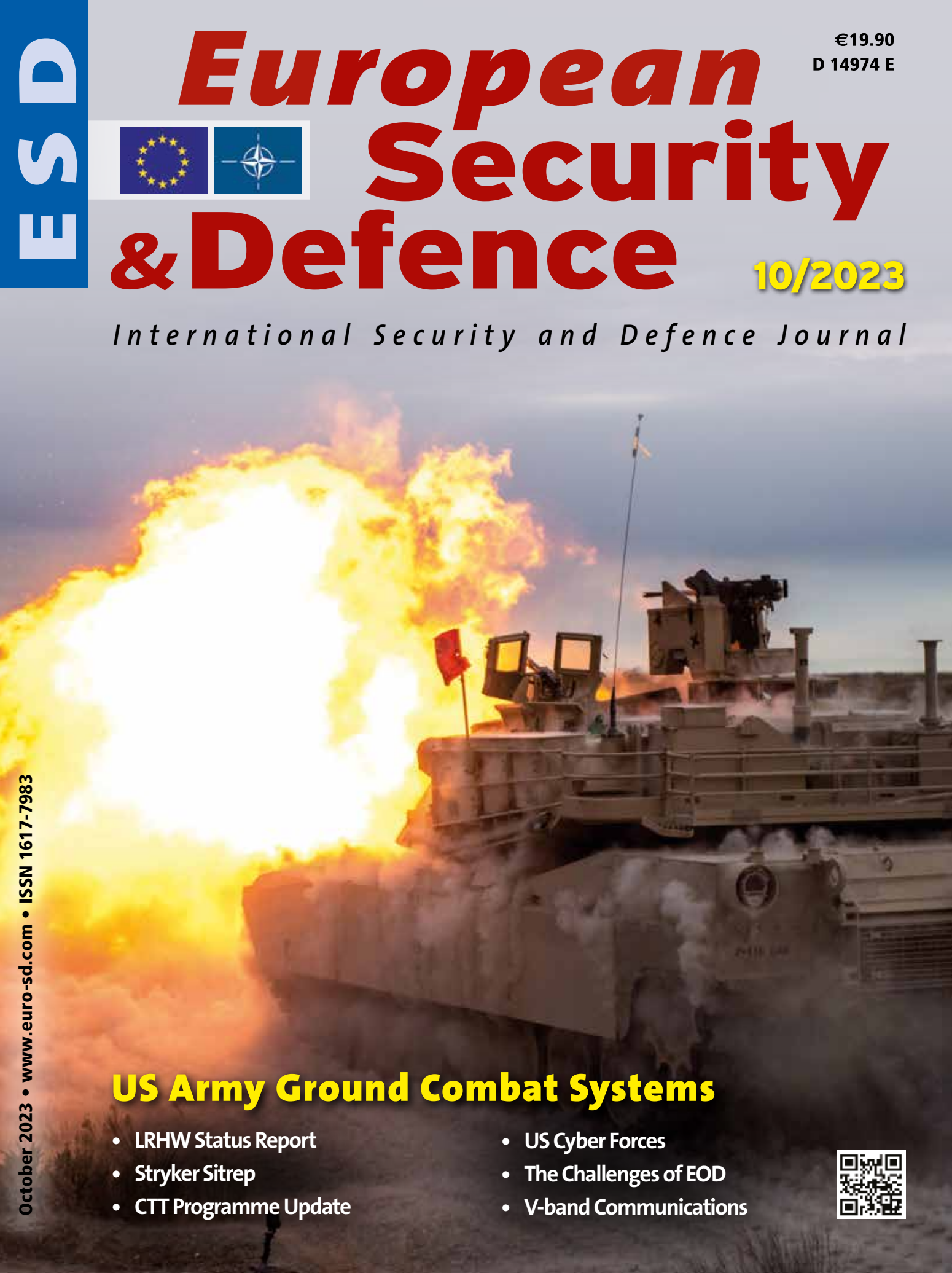
ESD

European Security & Defence

€19.90
D 14974 E

10/2023

International Security and Defence Journal



US Army Ground Combat Systems

- LRHW Status Report
- Stryker Sitrep
- CTT Programme Update
- US Cyber Forces
- The Challenges of EOD
- V-band Communications

October 2023 • www.euro-sd.com • ISSN 1617-7983

Politics · Armed Forces · Procurement · Technology


Detect. Classify. Defeat.
ELTA Drone Guard Gen5 C-UAS System
The drone threats are on the rise: Smaller, faster, and equipped with increasingly potent payloads. Control Operations with ELTA's Drone Guard Gen5 C-UAS System - The combat proven, multi-layer C-UAS solution. With an optimized sensor suite, including our class leading purpose designed 3D radars, highly evolved automated C2, and full "on the move" capabilities, Drone Guard delivers the protection you need wherever go.
ELTA Systems Ltd.
www.iai.co.il • market@elta.co.il
Meet us at
AUSA 2023
Discover More
IAI
Where Courage Meets Technology

A Flash Fire in the Caucasus

Azerbaijan's swift incursion into Nagorno-Karabakh, on 19-20 September 2023, was a bloody demonstration that the status of the enclave was anything but settled. Following this operation, Azerbaijan's control over the region has never looked more secure.

Observers of the region will have noticed tensions and small clashes continuing sporadically since the last major war, lasting 44 days, officially ended on 10 November 2020. These clashes have tended to be caused by Azerbaijani troop movements into previously Armenian-held areas, and due to the former's larger and better-equipped armed forces, have resulted in numerous small but important gains. These can be described as effectively a modern instance of 'salami tactics' at work, wherein an actor seeks to overcome their opposition one small slice at a time. In this context, the aim of such tactics is to gradually make gains while keeping below the threshold of action which is sufficiently serious to trigger an organised or unified response, or capable of convincing external actors to intervene. Over time, these tactics can be highly effective, as seen in various other instances of irridentism-driven occupation.

Occasionally, a bigger slice is taken – a key example was Azerbaijan's seizure of the critically-important Lachin corridor back in late-August 2022. Azerbaijani forces moved in and took control of the town of Lachin, replacing Russian peacekeepers who had been stationed there since the previous war ended in 2020. At the same time as taking Lachin, Azerbaijan also took control of some smaller villages including Zabukh and Sus, and surrounding areas. This resulted in the remainder of Armenian-controlled Nagorno-Karabakh being completely cut off from Armenia proper, and with all routes into and out of the enclave under Azerbaijani control.

With the one-day incursion of 19-20 September 2023, Azerbaijan seems to have seen a chance for yet another significant slice, by pressuring Armenian forces stationed there to disarm. The attack was swift and coordinated, with footage from the conflict on social media showing heavy use of precision-guided munitions, such as SkyStriker loitering munitions and Spike NLOS anti-tank guided missiles, as well as artillery strikes. The result was a swift victory, with Azerbaijani forces breaking through Republic of Artsakh defences quickly, and seizing various key strategically-important points. On 20 September, the Republic of Artsakh forces agreed to a Russian-proposed ceasefire, whose conditions included their total disbandment and disarmament. This capitulation now leaves the entire enclave firmly under Azerbaijan's control.

Alongside approximately 200 dead on the Armenian side claimed by Republic of Artsakh officials, the attacks also resulted in the death of Russian peacekeepers, most notably Captain 1st Rank Ivan Kovgan, Deputy Commander of the Russian Navy's Northern Fleet Submarine Forces, who had been seconded to the Russian peacekeeping contingent in Nagorno-Karabakh. While Azerbaijan apologised to Russia for the accident, this did not result in any meaningful changes to the situation. In some ways, this is an indicator of just how far Russia's regional influence has fallen since it commenced its invasion of Ukraine.

Since the fall of the Soviet Union, Armenia has been dependent on Russia as guarantor of its security, and over the following decades Russia has not been a particularly effective steward of Armenian security interests. Through strengthening its military, economic, and political ties to Turkey and Israel, Azerbaijan has managed to modernise and strengthen its armed forces relatively quickly. By contrast, Armenia's alliance with Russia has yielded less, with the latter showing itself to be unwilling to intervene in situations which were not aligned with the Kremlin's rather narrow (and often transactional) reading of national self-interest. All told, it is not unfair to say that Russia has squandered a lot of political capital and goodwill with its Armenian ally. The latest ceasefire is viewed by many Armenians as a betrayal by Russia, given that it appears to have resulted in the de facto ceding of control of Nagorno-Karabakh to Azerbaijan. Following the introduction of the ceasefire, footage of Armenian protestors throwing bags of red paint at the Russian embassy in Yerevan emerged on social media.

In many ways, this was to be expected. Azerbaijan has made no secret of its desire to take full sovereign control of Nagorno-Karabakh, and Russia, even if it were willing, is presently in no position to undertake a major military intervention – or even maintain a large peacekeeping presence – with the majority of its forces tied up in Ukraine. Even if it had the forces to commit to the effort, Russia's diplomatic and economic ties with other countries have shrunk considerably since the invasion of Ukraine, making it imperative that it retain what ties it has left. A move against Azerbaijan would upset Turkey, with whom Russia shares important economic and diplomatic ties. Under these circumstances, Russia's hands are effectively tied. Armenia is well aware of the problem, and has been making diplomatic overtures to European countries and the US, even holding a 10-day joint peacekeeping exercise with US forces, Exercise Eagle Partner 2023, near Yerevan from 11-21 September 2023. However, for now, Azerbaijan seems unperturbed by these gestures, not least demonstrated by the fact that this latest incursion occurred during Eagle Partner 2023.

Mark Cazalet

Contents

Index of Advertisers

Masthead

European Security & Defence
Issue 10/2023, October 2023
ISSN 1617-7983 · www.euro-sd.com

Published by

Mittler Report Verlag GmbH
A company of the TAMM Media Group

Office Address:
Mittler Report Verlag GmbH
Beethovenallee 21, 53173 Bonn, Germany
Phone.: +49 228 35 00 870, Fax: +49 228 35 00 871
info@mittler-report.de, www.mittler-report.de

Managing Director: Peter Tamm

Editorial Team

Publisher and Editor-at-Large: Stephen Barnard (sb)

Editor-in-Chief: Mark Cazalet (mc)

News Editor: Peter Felstead (pf)

Editorial Staff:

Burghard Lindhorst (bl, Editorial Coordinator),
Waldemar Geiger (wg, Infantry, Industry), Wolfgang Gelpke (wge),
Gerhard Heiming (gwh, News, Land Forces), Ole Henckel (oh),
Rolf Hilmes (rh, ArmyTechnology), Lars Hoffmann (lah),
Hans Uwe Mergener (hum, Naval Forces)

Copy Editor: Christian Kanig (ck)

Regional Correspondents
Belgium/EU/NATO: Joris Verbeurgt (jv),
Brazil: Roberto Guimarães de Carvalho (rgc),
Denmark: J. Bo Leimand (jbl), **France:** David Saw (ds), **Georgia:** Beka Kiria (bk),
India: J C Menon (jcm) **Israel:** Tamir Eshel (te), **Italy:** Luca Peruzzi (lp),
Japan: Shinichi Kiyotani (sky), **The Netherlands:** Jaime Karremann (jk),
Poland: Grzegorz Sobczak (gs), **Portugal:** António Brás Monteiro (abm),
Spain: Esteban Villarejo (ev), **Taiwan, North & East Asia:** JD Kitsch (jdk),
Turkey: Korhan Özkilinc (kÖ), **UK:** Christopher Foss (cf), Tim Guest (tg),
Ukraine: Alex Horobets (ah) **USA:** Sidney Dean (sd), Chet Nagle (cn)

Layout:
AnKo MedienDesign GmbH, Germany

Production:
Lehmann Offsetdruck und Verlag GmbH, 22848 Norderstedt, Germany

Advertising, Marketing and Business Development
Achim Abele
Phone: +49 228 25900 347
a.abele@mittler-report.de

Stephen Barnard
Phone: +49 228 35 00 886, Mobile: +44 7984 033154
s.barnard@mittler-report.de

Stephen Elliott
Phone: +49 228 35 00 872, Mobile: +49 1590 173 0346
s.elliott@mittler-report.de

Exhibition Management and Advertising Administration:
Renate Herrmanns

Advertising Accounting: Florian Bahr

Subscription/Reader Service:
PressUp GmbH, PO Box 70 13 11,
22013 Hamburg, Germany
Phone: +49 40 38 66 66-319, Fax: +49 40 386666-299
Email: mittler-report@pressup.de

Cover Photo: Bravo Company, 2nd Battalion, 116th Cavalry Regiment, conducts tank crew gunnery, on 11 November 2019 at the Orchard Combat Training Center. Credit: US ANG/Sgt Mason Cutrer

Annual subscription rate: €113.00 incl. postage

Reduced annual subscription rate for distribution in Germany:
€95.00 incl. postage

DSEI 2023: SubSea Craft's Victa-class Maritime Delivery Platform Has Conducted its First Underwater Trials

(pf) Portsmouth-based SubSea Craft has conducted the first underwater trials with its novel Victa-class maritime delivery platform, the company revealed at DSEI 2023.

Speaking to ESD at the show on 14 September 2023, SubSea Craft CEO Scott Verney revealed that the Victa prototype undertook its first underwater tests early this summer out of the company's Trials, Testing, and Training (T3) facility at Portland in Dorset, submerging to a depth of 3-5 m.

Photo: SubSea Craft

Verney said the craft had surpassed expectations in its initial performance, for example reaching a speed of 37.5 kts on the surface even though the first craft, operating as a prototype, is a little overweight.

The Victa class is unique in that it combines a fast surface craft and a submersible within the same platform. The vessel can therefore approach its target at speed from offshore before submerging – an automated process in which the cabin is flooded – to effect the stealthy insertion of up to six divers seated behind a crew of two. The prototype first entered the water from the SubSea Craft's headquarters in Portsmouth, Hampshire, in September 2021, before moving on to the company's T3 facility in Portland for further testing.

Following Victa's initial underwater trials the rest of the summer involved work to optimise the performance of the craft. "We've continued to test some of the systems, such as the dive planes," said Verney, "and we're having client demos next week and the week after.

"Now we're demonstrating it, we're very excited about the commercial prospects," said Verney. "On completion of proof of concept we've now started manufacture of the second craft and we will continue to progress through to a more advanced TRL [technology readiness level]."

Noting that there will be numerous changes to the second craft as the Victa design is optimised, Verney classified the second Victa as a production craft.

While the Victa class was originally envisaged as a swimmer delivery vehicle, Verney said that a number of other potential mission roles are emerging.

"We're already talking about the modular capability of Victa and carrying systems rather than people," he said, adding that possible payloads are "limited only by your imagination, from ISR to potentially kinetic."

Verney said that SubSea Craft has brought together a digital ecosystem for the Victa class, "allowing us to provide subsequent craft at considerable pace for our clients". He said it is envisaged that production hubs for the Victa craft would be established in client countries, given that most clients would want some degree of local production.

Meanwhile, Verney said that SubSea Craft, which has now grown to around 75 employees, is engaging in a number of projects that are complementary to the Victa technology, such as biometrics, material science and communications networking, with a particular focus on underwater communications. This work includes establishing partnerships with industry leaders in their fields, including in the UK.

BAE Systems Awarded Contract to See Striker II HMD Integrated with RAF Typhoon Fleet

(pf) BAE Systems announced at London's DSEI exhibition on 13 September 2023 that its has received a GBP 40 M (EUR 46.55 M) contract to develop its Striker II next-generation helmet-mounted display (HMD) for the Royal Air Force's (RAF's) Typhoon fighter fleet.

The contract will see the Striker II reach substantial maturity and be fully integrated with the RAF Typhoon fleet in the latter half of this decade.

While the current-generation Striker I helmet is substantially an analogue system, the Striker II is fully digital, allowing colour symbology in the display instead of a purely monochrome green. Perhaps the most significant feature of the Striker II HMD, however, is that a night vision camera has been fully integrated into it, replacing the requirement for night-vision goggles (NVGs) to be attached to the front of the helmet. This allows a night vision image to be projected onto the visor, which is seamlessly blended with the flight reference symbology.

Andrew Mallory-Blythe, the Typhoon operational requirements manager within BAE Systems' Air Sector, noted at DSEI 2023 that the Striker II HMD is now at the point where it can meet "what is almost certainly the most stringent list of operational requirements of any helmet in service in the world today".

Photo: BAE Systems

Speaking to an audience at the exhibition, Mallory-Blythe highlighted the key advantages brought to the pilot by the Striker II HMD.

"The first thing that it does is it allows the aircraft system to queue your eyes onto something." This, he said, will "almost double the range that I'll detect that target. And that will give me double the time to decide what to do about it.

"The next capability is that I can cue either a weapon or one of the aircraft's many sensors onto something that I can see," he explained. "Again, that will save a huge amount of time. If I see something I can press a hands on throttle and stick (HOTAS) button in the cockpit and immediately cue a sensor or a weapon; I can save time … which can be a significant tactical advantage.

"The third area where this particular capability can really help me is the flight reference information," said Mallory-Blythe. "As a pilot, I need to apply the aircraft to the parameters where it performs best within an engaging, demanding, tactical within-visual-range situation, so if I can look at the target, which might well be over my shoulder, and I can see my altitude and speed without having to go 'heads in' and reference the head-up display or other flight instruments, again, not only can I save time, but I can make sure that I don't take my eyes off of a target or whatever entity it is that I'm looking at."

Finally, Mallory-Blythe noted the significant improvements the Striker II HMD brings in terms of overall situation awareness. "What the helmet does through the tactical symbology," he said, "is it augments the three-dimensional real world with that image using the same type of displays as are represented on the two-dimensional displays in the cockpit, so I can look at the two-dimensional displays and I can immediately reference the real world and see the same tactical information. So I'm using the real world as an extra display, and that is painting a picture for me in three dimensions – and that gives me significantly better situation awareness than if I was solely referencing the two-dimensional displays. And all of those capabilities are available now with the combination of the night vision image and the day tactical symbology in this helmet day and at night."

Mallory-Blythe said that, "of those, situational awareness is probably the most important because, if you've got better situational awareness in cockpit than your adversary, you can

make faster decisions than your adversary. If you can make faster decisions, you have the tactical advantage and you will stay ahead."
BAE executives associated with the programme told ESD that, while the Striker II helmet will be just over 2 kg heavier than the current-generation Striker I HMD, this will still be lighter than a Striker I helmet plus its NVG fit. Mallory-Blythe additionally noted that the Striker II has "significantly improved the centre-of-gravity situation over NVGs" and that centre of gravity "is slightly more important than the overall mass of the helmet".
In terms of what the Striker II contract means at a defence-industrial level, BAE Systems has stated that it will create and sustain more than 200 highly skilled jobs at its sites in Kent and Lancashire in direct relation to the programme.

Austria Becomes Next Customer for Embraer's C-390 Millennium

(pf) The Austrian Ministry of Defence (MoD) announced on 20 September 2023 that it had selected the Embraer C-390 Millennium airlifter as its new military transport aircraft.
Four C-390s will be procured to replace the Austrian Air Force's current fleet of three Lockheed Martin C-130K Hercules transport aircraft, which were purchased from the UK Royal Air Force in 2002 and are now 56 years old. The air force will thus experience an increase in airlift capabilities in terms of both the fleet and the individual aircraft.

Photo: Bundesheer

"True to our motto 'Mission Forward', we can now finally announce another major milestone for our air force," Austrian Defence Minister Klaudia Tanner was stated as saying in an MoD press release. "Since 2003 the three Hercules aircraft have completed many missions and have always been a reliable transport device for our soldiers. Now it is time for the Embraer C-390 to replace the C-130 Hercules. Embraer's aircraft system is the only one in the 20-ton class that meets all of our requirements. … It's a big step towards a modern army and thus more security for the Austrian population."
The process of initiating a successor to the Hercules fleet was initiated in 2021, according to the Austrian MoD, which added that the "procurement costs for an aircraft" are between EUR 130 M and EUR 150 M and that delivery of the first aircraft "would be possible in 2026/2027 after successful negotiations".
While the C-130Ks (similar to C-130Es) have a maximum payload of 19 tonnes and a cargo hold that is 12.19 m long, 3.02 m wide and 2.74 m high, the C-390s will each have a maximum payload of 26 tonnes and feature a cargo hold measuring 18.5 m long (floor plus ramp), 3.45 m wide and 2.95 m high.

Sweden Orders 48 New Archer 155 mm Wheeled Artillery Systems

(pf) BAE Systems announced during DSEI 2023 on 13 September that it had signed a contract worth around USD 500 M (EUR 468 M) with the Swedish Defence Materiel Administration to supply 48 new Archer wheeled 155 mm artillery systems for the Swedish Army.
The Archer system is designed and produced by BAE Systems Bofors in Sweden. Although the Swedish Army had previously ordered two batches of 24 Archer systems in 2009 and 2016, only half of these were put into service, with 14 systems sold to the UK in March this year and eight transferred to the Ukrainian armed forces. Thus, this latest order for 48 systems will triple the number of Archer systems the Swedish Army has in service.
The Swedish Army's new Archer systems will be mounted on Rheinmetall MAN Military Vehicles (RMMV) HX2 8×8 trucks, rather than the Volvo A30 6×6 articulated haulers on which the previously ordered systems are mounted.
"This important milestone establishes Archer as the basis of the Swedish Army's new divisional artillery forces," Lena Gillström, president of BAE Systems Bofors, was quoted as saying in a company press release. "It is also critical to BAE Systems Bofors' work in jointly developing the Archer with Sweden, to confirm it as the most advanced wheeled 155 mm howitzer in operation today."
The Archer system can fire the BONUS anti-armour munition out to a range of 35 km, conventional munitions out to 40 km, and precision-guided Excalibur rounds to in excess of 50 km. Its automated magazines can hold a mix of different ammunition types and modular charges needed to support any particular fire mission.
As well as the systems donated to Ukraine and sold to the United Kingdom to address its interim artillery requirement, the Archer system has also been down-selected in Switzerland's latest artillery programme.

Photo: BAE Systems

Russia's Sarmat ICBM Declared Operational

(pf) Russia's RS-28 Sarmat heavy intercontinental ballistic missile (ICBM) has entered operational service. A 1 September 2023 report from Russian news agency TASS quoted Yury Borisov, the head of Russia's Roscosmos state space corporation, as saying that day that the Sarmat system "has assumed combat alert posture".
One of six new Russian strategic weapons heralded by Russian President Vladimir Putin on 1 March 2018, the Sarmat ICBM was designed to replace Russia's ageing R-36 (NATO designation SS-18 'Satan') ICBMs and has thus been given the NATO designation SS-X-30 'Satan II'.

Photo: Russian MoD

The Sarmat is a three-stage, liquid-fuelled ICBM with a range of 18,000 km, a launch weight of 208.1 tonnes, a length of 35.3 m and a diameter of 3 m

Russia claims the RS-28 Sarmat is capable of delivering a MIRVed warhead weighing up to 10 tonnes to any location worldwide over both the North and South Poles, to which Western ballistic missile defences have not traditionally been orientated. The missile is also capable of delivering a payload consisting of hypersonic glide vehicles.
Putin has also noted that the missile "has a short boost phase, which makes it more difficult to intercept for missile defence systems".
Russia successfully test-launched its Sarmat ICBM for the first time from the Plesetsk spaceport in Russia's northern Arkhangelsk Region on 20 April 2022. The Makayev Rocket Design Bureau then received a production contract from the Russian Ministry of Defence for Sarmat ICBMs on 16 August 2022.

Biden Administration Approves FMF for Taiwan for First Time

(pf) The US Biden Administration has approved the first ever transfer to Taiwan under the US Foreign Military Financing (FMF) programme, with the US Congress notified of the move by the US State Department on 30 August 2023.

Photo: 玄史生 / Wikipedia CC0 1.0

The move has predictably infuriated China, since the FMF programme is normally used for sovereign states, whereas China perceives Taiwan as a breakaway province. The US State Department emphasised to US media outlets that US policy on China and Taiwan, which "acknowledges the Chinese position that there is but one China", has not changed.

"Consistent with the Taiwan Relations Act and our longstanding one China policy, which has not changed, the United States makes available to Taiwan defense articles and services necessary to enable it to maintain a sufficient self-defense capability," a US State Department spokesperson told CNN. "The United States has an abiding interest in peace and stability in the Taiwan Strait, which is critical to regional and global security and prosperity."

As the largest military assistance programme managed by the State Department, FMF provides primarily grant and sometimes loan assistance to foreign governments for the purchase of US defence equipment and military training under the Foreign Military Sales (FMS) programme. Taiwan has in the past bought US weapons through the FMS programme, but the FMF programme will provide grants paid for by US taxpayers in order to make such purchases.

The initial notification details the US State Department's intention to obligate just USD 80 M (EUR 73.8 M) in FMF funds for Taiwan, but under the Taiwan Enhanced Resilience Act passed last year the US government is authorised to spend up to USD 2 Bn annually in military grants to Taiwan from 2023 to 2027.

Following the announcement of the Biden Administration extending FMF to Taiwan, House Foreign Affairs Committee Chairman Michael McCaul, a Republican, released a statement saying, "I am glad the administration is further implementing our bipartisan Taiwan Enhanced Resilience Act by finally providing FMF to Taiwan. These weapons will not only help Taiwan and protect other democracies in the region, but also strengthen the US deterrence posture and ensure our national security from an increasingly aggressive CCP [Chinese Communist Party]."

In remarks to the press on 31 August Chinese Foreign Ministry Spokesperson Wang Wenbin stated, "The US decision to provide weapons to China's Taiwan region under the so-called Foreign Military Financing used for sovereign states seriously violates the one-China principle and the stipulations of the three China-US joint communiqués, especially the August 17 Communiqué of 1982. This move seriously violates international law and basic norms governing international relations, undermines China's sovereignty and security interests, harms peace and stability across the Taiwan Strait, and sends gravely wrong signals to 'Taiwan independence' separatist forces. China deplores and firmly opposes them."

US State Department Approves More F-35As for South Korea

(pf) The US State Department has approved a potential Foreign Military Sale to South Korea of up to 25 more F-35A conventional take-off and landing Joint Strike Fighters, the US Defense Security Cooperation Agency ((DSCA) announced on 13 September 2023.

Photo: Lockheed Martin

The sale, which is worth an estimated USD 5.06 Bn (EUR 4.72 Bn), has been passed to the US Congress for final approval.

The sale includes 25 installed Pratt & Whitney F135-PW-100 engines plus one spare along with various additional items such as spares and logistics, technical, training, service and programme support.

South Korea initially selected the F-35 to address its F-X III fighter acquisition programme in 2014 and received the first of 40 aircraft ordered at Luke Air Force Base, Arizona, in 2018. The first South Korean F-35As were delivered to their permanent home location, Cheongju Air Base, in 2019.

To start replacing its fleet of around 167 F-16A/Bs, 185 F-5E/Fs and roughly 27 F-4Es the Republic of Korea Air Force (RoKAF) could thus end up operating up to 65 F-35As before the indigenous KF-21 Boromae fifth-generation fighter is introduced towards the end of this decade. South Korea expects to field 120 KF-21s by 2032.

The RoKAF also currently deploys 60 indigenously produced FA-50 light fighters delivered from 2013 and 59 Boeing F-15K Slam Eagle multi-role fighters delivered from 2005.

