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Ukraine: Five sieges

Much of the attention in the Russo-Ukrainian War this year has been focussed on a few key areas, including Russia's increasing use of massed one-way attack (OWA) drones and developments in drone technologies, such as fibre optic control; Ukraine's innovative use of drones and domestic cruise missiles to strike key economic and military targets behind enemy lines; along with political developments stemming from US President Donald Trump's actions on the world stage.

Amid these developments, less has been said about the territorial changes on the ground. Russia's offensive efforts in Ukraine have been fairly slow for the majority of the year, but they have continued to make slow gains, often at high cost. Much of the fighting has been in the countryside, and over relatively small settlements, such as villages. However, the focus of the fighting is likely to shift toward urban combat in the coming months, with five Ukrainian towns currently at risk of being encircled and captured. These would represent Russia's first gains of major settlements since the fall of Avdiivka.

At the time of writing, three towns – Pokrovsk, Myrnohrad, and Kupiansk – are already partially encircled, and Russian forces have already entered the outskirts of Pokrovsk and Kupiansk. Over the longer-term, two more towns – Kostiantinivka and Siversk – are at risk of encirclement, though of these five towns, Kostiantinivka seems least at risk presently. Going by Russia's past performance, total encirclement will be difficult, and the process of capturing any of these towns is unlikely to be that swift. However, with multiple towns under simultaneous threat, Ukraine now faces a difficult choice over where to commit its limited defensive strength. While the civilian populations have been evacuated, the fall of any of these towns would nonetheless be a painful symbolic loss for Ukraine. That said, in terms of strategic value, the capture of some towns would be more significant than others.

Kupiansk is a key example of a town whose capture is likely to translate into further gains. If Kupiansk falls, as seems probable over the coming months, this will not only give Russia a strong foothold on the West bank of the Oskil river, but Ukrainian forces will find it very difficult to retain control of the nearby salient on the East bank. Russian forces would then be relatively free to push up to the river – a position from which it would be challenging for Ukrainian forces to dislodge them, due to the complexities of attacking over a river. This in turn would free up Russian forces to push South on both banks of the river.

The fall of Pokrovsk, Myrnohrad, Kostiantinivka and Siversk would likely not translate into the same kind of potential for rapid territorial gains post-capture, but would allow Russian forces to consolidate their positions, and control new road and rail hubs to facilitate improved logistics. These would then likely be leveraged to accelerate further offensive efforts.

Yet perhaps more concerning than any of these have been Russia's recent capture of the village of Torske and territorial gains in the Novoselivka direction. While in of themselves, these advances may appear minor, they are putting the Ukrainian-controlled town of Lyman at risk. Originally captured by Russia in early 2022, and then subsequently lost during Ukraine's September 2022 Kharkiv counteroffensive, Lyman is a key road and rail hub for the entire region, and its loss would significantly weaken Ukraine's ability to control much of the nearby territory. While Lyman is not at direct risk of capture presently, its strategic value makes the fighting nearby a key development to watch over the coming months.

With the traditional summer-early autumn window for counteroffensive efforts closing, the odds of a Kharkiv, Robotyne, or Kursk-style counteroffensive happening this year seem low, suggesting Ukraine is conserving its forces for defensive efforts. This stands to reason; with so many towns under near-simultaneous risk, the likelihood is that Ukraine will need to conserve its fighting strength for strategically-significant defensive actions, and protecting its towns and cities would certainly qualify. While Russia still appears quite far from being able to meaningfully threaten larger towns and cities such as Sloviansk and Kramatorsk, the front is slowly shifting their way. Halting the Russian advance at the mid-sized towns would therefore seem the most logical option to keep the larger population and economic centres safe.

Mark Cazalet

Contents

Operations, Training & Planning

[US Army]

[Thales Alenia Space]

Armament & Technology

Columns

Masthead

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Cover Photo: The 3d Multi-Domain Task Force deployed the Long Range Hypersonic Weapon (LRHW) system to Northern Territory, Australia, on 9 July 2025, to participate in Exercise Talisman Sabre 25. [US Army/Sgt Perla Alfaro]

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Index of Advertisers

Estonia is third NATO ally in 10 days to suffer Russian airspace violation

(pf) On 19 September 2025 Estonia became the third NATO nation in 10 days to suffer an airspace violation at the hands of Russian forces when three Russian MiG-31 'Foxhound' fighters entered Estonian airspace "without permission and remained there for a total of 12 minutes" over the Gulf of Finland, the Estonian government stated.

[wikimedia_Dmitriy Pichugin]

As a consequence Estonia became the second NATO country in that timespan to invoke NATO's Article 4, under which alliance members can bring any issue of concern, especially related to the security of a member country, to the table for discussion within the North Atlantic Council.

The Estonian airspace incursion followed Polish airspace being violated 19 times on the night of 9/10 September by Russian drones during a heavy air raid on Ukraine – which prompted Poland to invoke NATO's Article 4 – and then Romanian airspace being violated by a Russian Geran drone on 13 September.

On 12 September, in response to the initial Russian drone incursion over Poland, NATO launched its 'Eastern Sentry' mission: a military activity aimed at bolstering NATO's posture to the east. This involves "a range of Allied assets" and features "both traditional capabilities and novel technologies, including elements designed to address challenges associated with drones", according a report on the NATO website.

On its website the Estonian government described the 19 September incident as follows: "The Russian aircraft entered Estonian airspace from the northeast. Over the Gulf of Finland they were intercepted by Finnish jets. Once inside Estonian airspace, Italian Air Force F-35s deployed at Ämari under NATO's Baltic Air Policing mission took over and escorted the Russian aircraft out of Estonian airspace. The Russian planes had no flight plans, their transponders were switched off, and at the time of the violation they also lacked two-way radio communication with Estonian air traffic control."

NATO's Baltic Air Policing mission was first stood up in 2004 when Estonia, Latvia and Lithuania – which do not possess their own fighters – joined NATO, but the mission has been strengthened since the start of the Ukraine War.
NATO Secretary General Mark Rutte stated that the alliance's "response under Eastern Sentry was quick and decisive".

Estonian Prime Minister Kristen Michal was quoted by the Estonian government as asserting that such a provocative act by Russia shows that its war of aggression against Ukraine is not proceeding as planned and that "the aim is to draw attention and assistance away from Ukraine by forcing NATO countries to focus more on the defence of their own territories".

Estonian Defence Minister Hanno Pevkur stated, "Russia continues its war in Ukraine and is acting with increasing aggressiveness toward Estonia and NATO's entire eastern flank, as recent events in Poland and Romania also illustrate. NATO's defence mechanisms worked. The Alliance responded decisively, with Italian fighters stationed in Estonia scrambling immediately and forcing the intruders out of Estonian airspace. This incident underscores the importance of NATO's recently launched vigilance measure Eastern Sentry, which must strengthen Allied air defence across the entire eastern flank."

Russia has rejected Estonia's version of events, with Kremlin spokesman Dmitry Peskov stating on 22 September that Russia's military operates "strictly within the confines of international law, including those pertaining to flights". He described Estonia's version of events as "empty, unfounded and a continuation of the country's utterly unstoppable policy of escalating tensions and provoking a confrontational atmosphere".

While there have been previous Russian violations of Estonian airspace, an incursion lasting 12 minutes is unprecedented and unlikely to be accidental.

In an interview with the BBC on 20 September Estonian Foreign Minister Margus Tsahkna said the Russian incursion "was a very clear provocation; it was definitely meant like this". The consensus among the NATO allies is that Russia is methodically ramping up provocations intended to test and potentially undermine NATO's defences, but this could end up being a high-risk game. Almost 10 years ago, on 24 November 2015, a Russian Su-24M attack aircraft violated Turkish airspace near the country's border with Syria. Having ignored repeated warnings to change course, the Su-24M was shot down by a Turkish F-16 and, while the two aircrew managed to eject, the pilot was killed by ground fire from Syrian rebels while descending by parachute.

Rafael and IMOD complete development of Iron Beam laser weapon

(pf) Development of Rafael's Iron Beam 450 high-energy laser weapon (HELW) is now complete, with delivery to the Israel Defense Forces (IDF) due to take place soon, the company announced on 17 September 2025.

The Iron Beam 450 HELW has been produced by Rafael in a development headed by the Israel Ministry of Defense's (IMOD's) Directorate of Defense Research & Development (DDR&D) in conjunction with the Israeli Air Force (IAF), with Elbit Systems manufacturing the 100 kW laser source. A series of tests with the system have been successfully completed over the last several weeks at a facility in southern Israel. These

[Rafael]

have concluded the system's development phase, representing the final milestone before the system is delivered to the IDF for operational deployment.
During the tests the system proved its effectiveness in an operational configuration by intercepting rockets, mortars, aircraft and unmanned aerial vehicles (UAVs) across what Rafael described as a comprehensive range of operational scenarios. The first systems are set to be integrated into the IDF air defence network by the end of the year.

Iron Beam features an "advanced targeting system that enables enhanced operational range, high precision and superior efficiency while maintaining its unique advantage of rapidly neutralising threats using laser technology at negligible cost", Rafael stated in a press release.

"The Iron Beam system represents a global technological and engineering breakthrough, expected to integrate into Israel's multi-layered defence array as a complementary capability to the Iron Dome, David's Sling, and Arrow air defence systems. The system utilises Rafael's unique 'adaptive optics' technology, enabling a stable, focused, and precise beam," the company stated.

Rafael claimed in a 28 May 2025 press release that its short-range tactical laser systems had intercepted "scores of enemy threats" during the Swords of Iron War, which is what the IDF call operations in Gaza and elsewhere following the 7 October 2023 terrorist attack on Israel by Hamas militants.

"Now that the Iron Beam's performance has been proven, we anticipate a significant leap in air defence capabilities through the deployment of these long-range laser weapon systems," Rafael stated.

Norway chooses the UK and Type 26 for its future frigate programme

(pf) The Norwegian government has selected the United Kingdom as the strategic partner for its new frigate programme and will purchase at least five Type 26 anti-submarine warfare (ASW) frigates under a GBP 10 billion (EUR 11.58 billion) deal announced by the two governments on 31 August 2025.

The deal was stated by the UK Ministry of Defence (MoD) as being the UK's biggest ever warship export deal by value and Norway's biggest ever defence procurement deal.

Since November 2024 the Norwegian authorities had been considering France, Germany, the United States and the UK as potential strategic partners for the country's frigate programme.

While conceding that the selection had been a "difficult choice", with all four candidates being strategic partners for Norway that "provided strong and competitive proposals", Norwegian Prime Minister Jonas Gahr Støre stated, "Norway and the United Kingdom are close allies, with common interests and strong bilateral ties. I am confident that the strategic partnership with the UK for purchasing, developing and operating frigates is the right decision. This partnership enables Norway to reach the strategic objectives our Parliament set out in the current Long-Term Plan on Defence."

Delivery of the Type 26 frigates to Norway will start in 2030.

The decision comes ahead of a new UK-Norway defence agreement that will strengthen Euro-Atlantic security while bringing the two countries' defence industries closer together to boost jobs, growth, and innovation.

[BAE Systems]

As well as securing 4,000 jobs in the UK, the Norwegian frigate deal will have a major effect in bolstering NATO's ASW capabilities; it will ultimately see the fielding of a combined fleet of 13 Type 26 ASW frigates – eight British and at least five Norwegian – to detect, classify, track and defeat hostile submarines in the North Atlantic, significantly reinforcing NATO's northern flank.

"Together we will acquire frigates to the British Royal Navy and the Royal Norwegian Navy," said Støre. "We will operate and develop the frigates for the coming decades. This will strengthen our and NATO's ability to patrol and protect the maritime areas in the High North. This is of great importance to Norwegian, British and allied security in these times of global instability.

"Norway and the United Kingdom have long lasting, close ties," he noted. "After having operated British vessels during World War II, the post-war navy was largely built on British doctrines, tactics and operational concepts."

Norwegian Defence Minister Tore O Sandvik added, "We have strong shared interests in the North Atlantic. Our armed forces maintain a close co-operation, and with a joint frigate programme we will be able to operate seamlessly and integrated in our joint areas of interest."

Norway's strategic partnership with the UK will be accompanied by extensive industrial co-operation. In the draft agreement the UK has guaranteed industrial co-operation with Norwegian industry equivalent to the total value of the frigate acquisition.

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PHOTONIS UNVEILS THE 5G
THE FUTURE OF NIGHT VISION

In a world where technological superiority makes the difference on the battlefield, Exosens is taking a major leap forward.
With the official launch of the **5G** at the DSEI exhibition in London (September 2025), its flagship brand Photonis is introducing what is already shaping up to be the new global benchmark in night vision.
This cutting-edge image intensifier tube, designed and manufactured in France and the Netherlands (Photonis operates two production sites in Europe), combines unmatched performance, enhanced user comfort, and sturdiness in an 18mm format, perfectly suited to the operational needs of modern armed forces worldwide.

When night becomes the battlefield

In today's conflicts, darkness is no longer a shield. It has become a fully-fledged operational domain where the ability to see without being seen provides a decisive tactical advantage.

Whether in the war-torn streets of a city, the damp woodlands of Central Europe, or the vast deserts of the Middle East, modern armies must now conduct night operations with the same precision as daytime ones. And for that, they need the right technology.

A revolution born from field experience and unmatched image performance

This operational imperative guided the design of the **5G**, the latest creation from Photonis. The result of five to seven years of development, this image intensifier represents a major R&D investment by the group and a successful gamble. With a **global performance improvement** of around +30% (FOM) compared to standard tubes on the market, the **5G** is a true technological breakthrough. It does not simply replace the 4G : it **reinvents the use of night vision**.

The **5G**'s first promise is to **deliver radically enhanced images**: thanks to top-tier components and continuous innovation in manufacturing processes, the **5G** delivers **sharper, more contrasted images with improved depth perception**. Tested under all night levels, including the darkest (level 5), it significantly improves perception of the environment, making it easier to read ground relief and identify elements in the dark (silhouettes, branches, etc.).It drastically reduces image noise, particularly in ultra-low light conditions. «Snow» disappears, textures gain clarity,

and visual comfort is dramatically improved. Field feedback confirms these advances. For soldiers, this means less eye fatigue, greater precision, and sharper awareness of their surroundings.

Beyond image performance, the **5G** extends the horizon. It provides a significant gain in detection, recognition, and identification (DRI) range at short and medium distances, up to 35% farther than current standard tubes. In engagement scenarios, that margin can make all the difference. This isn't just about numbers : it's about **trust, reactivity, and tactical superiority.**

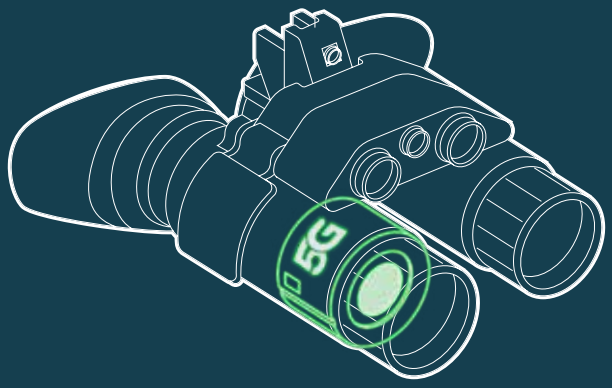
From special forces to infantry

Originally designed to meet the rigorous standards of **special forces**, the **5G** has already been tested and adopted by several elite European units. But it doesn't stop there. Its robust architecture will enable rapid integration into **conventional armed forces and support units** alike: drivers, logistics personnel, medical teams, reservists.

Compatible with existing gear and offering long-term performance, it is a universal operational asset, facilitating rapid deployment with minimal adaptation costs, a major strength in the eyes of public-decision makers.

The **5G** carries a simple but powerful ambition:

« One soldier, one goggle. »



A building block for future systems

More than just an image intensifier tube, the **5G** is a cornerstone of tomorrow's systems. Designed from the ground up as a modular component, it integrates seamlessly into embedded systems (light armored vehicles, ISR drones, advanced surveillance platforms) while remaining tailored to individual soldier needs

.

Its primary role remains clear: the **5G** is engineered for large-scale deployment in night vision goggles for soldiers, just as Photonis tubes already equip most European military helmets.

But the **5G** is also future-ready. It's built to evolve alongside the next generation of systems: real-time image processing, connected helmets, enhanced human-machine interfaces. It will serve as a key sensor in multi-sensor digital architectures, cross-referencing optical, thermal, and infrared data to deliver augmented tactical vision. A european technology built to serve operational sovereignty.

A sovereign vision

As geopolitical tensions rise, traditional coalitions shift, and European states invest heavily in rebuilding military capabilities, the demand for sovereign high-tech solutions has never been more critical. The **5G** is a concrete, strategic, and industrialized answer, built in Europe. With two production sites in France and the Netherlands, Photonis ensures a **100% European supply chain**, entirely independent of ITAR constraints.

This advanced technology provides European nations with full operational freedom and can be integrated without restriction into bilateral or multilateral cooperative defense programs, a key enabler of European strategic autonomy.

Through Exosens, Photonis is a long-recognized partner of public institutions: a certified supplier to the French DGA (Defense Procurement Agency), a trusted contributor to NATO-related programs such as OCCAR (the Organisation for Joint Armament Cooperation), and a regular contact for defense innovation agencies.

The **5G** is more than a product : it embodies a Europe capable of innovating, manufacturing, and exporting critical technologies without relying on external allies.

« With the 5G, Photonis is not just introducing a new image intensifier tube, but setting a milestone in the history of night vision: a 100% European technology, built for operational superiority and sovereignty, and poised to become the new global benchmark.» **Frédéric Guilhem, Commercial Director Night Vision**

The Norwegian and British governments will now move to finalise a binding agreement that sets out the framework for the strategic partnership. Once that agreement is signed, the two parties will enter into contract negotiations with BAE Systems as the prime contractor.

The Type 26 frigate, originally developed under the Global Combat Ship programme, has been designed to be capable of undertaking a wide range of roles and has already been selected by Australia and Canada as well as the UK and now Norway. The Type 26s ordered for the Royal Navy (eight City-class frigates) and Royal Australian Navy (six Hunter-class frigates) are all optimised for the ASW mission. Canada, meanwhile, has so far ordered four of up to 15 Type 26s, which will be known as River-class destroyers and have more general, all-round capabilities.

The principal sensors and weapons for the UK's Type 26s are the Sonar 2087 towed-array sonar, the Type 997 Artisan 3D medium-range air and surface surveillance radar, the Sea Ceptor anti-air missile system and a five-inch (127 mm)/54-calibre Mk 45 naval gun.

Polish MND signs LOA to upgrade its F-16C/D fleet to the Viper standard

(pf) The Polish Ministry of National Defence (MND) has signed a letter of offer and acceptance (LOA) to modernise its entire fleet of 48 F-16C/D Block 52+ aircraft to the advanced F-16 Viper (F-16V) standard.

[X_Polish MND]

The LOA, which is valued at USD 3.8 billion (EUR 3.26 billion), was signed on 13 August 2025 at the Military Aviation Works No 2 (Wojskowe Zakłady Lotnicze No 2 – WZL-2) in Bydgoszcz by Polish Defence Minister and Deputy Prime Minister Władysław Kosiniak-Kamysz.

The Polish MND noted on its X account that, while control flights and the testing of two aircraft will be conducted in the United States, the rest of the work will be conducted at WZL-2 in Bydgoszcz.
The modernisation package for the Polish F-16C/D fleet will include integration of the following systems and capabilities:

- the AN/APG-83 active electronically scanned-array (AESA) Scalable Agile Beam Radar (SABR);
- a high-resolution centre pedestal display;
- an upgraded mission computer and a new display generator;
- advanced helmet-mounted devices;
- electronic warfare enhancements;
- the Sniper Advanced Targeting Pod with digital video interface;
- the Automatic Ground Collision Avoidance System;
- structural modifications that will extend the aircraft's service life to 12,000 flight hours.

The fleet of Polish F-16Vs will operate alongside the fleet of 32 Lockheed Martin F-35A Lightning Joint Strike Fighters Poland has on order. The Polish Air Force also has a fleet of Korea Aerospace Industries FA-50 fighters that will eventually number 48 aircraft, along with a small number of Soviet-designed MiG-29s and Su-22s that will soon be retired.

Saab receives Royal Thai Air Force order for four Gripen E/Fs

(pf) Saab has received an order for four Gripen E/F fighter aircraft from for the Royal Thai Air Force (RTAF), announcing on 25 August 2025 that it had that day signed a contract with the Swedish Defence Materiel Administration (FMV) to that effect. The order, which is for three single-seat Gripen Es and one twin-seat Gripen F plus associated equipment, support and training, was valued at approximately SEK 5.3 billion (EUR 480 million), with deliveries set to take place in the 2025-2030 timeframe.

Saab has also signed a contract with the RTAF to deliver a long-term offset package to Thailand as part of the country's fighter acquisition plan. This will include significant transfer of defence technology and industrial co-operation with Thailand together with new investments across many sectors of the Thai economy.

The RTAF indicated in August 2024 that it had selected the Gripen E/F to replace its ageing fleet of F-16A/Bs.

The RTAF currently operates one squadron of Gripen C/D multi-role fighters that were ordered in 2008 and entered service from February 2011. Originally eight single-seat Gripen Cs and four twin-seat Gripen Ds were in service, but a Gripen C was lost on 14 January 2017 when it crashed at an air show.

Once in operation, the new Gripen E/F fighters will operate alongside Thailand's existing Gripen C/Ds, which all received the type's MS20 upgrade in 2022. This featured both hardware and software upgrades to enhance the aircraft's air-to-air, air-to-surface and intelligence, surveillance, target acquisition and reconnaissance (ISTAR) capabilities.

[Saab]

Spanish Navy's first F110-class frigate launched by Navantia

(pf) The first of the Spanish Navy's F110 class of frigates, ***Bonifaz*** (F-111), was launched at Navantia's Ferrol Shipyard on 11 September 2025.

With the launch of ***Bonifaz*** ushering in a new generation of frigates for the Spanish Navy, the launch ceremony was attended by numerous VIPs, including Spanish Prime Minister Pedro Sánchez, Spanish Chief of the Defence Staff (JEMAD) Admiral Teodoro López Calderón and Navantia President Ricardo Domínguez. The ship was sponsored by Her Majesty Queen Sofía.

From this point forward construction work on ***Bonifaz*** will continue at the shipyard's dock, with the ship scheduled for delivery in 2028.

[Navantia]

There are to be five frigates in the F110 class, three of which are currently under construction at Ferrol, with four blocks of ship F112 already on the slipway following its keel-laying milestone in April 2025. The remaining blocks of the F112 and nine blocks of ship F113 are being built in the workshops.

Approved in 2019, with construction of ***Bonifaz*** started in April 2022, the F110 class are multi-purpose frigates that will feature anti-air, anti-surface and anti-submarine capabilities and are designed to operate jointly with other units and support maritime security missions alongside civil authorities. The F110 design is 145 m long, with a beam of 18 m and a draft of 5 m, while the ship's displacement is 6,100 tonnes.

The frigates will be equipped with the SCOMBA combat management system (CMS) developed by Navantia's Systems division, which acts as the ship's 'brain' and is capable of processing sensor, radar and weapon data in real time.
Also among the F110 class's innovations is an integrated mast, located on the superstructure, which optimises electromagnetic spectrum use and reduces radar signature. The ship's solid-state S-band radar is integrated with an Aegis Weapon System and the SCOMBA CMS.

The main armament of the F110 class is a Lockheed Martin 16-cell MK 41 Baseline VII Vertical Launching System that can fire both RIM-162 Evolved SeaSparrow Missile (ESSM) Block 2 and RIM-66 Standard SM-2MR air defence missiles. The frigates will also be armed with RGM-84 Harpoon anti-ship missiles, a Leonardo 127/64 LW Vulcano 5-inch (127 mm) naval gun and two Mk-32 Mod torpedo tubes.

Navantia stated on its website that with ***Bonifaz*** it will "deliver one of the most digital and automated ships to the navy, equipped with a digital twin and a sensor network (Integrated Services System) that enables data-driven decision-making". It added that the F110-class ships "are safer, can operate with reduced crews, and are capable of integrating unmanned vehicles".

MBDA makes progress with a number of new weapon developments

(pf) European missile house MBDA outlined a range of new weapon developments in the lead-up to London's DSEI 2025 defence exhibition in September.

During an embargoed press briefing at MBDA's Stevenage site on 29 August, MBDA detailed developments in relation to five systems: the Crossbow One-Way Effector (Heavy), the Akeron MBT 120 gun-launched projectile, the SPEAR Glide munition, the Surface-Launched ASRAAM (Advanced Short Range Air-to-Air Missile), and the Future Cruise/Anti-Ship Weapon (FC/ASW).

The Crossbow One-Way Effector (Heavy), as explained by an MBDA business development executive associated with the programme, has been developed "at a massive pace" and is intended to "deliver affordable strike in the deep", meaning out to 800 km and beyond, with a payload of up to 300 kg. Designed to operate off GNSS, but with an anti-jam capability, the weapon features an artificial intelligence (AI)-enabled, image-based navigation system.

"That really will make the difference in terms of its ability to operate in those GNSS-denied environments," said the executive, "so it's the ability to match satellite imagery or Google Maps-type imagery with its location in terms of the IR [infra-red] camera, so a day and night capability that it will have on board.

"In terms of the target set, we are looking very much at destroying those strategic and tactical, static, high-value targets, so those logistic nodes etc in the deep that are enabling manoeuvre in the tactical space."

In relation to providing the weapon at pace, the executive explained that MBDA had created an ecosystem of small/medium enterprises and prime contractors from across Europe to maximise military and commercial off-the-shelf capabilities and "deliver mass very quickly". He added that the paper design of the weapon through to demonstration in the fourth quarter of this year would be seven months, which has "signif-

icantly cut down the development time scales that we would ordinarily associate with our high-end capabilities". He added that MBDA could move to production at scale in the second quarter of 2026.

The Akeron MBT 120, meanwhile, has been developed in light of lessons from the Ukraine War, where main battle tanks (MBTs) remain a core warfighting capability but must be able to fight without reliance on air power and supporting artillery. The MBDA executive briefing on this weapon noted that, while MBTs are typically rated to engage in line of sight out to 5 km, MBT engagements in Ukraine have been taking place at under 500 m.

[P Felstead]

In response to this, the Akeron MBT 120 provides a cost-effective non-line-of-sight missile that, in matching the space dimensions of existing 120 mm tank ammunition, is able to be used by the vast majority of NATO and allied MBTs. "Therefore, what that can provide is a revolutionary uplifting capability for a very low integration cost and burden," the MBDA executive noted.

Cued by other battlefield sensors to find the vicinity of its target, the Akeron MBT 120 missile uses a passive electro-optical/infrared (EO/IR) seeker, allowing it to bypass laser-activated defensive air systems and active protection systems.

"Armoured infantry and armour are effectively now self-sufficient," said the executive. "This increases their combat momentum and their tempo of operations. If they come up against a sticking point … there is no requirement to wait for artillery; there is no need to request air support. This means that tanks can do it themselves and support their infantry to the full extent that is required."

The Akeron MBT 120 has a top-attack profile that significantly increases its lethality by targeting the weak points of enemy armour not protected by explosive reactive armour, for example. Additionally, as a fire-and forget weapon, the Akeron MBT 120 minimises the cognitive burden on the firing MBT crew and, unlike other gun-fired missiles that are command to line of sight weapons, does not require the firing MBT to remain exposed.

SPEAR Glide, meanwhile, is a concept that MBDA has considered for some time but has not actually launched until now. As an unpowered variant of MBDA's SPEAR air-launched weapon, SPEAR Glide is a shorter-range, lower-cost weapon designed to be used en masse to comprehensively destroy targets such as enemy air defence, hardened bunkers and command post structures that have initially been degraded by higher-end SPEAR missiles.

Compared to the SPEAR missile, SPEAR Glide sees the high-end turbojet and fuel system removed and the introduction of a full-calibre kinetic penetrator, while its front end has the SPEAR's radio frequency (RF) seeker replaced by an EO/IR seeker that facilitates image-based navigation and terminal guidance in a GNSS-denied environment.

The key drivers for the weapon's development are low cost, the ability to manufacture at a high rate if required, and rapid integration onto carrying platforms as facilitated by its commonality with the form factor of the SPEAR missile.

Surface-Launched ASRAAM, meanwhile, is a very-low-cost air defence system, intended to be used in a point defence role to protect employed forces and critical national infrastructure against multiple air threats. The system comprises a target designator, launcher and stores management system that requires minimal logistical support and a minimal training burden that takes a few weeks rather than months. Either static or vehicle mounted, the system is most effective against drones and cruise missiles and, given that it used the ASRAAM missile, has the advantage of taking that single stockpile of missiles and putting it to multiple uses.

Lastly, an MBDA executive associated with FC/ASW briefed on the latest developments with that programme. A next-generation missile programme launched by France and the UK in 2017 to succeed their jointly developed Storm Shadow/SCALP air-launched cruise missile, FC/ASW is intended to provide a deep strike, anti-ship and suppression/destruction of enemy air defence capability out to the 2060s and beyond. The project essentially covers two complementary missiles in one programme: a high-speed, supersonic, precision cruise missile and a stealthy, low-speed, long-range cruise missile.

The FC/ASW weapons are designed to be both multi-domain and multi-platform for both the UK and France, with Italy also looking to join the programme.

The key reveal for DSEI 2025 was that MBDA unveiled the true shape of the stealthy FC/ASW weapon, with a representation of this displayed to the audience at Stevenage. Although at first glance this looked vaguely similar to a Storm Shadow, the MBDA executive noted, "The fact that physics dictates, when you put it on certain platforms and certain launchers, physics will dictate going to look a certain way, when you look into the detail actually you'll see things are quite substantially different."

A full-scale model of the weapon was displayed at DSEI 2025.

BAE Systems' FalconWorks and Lockheed Martin's Skunk Works team to develop disruptive air vehicles

(pf) BAE Systems' FalconWorks, a centre for the company's advanced research and development of cutting-edge combat aviation technologies, has announced a strategic partnership with Lockheed Martin's legendary Skunk Works Advanced Development Programs arm.

[P Felstead]

The announcement was made on 9 September, on the first day of the DSEI 2025 defence exhibition in London, following a briefing on BAE Systems' latest unmanned aerial systems developments.

According to BAE Systems, the partnership will see the two companies' advanced research and development divisions "work together on a common design that will be rapidly deployable and modular to deliver a range of effects, including disruptive capabilities".

Drawing on both organisations' rapid design, prototyping and advanced manufacturing expertise, the collaboration will focus on producing a cost-effective and easily deployable system with multiple launch options. It will initially focus on delivering an electronic warfare and attack capability that would deliver disruptive capabilities and could complement and enhance the survivability of current crewed combat aircraft.

