organisation and readiness were sluggish. None of the services had integrated with each other, instead fighting their own battles simultaneously. Reconnaissance, communications, and airpower had all proven less effective than imagined and it was clear that change was needed. The 'New Look Reforms' were initiated in October 2008, just two months after the war in Georgia had ended. They set out to revamp Russia's equipment and restructure its forces, improving real-time reconnaissance and modernising the Soviet-era equipment to meet the conditions that dominated modern warfare.

In essence, the Russian forces were primarily expected to be capable of dealing with disruption at Russia's borders and in the former Soviet Union. It was expected that brigade-sized formations would be sufficient for this task, especially if they could carry most of the required equipment. This led to the first boost in investment for the Russian defence industry for domestic orders since the early 1990s. Some growth in export had helped stabilise the Russian defence industry's spiral, but was not enough of a demand to drive expansion. By 2008, the country exported USD 8 billion worth of conventional weapons, around four times the exports from 1996 and 23% of the global arms exports, placing Russia second behind the US.

The year 2008 is noteworthy for another reason beyond the start of the New Look Reforms, and that is because it was essentially the last year of war for the Russian Federation until 2014. Previously, the country's armed forces had been involved in at least one conflict every year since 1992, and the conclusion of counter-insurgency operations in Chechnya in March 2009 would bring that spell to an end. In order, Russian forces had fought in:

- 1991 to 1993: Georgian Civil War
- 1991 to 1992: South Ossetian War (creating the conditions for the 2008 war)
- 1992 to 1993: War in Abkhazia
- 1992: Transnistrian War
- 1992 to 1997: Tajikistani Civil War
- 1994 to 1996: First Chechen War
- 1996 onwards: Peacekeeping deployment in Serbia.
- 1999: Peacekeeping deployment in Kosovo
- 1999: War in Dagestan (which led to the Second Chechen War)
- 1999 to 2009: Second Chechen War
- 2008: Russo-Georgian War

**A Chechen fighter stands near the government palace building during a short lull in fighting in Grozny, Chechnya, 1995. Russian forces deployed to Chechnya and fought that war mostly from existing stocks. [Mikhail Evstafiev, via Wikimedia Commons; CC BY-SA 3.0]**

So, 2009 would bring relative calm and time to focus on modernisation. Most importantly for the Russian defence industry, it brought funding and the return of state orders for equipment. However, there were not enough funds to warrant any dramatic expansion and, to some extent, you could argue expansion was not needed. Russian forces had been involved in at least eight conflicts and had eventually muddled their way through them. There had been some painful setbacks and there was definitely a need for modernisation – especially where deterring NATO was concerned – but the timelines for modernisation under the New Look Reforms and the 2011–2020 State Armaments Programme were eminently achievable within the existing industrial footprint. Modernisation was essential, with the Russian government estimating in 2013 that the defence industry would need at least USD 3 billion worth of computer numerical control (CNC) machine tools every year until 2017.

The Russian defence industry went to Europe, the US, and Japan to meet its modernisation needs, buying between 35 and 60% of its CNC machine tools from those states between 2009 and 2017. Many plants were able to modernise their production methodologies, such as the Serov Mechanical Plant, which produces shell bodies for artillery and mortars. Some plants, like the Votkinsk and Almaz-Antey plants were almost entirely re-equipped with western CNCs, enabling the much more precise and accurate milling and machining of missile components. Some factories, like Stankomash, which produces a range of products from artillery ammunition to propellers for large ships, were almost completely built by European companies. A large number of Italian CNC providers, for instance, appear to have supplied machinery to the Konar company, essentially building a factory from scratch.

This modernisation revived the Russian defence industry, and came with further partnerships to upgrade and improve Russian equipment. Thales was selected in 2007 to supply its Catherine series thermal imagers for Russian tanks, that would go on to equip most of Russia's modernised armoured vehicles, with some form of domestic production also undertaken. The defence industry continued in this way, modernising its own equipment and processes, and delivering at a modest pace to the Russian armed forces. Between 2005 and 2015, the increases in Russia's defence budget outstripped its increases in GDP, with an average of 7.9% for the former, and 3.4% for the latter. That is, until the 2022 invasion of Ukraine.