Polish MND Places Major Naval Strike Missile Coastal Defence System Order

(pf) The Polish Ministry of National Defence (MND) has awarded Kongsberg a contract for four squadrons of Naval Strike Missile Coastal Defence Systems (NSM CDSs), the Norwegian company announced on 5 September 2023.

The contract, which is worth around NOK 16 Bn (EUR 1.39 Bn), "is the largest single contract in the history of Kongsberg and is an important milestone in our more than 200-year-long history", Geir Håøy, Kongsberg President and CEO, was quoted as saying in a company press release.

ESD understands that each NSM CDS squadron in Polish service comprises two batteries each with three self-propelled launchers, totalling 24 NSMs.

The contract is dependent on approved export financing, which is expected to be finalised within a few weeks.

Poland was the first nation to acquire the NSM CDS capability, buying an initial squadron in 2008, after which it purchased an additional squadron in 2014. The latest contract award thus builds on more than a decade of successful co-operation between Kongsberg, the Polish government and Polish defence industry. The new NSM CDS deliveries will carry on into the 2030s.

"Poland has been a longstanding partner and we are proud to sign this agreement," said Håøy. "With the changed security situation in Europe, Poland is firm in its commitment to ensure important defence capabilities, and for Kongsberg as an industry partner this ensures predictability to invest and continue to build capacity to deliver on these needs."

Eirik Lie, President of Kongsberg Defence & Aerospace, added, "The NSM coastal defence system plays a significant role in supporting nations' ability to defend their territory and citizens. We are proud to support Poland in building up such a capability. The determination demonstrated by the Polish Ministry of National Defence to acquire more NSM CDS is a sign of trust and confirms that our system

Photo: Kongsberg

represents the most effective capability available" said Eirik Lie, President of Kongsberg Defence & Aerospace.
The Coastal Defence System uses the command-and-control (C2) system of Kongsberg's National Advanced Surface-to Air Missile System but with NSM control functionality. Polish industry will contribute to significant parts of the NSM CDS units, including the communication system, vehicles and part of the C2 system, as well as taking part in system integration activities.
As part of the contract, Kongsberg will provide training and technical support, including simulators, to enable Polish personnel to conduct maintenance services in Poland.
The NSM can be launched from both land- and sea-based platforms and is already in use by, or under delivery to, 12 countries. Initially developed by Kongsberg for the Royal Norwegian Navy, the NSM is a fifth-generation missile regarded as the most advanced naval strike missile in the world. Its stealthy design makes it difficult to detect and its seeker system enables autonomous target recognition of hostile units at sea or on land.
The NSM, which travels at sea-skimming altitudes and at high subsonic speed, is stated by Kongsberg to have a range in excess of 185 km.

Two Contracts Signed for Polish Narew SHORAD System

(gs) On 5 September, on the opening day of the MSPO 2023 exhibition in Kielce, the Polish defence minister approved two contracts relating to the Narew short-range air defence (SHORAD) system between the PGZ-Narew consortium and the Polish Armament Agency. The contracts were the result of framework agreements signed in 2022.
The first contract covers the delivery of over 1,000 surface-to-air missiles, while the second is for 138 launchers adapted to work in conjunction with Poland's Northrop-Grumman-supplied Integrated Battle Command Systems. The Narew SHORAD system uses iLaunchers and CAMM-ER missiles designed and manufactured by MBDA UK – a key partner in the programme – mounted on Polish Jelcz P882.57 8×8 chassis.
Deliveries of the above-mentioned new elements of the Narew system are scheduled to take place between 2027 and 2035. The total value of both contracts is about PLN 54 Bn (EUR 12.3 Bn).
Both contracts contain paragraphs about technology transfer and manufacture of both the missiles and launchers by Polish industry.
The ordered launchers will create 24 air defence batteries with 46 fire units. Every fire

Photo: G Sobczak

unit will comprise three iLaunchers with eight missile containers each.
In 2022 the Polish Armament Agency and PGZ-Narew signed contract for elements of two air defence fire units called Mała Narew (Little Narew). The first unit has already been integrated into the Polish air defence system, while the second one is currently receiving its last elements of equipment.
The Narew SHORAD system is intended to protect military bases and infrastructure and will be supplemental to the Wisła MRAD (PATRIOT) air defence system to counter targets flying at lower altitudes. The lowest Polish air defence tier, consisting of Pilica+ VSHORAD systems, is also in the process of being delivered.
The ordered elements do not complete the Narew system. Among others elements, the Polish Ministry of National Defence will also have to order radar systems, command-and-control (C2) cabins, mobile communication nodes, vehicle-mounted opto-electronic sensors and the Zenit-M Polish C2 system.
The Narew SHORAD system includes P-18PL early target designation radars and Sajna fire control radars. Both systems are developed and manufactured by Polish company PIT-Radwar.
The PGZ-Narew consortium contains 11 Polish companies: Polska Grupa Zbrojeniowa (leader of the consortium), Huta Stalowa Wola, Jelcz, Mesko, Ośrodek Badawczo-Rozwojowy Centrum Techniki Morskiej, PCO, PIT-Radwar, Wojskowe Zakłady Łączności Nr 1, Wojskowe Zakłady Uzbrojenia, Wojskowe Zakłady Elektroniczne and Zakłady Mechaniczne Tarnów.

Royal Navy Flies Fixed-Wing UAV On and Off Carrier for First Time

(pf) The UK Royal Navy (RN) has flown a fixed-wing uncrewed aerial vehicle (UAV) on and off one of its aircraft carriers for the first time. The historic event, which an RN source confirmed to ESD occurred on the afternoon of 5 September 2023, involved a twin-engine, twin-boom UAV from UK firm W Autonomous Systems (WAS) taking off from Predannack, the satellite airfield of RNAS Culdrose on the Lizard Peninsula, conducting a flight of around 20 minutes out to HMS *Prince of Wales*, which was stationed off the Cornish coast, and then landing on the carrier. Once a symbolic payload of naval memorabilia was removed by crew, the UAV was turned around and relaunched back to Predannack.
In a press release the RN noted that, while HMS *Prince of Wales* has experimented with UAVs before, these were either small quadcopters or Banshee target drones that were launched by catapult and ultimately recovered via parachute.
The UAV trials off Cornwall with HMS *Prince of Wales* are a vital precursor to the RN integrating UAV operations onto its two Queen Elizabeth-class carriers alongside manned F-35B Joint Strike Fighters and helicopters. While UAVs would probably initially be used just for logistical purposes, further into the future they are also likely to be adopted for combat operations.
The trials were the first stage of an autumn programme in which the RN will continue to push the boundaries of naval aviation with its largest warship class.


Photo: Crown Copyright

Southampton-based WAS is generally known for its work in producing long-range, heavy-lift logistical UAVs. Its HMCS UAV, which can carry a payload of 100 kg up to 1,000 km, was selected for the RN trials because it only needs a 150 m-long runway: just over half the length of a Queen Elizabeth-class carrier's flight deck. The WAS UAVs also possess a ground-breaking autopilot system that allows them to land on uneven surfaces and eliminates the need for them to be controlled remotely by trained pilots.
The commanding officer of HMS *Prince of Wales*, Captain Richard Hewitt, was quoted by the RN as saying, "HMS *Prince of Wales* is a fifth-generation aircraft carrier and operating autonomous drones like this will become the norm across future Royal Navy Carrier Strike Groups in our 50-year lifespan.
"We are all proud here in HMS *Prince of Wales* to achieve this: a fantastic milestone for all involved and the first of many firsts on this deployment to shape the future of Royal Naval Carrier Strike innovation as we prepare for our strike group deployment in 2025."
Lieutenant Ash Loftus, leading the trials for the RN on board the carrier, added, "Today's demonstration is the culmination of 18 months of hard work from dozens of people

across the Royal Navy and W Autonomous Systems. Carrier aviation is amongst the most difficult aspects of naval warfare and this success is testament to their efforts."
Stephen Wright, executive chairman and founder of W Autonomous Systems, was quoted as saying, "This landing demonstrates the agility of our autonomous drone. We are hugely proud to deliver this ground-breaking trial for the Royal Navy and showcase the future of aviation."
Charles Scales, Co-Founder of W Autonomous Systems, added: "Landing on a moving naval carrier was the ultimate test and our autonomous heavy-lift HCMC drone passed with flying colours."
Apart from the US Navy, China and Turkey are the only other nations that appear to be making progress integrating fixed-wing UAV operations onto carriers.
The first pilot to take off from a moving warship was the RN's Commander Charles Rumney Samson, who on 9 May 1912 took off from the battleship HMS Hibernia in a Short S.38 biplane. The first pilot to land on a moving warship was Squadron Leader Edwin Harris Dunning of the Royal Naval Air Service, who on 2 August 1917 landed a Sopwith Pup biplane onto a forward deck built onto the battlecruiser HMS Furious.

US Navy Awards Sikorsky Contract for 35 CH-53Ks

(pf) The US Navy has awarded Lockheed Martin's Sikorsky business a USD 2.77 Bn (EUR 2.56 Bn) contract to build and deliver 35 additional CH-53K King Stallion heavylift helicopters, the US Department of Defense announced on 24 August 2023.
The contract, which constitutes the largest procurement of the CH-53K to date, covers 12 Lot 7 aircraft for the US Marine Corps (USMC), 15 Lot 6 aircraft for the USMC, and eight aircraft for the Israeli Air Force (IAF) under the US Foreign Military Sales (FMS) construct, with deliveries to begin in 2026.
The US Navy declared full-rate production for the CH-53K programme in December 2022, which is expected to see an increase in the production rate to more than 20 helicopters annually in the coming years.
Initial operating capability for the CH-53K in USMC service was declared in April 2022, with a US Navy spokesperson telling ESD on 7 September that 71 of the type had been delivered or were on contract for the navy at that point. The USMC has a procurement objective of 200 CH-53Ks.
The IAF procured an initial four King Stallions in 2022.
The CH-53K can carry a 27,000 lb (12,247 kg) external load over 110 nautical miles in high/hot conditions, which is more than triple the external load-carrying capacity of the legacy CH-53E aircraft in the same conditions. The King Stallion is designed to conduct expeditionary assault transport of armoured vehicles, equipment, and personnel to support distributed operations deep inland from a sea-based centre of operations, which is critical to USMC operations in the Indo-Pacific region. The type can also perform operations such as humanitarian relief, firefighting and search and rescue.

Photo: USMC

US Army Adds to Bradley A4 Order

(pf) The US Army has awarded BAE Systems a USD 274 M (EUR 254 M) delivery order for continued production of 115 M2A4 Bradley infantry fighting vehicles and M7A4 fire support team vehicles, the US Department of Defense announced on 31 August 2023.
The award follows a previous USD 190 M contract awarded on 23 August for more than 70 M2A4s and M7A4s, bringing the total contract value to USD 464 M.

Photo: US Army

The contract upgrades the M2A2 Operation Desert Storm – Situational Awareness (ODS-SA) Bradley variant first fielded in 2011 to the newer A4 variant. The Bradley A4 features the latest digitised electronics for optimum situational awareness, network connectivity, and communication within the US Army's armored brigade combat teams and includes enhanced mobility, survivability and situational awareness.
The US Army plans to acquire more than 700 M2A4s through to 2029 before its Bradley fleet is replaced by the winner of the XM30 Mechanized Infantry Combat Vehicle (formerly Optionally Manned Fighting Vehicle) programme, for which American Rheinmetall Vehicles and General Dynamics Land Systems are currently competing.
The first Bradley M2A4s were delivered to the US Army from February 2022, although the first unit to be officially equipped with and trained on the IFV was the 3rd Battalion, 67th Armor Regiment, 2nd Armored Brigade Combat Team, 3rd Infantry Division, in April 2022.

British Army Units to Receive More Lethal Assault Rifle

(pf) British Army soldiers are receiving a new, high-precision rifle procured under the British Army's Project Hunter, the UK Ministry of Defence (MoD) announced on 7 September 2023.
The Alternative Individual Weapon (AIW) system – known as the L403A1 in British service – is more generally known as the Knight's Stoner 1 (KS-1) and is a modern development of the ArmaLite Rifle (AR). It is manufactured by Knight's Armament Company in the United States but it being delivered to the British Army via Macclesfield-based Edgar Brothers, which as prime contractor is responsible for sourcing and assembling the subsystems that make up the AIW system.
An initial GBP 15 M (EUR 17.5 M) order of 1,620 AIW systems has been placed by the UK MoD's Defence Equipment & Support (DE&S) organisation, with options to procure up to 10,000 systems worth GBP 90 million under the contract over the next decade.
The key features of the L403A1, which will supplement the current L85A3 rifle in British service, are a muzzle signature reduction system and an improved optical sighting system that allows threats to be engaged at greater distances. Additionally, unlike the L85A3, the L403A1 is designed to be ambidextrous, allowing both left- and right-hand/eye-dominant users to operate it identically.
Already in service with the Royal Marines, this latest L403A1 order will see it equip the Army Special Operations Brigade (ASOB), with the Ranger Regiment – a key ASOB component that was formed on 1 December 2021 under the Defence Command Paper of that year – receiving the AIW later this year.
Lieutenant Colonel Gareth Davies, SO1 SoldierWorks, Military Capability Delivery, at Army Headquarters, was quoted by the MoD as saying that the L403A1 "offers a marked increase in lethality" over current weapons and that the system "includes one of most capable day sights currently available. Importantly the weapon system will be further enhanced by our newest generation of night optics, with which the ASOB are already equipped".
As an AR system the L403A1 also shares much in common with the rifle systems used by many UK allies, optimising interoperability in multinational formations.

The Future

of European Land Systems is Here.

MISSION SOLUTIONS
MAIN BATTLE TANKS
ARTILLERY
TRACKED ARMOURED VEHICLES
WHEELED ARMOURED VEHICLES
BRIDGES
ANTI-AIRCRAFT SYSTEMS
AMMUNITION
ROBOTICS
SERVICES & SUPPORT
TRAINING
SIMULATION

KNDS

www.knds.com

Shapps Succeeds Wallace as UK Defence Secretary

(pf) Former energy secretary Grant Shapps was appointed as the UK's defence secretary on 31 August 2023 following the resignation of Ben Wallace, who had occupied the post since 2019 and has now decided to leave politics.

Photo: Downing St

Like his predecessor, Shapps is a strong advocate of spending more on defence. When he briefly ran for the Conservative Party leadership in July 2022 following the resignation of Boris Johnson, Shapps called for defence spending to be increased to 3% of GDP.

Wallace, meanwhile, wrote in his resignation letter to Prime Minister Rishi Sunak, "I know you agree with me that we must not return to the days where Defence was viewed as a discretionary spend by government and savings were achieved by hollowing out. I genuinely believe that over the next decade the world will get more insecure and more unstable. We both share the belief that now is the time to invest."

Thus far Sunak has only agreed to UK defence spending rising to 2.5% of GDP as and when economic circumstances allow.

Both Shapps and Wallace are also strong advocates for Ukraine. In his response to Wallace's resignation letter Sunak acknowledged of the former defence secretary, "You saw, before others did, what Vladimir Putin's true intentions in Ukraine were. Your determination to get Kiev weaponry before the Russians attacked had a material effect on the ability of the Ukrainians to thwart the invasion."

Sunak added, "You have eloquently made the case that this is not simply an attack on a prod and sovereign nation, it is an attack on our values, European security and the open international order on which stability and prosperity have depended for three quarters of a century."

Shapps, for his part, showed his support for Ukraine by taking in a family of Ukrainian refugees in April 2022.

As he settles into his new post, Shapps will have more than diplomatically and materially supporting Ukraine to deal with. Wallace's tenure saw the UK join Australia and the United States in the AUKUS pact in September 2021: one of the most significant security treaties of the last decade or so.

At home, meanwhile, there are some major procurement issues, largely relating to land forces. The British Army's GBP 5.5 Bn (EUR 6.42 Bn) Ajax armoured vehicle programme has still not been delivered, thwarting plans to stand up a modernised armour capability, and the army's GBP 3.2 Bn Morpheus battlefield communications programme also looks to be in trouble; the programme will miss its original initial operational capability (IOC) target of 2025 and a new IOC is yet to be defined.

Paramount Widens Production Relationship with India's Kalyani Strategic Systems

(pf) UAE-headquartered global aerospace and technology company Paramount announced at DSEI 2023 on 14 September that it is broadening its development and manufacturing partnership with India's Bharat Forge Ltd (BFL) and its subsidiary, Kalyani Strategic Systems, to produce a wider range of armoured vehicles in India for Paramount's global customers.

The existing industrial partnership between Paramount, BFL and Kalyani Strategic Systems has to date resulted in the successful development and production of large volumes of locally made KM4 armoured vehicles for the Indian Army.

The KM4 is a mine-protected, high-mobility armoured personnel carrier (APC) that is a licence-made version of Paramount's Mbombe 4 APC.

The companies are now looking to leverage their relationship to develop and manufacture a wider range of armoured vehicles for Paramount's global customers in step with Paramount's continued global expansion and production strategy.

Paramount Global CEO Steve Griessel was quoted by the company as stating, "The global armoured vehicle market is undergoing a monumental shift and within such a dynamic environment our partnership with Kalyani Strategic Systems has become ever more strategic. We are excited to broaden our partnership to include the development and production of 4×4 and 6×6 infantry combat vehicles for customers around the world. We are very proud that our partnership is growing from strength to strength."

Neelesh Tungar, President of BFL's defence portfilio, stated, "We at Kalyani Strategic Systems have come a long way in developing and scaling up our manufacturing of world-class defence platforms and reliable specialist vehicle platforms with our deep technical and industrialisation expertise. This continuing and growing partnership with Paramount substantiates the fact that the world considers India being ready to be "the manufacturing capital" for the global defence industry. We are committed to take this successful partnership to further greater heights, supporting the ability of Paramount to serve its global customers."

Image: Kalyani Strategic Systems

ST Engineering Antycip and Cervus Expand Collaboration

(pf) ST Engineering Antycip, a leading European provider of VR solutions, visual displays, simulation tools and engineering services, announced on 31 August 2023 that it has expanded its successful partnership with UK-based data-driven innovation company Cervus.

The two companies began working together collaboratively in 2016 and earlier this year signed a memorandum of understanding formalising their relationship in the UK. The new partnership results in ST Engineering Antycip becoming the sole authorised reseller of Cervus products and services across Europe.

Greater integration between Cervus ST Engineering Antycip, a subsidiary of Singapore's ST Engineering, will also see the two companies share more resources and collaborate further on joint training, marketing and technical partnerships, according to Katie Howe, senior accounts manager for aerospace and defence, at ST Engineering Antycip. "By cementing our partnership with Cervus on an international basis, ST Engineering Antycip will leverage the two companies' natural synergy to deliver an enhanced and complementary multi-domain training effect throughout the defence market," Howe was quoted as saying in a company press release.

Commenting on the partnership with Cervus, ST Engineering Antycip CEO Michel Pronier said, "We are extremely proud to expand our collaborative effort with Cervus, which marks a significant stride in our journey to push the boundaries of technological innovation in the defence industry. By combining our expertise, we will be able to offer an even broader range of unparallelled solutions to our clients, now and into the future."

Alan Roan, managing director of Cervus, added, "Expanding our relationship with ST Engineering Antycip is an important step for Cervus' access into the European defence markets. We look forward to strengthening our relationship, helping ST Engineering Antycip increase the range of their offerings and helping us scale through access to wider market opportunities."

VINCORION's Green Defense Technology Offers Tactical Advantages

A safe energy supply for the command post, the radar system, the launcher, and the firing unit—these are applications for which VINCORION delivers energy. The technology company from Germany specializes in military power and propulsion systems. These include advanced generator sets and interconnect systems, hybrid energy systems, and power electronics. The weapon stabilization and power supply systems in main battle tanks such as the Leopard 2 and infantry fighting vehicles are supplied by the companies' production facilities in Wedel, Altenstadt, and Essen. Likewise, VINCORION has supplied over 1,500 power systems for various air defense systems, from the first back in the 1980s for Patriot systems in the USA, Germany, and numerous other user countries, through to the new IRIS-T systems delivered to Ukraine in 2022.

Photos: VINCORION

For more than 30 years, VINCORION has thus provided a secure power supply to intercept hostile flying objects such as airplanes, helicopters, missiles, and drones before they reach their target. As Managing Director Dr. Stefan Stenzel explains, one key component is the hybrid technology VINCORION uses. "This technology has great advantages in how it works, how easy it is to use in terms of a modern, highly automated system, and how much it costs lifecycle-wise. Fuel consumption is thus lower, which reduces dependence on fuel in-field fuel supply."

He discusses the new VINCORION generator, which is available in different power classes. These offer a variety of possibilities – the version with 15 kilowatts only consumes 1.2 liters of diesel per hour. In contrast, the old system required 2.5 liters per hour. "The new platforms are better optimized, for example, by being more efficient below maximum output. They can be operated more efficiently and use hybrid elements, i.e., storage modules for electricity. They can, however, also be connected to external sources." That could include, for example, power supplied from the power grid or through renewable energies.

In the context of military requirements, the systems are especially efficient, Stenzel adds. "We understand the tactical requirements of our military users." The positive budgetary and environmental effects go hand in hand with increased performance. The systems also increase operational readiness – the gensets require maintenance at longer intervals because they are less susceptible to wear.

VINCORION is gearing up for green defense, the trend towards more environmentally friendly military operations affecting armies worldwide. "We are working hard on changes around carbon reduction, digitalization, and decentralization at our company," says Stenzel. "Our employees provide green defense solutions to reduce the environmental impact of military operations, such as by conserving energy and reducing carbon emissions," as the managing director of VINCORION explains. "We enable our military users to take advantage of reliable modern hybrid technology, not only for air defense systems, but also for military vehicles and other military applications that need tactical power."

Energy is the backbone of defense. VINCORION is an expert in the generation and supply of energy – energy that is produced extremely efficiently and consumes less fuel. VINCORION, the technology company from Germany, is ready to make an essential contribution to the green military of the future.

VINCORION has published a new white paper that explains precisely what decision-makers need to know about green defense. It addresses questions such as: "What is the current state of research?" "How much effort is being made by the armed forces?" "How does the German approach compare to the British approach to green defense as well as those of other countries?" "What solutions can the industry bring to the table?" Answers to these questions can be found in the white paper "What You Need to Know about Green Defense," which can be downloaded free of charge from VINCORION at bit.ly/vincorion.

What NATO and the US Should Learn from Three Recent Wars

John Antal

NATO is the most successful military alliance in modern history, but it is being put to the test. Three recent conflicts—the Second Nagorno-Karabakh War (2020), the Israel–Hamas conflict (2021), and the ongoing Russia–Ukraine War (2022–)—provide valuable lessons concerning the methods of the next war.

The Second Nagorno-Karabakh War has been called the first war in history to be primarily won by robotic systems, while the Israel–Hamas conflict is sometimes credited with being the first to be won primarily by artificial intelligence (AI). The ongoing Russia–Ukraine War, the largest in Europe since WWII, is a war of vast scale, bloody attrition, and constant innovation. We must use these conflicts to recognise the changes in warfare and reimagine how we fight. There are many leaders in NATO committed to studying these wars in breadth, depth, and context, but more need to do so. Human will, inspired and guided by determined leadership, is the driving force of victory. The best way to deter war is to be so prepared that any potential adversary will never take the risk of starting one. Facing multiple threats, and with conflict escalating in Ukraine, NATO must understand and anticipate the changing methods of warfare and act in time to shape, contest and deter. Here are seven takeaways that NATO should embrace from these conflicts.

Credit: NATO

Photo from NATO Secretary General Stoltenberg's visit to Kyiv in April 2023. To deter the next war, NATO must understand and adapt to the changing methods of warfare. This will require learning the lessons of recent major wars.

Leadership Matters

The most urgent challenge is to cultivate leaders with the imagination and foresight to envision possibilities beyond existing boundaries. Fostering imagination concerning the changing methods of war and the foresight to act in time, is not an easy task. Leaders can improve their imagination and gain foresight through reading, study, interaction, dialogue, wargaming, and Red Teaming. The three significant conflicts – the Second Nagorno-Karabakh War (2020), the Israel-Hamas War (2021) and the ongoing Russia-Ukraine War (2022) – have highlighted the harsh reality of using novel and evolving technologies in new ways in war. Leaders at all levels, including soldiers, generals, and policymakers, must comprehend the dynamic changes of these conflicts and adapt in time, or else pay for their ignorance in the blood of their soldiers. It is crucial for NATO and the US to promptly examine these conflicts and explore potential strategies in different situations in order to cultivate visionary and imaginative leaders who can effectively prevent a bigger war in Europe.

Author

John Antal, US Army (Retired) is a best-selling author and a thought-leader in military affairs.
He writes and speaks extensively about the art of war and the changing methods of warfare.

How CTA International's 40 mm capability can help forces overcome the UAV threat

Richard Macintosh, Business Development Manager at CTA International

What challenges have arisen from the increased use of UAVs in modern warfare?

The explosive growth of UAV technology has resulted in the relatively cheap and rapid acquisition of modified commercial off-the-shelf (COTS) assets for use in the defence arena. UAVs are undoubtedly re-defining modern warfare and a clear demonstration of the rapid advancement in technology driving down market prices and providing smart solutions which are consequently enabling new military tactics.

UAVs are being used frequently on and around the battlefield in Ukraine for both traditional reconnaissance missions to support artillery strikes but further they are being modified as 'effectors' in the form of 'kamikaze' drones that can conduct direct attacks on infantry and critical supply infrastructure. The use of UAVs in modern warfare represents a shift in paradigm where quantity may become the new quality.

Some of the world's favourite pro-consumer drones such as the 'DJI Mavic' based out of China's Silicon Valley and used on both sides of the war in Ukraine can be purchased for less than EUR 2,000. To put that into context, you could purchase around 60,000 'Class 1' UAVs for the cost of a single Rafale or Eurofighter Typhoon. Even the Iranian 'Shahed-136' loitering munitions cost around EUR 20,000 – a fraction of the cost of a cruise missile. This threat will only be exacerbated by autonomy, with future autonomous drone swarms operating without the need for direct human control.

How can CTA International's product range help to overcome these threats?

To address the plethora of future threats and their advanced range of capabilities an integrated and multi-layered VSHORAD defence approach is required. Part of this layer can be effectively serviced using the 40mm Cased Telescopic Armament System and its associated natures of ammunition. Thus far the 40-CTAS has been integrated onto armoured fighting and reconnaissance vehicles in the Land domain for three NATO users. Additionally, the system has now been integrated at Sea offering anti-surface and anti-air capabilities in the Naval environment. The 40-CTAS mission flexibility is a key differentiator and unparalleled by competitors. The system can perform in the C-UAV role using 'Kinetic Energy Airburst' (KE-AB) round and seamlessly switch to the APFSDS-T round to engage an enemy IFV, before switching again to General Purpose Round – Point Detonating – Tracer (GPR-PD-T) to defeat enemy structures, or 'General Purpose Round – Airburst – Tracer' (GPR-AB-T) to defeat infantry behind cover, all available in a single ammo loadout. With most medium-calibre weapons systems being either single or dual-feed, they cannot offer this mission capability, which means their range of defensive and offensive capabilities are limited from the offset.