Dave Holmes, managing director of FalconWorks, noted at the partnership launch announcement that the companies "have been working together for over 12 months to determine whether the two organisations could be brought together in this important nascent technology area, looking at common collaborative capabilities in a family of autonomous vehicles".

O J Sanchez, general manager of Skunk Works, followed by stating, "Our organisations have a history of doing rapid prototyping, advanced manufacturing and design, and it's really exciting to see what we're going to be able to do together.

"What we're talking about," Sanchez explained, "is being able to design together a vehicle that brings the intersection of a lot of customer needs. ... We will do this together in a way that's cost effective for our customers, easily deployable, and has the expandability that is needed in the marketplace."

Holmes additionally stated, "What we've seen over the last three years [ie during the Ukraine War] is the need for our warfighters to be given the capability that allows them to punch a hall through these very complex and denied electronic warfare environments. ... What we're describing is a family of systems that starts off with an electronic attack capability in the SEAD [suppression of enemy air defences]-type role. ... We think we can bring a solution that will be game changing for our end-user community."

PGZ selects BAE Systems as strategic partner to boost Polish 155 mm ammo production

(pf) Poland's Polska Grupa Zbrojeniowa (Polish Armaments Group - PGZ) has selected BAE Systems for a strategic partnership to establish a new 155 mm artillery ammunition manufacturing facility in Poland, the two companies announced on 12 September 2025.

PGZ had considered various partners to help it increase Poland's capacity to produce battlefield ammunition, but chose BAE Systems following a multi-stage bid verification process.

"The analysis considered several aspects, including three main selection criteria: production sovereignty, technological solutions, and price," PGZ stated on its website. "The offer submitted by BAE Systems proved to be the most advantageous in the context of the selection criteria, national security, and the future development of PGZ's ammunition domain potential. BAE Systems' offer fully met the requirements defined during the partner selection process. It is an open-ended contract with a 40-year notice period."

[BAE Systems]

Under the partnership BAE Systems will transfer technology and know-how to PGZ, including automated manufacturing technology that is already being implemented in the UK to deliver a sixteen-fold increase in the production of 155 mm rounds. Construction of 155 mm rounds production facilities in Poland is set to begin this year, with completion expected by 2027/2028, after which Poland is expected to initially achieve a production level of approximately 130,000 rounds per year.

Global demand for artillery ammunition has increased dramatically since 2022 as a result of the war in Ukraine, while plentiful supplies of 155 mm ammunition are critical to the operation of the Polish Land Forces' K9 and Krab self-propelled howitzers. PGZ ultimately intends to increase its production capacity to between 150,000–180,000 large-calibre shells annually to support the country's national security requirements.

Capability profile: The US Army's Multi-Domain Task Forces

Sam Cranny-Evans

The Indo-Pacific's vast distances and China's growing A2/AD capabilities demanded a new kind of military unit. Aimed at meeting this challenge, the US Army's Multi-Domain Task Forces (MDTFs) represent a new paradigm in US military thinking. This deep-dive analysis examines the nine key systems that will enable these experimental units to project power across vast distances and multiple domains simultaneously.

It is difficult to grasp the scale of the Pacific Ocean and the distances that the US would have to overcome to fight in that theatre. Even from space, it is difficult to capture the entire Pacific Ocean in one shot. This image, taken from the International Space Station, shows just the Southern Pacific Ocean. [NASA]

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In 2016, Admiral Harry Harris was in command of what was then the US Pacific Command (USPACOM); it changed to the Indo-Pacific Command (INDOPACOM) in 2018, the largest of the US's combined combatant commands. Harris was responsible for more than 360,000 service personnel and an area of operations that covered 52% of the Earth's surface. A decorated and experienced pilot, he had assumed command of the US Pacific Fleet in 2013 and became Commander USPACOM in 2015. At the time, he was public about the threat posed by North Korea, but during his time as Commander, he had also witnessed a change in the US Department of Defense's (DoD's) approach to China. The 2016 annual Pentagon report to Congress on the development of the People's Liberation Army (PLA) stated that the number of intercontinental ballistic missiles was increasing and so was their range. China was modernising its submarine force, and at that time its production of surface combatants was beginning to gain speed.

China had 300 surface vessels when the Pentagon report was released in May 2016, making it the largest navy in Asia. To make matters worse for the US, the PLA Navy (PLAN) was busily retiring legacy vessels in favour of its new guided missile destroyers with their multi-purpose launch cells and anti-ship cruise missiles. It had not yet surpassed the US in terms of vessel numbers, but was on the way. The report also established that China was now a pacing threat, marking a shift from the language used in 2014 and 2015. So, with all this in mind, Adm Harris dialled into the Association of the United States Army (AUSA) Conference in October 2016 using Skype. Harris did not mince his words, and emphasised that North Korea had recently conducted a nuclear test, the only country to do so this century. Russia and China had developed extensive anti-access and area denial (A2/AD) capabilities that were genuinely capable of holding US ships and aircraft at risk at extreme ranges. Four of the five significant risks to US security were in the PACOM area of operations.

"I'm already on-the-record for saying that our security environment now, and in the future, will require all the Services to exert influence in non-traditional domains," Harris told the audience. "That means the Army's got to be able to sink ships, neutralize satellites, shoot down missiles, and hack or jam the enemy's ability to command and control its forces," he explained. An interesting statement for a force that was repositioning itself after more than a decade fighting non-state actors. Harris went on to discuss "path dependency", a concept that explains how decisions made in the past can constrain or influence decisions and outcomes in the present and future. The US forces had to break their path dependency, and do it quickly.

Harris challenged the assembled audience of US Army personnel, stating: "Before I leave PACOM, I'd like to see the Army's land forces conduct exercises to sink a ship, shoot down a missile, and the aircraft that fired that missile…near simultaneously…in a complex environment where our joint and combined forces are operating in other domains." He had certainly set down a gauntlet for them. "I don't have a whole lot of time left at PACOM. Good luck," he concluded.

Perhaps, somewhat surprisingly, the US Army would achieve a lot of what he challenged them to do. Adm Harris moved on from PACOM in May 2018, handing over to Adm Philip Davidson. By that time, the US Army had set up the Multi-Domain Task Force Pilot Program (MDTF-PP), an experimental unit based on the 17th Field Artillery Brigade with an intelligence, information, cyber, electromagnetic warfare, and space (I2CEWS) capability integrated into its existing fires command structure. During the Rim of the Pacific Exercise (RIMPAC) in August 2018, the US Army sank a ship with a Naval Strike Missile fired from an M1075 palletised load system truck. A Dismounted PATRIOT Information Coordination Central (D-PICC) unit (a C2 node for PATRIOT air defence batteries) provided air defence in support of the experimental unit. Using Link 16, the MDTF-PP was connected to several different air defence sensors and able to engage both an aircraft and the simulated missile that it launched.

It's not clear if the MDTF managed to achieve all of this simultaneously, but RIMPAC was enough of a success for the US Army that as the MDTF-PP came to an end in October 2019, the Army already had plans to establish three more based on the lessons from the pilot. "US Indo-Pacific Command is making the Army's MDO efforts its foundational concept as it develops its own joint warfighting concept for the region," the INDOPACOM press release announcing the decision explained. With that, the US Army's MDTFs were born and efforts started to equip them. They are now starting to show their strengths, with another SINKEX conducted during Talisman Sabre 2025; only this time it was an SM-6 launched from a Mid-Range Capability Launcher with support provided by the US Marines. A Long-Range Hypersonic Weapon launcher was also displayed during the exercise, drawing the ire of various Chinese academics. Despite the focus on the missiles deployed by the MDTFs, there are actually nine key capabilities that underpin their warfighting capacity and they start with reconnaissance.

US Army Sgt Edward Dorba and Sgt Matthew Palombo, both electromagnetic warfare specialists assigned to 2nd Multi-Domain Effects Battalion, 2nd Multi-Domain Task Force, ensures an aerostat aircraft successfully launches in a field in northwest Poland, 31 August 2023. [US Army/SSgt Ashley M. Morris]

Long-range strikes need long-range reconnaissance

The addition of an I2CEWS team to the 17th Field Artillery Brigade is what started the development of the MDTFs. There is very little said about them and their capabilities, and they are now known as the Multi-Domain Effects Battalion (MDEB), which includes the sections that launch and operate the high-altitude balloons. The role of the MDEB is to provide targeting intelligence and non-kinetic offensive and defensive capabilities. They support the kinetic elements of the MDTF by creating windows of opportunity on the battlefield, according to the US Army. This may include things like 'navigation warfare' (NAVWAR), which involves targeting an adversary's satellite navigation system, for example. The MDEB encompasses five non-kinetic capabilities:

- **Intelligence**: The collection and analysis of information.
- **Information**: Shaping the information environment to influence adversaries and friendly forces.
- **Cyber**: Offensive and defensive operations in cyberspace.
- **Electronic warfare (EW)**: The use of the electromagnetic spectrum to attack or defend assets.
- **Space**: The use of and ability to deny adversaries the use of assets in space.

Some aspects of their role were revealed during Vanguard 24, an exercise conducted in October 2024 by the MDEB from the 3rd MDTF. The unit focused "on integrating cyber, electronic warfare, extended range sensing and data transfer. The distances between training areas and teams replicated the distances required to operate in the Indo-Pacific Command theater, where 3rd MDTF is assigned", the US Army explained. "My team was able to effectively locate signals of interest, aggregate the sensor data, pass it back to the MDEB tactical command post at Fort Huachuca, then integrate the data into mission command systems to include the Army Intelligence Data Platform (AIDP), and send the data to the TF level All Domain Operations Center back in Hawaii," said MDEB Commander Lt Col Pablo Diaz. This indicates that the unit was working to locate signals of interest, which, given the A2/AD disintegrating role of MDTFs, suggests that they may focus on locating radars for some fire missions. The AIDP is currently based on a number of tools from Palantir that are designed to bring data from diverse sources together and fuse it into a single picture, providing insights on patterns and key elements of the data for the users. It is accessed by intelligence personnel from across the US services.

The intelligence and reconnaissance of the MDEB isn't all that the MDTFs draw upon. The Keen Sword exercise with Japan in January 2025 demonstrated the ability of a Virtualized Aegis Weapon System (VAWS) to provide fire coordination support to the 3rd MDTF. VAWS was used to provide digital fire control coordination across multiple platforms, which included the Advanced Field Artillery Tactical Data System, removing the need for the manual transmission of orders. The exercise was used to show that the MDTF could coordinate with allies, the Japanese Self Defense Forces, as well as naval forces to conduct and deliver simulated long-range strikes. With that, however, there are three systems within the MDEB that are worth exploring in greater detail.

A Kraus Hamdani Aerospace K1000ULE unmanned aerial vehicle operates in Aqaba, Jordan, 9 March 2023, during International Maritime Exercise 2023. [US Army/Spc Aaron Troutman]

1. K1000 Ultra-long range endurance unmanned aircraft system

- **Size**: Length of 3.0 m (9.8 ft) and a wingspan of 5.0 m (16.4 ft).
- **Range**: Approximately 1,600 km (1,000 miles).
- **Payload**: Up to 2.5 kg (5.5 lb); it has a modular payload bay that can carry optronic day/infrared cameras, signals intelligence (SIGINT), and EW packages.
- **Endurance**: Over 24 hours, with a record flight of nearly 76 hours for its class.
- **Manufacturer**: Kraus Hamdani Aerospace.

The K1000 is a Class 2 ultra-long range endurance unmanned aircraft vehicle developed for persistent intelligence, surveillance, and reconnaissance (ISR) missions. It has electric motors and can be charged using solar power whilst in flight, extending its flight time. It is a prime example of the US Army's rapid acquisition strategy, procured as a commercial-off-the-shelf capability to meet an urgent need for long-endurance ISR. The K1000 was first acquired and evaluated by the Army's MDTF, which sought to quickly field cutting-edge technologies. The UAV has notably participated in the Army's flagship Project Convergence exercises, where it demonstrated its ability to serve as a high-altitude, long-endurance airborne sensor. During these exercises, the K1000 transmitted targeting data directly into the Army's network, connecting with systems like the Tactical Intelligence Targeting Access Node (TITAN) to accelerate the kill chain and support long-range precision fires.

2. High-altitude balloon

US Army soldiers, assigned to Extended Range and Sensing Effects Company, 1st Multi-Effects Battalion, 1st MDTF, fill a high-altitude balloon, in support of Exercise Balikatan 25. [US Army/SSgt Brandon Rickert]

High-altitude balloons are not a single system but a class of platforms. The MDTFs have experimented with them in various formats and configurations, including in partnership with the K1000. Their primary purpose is to provide an uninterrupted stream of data on a target area. This information is then passed through a secure network to long-range missile systems, which can then be used to rapidly engage targets in a concept known as the 'kill chain'. The use of these balloons offers an advantage over traditional air assets, as they can loiter over a target area for weeks at a time, providing a constant presence and a resilient sensor layer that complements other platforms such as satellites and aircraft. This capability has been demonstrated on exercises and the Extended Range and Sensing Effects Company of the 1st MDTF flew a constellation of balloons from different vendors to see what they could add to the 1st MDEB's sensing and targeting capacity.

3. Tactical Intelligence Targeting Access Node (TITAN)

- **Description**: TITAN is a mobile ground station consisting of a truck and trailer. It has different variants, with the size dependent on the specific equipment it carries. Its primary function is to process and disseminate data, and receives intelligence from a wide range of long-range sensors, including space, aerial, and terrestrial assets. It uses artificial intelligence (AI) and machine learning (AI/ML) to process intelligence from numerous sensors and provide targeting information to battlefield commanders.
- **Equipment**: The system includes a truck-mounted mission module, a satellite communications link, and a trailer to carry generators and other equipment.
- Software: The software is designed to integrate data from all-domain sensors and apply AI/ML to produce intelligence that can be used for both lethal and non-lethal operations. This includes downlink stations for satellite imagery. In 2020, it was reported that the Maxar US Army Remote Ground Terminal (RGT) would be installed into the TITAN vehicles, providing access to MAXAR's commercially available imagery as well as that of other suppliers as soon as it is available. It is unclear if this has been integrated into the vehicles delivered to the US Army. Other reports indicate that of the two TITAN variants, one will also be able to directly access national level satellite assets.
- **Manufacturers**: Palantir is the prime contractor. Other companies involved include Northrop Grumman, Anduril Industries, L3Harris Technologies, and Raytheon.

From available information, TITAN is the glue intended to bring the MDTF's reconnaissance assets under the MDEB, together with the kinetic strike systems under the Strategic Fires Battalion. It is positioned as a receiving point for many different types of sensor data with a particular focus on satellite reconnaissance. It also acts as a node to provide unclassified data to allies and partners. The TITAN programme began in 2021 with a competitive prototyping phase. In July 2022, the Army

TITAN is designed to support the commanders of an MDTF in their target selection and engagement. It is the conduit through which intelligence from various sources flows. [US Army]

awarded separate contracts to Lockheed Martin and Palantir to develop competing prototypes. After the prototyping and evaluation phase, the Army awarded a USD 178 million contract to Palantir in March 2024 to continue developing and delivering ten TITAN prototypes, with an expectation of more deliveries in the future. The first vehicles were delivered to the 1st MDTF in 2025. The advanced variant is truck-based, employing the Family of Medium Tactical Vehicle (FMTV) fleet's M1083, while the basic variant is mounted on a Joint Light Tactical Vehicle (JLTV). The differences between the advanced and basic variants are understood to be the types of data that they can receive. Advanced vehicles can reportedly receive classified sources of intelligence directly, without the need to reach further up the command chain.

The Father of All Monsters

A Typhon is not a typo, it is the name of a mythical fire-breathing giant and the deadliest monster in the entire Greek pantheon. Typhon was said to be so tall, his head touched the stars and he launched a battle against Zeus and ultimately lost. And through his partnership with another creature, Echidna, is said to be the father of all monsters. It is also quite fittingly the name given the Mid-Range Capability, which has been developed for the MDTFs. The Typhon launchers are one of three kinetic capabilities available to the commander of an MDTF and arguably the most mature in terms of their effectors.

The Strategic Fires Battalion is the coordinating organisation for the Father of All Monsters. It includes three batteries; the HIMARS battery, the Mid-Range Capability Battery, and the Long-Range Hypersonic Weapon (LRHW) Battery. The capabilities are interesting from a number of perspectives, not least their range. The MDTFs are technically under the direct command of the geographic combatant commander, the intersection between political and military leadership, which is necessary their effects can be delivered across a theatre. In theory, this means they are an echelon above a corps.

While much of their concept of operations (CONOPS), particularly integration with a US Army corps, is being developed, it is clear that MDTFs are meant to be an enabler for the joint force. They are purpose-built to degrade and penetrate an adversary's A2/AD capabilities in a given theatre. This likely means that

The 3d Multi-Domain Task Force deploys the Long-Range Hypersonic Weapon System to Northern Territory, Australia, 9 July 2025, to participate in Exercise Talisman Sabre 25. Talisman Sabre 25 marks the first operational employment of the Dark Eagle west of the International Date Line and outside the continental United States. [US Army/Sgt Perla Alfaro]

a US Army corps commander would request capabilities from a supporting MDTF, and the Commander INDOPACOM would make the decision on whether or not to release those assets. That said, it is not clear that the MDTF makes sense as an 'above corps level organisation', it would perhaps make more sense for them to be a divisional asset despite their strike range.

4. Dark Eagle (Long-Range Hypersonic Weapon (LRHW))

- **Size of launchers**: The launcher is an M870A4 trailer, which is 18.2 ft (5.5 m) long and 8.3 ft (2.5 m) wide. It is pulled by an FMTV truck.
- **Range of missiles**: The LRHW has a reported range of 1,725 miles (2,776 km).
- **Number of missiles per launcher**: Each Transporter Erector Launcher (TEL) carries two missiles.
- **Organisation of a battery**: An LRHW battery consists of four launchers (eight missiles in total) and a Battery Operations Center (BOC) for command and control.
- **Manufacturer**: The missile component is being developed by Lockheed Martin and Northrop Grumman, with Dynetics building the Common Hypersonic Glide Body.

Relatively little is known about Dark Eagle and it is somewhat behind schedule in terms of its entry into service. As a concept, it is expected to provide very long-range strikes at hypersonic speeds. However, it is not clear what it will be engaging at those ranges. Chinese naval vessels appear to be the obvious answer, which indicates that the Common Hypersonic Glide Body (C-HGB) would be required to carry some form of seeker and shed much of its speed when it approaches a target to complete the target acquisition and terminal phase of the engagement. In addition, the missiles are fantastically expensive. The Army requested USD 744 million in 2025 for "the production of LRHW Battery, Ground Support Equipment (GSE) and the basic load of eight All-Up Rounds" (AURs). Separately, US Army officials have confirmed that they expect production costs of eight AURs to exceed the USD 41 million per round cost estimate produced by the Congressional Budget Office. This indicates a missile cost per battery exceeding USD 328 million. This figure will come down with future orders, the US Army claims, but it is nonetheless indicative of a potentially shallow magazine depth. That said, if the primary purpose is to sink ships, then a few dozen may be sufficient.

5. Typhon (Mid-Range Capability (MRC))

- **Description**: The launcher, also known as Typhon, consists of a trailer-mounted system that uses Mk 41 Vertical Launch System (VLS) cells mounted on an FMTV truck.
- **Types of missile**: The MRC can launch two types of missiles: the Standard Missile 6 (SM-6) in a land-attack role with an estimated range of 500 km, and the Tomahawk cruise missile, a long-range land-attack weapon with a range of around 2,414 km.

US Marines with Marine Air Control Group 38, Marine Rotational Force – Darwin 25.3, deconflicted airspace as the US Army's 3rd MDTF conducted the first Mid-Range Capability live-fire exercise outside the continental United States, successfully sinking a maritime target with a Standard Missile-6 during Exercise Talisman Sabre 25. [USMC/Sgt Brian A. Stippey]

- **Missile warheads**: The SM-6 uses a high-explosive blast-fragmentation warhead, while the Tomahawk uses a conventional high-explosive warhead weighing 450 kg.
- **Number of missiles per launcher**: Each launcher has four missile launch cells.
- **Organisation of a battery**: A battery consists of four launchers and a Battery Operations Center.
- **Manufacturer**: The launcher is manufactured by Lockheed Martin. The missiles are made by Raytheon (SM-6) and Raytheon/Lockheed Martin (Tomahawk).

Typhon was developed very quickly to provide additional firepower to the MDTFs. Initiated in 2020 as a rapid prototyping effort to field a land-based fires capability using existing missile systems. The project's goal was to deliver a new missile system capable of striking targets at ranges between the Army's short-range precision fires and long-range strategic systems. The programme achieved a significant milestone with its first equipment delivery in late 2022 to the US Army's 1st MDTF. Following the delivery, the system's first full-scale firing, a live launch of a Standard Missile 6 (SM-6) from the Typhon launcher, took place in July 2023 at Vandenberg Space Force Base in California. It uses the existing Mk 41 launch cells which are fitted to US Navy ships including the Arleigh Burke class, which enabled the rapid integration of SM-6 and Tomahawk onto a land-based launcher. With 16 missiles per battery, the Typhon is likely to carry out a lot of an MDTF's kinetic targeting, especially against less well-defended targets.

6. M142 HIMARS and Precision Strike Missile (PrSM)

- **Size of launchers**: The M142 HIMARS launcher is mounted on a standard Army Family of Medium Tactical Vehicles (FMTV) 5-tonne truck. It is 7 m (23 ft) long, 2.4 m (8 ft) wide, and 3.2 m (10.5 ft) high.
- **Range of missiles**: The PrSM has a range exceeding 500 km.
- **Types of missile**: HIMARS can fire the entire family of Multiple Launch Rocket System (MLRS) munitions, including the GMLRS rockets and the new Precision Strike Missile (PrSM).
- **Missile warheads**: The PrSM is equipped with a unitary warhead.
- **Number of missiles per launcher**: A HIMARS launcher carries a single pod that can hold one PrSM missile or six GMLRS rockets.
- **Organisation of a battery**: A HIMARS battery typically consists of three platoons, with each platoon having two launchers for a total of six.
- **Manufacturer**: The prime contractor for both the HIMARS launcher and the PrSM missile is Lockheed Martin.

The M142 HIMARS has played a prominent role in Ukraine, striking Russian targets at very long ranges, and that is the role it is expected to play for the MDTF. PrSM is expected to provide additional reach and later iterations of the missile will be explicitly configured to engage moving targets including ships. The US Army has already conducted tests with PrSM against ships, and has also used its Autonomous Multi-Domain Launcher (AML). The AML is an autonomous vehicle carrying the MLRS family of munitions rocket pod; it is an Army initiative to explore the benefits of autonomous rocket launchers in increasing the mass of its firepower. Since those tests, both Raytheon and Oshkosh have released similar autonomous concepts, indicating that there is a demand for an autonomous rocket launcher on the horizon. Given some of the other joint exercises conducted by the 1st and 3rd MDTF with the M142 and those systems used by allies like Australia and Japan, it is probable that it will also be used to provide conventional fire support to US Army formations.

Point defence

As mentioned above, the MDTFs are essentially a strategic asset in terms of their operational reach and ability to deliver effects across a theatre. This likely makes them a high-priority target for an adversary in the opening phases of a war. The launch sites for its missiles are presumably a point of particular vulnerability. It is not clear how long it takes the Typhon or Dark Eagle TELS to set up, but their size and reliance on strategic airlift assets likely provides some warning of their probable location. To help protect them, MDTFs are provided with an air defence battalion that includes at least two systems designed to counter small drones. They may also include more conventional air defence assets like Patriot teams, as well as integration with naval assets like the Aegis Weapon System, based on past exercises.

US Marines execute a simulated High Mobility Artillery Rocket System fire mission during Orient Shield 24 at the Yausubetsu Maneuwver Area, Japan, 21 July 2024. The MDTFs are expected to provide a cohering function for allied forces to join fire missions with the US. [USMC/LCpl Evelyn Dohert]

7. Integrated Fires Protection Capability High-Powered Microwave (IFPC-HPM)

The IFPC-HPM has been developed for the US Army by a company called Epirus, which calls it Leonidus. It is designed to provide protection of fixed infrastructure and launch sites from UAV swarm attacks using high-power microwave beams. The electromagnetic energy emitted by the IFPC-HPM can cause near instant failure of a drone's control systems such as its flight controller. It can be directed at a specific drone or provide more wide-area effects against a number of drones. The 1st MDTF was the first unit to accept-

High-power microwave weapons with 1st Battalion, 51st Air Defense Artillery Regiment, staged for a training iteration in support of Exercise Balikatan 25. [US Army/SSgt Brandon Rickert]

the system into service, receiving four in 2024 and has been experimenting with it since. A contract was placed in July 2025 to procure two IFPC-HM Gen II systems, which will double the range of the Gen I systems and increase the power output by 30%, as well as allowing for more rapid pulse engagements and higher capacity batteries. As with most directed energy weapons (DEWs), the defining element of IFPC-HPM's ability to defend a deployed MDTF will be how long it can operate on its own batteries and whether or not it needs any down time between engagements to cool.

8. Fixed Site-Low, slow, small unmanned aerial system Integrated Defeat System (FS-LIDS)

FS-LIDS is a modular system designed to make use of multiple sensor modalities to track and engage UAVs up to Group 3, which would include larger reconnaissance drones like the Russian Orlan-10, as well as smaller hobby drones. It is usually equipped with the Raytheon Ku-band radio frequency sensor (KuRFS), which is an active electronically scanned array (AESA) radar providing 360° coverage. It can detect and classify small drones out to 15 km, according to Raytheon, and can be paired with lots of different interceptors including the Coyote drone. It was developed for the counter-rocket mission in Iraq in 2012, and has since logged over a million hours of operation. Other sensors like optronic cameras from SRC can be integrated, providing the layered sensor network that is really key for detecting and engaging small drones. The primary kinetic effector is Coyote, a small, jet-engine-powered, expendable drone that can be pneumatically launched from a container. The Coyote Block 2+ variant can intercept targets at ranges of up to 15 km. FS-LIDS is also provided with an EW system for jamming and degrading UAV control links.

The vehicle in the middle is M-LIDS, which provides a mobile form of defence against small drones. The two stationary elements, including the launcher for a Coyote missile on the left and Raytheon Ku-band Radio Frequency Sensor on the right, are part of the FS-LIDS solution used by the Air Defense Battalion in the MDTF. [Raytheon]

MDTFs: A lesson in rapid experimentation and fielding

In a very short space of time, the US Army has responded to Adm Harris's challenge and established a new type of long-range warfighting capability. Its MDTFs are now able to hold PLAN vessels at risk from extended ranges, as well as other sites that may be important. The prospect of them deploying forward to Japan, the Philippines, or South Korea is something that the PLA will now have to factor into anyplans for conflict in the region. Some elements remain developmental; the Dark Eagle and seemingly the intelligence collection/understanding functions, stand as two examples. But overall, the MDTF experiment appears to be quite promising. Perhaps the key has been the clear problem set posed by China's A2/AD capabilities, which uniquely position the US Army – as opposed to the other services – to develop capabilities to help reduce them.


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Leading from the front: PEO STRI

Dr Trevor Nash

PEO STRI is the focal point for US Army training and simulation activities as well as providing a route for many overseas sales through its international programme office. Requirements such as the US Army's Transformation Initiative and Synthetic Training Environment provide challenges for the future but new procurement processes such as Other Transaction Authorities are assisting in helping to manage this period of change.

Located at the Central Florida Research Park (CFRP) in Orlando, the Program Executive Office, Simulation, Training and Instrumentation (PEO STRI) is tasked with providing testing, training and information operations solutions for the US Department of Defense (DoD). Working closely with the end-user, industry and academia, most of the organisation's output is directed towards the US Army.

In many ways, PEO STRI is the envy of the world as it provides a focal point for the US Army's simulation and training activities and a conduit for discussion and debate for extant and future programmes. Not only does this assist the military in honing its specific training requirements but it also allows industry to target those requirements in a more cost-effective manner. Located alongside the US Navy Naval Air Warfare Center Training Systems Division (NAWCTSD), US Marine Corps (USMC) Training Systems Command (PMTRASYS) and US Air Force Agency for Modeling and Simulation (AFAMS) training procurement hubs at the CFRP and adjacent to the University of Central Florida, this group is known as 'Team Orlando' and provides a focused point of contact for the DoD's simulation and training activities.

Orlando is also home to a contracting centre that is part of Army Contacting Command (ACC). According to the Director of ACC Orlando, Col Lisbon Williams, "we sit side-by-side with PEO STRI and advise and provide different types of contracting vehicles for new programmes," adding "we are a bridge between industry and PEO STRI."

PEO STRI reports to the US Assistant Secretary of the Army for Acquisition, Logistics and Technology (ASA ALT) with its mission of modernising the US Army "as part of the Joint Force, through rapid and timely development and delivery of soldier capabilities that deter adversaries and win our nation's wars". PEO STRI is an acquisition office that also serves as a development centre to transition technology and capabilities to meet US Army requirements. An example of this is the work currently being undertaken on the US Army's Synthetic Training Environment (STE) programme.

PL TSO, Michael Willoughby, briefs members of PEO STRI global operations Liaison Representatives that are located at major US Army locations across the globe. [US Army/Donnie Ryan]

As part of its feedback process, PEO STRI has a number of Liaison Representatives (LRs) that form what is known as its 'global operations team'. LRs "are deployed at military installations around the world and provide a critical communications link between PEO STRI's project managers/leads and customers in the field."

Travelling to Orlando for an annual LR wash-up in June 2025, Justin Fortune, Deputy Project Lead for TSO and Global Operations manager explained, "the LRs' key value is synchronising and implementing PEO STRI's programmes and products at the regional and installation level[s]. They translate high-level programme goals into actionable, locally-coordinated efforts, ensuring PEO STRI products and services align with the realities and priorities of the warfighter to enhance readiness and lethality."

AUTHOR

Following a career in the British Army specialising in air defence, **DrTrevor Nash PhD** spent four years in the T&S industry before becoming defence journalist concentrating on training, simulation

As mentioned previously, PEO STRI is considered by many in industry as an exemplar of training procurement when it comes to opening communication channels between procurer, user and industry. Each year the organisation takes part in the two-day Training & Simulation Industry Symposium (TSIS) organised by the US National Training & Simulation Association (NTSA) where the four services brief industry on future procurement plans and the status of current programmes.

Other activities such as 'soldier touchpoints' where the military have the opportunity of using prototype equipment that is still in development, provide industry with valuable feedback. In July 2025, another initiative saw PEO STRI organise what it

▲ **One of the methods PEO STRI uses to gain feedback on potential solutions to its training requirements is through Soldier Touchpoints. This image shows a soldier using a prototype of RVCT-G. [US Army/Lt Col Margaret St Pierre]**

referred to as a Tabletop Exchange that drew 130 attendees "to address current challenges to soldier training, performance analysis, and the acquisition process".