## A war economy

If Russia's operations in the opening phases of the operation had gone as planned, and if Western states had not provided the equipment that they did, it is likely that Russia would have succeeded with many of its original goals. For instance, if the airborne VDV that initially seized Hostomel Airport (25 km north-west of Kyiv) had linked up with armoured units driving around the capital, they may have successfully held the airport for reinforcements to be delivered. Without Western ammunition, Ukraine's defenders would have run out of their own reserves sooner or later, and the fight would have become even more one-sided than it was in terms of firepower until mid-2023. This is an important caveat to bear in mind; Russia was confident that its so-called 'special military operation', led by its intelligence services, would succeed relatively quickly. There would be intense fighting and that was expected, but it was not expected to last too long, and if it did, Russia's strategic reserves of ammunition and vehicles would cover the military's needs.

**The then-Minister of Defence Sergei Shoigu, visiting a unit in Russia's Western Military District and inspecting what appears to be freshly-produced 30 mm ammunition in June 2023. [Russian MoD]**

However, it seems that the consumption of both was far greater than imagined and consumption rapidly outstripped production of the Russian ammunition and missile industry in particular. Gradually, Russia transitioned to a wartime economy, albeit in a quiet way. The order to fully mobilise the defence industry was given in 2022, creating the legal framework for the shift to a wartime economy, according to a 2025 RUSI paper. This allowed the Kremlin to access the Federal reserves of strategic materials, mandate companies to go into contracts with the State for defence production, adjustments to labour regulations that meant factory workers would be expected to work for 12-hour shifts, six days per week, and state regulation of prices within the defence industry.

The Kremlin poured money into the defence industry and armed forces in a move that could be described as 'military Keynesianism'; an economic policy that advocates increased government spending on the military to stimulate economic growth and maintain full employment. Military Keynesianism is a specific application of the broader Keynesian economic principles that government spending can boost aggregate demand, especially during economic downturns.

Although, it is worth noting that Putin already saw defence as a driver of domestic growth and said as much publicly in 2012. Defence spending averaged USD 53 billion per year between 2011 and 2021, rising to USD 79 billion in 2022 and USD 94 billion in 2023, then USD 140 billion in 2024 and a projected USD 143 billion in 2025, according to a research paper from CSIS. Rostec, the state-owned conglomerate, was given control over several ammunition plants and others within the ammunition supply chain to modernise their production, and other elements of the defence industry were further rationalised. By the end of 2024, Rostec had invested USD 8.7 billion in expanding and modernising its factories in order to meet the state defence orders. The company's total revenue in 2024 reached approximately USD 39 billion, Rostec CEO Sergey Chemezov told Putin in June 2025. This was more than Italy's defence budget for that year. The expansion is now becoming clear, through satellite imagery, which some open-source outlets have analysed. Other reports point to the dramatic expansion in procurement of CNC machines from China, which now appears to supply most of Russia's machine tooling needs.

## Missiles

Russia had a varied collection of missiles when it invaded Ukraine, and was widely expected to make extensive use of them, from the tactical level to the strategic. This is largely how the war panned out, even after the first Iranian Shahed-136 one-way attack (OWA) drone was launched at Ukraine in September 2022. Russia's missile strikes occurred on a regular basis and included dozens of cruise and ballistic missiles. The balance of the strike packages was eventually altered to include more and more Shaheds, and in increasing numbers, Gerans (Russia's domestic version of Shahed, which includes various modifications and upgrades) manufactured in Russia. The night of 28 June 2025 saw the use of massive waves of Gerans, including decoys, and a mixture of missiles including ground-launched 9M723 Iskander ballistic missiles, 3M-54 Kalibr cruise missiles launched from the Black Sea, air-launched Kh-101 cruise missiles, and Kh-47M2 Kinzhal aeroballistic missiles. In total, Russia deployed 537 weapons (including decoys) in a wave of attacks lasting nearly 12 hours. Just 60 of the weapons used were missiles, the remainder were OWA drones.

Regardless of the ratios used, Russia has expended an enormous quantity of missiles in Ukraine. Between September 2022 and 2024, Russia launched 11,466 missiles and OWA drones at Ukraine, according to data collected by Ukrainian Data Scientist Petro Ivaniuk. Russia's attacks reached a total of 4,000 OWA drones launched in May 2025 alone, compared to just 1,100 between May and June 2023. A massive wave of 728 drones was launched against Ukraine on 9 July 2025, with many striking Kyiv. So, the Russian defence industry has clearly expanded to meet this need, and satellite imagery helps track their progress.