Credit: CTA International

The range of 40-CT ammunition current comprises six natures which can all be loaded and managed together in the intelligent ammunition handling system, which can automatically choose the best ammunition depending on the threat. Out of the six natures, two are air-bursting munitions. The General-Purpose Airburst – Tracer (GPR-AB-T) high-explosive round is optimised for fragmentation effects and has a lethal area of 125 m2 at 2,500m. Specifically designed for use in an anti-air capacity the KE-AB round leverages CTA International's qualified air-burst technology, launching 1.4 kg of high velocity tungsten pellets in a shotgun-type spread on the target, at distances up to 4,000m. The projectile's aerodynamics reduces the time of flight and increases the probability of each hit.

The system can change ammunition natures in seconds, managed by a simple linkless single feed system, which can accommodate a high number of ready rounds. The number of rounds stored is only limited by the platform's usable volume and can be tailored to user requirements. Another differentiating factor is the use of cased telescoped rounds, which require a smaller volume than equivalent conventional rounds. This unique design, paired with an increased kill probability means each 40 mm round provides more 'bang for buck' when compared to other designs.

What features of 40-CTAS make it suited to operate in a C-UAV role?

The 40-CTAS is a high precision system which is effective as a C-UAV solution. The system with its range of available ammunition and its ability to fire in single shot, burst and 'high accuracy mode' can effectively eliminate UAV threats.

The 40-CTAS chas an 85° arc of elevation, thus giving more flexibility to engage high-angle targets. This is further supported by its unique compact design, which results in no deck intrusion. Additionally, the control and coordination unit for the weapon system enables continuous firing on the move, while simultaneously aiming and re-calibrating as targets move.

The power behind each KE-AB round surpasses that of smaller medium-calibre munitions, which means fewer rounds expended on a single target, resulting in a more cost-effective solution than alternative V-SHORAD defence systems. The 40-CTAS rate of fire of up to 200 rds/min enabling the system to manage multiple threats in rapid succession, which could help to counter future drone swarms. These performance characteristics ensure any enemy UAVs can be neutralised before they can fulfil their mission.

Credit: US Army/Troy Darr

US Apache AH64E attack helicopters provide close air support for Romanian Piranha III C armoured personnel carriers in Galati, Romania during Exercise Dacian Strike 2023. The Headquarters of NATO Multinational Division-Southeast conducted the exercise at the Smardan Secondary Combat Training Center 12-16 June 2023.

Fighting Spirit is Vital

In the three conflicts listed above, there is no better example of the intangible strength of fighting spirit than the military and people of Ukraine in the first weeks and months of the Russian invasion. In late-2021, the idea that Russia would attack Ukraine and begin the deadliest war in Europe since 1945 seemed possible, but not probable. By mid-January 2022, the intelligence view had changed, and the US seemed certain the Russians would attack Ukraine, but NATO and American diplomacy did not deter the Russians. Just before the invasion, the US Chairman of the Joint Chiefs of Staff, General Mark Milley, told lawmakers that "Kyiv could fall within 72 hours if a full-scale Russian invasion of Ukraine takes place." When Russia did invade on 24 February 2022, US intelligence agencies, calculating the size and capabilities of the opposing forces, predicted the Russians would capture Kyiv in two or three days. Apparently, the Russians believed the same logic and thought the Ukrainians would greet them with bread, salt, and flowers, traditional Russian gifts for greeting important guests. Instead, the Ukrainians greeted the invaders with Molotov cocktails, anti-tank guided missiles (ATGMs), and assault rifles. Ukraine's stout resistance surprised the world. It is difficult to measure an army's willingness to fight; the courage and determination to adapt, improvise, and overcome is something at which we can only guess until proven in battle. Second only to the Ukrainians' will to fight is their ability to think and create solutions as they confront the ever-changing methods of warfare. Fighting back fiercely against the invasion and adapting rapidly in the chaos of the first weeks of battle, the Ukrainians beat the odds. This ongoing conflict demonstrates the value of fighting spirit. If NATO is to deter war, or defend against a resurgent Russia if deterrence fails, it must have a similar fighting spirit to that demonstrated by Ukraine. It is also a striking reminder of the need to mobilise a nation's resources in time of war. Manpower and the depth of a nation's ammunition magazine are just two critical aspects to consider. Mobilising the nation to fight seems unheard of in an era of small, professional military forces, but what is happening in Ukraine is a wake-up call. Could NATO mobilise to fight a major conflict in Europe, or more than one conflict at the same time?

Think to Win

NATO's military and national security leaders have a duty to understand and study the changing methods of war. We count on these leaders to deter war and, if deterrence fails, to fight smart and win. NATO is at an historic turning point. Faced with the need for change, the US Army has transformed its doctrine into a concept known as Multi-domain Operations (MDO), as a spiritual successor to the AirLand Battle doctrine. This concept describes how the US Army, as part of the joint force (Army, Navy, Air Force, Marines, and Space Force) will counter and defeat near-peer adversaries capable of contesting the US in all domains (air, land, sea, space, and cyberspace) in both competition and armed conflict. Eventually, this may evolve into a joint doctrine called Joint All Domain Operations for the entire US military. NATO has not yet formalised MDO, but as it develops consensus among its 30 member countries, it has adopted a common theme for MDO. In a 2021 Three Swords magazine article titled 'Understanding Multi-Domain Operations in NATO', Lieutenant Colonel Jose Diaz de Leon, US Air Force, described this theme as "the desire by Allies and partner nations to keep up with, and stay ahead of, the challenge imposed by complex future warfare, through harnessing technology." In his keynote presentation

at the NATO Space and Defence Seminar on 14 June 2023, General Philippe Lavigne, NATO Supreme Allied Commander Transformation, said: "MDO is the ability to effectively address complex, multiple threats across the five operational domains of land, sea, air, space and cyberspace, while synchronising the military instrument of power with others." To do this will require a focused intellectual effort by leaders in all NATO nations. Reacting to threats is not enough; NATO must think now to win later.

Train as you will Fight

After 20 years of counterinsurgency warfare, NATO is relearning how to fight in peer-on-peer combat. Military units do not rise to the level of their leader's expectations; they fall to the level of their training. The experiences of the three conflicts referenced earlier demonstrate that the battlespace is becoming more transparent, that there are no firm sanctuaries, and anything that is seen by multi-domain sensors will be targeted. Units must learn to fight dispersed and masked, yet connected. Massing in a more transparent battlespace is impossible without a full spectrum, multi-domain effort to deceive enemy sensors and disrupt enemy targeting. NATO forces must routinely train in this unforgiving and lethal battlespace to gain the level of competence demanded by modern war.

The importance of being prepared to fight on the first day of conflict was demonstrated during the Second Nagorno-Karabakh War, when Azerbaijan struck first against unprepared Armenian positions. Employing newly purchased, unmanned aerial vehicles (UAVs), loitering munitions, and conventional artillery and rockets, the Azeris destroyed the majority of the Armenian air-defence and command-and-control network within the first week of the war. Armenian air defence, made up of older, Soviet-era systems, could not stop the Azeri UAVs and loitering-munition attacks. Even when the Armenian air-defence systems were operating, Azerbaijan's aerial weapons penetrated Armenian airspace and knocked out the defenders.

In sports, a winning team does the repetitions needed to master its moves. How many iterations will it take to gain mastery at collective warfighting skills? How many times must a leader plan, prepare, and execute various missions to gain excellence? Every NATO leader must objectively pose this question and plan accordingly. The number of training iterations that leaders and units perform—in constructive, virtual, and live simulation exercises—must reach a level of execution that becomes second nature.

First Strike Advantage

As a defensive alliance, any new crisis in Europe, either from an accidental spillover from the Russian–Ukraine War, or a deliberate attack to seize the Suwalki Gap, will not be initiated by NATO. As a result, any attacker will be able to strike NATO forces first, and at a time of their choosing. This is a dangerous advantage that requires NATO preparation to prevent. NATO forces in Poland, Lithuania, Latvia, Estonia, Romania and other NATO countries are stationed at known positions and in largely unprotected facilities. Today, various sensors can detect almost everything in the battlespace, and long-range precision fires and drones can capitalise on these capabilities to destroy high-value targets (HVT).

The first-strike advantage is the ability of an attacker to paralyse an enemy in the

Credit: US Army/Troy Darr

US Soldiers launch a RQ-7B Shadow UAV in Galați, Romania during Exercise Dacian Strike 2023. The Headquarters of NATO Multinational Division-Southeast conducted the exercise at the Smardan Secondary Combat Training Centre in June 2023.

first hours and days of a war. A surprise first strike that destroys the most critical targets, if executed with overwhelming force, can be decisive. Azerbaijan's armed forces achieved this in the first week of the Second Nagorno-Karabakh War. The Russians did not maximise their first-strike advantage when they invaded Ukraine. On 10 March 2022, Russian Defence Ministry spokesperson Igor Konashenkov said Russia hit 2,911 Ukrainian military facilities in the first two weeks of the invasion. Even if this number were accurate, it did not break Ukrainian defences, nor their will to fight. Despite hundreds of Russian artillery, missile, and air strikes in the war's opening stages, Russian long-range precision-fires were inadequate for the scale and depth of the battlespace. Russia hit key targets, such as Ukraine's internet service and communications capabilities, but in two weeks, the internet was back in operation thanks to the Starlink satellite constellation. The Russians failed to eliminate other high-value targets (HVTs), such as capturing or killing President Zelensky and destroying key Ukrainian Government facilities and headquarters. If a resurgent Russia ever conducted a first strike against NATO, they would have learned from the 2022 invasion that they must go 'all in' to make the first strike a decisive blow. China, a vigilant observer of this conflict, has also learned this lesson.

Loitering Munitions and Unmanned Aerial Vehicles

Of all the latest battlefield technologies, loitering munitions (LMs) and unmanned aerial vehicles (UAVs) have had the most dramatic impact in the battlespace. LMs provide the most cost-effective means to attack forces on the other side of the hill or deep behind enemy lines. Capable of loitering over an area, searching for targets, and then striking, they are an effective and cost-effective means by which to conduct precision strikes. In any military engagement, timing is vital, and LMs deliver a 'loiter, sense and strike' ability that can reduce targeting time from minutes to seconds. Unlike traditional aircraft, most LMs require little or no runway; most launch from rails or can take off vertically. Some LMs, such as the IAI Harop, launch from truck-mounted launchers, much like a multiple rocket launcher. The Harop can loiter over a target area for up to 9 hours, and carries a 16 kg high-explosive fragmentation (HE-FRAG) warhead. If the Harop cannot identify a suitable target, it shifts to a subsequent priority. If no target is found, it can return to a designated landing point on its own for retrieval and reuse. There are a wide variety of LMs, from short-range versions such as the American-made Switchblade, to the longer-range Russian Lancet, which has had significant success against Ukrainian armoured vehicles in the summer of 2023. Because of their low cost compared to the price of their targets, LMs are a cost-effective means of delivering persistent, precision strikes. It appears intuitive that every mortar platoon, reconnaissance, and manoeuvre

organisation will have LMs, and artillery units will be equipped with LM batteries and longer-range armed UAVs. This does not mean the tank is dead, as it provides the primary platform for offensive manoeuvre, something drones do not. Tanks, however, will only survive and win if they adapt to the new battlespace. Those militaries that recognise this, and prepare, will gain a tremendous tactical and strategic advantage.

Artificial Intelligence

Technological convergence, in the synergy with miniaturisation, improvements in computing power, robotics, and sensors, is altering the way wars are fought. The introduction of AI is speeding up this paradigm shift. Our AI today is still 'narrow' and simple, but it enables a wide array of smart, autonomous weapons that swim, drive, and fly throughout the battlespace. Robotics and AI are clearly on the verge of ushering in a period of hybrid human–machine intelligent systems warfare. AI can intelligently sort through large amounts of data to discover optimal targeting parameters much faster than any human.

A noteworthy recent example of AI in combat operations occurred during Operation Guardian of the Walls, the name used by the Israel Defense Forces (IDF) for the 2021 Israel–Hamas War. This war lasted only 11 days but showed the possibilities of future conflicts. The IDF called this the "first artificial intelligence war," as AI was a key element in their success. Hamas fighters were hiding among the Gazan populace and Israel's dilemma was to separate combatants from non-combatants in a dense, urban battlespace. Israeli sensors collected data on their enemies from all sources, centralised this information into a multi-domain sensor database, and accessed it in real-time to generate multi-domain targeting information. Sensors input data continuously and in real-time to update a common operational picture that provided the IDF with a transparent view of their opponents. The IDF also used AI-enabled drone swarms for sensing and striking. The AI generated a super-fast kill chain that enabled the IDF to eliminate enemy fighters and destroy numerous Hamas rocket launchers while minimising civilian casualties within the city of Gaza.

According to Avi Kalo, in a 9 June 2021 Frost and Sullivan report, during Operation Guardian of the Walls, the IDF's ability to create a "seamless exchange of technology, comprehensive data management, extensive defence digitalisation, and a new Concept of Operations (CONOPS) called 'Intelligence-as-a-Service' have also been acknowledged as key to IDF's successful operations." AI-powered applications streamlined and analysed a vast amount of data from multiple sources. With this exchange of data, the IDF destroyed their opponent's rocket production sites, command facilities, key tunnel networks, and ammunition dumps.

A vital lesson from this conflict is that digitally-driven intelligence led to a successful combat outcome. Speeding up the ability to sort, prioritise, recognise patterns, and act on this accumulated information in seconds, rather than hours, makes AI an essential tool of modern warfare. As we connect more military systems in AI-enabled networks where weapons systems transmit and share information, AI will sort through thousands of data points, correlating their significance, recognising the patterns, and providing commanders with actionable courses of action. The military that uses AI to synchronise multi-domain kinetic and non-kinetic effects at machine speeds will gain a significant advantage over those who do not. This is the essence of war in the 21st century.

Looking Ahead

We live in a time of exponential change. Technology is transforming everything, especially the methods of war. Christian Brose, the best-selling author of the book "Kill Chain: Defending America in the Future of High-Tech Warfare", emphasised this transformation in his testimony to the Congressional Armed Services Committee on 9 February 2023: "In the recent Nagorno-Karabakh conflict, in the continued fighting in the Middle East, and in the ongoing war in Ukraine, we are seeing how low-cost, robotic vehicles, AI-enabled loitering munitions, digital targeting systems, cyber-weapons, persistent communications and surveillance satellites, and other advanced capabilities – especially when paired with large volumes of more traditional weapons – are transforming the modern battlefield."

The nature of war is a violent clash of interests between opposing wills. Technology and tactics change the methods of war, but not its nature. Many citizens of NATO countries are unaware of the rapid changes in warfare. Military leaders, policy decision-makers, and those in the defence industry must be cognisant of this shift. With a major war raging in Europe, and the potential for that war to escalate into a greater conflict, we must all pay attention. In late June 2022, the British Army's Chief of the General Staff, General Sir Patrick Sanders, called this time "our 1937 moment," drawing a comparison to the years leading up to the gathering storm of World War II. It seems the winds of war are howling once again. Are we ready for the coming storm? Will we use the time we have wisely before the gale hammers us?

Georgian–Turkish Relations and their Impact on Russia

Eugene Kogan

In a nutshell, friendly relations between Georgia and Turkey are not a deterrent against potential Russian aggression against Georgia. Russia can always impose a blockade of Georgia's Black Sea coast by using its naval assets in Sevastopol, Crimea and Ochamchire in occupied Abkhazia, thereby effectively 'strangling' the nascent Georgian Coast Guard. However, despite being somewhat politically marginalised by the West, Turkey remains a crucial partner for Georgia.

Introduction

Georgian–Turkish relations are in essence cordial but not equal. Georgia's Prime Minister, Irakli Garibashvili, is viewed as a junior partner in the relationship with President Recep Tayyip Erdoğan. For Georgia, Turkey represents an important partner in the volatile South Caucasus region. At the same time, enjoying friendly relations with Georgia as a transit country for oil, gas and cargo trains from Azerbaijan to Turkey, known as the Baku-Tbilisi-Kars (BTK) railway, is important for Turkey. Moreover, cargo transferred by road from Russia and Azerbaijan via Georgia to Turkey is a basic necessity. Bilateral relations are mainly focused on the economy and, occasionally, the Turkish military donates or sells military equipment to the Georgian Defence Forces (GDF). The Turkish Government also offers modest military assistance to Georgia worth about USD 10 M to USD 15 M which is about 50–60% less than Georgia receives annually from the United States. That being said, Turkish military assistance is highly appreciated by Georgia. Russia looks unfavourably at Ankara's military assistance to Georgia, however, it knows that Turkish assistance is not changing the balance of power and, as a result, tolerates it.

Credit: Government of Georgia

On 22 June 2023, Governor Seyfullah Hacımüftüoğlu, Secretary General of the National Security Council of the Republic of Turkey, met Prime Minister Irakli Garibashvili to discuss the ongoing strategic partnership between their respective countries and the potential for future cooperation.

From Turkish Military Equipment to Georgia to Joint Exercises

Military equipment flows between the two sides have been relatively modest, but bear relevance for Georgia in particular.

In July 2022, the Georgian Defence Ministry announced that the GDF would receive NATO-standard armoured personnel carriers (APCs) with their equipment and sub-systems after the defence ministry and Turkish company, ASFAT, signed a deal. Neither the model of vehicle, nor their number and value were disclosed. The same Turkish company also signed an agreement with Georgia to supply fire extinguishing kits in September 2022; the value of that contract was also not disclosed. It is known, however, that the kits will be locally manufactured in Georgia.

Georgia's Aviation and Air Defence Command has received two units of airfield specialist equipment and spare parts for UH-1H Huey helicopters from Turkey free of charge in December 2022. In January 2021, the Georgian Defence Ministry said: "Turkey donated laser rangefinders and various pieces of engineering equip-

Author

Eugene Kogan is an Eastern European defence and security expert based in Tbilisi, Georgia.

ment. The donated equipment was assigned to various combat and engineering regiments."

On the training front, joint exercises have been picking up recently. Moscow announced that it was closely following the progress of the Noble Partner 2022 military exercise in Georgia. For the Georgian Defence Ministry, the purpose of the exercise is to increase the readiness and interoperability between Georgia, the US, regional partners and allied countries and work towards a secure environment around the Black Sea region. The exercise took place for the first time since 2020 when COVID restrictions were in full force globally. According to the Russian Foreign Ministry, work was underway to transfer heavy equipment from European countries in the NATO Alliance to Georgia, this time by land from Turkey. Emphasis on the land transfer from Turkey is an important point because this had been carried out by sea from Romania until recently. In addition to the annual Noble Partner exercise, it is important to mention the trilateral military exercise between Azerbaijan, Georgia and Turkey.

The Special Operations Forces (SOFs) units of Azerbaijan, Georgia and Turkey launched the annual joint Caucasus Eagle 2022 exercises last year on 11 October, and which are hosted by Georgia in 2023. According to the Georgian Defence Ministry: "The purpose of the training is to deepen the coordination of SOF units of Azerbaijan, Georgia, and Turkey. To that end, the trio will share their experience with each other, increase interoperability and improve command capabilities." The first Caucasus Eagle exercise took place in 2017.

Bilateral Economic Relations

According to the Adjara Employment Agency, more than 17,000 people moved from Georgia to Turkey for employment opportunities between June 2020 and April 2021, despite COVID restrictions. The agency did not provide updated data on the number of Georgians employed in Turkey in 2023.

According to data from the National Statistics Service of Georgia (Geostat) for 2022, Turkey represents Georgia's main trading partner with turnover between the countries exceeding USD 2.8 Bn, with USD 2.4 Bn earned from imports. Exports from Georgia to Turkey amount to about USD 435.5 M. The country's largest trading partners after Turkey were Russia (USD 2.48 Bn) and China (USD 1.86 Bn). According to Geostat data published on 19 June 2023, Turkey was Georgia's largest trade partner with USD 1.2 Bn in trade volume, followed by Russia with USD 1.06 Bn, and China with USD 623.3 M. In other words, Turkey's exports to Georgia are in full swing.

Azerbaijan's President, Ilham Aliyev, said in December 2022: "Azerbaijan and Turkey want to increase the capacity of the BTK railway from the current one million tonnes of cargo to five million tonnes per year. In order to achieve this, USD 100 M will be invested", however Aliyev did not specify the time frame. At the same time, the idea to use BTK railway infrastructure for the overnight passenger train failed to materialise, although the Caucasus Business Week published a report in 2019 claiming that the first passenger train had arrived in Georgia using the BTK railway. However, Executive Head of the Passenger Transport Department at Azerbaijan Railways, Azer Farajov, said in an interview with APA on 8 August 2023: "In line with our post-[COVID] pandemic measures, which involve the reopening of cross-border travel, the idea of operating a high-speed passenger train on the Baku-Tbilisi-Ankara route is being explored." Whether or not the idea of a high-speed passenger train is financially viable and if there will be enough travellers remains to be seen.

Erdoğan and Aliyev's insistence on opening rail and road infrastructure via the so-called Zangezur Corridor linking Azerbaijan via Armenia to the Azerbaijani exclave of Nakhichevan to Turkey may have negative consequences for Georgia. If and when such a 'corridor' will be opened, it will downgrade the importance of Georgia as a rail and road transit link between Azerbaijan and Turkey because of the shorter distance. Furthermore, such a corridor will be a preferable route for China's Belt and Road Initiative (BRI). At the moment, Armenia and Iran are firmly against the opening of such a corridor and therefore its current and future prospects remain uncertain.

Earthquakes in Turkey and Landslides in Georgia

The Turkish Ambassador to Georgia, Ali Kaan Orbai, said in February 2023 regarding the devastating earthquake in south-eastern Turkey: "Georgia was one of the first countries to offer aid to Turkey." Georgia deployed rescue teams and sent more than 100 tonnes of humanitarian assistance. The government allocated GEL1 M from its reserve fund for humanitarian

Credit: Giorgi Balakhadze, via Wikimedia Commons

This map shows the extent of the Baku-Tbilisi-Kars (BTK) railway, an increasingly important freight corridor for Turkey, Georgia, and Azerbaijan.

aid for Turkey. The Georgian Government said in its statement: "The employees of the Interior Ministry's Emergency Management Service will be deployed to deal with the consequences of the earthquakes in Turkey." Garibashvili met with Erdoğan in Ankara on 23 February 2023, who thanked him for the rapid assistance provided [by Georgia] at this difficult time.

In the case of the landslide disaster in Shovi, Georgia, on 3 August 2023, Georgian government officials were criticised for refusing assistance from Turkey and Azerbaijan in the rescue operation.

Turkey's parliamentary and presidential Elections

Prior to the aforementioned elections in May 2023, Georgian political experts and economists were unanimous in their understanding, that no matter the outcome of the elections, substantial changes in Georgian–Turkish relations should not be expected. For now, bilateral relations remain solid; the last 20 years have shown the strength, resilience and steadfastness of this relationship.

Although Erdoğan's government has officially supported Georgia's quest to join NATO, the strength of this support at the Alliance is not always as decisive as it could be, and the Georgian Government should remember this. Furthermore, the Turkish Government is neither willing nor able to provide security guarantees to Georgia. Russia opposes Georgia's NATO membership and Turkey is well aware of this. As a result, it can be surmised that Turkey will not court confrontation with Russia over Georgia's NATO membership aspirations.

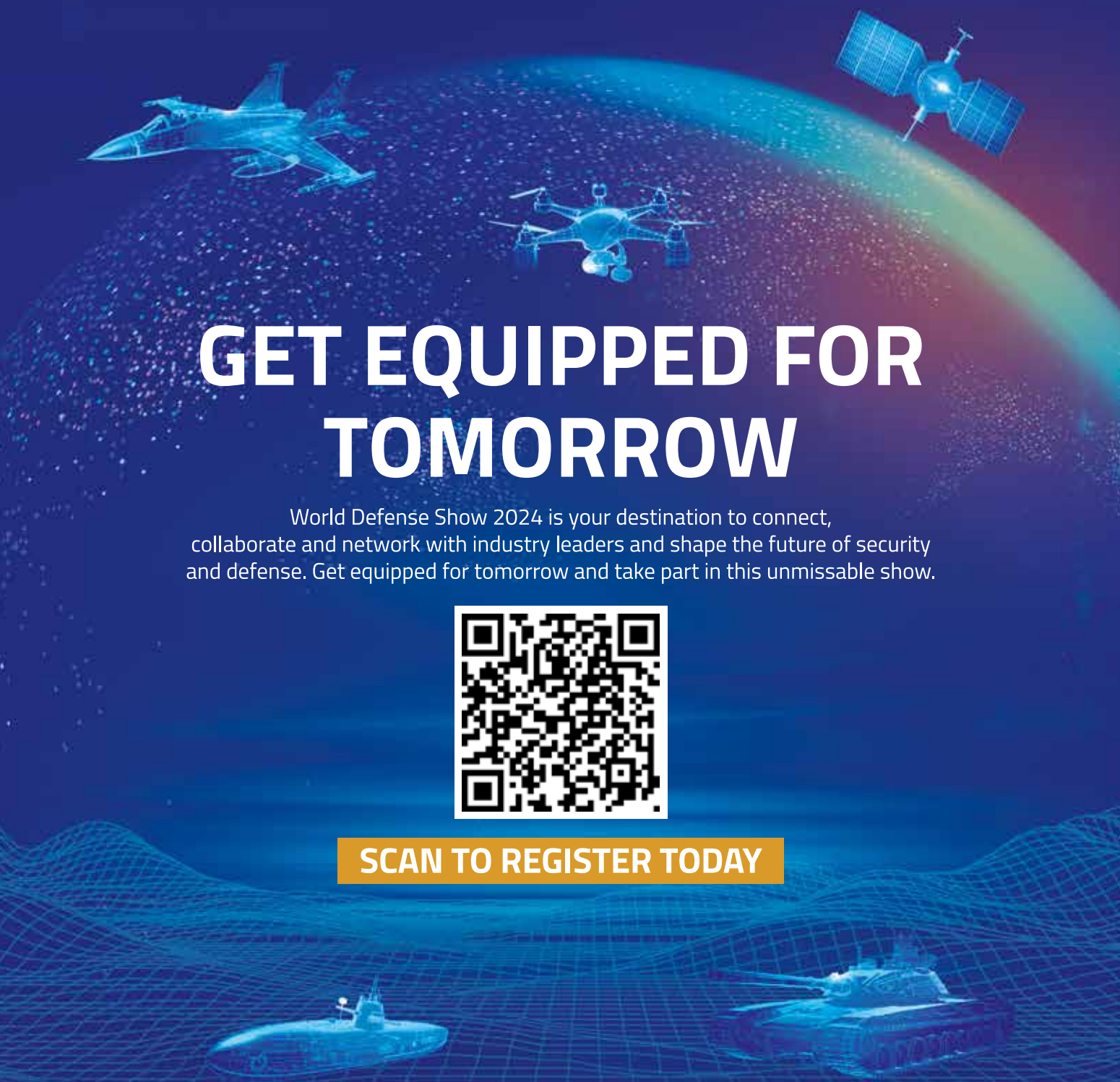
Impact on Russia

When assessing Georgian–Turkish relations, Russian President, Vladimir Putin knows that Turkey, despite its friendly relations with Georgia, will not come to its rescue should Russia decide to attempt to bring Georgia under its control. Moreover, if Putin and Erdoğan decide one day in the future to divide Georgia into their spheres of influence, the international community will be stunned but will not involve itself militarily on the side of Georgia. Although such a scenario sounds far-fetched or even unthinkable at the moment, it cannot be dismissed out of hand. The Georgian Government needs to learn from the example and experience of Ukraine; namely, that the international community is ready to support the underdog militarily when it fights for its survival alone.