Other opportunities to interact with PEO STRI are provided by the annual Inter-service/Industry Training, Simulation and Education Conference (I/ITSEC) that is held in Orlando and organised by NTSA along with other smaller events that are scheduled throughout the year. A key part of this process is engagement with Congressional leaders that have duties associated with the military and the nation's defence and aerospace industries.

Such events are supplemented when PEO STRI staff take part in a technical exchange panel during the monthly Procurement Administrative Lead Time (PALT) events. Normally held at the Central Florida Tech Grove in Orlando. In the latest iteration, PEO STRI staff addressed and answered questions about current priorities, programme updates, and how PEO STRI is supporting the US Army's modernisation strategy and transformation efforts. Held monthly, these PALT/technical exchanges are designed to improve communication between PEO STRI, Army Contracting Command-Orlando, and industry stakeholders.

This promotion of open dialogue between key stakeholders is in stark contrast to other mature users of simulation and training systems from around the globe.

Structure

With a staff of around 1,100 personnel, PEO STRI currently has a portfolio of more than 260 programmes managed by six teams:

- Project Manager Synthetic Environment (PM SE)
- Project Manager Training Devices (PM TRADE)
- Project Manager Cyber, Test and Training (PM CT2)
- Project Lead Training Aids, Devices, Simulations and Simulators (TADSS) Support Operations (PL TSO)
- Project Lead International Program Office (PL IPO)
- Project Lead Enterprise Transformation & Integration (PL ETI)

▲ **One of the many ways that PEO STRI communicates with industry is through 'tabletop exchanges'. The latest event drew representatives from government, industry and academia to address current challenges to soldier training, performance analysis, and the acquisition process. [US Army/Donnie Ryan]**

Acting as a backdrop to current and future US Army training requirements is the Army Transformation Initiative (ATI) that was elucidated by Dan Driscoll, Secretary of the Army and its CoS, Gen Randy George in their 'Letter to the Force' dated 1 May 2025. In essence, ATI offers a vision of future warfare and argues that many of today's weapon systems are obsolete. The letter states that: "To maintain our edge on the battlefield, our Army will transform to a leaner, more lethal force by adapting how we fight, train, organize, and buy equipment." This initiative will have a clear impact on the US Army's future approach to simulation and training.

In essence, ATI looks to achieve three goals: deliver warfighting capabilities, optimise force structure and eliminate waste and obsolete programmes. As far as training is concerned, established multi-billion-dollar training systems such as CAE's Aviation Combined Arms Tactical Trainer (AVCATT) and Lockheed Martin's Close Combat Tactical Trainer (CCTT) are set to be cut. These will be replaced by STE and specifically, derivatives of the Reconfigurable Virtual Collective Trainer (RCVT) Air (A) and Ground (G) respectively. These devices will use a common visualisation package referred to as One World Terrain (OWT).

Another area gaining traction is a growing emphasis on the US military services working more closely to undertake joint development and eventually, procurements where appropriate.

This initiative is also designed to aid interoperability between the services and break down single-service silos. Announced in mid-2025, one such initiative is to establish a joint Army/Navy simulation lab that focuses on maritime operations to foster, "a new level of interoperability and efficiency in cross-service maritime training".

Commenting on this new enterprise that is expected to begin in 2026, Donna Veil, PEO STRI's deputy product director of Virtual Training Systems stated that: "From an Army perspective, we are excited for the opportunity to drive change and deliver capabilities through inter-service combined forces with NAWCTSD." "This effort fits right in the Secretary of Defense's Army Transformation Initiative with cross service collaboration to optimize capability while rapidly putting modernized capability into the hands of the warfighter," Donna Veil added.

Another new initiative to impact PEO STRI's organisation has been Warfighter – Training, Readiness & Solutions (W-TRS). In effect, this programme replaced the USD 3.53 billion Army TADSS Maintenance Program (ATMP) won by Lockheed Martin in 2018. This sees W-TRS prime contractor, V2X, working with PEO-STRI and take responsibility for supporting over 300,000 TADSS systems at more than 400 locations in the continental US and overseas.

The main change over the previous ATMP contract is that W-TRS encompasses the partial, "addition of Foreign Military Sales (FMS) cases and other Army training maintenance and services contracts around the globe", said W-TRS Director, Zachary Lindsay in June 2025 following its declaration of Full Operational Capability (FOC).

Foreign programmes

As well as looking after the US Army's training needs, PEO STRI also manages FMS through its International Program Office (IPO). Its mission is "building partner capacity by providing training systems, training and sustainment in conjunction with PEO STRI PMOs portfolio of products" which is undertaken within three departments; IP Aviation, IP Ground and IP Train, Advise, Assist and Mentor (TAAM).

One of the major programmes managed by PL IPO is the CH-47F full flight simulator requirement. Worth an estimated USD 40 million, the programme is due to be awarded in late 2028. [CAE]

At present, IPO Aviation has five live programmes, four of which are expected to see a Request for Proposals (RFP) release by the end of 2025. Two represent Contractor Logistic Support requirements for Latvian and Swedish Blackhawk training systems that will be awarded through W-TRS and two for the integration of Tactical Engagement Simulation Systems (TESS) for the Australian and Polish AH-64E programmes. The AH-64E TESS will be awarded as Directed Source programmes to Inter-Coastal Electronics. The fifth programme is for a CH-47F full flight simulator for Saudi Arabia, the RFP being scheduled for release in 1QFY27 as a competitive programme.

As far as IPO Ground requirements are concerned, these are numerous and cover 13 programmes for Tunisia, Poland, Taiwan, Romania and Morocco. Only two are competitive, a Joint Fires Stationary Classroom for Tunisia and a Portable Joint Fires Trainer for Taiwan. The remaining programmes are either directed or sole source with companies such as CAE, Lockheed Martin, DiSTI, Bohemia, Cubic Defense, Theissen and Fidelity Technologies, all set to benefit.

IPO's TAAM has seven programmes in hand at the time of writing. The countries included in these projects are Georgia, Egypt, Iraq, Romania and Kosovo, with programmes focusing mainly on the provision of new and upgraded software systems.

Domestic needs

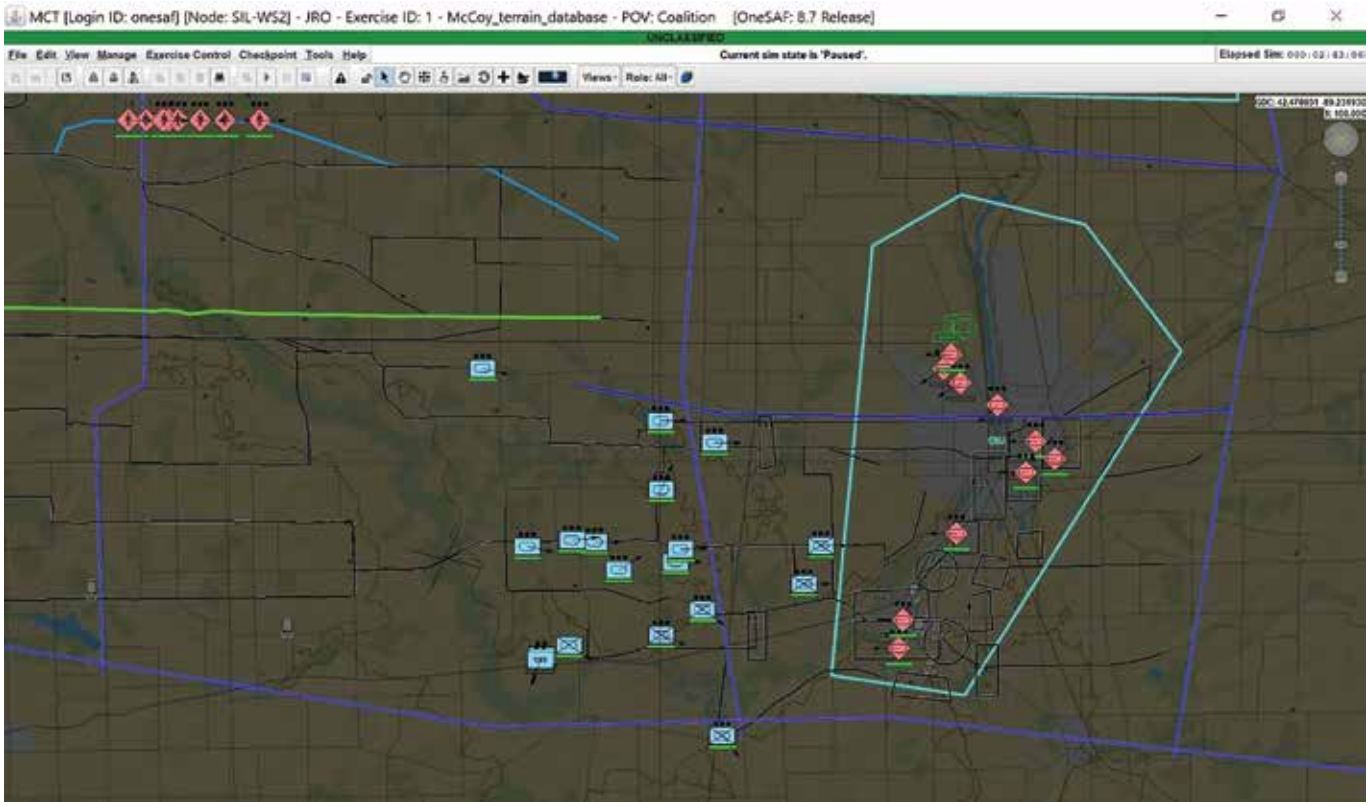
The majority of PEO STRI's activities are centred on the provision of training systems for the US Army. The major requirements that are now in process are detailed below.

PM SE is tasked with providing virtual, constructive and gaming training solutions to operate in concert with live training systems. Considering the Army's emphasis on ATI and the introduction of STE, PM SE will have to shoulder a significant workload over the coming years. Current active programmes include a six-year enhancement to One Semi-Automated Forces (OneSAF), a constructive simulation software and modelling system and, the development of an associated Next Generation Constructive (NGC) simulation based on STE software. In late July 2025, Battle Road Digital was awarded a USD 40 million contract to develop the core simulation for NGC through an Other Transaction Authority (OTA) agreement.

The other major PM SE programme is the highly ambitious One World Terrain (OWT) visual environment to provide, "a synthetic/virtual world representation that supports land, air, maritime, and space operations".

Two remaining major PM SE projects include the Training Simulation Software /Training Management Tool (TSS/TMT) requirement to provide "the capability to conduct multi-echelon Combined Arms Maneuver Training in support of Multi-Domain Operations in a Complex Operational Environment at the point-of-need from Squad through Brigade. This contract will address hardware/software development, production, procurement, fielding, and sustainment". This USD 350 million plus programme is set to be awarded by 4QFY26.

On the same award timescale is the RVCT-A and RVCT-G. These devices are designed to provide "the interface to the STE with minimum hardware necessary to represent form, fit, and function



Current active programmes include a six-year enhancement to One Semi-Automated Forces (OneSAF), a constructive simulation software and modelling system. Managed by PM SE, contract award is expected in late 2025. [JPEO-CBRND]

to enable execution of mission rehearsal, gunnery, and collective maneuver training."

Following on from the award to Cubic Defense of the Live Training Ranges and Combat Training Centres (LTRaC) programme in April 2025, PM TRADE is now looking at a range of supporting contracts that include range targets, digital range training systems and logistic support.

Turning to PM C2T, this group currently has three major programmes that it is supporting: the Persistent Cyber Training Environment (PCTE); Test Enterprise Network Modernisation (TENM); and the Aerial Target Flight Services (ATFS) requirement. All three contracts are due to be awarded in the 2026/2027 timeframe.

PL TSO's major programme is focused on Artillery and Chemical Training (ACT). This future contract provides worldwide Life Cycle Contractor Support (LCCS) for extant air defence, field artillery and chemical training systems. Like many US DoD training programmes, ACT features an initial one-year award and four one-year options.

Finally, PL ETI is tasked with developing systems to "enable agile acquisitions, rapid prototyping, and modernization to transform the product line". One of its goals is to, when possible, use common software across numerous platforms. The group is currently working on seven major projects that include automating after action reviews for use at CTCs and enhancing the storage and accessibility of cloud-based data for future simulations.

Closing thoughts

One of the major benefits provided by PEO STRI is that it is a focal point for industry and a repository of all things 'training and simulation'. With a staff comprising military and civilian personnel, the organisation provides long-term continuity and a well of experience that provides industry access to discuss current and future requirements. This open communication channel serves PEO STRI and industry in that the former is kept abreast of the latest technical simulation capabilities whilst the latter is provided with insights as to requirements and possible new and innovative desired training methods.

Although working closely with ACC, like all contracting/procurement authorities overcoming friction is always an issue. Some industry members would like to see the procurement process made more simple and although the US ACC is moving to digital systems where appropriate, as well as OTA vehicles, larger programmes are always potentially set for delays due to their costs, the need to provide incontestable contracts and the pervasiveness of 'risk aversion' by some contracting staff.

With the Live Training Ranges and Combat Training Centres (LTRaC) programme awarded to Cubic Defense in April 2025, PM TRADE is now looking at a range of supporting contracts that include range targets, digital range training systems and logistic support. [US Army/SSgt Effie Mahugh]

The US and China: Deep dependency amid increasing strategic competition

David Saw

Today around 41% of US weapons and defence infrastructure is reliant on Chinese semiconductors, while 91% of Navy weapons incorporate critical minerals whose supply is reliant on Chinese industry. As America pivots to the Pacific, it faces the stark reality that its military superiority increasingly depends on China – the very country it is preparing to potentially confront.

In the early 1990s, the US saw its strategic situation transformed; the Warsaw Pact had imploded and the Soviet Union, the primary strategic rival of the US, had collapsed. The US was the dominant power globally, having the largest economy and demonstrating its superior military power as a US-led coalition defeated Iraq in Operation Desert Storm between January and February 1991. In the taxonomy of international relations, the bipolarity of the Cold War era (1945–1990) had been replaced by unipolar system with the US as the undisputed leading power.

Opinion among elite policy circles in the US saw all of this as a critical moment when everything changed; the key text espousing this view was Francis Fukuyama's 'The End of History and the Last Man' (1992). It was his contention that the end of the Cold War and the emergence of the US as the major power in a unipolar world, marked the triumph of Western liberal democracy as the dominant political and economic system and that no plausible challenge could emerge to Western liberal democracy, hence 'the end of history'.
With no plausible strategic competitor, the US, like the Europeans, could go on and enjoy a 'holiday from history' in the 1990s, starting to downsize their defence capabilities and their supporting national defence industries. That is not to suggest that the US did not face any strategic or foreign policy challenges in the 1990s, but none of them could be classed as being of major concern. The 1990s were therefore an era where the US was at the top of a unipolar international system and at the apogee of its strategic dominance.

AUTHOR

David Saw has been a defence journalist for over 40 years, writing for and editing magazines in Asia, Europe and America. His interests include defence industrial developments in Asia, current conflicts and the role of artillery and infantry on the modern battlefield.

Then on 11 September 2001 (9/11), terrorist attacks on the US homeland caused almost 3,000 deaths, triggering the George W. Bush Administration (2001 to 2009) to embark on 'regime change wars' in Afghanistan and Iraq as a part of a broader 'war on terror'. US military involvement in Afghanistan, Iraq and across the wider Middle East would continue throughout the Bush Administration. With the US increasingly entangled in the Middle East, significant strategic challenges elsewhere did not receive the necessary attention. For example, a resurgent Russia and its 2008 invasion of Georgia failed to generate a robust US response. Elsewhere, Chinese economic and military power continued to grow, posing questions over Beijing's strategic intentions.

Strategic shift

The Obama years (2009 to 2017) marked a shift in US strategic policy; furthermore, many in the Obama Administration foreign policy team would go on to hold important posts in the Biden Administration (2021 to 2025) and continue with Obama-era policies. Obama/Biden strategic policies still have significant impact on US defence capabilities and strategic perceptions.

The Obama Administration sought a 'reset' in relations with Russia, though this ended up being short-lived, effectively ending with Russia's annexation of Crimea in 2014 and commencement of the Donbas War shortly thereafter. The most significant change in US foreign/strategic direction was in the Middle East, where the Obama Administration changed direction. This manifested in a number of different ways: firstly, the Obama policy was for a new balance of power in that region, relations with older client states such as Israel, Saudi Arabia and the majority of the Gulf States were frayed during the Obama Administration's efforts to secure a lasting deal with Iran, in which the country would agree to give up on its nuclear ambitions in exchange for lifting of sanctions.

Looking back at the heights of US strategic dominance in the 1990s, by 2025 the sun looks to have well and truly set on the unipolar international system. [US ANG/MSgt Luke Olson]

Another significant change was the US reaction to the 'Arab Spring' which started in Tunisia in December 2010 before spreading to Egypt, Libya, Syria, Yemen and beyond. There was little US reaction to the fall of the Mubarak regime in Egypt, a long-term US client. This was followed by the fall and death of Gaddafi in Libya, the start of the civil war in Syria, and the rise of the Islamic State, all of which led to a region in turmoil. The Obama plan for a new era in the Middle East proved difficult to deliver, added to which US forces remained engaged in Iraq and Afghanistan throughout the Obama years, despite a desire to end those commitments.

Arguably though, the critical change in strategic policy actioned by the Obama Administration was the so-called 'Pacific Pivot'. The reasoning behind this move was explained by Obama in a speech to the Australian Parliament in November 2011, when he stated: *"As the world's fastest-growing region – and home to more than half the global economy*

USS *Bulkeley* (DDG 84), an *Arleigh Burke* class guided-missile destroyer, launches a Standard SM-3 missile against a ballistic missile target during an exercise in May 2025. Operations in the Middle East revealed that US Navy missile utilisation rates far outstripped the ability to replenish missile stockpiles. [US Navy]

– the Asia Pacific is critical to achieving my highest priority, and that's creating jobs and opportunity for the American people. With most of the world's nuclear power and some half of humanity, Asia will largely define whether the century ahead will be marked by conflict or cooperation, needless suffering or human progress." He continued: "As President, I have, therefore, made a deliberate and strategic decision – as a Pacific nation, the United States will play a larger and long-term role in shaping this region and its future, by upholding core principles and in close partnership with our allies and friends."

This new focus on Asia would require change, with Obama stating: *"I have directed my national security team to make our presence and mission in the Asia Pacific a top priority. As a result, reductions in US defense spending will not – I repeat, will not – come at the expense of the Asia Pacific. My guidance is clear. As we plan and budget for the future, we will allocate the resources necessary to maintain our strong military presence in this region. We will preserve our unique ability to project power and deter threats to peace."*

While the Obama Administration talked about 'cooperation' with China, it was clear that US policy makers were of the opinion that China had emerged/was emerging as the primary strategic competitor to the US. The problem was that strategic competition with China presented the US with a different set of challenges than it had faced previously; this was not going to be a Cold War 2.0 situation! Unlike the situation in the first Cold War, the US now faced a serious competitor in the economic sphere, as well as in the industrial and scientific spheres. Where the US was once the global industrial

The guided missile submarine USS *Ohio* (SSGN 726) returning to the Puget Sound Naval Shipyard and Intermediate Maintenance Facility in Bremerton, Washington, after completing sea trials, 19 December 2005. Even such sensitive vessels as the *Ohio* class were found to have significant Chinese semiconductor presence according to the Govini report. [US Navy/Rick Chaffee]

leader, in an era of globalisation this was no longer the case as manufacturing was outsourced overseas. Also, in the post-Cold War era, defence industrial capabilities had shrunk significantly, driven by falling defence budgets and industrial consolidation.

In the military context, the US found itself facing an increasingly peer-level competitor for the first time in more than two decades. Furthermore, this was happening while the US military was deeply enmeshed in the asymmetric conflicts of the regime change wars primarily in Afghanistan and Iraq. On top of that, the technological lead that the US military had enjoyed was being eroded by Chinese progress. All in all, China presented a highly complex conundrum for US defence planners to counter.

The 'Pacific Pivot' in US strategy would be continued during the first Trump Administration (2017–2021) and also in the Biden Administration (2021–2025). However, the intensity with which the threat calculus in the Asia Pacific region would be understood and acted upon would differ between the two successor administrations after Obama. Turning to the second Trump Administration, the Asia Pacific strategy continues, but it is important to note that while the US and China both acknowledge strategic competition, they both work actively to avoid confrontation at this point.

Vulnerabilities

There was a time when the US could count on superiority over potential competitors in critical strategic areas; these included economy, industry, technology and unfettered access to key raw materials. In recent years though, the US has had to come to terms with vulnerabilities emerging in these critical areas. It has also started to take steps to recognise these vulnerabilities and look for solutions.

In 2019, the US Department of Defense (DOD) awarded a USD 400 million five-year contract to deliver data and analysis on DOD spending, supply chain and acquisition issues to Govini, a specialist company is this area. This led to a report entitled 'Numbers Matter: Defense Acquisition, US Production Capacity and Deterring China'. Key findings in the report were that between 2005 and 2020, the level of Chinese suppliers in US supply chains quadruped (from a little over 10,000 to over 40,000). Added to which was the fact that between 2014 and 2022, US dependence on China for electronics increased by 600%. The Govini report also stated: 'US companies at the bottom of the supply chain pyramid often source these parts (electronics/semiconductors) from China in open market transactions.' The end result of this was that major US defence primes have Chinese suppliers in their supply chain.

The report was able to establish that US weapon supply chains in areas such as datalinks, electronics, propulsion systems, seekers, software, structures, testing and fuzes and detonators, with hundreds of Chinese suppliers involved. According to the Govini report,

A USAF F-35A takes off at Nellis AFB Nevada. With each F-35 requiring 408 kg of Rare Earth Elements (REE), and with China responsible for 69.2% of REE production and 99% of REE processing, the US is now looking for alternative sources of REE supply. [USAF]

some 41% of DOD weapons systems and infrastructure supply chains rely on Chinese semiconductors! It was established that US Navy F/A-18E/F combat aircraft have 5,000 Chinese semiconductors present, while ***Arleigh Burke*** class destroyers have almost 6,000. Other weapon systems with a significant Chinese semiconductor presence include the B-2 bomber and the Ohio class SSBN, as well as systems such as the Tomahawk, Patriot, AGM-158 JASSM, AGM-158C LRASM and the GBU-31 JDAM. The necessity for rapid action to cleanse the US defence supply chain and critical weapon systems from reliance on Chinese semiconductors is obvious.

Recently Govini has released another report that contains more bad news for the DOD and the US strategic situation. This new report is entitled: 'From Rock to Rocket: Critical Minerals and the Trade War for National Security'. The introduction to the report makes clear why this is a critical issue: *"From raw minerals to advanced weapon systems – from rock to rocket – there lies a reality: America's military superiority increasingly depends on China. China recently tightened its grip on critical minerals essential to defense and commercial technologies by expanding its export controls to include tungsten, tellurium, and other vital materials. This action builds upon earlier restrictions introduced in 2024, targeting gallium, germanium, and antimony."*

The Govini report lists five critical minerals, namely tungsten, tellurium, gallium, germanium and antimony. Moreover, the report states that: "More than 80,000 parts across 1,900 weapon systems incorporate the five critical minerals, meaning that nearly 78% of all DoD weapon systems are potentially affected." It is stated that 91% of US Navy weapon systems rely on parts using these minerals – for the US Marine Corps, it is 61.7%.

Rare Earths

This brings us to another category of critical minerals where the US finds itself dependent on foreign suppliers; this category is known as Rare Earth Elements (REE). There are 17 different REEs which have applications in such areas as aerospace components, medical systems and devices, fuel cells, specialty glass and lenses, semiconductors, coatings for rare earth magnets, lasers, electric motors, nuclear batteries and superconductors. The problem for the US is that China was responsible for 69.2% of REE production in 2024, is said to account for 99% of REE processing and is credited with having almost 50% of global REE reserves.

In the REE sector, China essentially has a monopoly position. In April 2025, China instituted export restrictions via an export licensing regime for REEs and REE magnets. The elements in question are scandium, yttrium, samarium, gadolinium, terbium, dysprosium and lutetium. How important are REEs to US defence programmes? According to the Center for Strategic and International Studies (CSIS) in Washington DC, an F-35 combat aircraft uses 408 kg of REEs, while an ***Arleigh Burke*** class destroyer requires 2,359 kg of REE.

In a report by the US Government Accountability Office (GAO) to Congress, published in July 2025 entitled 'Defense Industrial Base - Actions Needed to Address Risks Posed by Dependence on Foreign Suppliers,' it was stated that: "The F-35 prime contractor, Lockheed Martin, identified prohibited Chinese magnets in the F-35 supply chain and notified DOD in 2023 and 2024. DOD subsequently paused manufacturing for several months to identify alternative suppliers." Until notified by Lockheed, DOD was unaware of the presence of Chinese magnets. Finding a new source of supply proved difficult and after determining that the magnets posed no security risk, they continued to be used on the F-35 until alternative arrangements could be made.

The GAO report also illustrated other areas where reliance on foreign supplies is being mitigated: *"DOD has started building domestic battery production capabilities and stockpiling certain types of lithium batteries to reduce reliance on foreign sources that are located primarily in China. Lithium is a critical material used in the production of batteries and supports many applications and weapon systems, including radios, ground combat vehicles, and aerial refuelling drones."* China is the dominant force in the battery domain, as battery manufacture in the US relies on Chinese-produced materials such as nickel, manganese and cobalt. The GAO report further notes that finding other sources for these minerals is often expensive or just not possible.

The report also referenced the fact that critical chemicals used in 155 mm artillery ammunition came from China and other foreign countries, with the DOD now establishing domestic sources of supply for these chemicals as 155 mm ammunition production is being ramped up. In the biotechnology sector, the US is reliant on foreign manufacturers, including China, for bio manufacturing. Reliance on foreign materials and manufacturers is only part of the problems with the US defence industrial base; the GAO report noted that "the US has lost large titanium casting capability." This is just one example of lack of investment and ageing equipment across the defence industrial base.

PLA Navy Type 055 destroyer Nanchang commissioned in January 2020, with Type 055 units often referred to as the Rehai cruiser class. As Chinese shipyards continue to out-produce the US in terms of combat vessels, China recently surpassed the US Navy to become the world's largest in terms of warship numbers. [via FaySue6 X Account]

There are currently so many other areas of concern within the whole defence ecosystem in the US with the US Navy for example suffering with a major maintenance, repair and overhaul backlog. All of the US services have experience with reaching recruitment targets in recent years, although that situation appears to be changing and numbers are recovering. Ammunition stockpiles were denuded in support of various clients, with Ukraine a

major destination. Recovery efforts are now underway to rectify this issue, particularly with 155 mm ammunition. Another critical area finally receiving attention is missile stockpiles and production rates; for example, the US Navy found itself burning through the various types of Standard missile at an unsustainable rate as production numbers were so low. It does not take much imagination to realise how quickly their missile arsenal would be depleted if they were confronting a peer-level adversary! Urgent action is obviously needed to increase missile production and acquisition across the US military.

A key part of US Marine Corps Force Design 2030, a Navy Marine Expeditionary Ship Interdiction System (NMESIS) launcher deploys ashore from a Landing Craft Air Cushion (LCAC) on to the Pacific Missile Range in Hawaii. NMESIS mounts the Naval Strike Missile with a range out to over 300 km. [USMC]

For more than 80 years, the US Navy has been the largest and arguably the most capable naval force on the planet, yet now it finds itself in a situation where its supremacy is being challenged by a peer-level competitor in the form of the People's Liberation Army Navy (PLAN). Indeed, it is thought that PLAN has now surpassed the USN in numbers of combat vessels, although a like-versus-like comparison could probably yield a different result. The trend lines are clear. PLAN is on course to surpass the US Navy and will field advanced modern vessels in large numbers year-on-year. Put simply, China is out-producing the US in advanced naval construction, a situation that the US has never faced before in the modern era. Naval power is fundamental to power projection in the Asia Pacific, and if the US is to project power it needs more advanced naval combatants and it needs them rapidly if it is going to compete.

Active responses

As the US is responding to challenges in the Pacific, it is actioning new basing options in the region under the Agile Combat Employment (ACE) programme, in response to the missile threat against existing major bases such as Guam. Tinian, one of the Northern Mariana Islands, one of the most westward US territories, was captured from the Japanese in July/August 1944, at which point construction of an enormous airbase began for B-29 bomber operations against the Japanese mainland. In fact, the atomic bomb missions against Hiroshima and Nagasaki were flown from Tinian. Post-1945, Tinian West Field eventually became the airport for the island, while the large North Field complex was abandoned. More recently, the US Marine Corps (USMC) have been using facilities on the island.

In 2023, funding was appropriated to improve facilities at Tinian West Field/Tinian airport for military use. Then in 2024, Fluor Corporation was awarded a USD 407 million contract to rebuild/refurbish the former Tinian North Field airbase, with significant work completed in 2024 and into 2025. Elsewhere, refurbishment works on former bases have been undertaken at Peleliu in the Palau Islands and at Yap Island in Micronesia. Rather than US assets all being concentrated on Guam, they can be spread across four locations complicating hostile targeting and increasing survivability.

If there is one US service that has embraced the challenge of the 'Pacific Pivot', it is the USMC. Back in 2014, as their involvement in asymmetric conflicts wound down, USMC leadership attempted to define the future threats the US would face and what roles this would require the Marines to undertake. In 2019, 'Force Design 2030' was released; this would provide the doctrinal basis for the future of the Marines. Part of the doctrine was 'Expeditionary Advanced Base Operations (EABO)'. Here the Marines establish temporary bases in austere locations and field their weapons and sensors and engage hostile naval units in a sea denial mission. The EABOs could be established along an island chain blocking enemy access to a disputed operational area.

New weapon systems central to the Force Design 2030 include the Navy Marine Expeditionary Ship Interdiction System (NMESIS), this utilises the Naval Strike Missile (NSM) in a coastal defence application. Air defence options include the Medium-Range Intercept Capability (MRIC) to confront air threats, cruise missiles and UAVs, with the effector here being the Rafael Iron Dome missile. Other air defence options are the JLTV-mounted Marine Air Defence Integrated System (MADIS) and the Light-MADIS mounted on the Ultra-Light Tactical Vehicle; these systems use missiles, guns and electronic means to confront and defeat UAV threats primarily. All of these weapon systems are supported by a range of sensor options, UAVs and USV systems, light armour, Marine Air and a range of Marine-specific amphibious vessels.

The rapidity with which new bases are being established in the Pacific is impressive, as is the ongoing transformation of the Marines to play a pivotal role in confronting threats in the Pacific area. However, there is no avoiding the fact that the US must seek to reduce dependence on foreign suppliers for critical minerals, especially REEs. It has to gain control of its semiconductor supply chain via onshore manufacture wherever possible. Finally, it has to modernise its defence industrial base and build weapon and munitions stockpiles that will realistically reflect utilisation rates against a peer competitor.