## Missile propellant

Analysis from the International Institute of Strategic Studies (IISS) published in November 2024 shows that expansions are underway at five sites related to the production of solid propellant used in Russian missiles, and may be underway at a raw materials producer:

- New buildings have been observed at the Morozov plant, which is reported to produce components for the 9M723 Iskander short-range ballistic missile (SRBM) and the Topol-M intercontinental ballistic missile (ICBM).
- The Perm solid propellant site has been refurbished and a significant area at the site cleared. It is involved in the production of most of Russia's ICBMs.
- The Federal State Unitary Enterprise 'Federal Centre for Dual Technologies Soyuz' also shows signs of refurbishment and clearances to make way for new buildings. It is involved in most of Russia's ballistic missiles as well as tactical systems like the BM-30 Smerch 300 mm multiple rocket launcher (MRL).
- The Kamensky Plant, was undergoing one of the most significant expansions according to the IISS analysis. The analysis showed a significant expansion to the plant's facilities and a number of new buildings. The site is associated with the production of motors for the Topol-M ICBM
- The Joint Stock Company 'Federal Scientific Production Centre Altai' in Biysk appears to be undergoing a similar mix of expansion and refurbishment. The site also supports strategic missiles, including Topol and the Bulava submarine-launched ballistic missile (SLBM).
- Anozit, thought to be Russia's only manufacturer of the ammonium perchlorate needed for solid missile propellant, reported plans to expand its production of the chemical in 2022.

The continued use of missiles of all classes against Ukraine is the greatest reflection of Russia's increased missile production. Without it, Russia would not have been able to sustain its strikes at the scale and pace that it has.

**A Tu-95MS loaded down with Kh-101 cruise missiles. Russia has launched extensive and massive cruise missile strikes against Ukraine, necessitating increased production of missile propellant. [Dmitry Terekhov from Odintsovo, Russian Federation, via Wikimedia Commons; CC BY-SA 2.0]**

**This image shows an American worker at Orbital ATK shaping uncured ammonium perchlorate before it is shaped and cured into a missile booster. Russia is thought to have a single plant producing this, Anozit. [NASA's Marshall Space Flight Center, via Wikimedia Commons]**

## Drones and loitering munitions

Expanded production of drones and loitering munitions has followed an interesting trajectory in that there appears to be a tendency to forcibly acquire shopping malls, evict the existing tenants, and turn the mall into a production facility. The expanded production of drones has become key for Russia as its forces rely on them for most reconnaissance and often also for command and control.

TABLE 1

### Growth in Lancet loitering munition use since 2022

| Year | Total uses | Average per month |
|---|---|---|
| 2022 | 100* | 25 |
| 2023 | 778 | 64 |
| 2024 | 1,889 | 157 |
| 2025 | 690 | 98** |

**Notes:**
*Lancet use appears to have started in August 2022.
**Data until mid-July 2025.
Data sourced from: lostarmour.info

Some of these conversions appear to have been quite successful, with the use of Lancet family loitering munitions being a strong indicator of the expanded production.

Thus far, 2024 was a peak year for Lancet use, with several exceptional months including May 2024, which saw more than 300 of the strike drones deployed in support of Russia's offensive operations in Kharkiv and elsewhere.

Overall, Russia's wider drone and loitering munition production has seen a truly staggering increase in production quantities since 2022. Select examples of key manufacturer expansion efforts are detailed below:

**Alabuga**
**Location:** Alabuga Special Economic Zone, Tatarstan
**Products:** Shahed/Geran series OWA drones
**Description:** The production site in the Alabuga Special Economic Zone responsible for producing Shaheds and Gerans has been variously reported on since 2024 when details of the site became public – but thought to have been established the previous year. It has produced thousands of Geran-2s for Russia's airstrikes against Ukraine, and has continued working despite several successful Ukrainian strikes hitting the factory. Some reports from early 2025 found that African women were working in the factory, often exposed to dangerous chemicals and overall dire working conditions. They had been promised high wages and a good standard of living in recruiting campaigns likely supported by Russia's intelligence agencies. Then, in June 2025, it emerged that there were plans to send 25,000 North Korean workers to the factory and satellite imagery from the same month appears to show extensive construction of additional accommodation, supporting those reports. Speaking to the BBC, also in June 2025, Artem Dehtiarenko, spokesman for Ukraine's security service, said that 25,000 Shahed and Geran drones had been produced at the site, with another 20,000 assembled from kits.