Today, one can say that Georgian–Turkish relations are on a solid footing. Georgia highly appreciates Turkey's modest military assistance. Bilateral economic relations and Georgia being a transit country for oil, gas and cargo sent via BTK, in particular, and cargo sent by roads that link Russia and Azerbaijan to Georgia and Turkey, in general, remain key for maintaining useful and mutually-beneficial relations. At the same time, the Georgian Government needs to be realistic and understand that Turkey is an important partner, but Georgia is not and will not be a top priority for Turkey. Aside from this, Turkey's voice in the Alliance is not sufficiently decisive when it comes to advancing Georgian interests in NATO. Therefore, Georgia needs to rely on itself. In this regard, Russia is well-aware of Georgia's vulnerabilities. As a result, it maintains a tacit understanding with the Georgian Government that bilateral economic relations between the two neighbouring countries represent the basis for bringing them closer to one another and keeping Georgia away from its Euro-Atlantic goals. However, if worse comes to worst, and Putin's administration decides to invade Georgia again, Turkey will likely remain neutral. ■

WORLD DEFENSE SHOW
SAUDI ARABIA
4-8 FEB 2024

FOUNDED BY
الهيئة العامة للصناعات العسكرية
General Authority for Military Industries



GET EQUIPPED FOR TOMORROW

World Defense Show 2024 is your destination to connect, collaborate and network with industry leaders and shape the future of security and defense. Get equipped for tomorrow and take part in this unmissable show.

SCAN TO REGISTER TODAY

MAIN PARTNER
وزارة الدفاع
MINISTRY OF DEFENSE

NATIONAL STRATEGIC PARTNER
SAMI

Common Tactical Truck: US Army Consolidates its Heavy Logistics Vehicle Fleet

Sidney E. Dean

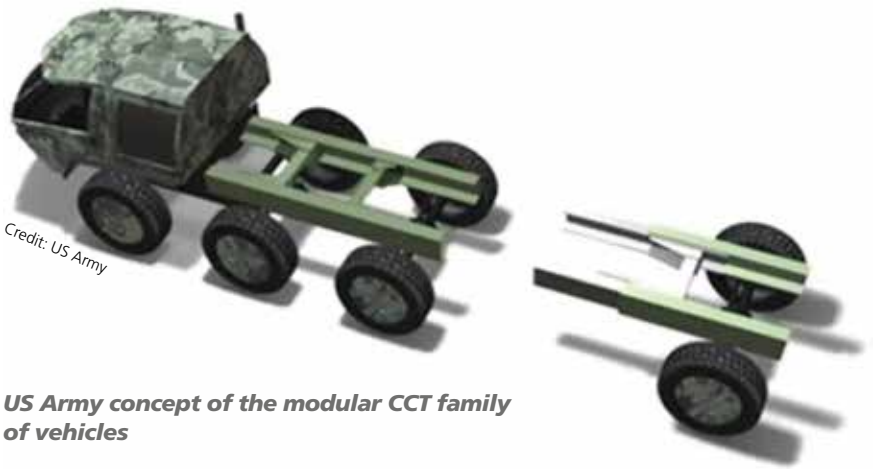
Four contractors are competing for the right to build a new fleet of heavy trucks for the US Army. By leveraging state-of-the-art and next-generation commercial technology, the Pentagon hopes to acquire a modernised transport fleet tailored to the needs of multi-domain operations (MDO).

Presently, the US Army operates four different classes of heavy tactical vehicle (HTV). These are: the M915 Line Haul Tractor; the M1088 Medium Tractor; the Palletized Load System (PLS); and the Heavy Expanded Mobility Tactical Truck (HEMTT). These trucks perform line-haul operations and, depending on type, are capable of self-load/-unload of flat racks, bridging assets and ISO containers. The base vehicles are also provided in various specialised configurations including tanker, heavy dump truck and concrete mixer truck.

The Common Tactical Truck (CTT) programme aims to procure a single new family of vehicles (FOV) which can be customised to take on all of these roles. The FOV will have at least five variants: an on-road tractor; an off-road tractor; a load handling system; a cargo-bed with crane; and a tanker. The CTT programme is managed by the Program Executive Office Combat Support and Combat System Support (PEO CS & CSS). The programme is being pursued as a rapid prototyping initiative using a middle-tier acquisition (MTA) strategy and other transactional authorities (OTA) in order to accelerate the test and evaluation process. As defined by the Program Executive Office, "the CTT will deliver all classes of supply, breakbulk, bridging, and containerized cargo across all tactical mobility levels as far forward as the mission requires, [serving as] an essential transportation link" between strategic ports and the front line.

Credit: US Army

US Army concept of the modular CCT family of vehicles



Credit: US Army

US Army concept of the modular CCT family of vehicles

Advantages

As conceived, CTT is intended to combine modern military and commercial technology. The Army plans to introduce technologies already either established or currently in the developmental phase in the civilian trucking market, such as telematics, predictive maintenance, and advanced driver assistance and safety systems. The new trucks should also be preconfigured for future introduction of drive-by-wire and autonomous operations. Currently, there are no plans to transition from internal combustion engines to hybrid or electric drive. Additionally, specific military-grade survivability, force protection and manoeuvrability standards must be incorporated beyond civilian levels. One specific requirement is an exportable power system capable of producing 20 kW of power at 28 V; according to Army documents, peak onboard power capacity should be 75 amps at 24 V to power the communications systems, although a higher capacity would surely be welcome, as it would allow for future technology upgrades.

Finally, the increased standardisation within the vehicle fleet is expected to streamline maintenance and training requirements for the fleet. Open modular designs will ensure that repair parts are interchangeable across the fleet, while relying increasingly on standard civilian vehicle components will enable

Credit: US Army

The US Army began fielding the M917A3 (based on the Mack Granite FOV) heavy dump truck in 2022.

Credit: Navistar Defense

CTT prototype submitted by Navistar

the Pentagon to benefit from civilian-industry research and development as well as commercial production economies of scale. This will not only reduce the logistics burden and manpower requirements, especially when coupled with improved fuel economy, but will reduce operating and lifecycle costs. Overall, the new acquisition approach is expected to allow the Army to modernise at the pace of industry, mitigating future obsolescence and integrating new technologies as they are developed, according to Wolfgang Petermann, project manager for transportation systems at the PEO CS & CSS.

Prototype Competition

The Army Requirements Oversight Council approved the rapid prototyping effort in July 2021 to evaluate the feasibility of procuring modified commercial-off-the-shelf (COTS) solutions to modernise the aging heavy vehicle fleet. The Request for Prototype Proposals was released in June 2022. On 27 January 2023, the Army proceeded to the next step, awarding prototyping contracts to four competing firms or groups: Mack Defense, Navistar Defense, Oshkosh Defense, and the American Rheinmetall Vehicles/GM Defense team. Each competitor will supply the Army with three prototypes of each CTT functional variant, for a total of 15 prototypes per firm. Additionally, the contenders will provide digital designs of all variants as well as a design study for a wrecker. The results of the prototyping phase will determine whether commercially based variants are currently capable of meeting military requirements. The contracts for the prototyping phase have a cumulative value of USD 24.5 M.

Mack Defense

Mack Defense is basing its CTT prototype on the established Granite vehicle line. The baseline civilian Granite trucks offer standard features including a modern cab layout with: Mack Co-Pilot (a 12 cm full-colour digital display providing navigation data); automated vehicle health monitoring; the Bendix Wingman Fusion 2.0 system which integrates radar, cameras and braking system data to help drivers detect road hazards; and the Command Steer system which monitors road variations at 2,000 times per second to maintain stability in rough terrain and high winds. A militarised variant of the Granite FOV is already in US Army service as the M917A3 Heavy Duty Dump Truck (HDT); five different variants are in Canadian Army service. The M917A3 introduced backup cameras, blind spot detection, electronic windows and mirrors, and a smartphone charging plug as standard equipment for the first time on Army logistics vehicles. Specifically, military solutions offered for Mack Defense trucks include scalable armour options to optimise the balance between protection and mobility.

Navistar Defense

On receiving the prototyping award, Navistar Defense underscored its experience in designing and building both civilian and military medium- and heavy-lift trucks. These include the 5000-MV tractor and the 7000-MV family of vehicles, thousands of which are serving with the Canadian Armed Forces, as well as with the Afghan and Iraqi militaries (smaller numbers are in service elsewhere in the Middle East, Asia and Latin America). Describing his firm as "an industry leader in Militarized COTS vehicles," Navistar Defense CEO Ted Wright emphasised that the company's "platforms are scalable to meet the vast majority of the Army's tactical wheeled vehicles vehicle applications and mission roles for their medium and heavy fleets." The firm declined to provide additional details regarding its CTT prototype entry.

Oshkosh Defense

Oshkosh Defense plans to submit modernised concepts of its family of heavy tactical vehicles (FHTV) product line, in service with the US Army since the 1980s and which has been regularly upgraded. Oshkosh intends to provide a modernised version of the current FHTV. "The FHTV's flexible architecture allows it to support a multitude of missions with the ability to scale up or down with minimal change to the

vehicle," Oshkosh stated in a January 2023 press release. The firm in particular emphasised the versatility of the HEMMT and PLS variants of the FOTV line, which are utilised not only for logistics missions but as missile and artillery platforms. The flexible architecture facilitates regular technology upgrades. Oshkosh-built FHTVs now routinely feature advanced driver assistance technologies including electronic stability control, lane departure warning, and collision mitigation braking. "The advanced architecture of these vehicles allows for seamless integration of additional features, such as drive by wire capability, Condition Based Maintenance (CBM), electrification, export power, fuel efficiency and demand reduction modifications," said Jeffrey Heggemeier, Vice President, Engineering, Oshkosh Defense.

ARV/GM Defense

American Rheinmetall Vehicles (ARV) and GM Defense partnered in 2022 to offer the HX3-CTT, a derivative of the HX3 (the newest member of Rheinmetall's HX truck family), and also incorporates GM commercial truck technologies. Like other members of the HX FOV, the HX3 (which begins serial production in 2024) is not a COTS vehicle. It was designed from the beginning for defence applications and is considered a military-off-the-shelf (MOTS) vehicle. However, it does utilise a high percentage of (partially militarised) commercial MAN components. Entering the competition, ARV has one major advantage in that the HX series is in use with 20 countries, most of whom are US allies or partners. This could further ease maintenance and supply chain access while on deployment.

ARV and GM describe the HX3-CTT as a "next generation" vehicle offering a very high level of commonality and modularity across variants, including cargo, load handling systems, tankers and line-haul tractors. The partners stress advanced capabilities and attributes such as enhanced off-road manoeuvrability, an open digital architecture, drive-by-wire capability, cybersecurity and survivability. Unmanned operations ranging from leader-follower to remote controlled to full autonomy will be possible. Emergency brake assist (EBA), adaptive cruise control (ACC) and lane departure warning (LDW) are standard features. Force protection measures include mine-blast-protected flooring, the modular armoured cabin (MAC) applique kit, and the optional integrated armour cabin (IAC) with a higher degree of protection than the baseline cab. The IAC can be swapped out for the standard cab and back again, depending on operational requirements; two technicians can perform the switch within 10 hours.

Credit: Oshkosh Defense

Oshkosh Palletized Load System (PLS) carries payloads on demountable flat rack cargo beds or inside ISO containers. The hydraulic Load Handling System (LHS) permits self-loading and unloading while the crew remain in the cab.

Future Timeline

The prototypes are to be delivered to the Army by January 2024 with prototype evaluation scheduled to begin in early 2024, approximately one year later than originally planned; testing is expected to conclude in 2025. The primary focus will be on whether the prototype designs are capable of performing military missions while relying heavily on COTS components and maximising commonality across the FOV. The results of the evaluation will flow into the formulation of the Capabilities Development Document (CDD) which the programme office will submit to the Army Requirements Oversight Council. The CDD will outline the final, approved operational requirements and performance criteria for future heavy trucks.

A decision on whether to proceed with the CTT programme is expected in 2026. If the decision is positive, the PEO will conduct a full and open competition for the engineering and manufacturing development (EMD) phase; this contest will be open to offers beyond the four firms selected for the prototyping phase. Interested firms will be required to deliver production-representative vehicles which will undergo a competitive testing programme. The testing programme will include so-called soldier touch points, which are immersive testing and feedback mechanisms through which operational personnel provide practical input on how equipment could be improved before final designs are locked down. A CTT production contract to a single manufacturer will be awarded following positive evaluation of the test vehicles' performance and attributes.

The goal is to advance to an initial production contract for between 5,700 and 7,000 vehicles. Current planning projects that procurement of CTT could begin in Fiscal Year 2028. Additional tranches will follow the first purchase contract with the total acquisition goal being approximately 40,000 vehicles. Ultimately, the CTT award could have a cumulative value of circa USD 14 Bn. ■

Credit: ARV

The ARV/GD submission is based on the RMMV HX3 heavy truck.

US Army Ground Combat Systems Update

Sidney E. Dean

The US Army is currently modernising its combat vehicle fleet in order to meet more challenging adversaries. This effort combines upgrading in-service systems and introducing completely new combat vehicles.

The US Army is currently pursuing 35 high-priority acquisition programmes covering six capabilities categories. These include various vehicle classes as well as improved-range tube artillery. Overall, the goal is to make Army formations more mobile, more survivable, and more lethal. There is a notable shift toward weapon systems optimised for confronting peer- and near-peer opponents. Despite the urgency to modernise, budget constraints are forcing the Army to balance between development and acquisition on the one hand, and maintaining operational readiness on the other. Fiscal Year (FY) 2024 budget request documents presented in early 2023 show an anticipated 18% reduction in procurement funding for weapons and tracked vehicles compared to the 2023 budget. This will result in slower than expected acquisition rates for some systems.

Credit: US Army

M1A2 SEPv3 on the firing range

Abrams MBT

The M1A2 Abrams main battle tank (MBT), which achieved initial operating capability (IOC) in 1993, remains the 'armoured fist' of the US Army. The service continues to upgrade the weapon system to counter improved offensive and defensive capabilities of potential adversaries. The current US Army inventory is composed primarily of the M1A2 Systems Enhancement Package Version 2 (SEPv2) which first entered service in 2006. The current production version is the more modern M1A2C which until 2018 was known as the M1A2 SEPv3. In addition to newly-built tanks, M1A2C variants can also be created by refitting older tanks to the new standard. While the Army has not revealed a final procurement goal regarding new-build tanks, it has announced its intent to convert all 1,500 SEPv2 MBTs to the M1A2C standard. This is expected to take until 2028. Export agreements for newly-built M1A2C MBTs have been signed with Australia and Poland.

The M1A2C uses the same Watervliet Arsenal M256 120 mm L/44 main gun (derived from the Rheinmetall Rh-120 L44 gun) and auxiliary armament as the SEPv2. Performance parameters such as speed and operational range are also virtually unchanged. However, the M1A2C variant is significantly enhanced in terms of communications, lethality, sustainment, reliability, fuel efficiency and survivability. This was accomplished by integrating numerous new or improved components:

- the enhanced fire control computer can accommodate a broader selection of modern munitions types, including programmable munitions, and can integrate new munitions as they are introduced;
- the tank has been equipped with a high-resolution, digital, third-generation IR gunner sight, sometimes referred to as the 'improved forward-looking infra-red' (IFLIR). Compared to the earlier sight, this enables the tank to locate targets at greater distances, even under degraded visual conditions;
- the turret-mounted common remotely operated weapon system (CROWS) bearing the 12.7 mm machine gun now has an improved camera;
- an auxiliary power unit has been added to support electric and electronic systems while the main engine is off, enabling silent overwatch operations and preservation of fuel;
- a vehicle health management system continually monitors the tank's components to enable predictive maintenance and boost reliability;
- the CREW Duke V3 counter remote-controlled IED electronic warfare system offers protection against roadside bombs;
- additional passive armour has been added to the hull and turret to increase protection against anti-tank weapons, as well as mines and IEDs;
- the tank can be fitted with appliqué explosive reactive armour (including the Abrams Reactive Armour Tile (ARAT) types I and II), as well as the Trophy active protection system (APS).

The net result of these upgrades is a vehicle weight of 66.7 tonnes (73.5 US tons), nearly 2.2 tonnes more than the SEPv2 in its basic configuration, with this rising to a maximum of 83.7 tonnes (92.23 US tons) when fitted with the Force Protection (FP) armour kit, Trophy, and a mine roller. In 2022, the 2nd Armored Brigade

Combat Team (ABCT), 3rd Infantry Division – nicknamed the 'Spartan Brigade' – became the first major unit to replace its legacy equipment with the M1A2C. In February 2023, the ABCT conducted a first field evaluation at the Army's National Training Center (NTC) in California, testing the early interoperability of the new MBTs with the brigade's other major weapon systems. "The cycle at the NTC is there to help stress us, [and learn to] sustain and build combat power with the new equipment," Spartan Brigade Commander Colonel Ethan Diven told reporters in October 2022. "[We're] trying to mirror what it would be like to deploy into an austere environment, from fort-to-port, and then generate combat power on a foreign soil." In early 2023, a second unit, the 1st ABCT, 3rd Infantry Division, began receiving the upgraded MBTs. Some lessons have already been learned. The new tank's weight increase now makes recovering the Abrams in the field more difficult. Until a new, more powerful recovery vehicle enters service, the Army now plans to use two M88A2 recovery vehicles to retrieve the SEPv3.

Credit: US Army

Unveiling of the MPF's renaming as the Booker in a 10 June 2023 ceremony.

M10 Booker

The Mobile Protected Firepower (MPF) programme was initiated in 2015 to provide light infantry units with an organic armoured direct fire capability. Despite its appearance, the Army emphasised that the tracked, turret-equipped combat vehicle is not a light tank because the mission profile is considerably different. Functionally the MPF fills the capabilities gap between the Abrams MBT and the Stryker ICV by acting as a fast, highly mobile fire support vehicle for advancing dismounted infantry (while

Credit: US Army

The 38-tonne M10 Booker has a 105 mm main gun.

tanks primarily act as the spearhead for a mounted mechanised charge).

The MPF's 105 mm main gun fires a range of in-service munitions meant for engaging light armoured vehicles, fortified positions, bunkers and dismounted personnel in order to eliminate obstacles and suppress opposition in support of friendly infantry. Depending on the munition, the maximum effective range can reach 4 km. The Booker's turret and fire control system shares many components in common with the Abrams family. The commander's station is equipped with the Safran Optics PASEO long-range panoramic targeting sight which permits the commander to independently search for new targets or threats while the gunner combats current targets, speeding up the engagement tempo. The 38 tonne MPF is configured to be light and small enough to cross most bridges and manoeuvre in confined urban terrain; it is air transportable by C-17, but cannot be airdropped. The vehicle has a four-person crew consisting of the commander, driver, gunner, and loader.

In terms of protection, the Booker has multiple protective layers against direct and indirect fire, RPGs, and underbody threats. The base armour can be supplemented with modular appliqué protection, and to improve crew survivability, the turret is provided with blowout panels above the ammunition storage compartment. According to Kevin Vernagus, General Dynamics program director for the MPF, this includes add-on armour on the sides and belly plate, and leaves a margin for growth. "As threats evolve or new materials become available, you simply can take off one set of armour and put on new material or thicker or thinner armour as necessary," he said. Vernagus added that the MPF is also configured for mounting an Active Protection System (APS) to defeat ATGMs.

The Army formally designated the MPF as the M10 Booker on 14 June 2023. The name honours two soldiers who served in World War II and Operation Iraqi Freedom, respectively. The programme passed Milestone C in June 2022, transitioning from a middle-tier of acquisition (MTA) rapid development phase to an acquisition programme of record. In that month, General Dynamics Land Systems (GDLS) was awarded the low-rate initial production (LRIP) contract for up to 96 MPF. The order is valued at USD 1.14 Bn. LRIP deliveries are slated to begin in late 2023. This will enable Initial Operational Testing and Evaluation to proceed in late FY24. This schedule will permit GDLS and the Army to eliminate potential weak points. According to the January 2023 DOT&E report, the prototypes tested in 2021 during the programme's competitive stage were immature. The survivability of the vehicle design was confirmed, but vulnerabilities regarding operational effectiveness were detected during the MTA phase, which the Army is currently working to correct. Concerns include the vehicle's acoustic signature, the build-up of toxic fumes in the tank when firing the main gun, and the need to improve the compatibility of the MPF's sensors and dismounted infantry sensors. Cyber survivability testing had also not been conducted during the operational testing, but will be evaluated as part of the future operational testing in support of the FRP decision which is planned for Q2 of FY25.

Despite these concerns, the 2021 evaluation scenarios showed that companies equipped with the MPF achieved their mission objectives faster, more consistently, and with fewer casualties than units without the fire support vehicle. Current planning calls for procuring a total of 504 vehicles through 2035. The first operational battalion, outfitted with 42 vehicles, is scheduled for Q4 2025. Basing plans call for one Booker battalion per division, with individual companies being detached to support armoured brigade combat teams (ABCTs).

AMPV

The Armored Multi-Purpose Vehicle (AMPV) will – over time – replace the Vietnam-era M113 armoured personnel carrier. The new vehicle is designed to offer improved survivability, occupant protection, mobility and power generation, and will be better suited to operate in the face of intense electronic warfare (EW) and cyberwarfare. The AMPV provides 78% more internal volume than the M113. The US Army plans to acquire 2,936 units over a 20-year timespan. Most will be allocated to ABCTs; approximately 30% of the current ABCT inventory consists of M113s.

Credit: US Army

Field testing the AMPV

Credit: US Army

Firing the AMPV's mortar carrier variant

BAE Systems won the AMPV Engineering and Manufacturing Development (EMD) contract in 2014. The first prototype was completed in December 2016. The firm was selected to produce the AMPV in 2018. In terms of appearance, BAE's design can be thought of as a turretless Bradley variant, with the vehicle sharing many components in common with the M2/M3 Bradley, including the chassis, engine, transmission, and suspension. This reduces the ABCT's logistical burden by minimising the diversity of spare parts to stockpile and to carry in the field, while simplifying maintenance crew training. There are of course major differences between the Bradley and the AMPV, such as the aforementioned lack of a turret (instead, AMPV can be equipped with an armoured gun mount), and the hull has been redesigned to enhance protection against mines, IEDs, RPGs and small arms.

The AMPV is being configured in five variants. Vehicle crew will consist of two or three soldiers, depending on the variant. The greatest number of AMPVs will be the M1283 General Purpose vehicles suitable for personnel transport and logistics support including battlefield resupply. In addition to the crew, these will transport six combat-equipped infantry soldiers. Other variants include the M1284 Medical Evacuation vehicle (capacity: six litter patients); the M1285 Medical Treatment vehicle (which deploys an attached soft shelter when stationary and can treat four patients simultaneously); the M1286 Mission Command vehicle serving as the ABCT's mobile command post, and the M1287 120 mm Mortar Carrier vehicle. A sixth variant configured to replace current engineering vehicles based on the M113 is under consideration.

The low-rate initial production of the AMPV was approved in January 2019 with an initial award for the delivery of 450 vehicles. Supply chain issues and COVID restrictions prevented BAE from meeting the original July 2020 delivery of the first units (they actually rolled out in September 2020), forcing the baseline programme schedule to be reset in January 2021. The Army conducted full-up system-level (FUSL) live-fire testing from May 2021 through to May 2022, followed by an Army IOT&E in July 2022. The FUSL events used production-representative vehicles to evaluate vehicle and crew vulnerability to kinetic threats, and tested the AMPV's automatic fire-extinguishing system. These events were conducted in accordance with test plans approved by the Pentagon's DOT&E.

Supply chain and production impasses have now been resolved. The entire LRIP production lot has been completed. The 1st ABCT, 3rd Infantry Division became the first operational unit to be equipped with the AMPV in March 2023. On 1 August 2023, the Army announced its decision to approve FRP, and BAE announced receipt of the formal FRP contract award on 1 September 2023. The initial contract is worth USD 797 M, and covers an unspecified number of vehicles. Anticipated follow-on awards will increase the procurement program's value to more than USD 1.6 Bn. The Army has once again increased its production goals to 16 vehicles per month, which would equip one and a half brigades per year.

JLTV

The Joint Light Tactical Vehicle (JLTV) was conceived to provide better occupant protection and survivability than the up-armoured Humvee, but with less weight and greater manoeuvrability than MRAP vehicles. The combination of organic armour and supplemental modular armour permits mission-specific defence against direct-fire threats and IEDs. The JLTV is produced in two chassis variants, the four-seat Combat Tactical Vehicle (CTV) and the two-seat Combat Support Vehicle (CSV). The CTV can be configured for General Purpose, Heavy Gun Carrier or Close-Combat Weapon Carrier roles; the CSV features a flatbed cargo space for utility missions and can also support an enclosed shell. While the JLTV is utilised by every service branch, the US Army and US Marine Corps (USMC) are by far the greatest operators, with current fleets of circa 12,500 and 3,700 vehicles respectively. Foreign military orders have been placed by Brazil and several European NATO allies. Overall, as of 1 June 2023, a total of 20,000 JLTVs have rolled off the Oshkosh assembly line.

Credit: US Army

US Army special operations forces training with the JLTV.

Credit: US Army

JLTVs replaced Humvees of the 2d Cavalry Regiment (Vilseck, Germany) in 2021, providing a vehicle with improved armour, a more powerful engine and increased durability.

The original JLTV LRIP contract was awarded to Oshkosh Defense in 2015, with deliveries to the Army and USMC beginning in early 2019; the FRP decision was announced in June 2019. As planned at the outset, the Army (which manages the JLTV programme for all services) conducted a second competition in 2022 to award a new contract for continued production of the vehicle. The purpose of this second contract competition was to ensure that the Pentagon continues to receive high quality manufacturing and maintenance services at the best price. From the beginning, the Army acquired the rights to the JLTV technical data to avoid becoming dependent on one contractor.

On 9 February 2023, the Army announced that the follow-on contract had been awarded to AM General. Oshkosh filed a protest against this award, but on 12 June 2023 the Government Accountability Office denied the challenge, finding that the Army had equitably evaluated both companies' proposals. Oshkosh will continue to produce the JLTV through the end of 2024 (as planned under the original FRP agreement), with AM General activating its assembly line around August 2024.

The new contract will have a base fulfilment period of five years, plus an additional five one-year optional ordering periods. The initial order under the new contract is for up to 20,682 vehicles and up to 9,883 JLTV-optimised trailers. While it is currently unclear whether AM General will propose any actual vehicle design changes, several technological improvements were either required by the Army during the competition phase, or offered by the two competitors. These include enhanced corrosion protection, improved fuel efficiency, anti-idle technology, lithium-ion batteries, an automated guided vehicle system, radio frequency identification, and GPS traceability.