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US small UAV programmes

Sidney E. Dean

The US Army and Marine Corps are significantly increasing the number of small UAVs assigned to tactical units, and are providing these assets to the lowest echelons.

The United States Department of Defense (DoD) classifies unmanned aerial vehicles (UAVs) into five groups based on a combination of size and performance parameters. Group 1 and Group 2 include UAVs weighing up to 9 kg (20 lb) and 25 kg (55 pounds) respectively, while Group 3 encompasses a very broad weight spectrum up to 600 kg (1,323 lb). For the most part, the US armed forces apply the term 'small UAV' (or SUAV) to those in Groups 1 and 2. This article will follow suit. While these unmanned aircraft are used by all services, the ground forces are the primary operators and will be the focus of this review. [Author's note: There is one notable deviation from the standard application of 'small UAV' only to Group 1 and 2 aircraft. DoD Directive 3800.01E, which deals with counter small UAV activities, includes Group 3 aircraft in that category. However, counter-UAV applications are not discussed in this article.]

▲ SUAVs are controlled via handheld devices, tablets and laptops. Here a USMC rifleman operates a Skydio X2D. [USMC/Cpl Joshua Barker]

The US Army and US Marine Corps (USMC) are systematically expanding the integration of SUAVs at the tactical level, from battalion down to squad level. According to the Army's FY2026 budget request to Congress, these will provide ground forces with "situational awareness and enhanced force protection. The systems provide an organic and responsive reconnaissance and targeting capability with real-time full motion video and sensor data". Specific capabilities inherent in the SUAVs include intelligence, surveillance, and reconnaissance (ISR), target acquisition and strike, electronic warfare operations, and other missions.

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Currently operated SUAVs

The US Army currently operates several categories of SUAV, optimised for the tactical requirements of various echelons. The majority are easily portable by one or two soldiers – sometimes disassembled with wings, hulls and/or payloads carried separately – and are independent of specialised launch equipment. In most cases, soldiers of any military occupational specialty can be trained to operate the systems. Frequently deployed assets include:

RQ-20 Puma

The AeroVironment RQ-20 Puma entered service with USSOCOM in 2008, followed by the US Army and other services. The standard issue RQ-20B has largely been replaced by the Puma 3 AE which features enhanced payload capacity and an extension of the 20 km range to 60 km when utilising a long-range tracking antenna on the ground control unit. The primary payload consists of a gimbal-mounted high-resolution optronic video sensor and laser illuminator. The Army assigns the 2.8 m wingspan Puma at company and platoon level, while the USMC has utilised it at battalion level.

▼ US Marines and Sailors with 2d Reconnaissance Battalion, 2d Marine Division prepare to launch an RQ-20 Puma UAV from a combat rubber reconnaissance craft during Operation Baltic Sentry in southern Finland, 28 February 2025. [USMC/LCpl Brian Bolin Jr.]

A soldier assigned to the 101st Abn Div launches an RQ-11B Raven UAV at a forward operating site in Romania in 2023. The unit uses the RQ-11B to spot targets, support call-for-fire missions, and other reconnaissance tasks. [US Army/Pfc Matthew Wantroba]

RQ-11 Raven

The AeroVironment RQ-11B Raven was selected by the US Army in 2005, and was subsequently acquired by the USMC, US Special Operations Command (USSOCOM), and the US Air Force. The rucksack-portable UAV has a 10 km range and flight endurance of 75+ minutes. It carries a gimbaled optronic payload and an optional laser designator for low-level ISR missions. The 2.2 kg Raven can be assembled within five minutes and is launched by hand like a model aeroplane. In 2020, the RQ-11B was upgraded with new radio modules, flight control and ground control systems to optimise performance for the company-level medium-range reconnaissance (MRR) mission. In 2024, Army Chief of Staff General Randy George announced that the Army would phase out the Raven in favour of systems more capable or survivable on today's battlefield.

RQ-12A Wasp AE

The AeroVironment RQ-12A Wasp AE is assigned to Army and USMC platoons and reconnaissance squads to enhance situational awareness. The hand-launched, fixed-wing micro-UAV has a 5 km range and a 50-minute flight endurance. Introduced in 2014 (as replacement for the older Wasp III), this asset is being displaced by newer VTOL and hybrid designs.

Family of small uncrewed aircraft systems

The Army is currently seeking to "increase investments in research and development to expand and accelerate the Army's unmanned aerial reconnaissance capability", Gen. George announced in February 2024. As part of the Transformation in Contact (TiC) initiative introduced in late 2023, the Army is evaluating various types of small UAV for potential integration into ground units. Expansion of the drone arsenals of all categories is in line with the current

The US Army initiated production of the second tranche of its short-range reconnaissance (SRR) UAV in August 2025. Shown here is the Black Widow Quadcopter, one of two systems selected. [Teal Systems/Matthew Ryan]

administration's policy priorities. A 30 April 2025 memorandum by Defense Secretary Peter Hegseth specifically directed the Army to field unmanned systems and ground/air launched effects "in every Division by the end of 2026". This was followed by a 16 July 2025 press release citing a second memorandum by the Defense Secretary "rescinding restrictive policies that hindered drone production".

These policies are partly about increasing the number of unmanned aircraft in service, and partly about replacing legacy systems with more advanced and capable aircraft. For the US Army, the proposed Family of Small Uncrewed Aircraft Systems (FoSUAS) will play a central role in this expansion. The Army's Justification Book for the FY2026 budget estimates outlines the 'family of systems' significance. "*These systems ensure Army formations have the best existing and emerging technology at battalion and below to allow ground-based forces to project power from land into other domains to defeat highly capable enemies, secure terrain, and consolidate gains. The Rucksack Portable Uncrewed Aircraft System (RPUAS) Family of Small Uncrewed Aircraft System (FoSUAS) [will] solve current and emergent operational gaps by incorporating Modular Open Systems Approach (MOSA) including swappable payloads, advanced autonomy and software scalability.*"

FoSUAS is designed to align specific aerial systems to specific echelons between squad and battalion, with capabilities tailored to each unit level. Aircraft are to be selected according to what the Army calls a "flexible and agile acquisition plan" that makes full use of evolving technology. The Congressional Research Service (CRS) cites Congressional testimony by Army officials who say that the service's modular open systems approach (MOSA) to its SUAV programmes could enable the Army to "upgrade platforms without being locked into a specific configuration or solution." SUAVs are being sought to fulfil specific operational categories.

Soldier-borne sensor (SBS)

The SBS programme equips Army squads with a short-range small reconnaissance UAV weighing less than 150 g with a 15 minute flight endurance. The 70 g Teledyne FLIR Black Hornet, with a 2 km range and a 30 minute flight endurance, currently fills the SBS role.

Purpose built attritable system (PBAS)

According to the CRS, the PBAS programme will provide a first-person view (FPV) drone capability for Army platoons. The CRS' 15 August 2025 US Army Small Uncrewed Aircraft Systems Programs report cites Army requirements documents which state that the PBAS system consists of "two [25 cm] air vehicles and four [12.5 cm] air vehicles with modular payload(s) to include ability to integrate and employ a variety of lethal/non-lethal armaments and munitions." No selection of UAV systems has been announced to date.

Short-range reconnaissance (SRR)

The SRR provides manoeuvre platoons and squads with an organic real time imagery/battlefield situational awareness and target acquisition capability with a 30-minute flight endurance. According to Army budget documents, the system "includes modular payloads, obstacle avoidance, target recognition, automated following, and networked capability". The SRR constitutes the first US Army programme of record to supply a small quadcopter to the platoon level. In 2022 the Army selected the Skydio X2D and the Teal Drones Golden Eagle quadcopters as the initial SRR systems. In 2025 the Army selected the Skydio X10D and the Teal Drones Black Widow for the SRR tranche 2.

Medium-range reconnaissance (MRR)

The MRR provides Army companies with an ISR-capable UAV with a minimum range of 10 km and a 30 minute flight endurance. Seeking a replacement for the RQ-11 Raven, the Army's FY2026 budget request includes funding for an initial 107 "company-level" SUAVs. Anduril Industries (Ghost X) and Performance Drone Works (C-100) have been selected to supply the aircraft.

A soldier assigned to the 101st Airborne Division prepares an Anduril Ghost-X drone for integration into a live fire exercise at Novo Selo Training Area, Bulgaria, 12 August 2025. The Ghost-X is being procured for company level real-time ISR applications as part of the Army's Transforming in Contact initiative. [US Army/Spc Breanna Bradford]

Long-range reconnaissance (LRR)
The LRR will provide a Group 2 UAV to manoeuvre battalions to provide an organic reconnaissance, surveillance, and target Acquisition capability. According to Army budget documents, the UAV will have a range of 40-60 km and flight endurance of 5-10 hours. Attributes will include assured positioning, navigation and timing (APNT), optronic sensors, laser targeting/designating, "and kinetic architectures in a contested environment". On 21 August 2025, the Army announced contract awards to AeroVironment and Edge Autonomy to rapidly deliver initial sets of their P550 and Stalker Block 35X UAVs, respectively. Fielding to operational units will begin later in the year as part of the Transformation in Contact 2.0 initiative. The Army states that it anticipates additional LRR system selections in the future.

Joint Tactical Autonomous Aerial Resupply System (JTAARS)
The Army's FY2026 budget justification book includes the JTAARS under the SUAV category although the programme specifically calls for a Group 3 UAV. The autonomous aerial cargo delivery system will be organic to the manoeuvre commander and "provides options for rapid and agile sustainment of highly mobile tactical combat forces, operating in a widely dispersed manner in the tactical support and close areas. [It reduces] the tactical force's dependence on ground lines of communication and sustainment [and shrinks] the supply chain". Performance requirements include a 57 kg lift capability over 13 km one way (26 km round trip). The programme is currently at the prototyping stage. The Army and USMC are cooperating in the development of this capability.

USMC transitions from ISR to offensive missions

Like the Army, the USMC has primarily treated SUAVs as reconnaissance assets. Additionally, the Corps has tested their utility for frontline supply missions. More recently, the Corps has begun to exploit their offensive capacity. On 3 January 2025, the Marine Corps Training Command established the Marine Corps Attack Drone Team (MCADT). The USMC describes the decision as a response to the rapid proliferation of armed FPV drone technology and tactics observed in modern conflicts, particularly in Eastern Europe. "As emerging threats continue to evolve, the Marine Corps is prioritising the integration of FPV drone capabilities to enhance lethality and operational effectiveness across the Fleet Marine Force (FMF)," reads a March 2025 press release regarding the foundation of the MCADT.

The Team is incorporated into the Weapons Training Battalion (WTBn) at Marine Corps Base (MCB) Quantico, Virginia. "MCADT is committed to rapidly integrating armed first-person view drones into the FMF, enhancing small-unit lethality and providing organic capabilities that warfighters currently lack" said Maj. Alejandro Tavizon, headquarters company commander at Weapons Training Battalion and officer in charge of MCADT. "By leveraging emerging technologies and refining drone employment tactics, we are ensuring that Marines remain agile, adaptive, and lethal in the modern battlespace." Working in coordination with the Marine Corps Warfighting Laboratory, the Team will develop and refine armed FPV drone training, identify current and future requirements to ensure rapid fielding of cutting-edge FPV technologies,

and train Marines at the individual and unit level to enhance lethality and operational effectiveness. The USMC is currently participating in drone operator competitions with other service branches, and intends to hold internal competitions for FPV and SUAV operators beginning in FY 2026. In June 2025 the 1st Marine Division also published the Corps' first 90-page drone operations handbook focussed on SUAV operations.

Parallel to the training efforts, the USMC is ramping up acquisition of combat-capable SUAVs. On 3 July 2025, the Corps conducted its first live-fire exercise involving lethal-payload delivery by SUAVs. The primary test involved the vertical take-off and landing (VTOL) Archer FPV made by Neros Technologies. Additionally, the Skyraider Quadcopter, which the Corps uses for ISR missions, was evaluated for ordnance-delivery suitability. In August 2025, Brig Gen Simon Doran, Vice Chief of Naval Research, confirmed USMC plans to award a contract to Neros for the purchase of 8,000 Archer drones to extend the lethal range of its infantry formations. The jamming-resistant UAV can deliver a 2 kg explosive payload to strike a ground target at 20 km distance or intercept airborne targets at 10 km distance.

The US Marine Corps will purchase 8,000 Neros Archer FPV drones. Newly approved for US DoD procurement, the Neros Archer can deliver 2 kg payloads for ground-strike over 20 km or air intercept missions at 10 km. [USMC/Cpl Joshua Barker]

The first unit to field the Archer will be the 3rd Light Armored Reconnaissance Regiment, but the planned acquisition of 8,000 units points to a much wider distribution within the force. Col Scott Cuomo, commander of the USMC's Weapons Training Battalion at Quantico, told reporters in July 2025 that FPV capabilities would be fielded *"down into our infantry squads, and then you're also going to see them inside of the new Force Design battalion, inside of the organic precision fires section, within the fires and reconnaissance company, and you will very likely see them inside the scout platoon as well."* This mirrors Ukrainian battlefield tactics and reflects a shift toward precision strike capabilities embedded at the lowest tactical levels.

Attack mode

The Army is following suit. The first session of the Army's new Unmanned Advanced Lethality Course (UALC) was launched on 18 August 2025 at Fort Rucker, Alabama. According to the accompanying press release, the three-week UALC is designed to rapidly train soldiers on the lethal employment of SUAVs. "The course lays the foundation for standardised UAS employment across warfighting functions, redefining how small UAS platforms are used in reconnaissance, fires, and maneuver operations." The initial class had 28 participants from various military specialties, "and they are going to leave here as lethal operators that can go back out and train their units", said Maj Gen Clair Gill, commanding general of the Army Aviation Center of Excellence and Fort Rucker on 18 August.

Designed to evolve with battlefield needs, the UALC will adapt its curriculum as new technologies and tactics emerge. Future iterations will expand into advanced tactics, including one-way attacks using purpose-built FPV drones. By February 2026 the course director, Capt Rachel Martin, envisions students employing low-cost systems to prosecute targets with precision, a major step toward integrating UAVs as a lethal, scalable weapon system. "I am very aware that my team has been entrusted with developing solutions for a critical need in emerging Army tactics," Martin said. "This course is a catch-up. We're behind globally, and this is our aggressive attempt to close that gap."

Soldiers participate in the US Army's first Unmanned Advanced Lethality Course at Fort Rucker, Alabama in August 2025. [US Army/Leslie Herlick]

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Is drone-based resupply viable?

Alex Tarasov

Military logistics and sustainment have always played a crucial role in operations at all levels–strategic, operational, and tactical. Following major geopolitical changes, as well as shifts in technology and doctrine, military logistics have evolved over the past decades, with one of the main directions being a shift toward robotics and autonomy. The experience of the Russo-Ukrainian War provides new impetus to research and development programmes in this area and has also sparked many theoretical debates. Given the breadth of the topic, this article focuses specifically on drone-based resupply for ground forces.

▲ A Chinese CS/VP 16B, light unmanned all-terrain vehicle at IDEX 2025 [TE courtesy photo]

Why autonomous resupply?

Several factors have contributed to the trend of introducing robotics and autonomy in military logistics.

First, technological advances in robotics, microelectronics, and related fields. The proliferation and mass adoption of these technologies, including in the private sector, have made them more affordable, more robust, and therefore more attractive to the military.

Second, following the end of the Cold War, many militaries (primarily in the West) shifted from mass conscription to smaller, volunteer-based forces. This coincided with a growing imbalance between combat and non-combat elements of the armed forces, commonly referred to as the 'tooth-to-tail ratio' (T3R).

Since the First World War, the proportion of combat troops relative to command and sustainment elements has steadily declined, reaching roughly a 1:3 ratio in the US Army during the 1991 Gulf War. As a result, modern armies – already smaller than their Cold War counterparts – typically field fewer combat soldiers than sustainment, logistics, and headquarters staff. This imbalance is further exacerbated by chronic challenges in recruiting and retaining personnel.

These pressures have reinforced the understanding that at least some logistics and sustainment functions can and should be automated in order to free personnel for combat roles. In addition, greater automation can reduce the number of personnel required for logistics and sustainment tasks, thereby enabling more efficient resource allocation and cost savings.

Finally, a common feature of many initiatives is the use of robotisation and autonomous systems to reduce risk for soldiers and keep them away from exhausting and monotonous tasks.

Lessons have been drawn from the low-intensity conflicts of the 2000s and 2010s, the Global War on Terror (GWOT), and the ongoing full-scale Russo-Ukrainian conflict. The experience of these conflicts has underscored that, whether in counterinsurgency operations or in high-intensity warfare, logistics and sustainment operations have become increasingly dangerous and risky.

Logistics for the modern battlefield

What conditions define logistics on the modern battlefield? First of all, the increased density of intelligence, surveillance, and reconnaissance (ISR) assets, ranging from satellite observation to reconnaissance unmanned aerial vehicles (UAVs). Some observers suggest that the proliferation of UAV reconnaissance has made the battlefield 'transparent' and observation 'almost constant'. While these claims might be exaggerated at the strategic or operational levels, the growth of ISR at the tactical level and in the close rear is undeniable.

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A Rheinmetall's Mission Master UGV in CASEVAC variant [Rheinmetall]

Another issue is the growing threat to logistics routes and infrastructure, even in further rear areas. This was evident in Iraq and Afghanistan, where logistics systems were under constant threat from ambushes and improvised explosive devices (IEDs). In Ukraine, logistics is threatened by a wide range of conventional weapons (artillery, anti-tank guided missiles, airstrikes, etc.), while a new array of threats has also been added to the mix, including remotely-laid minefields, strike UAVs, loitering munitions, and UAV ambushes.

As a result of the increased density of ISR and the evolving threat environment, combat zones have expanded, sometimes stretching tens of kilometres in depth beyond the line of contact (LOC). Rear areas once considered safe are now under threat, imposing further strain on logistical operations.

On the other hand, units engaged in large-scale conflict with peer or near-peer adversaries (a likely scenario for future wars) require a continuous, high-volume flow of supplies, often comparable to or even exceeding Cold War-era logistical demands. For example, a tank company of ten T-72B main battle tanks requires about 450 rounds per day, which amounts to 10–14 tonnes of ammunition, depending on the types of rounds used.

Generally, the problem may be summarised as follows: large amounts of supplies and equipment need to be transported continuously in an increasingly contested environment. While operational and operational-tactical supply lines remain at risk, 'last-mile' resupply has emerged as the most dangerous and problematic element of the logistics chain. A possible answer to this may lie in drone-based resupply systems – whether employing unmanned aerial or ground platforms. However, the introduction of such systems also presents a number of dilemmas.

Logistical dilemmas

The key dilemmas revolve around platform class (light, medium, or heavy) and their payload capacity. In addition, there are unique, domain-dependent dilemmas specific to UAVs and unmanned ground vehicles (UGVs).

The typical payload capacity of small commercial aerial drones varies between 0.5 and 10 kg, while industrial or agricultural models can carry 20–50 kg. Some models, such as AeroVironment's HawkEye glider-type UAV, have demonstrated the capacity to deliver a payload of 25 kg. However, it remains in the development stage.

Larger models, such as the TRV-150C TRUAS drones employed by the US Marine Corps (USMC), including helicopter-type or vertical take-off and landing (VTOL) UAVs, have significantly higher payload capacities. For instance, the TRV-150C can carry up to 68 kg, while in November 2022, Sikorsky and the Defense Advanced Research Projects Agency (DARPA) successfully tested an unmanned Black Hawk helicopter that carried a payload of 226 kg during a resupply mission and also performed a rescue operation.

Aerial platforms on the lighter end tend to be relatively cheap, allowing deployment in greater numbers. This in turn enables the establishment of supply lines along multiple routes. They also provide higher speed compared to ground vehicles, are easier to disperse, and are not constrained by terrain. On the other hand, light or even medium aerial platforms are susceptible to electronic warfare countermeasures, have limited payload capacity, and are unable to carry certain types of cargo – for example, spare parts for heavy vehicles, engineering supplies, heavy munitions, or bulk fuel and lubricants. In addition, the use of small UAVs can be severely restricted by weather conditions such as strong winds, rain, or low temperatures.

UGVs by contrast typically offer greater payload capacity than their aerial counterparts. For instance, all three models of Rheinmetall's Mission Master family of UGVs have a maximum payload capacity of 1,000 kg, Hanwha's Arion-SMET can carry up to 550 kg, while General Dynamics Land Systems' MUTT offers 408 to 1,134 kg, depending on the variant. However, UGVs are required to negotiate terrain or artificial obstacles and minefields, all which can prove highly challenging; added to this, they are typically remotely controlled, with some elements of autonomy.

A US Marine Corps Tactical Resupply Vehicle (TRV)-150 prepares for takeoff. [USMC/SSgt Samuel Ruiz]

Light UGVs offer better concealment than UAVs, are able to stay idle and can carry more payload. However, even light UGVs tend to cost significantly more than small UAVs, often reaching into the hundreds of thousands of euros per unit. Heavier UGVs can offer better protection, including various types of passive armour, electronic warfare (EW) systems, or smoke and aerosol launchers. They have greater payload capacity, and greater operational range, but at the cost of reduced concealment and a higher price per unit. It is important to highlight that, given the conditions on the modern battlefield, the factor of concealment primarily benefits small-sized (likely single-vehicle) resupply runs. Due to the high density of ISR assets in the tactical zone, a swarm of small resupply UGVs would likely be detected with a similar probability as a group of larger ground vehicles.

▲ A prototype of a multipurpose logistics system showcased at Armiya 2024. Payload capacity: 500 kg. Preliminary cost: RUB 1.4 million. [Alexey Tarasov]

Given these conditions, the key question is what applications remain for drone-based resupply on the modern battlefield–and what future potential it holds.

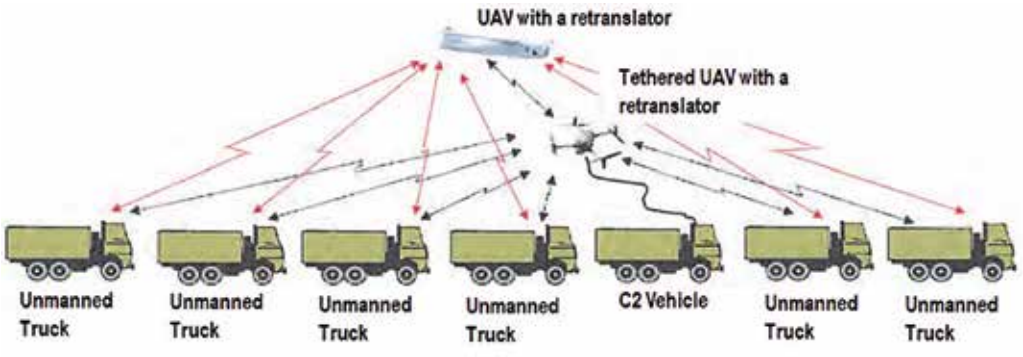
Concluding thoughts: A matter of scale

Many militaries have been experimenting with autonomy and robotics in logistics since the 2000s or even earlier. Despite substantial achievements in this field, most programmes related to logistics and sustainment (involving both UAVs and UGVs) remain at various stages of development and are either undergoing trials or deployed only in limited numbers. The results achieved to date vary depending on the vehicle class, domain, and position within the logistics chain.

At the tactical level, small and medium unmanned platforms are primarily employed for emergency resupply of light, high-value, and urgent cargo such as medical supplies, batteries, radios, spare UAV parts, water, small-arms ammunition, or field rations. These platforms may also prove useful in certain environments, such as urban areas or high-altitude terrain.

In some scenarios, UGVs ('robotic mules') may be useful for special operations forces (SOF) or small units of dismounted infantry. However, practical experiments with UGVs have produced mixed results. For example, trials conducted by US Army units in 2024 showed that an infantry unit deployed with the small multipurpose equipment transport (S-MET) had to deviate from its concealed route because the S-MET was unable to overcome obstacles in rough terrain.

▼ A US Army's autonomous truck in Kuwait, 14 July 2023 [US Army/Cpt Katherine Alegado]



One variant of a leader-follower autonomous convoy, based on standard Russian Kamaz-5350 trucks. [Russian MoD]

Given financial considerations, as well as the tactical and technical characteristics of small and medium UAVs and UGVs, large-scale, continuous supply and sustainment operations for large units, (or heavy forces such as armour, mechanised forces, or artillery), appear ineffective, if not impossible, at the tactical level, including last mile resupply.

On the other hand, logistics may benefit from wider implementation of robotics and automation at higher levels (from tactical to strategic) through their use in large hubs, warehouses, and depots, as well as in large-scale transportation with autonomous convoys or leader-follower technology. Experimentation in this area is ongoing in many militaries, including those of Russia, the US, China, and others. Given the scale of military transportation and logistics operations in a modern high-intensity conflict, focusing on autonomy at higher levels of the logistics chain seems reasonable. Statistics provided by Lieutenant General Andrei Bulyga, Deputy Minister of Defence for Logistics and Director of Logistical Support of the Russian Armed Forces, offer a broad overview. In a 2024 interview, Bulyga claimed that year Russian Material and Technical Support forces had transported over 8 million tonnes of materiel – a 30% increase compared to 2023 – including 50,000 tonnes of spare parts and 12 million units of ammunition. In February 2024, during an Association of the US Army event, Maj Gen Michelle Donahue, Commanding General of the Army Combined Arms Support Command, provided statistics on the US Army's logistics demands. According to Donahue, since the 1970s, the Army's fuel demand has increased by 374%, while demand for maintenance has grown by 37%. The experiments with light and medium unmanned platforms will continue in the near future, aiming to achieve a higher level of autonomy (rather than simple remote control) and to reduce the cost per unit. At the lightest end of the scale, small logistics UGVs or UAVs should be inexpensive and expendable.

It is reasonable to assume that UGVs designed to operate close to the line of contact will likely be based on 'robotised' versions standard armoured platforms, possibly even heavy ones. Adapting what already exists could offer a more cost-effective approach than developing specific designs for every role. This kind of approach has already been seen in experiments with autonomous logistics trucks – for example, the US Army uses the standard Oshkosh PLS (Palletized Loader System), while Russia has been experimenting with the ubiquitous Kamaz-5350 and Ural-4320 family of trucks.

Finally, it is important to highlight that many aspects of modern conflicts, in Ukraine, Gaza, and the Middle East, are unique and, therefore, their respective lessons cannot be regarded as universally applicable. Drone-based resupply and sustainment systems are still at the early stages of development, and the definitive form of such a system has not yet been established. Nor has the ideal design for a frontline resupply vehicle been determined.

US Army Long-Range Hypersonic Weapon: Programme status

Sidney E. Dean

The US Army's Long-Range Hypersonic Weapon system conducted its first overseas deployment in July 2025. Participation in Exercise Talisman Sabre 25 in Australia marked a milestone toward the fielding decision.

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The Long-Range Hypersonic Weapon (LRHW) is a mobile ground-to-ground hypersonic glide weapon expected to achieve a range in excess of 2,775 km and a minimum speed of Mach 5. It is intended to defeat anti-access/area denial (A2/AD) capabilities, suppress adversary long-range fires, and engage other high-payoff, time-critical targets. While the Army's developmental hypersonic weapon has been referred to as 'Dark Eagle' for some time, the service officially designated the LRHW as such on 24 April 2025. "Part of the name pays tribute to the eagle – a master hunter known for its speed, stealth and agility – due to the LRHW's combination of velocity, accuracy, manoeuvrability, survivability and versatility," the Army wrote in a press release, adding, "the word 'dark' embodies the LRHW's ability to dis-integrate adversary capabilities."

An LRHW launcher on static display in the firing position on 9 July 2025 during Talisman Sabre 25. [US Army/Sgt Perla Alfaro]

The core weapon consists of the Common Hypersonic Glide Body (C-HGB) developed by Dynetics Inc. (combining the warhead, guidance system, cabling, and thermal shielding) paired with a two-stage booster rocket to form the vertical-launch All Up Round (AUR). Both the US Army and the US Navy will utilise the AUR, with the Navy planning to deploy its Conventional Prompt Strike variant at sea. Lockheed Martin is acting as systems integrator for the Army's ground-based Dark Eagle variant, which will deploy in launch canisters mounted on mobile transporter-erector launchers (TELs). Each TEL will carry two AURs, with four TELs, plus the mobile Battery Operations Center (BOC) and a BOC support vehicle, forming a battery. Current plans call for one LRHW battery to be assigned to each of the service's five multi-domain task force (MDTF) formations. The LRHW battery will be incorporated into the task force's long-range fires battalion (LRFB).

End-to-end flight tests

LRHW development was initiated in 2019 as a prototyping effort to equip one battery for evaluation purposes. Following a successful critical design review in December 2020, the Army initiated a Middle Tier of Acquisition (MTA) rapid fielding effort to acquire an additional two battery sets. Technical issues significantly delayed the flight-testing programme which was the prerequisite for operational certification of the Dark Eagle prototypes. All flight tests scheduled during 2022 and 2023 either failed or had to be aborted. Following an in-depth review, the Army's Rapid Capabilities and Critical Technologies Office (RCCTO) concentrated on risk-mitigation and developmental testing of subcomponents and ground support equipment during the first part of 2024.

Satisfied that the technical issues responsible for previous failures had been addressed, the service resumed flight testing mid-year. On 28 June 2024 the Department of Defense (DoD) conducted the first successful end-to-end flight test of the AUR. The missile, to be used by both the Navy and Army, was launched from a ground stand at the Pacific Missile Range Facility in Kauai, Hawaii. The Pentagon confirmed that the weapon followed the intended course and released the CHGB, which reached the designated target in the Marshall Islands some 3,200 km from the launch site. While the test provided data on the performance of the actual missile, it did not include any Army-specific ground equipment such as launch canisters, TELs or control vehicles.

The Army-specific test was conducted on 12 December 2024 with a successful end-to-end flight test of the AUR conducted from Cape Canaveral Space Force Station, Florida. This was the first live-fire event for the LRHW system using a Battery Operations Center and a Transporter Erector Launcher. The Pentagon did not specify the precise target zone or the distance the missile covered, but on the day of the test temporary flight restrictions and advisories to mariners were posted for hazard areas extending southeast over the Atlantic from the Florida coast. "This test builds on several flight tests in which the CHGB achieved hypersonic speed at target distances and demonstrates that we can put this capability in the hands of the warfighter," said then-Secretary of the Army Christine Wormuth at the conclusion of the event.

First unit selection

The successful end-to-end flight tests of 2024 established the basis for operational certification of the LRHW prototypes. Following certification the Army, as anticipated, authorised Lockheed Martin to resume assembly of AURs for distribution to the first operational battery.

According to the US Government Accountability Office (GAO) Weapons System Annual Assessment (published in June 2025), production of a full battery set of eight hypersonic missiles was expected to take 11 months. On 2 April 2025, Defense News cited Major General Francisco Lozano, US Army PEO Missiles and Space, as predicting delivery of the first missile to the first battery in May 2025. The missiles would continue to be delivered to the unit one-by-one as they are assembled, Lozano said.