▼ The Alabuga carbon fibre factory under construction in 2013. Today, it is believed to support the production of Geran drones. [Aydar Murtazin, via Wikimedia Commons; CC BY-SA 3.0]

**NPO IzhBS**
**Location:** Izhevsk
**Products:** Granat 4 reconnaissance UAV and others.
**Description:** In 2024, the Scientific and Production Association Izhevsk Unmanned Systems (NPO IzhBS), part of the Kalashnikov Concern, was reportedly in the process of increasing its production of drones by a factor of ten. It had commissioned a new production facility with an area of 5,800 m2, and it later emerged that IzhBS had purchased a shopping mall in Novyi Dom in September 2023. The company plans to add to that production figure by 50% in 2025.

**Supercam**
**Location:** Ryazan'
**Products:** Supercam S350 reconnaissance drone
**Description**: Supercam (part of a group of companies formally known as Unmanned Systems) reportedly took control of the Solnechny shopping centre in Ryazan in January 2025. Eviction notices were served to existing tenants of the facility, which is reported to have a total area of 17,250 m2. Another company within the group known as Finco LLC appears to represent Supercam internationally and with the Russian MoD, according to Ukrainian investigative group, Molfar. Supercam's headquarters is in Izhevsk, which is also home to Zala Aero and Izhevsk Unmanned Systems (IzhBS).

▲ A Supercam S350 drone ready to launch in 2019. The duration of the War in Ukraine, and need for more drones for reconnaissance as well as command and control, led to the rapid expansion of drone types used by Russian forces. [Supercamaero, via Wikimedia Commons; CC BY-SA 4.0]

**Zala Aero/Aeroscan**
**Location**: Italmas
**Products:** Lancet loitering munition, possibly Z-16 reconnaissance drones.

**Description:** Zala Aero led the way for Russian drone manufacturers it seems, in commandeering shopping malls for production facilities. Alexander Zakarov, the company's chief designer was shown touring the Italmas mall in July 2023, using a Segway to travel the length of the facility that had been established there. The mall was reportedly abandoned because of the COVID pandemic, and subsequently turned into a production facility for Russia's Lancet loitering munitions.

Regarding the latter case, Zakarov appears to have suggested the mall's conversion in August 2022, in a presentation that managed to combine imagery of the Soviet past, with a justifiable blow against Western brands, *"As a person born and working in a city of gunsmiths, it was bitter for me to see how powerful factories built in Soviet times were being turned into shopping malls one after another...We have developed a concept for converting shopping malls, which before the start of the SVO mainly sold goods of Western brands, into factories for the production of three types of domestic drones," he was reported to have said. Zakarov later told Russia 1 TV that Lancet production was "organised in the building of a former shopping centre."*

The Italmas mall has since been renamed the 'Italmas Research and Development Center' (Научно-исследовательский центр 'Италмас'). Aeroscan reportedly purchased another shopping mall in Izhevsk called the Stolitsa shopping mall in September 2023, ordering the occupants to vacate the premises by October of that year.

## Ammunition

Ammunition, especially artillery ammunition, is central to Russia's way of war, and its defence industry struggled to meet the immense needs generated by fighting in Ukraine. Analysis based on modelling and publicly reported figures indicates that North Korea was called in to supply in excess of five million rounds of artillery ammunition to resource Russia's war. This is an enormous amount of ammunition, and comprises roughly 40% of Russia's 14 million rounds estimated to have been used between August 2023 and April 2025. Russia had strategic reserves and old ammunition to refurbish, combined with new production; it was estimated to be capable of producing between two and four million rounds in 2024. This is also a lot of ammunition, but nothing compared to the potential usage, so expansion became critical.