In a March 2023 report, the Congressional Research Service (CRS) cautioned that some uncertainties remain regarding the JLTV programme. These include restructuring plans announced by the US Army since 2022 (as well as downsizing and operational reorientation by the USMC), which might ultimately change the number of vehicles required by the forces. The USMC is also introducing significant modifications to some in-service vehicles, enabling the JLTV to serve in a counter-UAV and short-range air defence role, or as a remotely operated carrier/launcher for anti-ship missiles. Cumulatively, structural and operational developments in the Army and USMC could impact unit cost and production tempo over the duration of the new contract.

Credit: US Army

Test firing the M109A7 SP howitzer.

M109A7

The M109 self-propelled howitzer family was introduced in the 1960s. Since then, the tracked, turret-equipped armoured gun system has been upgraded many times. The M109A6, designated the Paladin, was introduced in 1994, with a total of 950 acquired by the US Army by 1999. The Army is now introducing the M109A7, which was originally designated M109A6 PIM (Paladin Integrated Management). While it retains the M109 family designator, the A7 variant features so much innovation that some analysts have expressed the view that it virtually constitutes a new weapon system.

Built by BAE Systems, the new howitzer retains the turret and main gun of the M109A6, but includes upgrades such as a 600-volt electric drive system to replace hydraulic drives in the turret and gun system. The lower section of the body has been completely replaced. Like the AMPV, the M109A7 has some components in common with the M2/M3 Bradley, including (upgraded) engine, (improved) transmission, as well as some of the suspension and tracks. Further important upgrades include a 70 kW, 600 volt onboard power system (the older Paladin's power system is rated at 18.5 kW), a digital architecture, digital fire control system, digital crew displays, and an integrated blue force tracker. On the one hand, the upgrades and the commonality with other armoured systems streamline peacetime and battlefield maintenance within the ABCT. They also boost performance – including power production capacity, weight-bearing capability, and speed – thereby ensuring that the artillery

EUROSATORY

PROTECT YOUR FUTURE

17·21
JUNE 2024

PARIS

Book your stand »

THE GLOBAL EVENT FOR DEFENCE & SECURITY

1,750+
Exhibiting companies
from 62 countries

250+
Official delegations from 150 countries
Decision makers from governements and supranational organisation

62,000+
International trade visitors

EUROSATORY.COM

organised by COGES EVENTS

a subsidiary of GICAT

a member of CIDEF FRENCH DEFENCE INDUSTRY

Credit: US Army

M992A3 CAT waits behind its companion howitzer.

can keep pace with the remaining armoured vehicles; the extra weight capacity can also permit mounting an applique, mission-configurable armour package to further increase crew survivability. Offensively, the M109A7's fire control system is configured to receive a fire mission and (using the on-board positional navigation system) calculate the firing solution on the move, then fire within 60 seconds of stopping. Improved acceleration capability permits the howitzer to evacuate the firing position rapidly to evade counterfire. In addition to the mobile gun system, a full system set also includes the new M992A3 ammunition carrier to restock the howitzer's magazine in the field. This companion vehicle is also known as the CAT (carrier, artillery, tracked), with a carrying capacity for 95 shells and an integrated loading arm for transferring ammunition.

The PIM modernisation programme was launched in 2007, leading to an R&D contract award to BAE Systems in 2009 and delivery of prototypes in 2011. The LRIP contract for 65 vehicle sets was awarded in October 2013, with initial deliveries occurring in April 2015. Production qualification testing was conducted using LRIP units. The FRP contract was to be awarded in December 2017. However, FRP was delayed until March 2020 due to capacity issues at the company's plant. The Army finally authorised initiation of full-scale production in February 2020. The first operational unit to replace its M109A6 howitzers with the M109A7 was the 3rd BCT of the 1st Cavalry Division, which received its vehicle sets in August 2020. The Army is expected to complete acquisition of all 580 vehicle sets by the end of the 2020s. The M109A7 is due to remain operational until 2050.

Credit: US Army

An M109A7 testbed with 9.2-m ERCA barrel.

Future Planning

The M109A7 also serves as the basis for the XM1299 Extended Range Cannon Artillery or ERCA. The developmental howitzer is expected to provide precision fire at a range of up to 70 km (depending on ordnance type), versus the 30 km range of the M109A6 and M109A7. To achieve this performance, the ERCA is equipped with a new barrel developed by Benét Laboratories. The 155 mm L58 barrel is 9.1 m long (approximately 3 m longer than the Paladin's). This increases the interaction time between propellant gases and projectile in the barrel, permitting the projectile to achieve greater muzzle velocity. Additional velocity gains will be achieved by utilising a new, 'supercharged' propellant to fire both current and future ordnance. ERCA will also be equipped with an autoloader which increases rate of fire to 10 rds/min (versus 4 rds/min on the M109A7). The programme received rapid prototyping/MTA status in 2018 and is considered a high-priority acquisition goal. However, technical issues prevented completion of subsystem developmental testing by December 2022, as had been planned, meaning ERCA will likely also fail to supply 18 prototype howitzers to a field artillery battalion by the end of FY23 for operational testing. As a result, ERCA will lose its MTA status (which is limited to five years) and revert to a traditional major capability acquisition programme. The status change will take place in late FY24.

The Abrams MBT story is also far from over. Development of the M1A2 SEPv4 variant began in FY18. Considered an incremental upgrade to the M1A2C, the primary enhancements would be achieved through integration of powerful new sensors and fire control technology. Fielding the SEPv4 was planned for 2028. However, on 6 September 2023 the Army declared that it was revamping the Abrams upgrade program. While M1A2C procurement will continue (at a reduced rate), the SEPv4 has been cancelled in favour of a far-reaching redesign currently designated M1E3. "We appreciate that future battlefields pose new challenges to the tank as we study recent and ongoing conflicts" said Brig. Gen. Geoffrey Norman, director of the Next-Generation Combat Vehicle Cross Functional Team. "We must optimise the Abrams' mobility and survivability to allow the tank to continue to close with and destroy the enemy as the apex predator on future battlefields."

Credit: GDLS

General Dynamics Land Systems AbramsX technology demonstrator

Maintenance and support are also to be simplified. "The Abrams Tank can no longer grow its capabilities without adding weight, and we need to reduce its logistical footprint," said Maj. Gen. Glenn Dean, PEO for Ground Combat Systems when announcing the change. He added: "The war in Ukraine has highlighted a critical need for integrated protections for Soldiers, built from within instead of adding on".

The 'best' technologies destined for the SEPv4 will be included in the M1E3, speeding development time and maturation. Army Under Secretary Gabe Camarillo stated during a 6 September press conference that this would include a "native APS" (the SEPv4 was to be provided with the Trophy APS). The new variant will comply with the latest modular open systems architecture standards, which will allow quicker technology insertion. This will facilitate the design of a more survivable, lighter tank that will be more effective on the battlefield at initial fielding, and easier to upgrade in the future, the Army announced.

Overall, the Army has revealed few details regarding the new vehicle, leading to considerable speculation regarding options for meeting the service's overarching goals such as a significant reduction in weight and logistical burden (read: lower fuel consumption). GDLS presented its AbramsX concept vehicle at the October 2022 Association of the United States Army (AUSA) defence exhibit. Next-generation innovations included a hybrid powertrain combining a diesel engine and electric batteries (which GDLS says will reduce fuel consumption by 50% and facilitate a silent watch capability); an unmanned turret with a 120 mm main gun and a remote weapon station armed with an XM914 30 mm chain gun; two 360° panoramic sights; externally located modular slots to mount sensors, countermeasures, and an active protection system; as well as an autoloader for the 120 mm gun, permitting reduction to a three-person crew. The AbramsX is designed to include the KATALYST Next Generation Electronic Architecture (NGEA) system that facilitates operational networking with other manned and unmanned platforms. While the Army has yet to express any preferences, it remains likely that elements of the AbramsX demonstrator will make their way into the new MBT. IOC for the M1E3 (which will then be redesignated the M1A3) is planned for the early 2030s. ■

V for Vantage

Thomas Withington

Military demands for connectivity show no signs of abating and are only likely to increase in the coming years. Could V-band radio help absorb some the growing communications burden on the future battlefield?

The V-band occupies part of the radio segment of the electromagnetic spectrum spanning from 40-75 GHz, corresponding to wavelengths of between 7.5 mm and 4 mm. The wavelength means the radio wave moves from a peak to a trough and back again across a distance of 7.5 mm for a 40 GHz frequency, or 4 mm for a frequency of 75 GHz. These measurements are important. One of the attractions of V-band radio communications is that it can handle a lot of data traffic. CableFree, a company specialising in wireless networks, says data rates of 1-2.5 gbps are achievable with V-band. Current fourth-generation (4G) cellular communications networks offer rates of around 20 mbps when downloading data into your mobile phone, and circa 5 mbps when uploading data. These figures, corresponding to 0.02 gbps and 0.005 gbps, are notably less than those offered by V-band.

The newer fifth-generation (5G) cellular protocols increase these data rates to circa 130-250 mbps according to the 4G.co.uk website. This is an improvement on 4G but still some way behind V-band even if, as the website continues, some 5G networks are already claiming download speeds of 1 gbps. SDxCentral, an online technology publication, says that uplink and downlink speeds of 10-20 gbps are being suggested for mature 5G networks by the International Telecommunications Union (ITU). The ITU is the United Nations organisation which regulates global use of the radio spectrum.

Why not just use 5G for high data rate communications rather than V-band? Such a question requires a detailed answer. Firstly, 5G uses three wavebands: low (under 1 GHz), mid (1-6 GHz) and high 24-40 GHz). The first problem is congestion. GlobalData, an analytical company, said in May 2023 that global 5G mobile subscriptions stood at 1.7 billion at the end of 2022. The company continued that this number of subscribers could increase to 5.5 billion by 2027. Militaries wanting to use high band 5G for high data communications will have to share this band with civilian 5G users around the world. Armies deploying 5G networks on the battlefield, or using local 5G networks when deployed, may find these wavebands heavily congested by non-military users. Inundating a local 5G network with military traffic when deployed to an operational theatre could pose problems. Saturating a local network could deprive local civilians of 5G services. Any denial of service risks being detrimental from a 'hearts and minds' perspective. Relying too heavily on local 5G networks to carry military traffic could also create security vulnerabilities. Lax local security standards could leave these networks are open to red force eavesdropping.

It is instructive that the US Army has a programme called the Integrated Tactical Network (ITN). The ITN is "a suite of communications and networking hardware and software that provides voice and data communications to tactical units," according to US Department of Defence documents. ITN provides a deployable network to accompany US Army manoeuvre units. This network will provide unclassified tactical communications using standard off-the-shelf, commercially-available capabilities. The logic behind ITN is to offload non-sensitive or unclassified information onto this network to free up secure tactical networks to handle classified traffic. In December 2022, it was reported that tests of a 5G network designed to provide tactical communications on the battlefield had been performed at Fort Bragg, North Carolina. During the test a 5G communications system from JMA Wireless was connected to the ITN. Reports continued that in

Credit: Arquus

5G communications are set to revolutionise the civilian and military worlds. The US Army is already looking at how to employ 5G on the battlefield. However, using 5G protocols for tactical communications is not risk-free.

Author

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

2020, the US Army performed tests of 5G networks as conduits between forward operating bases and tactical operations centres at Fort Cavazos, Texas; Fort Irwin National Training Centre, California; Joint Base San Antonio, Texas and Joint Base Lewis-McChord, Washington.

Data Carriage

It makes sense for the military to embrace 5G protocols to assist communications, although congestion and concerns over security are valid. To this end, V-band could yet emerge as an alternative, or a supplement, to and for high band 5G communications for military applications. A key attraction of V-band are its promised high data rates. Why are such data rates possible? Primarily because of the frequencies V-band uses.

Radio waves move digitised traffic. Whether you are making a voice call on your mobile phone, sending a written message, or a photograph or video, your smartphone turns that traffic into data. Your computer does much the same thing when moving traffic across the internet. The sound of your voice, or the text in a message is turned into binary zeros and ones. These zeros and ones are a series of instructions to the receiving phone or computer to perform a series of tasks to replicate the sound of your voice or the data you are sending.

To understand how this works in practice, we can borrow an analogy from the Centre for Democracy and Technology (CDT). Based in Washington DC, the CDT is a "non-partisan, non-profit organisation fighting to advance civil rights and civil liberties in the digital age." CDT's explanation invites us to image two people standing apart from each other holding a rope connecting the hand of person A to person B. Person A shakes the rope up and down at a frequency of once-per-second. The resulting wave moves along the rope until it gets to person B. For this demonstration, each time the shake of the rope reaches person B it carries one bit of data. If person A shakes the rope ten times over ten seconds, person B receives ten bits of information. Person A then shakes the rope at a frequency of seven million times a second (made possible for this demonstration). Person B then receives seven megabits of data in that single second. The more person A shakes the rope per second, the more bits person B receives.

Engineers can use a formula to indicate how much data a particular communications link may carry thanks or the Shannon-Hartley theorem. Named after mathematician Claude Shannon (1916 to 2001) and electronics expert Ralph Hartley (1888 to 1970), this provides us with a useful indication of V-band's data handling strengths versus mobile phone communications. Let us assume that we have a standard third-generation mobile phone. Publicly-available information tells us that 3G phones can handle voice and data traffic across bandwidths of between 15MHz and 20MHz. Before doing our calculation, we need to know the signal strength of our phone and the strength of the prevailing electronic 'noise' in our locale. Once again, publicly available information tells us that our phone may have a signal strength of between -70 dB to -85dB. Naturally and artificially created electromagnetic noise is all around us in the atmosphere. The warmer the day, the more noise there is. Quite simply this is because heat excites electrons, causing them to behave more energetically than at cooler temperatures, which can correspondingly cause interference.

To demonstrate the above in action, we can use a simple scenario. Today, it is a pleasant 28 °C (82.4 °F), giving us -102.05 dB of noise. The important thing here is for our signal to be stronger than the noise. We will assume that we have 15 MHz of bandwidth on our 3G phone with a signal strength of -70dB. This should give us a theoretical data rate of 11.26 mbps. V-band communications typically offer channel bandwidths of circa 5 GHz. We will keep all the other variables the same as in the first calculation and get a total of 3,767.8 mbps. At a stroke, we can see that V-band communications can carry much greater quantities of data.

Data carriage is incredibly important. Quantities of data zooming around a battlefield are only likely to increase in the coming years. In 2012, Milsat Magazine provided intriguing figures on US military bandwidth demands since Operation Desert Storm, waged by a US-led coalition to evict Iraq from Kuwait in 1991. Back in the early 1990s, the US military was generating well under 50 mpbs per 5,000 military members. By 2003, when the US mounted Operation Iraqi Freedom, this had risen slightly above the 50 mbps mark. By 2020, the article estimated this demand would exceed 300 mbps per military member. Put another way, in the early 1990s each military member generated 10 kbps of data. This figure was predicted to increase to 60 kbps by 2020.

Credit: Oxford Science

V-band communications use comparatively small-sized antennas which can make V-band radios attractive for use in space-constrained environments or in areas where antennas must be camouflaged or discreet.

How much the US military is expected to use in the future is anyone's guess. Curiously, there appears to be no discussion, or information, in the public domain regarding current and forecast US military data consumption.

Nonetheless, it is reasonable to assume this will follow an upwards trajectory. The US Department of Defence has embraced the Multi-Domain Operations (MDO) military philosophy. Definitions differ, but this author terms MDO as the inter- and intra-force connection of all military assets (personnel, weapons, sensors, platforms, bases and capabilities) at all levels of war to perform synchronic operations guided by a better quality and pace of decision-making than one's adversary. As becomes immediately clear, such aspirations require eye-watering levels of connectivity. This connectivity is essential because these military assets will need to be continually uploading and downloading their data to computer cloud stor-

age. These 'combat clouds', as they are known, will be the central repositories for all data generated by these assets. Artificial intelligence and machine learning techniques will manage these data. In turn, the data will be shared to aid command and control (C2), battle management, and intelligence, surveillance and reconnaissance (ISR). In fact, the data will be used to aid pretty much all decision-making on and off the battlefield.

The problem for the US military, or any military planning such a data-reliant approaching to waging war, is ensuring they have the communications links to move this data. It is no good living in a megacity if a single-track steam railway is the only way to travel around the metropolis. Militaries use conventional High Frequency (HF) and Very/Ultra-High Frequency (V/UHF) radios with 3 MHz to 3 GHz wavebands. Conventional radio is backed up by satellite communications, and militaries also use standard telecommunications like traditional copper telephone lines and their fibre optic counterparts. As the US Army is demonstrating with ITN, it is having to think about non-conventional approaches like 5G to absorb some of the data burden. Do such demands open a potential window of opportunity for emerging technologies such as V-band communications?

Credit: US Army

The US Army's Integrated Tactical Network is employing civilian standard technologies to provide parallel, yet unclassified, communications links at the tactical level using technologies like 5G networking.

Beamwidth

Another potential benefit offered by the V-band is the narrowness of its radio beams. Beamwidth is an important consideration in Electronic Warfare (EW). A wide beam can betray the presence of a device such as a radar or a radio emitting a signal. To understand how beamwidth works, imagine you are in a large, dark room. You are standing on one side of the room and two individuals are on the other. One person has a large, powerful torch. The other has a torch with a narrow, focused spotlight. Put simply, the wide beam from the large torch will be easier to see than the focused beam from the spotlight. It maybe that you can only see the narrow beam if you are looking directly at it.

Simple calculations reveal how narrow V-band signals can be, and hence how difficult they might be to detect. This is important in helping to firstly mask a V-band radio from discovery, which could inadvertently reveal the presence of troops, platforms or sensors using a V-band transceiver for communications. Secondly, once EW operatives discover a radio they may try to jam the signal or eavesdrop to exploit it for intelligence. If we take an antenna with a 0.5 m (1.6 ft) diameter transmitting a 2 GHz signal, the resulting beam will have a width of 21°. If we take the same antenna but transmit a 57 GHz signal, we get a beamwidth of 0.74°. In reality, engineers calculate a radio's power and a myriad of other factors into account when calculating beamwidth. Nonetheless, for the purpose of our discussion, this gives a good indication of the narrowness of a V-band signal and hence why this could be difficult for EW operatives to detect.

Range

Like any form of radio communications, V-band has its disadvantages and these typically relate to range and susceptibility to precipitation in the atmosphere. Precipitation creates problems. The frequencies V-band uses have similar wavelengths to the physical size of water droplets which appear in the atmosphere. A frequency of 40 GHz has a wavelength of 7.5 mm, which reduces to 4.28 mm for 70 GHz. As NASA states, raindrops range in size from 0.1 mm to 6 mm in diameter. The problem is that droplets of these size, particularly from 4 mm and above, can absorb some of a V-band signal's energy. This energy absorption can greatly reduce the signal's range. Generally speaking, V-band is good for high-bandwidth communications up to circa 2 km (1.2 miles). After this, signal performance can degrade.

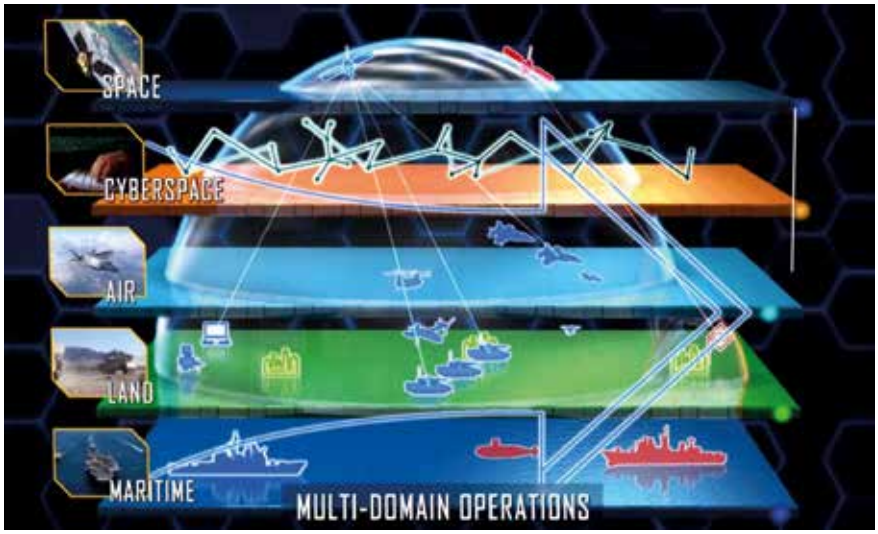
Uses

Like all forms of radio communications, be those HF, V/UHF and satellite communications, V-band has pros and cons. Any form of radio chosen by the military for a particular purpose such as ground-to-air/air-to-ground communications results in a trade-off. This compromise is usually the consequence of the desired signal power, the traffic it must carry, the available power to generate that signal and the most practical size of antenna. V-band is not a panacea. It would be no good for long-distance communications on account of its comparatively short range.

That said, it does have some clear applications, one of which could be the connection of unattended sensors on the battlefield which routinely need to share large amounts of data. Let us suppose a detachment of troops has deployed concealed acoustic sensors, ground-surveillance radars and conventional/infrared optronics in several places. Each sensor has a V-band radio with a range of about 1 km (0.6 miles). These sensors are left to continually monitor the locale in their field-of-view. As such, they continually generate large quantities of data regarding the goings-on in their environment. Most of this data will be superfluous to the troops deploying the sensors and others elsewhere in the force. However, each sensor has an edge computing application incorporating Artificial Intelli-

gence (AI). The sensor's processors are trained to notice something of interest. For example, the radar detects a troop of monkeys moving through the trees. The radar's computer recognises these as primates and ignores them. A few moments later a military vehicle drives through the same area. The processor immediately recognises this as a military vehicle. All the radar information pertaining to this vehicle the processor has gathered is transmitted on the V-band link to a laptop carrying sensor management software. The laptop performs additional processing, ascertaining the vehicle type, determining it as potentially hostile and predicting its possible movements. Given the size of the V-band link, the radar continues to monitor the vehicle and send the sensor management software updates for as long as the vehicle stays in the radar's field-of-view. V-band is perfect when electromagnetic discretion is needed, along with short range, and large data carriage.

The advent of MDO, as discussed above, underscores the seemingly insatiable desire for secure, efficient, redundant and robust communications links. The data burden MDO looks set to impose shows that the ability of conventional military communications links to satisfy these demands is questionable. The US Army's adoption of technologies such as 5G show that the force is looking seriously at non-traditional military communications. However, 5G will only be able to solve part of the puzzle. Other communications technologies must also be brought to the fore. Perhaps the time has come to look seriously at V-band? ■



Credit: US DOD

The US military's embrace of Multi-Domain Operations will herald exponential increases in the quantity of data which must be moved around the battlespace. These demands could place a heavy burden on conventional and non-conventional communications links.

Stryker SitRep: Enhancing Lethality and Versatility in the Medium Armoured Formation

Sidney E. Dean

Ongoing programmes to equip US Army Stryker vehicles with new weapon systems are intended to boost both lethality and survivability.

The US Army's Stryker Brigade Combat Teams (SBCT) were conceived in 1999 as an interim level armoured unit to fill the void between heavy (mechanised) and light infantry formations. The Stryker family of vehicles (FOV), based on the General Dynamics Land Systems – Canada (GDLS-C) Light Armoured Vehicle III (LAV III), was developed to equip these units. The 8×8 wheeled armoured vehicles were originally presented in 10 variants (this has now increased to 19 separate iterations); the Infantry Carrier Vehicle (ICV) and its direct derivatives, as well as the Reconnaissance Vehicle (RV) variant are the most common. GDLS won the Stryker production contract in November 2000. Between 2002 and 2014, the US Army acquired 4,466 vehicles, which currently equip eight brigade-equivalent units. While procurement of new vehicles ended a decade ago, the Stryker FOV has been repeatedly upgraded to enhance performance and survivability, or to equip portions of the fleet to perform new missions.

'Third-generation Stryker'

The most important enhancement programmes to date include the Double-V hull (DVH) upgrade initiated in 2011. The original Stryker design featured a flat underbody, but it – and a subsequent Single-V underbody variant – had proven vulnerable to IEDs in Afghanistan and Iraq. The double-hull design significantly improved survivability. An improved Double-V design (DVH A1) was tested in the period 2016-2019 and was found to have a 93% probability of completing a mission without aborting. This latest hull design is accompanied by additional engineering changes including stronger armour, a larger interior, a stronger engine and suspension, wider tyres, and enhanced onboard electrical power capacity to facilitate future network upgrades and integration of new mission equipment packages. The upgrades have led some observers to refer to the A1 series as the 'Third Generation Stryker'. "The DVHA1 offers substantial improvements in mobility, power and network interoperability. It has got a larger horsepower engine and improvements in suspension and larger tires, giving it greater ground mobility," according to Colonel William Venable, Army SBCT project manager, in June 2020. A total of seven variants are produced in the A1 configuration, including the infantry carrier vehicle (ICV), designated the ICVVA1. The first operational brigade was equipped during the second half of 2020. Conversion of flat-bottomed vehicles to the double-hull configuration is still in progress, with GDLS' current DVH A1 production contract running through FY 2025. According to an Army Request for Information (RFI) published in March 2023, the service plans to award a follow-on contract for the 2026-2031 timeframe. The RFI seeks to assess industry's capacity to produce new DVH A1 hulls and provide integration and support services.

Other ongoing major projects seek to significantly enhance the combat power of the ICV and RV variants by replacing the Protector M151 remote weapon station (RWS) which is armed with a machine gun or automatic grenade launcher. Instead, the vehicles are to be equipped with either a common remote weapon station armed with Javelin missiles (CROWS-J), or a 30 mm medium calibre weapon system (MCWS). The impetus for up-arming the Stryker was the realisation – manifested after the 2014 annexation of Crimea – that the Stryker would be at a significant disadvantage against Russian armoured combat vehicles, especially the BMP-3. The Army expects both weapon replacement programmes to enhance the survivability and combat effectiveness of the Stryker by providing overmatch against peer and near-peer adversaries. These weapon con-

Credit: US Army

Oshkosh Defense beat four competitors to win the 30 mm MCWS contract.

Credit: US Army

Launching the FGM-148 Javelin from a Stryker using the CROWS-J system.

version projects are classified as Acquisition Category 1C, which identifies them as major defence acquisition programmes. Both programmes are ongoing.

CROWS-J

The first, urgent-requirement fielding of Strykers armed with Javelin anti-tank guided missiles (ATGM) resulted in 86 such ICVs being delivered to the 2d Cavalry Regiment (2CR) stationed in Vilseck, Germany in 2018. However, the rapidly configured solution was not optimal, leading the Army to refine the technical concept. The Engineering and Manufacturing Development (EMD) contract for the improved CROWS-J system was awarded to Kongsberg Defence and Aerospace as prime contractor and primary system developer in 2019. Major partners include Raytheon/Lockheed Martin for the Javelin missile, and GDLS as systems integrator.

The CROWS-J upgrade consists of the stabilised M153 CROWS II weapon mount produced by Kongsberg, modified to fire the FGM-148 Javelin. This permits the Stryker to directly engage targets up to and including main battle tanks (MBT) at distances up to 4,000 m, while crews remain under armour. The CROWS is configured to mount a single Javelin tube at a time. After firing, the tube must be replaced. This requires two crew members to expose themselves through their hatches; an official Army video produced in April 2022 shows the procedure being accomplished within approximately 60 seconds.