The First Multi-Domain Task Force (1MDTF) situated on Joint Base Lewis-McChord in Washington state was the first such unit to stand up a LRHW battery, namely B Battery of the 5th Battalion, 3rd Field Artillery Regiment; the 5th Bn 3rd FA functions as the 1MDTF's Long Range Fires Battalion. The battalion and the Dark Eagle battery are co-located with the task force headquarters at JBLM.

In 2021, B battery received the full LRHW equipment set – minus the AURs – in order to develop and practice operating procedures. Using the LRHW ground support equipment, the 1MDTF participated in various named and joint exercises,

The US Army's RCCTO, in collaboration with the US Navy Strategic Systems Programs, completed the first conventional hypersonic missile test using the full Dark Eagle technology suite on 12 December 2024 from Cape Canaveral SFS. [US DoD]

A US Air Force F-16 Fighting Falcon flies by one of the LRHW TELs assigned to B Battery, 5th Bn, 3rd FA, LRFB, 1st MDTF, participating in exercise Bamboo Eagle 24-3 on Nellis Air Force Base, Nev., 3 August 2024. [US Army/1Lt David Kim]

Soldiers from B Battery (Dark Eagle), 5th Battalion, 3rd Field Artillery Regiment (LRFB), display the LRHW in Northern Territory, Australia, during exercise Talisman Sabre 25. [US Army/Sgt Perla Alfaro]

demonstrating the ability to fully integrate into operational command and control systems at various echelons. The LRHW battery marked a first milestone in February 2023 by airlifting 5,000 km from JBLM to Cape Canaveral, Florida, demonstrating the capacity for rapid deployment and being operational soon after arrival. In August 2024, the battery participated in the US Air Force's Exercise Bamboo Eagle to test interoperability between Army long-range fires and Air Force operations, as well as validating joint tactics, techniques, and procedures for employing hypersonic fires in a theatre-level engagement.

First overseas deployment – Talisman Sabre 2025

In July 2025, the Hawaii-based 3rd MDTF participated in exercise Talisman Sabre 2025 (TF25) in Australia. That task force has not yet established its own LRFB or a LRHW battery, so it deployed with the 1MDTF's B Bty, 5th Bn, 3rd FA. At least two TELs and the BOC were airlifted by C-17 to Australia's Northern Territory. This was explicitly described as the first ever 'operational employment' of the LRHW outside the continental United States. The Pentagon's press releases did not indicate whether or not live missiles were brought to Australia. It would seem doubtful, given the small inventory and the ongoing efforts to field the first full complement. In any case, no LRHWs were launched. US military statements and reports emphasised that the unit's participation demonstrated the capability to operate globally and integrate with allied forces. "The deployment of the LRHW system to Australia marks a significant achievement for US Indo-Pacific Command, as it validates the Army's ability to deploy, position, and exercise command and control (C2) of the system in a forward environment," said Adm. Samuel J. Paparo, Commander of U.S. Indo-Pacific Command. "The exercise demonstrates the Combatant Command's capacity to project power and support the defence of Australia, a key ally in the region."

Fielding plans

In early September 2025 a spokesman for the Army Materiel Command (AMC) confirmed to *ESD* that the Army remains on track to field the first LRHW battery by the end of the calendar year. For security reasons, the Army declined to disclose the specific units selected to receive the LRHW capability. To date, it has been presumed that B Bty, 5th Bn, 3rd FA – which has spent the past four years testing and exercising with the support equipment – would be the first unit declared operational. The fact that the 1MDTF is the only Multi-Domain Task Force with an operational LRFB underscores the central role of B Bty, 5th Bn, 3rd FA. Of course, that battery could always be reflagged and transferred to a different task force to meet pressing operational priorities, but this seems impractical until another MDTF stands up a LRFB.

The next two LRHW batteries are widely expected to be established with the 2MDTF headquartered in Wiesbaden, Germany and with the 3MDTF headquartered at Fort Shafter, Hawaii. Both task forces are still in the process of standing up their LRFBs, which will not be co-located with the unit headquarters. In March 2025, the Congressional Research Service (CRS) cited the Army's updated MDTF Alignment and Stationing plan which calls for the 2MDTF's LRFB to be established at Fort Drum in New York State during FY2026. The same CRS report stated that the Hawaii-based 3MDTF will station its LRFB (as well as a sustainment battalion) at JBLM, co-located with the 1MDTF. On 14 March 2025, Inside Defense cited the 3MDTF's then commander, Brig Gen Michael Rose, as stating that the unit would stand up its long-range fires battalion over the next 12 to 18 months (so, during FY2026), as part of a "sizeable amount of growth" for the task force.

A Battery Operations Center assigned to Bravo Battery, 5th Battalion, 3rd Field Artillery (Long-Range Fires Battalion), 1st Multi-Domain Task Force, provides command and control for the battery during exercise Resolute Hunter 24-2 on JBLM on 25 June, 2024. [US Army/Cpt Ryan Debooy]

While these figures do not specify that the Dark Eagle battery of each long range fires battalion will be fielded concomitantly with the LRFB's establishment, other government documents confirm that both the second and the third LRFW battery are expected to be equipped and operational by FY2027. Specifically, the GAO's Weapon Systems Annual Assessment 2025 cites LRHW programme officials stating that the second battery, which is part of the rapid fielding MTA effort, remains on schedule for fielding in the 4th Quarter of FY2026. The Army FY2026 Budget Justification Book dated February 2025 shows funding and delivery phasing for Battery 3 across FY 2026-2027. Notably, it remains unclear when in the course of this fielding cycle the Army will actually declare Initial Operational Capability (IOC). "IOC criteria and timing remain under senior-leader review and will be announced when decisions are complete. IOC will not be associated with a delivery milestone," the AMC spokesperson told *ESD*.

Procurement going forward

Following completed equipment of the second and third batteries, the MTA rapid acquisition track of the LRHW programme will formally close by Q4 of FY2028, according to GAO data. The Army anticipates continued procurement to equip two additional LRHW batteries after Battery 3, in tandem with the planned formation of the fourth and fifth MDTFs in FY2027 and FY2028, respectively.

To date, the Army has not provided a specific number of missiles it ultimately wants in the inventory. While the Army is expected to preserve the LRHW for exceptionally high-value targets, it will need to provide for sufficient reloads to make deployments to war zones viable. With the Navy introducing its version of the hypersonic missile on the *Zumwalt* Class destroyers by FY 2027 and subsequently on the Virginia class attack submarines, Lockheed Martin Space will be ramping up production of the joint missiles, which is expected to bring the unit cost down from the current USD 41 million, to the benefit of both the Navy and the Army. On 1 June 2025, the firm was awarded a USD 1 billion cost-plus-incentive-fee and cost-plus-fixed-fee unpriced letter contract modification to support the Navy's Conventional Prompt Strike programme, underscoring the Pentagon's commitment to the hypersonic weapon capability. That being said, both US Army Secretary Daniel Driscoll and Army Chief of Staff General Randy George testified to Congress on 4 and 5 June 2025 that the Army was actively seeking to acquire more affordable ground-launched hypersonic weapons that would provide deeper magazines. While such aspirational weapon systems may not match the full capabilities profile of the LRHW, they could hold significant enemy assets at risk while retaining Dark Eagle as a niche capability against the most challenging targets.

Continued development and testing

Lessons learned from the end-to-end flight tests in 2024 and from the operational evaluation by B Bty, 5th Bn, 3rd FA are guiding final adjustments to the design. According to the GAO's 2025 Assessment, fielding the second battery will involve a missile with minor modifications. Flight tests of the modified weapon are to begin in the fourth quarter of FY2025.

Programme officials have also informed the CRS as well as news outlets regarding plans for further LRHW flight tests, although the number and timing of these tests will be influenced by missile cost and the sufficiency of test ranges. In that vein, *Defense News* cited General Lozano on 2 April 2025 as saying that the Army had scheduled the next test launch of the LRHW system in December 2025. "We're trying to be efficient," Lozano said, citing the "very expensive" nature of the missiles. On 8 August 2025, *Newsweek* quoted a US Army source as confirming that "as of mid-2025, testing continues, with the Master Test Strategy projecting activity through fiscal year 2026".

Still ahead of the game

The LRHW prototyping effort was formally initiated in 2019. The Army originally hoped that the fast-tracked project would lead to fielding at least a limited operational capability weapon system by late FY2023, after a good four years of R&D. If all goes as planned, that goal will be met in late 2025, circa two years later than planned. However, the Pentagon is taking a 'glass half full' position, pointing out that missile development programmes normally take around ten years. In that light, LRHW can indeed be seen as ahead of the statistical curve.

Concept rendering of the LRHW launching from a TEL. [Lockheed Martin]

IFPC Increment 2: Filling the medium-range gap

Tim Guest

The US Army's Indirect Fires Protection Capability (IFPC) Increment 2 (Inc 2) programme is making steady headway towards its eventual, essential place in the Army's layered defence strategy.

IFPC Inc 2 – an overview

The US Army's IFPC Inc 2 programme is intended to develop a new mobile, medium-range air-defence weapon system – launcher and missile interceptors – for the US Army, to defend a variety of assets from current and emerging aerial threats, including: subsonic and supersonic cruise missiles, unmanned aerial vehicles (UAVs), and rocket, artillery, and mortar (RAM) threats, as well as low-flying rotary and fixed-wing aircraft.

The IFPC Inc 2 AD system is intended to defend fixed and forward operating bases against the latest and emerging aerial threats including rotary and fixed-wing, UAVs and cruise missiles, most likely using a second, more capable interceptor. [US Army]

Between the air-defence (AD) layers covered by very short-range air defence (VSHORAD), such as man-portable air-defence systems (MANPADS), and short-range air defence (SHORAD) solutions, to those covered by longer-range weapons such as PATRIOT and the Terminal High Altitude Area Defence (THAAD) systems, a gap for a system to cover medium-range AD threats exists. A system is needed to protect facilities like fixed critical infrastructure (CI), high-value military installations, as well as semi-fixed assets like forward operating bases. It's a capability the US Army has been meaning to fill for many years and which is now, through the IFPC Inc 2 programme, well on the way to full realisation.

The programme currently involves several companies, including Leidos, with its subsidiary, Dynetics, producing the IFPC Inc 2 launchers. Prototype launchers have been produced, initially using RTX's AIM-9X Sidewinder as a preliminary interceptor to support various system and development tests. A second missile is, however, currently on the drawing board, with Boeing selected to pursue a new interceptor, more capable than the Sidewinder, to ensure effectiveness against the most advanced and emerging threats. Of course, several other companies are also involved in IFPC Inc 2, such as Anduril, working on rocket motor technologies for the new interceptor, while others, including Lockheed Martin and Rafael, have previously been involved. However, they reportedly had potential interceptor work interrupted by the current Israel-Gaza crisis. Whether they will re-enter remains to be seen.

IFPC must integrate into the Army's layered AD ecosystem; to do so, the Dynetics launchers will integrate and network with other AD assets via the Integrated Battle Command System (IBCS). This coordinates multiple sensors and shooters, active in each layer of the overall strategic AD picture, against a wider threat target set, more effectively. As a key element in the mix, the mid-range capability IFPC Inc 2 system, will be a crucial weapon in the US Army's layered air defence arsenal, which, once operational, will result in 360° protection against mid-range targets. And as threats evolve rapidly, the IFPC Inc 2 programme's open-architecture approach and technologies are being designed, so both launchers and interceptors will be adaptable and upgradable to meet any adversarial advances head-on, through the incorporation of latest technologies to counter new threats.

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Running the show

At the Programme Executive Office - Missiles and Space (PEO MS) at Redstone Arsenal Alabama, some 30 programmes are managed by six project offices. It's under the umbrella of the Short and Intermediate Effectors for Layered Defence Project Office (SHIELD PO) where solutions to enable US and Allied forces to detect and defeat cruise missiles, UAVs, rotary and fixed-wing targets, as well as RAM threats, are managed throughout their lifecycle: from development, qualification and testing, to integration, production, sustainment, and more, then eventual fielding with operational units. And it's under the SHIELD PO in its M-SHORAD Product Office, that IFPC Inc 2 has its own product office.

▲ **Leidos subsidiary, Dynetics' IFPC Inc 2 Enduring Shield launcher. [Dynetics]**

The launcher story so far

Back at the end September 2021, the PEO MS awarded Dynetics a USD 237 million, 2.5-year contract for the prototyping manufacture of a 'mobile ground-based weapon system', what it called at that time the 'Enduring IFPC', that would defeat cruise missiles and UAVs. Some 16 Enduring Shield units were slated for delivery by end 2023, with Army officials saying that the prototypes will be issued, in the fourth quarter of 2025, to multiple AD artillery battalions. The first IFPC Increment 2 battalion is slated to be fielded by the US Army by FY2026.

The September 2021 contract also included a follow-on option for a further 400 launchers and 'associated interceptors' – the AIM-9X Sidewinder missile. Dynetics designed its 'Enduring Shield' launchers with open-system architecture to support flexibility and growth, and integration with the IBCS, mentioned earlier. The company had worked collaboratively with Raytheon to select its AIM-9X All-Up Round Magazine (AUR-M), carrying 18 AURs, for the IFPC platform. Sidewinder, for its part, had already proven successful integration with the IBCS back in May 2021, and was therefore suited for supporting the Army's accelerated prototyping timeframe request for the first launchers.

On schedule, at the end of December 2023, Leidos and its Dynetics team delivered the first Enduring Shield launchers during a ceremony at its Huntsville, Alabama facility, with IFPC Inc 2 programme representatives, Brig Gen Frank Lozano, PE Officer MS, and Col Andrew Lunoff, SHIELD programme manager. At the time, the company said that successful integration tests between Enduring Shield launcher 'fieldable prototypes' and the IBCS had been demonstrated mid-2023, and that the Army's developmental test programme of the prototype launchers would begin in 2024. Meanwhile, Leidos set preparations in motion at its Chase plant for the manufacture of further launchers, expecting an order during 2025.

Testing times

It is also worth noting that in December 2023, Leidos announced that an Enduring Shield risk reduction flight demonstration (RRFD) had taken place, showing the platform's ability to launch a test Sidewinder interceptor from a simulated IBCS interface. As a result, the company's first shipment of launch-

▼ **Dynetics delivered its first fieldable* prototype Enduring Shield launchers to the US Army in December 2023, though supply-chain issues have slipped the original March delivery date. Pictured are employees working on the programme gathered at the company's Chase, Huntsville, Alabama facility for the occasion. (*Fieldable prototypes can be operationally deployed, if necessary). [Dynetics]**

Intended to provide a critical AD layer to fixed critical infrastructure, as well as forward operating bases, IFPC Inc 2 is designed to protect against incoming unmanned aerial vehicles, cruise missiles, as well as rockets, artillery, and mortars. [US Army]

ers entered the next phase, to begin the Army's developmental test programme in January 2024, as well as an operational assessment later that year. Feedback to Leidos from both of these activities would be incorporated, as necessary, to improve its next Enduring Shield platforms.

In September 2024, Leidos, the PEO MS, the SHIELD PO, together with the PEO MS integrated fires team, undertook target interception trials against cruise missile and UAV threats; this successfully demonstrated the ability of the launcher to detect, track, and engage the target with a surface-launched AIM-9X Sidewinder fired from the launcher platform's AUR-M. This was all achieved while networked with the IBCS, a legacy Sentinel A3 (AN/MPQ-64A3) air and missile defence radar, and missile datalink.

At the time, Dino Pusinsky, Leidos IFPC Inc 2 product area VP, said that the successful intercept was a further milestone in evaluating the system's overall operational capabilities and lethality. Mention was also made that US Army Contracting Command at Redstone Arsenal had, prior to the intercept trials timeframe, awarded the company a contract for additional hardware assets to support the programme's initial operational test and evaluation process, including: missile remote communications link and software upgrades, in order to network with the Army's integrated air and missile defence (AIAMD) architecture.

As expected...and more

Earlier than expected in mid-November 2024, in partnership with Army Contracting Command at Redstone Arsenal, PEO MS announced an Undefinitised Indefinite Delivery/Indefinite Quantity (IDIQ) contract to Dynetics, valued at USD 4.1 billion for low-rate initial production (LRIP), and full-rate production (FRP), together with support services, for an initial 18 units of its Enduring Shield launchers; the advantage of the IDIQ approach, was said by the Army to enable a more streamlined and flexible procurement process, effectively resulting in faster delivery.

At the of end April 2025, Leidos announced it had begun preparations for launcher mass production, referring back to the IDIQ contract expectations. The first delivery order under the terms of the IDIQ has been awarded by the PEO MS for 18 launchers to be produced by Dynetics in support of Guam Defence Systems (GDS), a collective name for US air and missile defences deployed, or being developed, to defend the Pacific island of Guam from potential ballistic and hypersonic missile attack. IFPC Inc 2 will eventually take its layered position on Guam alongside the likes of Aegis, THAAD and PATRIOT. The company said the new launchers will play a crucial role in regional defences, supporting the US Indo-Pacific Command (USINDOPACOM) Pacific Deterrence Initiative, with this specific contract slated to run through December 2026. Remaining orders under the IDIQ contract will continue to 2029. Indeed, precise LRIP and FRP numbers to be ordered are not yet known.

Larry Barisciano, Land Systems Lead for Leidos, said that the company had "been preparing for this [mass production] phase long before our first prototype system deliveries in 2023". He

US Army awarded a USD 4.1 billion contract to Leidos and its Dynetics subsidiary in November 2024, for the production of an initial 18 Enduring Shield launchers, (beyond prototypes previously delivered). [PEO Missiles & Space/Darrell Ames]

added that the latest production order highlighted the demand for the critical capability of IFPC Inc 2, delivered via the Enduring Shield launcher and interceptors, which he stressed would be delivered with "unmatched speed and precision". SHIELD programme manager, Col Andrew Lunoff, said that investing in cruise missile defence is essential to strengthening the Army's integrated layered air and missile defence capabilities, and that it demonstrated the Army's focus on rapid development and deployment, to ensure such rapidly and advanced evolving threats can be countered.

RTX's AIM-9X Sidewinder missile is one of the initial interceptor options for IFPC Inc 2 with testing underway to ensure its suitability for ground-based launch from the Dynetics Enduring Shield launcher. A second, more advanced interceptor is in development with Boeing. Pictured: AIM-9X in the air-to-air role. [USMC]

Cindy Gruensfelder, president of the Defence Systems Sector at Leidos, placed Dynetics in context, saying that the 2019 acquisition of Dynetics "has significantly enhanced our [Leidos] manufacturing capabilities", aiding the delivery of hardware and integrated systems to the end user, "at speed".

In the latest development on 30 July 2025, the Army's Contracting Command, Redstone Arsenal, awarded Dynetics a cost-plus-fixed-fee, firm-fixed-price contract for IFPC "weapon system requirements", worth USD 264.6 million. The requirement was solicited online, with only Dynetics responding. Work is expected to be completed by 30 July 2026 and will be undertaken at company facilities in Huntsville, Alabama; Dallastown, Pennsylvania; and Chanhassen, Minnesota. Army funding for R&D, test and evaluation for the remainder of FY2025 amounts to USD 127.9 million, which was obligated at the time of the award.

Commenting briefly to *ESD* about the end-July contract, Leidos IFPC Inc 2 product area VP, Dino Pusinsky, said, "This award reflects strong confidence in IFPC and the growing demand for a proven capability available today. We're scaling production, strengthening supply chains, and delivering with urgency." Pusinsky left *ESD* with a final thought about the Enduring Shield launchers' ability to interoperate with various different and future interceptors, the open architecture of IFPC Inc 2 enabling greater flexibility in accommodating different or new interceptors, potentially from different suppliers, which might be developed in line with changing operational and mission requirements. So, while current launchers, with their open architecture, support the AIM-9X Sidewinder as the first interceptor, (though the AGM-114L Longbow variant of Hellfire might similarly suit), future launchers leaving the production line should be able to accommodate any suitable new missile effector developed for the programme, such as the second interceptor currently being developed by Boeing.

On such future interceptor developments, Leidos' Dino Pusinsky offered *ESD* one final brief comment, "As the IFPC prime integrator, we're partnering with our customer and industry to harness the open architecture features of the system. This allows us to quickly integrate new capabilities to make the system more lethal and effective."

Interceptor developments

This brings us to the latest interceptor development, with the Army narrowing the field in its quest for a new mid-range interceptor to move on from using Sidewinder, by selecting Boeing at end of February 2025 to progress to the next phase of the competition to develop second interceptor for the IFPC Inc 2 programme. In a statement, Boeing suggested its new medium-range missile would protect the kind of installations already outlined better than the AIM-9X, particularly in the face of aerial threats yet to materialise.

Jim Leary, Boeing's executive director of business development for precision engagement systems, said that with an understanding of warfighter needs, as well as the dynamic environments and conditions under which soldiers operate, the company's aim is to "keep them safe with an innovative, affordable offering that leverages our industry-leading missile expertise". He added at the time, that the company's missile design offers increased magazine depth, and will be an interceptor providing increased speed to target, as well as greater range and manoeuvrability than AIM-9X. The new missile's development has embraced a modular open systems (MOSA) approach, so that it can be updated/upgraded as and when threats evolve, and changes needed. Boeing said that the Army will select companies for the second interceptor's prototype development phase sometime in 2026.

So, the path to a new interceptor for IFPC Inc 2 seems clear, with Boeing's selection to move forward and develop a second bespoke missile for the programme. While Dynetics' Enduring Shield prototype launchers have been operating effectively during tests and evaluation using the AIM-9X as the first interceptor, the second, more capable effector is eagerly awaited. Indeed, the US Army announced its request for information (RFI) for a second interceptor for IFPC Inc 2 in January 2024, and awarded the contract just over a year later in February 2025. IFPC Increment 2's second interceptor will be expected to integrate with and bolster the US Army's layered air and missile defences, just as the first interceptor has done in tests.

NGSRI: Progressing towards Stinger's replacement

Tim Guest

Intended to result in a high-performance replacement for the ageing, though still capable FIM-92 Stinger family, the US Army's Next-Generation Short-Range Interceptor (NGSRI) programme is making steady headway.

▲ Lockheed Martin and Raytheon are competing for their respective interceptor designs to be the US Army's eventual new M-SHORAD Increment 3 missile. Illustrated: LM's interceptor launched in dismounted configuration. [Lockheed Martin]

For many reasons, not least of which are depleted US Army stocks due to the supply of more than 3,000 of the missiles to Ukraine since Russia invaded in February 2022, added to the fact that Raytheon's Stinger production is limited to refurbishing old Stingers or upgrading them to new variants rather than producing entirely new-build missiles, Stinger is up for replacement. With evolving aerial battlespace threats, its successor must, itself, be as advanced as possible to meet those threats, effectively, performing well beyond the ageing Stinger's parameters.

Seeking that replacement since March 2023, when two prime contractors, Lockheed Martin (LM) and Raytheon, (Boeing having dropped out after the 2022 RfP stage) were awarded an 'other transaction authority' (OTA) prototyping contract by the US Army to progress competing offerings. The two have since been vying for their respective missile designs to be the winning choice for what will eventually be the US Army's new short-range air-defence missile component of the Manoeuvre Short-Range Air Defence (M-SHORAD) Increment 3 programme. As such, Stinger's replacement will be capable of countering a wide range of current and future threats, including manned aircraft, cruise missiles, and various drones.

US Army NGSRI overview

M-SHORAD Increment 1 is currently based on Stryker A1 combat vehicles, (configuration name: Sgt Stout, after a Vietnam War hero), with the Army potentially set to have up to 361 Sgt Stout vehicles no later than FY 2031. Increment 1 vehicles currently have a suite of weapons that, amongst other systems, include eight Stinger interceptors housed within two, four-round Stinger Vehicle Universal Launchers (SVULs); previously they had four Stingers and two AGM-114L Hellfire Longbow missiles, but the latter are being gradually replaced with a second pod of four Stingers. It is the M-SHORAD Increment 3, however, where the new NGSRI comes in, to replace Sgt Stout's current Stingers, just as soon as the NGSRI programme delivers.

▼ In early 2025, Raytheon announced it had completed all ten of its NGSRI subsystem tests, including seeker, rocket motor, CLA, and warhead subsystems. Illustrated: In its M-SHORAD role, the NGSRI will fit existing SVULs on Sgt Stout vehicles and provide a dismounted capability. [RTX]

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According to the US Government Accountability Office (GAO), the Abbreviated Capabilities Development Document (A-CDD) for NGSRI came from original requirements for Sgt Stout, that set out many of the 'desired capabilities' for a Stinger replacement. These include: the new missile having improved target acquisition, range, and lethality to counter evolving aerial threats; the new missile not being heavier than Stinger, allowing it to be used by both vehicle-mounted SVULs and in MANPADS configuration, as well as on a tripod; the NGSRI also being capable of defending a manoeuvre force from latest threats, such as cruise missiles, fixed and rotary-wing aircraft, as well as various types of unmanned aerial vehicles (UAVs).

Army officials, together with the Army Capability Manager, (the user representative who informs further development of NGSRI's A-CDD), are currently working together on the document. Once formalised Army requirements for NGSRI are finalised, with all input and feedback from ongoing tests and user touchpoints included, these will be set out in a final CDD, which, curiously, is not projected to be completed before early FY 2028. 'Curiously' is used because the replacement programme itself is set to last five years, from the 2023 OTA award date, with NGSRI slated to reach low-rate initial production (LRIP) in 2028, once the winner has been selected, in the same year.

It is worth noting that the development budget requested by the army for NGSRI, as of 2025, is USD 373.7 million, and overseeing the NGSRI programme is the US Army's Programme Executive Office Missiles and Space (PEO MS).

Meanwhile, the first of two primes... Raytheon

Raytheon's latest NGSRI milestones include its solid-rocket-motor tests, which were announced in June 2025, when, together with Northrop Grumman, four successful tests were conducted of flight-ready, solid rocket motors, fuelled with highly loaded grain (HLG) energetics. The HLG solid propellant provides a longer burn time and greater energy output than a conventional solid rocket motor, increasing acceleration, velocity, and range of the missile beyond those of the legacy Stinger. Of the four tests, three were static firings under different environmental conditions, with the fourth, a successful ballistic flight demonstration, of which further flight tests are planned and ongoing. Working collaboratively at Northrop Grumman's Allegany Ballistics Laboratory in West Virginia, the two companies have been researching and developing this new extended-range motor design, making the transition from proof of concept to first flight in less than six months.

Raytheon's President of Land and Air Defence Systems, Tom Laliberty, said that the tests demonstrated the company's ability to rapidly develop this 'transformational air defence capability', able to defeat "a variety of airborne threats at far greater ranges than legacy systems". For Northrop Grumman, Frank DeMauro, VP and GM, Weapon Systems, said the innovative HLG motor had been developed in five months and delivers "increased speed, range, effectiveness and mission flexibility in a very small package". Compared with Stinger's Mach 2.17 speeds, NGSRI is expected to accelerate beyond Mach 3, and intercept targets as far as 9 km away, almost twice the intercept range of Stinger. In addition to the dismounted configuration, Raytheon's NGSRI is designed to be compatible on platforms such as Sgt Stout using existing SVULs.

In June 2025, Raytheon completed three static firings of its solid rocket motor under different environmental conditions, followed by a successful ballistic flight demonstration of its new short-range interceptor. [RTX]

The June 2025 tests followed Raytheon's announcement, mid-February 2025, that ten subsystem demonstrations had taken place over 'several months'. With each subsystem critical, if Raytheon's NGSRI was to meet the Army's overall system performance demands, much was at stake, as one-by-one, the subsystems, including: seeker, rocket motor, command launch assembly (CLA), warhead, tracking, guidance, aerodynamic control, and fuzing, were put through their paces. The man-portable CLA, for example, displayed enhanced target-detection and target-identification ranges under real-world, low-visibility conditions, while the missile's new rocket motor enabled an extended target intercept range. Also demonstrated, the NGSRI's new advanced seeker assembly, which enabled a maximum acquisition range far exceeding Stinger, both in the lab and in the field. As for the missile's warhead assembly, precise and repeatable lethality against a variety of aerial threats, was demonstrated. Laliberty emphasised at the time, that success in the subsystem tests was a crucial step in demonstrating that the company's NGSRI could meet the US Army's range and performance requirements for the weapon.

For the latest on Raytheon's progress, as of mid-August 2025, *ESD* spoke with the company's VP for Short- and Medium-Range Ground Based Air Defence, Brenda Ortiz, who began by emphasising the company's NGSRI programme execution is on schedule to meet the US Army's initial operational capability (IOC). Of the earlier subsystem demonstrations and rocket motor tests, she said these had taken place "in advance of our system demonstration planned for later this year".

Ortiz said, Raytheon's focus is to deliver the Army a best-value, open-system-approach solution, low-risk and highly producible, which meets M-SHORAD performance requirements. *"Our design enables backward compatibility with training and DOTMLPF (Doctrine, Organization, Training, Materiel, Leadership and Education, Personnel, Facilities), in order to minimise integration burden for our warfighters and to save costs by leveraging existing Army investments."* She added that its CLA, for example, has demonstrated a significant increase in dismounted performance, enabling the gunner to identify threats sooner for faster engagements.

"Raytheon's NGSRI provides the Army with a mounted-equivalent capability at a dismounted price," said Ortiz, adding, "Additionally, our NGSRI design and producibility, results in a significant reduction in touch labour over current Stinger, accelerating schedule and increasing affordability."

Since the subsystem tech demonstrations, Ortiz confirmed that Raytheon has now successfully completed its second soldier touchpoint exercise. *"During this event,"* she said, *"soldiers and marines evaluated engagement sequences and a deployment demonstration, and then provided positive feedback on Raytheon's solution. Designing for the warfighter remains at the forefront of our focus, and we are leveraging their valuable feedback to inform our design."* In closing, she confirmed that, "A system flight test demonstration is scheduled for later this year."

Lockheed Martin first showed a model of its Stinger replacement in a MANPADS configuration during the AUSA event in October 2024. [Lockheed Martin]

Second prime time... Lockheed Martin

For the latest from the LM camp, *ESD* spoke with Chris Murphy, LM's Business Development lead for Integrated Air and Missile Defence Advanced Programmes, about their NGSRI activities and progress with its Quadstar interceptor solution. It was just 18 months after the March 2023 OTA, that LM first showed a model of its Stinger replacement in a MANPADS configuration during the Association of the US Army (AUSA) event in October 2024. Since then, other milestones have been passed and at the end of August 2025, Murphy told *ESD* that "the company is on schedule with respect to the US Government's programme plan, having progressed through subsystem qualifications and tests, and is currently working on system and platform integration."