**Biysk Oleum Plant**
**Location:** Biysk
**Products:** RDX
**Description:** The Biysk Oleum Plant is located in Siberia and has been reportedly undergoing an expansion since May 2023, with wooded areas at the site cleared and new buildings evident by September 2024. It has since emerged that the site is the subject of a USD 189 million expansion that would deliver a new production line estimated to be capable of producing 6,000 t of RDX per year, which is enough for around 1.2 million 152 mm artillery rounds.

**Plastmass Plant**
**Location:** Kpoeysk
**Products:** Artillery ammunition and unguided rockets
**Description:** Plastmass is a large ammunition facility producing a variety of different munitions for the Russian armed forces. It was expected to start a modernisation and refurbishment process in 2021 that would add 4,000 m2 to its production capacity, but it was unclear if this had progressed by October 2024. However, Rostec did report a five-fold increase in the plant's production in June 2024 with another 20% expected to follow the year after. It also has extensive recruitment requirements and appears to be working either with or towards three-shift schedules to maximise its output.

**Tambov Powder Plant**
**Location:** Kotovsk
**Products:** Propellent for 122 mm and 152 mm artillery rounds as well as explosives.
**Description:** Tambov is a Soviet legacy plant producing pyroxylin powders for various ammunition types. It had hired 500 additional staff by the end of 2022, and in 2023 was transferred to Rostec's ownership in 2023 to facilitate improved production and the site's expansion. Subsequently, the company planned to hire 3,000 more staff by 2025. It was also undergoing refurbishment and modernisation, including expansion of its facilities through a contractor called Gidroavtomatika. Tambov has been targeted with Ukrainian drone strikes, the outcome of which remains unclear.

## Looking ahead

The above provides a small insight into Russia's defence industry, which is estimated to include at least 1,400 entities. Nevertheless, it does provide an indication of the expansion underway and what is happening to increase the country's production. However, Russia's defence exports have collapsed since 2022 as the state-mandated support for the War in Ukraine and interest rates on domestically-available capital made Russia unattractive to foreign militaries, and unprofitable for the defence industry itself.

There is also the element of the social impact of all this spending and government approach, which has militarised Russian society. Many Russians now work in the defence industry, an estimated 4.5 million in 2024 according to RUSI, although it is worth noting that Putin gave a figure of 3.5 million in February 2024. Either way, Russia is militarising, with even school children now being taught to build and fly FPV drones, others to dig trenches and fire assault rifles. A raft of policies is aimed at increasing birth rates, with rewards offered to young Russian women that fall pregnant and give birth, all of this enmeshed in a wrapper of patriotism.

This all matters because these are policies that will be hard to reverse. Moreover, these policies will leave an indelible mark on Russia, its economy, and its people. It potentially sets the stage for decades of further confrontation and potentially conflict with NATO. Whereas the Russian defence industry of 2021 probably could not have supported a prolonged conflict with NATO, the one that looks likely to emerge in 2027 or 2028 almost certainly could.

**A 2S19M1 Msta-S self-propelled howitzer shown during a 2017 demonstration. Despite the rise of small drones, expanding the supply of artillery ammunition remains critical to Russia's war effort. [RecoMonkey]**

# NEXT GENERATION MULTI WEAPON SIGHTS

## FIRE CONTROL SYSTEM

### AIMPOINT® FCS14™

For use on Multiple Weapon Platforms with built-in laser range finder, inclinometers, gyro, and ballistic computer calculating for lead and distance to moving, stationery and airburst targets. Exceptionally high first hit probability reduces ammunition consumption, training time and collateral damages.

## RED DOT SIGHT

### AIMPOINT® COA™

Experience exceptional accuracy and quick target acquisition with Aimpoint's latest innovation - the COA red dot sight. Introducing the revolutionary A-CUT™ Mounting System, a system that ensures that your sight remains securely attached to your weapon, providing unmatched stability and reliability.

aimpoint.

Performance from Trust™

Aimpoint®

0146344

# PARTNER 2025
## Defence Exhibition

INTERNATIONAL EXHIBITION OF ARMAMENTS AND DEFENCE EQUIPMENT PARTNER 2025,
Belgrade, Republic of SERBIA

**September 23–26, 2025**

www.partner.rs

# NORA B-52 NG

SELF-PROPELLED GUN-HOWITZER 155 mm