In addition to the ATGM, the CROWS also carries a 12.7 mm (.50 cal) M2HB Mk2 heavy machine gun (HMG) or a 40 mm Mk 19 automatic grenade launcher (AGL), as well as an integrated surveillance and targeting sensor suite. The latter includes optronic cameras, a TIM 1500 thermal imaging module and the Storm II Laser Rangefinder (LRF). According to the Army, the sensor suite and fire control software enable setting on-the-move target reference points, programmable target reference points, programmable sector surveillance scanning, automatic target tracking and programmable no-fire zones. The combination of enhanced optics, fire control system, and elevation of the platform permits the Stryker to engage targets at a greater range than dismounted infantry are able to. "Including both optics and control of the primary vehicular weapon system, [CROWS-J allows] operators to engage targets from inside the vehicle at extreme distance with an increased resolution in the camera feed," said Colonel Andrew Kiser, commander of the Fort Carson, Colorado-based 2nd SBCT (2SBCT) upon receiving the first new systems in 2022.

Credit: US Army

Major elements of the CROWS-J weapons station include the Javelin missile, a M2HB Mk2 HMG or Mk19 AGL, and sensors including VIM-C, Storm LRF, and TIM 1500.

Credit: US Army

The MCWS is a 30 mm, unmanned turreted auto-cannon integrated on a Stryker DVHA1 ICV.

To date, the 2SBCT of the 4th Infantry Division is the only major unit to be equipped with the CROWS-J system. Those 2022 deliveries were conducted under an urgent materiel release. Officially the programme currently remains in the EMD phase. The Pentagon's Director of Operational Test and Evaluation (DOT&E) has criticised the Army's testing of the CROWS-J system. The service's Follow-On Test and Evaluation (FOT&E) of the CROWS-J was concluded in November 2021. Numerous technical issues were detected during this process, which included software reliability problems, as well as system integration challenges which led to slower-than-anticipated engagement of targets. The Army and Kongsberg have been working to remedy these shortcomings, however, the DOT&E's annual report published in January 2023 notes that the Army has not verified through testing that these issues have actually been resolved. The report recommends that the Army convene a failure review board while continuing to implement corrective actions, then conduct a new FOT&E to verify that all deficiencies have been addressed. Additional brigades will subsequently be equipped under a conditional materiel release after resolution of the issues discovered during the 2021 FOT&E. The conversion is slated to run through 2027.

Credit: Lockheed Martin

Stryker ICV configured with the TLS-BCT EW system.

30 mm MCWS

The Army's first effort to install a 30 mm cannon on the Stryker dates back to an urgent requirements request presented by the 2CR in April 2015. Emergency funding was allocated to design and equip a stabilised, unmanned, medium-calibre turret-30 mm (MCT-30) weapon system. Infantry carriers receiving the new turret were designated the Dragoon or ICV-D. A total of 81 units were delivered to the 2CR in early 2018; this represents half of the vehicles in the regiment's rifle and scout platoons, balancing out the Javelin-armed Strykers delivered to the unit that same year. As soldiers gained experience with the Dragoon, a few weak points became apparent (over and above the fact that the 30 mm turrets had been applied to original-build, comparatively vulnerable flat-bottomed Strykers).

The Army later rebooted the programme with the intent to outfit Double-V hull ICV vehicles with the 30 mm cannon. A new engineering concept competition was conducted in the period August-December 2020, with the 30 mm MCWS design presented by Oshkosh Defence selected. The firm has partnered with Pratt Miller and Rafael Advanced Defense Systems for the project. The contract for production and fielding the MCWS for "up to" six SBCTs was awarded to Oshkosh in June 2021. The cumulative contract – which also includes complete system technical support, interim contractor logistics support, and integrated product support – is valued at USD 942.9 M. Orders for 91 and 83 MCWS equipped vehicles were placed in June and August 2021 respectively, with the goal of outfitting the first two brigades.

The primary component of the MCWS is the 30 mm XM813 cannon mounted on a modified Rafael SAMSON turret. The weapon will fire the MK 238 high explosive incendiary – tracer (HEI-T) anti-materiel/anti-personnel round and the MK 258 armour-piercing fin-stabilised discarding sabot-tracer (APFSDS-

T) round; both munitions are produced by Nammo. According to the firm, the armour-piercing round can penetrate 100 mm of rolled homogenous armour equivalent (RHAe) at 1,000 metres. Other elements of the new weapon system include smoke grenade launchers, a mount for an optional 7.62 mm machine gun, a fire control system, a stabilised day/night sight system, and an automated dual-feed ammunition handling system for the main gun. The dual-feed system provides the ability to deploy programmable airburst munitions, as well as the HEI-T and AFPSDS-T. The armour-piercing munition, in particular, permits the Stryker to effectively engage medium armoured fighting vehicles. According to an Army statement, the weapon system supported by high-performance optics will ensure the MCWS-equipped Stryker can engage targets at ranges of 3,500 metres.

To accommodate the new weapon system and to make full use of its capabilities, the upgrades will also include some redesign measures including: a new hull configuration; increased protection; upgraded suspension and braking system; wider tyres; blast-attenuating seats; and a height management system (HMS) which allows the crew to modify ground clearance through hydro-pneumatic suspension struts.

The DTO&E approved the Army's Test and Evaluation Master Plan for the 30 mm MCWS in June 2021. The first seven Stryker ICVVA1 vehicles with the new weapon suite were delivered to the Army for testing in August 2022 for production verification testing (PVT). The 1-2 SBCT based at Joint Base Lewis-McChord (JBLM) in Washington State will be the first major unit to be equipped with the 30 mm MCWS. Fielding to the 1-2 SBCT is being conducted under a conditional materiel release pending completion of the FOT&E and the Live Fire Test & Evaluation (LFT&E) by the end of Fiscal Year 2023. Test results will be reported to the DOT&E, which will assess test adequacy and publish a combined FOT&E/LFT&E report in the first quarter of FY 2024. Deliveries to three SBCTs are expected to be completed by the end of 2027.

Air Defence and EW in, MGS out

The mobile, distributed lethality upgrades represented by the MCWS and the CROWS-J will provide better tactical options than the Stryker Mobile Gun System (MGS) which was one of the original 10 Stryker variants. Citing operational obsolescence as well as sustainability issues with the 105 mm MGS – which had originally been devised to support infantry assaults by destroying or suppressing enemy bunkers, machine guns and sniper positions – the Army retired the MGS in late 2022.

Overall, however, the Stryker FOV continues to add new variants. This includes an electronic warfare (EW) vehicle deploying the Terrestrial Layer System – Brigade Combat Team (TLS-BCT) which combines cyberspace operations, EW and signals intelligence capabilities. Contributions range from jamming enemy UAVs to disrupting enemy communications networks to providing brigade commanders with enhanced situational awareness. Lockheed Martin won the contract to

Credit: Leonardo DRS

M-SHORAD launching a Stinger very short range surface-to-air missile.

outfit Strykers with the 'next generation' EW system in April 2023.

The Stryker ICV also serves as the platform for the Army's Maneuver Short-Range Air Defense (M-SHORAD) system. M-SHORAD is intended to defend mobile forces from the full spectrum of air-breathing threats including fixed-wing and rotary aircraft, cruise missiles, and UAVs. The initial procurement decision was made in 2018. Stryker was chosen because of the armoured vehicle's survivability and manoeuvrability, as well as the onboard power capacity.

The M-SHORAD system is being implemented in three increments. Increment I calls for 144 vehicles, sufficient to outfit four battalions of 40 systems each (further procurement for up to five additional battalions remains an option). The first unit to be fully equipped is the 5th Battalion of the 4th Air Defense Artillery (5-4 ADA) stationed in Ansbach, Germany, which received its full complement in 2021-2022. The second unit will begin fielding in the 4th quarter of FY 2023. The Increment I vehicles' weapons turret mounts two AGM-114L Longbow Hellfire missiles capable of hitting ground targets, four FIM-92 Stinger family missiles, an XM914 30 mm cannon and an M240 7.62 mm machine gun. Leonardo DRS, which received the systems integration contract, provides the multi-mission RADA fire control/air surveillance radar system with 360° coverage. This con-

Credit: RTX

Prototype DE-M-SHORAD mounting a 50 kW laser developed by Raytheon.

figuration is in the process of being revised slightly – according to US Army M-SHORAD operators who spoke to ESD, the Longbow Hellfire missile armament is due to eventually be replaced by a second pod of four Stingers.

Increment 2 is also designated as the Directed Energy Manoeuvre SHORAD (DE M-SHORAD). Kord Technologies and their industry partner Raytheon Intelligence & Space were selected in 2019 and 2021, respectively, to jointly integrate and test a 50 kW laser and associated sensors on the Stryker ICV. The laser will be powered by high-capacity batteries which are charged by the Stryker's diesel engine. The primary mission will be to counter UAVs, as well as counter rocket, artillery and mortar (C-RAM) operations. While early testing has proven successful against a variety of UAVs and some mortars, the Army reports that challenges remain for the C-RAM role. The first four DE M-SHORAD systems were delivered to Fort Sill, Oklahoma between January and September 2023. The Army had delayed the deliveries by several months in order to ensure technical maturity had been achieved. The first four units will form a platoon assigned to an active duty air defence battery. The platoon's personnel will develop tactics, techniques and procedures before beginning the operational user assessment phase in 2024. An additional eight systems are to be delivered through 2024, whereby the Army has stated that unspecified design changes are already planned for those units. Lt. General Robert Rasch, director of the Army's Rapid Capabilities and Critical Technologies Office, stated in August 2023 that DE M-SHORAD will transfer to the Program Executive Office Missiles and Space in 2025, becoming an acquisition programme of record.

M-SHORAD Increment 3 will be based on Increment 1. It will replace the aging Stinger missile with its designated successor, the next-generation short-range interceptor. This weapon is currently in the design and development stage, though a production decision is not expected before FY 2027. Increment 3 will also add the XM1223 multi-mode proximity airburst (MMPA) munition to the 30 mm cannon's arsenal. Development of the MMPA is expected to begin in 2024.

StrykerX

The Army plans to operate the Stryker FOV through 2050. GDLS presented a concept demonstrator dubbed StrykerX at the 2022 Association of United States Army (AUSA) defence exhibition. Not intended as the basis for an immediate production tender, the StrykerX showcases advanced technologies which could flow into future medium-weight armoured vehicles, including any future Stryker iterations. Improvements include: side-by-side seating for the driver and commander, permitting the latter to take control of the vehicle if needed (current Strykers have a tandem configuration with the commander behind the driver); a roomier passenger cabin; integrated APS; integrated cyber-defence capability; a roof-launched reconnaissance UAV; a hybrid diesel-electric propulsion system which would reduce fuel consumption and thermal emissions while enabling silent overwatch and silent movement to objective. With the Army seemingly intent on constant incremental improvement of the Stryker FOV, it is quite possible that some of these technologies will find their way into future upgrades. ■

Balancing the Artillery Picture

David Saw

About 19 months have passed since the Russian invasion of Ukraine. What was supposed to be a rapid campaign taking just a few days, has morphed into a grinding attritional battle, with both sides continuing to suffer significant personnel and materiel losses. In the midst of this dreadful conflict, it has become clear that artillery has returned to claim a major, some might say pre-eminent, role on the modern battlefield.

In the context of artillery, the conflict in Ukraine is the most significant utilisation of both tube and rocket artillery in the modern era. As such, it will clearly influence artillery system acquisition and the development of operational doctrine in Europe and beyond.

Credit: Ukrainian Ground Forces

Poland has supplied Ukraine with a substantial quantity of defence equipment; including 72 AHS Krab 155 mm L52 self-propelled howitzers, and subsequently Poland ordered 54 more systems. Note the effort to obtain some concealment for this particular system.

Soviet legacy

When Russian troops invaded Ukraine, both sides had an artillery park that was primarily based on Soviet-era systems, munitions and, in many cases, employment doctrine. In the Imperial Russian Army and then the successor Soviet Army, considerable prestige was attached to service in the artillery branch. The Soviet military was also wedded to analysing its combat experiences, and this was particularly true of the 'Great Patriotic War' of 1941-1945. All aspects of the conflict were analysed in depth in the Soviet General Staff studies of all of the major combat operations. Moreover, many of these operations took place in areas where the current conflict between Russia and Ukraine is being fought.

The studies prepared by the Soviet General Staff are still incredibly relevant, for example the use of defensive works by the Soviet Army at Kursk in 1943, finds an echo in the defensive belts and minefields constructed by the Russian Army to defend its position in Ukraine. The objectives are the same, offensive actions by the opponent are absorbed by the defensive belts, these weaken the opponent via attrition and remove offensive impetus, opening the way to a counterattack or creating an operational stalemate.

Credit: Ukrainian Ground Forces

The BM-21 and its many variants are used by both Russia and Ukraine in the current conflict.

The importance of 'Great Patriotic War' combat operations on Soviet and post-Soviet artillery developments cannot be underestimated. Between 1941 and 1944, Soviet estimates were that artillery caused 51% of their combat casualties. In 1945, that figure had risen to 61%! As a comparison, in the Korean War (1950-1953) it is estimated that some 60% of US troops killed in action resulted from blast or fragments from artillery and mortars.

Another important point to bear in mind is that Soviet artillery was based on both tube artillery and multiple rocket launcher (MRL) systems. Indeed, the Soviet Army was the first to introduce MRL systems to combat, on 14 July 1941, near the Orsha railway junction in what is now Belarus. The combat power of Soviet artillery grew substantially during the conflict on the

Eastern Front and by the end of hostilities it was determined that some 70% of opposition personnel and materiel losses were caused by artillery. The critical lesson learned during the conflict on the Eastern Front was that the suppression and destruction of enemy artillery was the prerequisite to success on the battlefield in both offensive and defensive operations.

Artillery evolved beyond a simple choice between tubes and MRL systems, as rocketry in the form of tactical ballistic missiles (TBM) entered the equation. Soviet artillery deployed the 2K6 Luna, with two configurations known as Frog 3 and Frog 5 to NATO. The missile had a maximum range of 45 km and could accommodate either a nuclear or HE warhead. Then came the far more successful 9K52 Luna-M (Frog 7) with a range of 65 km and choice of nuclear warheads with selectable yields from 3 kT up to 200 kT. In addition, there was an HE-FRAG warhead, a chemical warhead with a VX nerve agent payload and a warhead with sub-munitions.

The successor to the Frog was the OTR-21 Tochka/Tochka-U, the Tochka arrived in the mid-1970s, with the Tochka-U fielded at the end of the 1980s. Warheads were HE-F, sub-munition, EMP and nuclear, with yield scalable from 10 kT to 100 kT. Range for the initial Tochka was 70 km and the Tochka-U could reach 120 km. Tochka systems have been utilised by both Russia and Ukraine in the current conflict. Equivalent Western systems included the Lance, in service from the early 1970s to the early 1990s, with a range of 121 km and a selection of nuclear warheads, including a neutron warhead, plus sub-munition and HE warhead options. France had its own system in the form of the Pluton, in service from the mid-1970s to the early 1990s. This had 15 kT or 25 kT nuclear warheads, plus an HE warhead option and a range of around 120 km.

All of these systems with ranges out to 120 km could be classified as battlefield or pre-strategic systems. Ballistic missiles, such as the R-11 and R-17 Scud with maximum ranges beyond 300 km (Scud B) out to 700 km (Scud D) and the 9M723 missile for the Iskander-M system was introduced by Russia in 2006 with a range out to 500 km, are dual-capable systems. These are dual-capable systems, capable of being outfitted with nuclear or conventional warheads. While numerous states retain both nuclear and chemical rounds for their artillery, thankfully, major conflicts involving Weapons of Mass Destruction (WMD) have not broken out in recent years.

The Current Environment

As military art moved beyond the use of WMD, the primacy of artillery as the central source of firepower for ground forces was increasingly challenged by airpower. Aircraft in ground-attack missions were joined by attack helicopters, for the US and other NATO nations it was control of the air that was seen as a truly decisive element in ensuring successful outcomes in ground combat. It is impossible to underestimate the importance of air superiority over the battlefield, but the assumption that air superiority will always be achievable is where problems start to arise. In the ongoing Russo-Ukrainian conflict, neither side has been able to achieve air superiority, meaning the role of artillery has returned to pre-eminence.

As shown in the accompanying tables (see Tables 1, 2 & 3), both Russia and Ukraine were equipped with virtually the same artillery systems at the start of the conflict in terms of towed, self-propelled and MRL systems. Both sides were therefore fully cognizant of the performance parameters of the op-

Table 1: Soviet Calibre Towed Artillery in Russian & Ukrainian Service

Calibre	Designator	Russia	Ukraine
100 mm gun	MT-12	Yes	Yes
120 mm gun/mortar	2B16 Nona-K	Yes	Yes
122 mm howitzer	D-30	Yes	Yes
130 mm gun	M-46	No	Yes
152 mm gun/howitzer	D-20	Yes	Yes
152 mm howitzer	2A65 Msta-B	Yes	Yes
152 mm howitzer	2A36 Giatsint-B	Yes	Yes

Table 2: Soviet Calibre Self-Propelled Artillery in Russian & Ukrainian Service

Calibre	Designator	Russia	Ukraine
120 mm gun/mortar	2S23 Nona-SVK	Yes	No
120 mm gun/mortar	2S9 Nona	Yes	Yes
120 mm mortar	2S34 Khosta	Yes	No
120 mm mortar	BARS-8MMK	No	Yes
120 mm mortar	BTR-3M2	No	Yes
122 mm howitzer	2S1 Gvozdika	Yes	Yes
152 mm howitzer	2S3 Akatsiya	Yes	Yes
152 mm howitzer	2S5 Giatsint-S	Yes	Yes
152 mm howitzer	2S19 Msta-S	Yes	Yes
152 mm howitzer	2S33 Msta-SM2	Yes	Yes
203 mm howitzer	2S7 Pion	No	Yes
203 mm howitzer	2S7M Malka	Yes	No
240 mm mortar	2S4 Tyulpan	Yes	No

Table 3: Soviet Calibre Multiple Rocket Launchers in Russian & Ukrainian Service

Calibre	Designator	Russia	Ukraine
122 mm	BM-21 Grad	Yes	Yes
122 mm	2B26 Grad-K	Yes	No
122 mm	Bastion-1	No	Yes
122 mm	2B17M Tornado-G	Yes	No
220 mm	BM-27 Uragan	Yes	Yes
220 mm	TOS-1A	Yes	No
220 mm	Bureviy	No	Yes
300 mm	BM-30 Smerch	Yes	Yes
300 mm	9K515 Tornado-S	Yes	No

position's artillery. Not to forget the practical artillery experience gained by both sides during combat operations in the Donbas from 2014 onwards. Bearing these facts in mind, plus the fact that Russia had a significant numerical advantage in artillery systems, the fact that they were unable to dominate the battlefield with their artillery is a major failure. That being said, in the initial period of the current conflict, Russian planning was based on a victory in days with the rapid collapse of Ukrainian resistance. In those circumstances it would not have been necessary to utilise the plethora of artillery systems available to Russian forces.

Table 4: NATO calibre Towed Howitzers Supplied to Ukraine post-February 2022

Calibre	Designator	Source
105 mm	L118/L119/M119 Light Gun	UK + US
105 mm	M101	Lithuania + Others
105 mm	Model 56	Spain
155 mm	FH-70	Estonia + Italy
155 mm	TRF1	France
155 mm	M777	US, Australia + Canada

Table 5: NATO sourced/Indigenous Self-Propelled Howitzers Supplied/ To Be Supplied to Ukraine

Calibre	Designator	Source
152 mm L37	ShKH vz.77 Dana	Czech Republic
152 mm L37	Dana M2	Czech Republic
155 mm L39	M109A3GN	Norway
155 mm L39	M109L	Italy
155 mm L39	M109A4BE	via UK
155 mm L39	M109A6	US
155 mm L39	M109A5Ö	Latvia
155 mm L39	AS90	UK
155 mm L52	Zuzana 2	Slovakia
155 mm L52	Caesar	France, Denmark
155 mm L52	PzH 2000	Germany, Netherlands, Italy
155 mm L52	AHS Krab	Poland
155 mm L52	T-155 Firtina	Turkey
155 mm L52	RCH 155	Germany
155 mm L52	Archer	Sweden
155 mm L52	2S22 Bohdana	Ukraine

Table 6: NATO-sourced Multiple-Rocket Systems Supplied/ To Be Supplied to Ukraine

Calibre	Designator	Source
122 mm	RM-70	Czech Republic
122 mm	RM-70 Vampire	Czech Republic
122 mm	BM-21	Czech Republic (ex-Bulgaria)
122 mm	BM-21	Poland
122 mm	APR-40 (BM-21)	Romania
128 mm	RAK SA-12	Croatia
227 mm	M270B1 MLRS	UK
227 mm	M270 MARS MLRS	Germany
227 mm	M270A1 LRU MLRS	France
227 mm	M270A1 MLRS-I	Italy
227 mm	M142 HIMARS	US
230 mm	TRLG-230	Turkey

For all of the new thinking on artillery, there are also old lessons that are still proving their relevance today. The first of these is ammunition and its usage, which has far outstripped expected norms. Admittedly, both sides are firing a prodigious number of rounds, but from the perspective of NATO forces, it was always known that far too many nations lacked adequate ammunition stockpiles for any form of sustained combat operations. Years of asymmetric conflicts hardly created an environment for budgets to be sympathetic towards artillery systems and ammunition.

Another old lesson that has shown its importance time and again is that it is vital to suppress hostile artillery if any real offensive or defensive progress is to be made. This led to the counter-battery mission taking on critical importance and to countermeasures being employed. Typically, artillery systems would be dispersed and would go rapidly into and out of action before moving to a new location, hopefully before they could be engaged. One significant development in the current conflict has been the targeting of artillery systems and their associated command and support elements by UAVs, which adds further complexity to the effective management and utilisation of artillery assets.

There are many lessons to be learned from Ukraine; arguably the most significant is an old lesson – the importance of effective artillery on the battlefield. As previously noted, at the start of the current conflict, both Russia and Ukraine used essentially the same artillery systems. Ukraine would then receive international assistance (see Tables 4, 5 & 6) in terms of the supply of towed, self-propelled and MRL artillery systems.

The arrival of these foreign artillery systems was obviously welcomed by the Ukrainian Ground Forces (UGF). However, finding crews for all of these new systems, training on how to use them, and then understanding their operational characteristics for full effect, has represented a massive challenge. Beyond that was the logistics and support challenge for these new systems, and all of sudden you are dealing with new ammunition types in unfamiliar calibres and a host of other problematic areas.

Learning lessons

There is extensive OSINT information regarding artillery in the Russo-Ukraine conflict; whilst it might not be 100% reliable, it does enable key trends to be identified. One of the most significant is the vulnerability of towed artillery systems – here loss rates have become alarming.

Credit: Ukrainian Ground Forces

A pair of D-30 122 mm howitzers abandoned in the early phase of the Russian invasion of Ukraine in 2022. Towed artillery has proven extremely vulnerable in this conflict. According to open sources, at the time of writing, Russian forces have lost a total of 76 D-30 howitzers since the start of the current conflict.

Major towed artillery system losses for Russia included 76 D-30 122 mm howitzers, 109 2A65 Msta-B 152 mm howitzers and 39 2A36 Giatsint-B 152 mm field guns. For Ukraine, losses of equivalent systems included nine D-30, six 2A65 Msta-B and 14 2A36 Giatsint-B units. Turning to foreign equipment supplied to Ukraine, a total of 67 M777 howitzers have been lost, captured or damaged, equating to a third of the number of these systems supplied. Readers should also note that Ukrainian losses tend to be under-reported in many Western sources, and the real loss figures are likely far higher.

It would appear that towed artillery has become incredibly vulnerable in an environment where rapid counter-battery action is a key mission. It takes too long to get into and out of action and then redeploy. Another issue is that many of these towed guns are out-ranged by opposing force artillery systems. In a manoeuvre battle, the limitations of towed artillery are readily apparent, but in a defensive battle where the frontline is static and towed systems can be dug in and better protected, they still have a role to play. If towed systems are to be used, camouflage and concealment are priorities.

Bearing in mind the limitations of towed artillery, self-propelled artillery emerges as the logical solution to artillery requirements. However, they have also proven to be vulnerable in the current conflict. For example, looking at Soviet-era systems operated by both sides. Russia has lost 82 units of the 2S1 Gvozdika and 132 2S3 Akatsiya howitzers, while Ukraine has lost 75 Gvozdika and 34 Akatsiya systems.

Other Russian self-propelled artillery losses have also been severe, and include 42 2S5 Giatsint-S, 143 2S19 Msta-S and 34 2S33 Msta-SM2 howitzers. Ukraine has employed captured Msta-S systems and has also lost some of these in combat. As for Ukraine, they have lost 34 M109s, 21 AHS Krabs, four CAESARs, three Giatsint-S, three AS90s, and small or single quantities of other models. A number of factors influence these loss rates, primarily how and where artillery is employed. Performance in this regard inevitably improves with combat experience. Also important is system performance, with range a critical determinant. The greater the range envelope of a particular system, the greater the deployment possibilities to maximise performance and minimise risk.

The last category of artillery losses to be evaluated is in the category of MRL systems. Once more, Russian losses are severe. They are said to have lost as many as 163 BM-21 Grad 122 mm MRL and smaller quantities of other Grad variants, plus 17 of the modern 2B17 Tornado-G system. Also lost are 67 BM-27 Uragan 220 mm systems and two BM-30 Smerch 300 mm system. Ukrainian MRL losses are reported to include 38 BM-21 systems and three RM-70 systems with a similar performance envelope, six BM-27 Uragan and a single Bureviy.

It is noteworthy that according to the open source figures Ukraine has not lost any of its M270 MLRS or M142 HIMARS systems. These high-value systems are not being risked in the same way that lower-performance MRL systems are. Using GMLRS rockets such as the M30/M31, ranges of out to 84 km can be achieved. More recently, M30A1 rockets have been supplies, and these use a high explosive fragmentation warhead with a large quantity of tungsten fragments, which are suitable to engaging lightly armoured area targets in the open.

One frustration for Ukraine is the limitations that they face in terms of the equipment that they can acquire. In the context of MLRS/HIMARS, they would really like to add ATACMS to their rocket arsenal. ATACMS would enable them to accurately engage targets out to 300 km, offering obvious operational advantages. Presumably

Credit: USMC

A HIMARS rocket system conducts a launch during a US Marine Corps Combat Readiness Evaluation (MCCRE) at Camp Lejeune, North Carolina, in July 2023. For Ukraine the supply of the HIMARS system has added vital capabilities for long-range precision strike engagements.

the US is withholding ATACMS to avoid escalation, something that would be difficult to explain to the Ukrainians as their cities and civilian populations are targeted. In future, ATACMS will be replaced in US service by the Precision Strike Missile (PrSM), which has a range of 499 km, with the possibility of further extending this range in future modifications.

Credit: Maavoimat

The Hanwha K9 Thunder 155 mm L52 SPH has been adopted by Estonia, (as shown here), Norway and most recently by Poland who have placed massive orders for the system. Initially Poland ordered 48 K9 systems, but with local production the total number acquired could be around 672.