The Army previously indicated that it expects operational demonstrations of a new interceptor from both primes to take place during FY 2026, with FY 2027 slated as the timeframe for a production decision. Murphy, meanwhile, added that having completed subsystem testing and a majority of the system tests, LM is continuing to conduct some systems integration and a flight-test campaign from August 2025 onwards, as it prepares for the weapon's development testing phase.

While Quadstar has been developed in response to the US Army NGSRI need, Murphy confirmed, that the design, nevertheless, draws on the company's related, broader interceptor experience and "leverages recent work in small-diameter missiles". However, by starting with what he called a 'clean-sheet' design, the company has been able to develop a modular concept, use a military standard open systems architecture, incorporate the latest applicable technologies in the interceptor and the weapon's CLA, and, crucially, drive affordability into the design from the beginning. "The result," he said, "is an Army-owned product, that not only performs, but can be quickly modified in the future – which is the benefit of modularity and open systems architecture – as the threat evolves, or as relevant technologies mature."

In its MANPADS/dismounted configuration, the Quadstar AUR canister integrates with the dismount AD operator's CLA, with the operator able to track targets out to greater ranges than Stinger. [Lockheed Martin]

As for some of the performance stats that differentiate Quadstar from Stinger, Murphy said, Quadstar is able to defeat targets "at significantly greater range than the legacy system [Stinger]", and both simplifies and enhances the engagement process. Expanding on that, the company has documented the new missile as more effective than Stinger for a number of reasons, including the extended range, as highlighted by Murphy, which is partly down to the missile's low-drag and highly-manoeuvrable airframe. In addition, its warhead is also larger and delivers greater lethality than Stinger's 3 kg warhead and is, as a result, suited for use against a wider set of existing and evolving threats than the legacy system was ever designed to address.

Indeed, with NGSRI and its improved capabilities, when introduced into the M-SHORAD ecosystem, it will cover and extend the battlespace currently addressed by Stinger. Murphy said that Quadstar will be effective against aerial targets consistent with the expectations of a SHORAD interceptor; generally, these will include a broad cross section of UAVs, as well as manned rotary- and fixed-wing targets. Indeed, Army representatives have indicated the eventual NGSRI, its improved performance characteristics in terms of range and speed, together with new seeker and warhead technologies, is expected to be effective against 5th-generation UAVs.

LM's Quadstar improved performance characteristics over Stinger, including its extended range, are partly down to the missile's low-drag and highly-manoeuvrable airframe. [Lockheed Martin]

That said, the enduring effectiveness of Stinger has been a challenging benchmark to surpass and LM's Murphy acknowledged this, saying, *"the legacy system has been the pre-eminent MANPADS and workhorse for many users for decades. Understanding how the Army fights today, we're allowing for changes in the way the system may be used in the future, which is both challenging and rewarding. Balancing new technologies and capabilities with the critical need for affordability adds an extra dimension to the challenge."*

Having seemingly met that challenge, LM's Quadstar missile is worth mentioning in more detail. The all-up-round (AUR), a complete, assembled, and packaged missile ready for deployment to its designated platform in the field, comprises the Quadstar missile, its launch tube/cannister enclosed by front and rear covers, and a shoulder strap for carriage. In its MANPADS/dismounted configuration, the missile-containing tube integrates with the operator's CLA, the latter comprising front and rear mounting brackets, shoulder pad, eyepiece, and handgrip, and housing the system's improved optics and computerised targeting system, which uses advances in artificial intelligence (AI) and machine learning, that the company views as a 'game changer' in the development of new systems and capabilities, such as Quadstar's CLA and advanced targeting. An 'identification friend or foe' (IFF) antenna enables the operator to distinguish between friendly and enemy aircraft. LM's CLA has also been designed to support future growth in terms of wider battlefield network integration, beyond line-of-sight capabilities, and solid rocket motor upgrades. The CLA enables the operator to track targets at greater ranges than Stinger and legacy systems, regardless of any environmental clutter, and its advanced camera provides improved target discrimination; the company claims target acquisition and identification ranges have significantly 'more than' doubled, while target intercept range by Quadstar is now 'at least' double the range of Stinger.

LM's missile is also compatible with the four-round SVUL, regardless of the weapon-carrying platform. Indeed, beyond its MANPADS configuration, Murphy said, "Any platform, (surface or air), that can carry, or launch, the legacy system can carry, or launch, our NGSRI solution," adding that as additional platforms emerge, integration of the LM NGSRI "will be expedited by our open systems architecture and modular design".

Rounding off, Murphy had some thoughts to convey about how the US Army's methodology has impacted the programme overall. "The Army's innovative approach towards NGSRI has been spot-on and we feel their communication and support through this phase have been helpful." He added that the Army had expressed its desire for a better capability to industry, providing certain boundaries, such as using the same launchers the legacy Stinger system uses, then invited the primes to bring solutions to the table. "The Army's clear statement of 'the need', together with associated 'must haves', combined with use of an OTA as a contracting vehicle, has provided the flexibility for solid collaboration and rapid advancement of the capability, thereby ensuring our soldiers and marines are provided the best solution possible."

Footnote: A Stinger in the tail

Even as the NGSRI programme progresses, the FIM-92 Stinger family, nevertheless, remains in widespread use. Globally, there are some 24 users, and refurbishment of existing systems under the US Army's Stinger Service Life Extension Programme, looks set to extend the weapon's service life a full ten years, well into the 2030s. At the same time, NATO members, Germany, Italy, and The Netherlands, are set to take delivery of new Stinger family systems over the coming years, following a mid-2024 USD 780 million contract award to RTX' Raytheon by NATO's Support and Procurement Agency, NSPA. This deal alone, for some 940 missiles, is set to keep Stinger production (through refurbishment and upgrading of existing models) going to 2030. Germany has already supplied some 500 Stingers to Ukraine during the ongoing war, so the 2024 order will go some way to replenishing stocks.

Stinger has previously been manufactured under license by the European Common Stinger Production Consortium, with Germany's Dornier (now part of Airbus Defence & Space) as prime contractor, and later with Türkiye's Roketsan (responsible for the rocket motor) contributing. However, it is understood that this is no longer taking place, with Rocketsan long since offering its Sungur MANPADS class missile. This has been further underscored by the fact that Raytheon signed a memorandum of understanding with Germany's Diehl "to co-produce key elements of the Stinger missile in Europe", according to a Diehl press release. However, this agreement is understood to concern Stinger production through refurbishment and upgrade of existing models, rather than new-build production. So while Stinger is likely to remain a VSHORAD mainstay in NATO inventories for some years to come, its end seems to be in sight.

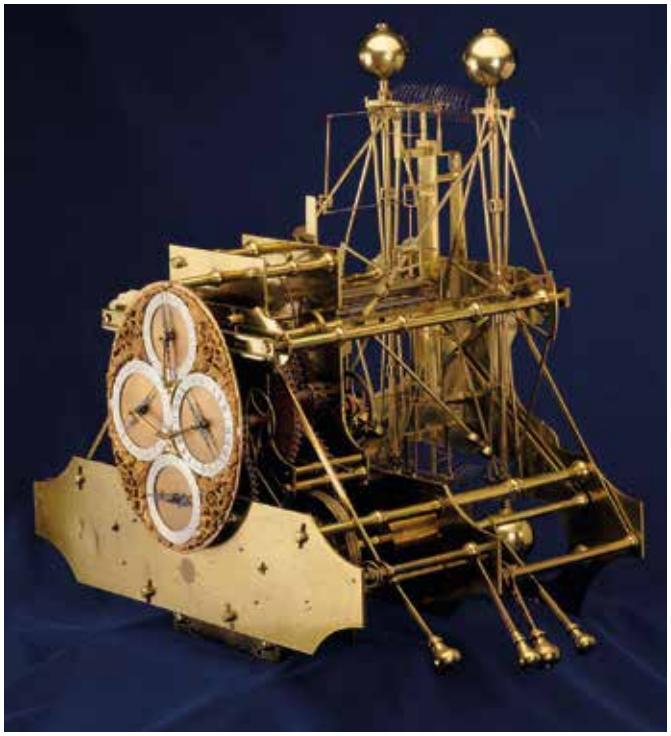
Stinger has a lot of life left in it for use by ground troops against aircraft, cruise missiles, and other emerging battlefield aerial threats, as highlighted by the mid-August 2025 agreement between RTX's Raytheon and Diehl Defence to expand Stinger production in Germany. [RTX]

Time as a weapon – resilient PNT in the age of NAVWAR

Alix Valenti

Modern navies depend on fragile satellite signals for everything from navigation to weapon systems. As jamming and spoofing attacks surge in contested waters, Navies are racing to build layered defences against the growing threat of navigation warfare (NAVWAR).

"To master time is to master position – and with it, navigation," said Maxime Gorlier, Head of Safran's positioning, navigation, and timing (PNT) Business Unit. Rulers in the 16th, 17th- and 18th centuries understood this well. In their race to dominate distant lands and their resources, they dangled vast prizes for anyone who could solve the 'longitude problem'. It was John Harrison, driven by the GBP 20,000 reward (worth millions today) promised under Britain's Longitude Act of 1714, who delivered the breakthrough: a mechanical clock precise enough to let mariners fix their position by comparing the heavens to their time charts.



AUTHOR

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That legacy lives on in the atomic clocks orbiting Earth today. They are the atomic anchors of the satellite constellations that keep global time and guide naval fleets. The 'T' in PNT may sit at the end of the acronym, but it underpins everything: from navigation and communication, to weapon systems and drones; without timing, missions collapse. Yet these signals are fragile, and as great-power competition intensifies, time itself has once again become the contested terrain of NAVWAR.

Why timing rules the seas

As David Barrie notes in *Sextant - A Voyage Guided by the Stars and the Men Who Mapped the World's Oceans*: "Celestial navigation would be easy if the sun and all the other heavenly bodies stood motionless in the sky." From the 14th to the 19th century, astronomers and scientists wrestled with this problem: how could mariners use time to determine their position when far from land, navigating a restless cosmos of shifting earth rotations, lunar cycles, and planetary motions? Today, timing goes well beyond the need to navigate the skies to conquer the seas. Global navigation satellite systems (GNSS) – and their atomic clocks – are at the core of naval operations.

In 1714, John Harrison solved the 'longitude problem' with the development of his mechanical clock. [National Maritime Museum, Greenwich]

"If timing is corrupted or malfunctioning it could have a big knock-on effect to other systems," Adam Price, Vice President PNT Simulation at Spirent Communications, told ESD. Timing is coordination: of onboard systems, of weapon systems, the fleet itself. If a ship's clock drifts by just a few seconds, a missile may miss its target, or an ally may lose track of its position relative to the group.

That reliance will only deepen. As Michel Monnerat, Director of Bids & Advanced Projects in Navigation at Thales Alenia Space, explained, navies are increasingly turning to unmanned systems (UxVs) to scout, sense and strike. For them, precise PNT is indispensable, enabling autonomous navigation, communication and coordination. "There's a natural, historical link between satellite navigation and the maritime domain," Monnerat noted, adding, "That link is more important today than ever." But anything this central quickly becomes a target, and in today's strategic environment, PNT is no exception.

NAVWAR – turning time into a battlespace

Enter NAVWAR, now a key attack and defence vector, precisely because so much naval infrastructure relies on PNT. "Incapacitating an adversary by denying them the time reference, and therefore impairing key systems, means gaining combat advantage across the battlespace," Price explained.

Pictured: Artist's impression of that Galileo constellation. PNT signals underpin everything, yet these signals are fragile, and hence vulnerable to NAVWAR threats. [Thales Alenia Space]

GNSS constellations (GPS, Galileo, GLONASS, BeiDou, etc.) orbit in medium Earth orbit (MEO), about 20,000 km up. By the time their signals reach sea level, they are already faint. At sea, they are further distorted by weather and ocean-surface reflections, and they are highly vulnerable to hostile action: jamming and spoofing.

Jamming involves overpowering a weak satellite signal with a stronger, localised signal, resulting in a total loss of the PNT signal, often indicated by a receiver displaying "No Fix" or "Acquiring Satellites". "Jamming has become much more common in the past few years because the technology required is cheap and easily accessible," Monnerat explained. In May 2025, for instance, the UK Maritime Trade Operations reported multiple GPS disruptions around the Red Sea, and the container ship MSC Antonia even ran aground after its GPS was jammed.

Spoofing, a more insidious and dangerous threat, involves transmitting false, deceptive GNSS-like signals to trick a receiver into providing an incorrect position, velocity, or time. Unlike jamming, spoofing provides a false sense of security, as the receiver may continue to function with seemingly valid, albeit erroneous, data. It is also more complex, requiring intimate knowledge of the signal one seeks to mimic.

"There can also be man-in-the-middle attacks," Price warned, "where an attacker hacks the least-protected system relying on PNT and, from there, compromises the ship's entire capability." PNT is therefore a cyber vulnerability as much as it is a space and radio frequency (RF) vulnerability.

Decades of reliance on single-constellation GNSS have left navies with a strategic vulnerability, one that adversaries are now probing in earnest, under the banner of NAVWAR. Just as Harrison's clock gave mariners redundancy against the chaos of the heavens, today's navies are searching for new layers of assurance against the chaos of NAVWAR. These layers fall broadly into two categories: hardening the signal (protect and toughen) and diversifying it in orbit (augment).

Layer 1: Hardening the signal

While none of these threats are new, the resurgence of great-power competition and recent incidents in the Red Sea have made them far more frequent. For navies, the first line of defence is to toughen and protect their systems against jamming and spoofing – Layer 1.

Encryption is central, and both the US and Europe continue to develop new signals to harden GPS and Galileo against interference and spoofing. For the US, this builds on the M-Code, part of the ongoing GPS modernisation programme. Transmitted through a high-gain directional antenna, it boosts signal strength by around 20 dB and makes jamming far more difficult. A limited capability has existed since the Block IIR and IIF satellites launched between 2005 and 2016, 19 of which remain operational, while greater coverage comes with the Block III satellites, the first of which went up in 2018 – four are now active.

The GPS Block III will bring greater M-Code capability to armed forces. [US Space Force]

A September 2024 GAO report, however, noted that the Navy had intended to have a functioning M-Code receiver card installed on its *Arleigh Burke* test ship by that date, but no such testing appears to have taken place. As the GAO put it: "To mitigate some of these delays, the Navy and Air Force are planning an interim solution that would provide M-Code capability with some of their current receivers."

There is no publicly available information on whether European Allied navies are making better progress in their integration of M-Code cards in their receivers. Germany has already received M-Code receivers, and industry players such as BAE Systems, Collins Aerospace and Safran can supply the technology. Yet given US delays, there is little pressure for Europe to rush integration.

Europe is instead betting on Galileo's Public Regulated Service (PRS), an encrypted, interference-resistant signal reserved for government users such as navies, coast guard and police. "But there is one critical difference," noted Michel Monnerat of

Thales Alenia Space: "it has been designed to sustain several governmental usages and is also ready to operate in times of crises when access to other navigation services may be degraded – something that adds to its complexity."

Galileo PRS has been live since 2016, and is about to become fully operational, but receivers are still being fielded. Under the Galileo for EU Defence (GEODE) programme, 30 companies from 14 European countries are developing standardised military PRS receivers, with demonstrations planned for 2026. In March 2025, Leonardo unveiled the first pan-European certified PRS receiver, but integration aboard naval platforms has not yet been confirmed.

Beyond strengthening the signal, navies can also protect it. Controlled Reception Pattern Antennas (CRPAs) add agility: multiple antenna elements adjust dynamically to block interference. They can 'null' the direction of a jammer or steer towards genuine satellites, especially when paired with sophisticated algorithms such as Safran's Interference Detection Mitigation (IDM). The trade-offs are size, weight, power, and cost – but for naval platforms, the added resilience often outweighs the cost.

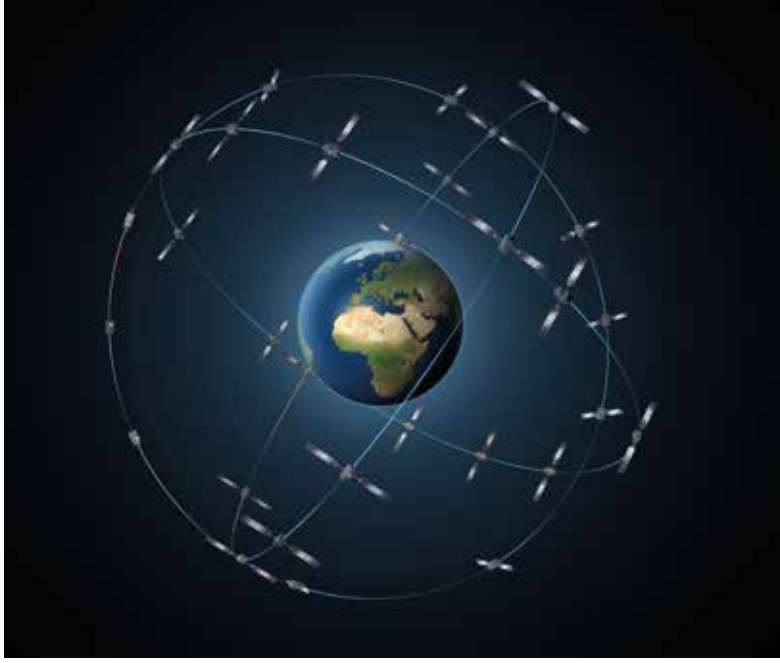
Yet protecting the signal is only half the battle. Navies are also working to diversify where those signals come from, adding redundancy in orbit.

Layer 2: Bring redundancy in orbit and autonomous navigation at sea

In addition to protecting and toughening, both Europe and the US are working to augment their GNSS constellations through the development of low Earth orbit (LEO) constellations – both GPS and Galileo being MEO constellations.

LEO constellations provide several benefits. At 500–1,200 km altitudes versus 20,000 km for MEO, their signals arrive hundreds of times stronger. They also move faster, circling the Earth in 90 minutes. That speed and power make them harder to jam or spoof and provide a back-up layer for navies reliant on GNSS.

LEO satellites are also quicker to develop and launch. As Xona Space Systems and Thales Alenia Space both note, the weakness of traditional space systems is the long cycle time: threats identified today may only be addressed by satellites launched a decade later, at huge cost. "What we want are small satellites complementing Galileo MEO that can be built quickly. If someone attacks, we can reinforce the space segment with enormous reactivity," explained Monnerat. "With simpler technologies and a flexible production chain, we can put replacements into orbit much faster and strengthen the system when it's needed."



▲ **The full Galileo constellation: orbiting 20,000 km above Earth, its signals arrive faint and vulnerable. [ESA]**

To that end, the European Space Agency (ESA) is leading the LEO-PNT in-orbit demonstrator mission. Approved by the ESA Council at ministerial level in 2022, the LEO-PNT in-orbit demonstrator mission involves two prime industrial partners – GMV (Spain) and Thales Alenia Space (France) – each developing a 'Pathfinder A' (one satellite plus a spare) and four 'Pathfinder B' satellites, bringing the total to 12. The full demonstrator is due in orbit by 2027. To meet this schedule, ESA signed a launch agreement with GMV, Thales Alenia Space and Rocket Lab: an Electron rocket will lift the first two satellites from New Zealand to 510 km in the sky in a three-month window beginning in mid-December 2025 – giving just two years from programme launch to the full demonstrator's first orbit.

Across the Atlantic, the US is pursuing a different model: multiple commercial partners building redundancy into GPS from LEO. The U.S. Space Force is also running the Resilient GPS (R-GPS) programme, a constellation of smaller, more affordable satellites intended to resist interference and jamming. The first eight are scheduled to launch by 2028. Alongside, the US Air Force and Space Force are nurturing a broader ecosystem of commercial LEO-PNT ventures.

▶ **The LEO PNT constellation's full demonstrator is due in orbit by 2027 and will augment the Galileo MEO constellation. [Thales Alenia Space]**

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MITTLER REPORT

Private industry is already making headway. Xona Space Systems, for instance, is developing its own constellation and on 20 June 2025 launched Pulsar-0, its first production-class LEO satellite – just over a year from partnership signing to launch! In the coming months Pulsar-0 will demonstrate centimetre-level accuracy, signal authentication, jamming resistance, and even penetration into denied spaces like reinforced buildings or urban canyons. Crucially, it has been designed to deliver these capabilities via firmware updates to existing GPS-enabled devices. "Pulsar combines centimetre-level accuracy, high signal power, and robust protection into a single capability that's usable by the billions of GPS-enabled devices people already have," Luca Iuliani, Xona's Director of Product, told ESD.

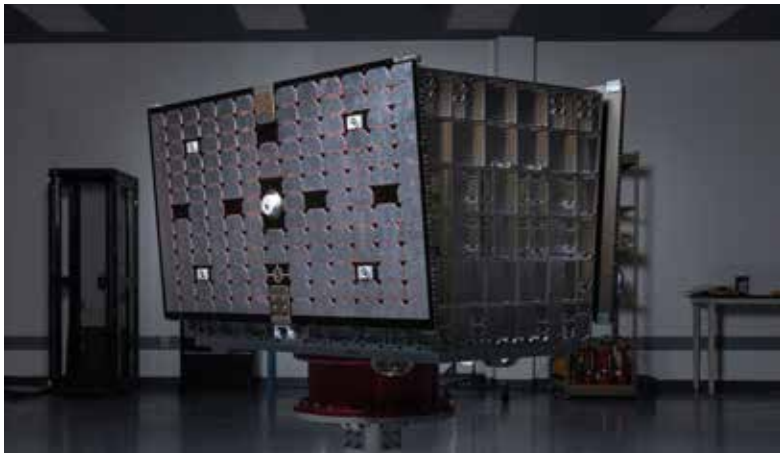
Yet LEO is not without challenges, as Adam Price explained, their speed introduces Doppler shifts (like the changing pitch of a passing siren), which complicates tracking and forces receivers to switch constantly. Their small form factor also means they lack the precise atomic clocks carried by MEO satellites. However, evidence is now showing credible steps forward to overcome many of these technical hurdles.

This is why navies favour layered approaches. LEO offers resilience, but it is not invulnerable. Non-satellite systems remain an important hedge, and alternate, autonomous solutions are key to augment overall PNT resilience. Safran, for example, has developed compact dual-core hemispherical resonator gyroscopes (HRGs) that double sensors on each navigation axis, boosting precision without adding bulk. Combined with atomic clocks and IDM algorithms, these systems allow platforms to switch autonomously and seamlessly to pure inertial navigation when GNSS signals are jammed or spoofed. For timing, this shield is just as vital: atomic clocks and oscillators ensure the mission keeps ticking, even when satellites fall silent.

The next frontier: Quantum, AI, and the future of naval PNT

Looking ahead, quantum technologies are set to bring significant advances to satellite PNT – from sensors that enable precise magnetometry mapping to quantum inertial sensors. However, as Gorlier noted, such technologies are unlikely to reach industrial maturity before 2040. In the meantime, the company is investing in hybrid approaches, combining mature inertial systems, vision-based navigation, and emerging quantum techniques – a reminder that resilience in PNT is never single-layered, but always built with redundancy in mind.

Companies like Xairos are pushing the frontier further. Their systems use entangled photons to transfer time with extreme precision and inherent security, synchronising clocks across ships, drones and networks to within a few picoseconds, even in contested RF environments. "What we're doing at Xairos is leveraging quantum technologies to deliver very secure and very accurate time transfer – exactly what GPS was designed to do, but with far greater resilience," David Mitlyng, CEO of Xairos, told ESD. For navies, the appeal is clear: trusted timing that cannot be jammed or spoofed. While the hardware remains bulky today, rapid progress in miniaturisation points toward compact, ruggedised systems and, ultimately, a global 'time-as-a-service' network with both military and civilian applications.



▲ **Xona Space Systems is developing its own constellation and, on 20 June 2025 launched Pulsar-0, its first production-class LEO satellite. [Xona]**

This vision is not just theoretical. In late 2024, Xairos took part in the KiQQer demonstration in The Netherlands, distributing entangled photons over a hybrid fibre and free-space link with picosecond-level synchronisation. Its work has also been endorsed by ESA's NAVISP programme, which is backing future quantum time-transfer architectures. These milestones show quantum timing moving from the lab to the field, making the future feel a lot closer.

Artificial intelligence (AI) will also play a role, both in detecting jamming and spoofing attempts and in switching seamlessly between signals and sources. AI is not a panacea, but it could dramatically cut the time a ship might otherwise spend without GNSS coverage.

As Jerry Brotton writes in *Four Points of the Compass: The Unexpected History of Direction*: "[The blue dot indicating one's position on digital maps] is now the most extreme expression of a long history of egocentric mapping... We just want to move as quickly and conveniently as we can, as the cardinal directions wither away." For citizens, navigation has become about position alone, time forgotten. Navies, however, cannot afford that luxury. Harrison gave navies the clock. Today, with NAVWAR on the rise, time itself is a battlefield.

▼ **Safran's compact dual-core hemispherical resonator gyroscope (HRG) features dual sensors on each navigation axis, boosting precision without adding bulk. [Safran]**

SATURN rising

Dr Thomas Withington

Two legacy tactical communications systems, which have been mainstays of NATO and Allied nations for decades, are gradually making way for the SATURN waveform.

▲ **The SATURN waveform includes several important improvements vis-à-vis legacy systems, one of which is the ability to carry J-series NATO tactical datalink traffic. The carriage of J-series messages helps to improve synergies between Allied air, land and maritime forces. [US DoD]**

The Second-Generation Anti-Jam Ultra High Frequency Radio for NATO is perhaps unsurprisingly better known as SATURN, given the clumsiness of the appellation. Unlike the eponymous planet, which is around 4 billion years old, the SATURN waveform is more recent, coming into being when NATO published its Standardisation Agreement 4372. Known as STANAG-4372, the agreement was adopted by the Alliance on 1 January 1992. STANAG-4372 effectively outlines the engineering requirements for radios to be able to transmit and receive traffic using the waveform. The STANAG is secret and likely includes specifications regarding the waveform's communications/transmission security (COMSEC/TRANSEC) arrangements, among other factors. Despite the standardisation agreement remaining outside the public domain, details of its design are freely available in the public domain. SATURN's design features are discussed in more detail below.

Nonetheless, before discussing SATURN it is necessary to understand the waveform's heritage, which in turn explains its attributes. NATO forces use a bewildering array of radio waveforms for surface-to-surface and air-to-surface/surface-to-air tactical radio communications. A waveform refers to the characteristics a particular radio signal must have to perform a particular set of tasks. For example, if the radio signal is to transmit data at a comparatively slow rate using encryption, it will have different characteristics compared to a radio signal transmitting data at a high rate *en clair*. To use an analogy involving one's cell phone, the radio signal transmitting a text message will have unique characteristics compared to a signal carrying a voice call. Today's military radios are software-defined systems, which means that the operator can instruct the radio to perform a particular function, such as to report the position of the soldier using the radio, at the touch of a button. Like radios used in the civilian world, a tactical radio can be tuned to a particular frequency in much the same way. Prior to the arrival of software defined radios (SDRs) in the 1980s and 1990s, users would have to physically tune the radios according to the signals they wished to transmit or receive.

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What came before

To understand SATURN's significance, it is worth taking a quick canter through the history of NATO and Allied tactical radio waveforms. The seminal Single Channel Ground and Airborne Radio System (SINCGARS) began to proliferate across US and Allied forces from the late 1980s. SINCGARS was not a waveform per se; instead, it was a family of tactical radios, around 20 in total, designed with certain characteristics. SINCGARS radios used very-high frequencies (VHF) of 30 MHz to 87.975 MHz. The radios could produce between 5 W and 50 W of transmission power according to the transceiver type. As official US Marine Corps (USMC) documents describing the SINCGARS architecture make clear, 5 W radios could be used in backpack and vehicular configurations. 50 W radios tended to be solely vehicular designs.

▼ **SINCGARS was originally envisaged as a family of radios with specific capabilities, chiefly comprising backpack and vehicular transceivers such as those seen occupying the central console of this US Army AM General High Mobility Multipurpose Wheeled Vehicle. [US Army]**

SINCGARS signals typically achieve surface-to-surface ranges of between 200 m up to 10 km. By adding a power amplifier, some of the 50 W vehicular radios can achieve ranges of circa 40 km. Each SINCGARS radio can be programmed with up to eight single-channel frequencies, which lets the user occupy eight separate channels. Each SINCGARS channel was designed to be 25 kHz wide. Given SINCGARS' 57.975 MHz of frequency bandwidth, a total of 2,319 channels to be hosted on a single, deployed SINCGARS network when using the entire frequency bandwidth. The radio's single channel mode was not resistant to communications jamming. Once an adversary had determined which frequencies were being used, had positioned a jammer within range of the targeted radio, and had begun their attack, the targeted transceiver would be unable to use the targeted frequency. To safeguard against such attacks, SINCGARS radios were also designed with a frequency hopping (FH) mode.

A SINCGARS radio could be loaded with a transmission security key (TSK), which would detail the wavebands and frequencies that the radio's transmissions would hop across. As the USMC document continues, hopping would be performed in a pseudo-random sequence. All the radios in the local networks would be issued with the same TSK so their FH schemes would match. Without the TSK, the radio would only send or receive a mess of garbled signals which it could not assemble into coherent traffic.

SINCGARS radios, many of which remain in service today, were chiefly designed for voice communications. Nonetheless, these transceivers could carry data, albeit at modest speeds of up to 16 kbps. Interestingly, SINCGARS radios have been supplied by the US to Ukrainian forces since Russia's annexation of Crimea and the subsequent Donbas War in 2014. Despite the age of the SINCGARS' architecture design, these radios have acquitted themselves well in the face of robust Russian communications jamming. In 2017, the US Army's Programme Executive Office for Command, Control, Communications and Networks (PEO C3N) began updating the architecture based on lessons learned from Ukraine. A key part of this modernisation is the incorporation of the US National Security Agency's AES-256 advanced encryption standard into SINCGARS radios. AES-256 provides additional COMSEC/TRANSEC beyond the FH functions in the form of encryption.

The US Army is performing an extensive upgrade of the SINCGARS radio system based on lessons learned from the war in Ukraine. [US Army]

SINCGARS was essentially a family of radios which had the accompanying signal performance characteristics 'baked' into them. Since SINCGARS was developed, these characteristics have been subsequently enshrined in software. This software can be loaded into later-generation SDR radios to allow them to communicate with legacy SINCGARS transceivers using signals that the latter can handle. This approach has allowed handheld radios with the appropriate software to inhabit SINCGARS networks. This is important if a dismounted squad commander wants to maintain contact with a vehicle equipped with a legacy SINCGARS radio, for example.

As the PEO C3N's work indicates, SINCGARS is likely to remain in service for several years to come. For this reason, tactical radios currently being procured by the PEO C3N for the US armed forces are backwards compatible with the architecture. For instance, Thales' AN/PRC-148 multi-band inter/intra team radio and L3Harris AN/PRC-163 multi-channel handheld radio can both communicate with SINCGARS systems. Enshrining SINCGARS functionality in software has effectively created a SINCGARS waveform that can be installed on both new and legacy SDRs.