Looking Ahead

The conflict in Ukraine has provided real lessons on the employment of artillery in a conventional conflict under modern conditions. The knowledge gained from the war in Ukraine ought to change how other ground forces think about artillery in terms of acceptable performance, deployment, command and control (C2) and provision of ammunition and support. First and foremost, this conflict has transformed the artillery ammunition production picture in Europe. All of a sudden, serious 155 mm ammunition orders are being placed and in the case of Ukraine, significant 122 mm ammunition production has commenced. With artillery ammunition being fired at rates that were typical of intense combat in World War II, levels of ammunition that were once thought adequate have been exposed as totally inadequate.

Regarding tube artillery systems, the key performance factors would be mobility, into and out of action time, the dispersal of fire units, and the ability to accurately engage targets at extended ranges. Friendly artillery would ideally out-range hostile artillery, thus maximising deployment possibilities and dominating the artillery battle. There are now doubts over the long-term viability of towed artillery, which in turn leads to concerns over artillery support for air mobile operations, with new thinking and new artillery systems required to support airmobile operations. Successor systems to the 105 mm Light Gun and the M777 will likely have to operate in far more challenging environments.

This indicates that self-propelled tube artillery is the basis for ground forces to build their artillery future. The presence of 155 mm L52 ordnance has transformed the capabilities of tube artillery systems, but as noted, more performance in terms of extended engagement ranges is required. Rheinmetall is working towards increasing the range of current 155 mm L52 systems from 40 km out to 63 km and then to 68 km in the medium term. Beyond that, they are looking at an L60 weapon to attain a range of 82 km.

Others are also working on extending artillery system ranges. In the Republic of Korea (ROK), the K9A2 variant of the K9, presently completing development, is being fitted with an autoloader capable of allowing a rate of fire of 10 rounds per minute. Further down the line, the planned K9A3 variant is slated to receive an L58 gun, increasing ranges by approximately 10 km over the existing limits (roughly 50-80 km depending on the ammunition type). After that, a future robotised variant of K9 could be capable of fully autonomous operation.

Fielding artillery with the extended ranges under discussion will be a major development, but future systems will need to have the ability to reliably acquire, designate and engage targets at these extended ranges. Identifying and engaging threats before being engaged is critical. Another important item is that artillery systems must have enhanced protection, and obviously improved mobility, plus camouflage and concealment will help. However, the UAV threat needs to be countered as a matter of urgency, with both soft-kill and hard-kill C-UAV means being required.

The availability of HIMARS and MLRS systems has provided Ukraine with a long-range precision strike capability, as previously noted though, the US has been reluctant to supply extended-range ATACMS missiles that would further increase the reach of these systems. Despite that, the ability to engage high-value targets such as bridges, ammunition dumps and command centres at extended ranges has been immensely valuable.

The operational potential of HIMARS and MLRS, plus the possibilities on offer from extended range rockets, make these systems an important capability. The downside of this is that everybody now recognises what these systems are capable of and opposing forces will therefore look to neutralise such systems as a matter of urgency. Asset protection will therefore become very important when fielding HIMARS and MLRS.

The US Army is developing a new self-propelled artillery system and in parallel, it will field new generation extended-range rockets (ER GMLRS and PrSM) for HIMARS and MLRS. Elsewhere, the British Army is upgrading its MLRS launchers to the M270B1 configuration allowing the use of the Guided ER GMLRS rocket. In parallel, the UK is moving forward with a new 155 mm artillery system in the form of the Mobile Fires Platform (MFP). These are just two examples of the enduring belief that the future of artillery is based on a balanced force consisting of self-propelled tube and rocket systems. ■

Credit: UK MoD

March 2023, Ukrainian Ground Forces (UGF) personnel train in the UK on AS90 155 mm L39 self-propelled howitzers. The UK committed to supply the UGF with a battery of eight AS90s at 'high readiness' and a further two batteries at 'varying states of readiness'.

DIMDEX 2024

Doha International Maritime Defence Exhibition & Conference

معرض ومؤتمر الدوحة الدولي للدفاع البحري

04 - 06 MARCH | مارس

www.dimdex.com

MARCH 04-06 2024

@DIMDEXQatar

Strategic Partner

بـرزان الـقـابضـة
BARZAN HOLDINGS

Hosted & Organised by

القوات المسلحة القطرية
QATAR ARMED FORCES

Official Show Guide Producer

EventGuides

Media Partners

The Chanakya Aerospace Defence & Maritime Review

المسلح - MISAH Magazine

APDR

ARMADA International

Asian Military Review

Defense Arabia دفاع العرب

Defence Procurement International

Defence Review Asia

Defence Turkey

دفاع Defence

ESD European Security & Defence

Mittler Report

السفينة Robban Assafina

sourceSecurity.com making the world a safer place

Acquiring Future Land Fires Capabilities for Multi-Domain Operations

Manuela Tudosia

Marking the return of high-intensity conflict, the war in Ukraine has exposed the long-overdue need to invest in land fires capabilities.

In Europe, short-term needs can be identified in the assistance instruments designed for Ukraine, such as the 'European Peace Facility' financing the provision of 155 mm artillery rounds and, if requested, missiles. Short to medium-term needs can be deciphered in the 'Joint Communication on the Defence Investment Gaps Analysis and Way Forward' issued by the EU Commission and the High Representative for Foreign Affairs and Security Policy in May 2022. The investment gaps analysis, resulting from a coordinated effort between the EU Commission and the European Defence Agency (EDA), reveals among the "most urgent capability gaps" the need to replace existing Soviet-era legacy systems still in use within EU armed forces with modern European solutions, including heavy artillery. Among strategic medium- to long-term capabilities, the analysis and Joint Communication proposes to work on modernisation of anti-access/area denial (A2/AD) systems in the Air domain, and "combat support, notably a wide range of anti-tank and artillery systems, with an emphasis on precision strike and counter-artillery", in the Land domain.

The Joint Communication was followed in July 2022 by the EU Commission's proposal for a 'European Defence Industry Reinforcement Through Common Procurement Act (EDIRPA)', expected for adoption in September 2023 after intense political negotiations. EDIRPA incentivises common procurement by the EU Member States of the most critical and urgent defence products and will likely have a total budget of EUR 300 M, as the result of the political agreement between the European Parliament and the Council of the EU indicates.

Credit: US Army/Dori Whipple

155 mm projectile storage at Blue Grass Army Depot, Kentucky. Demand for artillery ammunition of all types, in particular 155 mm rounds, has grown rapidly in the West following high rates of ammunition expenditure by Ukraine.

Conflict in Ukraine

Like many other capabilities, the acquisition of future fires is likely to be an integral part of emerging concepts, notably Multi-Domain Operations (MDO). MDO seems to mean "different things to different nations" according to LTC Jose Diaz de Leon from the NATO Joint Warfare Centre who explained how the complex concept of MDO can be understood in the NATO context. Despite variations of interpretation, a common but less noticed aspect appears in several official publications, starting with the 'U.S. Army in Multi-Domain Operations 2028' released in December 2018 and considered to be among the originators of the concept. This common aspect is a differentiation between "below the threshold of armed conflict" or "competition", and "armed conflict". The transition between the two states can happen very quickly, and requires commensurate capacity of swift response. This distinction can also be found in the UK 'Joint Concept Note 1/20 on Multi-Domain Integration' published in November 2020, or other NATO members' MoD publications, for example, the Norwegian 'Military Advice of the Chief of Defence 2023'.

As the 'U.S. Army MDO 2028' highlighted, three years before the 2022 Russian invasion of Ukraine, revisionist powers such as Russia or China attempt(ed) to create multiple layers of stand-off to achieve their goals. During the state of "competition", aiming to "win without fighting", stand-off is sought without resorting to armed conflict by "fracturing (US's) alliances, partnerships and resolve" through the use of diplomatic and economic actions, as well as unconventional and information warfare. Threatened employment of conventional forces is also used to achieve goals during competition, and even actual employment of them. During the state of armed conflict, physical stand-off is sought "by employing layers of anti-access/area denial systems (A2/AD) designed to rapidly inflict unacceptable losses (…)".

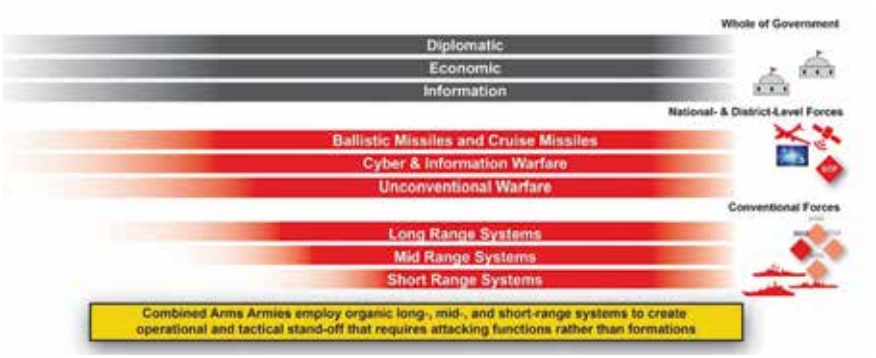
Author

Manuela Tudosia is government affairs expert in defence, and contributor to the NATO Industrial Advisory Group and NIAG Industry Interface Group. She is also founder of the Pole CM [Civil-Military Innovation Network], initiative that provides strategic advice to Small- and Medium-Sized Enterprises in defence.

During the last two decades of counter-insurgency operations, air superiority was relatively unchallenged and operational approaches were time-phased, domain-federated, and thus predictable. The 'U.S. Army MDO 2028' points to the fact that this predictability had become a vulnerability which could be exploited by the opponent by creating layers of A2/AD systems which can (physically) separate the elements of the Joint Force in time, space, and function.

Russia's stand-off approach is explained as having three layers: whole of government, national and district level forces, and conventional forces. Its elements are visible in fig 1.

Russia's – and, for that matter, any adversary's – long-range fires capabilities present a particular challenge because, with these, the 'support areas' of their opponent's battlefield can be targeted. Support areas can cover forward postured forces, prepositioned equipment and stocks, but also – with sufficient range and precision – military land, air and maritime infrastructure and maintenance hubs, and civilian infrastructure. Advanced mid-range radars and surface-to-air missiles (SAMs), capable of integration with long-range systems, are thought to pose a significant threat in the 'U.S. Army MDO 2028'. Employment of massed tube artillery and multiple rocket launchers (MRLs) could destroy friendly ground forces before these have time to close with enemy manoeuvre forces. Mid-range fires are all the more enabled by networked multi-domain reconnaissance forces that are deployed in depth, for example, ground observation teams, unmanned aerial vehicles, radars, and signal intercept units. Mid-range systems thus help to create a stand-off which allows ground manoeuvre forces to occupy terrain by using short-range systems. In turn, this enables protection of friendly long- and mid-range fires systems and finding the location of the opponent's forces for subsequent targeting and engagement with short- and long- range fires.



Credit: US Army

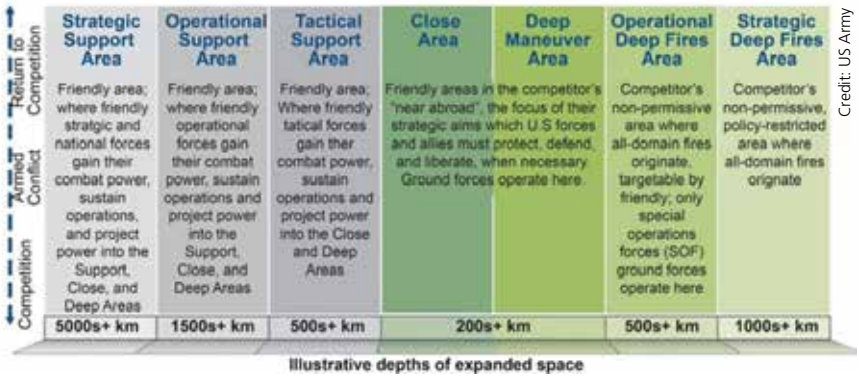
Fig 1: US Army conception of notional adversary's layered stand-off. From: 'The US Army in Multi-Domain Operations 2028; TRADOC Pamphlet 525-3-1'.

Re-thinking our Fires Capability Requirements

Far from being a comprehensive description of all elements of the MDO concept, the operational characteristics broadly described above, require a rethinking of capability requirements, including future fires. These should enable deterrence during competition and during armed conflict, they should be integrated at all echelons to enable joint force manoeuvre, including by penetrating and defeating the adversary's A2/AD systems.

Defining the future role of the fires warfighting function, the 'US Army Futures Command Concept for Fires 2028' (AC-Fires) is a useful document to understand related capability needs and technological trends on the basis of the MDO battlefield framework explained in the same document. As mentioned above, the battlefield is expanded into support areas due to the availability of long-range fires capabilities.

AC-Fires considers a broader space by seeing the traditional deep, close, and rear areas



Credit: US Army

Fig 2: MDO framework for areas of the battlefield. From: 'US Army Futures Command Concept for Fires 2028'.

Credit: US Army

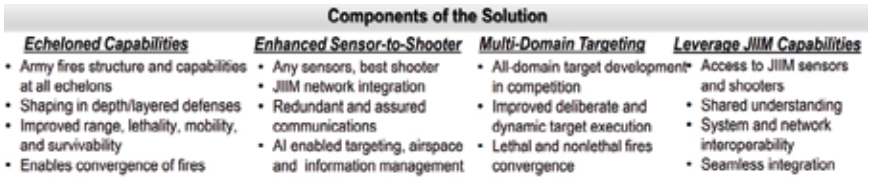


Fig 3: The proposed solution for success in MDO. From: 'US Army Futures Command Concept for Fires 2028'.

of the battlefield at more granular levels, which helps to better illustrate the distribution of friendly and adversary forces, as well as where and how they may employ capabilities, as shown in fig 2.

According to AC-Fires, army fires must facilitate deterrence during competition and, in armed conflict, integrate and employ fires at all echelons throughout the depth of the MDO battlefield framework. As can be seen, the depth can vary between 0 km and 1,000+ km. An obvious need that emerges is the ability to increase and adapt the range of the fires. Since massed fires can be extremely resource-consuming, leading quickly to the depletion of stocks without necessarily hitting high-value targets, achieving precision appears as a second obvious need. An underlying need besides extended range and precision is the capacity to reach the target at increased speed, to create surprise and deny the enemy sufficient reaction time. The most illustrative example, widely recognised and stated nowadays, is the hypersonic threat – notably hypersonic missiles. However, increase of speed is also sought at lower, more tactical levels.

If these are obvious needs on the offensive, on the reverse side of the coin, it is assumed (or demonstrated) that the opponent will have the same offensive capabilities. Therefore, a complementary obvious need, is to invest in layered and in-depth defences. Among these is the capacity to intercept and destroy the offensive fires, which also require adaptation of range, accuracy and speed.

In the multi-domain setting, ground forces should be able to rapidly integrate with forces of other domains (Air, Navy, Cyber, special forces), so the commander can be provided with multiple options to target and strike the opponent. In turn, this provides the joint force the ability to infiltrate and to overwhelm dispersed adversary formations that are assumed to be concealed and to benefit from strong integrated air defences and long-range precision strike capabilities.

To achieve convergence and create synergistic effects in all domains, AC-Fires proposes a solution for success in MDO that has four components: echeloned capabilities, enhanced sensor-to-shooter linkages, multi-domain targeting (lethal and non-lethal), and leveraged joint, interagency, intergovernmental, and multinational (JIIM) capabilities. Many fires requirements can be derived and understood by simply having a look at the subsets of the four components, without further describing or analysing each of them (for description, refer to AC-Fires). Aside from range, precision and speed, fires requirements in an MDO framework cover a very broad spectrum of enablers that involve a myriad of technology applications, which cannot be detailed in this article. This author will focus here only on what appear to be the most urgent needs and on the latest developments regarding range, precision and speed in the Army component of the Armed Forces. Although being particularly strong enablers for targeting and range, unmanned aerial vehicles (UAVs) and loitering munitions are not covered by the article either. s

Urgent Requirements: Indirect Fires

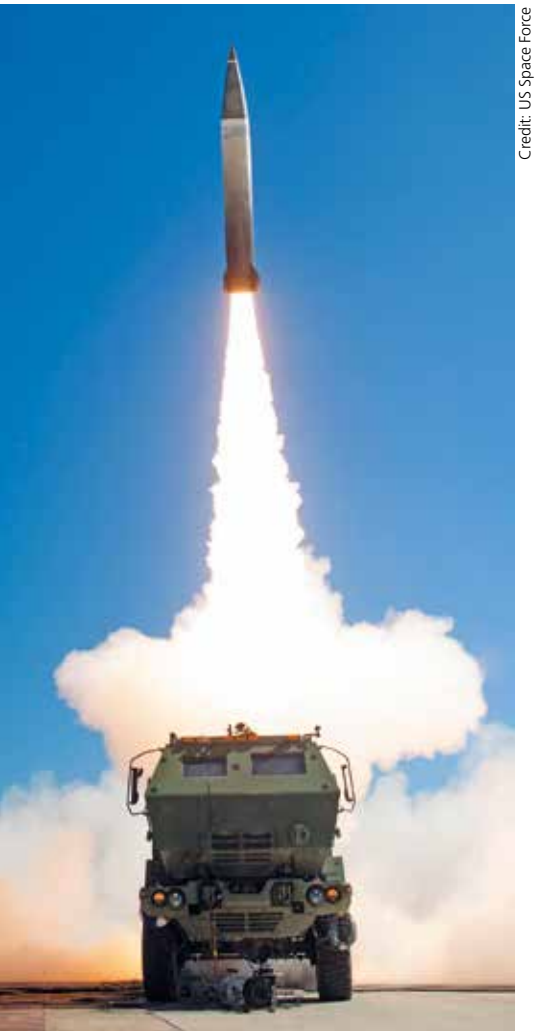
As the conflict in Ukraine undeniably shows, acquisition of indirect fire capabilities, both existing and in development, is likely to remain among the top acquisition priorities in the coming years. Indirect fires are essential for the ability to suppress the enemy defences and their offensive systems, thus supporting manoeuvre and advance of friendly forces. Continued support to Ukraine and the need to replenish our own artillery systems and ammunition stocks will fuel procurement demand in this direction, with a corresponding increase of investment in manufacturing capacity.

According to various reports of statements by US Army Undersecretary Gabe Camarillo, the US is expected to increase production of 155 mm artillery shells more than six-fold by 2028. In the EU, the proposed regulation establishing the Act in Support of Ammunition Production (ASAP) has a similar intent, to support the ramp-up of manufacturing capacities for the production of ground-to-ground and artillery ammunition, as well as missiles. All told, the beginning of 2023 has seen a ramp-up in the procurement of artillery systems.

To address the gap left by donations of AS90 155 mm self-propelled howitzers to Ukraine, the British Army announced in March 2023 their intent to procure 14 Archer 155 mm self-propelled howitzers from BAE Systems Bofors in Sweden as an urgent operational requirement. Additional units are expected to be procured in the following years. The AS90 has an L39 calibre length gun capable of attaining a firing range of 24.7 km. By contrast, the Archer has an L52 calibre length gun, allowing it to attain greater ranges – 30 km with ordinary High Explosive (HE) projectiles, around 40 km with high explosive, extended range (HEER) base bleed

Credit: BAE Systems

The Archer 6×6 is set to provide the UK with an interim artillery capability until the MPF programme selects a permanent replacement for AS90.



Credit: US Space Force

A US Army PrSM is launched during a test at Vandenberg Space Force Base, on 13 October 2021.

(BB) projectiles, and up to 50 km with M982 Excalibur extended-range GPS-guided projectiles. The manufacturer has also stated that Archer needs "less than 30 seconds from the time the operators receive a call for fire, to stop the vehicle, position for action, and fire the first round".

In April 2023, Israel's Elbit Systems announced the award of a contract worth nearly USD 102 M to supply a battalion's worth of 155 mm Autonomous Truck Mounted Howitzer (ATMOS) wheeled self-propelled howitzers (SPHs). While ATMOS can be equipped with a range of gun lengths, nowadays it is more typically marketed with the L52 gun, which is capable attaining ranges of 40 km with 155 mm Extended Range Full Bore – Base Bleed (EFRB-BB) ammunition. In July 2023, a USD 150 M contract was announced for the supply of Precise and Universal Launching Systems (PULS) rocket launchers and a package of precision-guided long-range rockets. Both contracts are said to be with an undisclosed international customer, thought by many to be Denmark. PULS can launch unguided rockets, precision-guided munitions and missiles with an effective range of up to 300 km, and according to the manufacturer, as a future growth feature, it could support the capability to launch Elbit Systems' Skystriker loitering munition.

Since the invasion of Ukraine, similar efforts to replace donations or simply reinforce existing capabilities were made by several NATO countries including France, Germany, Poland and Romania. The experience of Ukraine also reinforced the need for fires that are connected and complementary. In its war with Russia, Ukraine has had to use a myriad of indirect fires systems, a reflection of the diversity of systems in use with NATO countries. As future operations are more likely to happen in a JIIM environment, system interoperability and interchangeability of ammunition are paramount to enabling real-time coordination of fires.

The provision to Ukraine of the M270 Multiple Launch Rocket System (MLRS) and of the M142 High Mobility Artillery Rocket Systems (HIMARS) launchers, along with their associated munitions, clearly demonstrated the difference that precision and improved range can make to disrupt high-value targets, such as enemy logistics or command and control (C2) nodes. This has helped Ukraine fight deeper into its opponent's operational area, thereby encouraging Russia to station high-value command posts and munitions caches further back, outside their range. Availability of these systems and of the M982 Excalibur precision-guided projectile should help achieve a better balance between, massed fires, which are needed to disrupt the enemy's confidence and prevent them from grouping up (and also to keep costs down), and precision fires, which are needed to strike high-value targets, in order to degrade the enemy's ability to resupply and coordinate. The use of precision-guided munitions should also make Ukraine less dependent on massed fires using unguided rounds, thereby slowing the rate at which they burn through ammunition stocks. The following months will probably also show what tactics the Ukrainian Armed Forces are using to maximise the benefits offered by these capabilities.

Beyond Ukraine: Increased Range, Greater Speed, More Precision…

Achieving increased range and more precision is a stated goal in the acquisition plans of many countries, and part of ongoing development efforts.

Notably, for a number of years now, the US Army Long Range Precision Fires Cross Functional Team (LRPF CFT), part of the Army Futures Command, has been developing a portfolio of prototype systems among which:

- The Precision Strike Missile (PrSM) – a short-range ballistic missile developed by Lockheed Martin, designed to engage threats from a minimum range

Credit: US Army/Ana Henderson

The Extended Range Cannon Artillery (ERCA) autoloader's speed was demonstrated during a 30 March 2021 test at the US Army's Yuma Proving Ground.

Credit: Armée de Terre

The M270 MLRS, known as LRU in France, will provide the French Army's long-range precision fires capability for the foreseeable future. The system's use by Ukraine allows users to glean valuable insights from Ukraine's operational experience and integrate these into future developments and doctrine.

of 60 km, out to a maximum range of 499 km. This maximum range figure is understood to have been for compliance with the Intermediate-Range Nuclear Forces (INF) Treaty, however, since the US withdrew from the treaty on 1 February 2019, there would be no legal reason to keep this range limit in future variants of the missile. Indeed, Lockheed Martin have stated that the missile's open architecture ensures that "capability can be easily spiraled to achieve longer ranges", and according to the US Army Acquisition Support Center, follow-on spiral development will focus on attaining increased range, lethality, and the capability to engage of time-sensitive, moving, hardened, and fleeting targets. PrSM is due to enter service in late-2023, and set to gradually replace the US Army's current inventory of Army Tactical Missile System (ATACMS) missiles. PrSM will be launched from the M270A2 MLRS and the M142 HIMARS, and due to the missile's smaller diameter compared to ATACMS, two missiles can fit in each launch pod (as opposed to the one per pod for ATACMS), allowing two per M142 HIMARS launcher, or four per M270A2 MLRS launcher.

The British Army indicated their intention to join the US PrSM programme in a Memorandum of Understanding (MoU) signed in 2022 between representatives of the US and British Armies.

- The Autonomous Multi-Domain Launcher (AML), a mobile and transportable launcher that can be deployed, manoeuvred, and fired remotely – a particularly useful asset in A2/AD MDO scenarios. Considered to be 'the autonomous HIMARS', AML will be both compatible with current munitions and, due to its planned capability to fit a longer launch pod, will also be able to mount longer missiles than fit on the current HIMARS. It is unclear when the AML will become fully operational.
- The Extended Range Cannon Artillery (ERCA), an upgrade to the M109A7 self-propelled howitzer was designed to achieve greater lethality, precision and survivability through extended range and increased rate of fire. ERCA was planned for fielding in 2023, however, according a statement by Secretary of the Army Christine Wormuth reported by National Defense magazine in June 2023, engineering challenges were identified, which have delayed the programme's schedule.

In the UK, the recent procurement of Archer is seen as an intermediary step between the AS90 and the eventual results of the Army's Mobile Fires Platform (MFP) programme.

According to the British Army's website, modernised Land Deep Fires is one of the highest capability priorities for the Chief of the General Staff. Under the 'One Launcher, Many Payloads' vision, the UK Land Deep Fires Programme (LDFP) aims to deliver an upgraded M270A2 MLRS launcher to be equipped with a suite of missiles, including the Guided Multiple Launch Rocket System (GMLRS) with a range of 84 km, the Extended Range GMLRS (ER GMLRS), with a range of 150 km, the aforementioned PrSM, and the result of the Land Precision Strike (LPS) programme. The munition to be used by LPS has yet to be decided, but the British Army's requirement is for a munition suited to engaging mobile and armoured targets at ranges of at least 80 km. Since moving target engagement would require a seeker for target acquisition and terminal guidance, this is a capability the GPS-guided GMLRS lacks. In addition to these munitions, alternative payloads are being developed through the UK's Technical Demonstrator 5 (TD5) project.

In continental Europe, cooperation between the EU Member States, including via the European Defence Fund (EDF), seeks to achieve similar objectives regarding range, precision and speed. For example, the 'French Military Programming Law 2024–2030' prioritises air defence through the modernisation of air and missile defence systems. For long-range strike capabilities, the French stock of M270 MLRS, known in French service as the 'Lance Roquette Unitaire' (LRU; ENG: Unitary Rocket launcher) is expected to comprise nine units at the end of 2023, and to grow to at least 13 units by 2030 and 26 units by 2035.

Another example is the recommendation by the Norwegian Chief of Defence in 2023 to prioritise long-range precision weapons among the five recommended measures to achieve a scalable strengthening of the Norwegian Armed Forces over the short and long term. Overall, the requirement for increased ranges, greater speed, and greater precision in indirect fires will no doubt endure for many years to come.

Conclusion

Whereas an armed conflict is fully underway in Ukraine, one can assume that a state of 'below the threshold of armed conflict', or competition, continues in parallel in other parts of the world and could escalate into armed conflicts of shorter or longer duration, depending on various endemic geopolitical factors.

The times when NATO forces could operate in relatively uncontested environments, where air and naval strikes could easily shape the operational environment, seem to be drawing to a close. Therefore, the employment of current weapon systems and equipment needs to be adapted to the new context, and new systems must be developed with multi-domain operational logic in mind, where interoperability and ability to act in joint, interagency, intergovernmental, and multinational scenarios will be paramount. ■

Dark Eagle: Fielding the US Army's Long Range Hypersonic Weapon

Sidney E. Dean

The US Army remains confident that it will become the first Western military service to operationally field a hypersonic weapon, potentially as early as autumn of 2023.