SINCGARS sunset

Despite the improvements being conferred on SINCGARS, the architecture will eventually be phased out across those NATO and Allied nations using it. SATURN is destined to replace SINCGARS and will also supersede the existing HAVEQUICK-I/II surface-to-air/air-to-surface and air-to-air waveform. HAVEQUICK-I/II is of a slightly younger vintage compared to SINCGARS. HAVEQUICK-I/II was formally introduced in the US and across NATO and Allied nations from 1980. Work had commenced on HAVEQUICK-I/II in 1977 in the United States to provide UHF radios capable of voice communications with enhanced COMSEC/TRANSEC. The US Air Force (USAF) was the major sponsor behind HAVEQUICK-I/II's development. Unlike SINCGARS, HAVEQUICK-I/II was a waveform design which would be installed in tactical radios to provide the former's unique signal characteristics.

Unlike SINCGARS, HAVEQUICK-I/II provides ultra-high frequency (UHF) communications using a waveband of 225 MHz to 400 MHz. The difference between HAVEQUICK-I and HAVEQUICK-II is that the first incarnation provided single-channel communications with basic FH. Work commenced on HAVEQUICK-II in 1982 following the USAF's identification of shortcomings in HAVEQUICK-I. HAVEQUICK-II has improved FH performance as it uses a wider band of frequencies to this end and can use any one of circa 7,000 frequencies to provide channels.

According to USMC documents, users must enter a 36-digit 'Word of the Day' transmission security key into a HAVEQUICK-I/II compatible radio. The security key details the FH pattern and rate. All HAVEQUICK-I/II radios using a specific network must be synchronised with a common timing source. A source could be the position, navigation and timing signal transmitted by a global navigation satellite system (GNSS) constellation. As FH is a function of how many hops are performed over specific waveband during a specific time, a reliable timing source with which all the radios on the network can synchronise is vital. As a general rule, HAVEQUICK-I/II radios tend to use a timing signal transmitting 'Zulu Time' (more commonly known as Greenwich Mean Time).

HAVEQUICK-I/II radios and waveforms have been used extensively by Joint Terminal Attack Controllers to coordinate close air support and battlefield interdiction. HAVEQUICK-I has largely been superseded by the improved HAVEQUICK-II waveform which remains in service across NATO and Allied nations. [US DoD]

Like SINCGARS, the characteristics of the HAVEQUICK-I/II waveform has been enshrined in software that can be loaded into SDRs to allow them to send and receive HAVEQUICK-I/II traffic. Official documents seen by the author say the original HAVEQUICK-I waveform has largely fallen out of use. HAVEQUICK-II is now the standard NATO/Allied waveform for surface-to-air/air-to-surface and air-to-air communications. As such, HAVEQUICK-II compatible radios are extensively used by joint terminal attack controllers. HAVEQUICK-I/II traffic is not encrypted. The waveform's FH is intended to provide some electronic counter-countermeasure resistance against communications jamming.

Replacing legacy waveforms

SATURN partially emerged from an abortive effort by the US Air Force (USAF) to replace the HAVEQUICK-I/II waveform, with HAVEQUICK-II forming the initial basis for the SATURN architecture. The resulting SATURN STANAG-4372 was drafted by the United States later being ratified by NATO in 1992. As an analysis by Forecast International noted, budget constraints forced the US to withdraw from the initiative, which ultimately ended the USAF's involvement with the SATURN project as its sponsor. Fortunately, the programme was adjusted and the USAF transferred SATURN's technological specifications to NATO. The USAF also stated it would adopt SATURN as a replacement for HAVEQUICK-II once the STANAG was ratified.

STANAG-4372 instructs radio engineers on the parameters of the SATURN waveform so that transceivers can be configured to send and receive traffic using this capability. Sources at Rohde and Schwarz shared with the author that thousands of radios in service across NATO and Allied nations have already installed the waveform. NATO members, the United States among them, are mandated to implement SATURN for surface-to-air and air-to-surface communications. The sources continued that users may perform all the functions with SATURN that they can currently with HAVEQUICK-I/II and SINCGARS. Unlike SINCGARS and HAVEQUICK-I/II, SATURN can carry Link-22 tactical information. Link-22 is a NATO standard tactical data link chiefly used to support maritime operations. The link can move track and tactical information across frequencies of 2 MHz to 29.9 MHz and 225 MHz to 399.975 MHz. Link-22 traffic is enclosed in the same J-series format messaging as the NATO and Allied Link-11 and Link-16 Tactical Datalinks (TDLs). These latter TDLs support maritime and air operations respectively. Enabling J-series message carriage across SATURN will improve the interoperability of air, land and maritime forces at tactical and operational levels.

Timetables for the gradual retirement of SINCGARS and HAVEQUICK-I/II, and their replacement with SATURN, have not been made public, but it is possible that this process could begin over the next two years. [US Army]

Improved performance

Unlike the early days of SINCGARS, SATURN is designed to be radio-agnostic, the Rohde & Schwarz sources added, and can be 'loaded' into a radio based on the stipulations of STANAG-4372. Ostensibly, SATURN is designed to work in the same 225 MHz to 400 MHz waveband as HAVEQUICK-I/II. Nonetheless, the Rohde & Schwarz sources continued that they have performed tests using the SATURN waveform in the VHF waveband of 30 MHz to 300 MHz saying that it "would work just fine there".

A major change is that SATURN will "be significantly more robust in jammed environments" the same sources say. The waveform has improved COMSEC/TRANSEC vis-à-vis the legacy systems discussed in this article. Details of these COMSEC/TRANSEC techniques have been understandably vague; one technique which has been revealed is the waveform's fast FH. A lesson learned from the battlefields of Ukraine is that some FH configurations can be detected with relative ease. Once a FH signal has been determined, the waveband it is hopping across can be attacked by jammers in range of the radios using it. Increasing the hop rate, and widening the waveband used therein, makes it more difficult for EW practitioners to detect and jam the associated frequencies and/or wavebands.

SATURN will eventually supersede both HAVEQUICK-I/II and SINCGARS. It is known that SATURN has already been used operationally by NATO nations, although the exact particulars of this remain classified. Other sources have said the drawdown of SINCGARS and HAVEQUICK-I/II could commence over the next two years. Both SINCGARS and HAVEQUICK-I/II have had illustrious histories and continued to work well despite their age. SATURN may have a similarly long career. It is also possible that EW cadres in potentially hostile states such as Russia and the People's Republic of China may eventually ascertain how to successfully attack SINCGARS and HAVEQUICK-I/II. Hopefully by then, NATO and Allied nations will have already embraced the more advanced SATURN waveform. At that point, jamming SINCGARS and HAVEQUICK-I/II may simply be a waste of effort.

Tactical ISR solutions

Alex Tarasov

Intelligence, surveillance, and reconnaissance (ISR) represent the most critical and rapidly developing capabilities in many modern armies. ISR also forms a key foundation of modernisation efforts planned for the 2030-2040s. Many significant changes in ISR capabilities concentrate at the tactical level and are either already under way or planned for deployment in the near future.

The ISR segment and related sectors have been among the most dynamic over the past decades. According to Global Market Insights, the global ISR market is valued at USD 42 billion and is expected to grow at a compound annual growth rate (CAGR) of 5.6% from 2025 to 2034. In turn, the global market for military sensors alone was estimated at USD 12.5 billion in 2024, according to Research and Markets. By 2030, it is projected to reach USD 17.8 billion, reflecting a CAGR of 6.1%. A significant share of this market is represented by the land domain, which is projected to grow to USD 6.6 billion by 2030 at a CAGR of 6.6% – almost as much as the airborne segment, which has a projected CAGR of 6.9%. The main drivers have been large-scale modernisation efforts undertaken by major armies worldwide, coupled with significant advances in technology and shifts in tactics.

▲ The US Army's Terrestrial Layer System – Brigade Combat Team (TLS-BCT) mounted on a Stryker 8×8 vehicle. This system is designed to support troops in multi-domain operations. [US Army]

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This trend emerged in the 1990s with theoretical foundations largely shaped by such concepts as the system of systems and network-centric warfare, which later evolved into the modern multi-domain warfare doctrine and related approaches. At their core, these concepts envisioned a large-scale (often Army-wide) joint system in which sensors, commanders, and shooters across all domains (land, naval, air, cyber, space, and the electromagnetic spectrum) were linked by a network. This allowed them to receive real-time data, process it, and rapidly disseminate it, thereby accelerating the 'sensor to shooter' (STS) cycle.

In the 2000s, technological advances in fields such as microelectronics, miniaturisation, connectivity and networking, and robotics facilitated the transformation of theory into functioning ISR systems or their components, which were tested in the armed conflicts of the 2010s. As production and implementation costs dropped, more sensors of all types were deployed at every level – strategic, operational, and tactical – down to individual vehicles and soldiers. This expansion created better situational awareness but also introduced new challenges.

Sensors, shooters, and a lot of data

Tactical-level ISR systems operate in perhaps the most complex environment and, given the nature of tactical actions, present the most demanding requirements for both militaries and manufacturers.

The greatest concentration of sensors is found at the tactical level. These include radars, optoelectronic systems, acoustic sensors, electronic and electromagnetic sensors, chemical, biological, radiological, and nuclear (CBRN) sensors, among others.

All these tactical-level sensors generate vast amounts of raw data that must be processed, analysed, and disseminated at high speed. Speed is particularly critical for ISR at the tactical level, since it directly supports frontline commanders and units in real time on the battlefield. The information, therefore,

▼ The first Tactical Intelligence Targeting Access Node (TITAN) prototype is being transported to Joint Base Lewis-McChord, Washington State, March 2024 [US Army]

must be disseminated with high precision so that tactical commanders receive the necessary data (for example, targeting information) in time and are not overwhelmed with excessive inputs.

In addition, data collected at other levels of command or from other domains may be relevant across all three levels, which effectively increases the volume of data that must be processed and disseminated. As suggested in the Intelligence, Surveillance, and Reconnaissance Joint Doctrine Note issued by the UK Ministry of Defence, "ISR capabilities and processes are therefore best used entirely agnostic of operational domain or level of command."

Many believe the solution lies in the development and broader implementation of artificial intelligence (AI) and machine learning (ML) technologies.

An EBRC Jaguar reconnaissance combat vehicle at IDEX 2023. The vehicle is a key element of the ongoing SCORPION programme and is equipped with a sophisticated C2 and sensor suite. [Alexey Tarasov]

Tactical ISR: From AI-powered to hybrid

One of the most advanced tactical ISR systems today is the Tactical Intelligence Targeting Access Node (TITAN), developed by Palantir Technologies. TITAN is a next-generation tactical ISR ground station capable of collecting data from sensors deployed across space, high-altitude, aerial, and terrestrial layers, and rapidly processing it using AI and ML. The system provides intelligence support – such as situational awareness and accurate targeting data – to recipients at the tactical level.

According to the manufacturer, TITAN is designed to reduce sensor-to-shooter timelines while alleviating soldiers' workload and cognitive burden. TITAN will also absorb the functionality of four legacy systems currently used by the US Army:

1) the Advanced Miniaturized Data Acquisition System (AMDAS);
2) the Dissemination Vehicle (ADV);
3) the Advanced Remote Ground Terminal (RGT);
4) the Tactical Intelligence Ground Station (TGS).

This consolidation has the potential to reduce operational and administrative costs while providing greater system commonality. Another interesting capability mentioned by the manufacturer, and perhaps reflecting one of the US Army's requirements, is TITAN's ability to operate on the move.

In March 2024, a USD 178.4 million contract for the development and delivery of ten TITAN prototypes (five Advanced and five Basic variants) was awarded to Palantir Technologies. The first two TITAN systems were delivered to the US Army in March 2025, according to Defense News.

The TITAN system is considered a key enabler of the Army's modernisation priorities in support of the Army Cross-Functional Teams. In the future, it is expected to complement the Distributed Common Ground System–Army (DCGS-A), which will remain the backbone of Army intelligence at the higher levels (division and corps), while TITAN will be deployed at the tactical level, partially replacing DCGS-A's forward elements.

Israel is conducting research and development in the same direction, with one of the systems being ELTA's ELS-8994 StarLight–a cloud-based solution powered by AI and ML. The system is designed to process vast amounts of unstructured data from multiple types of sensors – including SAR/GMTI radars, SIGINT, optical, video, and others – and transform it into actionable intelligence and insights for warfighters and commanders. In August 2023, Israel Aerospace Industries' (IAI) Heron UAV, integrated with StarLight AI, was deployed for surveillance missions.

European countries largely follow the same trajectory in developing and integrating tactical ISR systems. France, for example, continues its large-scale Army modernisation programme, SCORPION, where enhancing situational awareness through the implementation of new technologies at the tactical level is considered one of the pillars of Army transformation vital to 'retaining the initiative'.

One of the key components of the French Army's SCORPION programme is the Scorpion Combat Information System (SICS), which replaces legacy command and control (C2) systems. While not identical in scope to the US Army's TITAN, SICS likewise connects sensors, shooters, and commanders, enabling network-centric warfare at the tactical level. AI technology has been integrated into the Scorpion collaborative combat system and its planned future extension, TITAN 2040.

In parallel with large-scale programmes involving AI and ML, many smaller-scale or hybrid mission-tailored solutions are also being developed. While these solutions often incorporate components of a full-fledged tactical ISR system, they are not specifically designed as dedicated ISR tools.

A Planshet-M-IR system mounted on a Patrul-A armoured vehicle [High-Precision Systems]

An example is Rostec's Planshet-M-IR artillery fire-control system (an improved next-generation version of a Planshet-A), which can receive battlefield data from various sensors – such as radars and UAVs – process it, and relay targeting information to artillery units or systems ranging from mortars to multiple launch rocket systems (MLRS). According to Rostec, an artillery unit commander can receive battlefield data in real time by using Planshet-M-IR in conjunction with reconnaissance UAVs, adjust fire, and exchange information with higher-level commanders via a secure satellite communications channel.

While designed for a specific mission, the Planshet-M-IR and other systems of similar scale and scope have the advantage of lower complexity in production and implementation, allowing for faster deployment. The Planshet-M-IR is currently in serial production, with at least two batches delivered to the Army.

Alongside smaller, mission-tailored solutions, in 2024 the Russian defence industry began developing the 'Svod' system. This is a system designed to enhance situational awareness at the tactical level – a task highlighted as one of the top priorities by Russia's Minister of Defence, Andrei Belousov, during a session of the Ministry of Defence Collegium on 29 August 2025. According to him, the 'Svod' system is scheduled for trial operational deployment between September and November 2025, after which it will be scaled across all Russian Army formations. Although no further details have been disclosed, the scale and pace of implementation suggest that Russia is placing particular emphasis on this programme, which may be designed as a large-scale system comparable in functionality to those fielded by the US Army.

Key Challenges

There is broad recognition that the new generation of tactical ISR solutions remain a top priority for any nation seeking to keep its army relevant in conflicts with peer or near-peer adversaries. At AUSA conference in October 2024, Secretary of the US Army, Christine Wormuth, emphasised that the Army needed to "see and sense more, farther, and more persistently at every echelon than the nation's enemies" in order to prevail on the battlefield.

At the same time, the development, integration, and operational deployment of modern tactical ISR systems pose significant challenges. Budgetary and resource constraints, implementation difficulties, high risks from adversary actions across multiple domains, as well as data overload and processing bottlenecks are among the major issues.

Developing a full-fledged system that meets all the requirements of modern combat is both expensive and time-consuming, even for nations with the necessary technological and industrial capabilities. Many

Planshet-A artillery command and control system mounted on VPK's Atlet armoured vehicle. [Alexey Tarasov]

technologies, such as AI and ML, remain immature for military use, require extensive testing, and are still not widely available. At present, the majority of AI- and ML-powered tactical ISR systems remain in the prototyping stage and have seen only limited deployment.

Implementation is another challenging area. New generations of tactical ISR systems often have to operate alongside legacy platforms, which increases overall system complexity and drives up interoperability challenges, integration burdens, and maintenance costs.

From an operational standpoint, tactical ISR systems rely heavily on secure and stable communications. Yet, these systems and their components are among the most valuable targets at the tactical level, facing significant threats from electronic warfare, cyber-attacks, and kinetic strikes such as artillery or other fires. To mitigate these risks, they must be designed for survivability and resilience – affordable, replaceable, and distributed to avoid single points of failure – ensuring continuity of operations in contested environments.

Finally, tactical ISR systems, regardless of their scale, purpose, or technical complexity, will be at the forefront of changes driven by rapidly evolving technologies and tactics. This trend is expected to increase over time as these systems continue to proliferate.

Closing thoughts

Given the general direction in which ISR systems are evolving, as well as lessons learned from modern armed conflicts, a tactical ISR solution can be described as follows: scalable, command- and platform-agnostic, capable of collecting data from multiple types of sensors, and customisable to mission or end-user requirements, ideally incorporating AI and ML capabilities.

Countries possessing sovereign industrial capabilities to develop these systems may gain a significant competitive edge, while others may need to rely on partners or adopt less costly hybrid systems with only partial capabilities.

However, overreliance on data, systems, and infrastructure provided by foreign countries can pose significant security risks. For example, Ukraine depends heavily on satellite intelligence and communications systems of foreign origin, which, while enhancing operational capabilities, also creates vulnerabilities in the event of denial, disruption, or political restrictions.

This reliance could introduce operational limitations and interoperability challenges in future conflicts, highlighting the strategic importance of investing in sophisticated tactical ISR technologies.

The US Army's search for new self-propelled artillery: A long haul for long guns

Peter Felstead

More than six decades after the M109 entered service and following a series of cancelled replacement programmes costing billions, the US Army is once again seeking a new self-propelled artillery system, but the path forward remains uncertain.

At the Association of the US Army (AUSA) exposition in Washington, DC, in October 2025 numerous artillery system manufacturers will present – just as they were at AUSA 2024 – their prospective solutions for the US Army's Self-Propelled Howitzer Modernization (SPH-M) programme.

However, despite the Army having previously indicated that an SPH-M request for proposals (RFP) was set for February 2025, it appears that no real progress with the programme will happen before 2026.

The long road to SPH-M

The US Army's current tracked SPH, the M109, first entered service in 1963 and has been progressively upgraded since then, with the latest variant, the M109A7, having entered in April 2015. Efforts to find a replacement system, however, go back to 1994, when the US Army began to develop the Crusader 155 mm SPH. This project was then cancelled in May 2002 when then US defence secretary Donald Rumsfeld determined that future enemy threats did not require the Crusader and other emergent technologies should be prioritised.

From 2003 the Army then began to develop the Non-Line-of-Sight Cannon (NLOS-C) as part of its Future Combat System (FCS) family of FVs, but the whole FCS programme was cancelled in 2009 due to concerns over affordability and technological readiness and amid a preoccupation with the counter-insurgency campaigns in Iraq and Afghanistan that the Army was fighting at the time. Overall the FCS programme had little to show for a total of USD 32 billion spent (EUR 24 billion at the time).

The ERCA autoloader being tested at Yuma Proving Ground in June 2019. Although the US Army conducted a number of successful tests with ERCA prototypes, engineering issues, such as excessive wear on the 58-calibre gun tube after firing a relatively small number of rounds, led to the ERCA prototyping effort's discontinuation in April 2024. [US Army]

More recently, in 2018, the US Army embarked upon the Extended Range Cannon Artillery (ERCA) programme, the prime intention of which was to extend the US Army's reach with SPHs from 30 km to 70 km. With this in mind the ERCA prototypes comprised a US Army-developed 155 mm L58 gun turret mounted on an M109A6 Paladin Integrated Management (PIM)/M109A7 platform.

In parallel to the ERCA effort, back in July 2020 the US Army issued an RFP for a 155 mm Wheeled Gun System (WGS) as a faster, lighter and more mobile alternative to the M109A6 Paladin. The intention here was to provide a mobile 155 mm platform that could provide organic artillery support to the Army's wheeled Stryker Brigade Combat Teams (SBCTs).

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The latest version of the BAE Systems Bofors Archer 155 mm wheeled SPH, as ordered for the Swedish and British armies, uses an RMMV HX2 8×8 truck, but for US Army requirements BAE Systems could offer the system mounted on a 10×10 Oshkosh chassis. [BAE Systems]

This led to a shoot-off in 2021 involving the BAE Systems Bofors Archer system, the ATMOS 2000 from Elbit Systems USA, the CAESAR system from France's Nexter, the NORA B-52 system from Serbia's Yugoimport-SDPR, and a sole purely US candidate in the form of the Brutus system, which was jointly developed by AM General and Mandus Group and mates a low-recoil 155 mm M776 gun with a Family of Medium Tactical Vehicles (FMTV) 6×6 truck.

Under the ERCA programme the Army conducted a number of successful tests with prototypes; in December 2020, for example, at Yuma Proving Ground in Arizona, one of them used an M982A1 Excalibur extended-range precision munition to achieve a direct hit at 70 km. However, engineering issues, such as excessive wear on the L58 gun barrel after firing a relatively small number of rounds, led to the ERCA prototyping effort's discontinuation in April 2024.

Meanwhile, in a US Army Fiscal Year (FY) 2025 budget estimates document published in March 2024 a new line appeared for a Next-Generation Howitzer (NGH). This system, the document stated, "will provide highly mobile, survivable, versatile, transportable, longer range fire support under a broad set of challenging operational conditions against current and emerging small- to large-scale threats through 2040 and beyond". Additionally, the document stated that the NGH "reduces emplacement and displacement times, provides increased crew survivability and better cross-country mobility, adds overall effectiveness, and affords improved fire support capability for field artillery formations well beyond what towed howitzer systems can provide". The NGH procurement has now become known as the Self-Propelled Howitzer Modernization (SPH-M) programme.

In October 2024 the US Army awarded Other Transaction Agreement (OTA) performance demonstration contracts to five potential SPH-M suppliers: American Rheinmetall Vehicles, BAE Systems Bofors, Hanwha Defense USA, General Dynamics Land Systems and Elbit Systems USA. Those demonstrations, which began in November 2024, were intended to inform multiple SPH-M lines of effort as identified in the US Army's Cannon Transformation Strategy.

At this time Major General Glenn Dean, the US Army's Program Executive Officer for Ground Combat Systems, gave some further insight into the termination of the ERCA programme. He explained that the Army "made the decision to close out the ERCA Rapid Prototyping effort as we determined further maturation and redesign of the 58-calibre cannon was required before we could transition into an acquisition pathway". He additionally noted that the Army was "exploring a range of options within the US and internationally in order to leverage mature and available industry solutions to fulfil critical capability gaps within the Army", adding that the demonstrations "will support the Army's pivot from development to procurement of a mature, available and non-developmental system".

With regard to the SPH-M programme, as February 2025 came and went with no RFP forthcoming, it subsequently emerged that the US Army is now planning for more firing demonstrations at Yuma Proving Ground at the beginning of 2026. These are supposed to constitute a nine-month evaluation process, after which the Army intends to refine requirements and develop a more detailed procurement strategy.

The RCH 155 system takes the 155 mm L52 gun from the KNDS Deutschland PzH 2000 tracked SPH gun and integrates this with the company's Artillery Gun Module mounted onto a Boxer 8×8 multi-role armoured vehicle. [KNDS]

Lessons from Ukraine

While the US Army had already embarked on seeking a 155 mm Wheeled Gun System back in July 2020, the conduct of the war in Ukraine since Russian forces invaded in February 2022 has brought sobering lessons with regard to the vulnerability of towed artillery systems. Unable to 'shoot and scoot' like an SPH, towed systems in Ukraine have been susceptible to counter-battery fire from both hostile artillery systems and loitering munitions, given the extended times they require to redeploy.

At the AUSA Global Force 2024 symposium, held in Huntsville, Alabama, from 26-28 March that year, the head of US Army Futures Command, General James Rainey, told the audience, "I personally believe that we have witnessed the end of the effectiveness of towed artillery; the future is not bright for towed artillery."

That said, BAE Systems announced in April 2025 that it had been awarded a USD 162 million US Army contact for major titanium structures for the M777 lightweight towed howitzer, which is in current US service.

A K9A2 being put through its paces at the UK's Millbrook Proving Ground. The K9A2 features a fully automatic handling system and an automatic turret, increasing its rate of fire to up to 10 rounds per minute, compared to the K9A1's rate of six to eight rounds per minute. [Hanwha Aerospace]

Potential candidates moving forward

With the US Army yet to fully refine requirements for a new weapon under the SPH-M programme, it is hard to say whether such a system will ultimately be tracked or wheeled, although the need for a wheeled system to accompany the Stryker Brigade Combat Teams presumably remains.

With that being the case various contending systems, both tracked and wheeled, are currently being pitched to the US Army. Most obviously there are the five potential SPH-M suppliers awarded OTA performance demonstration contracts in October 2024: American Rheinmetall Vehicles, BAE Systems Bofors, Hanwha Defense USA, General Dynamics Land Systems (GDDS) and Elbit Systems USA.

In late 2024 Rheinmetall demonstrated to the US Army its 155 mm Remote Controlled Howitzer (RCH 155) system, which takes the 155 mm L52 gun from the KNDS Deutschland PzH 2000 tracked SPH and integrates this with the company's Artillery Gun Module (AGM) mounted onto a Boxer 8×8 multi-role armoured vehicle. The system offers a rate of fire of eight rounds per minute, with range dependent on the ammunition used (up to 40 km with base-bleed ammunition, up to 54 km with V-LAP ammunition or further with extended-range ammunition such as Excalibur rounds.

In recent years, meanwhile, Rheinmetall has worked with Elbit Systems to develop an automated 155 mm wheeled SPH. This system, which is ostensibly focused on European requirements, features Rheinmetall's 155 mm L52 gun and mounts it on a high-mobility HX 10×10 tactical truck. The system conducted a live-fire demonstration at the Shivta firing range in southern Israel in March 2023. Rheinmetall has stated that this platform has also been designed to accommodate its in-development L60 gun in future, which will be able to attain ranges of up to 83 km with JBMoU-compliant ammunition.

BAE Systems Bofors brought its Archer 155 mm wheeled SPH to demonstrate to the US Army in late 2024. While the system originally mounted its 155 mm L52 gun on a Volvo 6×6 articulated truck (as demonstrated to the US Army back in 2021), the latest version, as ordered for the Swedish and British armies, uses an RMMV HX2 8×8 truck, while BAE Systems also offers the system mounted on a 10×10 Oshkosh chassis, presumably with an eye to US requirements. The Archer system offers a burst rate of fire of three rounds in 20 seconds, an intensive rate of fire of 21 rounds in three minutes and a continuous rate of fire of 54 rounds in 35 minutes. The weapon's range is dependent on ammunition, but reaches 40 km with Bofors' HEER (High Explosive Extended Range) ammunition and 50 km with Excalibur rounds.

The tracked K9 Thunder SPH from what is now Hanwha Aerospace comes to the contest with significant international momentum behind it, having been selected by the armed forces of Australia, Egypt, Estonia, Finland, India, Norway, Poland, Romania, Turkey, Vietnam and, of course, South Korea.
Hanwha has so far demonstrated its tracked K9A1, but to fulfil a US Army tracked SPH requirement would offer the upgraded K9A2 variant, which first made an appearance at AUSA in 2024. The K9A2, which is set to enter service with the Republic of Korea Army in 2027, features a fully automatic ammunition handling system and an automatic turret, increasing its rate of fire to up to 10 rounds per minute, compared to the K9A1's rate of six to eight rounds per minute.

Both K9 versions can strike targets out to a range of up to 40 km with conventional ordnance, while test firings using the precision-guided 155 mm M982A1 Excalibur round projectile at the US Army Yuma Proving Ground in Arizona in April 2024 demonstrated an ability to reach targets out to nearly 50 km away. Meanwhile, the company is developing a wheeled SPH that mounts the K9A2 turret onto a Mack Truck chassis.

At the 2024 Defence iQ Future Artillery Conference, held in Paris from 21-23 May of that year, KNDS Deutschland and General Dynamics European Land Systems (GDELS) presented KNDS' unmanned 155 mm L52 Artillery Gun Module mounted on a GDELS 10×10 Piranha Heavy Mission Carrier (HMC) vehicle. This system, known as the Piranha Advanced Artillery Carrier (AAC), is what GDLS initially submitted for the SPH-M programme. However, on the opening day of the FEINDEF 2025 defence exhibition in Madrid on 12 May GDELS and KNDS unveiled a new tracked SPH called Nemesis. This pairs KNDS' Artillery Gun Module with the latest GDELS ASCOD tracked platform. The Nemesis, according to GDELS and KNDS, is highly automated and can thus be operated by a crew of two, while the KNDS Artillery Gun Module on the

The GDELS Nemesis tracked SPH (pictured) and Piranha AAC wheeled SPH, which both feature the same KNDS 155 mm Artillery Gun Module, were displayed publicly for the first time at FEINDEF 2025 in Madrid. The two systems mean that GDLS has both tracked and wheeled SPH solutions to present to the US Army. [P Felstead]

Elbit Systems' Sigma wheeled SPH, already trialled by the US Army in 2021 and 2024, is already in full-rate production for the Israel Defense Forces as the Roem system in Charleston, South Carolina. [P Felstead]

Nemesis, as on the Piranha AAC, can engage targets across a full 360°, even while on the move. The Artillery Gun Module's 155 mm L52 weapon is stated to have a maximum firing range of between 54-70 km, depending on ammunition type, and, as previously stated, offers a rate of fire of eight rounds per minute.

Elbit Systems demonstrated its Sigma wheeled SPH in 2021 and the autumn of 2024: a system that is already in full-rate production for the Israel Defense Forces in Charleston, South Carolina. Manned by a crew of three, the system is based on a 10×10 chassis supplied by Oshkosh, while its 155 mm/L52 gun has a range of up to 40 km with normal base-bleed (and further with extended-range ammunition), can fire across a full 360° and is capable of a rate of fire of up to 10 rounds per minute.

BAE Systems has partnered with the US Army Combat Capabilities Development Command Armaments Center to advance a prototype M109-52 as a low-risk, low-cost SPH solution. This combines the M109A7 SPH with the proven Rheinmetall 155 mm/L52 gun system. [BAE Systems]

Also potentially still in the mix for SPH-M is the KNDS France (formerly Nexter) CAESAR wheeled SPH, which was demonstrated to the US Army in 2021, although KNDS France did not receive a performance demonstration contract in October 2024. Although possibly regarded as not-new-enough technology for the US Army's future plans, the CAESAR system nevertheless has been adopted by several countries' armed forces and comes with positive reports of its performance in Ukraine, while in February 2022 Nexter was awarded an initial EUR 600 million contract by the French defence procurement agency (DGA) for the development and acquisition of the CAESAR 6×6 Mark II new-generation system, which has also been ordered by Belgium and Lithuania. The CAESAR 6×6 Mark II mounts its 155 mm L52 gun on a new and reinforced chassis provided by Arquus, has a rate of fire of six rounds per minute and can achieve ranges out to 55 km using extended-range ammunition such as Excalibur rounds.

Meanwhile, BAE Systems announced in June 2025 that it had partnered with the US Army Combat Capabilities Development Command Armaments Center (DEVCOM-AC) to advance a prototype M109-52 as a low-risk, low-cost SPH solution. This combines the US Army's latest-generation M109A7 SPH with the proven Rheinmetall 155 mm L52 gun system.

Upgrading the Paladins

While the US Army takes its time with considering future SPH solutions, the US Army has been funding the upgrade its fleet of M109A6 Paladin SPHs to the M107A7 standard, along with upgrading the SPH's associated ammunition carrier vehicles to the M992A3 standard.

The first low-rate initial production (LRIP) contract award for this effort was awarded to BAE Systems on 30 October 2013 after the programme was approved to enter the production and deployment phase, with the first LRIP M109A7 presented to the US Army on 9 April 2014.

BAE Systems' most recent M109A7/M992A3 contract was announced by the company on 29 May 2025, at which point the Army had converted around 300 of its original holding of 670 active Paladin M109A6s to the M109A7 standard. The Army plans to ultimately field 689 M109A7s (there are around 850 more M109A6s in storage).

The M109A7 programme, formerly known as the M109A6 Paladin Integrated Management (PIM) programme, enhances the reliability, maintainability, performance, responsiveness and lethality of the combat-proven M109A6 SPH and M992A2 ammunition carrier while providing increased commonality within the US Army's Army Brigade Combat Team (ABCT) formations.

Further implications

Should the US Army ultimately press ahead with abandoning the use of towed artillery systems, as implied by the comments of Army Futures Command chief Gen Rainey in March 2024, one dilemma that presents itself is how to provide organic artillery support to its airborne divisions, which have maintained an ability to airdrop the M77 towed howitzer. While it appears that a mobile 155 mm solution would be too large and heavy to airdrop, options have appeared on the market mounting 105 mm guns that could potentially be airdroppable, albeit while offering lesser range.

One such example is the Humvee 2-CT Hawkeye 105 mm Mobile Howitzer System (MHS) developed by AM General in conjunction with fellow US company and artillery specialist Mandus Group. This platform uses patented soft-recoil technology to mount the normally towed M119 105 mm howitzer onto the 2-CT two-door cargo variant of the Humvee tactical vehicle. The result is what AM General bills as "the lightest-weight, most highly manoeuvrable self-propelled howitzer in the world". With a gross vehicle weight of 6,395 kg (compared to the 4,100 kg weight of an M777), the Hawkeye MHS' 105 mm gun offers a maximum range of around 17.5 km using conventional ammunition. The system was initially trialled by the US Army in 2021.

The US Marine Corps (USMC), meanwhile, which also operates the M777 towed howitzer, has likewise been considering the replacement of its towed artillery. An article written by USMC Captain Karl Flynn, published on the US Naval Institute website in September 2025, suggested that either the Humvee 2-CT Hawkeye MHS or a potential SPH variant of the USMC's Amphibious Combat Vehicle (ACV) could be an optimum SPH solution.

XM30 enters prototyping phase: Bradley successor taking shape

Sidney E. Dean

In June 2025, both contenders for the US Army's XM30 Mechanized Infntry Combat Vehicle (MICV) programme passed the Critical Design Review and advanced into the competition's prototyping phase. If all progresses according to schedule, a production contract for the M2 Bradley's successor could be awarded in late 2027.

The M2/M3 Bradley infantry fighting vehicle (IFV) entered service with the US Army in 1981, and has undergone several major modifications during the ensuing decades. While still capable, the Bradley platform has largely reached the limits for accommodating new electronics, sensors, armour and defensive systems. The US Army has chosen to develop and procure a new IFV more suited for the challenges of tomorrow's battlefield.

Development of the Bradley's successor was initiated in 2018, following two failed efforts launched in 1999 and 2010, respectively. It was designated the Optionally Manned Fighting Vehicle (OMFV), reflecting the requirement that the new system be able to operate either with an onboard crew (standard operational mode) or unmanned via remote control. In January 2020, the Army cancelled the programme after only one bid met the entry criteria, prompting a complete requirements reset. The Pentagon restructured the programme into a five-phase acquisition with an emphasis on digital design and broader industry participation; the Army describes the XM30 is the service's first ground combat vehicle designed using modern digital engineering tools and techniques. In 2023, the developmental vehicle was redesignated the XM30 MICV.

Like the Bradley, the XM30 is designed for combined arms operations, and will serve alongside main battle tanks in Armored Brigade Combat Teams (ABCTs). It will engage ground targets (including certain categories of enemy fighting vehicles) with its medium-calibre automatic cannon, as well as with machine guns, while carrying infantry soldiers into battle. It will also be designed to control robotic and semi-autonomous systems.

▲ Until the M30 enters service, the Army continues to upgrade the Bradley. The M2A4E1 variant introduced in 2024 is the most modern and survivable version to date. It integrates an Iron Fist APS, improved high definition day/thermal gunner's sight, and an environmental control unit to prevent heat stress for dismounts. [US Army]

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MICV requirements

In addition to optional manning, the Army has presented industry with several other required or desired attributes and capabilities, all of which have been satisfied by the two competing designs. The MICV is being developed as a Modular Open Systems Architected (MOSA) platform utilising Army-defined and -owned open standards. This will facilitate rapid integration of new hardware and software over the course of the M30's service life, and could free the military from excessive dependence on original contractors for future upgrades.

The XM30 will be equipped with Northrop Grumman's XM913 50 mm autocannon as the primary armament, chambered for the 50×228 mm 'Supershot' cartridge, representing a significant upgrade in firepower from the Bradley's M242 Bushmaster autocannon chambered in 25×136 mm. Both competing XM30 designs also include a mount for two anti-tank guided missiles (ATGM) on the side of the turret. An AI-assisted fire control system and an advanced 3rd generation FLIR (forward-looking infrared) will enhance the main gun's engagement speed, accuracy and range. Ammunition natures for the 50 mm gun include an armour-piercing fin-stabilised discarding sabot (APFSDS) round for defeating light and medium-armoured targets, including, according to the Army, "typical infantry fighting vehicle targets". The weapon will also fire programmable high-explosive air-bursting (HEAB) rounds suited to engaging infantry and aerial targets such as helicopters and unmanned aerial vehicles (UAVS). The cannon will be mounted on an unmanned turret, permitting reduction of the vehicle crew from three on Bradley, to two on the new vehicle.

In addition to the two crew, the XM30 can transport six dismounts. The XM30 will be equipped with an integrated active protection system (APS) utilising hard-kill and soft-kill countermeasures for defence against ATGMs and other projectiles. In April 2025, the Army awarded Duality AI a contract to develop a counter-drone AI target detection and recognition (AiTDR) system to support drone countermeasures. Given the recent proliferation of drones, the MICV will likely incorporate organic counter-UAV measures beyond the main gun and machine guns. These could include electronic warfare capabilities. Other defensive attributes will include modular armour, as well as innovative signature management technologies to minimise detection.

A hybrid electric propulsion system is expected to improve fuel efficiency and range, and provide tactical advantages such as reduced acoustic and thermal signature and a 'silent watch' capability (being able to operate the main vehicle systems with the engine off) via battery power.

Five-phase programme

The five phases of the OMFV/XM30 programme are:

1) Market research and requirements development, initiated in late 2020.
2) Concept design, including a modelling, simulation, and analysis (MS&A) component to inform requirements and support the (completely digital) design activities. Phase 2 contracts were awarded to five competing contractors in July 2021. All five firms submitted their completed digital design packages prior to the 1 November 2022 deadline. Following evaluation of the designs, the Army proceeded to downselect for Phase 3 of the programme.
3) Detailed (again fully digital) design phase to mature the competing XM30 designs. Using 'full and open competitive procedures', the Army simultaneously awarded Phase 3 and Phase 4 contracts to two of the five original competitors in June 2023. These were General Dynamics Land Systems Inc. (GDLS), which is basing its XM30 design on a modified version of Griffin 3 (itself a shortened derivative of the ASCOD 2 design), and American Rheinmetall Vehicles LLC (ARV), which is presenting a modified variant of the KF41 Lynx. In addition to continued digital engineering design work, Phase 3 also encompassed ongoing virtual testing and subsystem integration experiments. Virtual prototype testing was augmented by numerous soldier touchpoint events, during which active duty infantry soldiers and Bradley crewmembers tested physical models of the designs, overlaid with augmented reality, to assess their viability for real-world operations as well as maintenance. Army officials confirmed that user feedback resulted in the realignment of some design elements. In early June 2025, both firms announced that their designs had passed the Phase 3 Critical Design Review (CDR).
4) Prototype build and test (June 2025–mid-2027).
5) Production and fielding, beginning with down-select to a single vendor and approval of low-rate initial production (LRIP) slated for late 2027.

Left: rendering of GDLS's Griffin III armoured vehicle with the XM913 Bushmaster Chain Gun as the primary weapon. Right: rendering Rheinmetall's Lynx IFV with the XM913 Bushmaster Chain Gun as the primary weapon. [Northrop Grumman]

Phase 4/prototyping phase begins

The CDR decision in June 2025 represents the programme's Milestone B and the beginning of the engineering and manufacturing design (EMD) process. Both GDLS and ARV had already been awarded Phase 4 contracts in June 2023, simultaneously with the Phase 3 selection. Of course, actual transition to the prototyping phase was contingent upon successful completion of the CDR.

During Phase 4, fully integrated, production representative prototypes will be built to the final design baseline to verify that the system meets all operational requirements before production. The prototype manufacturing process is divided into various subphases. Prototype hull fabrication was slated for the June–August 2025 timeframe. Full system integration is scheduled for September 2025 through March 2026, with prototype rollout and delivery to the Army expected in late 2026. Overall, this translates to an 18-20 month period between beginning of fabrication and final delivery of the completed prototypes.

Under the current schedule, both GDLS and ARV are expected to deliver seven prototypes each by the fourth quarter (Q4) of FY 2026. The firms will also provide two ballistic hulls and turrets, armour coupons and digital engineering data. The government retains an option for an additional four full prototypes of each design. The prototypes will undergo an intensive Army testing and evaluation process through mid-2027, including a Limited User Test (LUT) late in the evaluation cycle.

Phase 5 – production and fielding

The Milestone C decision is expected in late FY 2027, marking the transition to the production and fielding phase. This schedule is contingent on no significant delays during prototype evaluation, and on a successful outcome of the LUT and survivability testing. The Army will downselect to a single vendor's design, and award an LRIP contract. Actual production under the LRIP contract is expected to begin in FY 2028.

After the production and fielding decision is made, the MICV's designation will advance from XM30 to M30. Initial operational fielding of the first unit-set is planned for FY 2029. A full-rate production (FRP) decision is expected by FY 2030, with initial operational capability (IOC) expected in FY 2032.

Army statements indicate that the service wishes to field the M30 and the developmental M1E3 Abrams main battle tank variant simultaneously to upgrade combat power at the brigade level in a concerted manner; this implies that the M30 will be fielded as brigade assets. No target year for completion of the Bradley replacement cycle has been announced. Moreover, the Pentagon has not officially set a total procurement goal for the M30. According to Congressional Research Service calculations, the US Army currently has circa 2,400 M2 Bradley IFVs assigned to the service's 16 ABCTs. Factors affecting the ultimate M30 procurement figure could include organisational changes to the Army structure, such as an increase or decrease in the number of armoured formations or adjustments to their table of organisation/table of equipment. Over and above the direct allocation to fighting formations, the service will need to procure an as yet undetermined number of additional vehicles for training purposes, as well as for overseas prepositioned stockpiles.

The turret of the Rheinmetall Lynx-based M30 candidate is designed by RTX. It supports a 50 mm XM913 autocannon, a multi-mission launcher for ATGMs and attack drones, and an array of sensors including 3rd-generation thermal imaging and 360° surround vision. [American Rheinmetall Vehicles]

The GDLS Griffin III-based M30 candidate was shown at AUSA 2018. In this configuration, it is armed with a 50 mm XM913 autocannon in an arrangement which allows it to elevate to 85°, and integrated with the Iron First hard-kill APS, along with the ArmorWorks Tacticam signature management coating on the hull and turret. This comprises solid foam panels pattered with hexagons set at random heights and angles, intended to greatly reduce the vehicle's signature in the visible and infrared bands. [GDLS]

Minimum viable product?

While the Pentagon continues to express confidence in the programme's progress, the Government Accountability Office (GAO) has cautioned that the timeline has not left adequate opportunity to ensure full technological and design maturity.

A focal point of these concerns is the fact that the CDR review was accomplished in June 2025, one quarter later than originally planned. An Army spokesperson stated in April 2025

that the three-month delay of the CDR would not impact the overall programme timeline. "The [new] Milestone B date will allow the two competing contractors to complete a more comprehensive Critical Design Review prior to the milestone decision," the spokesperson said. "The program continues to meet key events to deliver on schedule."

While the Army's statements to the press downplayed the significance of the delay, the GAO's Weapon Systems Annual Assessment published in June 2025 reported that "program officials said the delay resulted from both contractors failing to develop MOSA-compliant software and hardware" due to insufficient proficiency using a models-based engineering approach. "Building and maturing the system architecture model resulted in significantly more growth in data and specifications than programme officials anticipated. Programme officials stated, however, that "this approach has yielded a greater understanding of the vehicle than they anticipated for a development contract". Despite the Army's optimistic assessment, the GAO cautioned that "identifying critical technologies this late in development risks XM30 not reaching maturity before it transitions to the [Major Capability Acquisition] pathway" during the course of program Phase 4. "Using immature technologies further increases the risk of redesign," the assessment report warned.

In this context, the GAO's report cited programme officials who stated that the programme identified a minimum viable product (MVP) during the Phase 2 concept design. As defined by the US military's joint Defense Acquisition University, MVP refers to an early version of a product which can "deliver or field basic capabilities to users to evaluate and provide feedback on. Insights from MVPs help shape scope, requirements, and design."

and 4 contract award would lead to a fielded MVP, and that they plan to add more capabilities to the system in the future, such as the ability to detect uncrewed aerial systems."

Responding to the GAO concerns, the Army stated that it was pursuing an iterative approach that refined capabilities over time to identify technically-achievable attributes and specifications. "[The Army] stated that this iterative, collaborative approach provided the ability to balance risk for the Phases 3 and 4 contract award and ensure that it did not direct high-risk requirements on an unachievable schedule."

Soldiers from the 1st Infantry Division participate in a January 2024 Soldier Touchpoint at the Detroit Arsenal, reviewing plans and intewracting with mock-ups of potential future designs of the XM30, providing insights on what soldiers liked or did not like about the possible designs. [US Army]

Balancing technical risk and accelerated development

While neither the Army nor the GAO have outlined this specifically, it would seem likely that the MVP of the XM30 would need to include the core lethality suite (turret with integrated XM913 and coaxial machine gun), the survivability suite with the baseline armour and the APS, the mobility baseline (engine, transmission and suspension), as well as the open architecture vetronics incorporating key mission systems and network interfaces in order to meet minimum requirements for LRIP. The GAO report specifically noted that "the [programme] officials stated that the Phase 3

That position is consistent with the recent drive to streamline development and acquisition programmes. With the pace of technological development increasing significantly, it is no longer viable to spend 15 or more years to field new systems. 'Exquisite' weapons may still be the ultimate goal, but 'good' systems in the field will beat 'great' systems which are still in the laboratory. The XM30 would not be the only currently developmental programme in which the US military plans to field a first iteration which does not meet all of the objective criteria. On the one hand, early fielding will provide a limited but palpably upgraded capability when compared to currently operational IFVs. Secondly, initial tranches will serve as a field laboratory to guide upgraded capabilities in follow-on production batches. Since LRIP, by definition, involves comparatively small numbers of vehicles, a calculated decision to field the XM30 as early as responsibly possible need not prevent the full-rate production tranches from displaying the full objective capabilities profile.

What next for Abrams?

Dr Robert Czulda

The United States is pressing ahead with work on a new version of the Abrams main battle tank. The programme is currently in the technology evaluation stage, but the Pentagon hopes to accelerate its pace.

A US Army M1A2 Abrams main battle tank (MBT) from Comanche Company, 4th Battalion, 6th Infantry Regiment moves to a refuelling point during Exercise Talisman Sabre 23 at the Townsville Field Training Area, Townsville, Australia, 25 July 2023. [US Army/Spc Charlie Duke]

From time to time, various commentators predict the imminent demise of the tank on the modern battlefield. The ongoing war in Ukraine, with its extensive use of first-person view (FPV)-class drones, has strengthened the voices of those sceptical regarding the relevance of heavy armour. Yet many countries continue to invest in the modernisation of armoured forces, which themselves are undergoing significant evolution. The M1 Abrams main battle tank (MBT) family is no exception, with ongoing upgrades aimed at adapting it to an increasingly demanding combat environment.

At present, the US operates three variants of the Abrams: the M1A1SA (Situational Awareness), the M1A2 SEPv2 (System Enhancement Package version 2), and the M1A2 SEPv3. As part of its modernisation programme, the US military is retiring the M1A1SA variant, rebuilding and upgrading these tanks to the M1A2 SEPv3 standard. The US Army currently fields 11 Armored Brigade Combat Teams (ABCTs), while the Army National Guard has an additional five. Each ABCT is equipped with 87 M1 tanks. It is worth recalling that since 2020, the US Marine Corps has had no tanks at all. This decision, known as Force Design 2030, focused the Marines on lighter, more mobile, and expeditionary capabilities.

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The SEPv3 variant was officially adopted by the US Army in October 2017 as the successor to the SEPv2 model, which had been in production since 2005. It is manufactured at the Joint Systems Manufacturing Center (JSMC) in Lima, Ohio, and at the Anniston Army Depot in Anniston, Alabama. Compared to its predecessor, the SEPv3 features a new tactical communications suite, an upgraded IFLIR thermal imaging system for improved target acquisition, and a redesigned power management system (Enhanced Hull Power Distribution Unit) that reduces energy consumption and supports integration with advanced systems such as the Rafael Trophy Heavy Vehicle (HV) hard-kill active protection system (APS). The tank has also gained enhanced network compatibility, allowing better integration of onboard electronics, as well as the ability to remotely shut down specific modules.

According to the manufacturer, the M1A2 SEPv3's fully isolated ammunition compartments improve survivability in case they are penetrated. Its protection against improvised explosive devices has been enhanced through reinforced flooring with lightweight armour plates, redesigned crew seating, and other structural modifications, including an energy-absorbing support under the turret basket. Crew safety is further increased by the AN/VLQ-12(V)3 CREW Duke electronic countermeasure system, designed to disrupt the signal between an IED operator and a remotely detonated explosive. This system was first introduced with the SEPv3 variant.

An Australian Army M1A2 SEPv3 Abrams MBT is secured onto a Kenworth Mack Super-Liner truck by a soldier from the 9th Force Support Battalion during redeployment of 3rd Brigade assets to Shoalwater Bay Training Area, carried out at Gladstone Port as part of Exercise Talisman Sabre 25. [Australian Army/Capt Joanne Leca]

M1E3

While the US military recognises the need for further improvements to the Abrams, it has concluded that the current design has reached the limits of its potential. Additional modifications are no longer technically feasible, primarily due to excessive weight. The M1A2 SEPv3 now tips the scales at 66.7 tonnes (depending on configuration and extra protection or equipment), compared to 54 tonnes for the original M1 and 64.6 tonnes for the M1A2 SEPv2.

Several options were considered, including upgrading existing tanks to the SEPv4 standard. However, the US decided on a riskier but potentially more rewarding path: developing an entirely new variant. In September 2023, the US Army terminated the M1A2 SEPv4 development programme and announced that it would instead pursue the M1E3. The 'E' stands for 'Engineering', signalling relatively deep structural changes. It is likely that the final production version will enter service as the M1A3. The main priorities for the programme are improved mobility and enhanced crew protection. The project will incorporate selected features from the M1A2 SEPv4 (Abrams System Enhancement Package version 4) and conform to the latest modular open-systems architecture (MOSA) standards.

The M1E3 concept emerged largely as a result of the dead end encountered with the SEPv4 programme, which, under earlier plans, was supposed to enter service with the US Army starting in 2025. In spring 2024, the US Army awarded General Dynamics Land Systems (GDLS) a contract to define requirements and produce the preliminary design for the M1E3. GDLS is a natural choice to lead the work, not only as the longstanding manufacturer of the Abrams, but also as the company behind the Abrams X concept. Unveiled in 2022, Abrams X introduced an unmanned turret, a reduced crew of three instead of four, a hybrid diesel-electric powertrain, a new XM360 120 mm gun with an autoloader, and a Kongsberg Protector RS6 remote weapon station armed with an XM914 30 mm automatic cannon.

If the M1E3 draws heavily on the Abrams X design, its weight could be reduced to around 59 tonnes, close to the target mass sought by the US Army. The tank may feature lighter tracks, possibly composite rubber, and an in-arm hydropneumatic suspension, which uses high-pressure nitrogen gas and an integral oil damper that are all contained within the road arm. This reduces weight and space. The current Honeywell AGT1500 gas turbine is expected to be replaced by a hybrid power unit, potentially halving fuel consumption. Such efficiency would ease the logistical burden and allow for a smaller hull volume due to reduced fuel tank capacity. Lower weight would also make it easier to cross bridges and deploy rapidly across multiple theatres of operation, an important consideration in a potential war or even a limited conflict with China or Russia.

Another major objective is improved crew protection. While specific details have not been disclosed, US officials have acknowledged that they are drawing lessons from the ongoing war in Ukraine. The new armour is expected to offer better protection against armour-piercing fin-stabilised discarding sabot (APFSDS) rounds and top-attack munitions. The tank is expected to be fully integrated with an active protection system. The current SEPv3 variant is equipped with the Trophy APS which improved survivability but also added to the vehicle's weight.

The current direction of travel suggests the new Abrams will most likely get a new main gun, paired with a remote weapon station. The gun will be mounted in a redesigned, lighter-weight turret. Designers are considering both an unmanned turret configuration and an optionally manned turret with a crew of three. The tank is also expected to feature an autoloader and upgraded power systems. It is believed that the Compact Autoloader was tested in the Abrams X technology demonstrator's turret. This autoloader was originally designed in the 1990s by Western Design Howden (now Parker Meggitt Defense) for the M1A1 and M1A2, but it was never implemented in any operational Abrams variant.

The new Abrams will be equipped with state-of-the-art digital systems and will be built on a modular architecture. Much like Abrams X, it will likely feature various sensors and cameras following a 'see-through armour' concept, allowing the crew to see beyond the tank's hull through screens or augmented reality goggles. The M1E3 is also planned to employ certain artificial intelligence systems and to operate in conjunction with unmanned systems under the manned-unmanned teaming (MUM-T) concept. These could include both ground vehicles and aerial platforms, such as reconnaissance drones or loitering munitions.

Based on lessons from the war in Ukraine, the new Abrams is expected to be better equipped to counter drones. In addition to improved survivability provided by more deeply integrated electronic warfare and active protection systems, the crew is expected to have the ability to engage small drones, potentially using the remotely controlled weapon station. In this context, it is notable that in July 2025 the US Army issued new instructions for crews on engaging hostile drones with their main 120 mm gun and M1028 canister rounds, which disperse fragments over a wide area.

At the AUSA 2022 exhibition, GDLS displayed their Abrams X concept, their view of a possible series of evolutionary developments for the Abrams family using available technology. [GDLS]

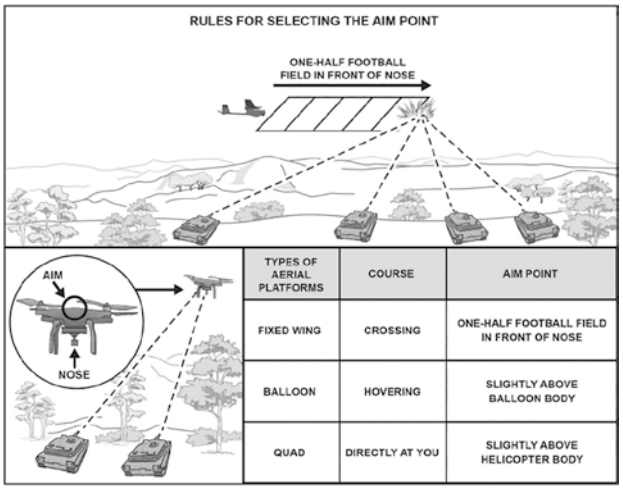

Figure 4
Point of aim

(1) Direct vehicles to aim based on type and course of UAS.

(2) Direct vehicles to engage with all machine guns or 120mm canister rounds.

(3) Direct cease fire when aircraft is destroyed or no longer a threat.

- **The US Army released an updated ATP 3-20.15 manual for tank platoons, outlining new tactics for countering UAVs. The document also highlights the use of tank-mounted weapon systems against hostile drones. [US Army]**

The M1E3 programme aims to provide the US Army with relevant armoured capabilities well into the 2040s. It was projected to achieve initial operational capability in the early 2030s. However, Pentagon leadership is aiming to shorten this timeline. In an interview with Defense News published in April 2025, the Army's Chief Technology Officer, Dr Alex Miller, stated that the military intends to field the first upgraded tank within 24 to 30 months. The contract will be awarded to General Dynamics Land Systems, which will handle parts procurement and systems integration.

The M1E3 is intended to enter service alongside the XM30, the Army's future infantry fighting vehicle. However, this remains a preliminary assumption, as the XM30 programme is still in its early stages. The US has yet to select a design to replace the aging M2 Bradley. The competition is currently between American Rheinmetall Vehicles and General Dynamics Land Systems. The XM30 is considered one of the US Army's top modernisation priorities, forming part of a broader effort not only to modernise the force but also to unify the equipment used by armoured and mechanised elements of the ABCTs.

Ongoing production

As mentioned earlier, General Dynamics Land Systems (GDLS), the manufacturer of the M1 Abrams family, is not short of work. The M1A2 SEPv3 is planned to be produced at a reduced rate until manufacturing transitions to the M1E3. In the meantime, key technologies from the cancelled M1A2 SEPv4 programme are set to be incorporated into the SEPv3 platform. These include advanced meteorological diagnostics, a laser warning receiver (LWR), an improved cooling system for electronic components, and upgraded coun-

ter-mine equipment. In 2020, GDLS received a EUR 3.9 billion contract for SEPv3 upgrades, with completion scheduled for June 2028.

One of the US Army's ongoing priorities is the modernisation of existing systems and the enhancement of their survivability under the Vehicle Protection Systems (VPS) programme, which is still under development. The GM1911 VPS Base Kit, featuring laser warning receivers (LWR), is designed to give ground combat systems early warning of enemy threats detected via laser

An Australian Army M1A2 SEPv3 Abrams MBT provides fire support for infantry during an urban assault at Shoalwater Bay Training Area as part of Exercise Talisman Sabre 25. [Australian Army/Cpl Michael Rogers]

sensors. The GM1912 VPS Signature Management coating will be applied to more than 380 vehicles – including, most likely, tanks – to reduce the probability of thermal detection. A third component, the GM1914 VPS Top Attack Protection kit, consists of passive armour designed to defend against overhead threats by reinforcing vehicle compartments and hatches. The Army plans to purchase enough kits to equip four ABCTs – 1,528 sets in Fiscal Year 2026 (1 October 2025–30 September 2026).

At present, GDLS is delivering new SEPv3 tanks as well as upgraded older variants for export. The largest customer remains the US Army, which, according to estimates by Damian Ratka of Defence24, has ordered around 690 M1A2 SEPv3s, with more under contract. In FY2024, the Army ordered 100 SEPv3s; in FY2025 and FY2026, it will receive 30 new tanks in each fiscal year.

Internationally, the 2022 Heavy Armoured Capability System (HACS) programme saw Australia purchase 75 M1A2 SEPv3s to replace its M1A1 AIM (Abrams Integrated Management) tanks, later known as the Situational Awareness (SA) variant, which had themselves replaced the obsolete Leopard AS1 (1A4) in the early 2000s. By July 2025, Canberra had confirmed delivery of most of the 49 M1A1 tanks it had pledged to transfer to Ukraine. Bahrain, currently operating M60A3s, has formally expressed interest in acquiring 50 M1A2 SEPv3 tanks. The deal, which has already been approved, is worth EUR 1.8 billion.

Romania placed an order in 2023 for 54 M1A2 SEPv3s valued at EUR 2.2 billion to replace some of its outdated tanks, primarily the TR-85M1 Bizonul (Bison), a heavily modernised derivative of the Soviet-era T-55. The United States also extended a EUR 787 million loan to Romania under the Foreign Military Financing (FMF) programme, part of which will support cooperation in Abrams ammunition production. Taiwan (Republic of China), with its ageing M60A, M48 tanks and their derivates, is becoming a new Abrams operator, having ordered 108 M1A2T tanks, 14 M88A2 Hercules armoured recovery vehicles, a full logistics and training package, ammunition, spare parts, and support vehicles such as M1070A1 heavy equipment transporters and M1000 low-bed trailers. M1A2T is based on the M1A2SEPv2 variant, but with additional features. The deal is worth approximately EUR 1.7 billion.

Egypt is planning to upgrade at least 555 of its 1,130 M1A1 tanks to the M1A1 SA standard. In December 2024, the US State Department approved a EUR 4 billion modernisation package that includes AN/VAS-5B DVE-A thermal driver's viewers, thermal imaging systems for gunners, M250 smoke grenade launchers, and AGT-1500 gas turbines. Kuwait is pursuing a similar approach for its fleet, having in 2025 requested sustainment support for both M1A2 and M1A2K tanks. Kuwait had purchased 218 M1A2s in the 1990s, followed by 218 M1A2K tanks ordered in 2017, with the first delivered in 2021.

Poland is currently undertaking one of the largest Abrams acquisitions. In April 2022, it ordered 250 M1A2 SEPv3s, with deliveries scheduled for 2025-2026. In January 2023, Warsaw also purchased 116 used M1A1 FEP tanks for EUR 1.2 billion. Those vehicles previously retired by the US Marine Corps. Before delivery to Poland, all underwent a comprehensive overhaul that effectively reset their service life. Deliveries were completed in 2023–2024.

In 2023, Poland took delivery of its first batch of M1A1 FEP Abrams MBTs in Szczecin. [Polish MoND]

The Abrams story is far from over. While the M1A2 SEPv3 stands as the most advanced operational variant to date, the forthcoming M1E3 is set to push the platform's capabilities even further, adapting it to the complex and technology-driven battlefields of the 21st century. Sustained foreign demand underscores its enduring global relevance, while continuous upgrades and design innovations ensure it remains at the forefront of armoured warfare. With impressive adaptability and a proven combat record, the Abrams is poised to remain a relevant asset on battlefields worldwide for decades to come.

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