Through a joint service memorandum, the US Navy and the US Army are collaborating on the development of a hypersonic glide vehicle (HGV). This category of weapon is launched atop a carrier rocket and transported to exoatmospheric altitude, during which it attains hypersonic speed, and then separates from the booster, transitioning to an unpowered glide mode for the remainder of its flight. In contrast to ballistic missiles, HGVs manoeuvre during their unpowered flight phase, enabling them to evade missile defence systems and denying the enemy certainty regarding the ultimate target.

The core system being developed by the Navy and Army will be adapted to meet the services' respective operational requirements and concepts. Lockheed Martin is acting as prime contractor and systems integrator for the Army variant, which is designated the Dark Eagle Long-Range Hypersonic Weapon (LRHW). The official development agency is the Army's Rapid Capabilities and Critical Technologies Office (RCCTO).

Credit: Lockheed Martin

Artist's concept of a deployed LRHM battery.

Credit: US Army

The 87.6 cm diameter AUR will be loaded into a launch canister; two launch canisters are deployed per launch vehicle.

Dark Eagle Profile

Despite the "long-range" designation, LRHW is a medium-range ballistic missile (MRBM). According to Douglas Bush, the Assistant Secretary of the Army for acquisition, logistics and technology, the weapon system's range is circa 2,700 km; during a portion of its flight it is expected to attain top speeds of around 6,000 km/h or Mach 5, Bush confirmed in August 2023. However, the glide vehicle's maximum speed during the high altitude portion of its flight is expected to be significantly higher than this.

The core component is the Common Hypersonic Glide Body (C-HGB) which was developed by the Navy and is produced by Leidos subsidiary Dynetics Incorporated. In addition to the kinetic-energy warhead, the C-HGB integrates the guidance system, cabling, and thermal shielding. The glide body is carried in a nose cone mounted atop a two-stage solid-fuel rocket booster which is produced by Lockheed Martin. The assembled system is referred to as the vertical launch All-Up-Round (AUR).

An LRHW battery consists of four tractor-trailer-mounted launchers utilising modified M870A4 trailers; each transporter-erector-launcher (TEL) carries two ready-to-launch AURs in launch canisters. A mobile battery operations centre (command and control), crane-equipped logistics vehicles for reloading launchers, and additional support vehicles complete the unit. The Army plans to utilise the existing Advanced Field Artillery Tactical Data System (AFATDS) for command and control. The system can be airlifted by C-17 aircraft. The 24 m long tractor-trailer launch vehicle has limited off-road manoeuvrabil-

ity. It is primarily intended to be road mobile, switching locations frequently to threaten enemy assets from varying directions while evading counterfires.

The LRHW remains one of the US Army's main acquisition priorities. According to a 2022 Army budget document, the programme will "provide the Army with a prototype strategic attack weapon system to defeat A2/AD [anti-access/area denial] capabilities, suppress adversary long range fires, and engage other high payoff/time sensitive targets." The ability to quickly target mobile command centres, mobile missiles, or other high-value targets with a system that is difficult to detect and intercept is considered a force multiplier, especially in a conflict against a peer- or near-peer adversary. Given the high value nature of potential targets and the limited number of available hypersonic missiles, the LRHW is being treated as a quasi-strategic asset. Operationally, US Strategic Command will identify targets and develop missions for the expeditionary batteries.

Testing Delays

The development programme goes back to a March 2019 directive by the Secretary of the Army to accelerate delivery of a "prototype ground-launched hypersonic weapon with residual combat capability" by Fiscal Year 2023 (which ends 31 September 2023). Given the head start of Russia and China in developing hypersonic weapons, the Pentagon prioritised LRHM and its Navy counterpart, pursuing both programmes using rapid prototyping authorities. Lockheed Martin was awarded the LRHW contract in August 2019. The Navy and Army have conducted joint tests to evaluate components of the hypersonic weapon systems. The most notable of these was Flight Experiment 2 which took place in March 2020 at the Pacific Missile Range Facility in Hawaii. The C-HGB was launched atop a generic booster rocket (not representative of the AUR). After a short flight the glide body separated from the booster and set course for the designated ground target, which it precisely impacted. Significantly, the demonstration validated the glide body's aerodynamics, stability, and control. However, the 2021 annual report by the Pentagon's Director of Operational Testing and Evaluation (DOT&E) found Flight Experiment 2 to have several limitations. "The flight test provided warhead performance data, but also lacked operationally representative targets. Neither programme has yet performed arena testing on the operationally representative warhead, which is fundamental to the development of the lethality model." The report also faulted that no data was available to evaluate the Dark Eagle system's survivability in a contested environment.

Credit: US Army

Flight Experiment 2 conducted in 2020 launched the C-HGB on a generic carrier rocket (not representative of the AUR – (left image)). After a short flight the C-HGB separated from the carrier and struck the intended ground target (right image).

A total of three LRHW-specific flight tests – including two of the complete AUR – were planned for the 2022-2023 timeframe to progressively prepare for operational certification of the Dark Eagle. To date, not a single one of these has been successfully completed. The latest setback was announced on 6 September 2023. The scheduled validation flight test was cancelled for unspecified reasons following the pre-flight checks. This followed an earlier test cancellation in March 2023 after a battery failure was detected during the pre-launch procedure. As of September 2023 the flight testing programme is a full year behind schedule.

Fielding in Sight?

Leading up to the September 2023 aborted validation flight test, Army leaders had publicly displayed great confidence in the system's progress. Speaking at the 8th Annual Army Summit organised by the Potomac Officers Club (a private organisation) on 7 August 2023, Assistant Secretary Bush expressed optimism that LRHM would be operational by autumn 2023. "The Army's been in this business before – we used to have a lot of MRBMs. We're coming back. Once we get through some – hopefully they go well – flight tests this summer, we will be actually fielding that system to a unit that could go to war this fall." Bush specifically said that the (now cancelled) event was to be the "most important one" of two as it constituted an "end-to-end evaluation" of the system.

On 10 August 2023, the RCCTO's director, Lt. General Robert Rasch confirmed the service's optimism regarding the road to certification. "We're birthing [LRHW] in RCCTO but for the long-term, for the second battery and the third battery, the sustainment, and the design improvements over time, those will happen" at the Program Executive Office (PEO) Missile and Space, Rasch said during a space and missile defence symposium at Huntsville, Alabama. However, Rasch did not commit to a specific timetable. "Once we [complete] end-to-end testing, and we have confidence

Credit: US Army

The launch canisters must be elevated to a fully vertical position before firing.

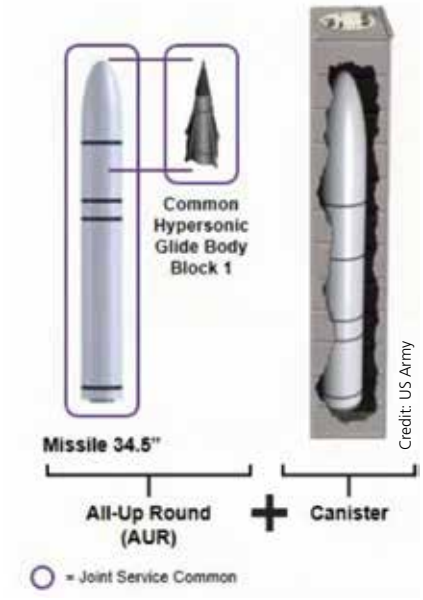
in the design, there are missiles lined up in various stages of production ready to finish buttoning up and get those out to the field."

First Operational Unit Standing By

The first operational unit to field the LRHW will be Bravo Battery of the 5th Battalion, 3rd Field Artillery Regiment (5-3 FA) at Joint Base Lewis-McChord in Washington state. The battalion is the strategic long-range fires unit of the 1st Multi-Domain Task Force (1st MDTF), which was formed in 2017 to test new technologies and operational concepts with a focus on defeating enemy A2/AD networks.

The battalion received the full LRHW panoply – minus the still developmental AURs – in 2021 in order to develop and practice operating procedures. The results of this New Equipment Training (NET) programme were tested in four three-week increments culminating with a field exercise in February 2022. According to the accompanying Army press release, "Bravo Battery's primary objectives included air transportation drills, security procedures, canister reload operations, operational emplacement of equipment and performing fire missions [...] enabling strategic objectives across echelons." In February 2023 the unit deployed the system from its home base over 5,000 km to Florida (as part of Exercise Thunderbolt Strike) in a full rehearsal of expeditionary hypersonic launch operations. According to the Army, the deployment exercised critical command and control linkages between the joint US Indo-Pacific Command and US Strategic Command, as well as the US Army Pacific command, the RCCTO, and the 1st MDTF. The validation of the recently developed and refined procedures should enable the unit to be operational with the hypersonic missiles soon after receiving the AURs, and will form a baseline concept of operations for future LRHW batteries.

At this point it must be noted that the Army has always intended for the planned 2023 operational capability to be a provisional capability which could be deployed in a contingency. Among other things this reflects the fact that the initial set of AURs which are to be provided to the 3-5 FA will still be classified as prototypes which are to serve as a baseline for the subsequent acquisition programme of record. In many ways the eventual outfitting of the first battalion with the provisionally certified weapon system will still constitute part of the Army's learning curve. Under the extant timeline (which to date has not been officially adjusted) the second Dark Eagle battery is expected to be fielded in Germany in 2025. The weapon system's Initial Operational Capability (IOC) is to be declared at that point.



Graphic depiction of the AUR and the AUR in the launch canister.

Programme Going Forward

Despite budget cutting in some other sectors, the Army continues to prioritise long range fires. According to Army budget director Major General Mark Bennett, an additional USD 1 Bn are being specifically sought "to support the further development and demonstration of the prototype battery that will provide the Army a strategic attack weapon system to defeat anti-access, area denial capabilities," which is the 3-5 FA's Bravo Battery. Bennett made this statement on 13 March 2023 during a budget briefing for the press.

Despite the testing delays, the service remains determined to field LRHM as soon as operational certification can be achieved. Referencing the 6 September 2023 cancellation, Army Under Secretary Gabe Camarillo stressed that he remains "very confident in the programme." Following the weapon system's ultimate certification, the RCCTO will transfer LRHM to the PEO Missiles and Space, where it will transition from a developmental and evaluation project to an acquisition programme of record. Up until now, this transition has been planned for the 4th Quarter of FY 2024. Army officials themselves have repeatedly termed this schedule as "aggressive" and conceded that the ambitious timeline carried inherent risks. Given the fact that the testing schedule is a year behind the original plan, and that no date for the next attempt at a test flight has been announced, it seems likely that the transition to a programme of record will have to be pushed up. The alternative would be to proceed to an operational capability with fewer or no full-fledged flight tests, consciously accepting the greater risk inherent in such an approach.

Regardless of when the system becomes operational, future technology upgrades have been pre-programmed into the procurement cycle, with each new battalion set expected to be incrementally improved over the previous missiles. One planned technology insertion would provide the ability to remotely reprogramme or update targeting data after launch, in order to enable engagement of moving or relocated targets.

To date a total of five batteries are planned, one for each of the Army's Multi-Domain Task Forces. The headquarters and cadre elements of the 2nd and 3rd MDTFs have been established in Germany and on Hawaii, respectively, in line with the stated intent to dedicate two such formations to the Indo-Pacific region and one to Europe. The fourth and fifth MDTF are yet to stand up. The fourth could be oriented either to the Arctic or form a third Indo-Pacific MDTF (in June 2023 Japanese media reported that negotiations with Tokyo were in progress), while the fifth and final is expected to be oriented towards global deployments. The allocation of a LRHW battery to each of these formations will guarantee a limited but formidable expeditionary strike capability, with a special focus on conflicts with China or Russia. ■

Graphic depiction of the complete LRHW weapon system.

Waiting for Ultimate Accuracy – The Progress of GPS III

Tim Guest

A mix of old and new satellites make up the current GPS constellation, with GPS III satellite launches and orbital insertions taking place according to plan, though the journey to deliver the system's other segments has been less smooth. This article looks at some of the latest efforts, associated activities undertaken and scrutiny to deliver an improved, next-generation GPS system.

GPS has been the mainstay of civil and military positioning, navigation and timing (PNT) purposes since the mid-90s. The satellite-based radio navigation system delivers benchmark PNT services to US and allied militaries, as well as civilian users. Over four billion people from civil sectors such as finance, transportation, recreation and agriculture – together with the military sector – rely on PNT radio signals in their everyday activities and operations.

The decision to procure the future generation of GPS satellites, known as GPS III, was made in September 2007. In August 2021, day-to-day responsibility for modernising and sustaining GPS transitioned from the US Air Force to Space Force's Space Systems Command (SSC), with the US Government committed to maintaining the availability of 'at least' 24 operational GPS satellites, 'at least' 95% of the time. This service-level commitment has been ensured by the US typically keeping 31 GPS satellites operational for well over a decade now.

The current modernisation programme covers the GPS system's three segments: ground control segment, space segment, and user equipment, with the effective interoperation of these segments designed to provide the very latest and improved levels of PNT service, as well the military-specific, Military-code (M-code) signal. M-code is a stronger, encrypted, GPS signal designed to meet military PNT information needs and will help military users overcome attempts to jam the GPS signal by using a more powerful signal with split-spectrum waveform. It will also protect against GPS spoofing, by encrypting the signal. SSC manages the acquisition of the space segment portion of this effort through the GPS III and GPS III Follow-On (GPS IIIF) programmes, which manage the replacement of existing satellites as they near the end of their intended operational life.

The latest activities to upgrade the system to GPS III have seen six successful GPS III satellite insertions into orbit, (although the first launch in 2018 came after a four-year delay), with the sixth launched in January 2023 and the tenth delivered in February. As a result, the GPS space segment currently consists of a constellation that includes older satellites, active before the current modernisation, and now, the first six GPS III satellites.

Ground control and user-equipment segments, however, have had their own delays and an early June report by the US Government Accountability Office (USGAO) has called several aspects of the programme upgrade into question, with recommendations made, more of which below.

Space Segment Developments

Delivery and launches of the space segment's GPS III satellites have gone well since the initial delays prior to first launch and the GPS satellite constellation today comprises four generations of satellites with varying capabilities and design lives. Interestingly, the first satellite capable of transmitting the M-code signal entered orbit as far back as 2005 and as of now, 25 of the constellation's current 31 active satellites are M-code capable. However, to ensure that the constellation maintains and expands this signal capability it looks like additional M-code-capable satellites will need to join the constellation.

The first GPS III satellite, built by Lockheed Martin, was launched in 2018 and, in mid-January 2023, the sixth GPS III satellite, Space Vehicle 06 (GPS III SV06), took off from Cape Canaveral Space Force Station in Florida aboard a SpaceX Falcon 9 rocket. As with the previous five GPS III satellite launches, the SV was sent into space under the control of US Space Force personnel and Lockheed Martin engineers at the company's Denver Launch & Checkout Operations Centre, and was eventually placed in operational orbit approximately 20,197 km above the Earth. Around 90 minutes after launch, control of the satellite is assumed by the ground control team, with the satellite's onboard liquid apogee engine propelling the satellite towards its operational orbit over the following days. Once it arrives in orbit, engineers send the SV commands to deploy its solar arrays and antennas in preparation for handover to Space Operations Command. GPS III SV06 was the 25th M-code satellite introduced to the constellation.

For its part, Lockheed Martin has now completed production on its original contract to deliver 10 GPS III satellites, SVs 1-10. The Space Force confirmed at the end of 2022 that SV10 had joined SVs

Credit: USAF

GPS III satellite in orbit, artist's impression.

7-9 in being completed and were ready to be launched at a later date; all four satellites remain in storage at the maker's facility in Waterton, Colorado, until the Space Force calls them forward for their respective launches. It's worth noting that the GPS III team is led by the Space Production Corps Medium Earth Orbit Division at the US Space Force's Space and Missile Systems Centre, Los Angeles Air Force Base (AFB), while GPS Operational Control Segment support is managed by the Enterprise Corps, GPS Sustainment Division at Peterson AFB. The 2nd Space Operations Squadron, at Schriever AFB, manages and operates the GPS constellation for both civil and military users.

GPS III satellites and associated systems have been developed with a modular design, factoring changing operational requirements and emerging threats into the mix, thereby allowing for new technology and capabilities to be added in the future. As such, they've been able to provide significant capability advancements over earlier-designed GPS satellites in orbit, including three times better accuracy, up to eight times improved anti-jamming capabilities, as well as improved L1C civil signal, which is compatible with international global navigation satellite systems (GNSSs), such as Europe's Galileo, to improve civilian user connectivity.

So, with GPS III SV1 launched in 2018 and SV6 in January this year, there are now six operational GPS III satellites in orbit, each with a 15-year design lifespan and currently transmitting Block IIF signals with enhanced signal reliability, accuracy and integrity. The improved L1C frequency, the fourth civilian GPS signal, is designed to enable interoperability between GPS and international satellite navigation systems. L1C, which has now been broadcasting from the six GPS III satellites since 3 July 2023, refers to the radio frequency used (1575 MHz, or L1). Two military signals also exist at L1 (P/Y-Code and M-Code), as well as the legacy civil C/A-Code signal. L1C allows use of the multiplexed binary offset carrier modulation (MBOC) waveform, which is interoperable between GPS' L1C and with Galileo's E1 OC frequencies. This is intended to improve mobile GPS/Galileo reception in cities and other complex environments.

Credit: Lockheed Martin

May 2021, 5th GPS III satellite prior to June 2021 launch.

Credit: Lockheed Martin

Lockheed Martin-built GPS III Follow On (GPS IIIF) satellite in orbit, artist's impression.

It is also worth noting that selective availability (SA), which had been a trait of the early years of GPS impacting civilian users with an intentional degradation of public GPS signals for US national security reasons, is no longer a feature of GPS service, the decision having been taken in 2007 not to include it in the GPS III upgrade. As of 3 July 2023, there were a total of 31 operational satellites in the GPS constellation, not including seven decommissioned, or in-orbit spares.

Lockheed Martin has begun building the first of the GPS III Follow On (GPS IIIF) satellites, which are set to feature new capabilities, such as a laser retroreflector array to enhance accuracy, a new search and rescue (SAR) payload, and a digital navigation payload. The first is due to be launched in 2027, and Lockheed Martin has been contracted to build 10 satellites. To clarify, numbering of the SVs used by the GPS IIIF series starts at SV11, with SV11-20 contracted so far.

Ground Control Segment

The ground control segment of GPS is made by Raytheon and consists of the ground-based stations that are responsible for tracking, monitoring, and updating the satellites. The enhanced ground control segment is referred to as GPS Next-Generation Operational Control System or GPS OCX, which will provide improved accuracy of the current system and will be able to fly more than twice as many satellites, an increase intended to improve coverage in hard-to-reach areas such as urban and mountainous terrain. According to the manufacturer, OCX also offers improved accuracy, availability, and resistance to jamming compared to the previous ground control segment.

As far as GPS OCX system deliverables are concerned, Raytheon has stated that these are divided into three blocks: Block 0, Block 1 and Block 2, with the first of these having taken place in late 2017, enabling the GPS OCX Launch and Checkout System (LCS) to support the first GPS III satellite launch in December 2018. Since then, according to Raytheon, the LCS has been used to launch three GPS III satellites.

However, there have been continuing OCX schedule delays, (reported to be seven years so far), and cost overruns, (the current price tag of USD 7 Bn is reported to be some 73% more than the US Government initially projected), to the delivery of 17 ground stations. The USAF informed Congress in mid-2016 that the OCX programme's projected costs had risen above USD 4.25 Bn, exceeding the initial estimates of USD 3.4 Bn by 25%. One of the factors said

to have led to these overruns was the complexity of the OCX's cybersecurity requirements; nevertheless, in October 2016, the DOD formally certified the programme, which was necessary for it to continue.

Deliveries of Blocks 1 and 2 of the OCX, expected in January 2023, have been delayed as a result of technical problems discovered during testing. According to a report published in June 2023, this will push the date for initial operating capability back to sometime in the spring of 2024. OCX has been designed with the intention of operating the entire GPS fleet, but that will be when it is fully functioning with all Block increments. While Block 0 can and has handled the GPS III launches, it cannot operate the satellites in orbit and only when Blocks 2 and 3 are up and running will that be possible. Nevertheless, the Space Force hopes to complete operational acceptance for all elements of the OCX segment in 2027, though only time will tell if that timeframe is met.

Scrutiny of GPS III

Considering the US DOD has been working to upgrade GPS with M-code for many years and as far back as 2005 launched the first M-code-capable GPS satellite, it's hardly surprising delays and cost increases to different parts of the programme have drawn attention, frustration and questions from government quarters. As a result, the US Congress tasked the US Government Accountability Office (USGAO), to assess the cost, schedule and performance of the various current GPS acquisition programmes, the result of which was an oversight report published in June 2023, titled: 'GPS Modernization - Space Force Should Reassess Requirements for Satellites and Handheld Devices'

Credit: Lockheed Martin

Launch of sixth GPS III satellite, SV06, 18 January 2023.

Credit: USGAO

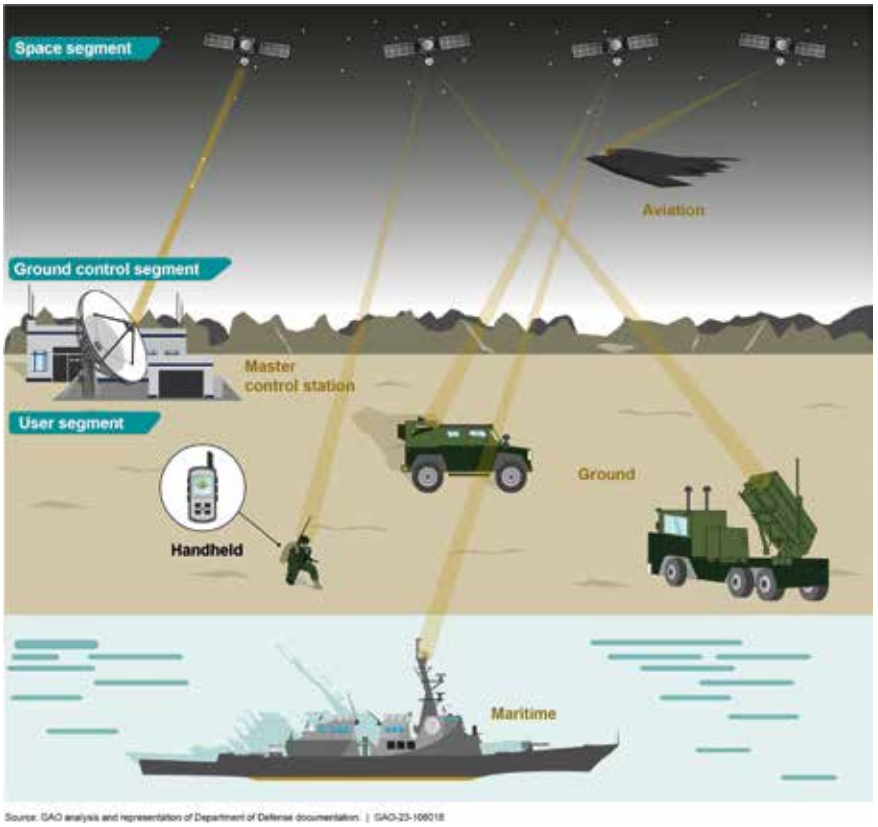


Diagram showing the various segments of the GPS system.

Of the ground segment, the GAO said the Space Force had further delayed delivery of the fully operational ground control segment in 2022 due to "development challenges", with the delay pushing delivery back until December 2023, at the very minimum. Indeed, the report said that Space Force officials had not, at that stage, even finalised a new schedule and acknowledged that remaining risks could lead to additional delays.

Of the space segment, on the other hand, the GAO report was more upbeat, saying that the Space Force had met its approved requirement to have "24 M-code-capable satellites on orbit", but went on to say that at least three further satellites would be needed for the upgraded GPS system "to meet certain user requirements for accuracy", though it acknowledged "[b]uilding and maintaining this larger constellation presents a challenge". In its analysis, the GAO suggested it is unlikely for 27 satellites to be consistently available over the next decade and that unless the USAF assesses its operational need for satellites to establish a firm, 27-satellite-constellation requirement, other DOD programmes might well take priority. The implications of such a scenario is that GPS equipment used by friendly forces could perform below their required capability levels.

Concerning that user equipment, Military GPS User Equipment Increment 1 (MGUE Inc 1) development has progressed to the point where military departments are ready to commence activities in support of testing and fielding it on key weapon systems. However, it added that delays and unexpected challenges could affect the fielding the capability on some platforms. Indeed, the GAO report stated that while, *"Space Force seeks to expand the use of M-code technology by developing a second increment consisting of an improved M-code chip and card, as well as a handheld receiver… it lacks a major committed customer for the handheld receiver."*

The GAO said that the US Army, the largest potential user of such a device, has its own plans for handheld receivers, and the USMC is, apparently, also still considering its options. This lack of a solid business case for its proposed handheld device, risks significant resources and costs being expended by Space Force with little or no benefit to military end users, according to the GAO report.

As for the military's response to the GAO's findings and recommendations, in an appendix to the organisation's report, head of the Air Force Space Acquisition and Integration Office, Frank Calvelli, accepted, in their entirety, the two GAO findings that stated, firstly, that the ser-

vice should consider officially adding three more M-Code-capable satellites to its current operational requirement something also approved by the Space Force. Secondly, he accepted those findings recommending the Space Force either re-work its requirements, or drop plans altogether to develop the new, smaller M-code chip card and specialised GPS receiver for handheld radios; the lack of a sound business case and because the other services, as mentioned, have their own plans were understood as the reasons for this recommendation for an alternative approach.

NTS-3 Testing to Support GPS

The Space Force announced in June 2023 that the Benefield Anechoic Facility (BAF) at Edwards AFB was in the process of testing Navigation Technology Satellite-3 (NTS-3), its first experimental navigation satellite system in nearly 50 years. Developed by L3Harris Technologies, NTS-3 was originally slated for launch in late-2023, but this has now been delayed until late-2024.

NTS-3 will demonstrate technologies and techniques to augment the GPS constellation and help maintain access to GPS in contested environments. Testing at the BAF is also an important step in ensuring that the AFRL team is ready to successfully conduct in-orbit experiments. The USAF, US Space Force, AFRL, and NASA's Jet Propulsion Laboratory have all had critical roles to play in the testing of the NTS-3 satellite. After the testing is complete, the NTS-3 will operate for one year in a near-geosynchronous orbit and will broadcast navigation signals from its phased array antenna. ■

Credit: USAF/Adam Bowles

The Navigation Technology Satellite-3 inside the Benefield Anechoic Facility at Edwards AFB, in April 2023.

Countering Land Mines and UXO: Old Threats and New Frontiers in Ukraine

Dan Kaszeta

We are well into the second year of the biggest war in Europe since the end of the Second World War. The Russian invasion of Ukraine has brought the issues of land mine warfare into the harsh light of day. In addition, unexploded ordnance (UXO), also referred to as 'explosive remnants of war' (ERW), has become a critical issue in Ukraine. Historically, Europe has had problems with old unexploded ordnance due to two World Wars, but the size and scale of this war greatly adds to the problem.

Land mines are problematic in international law. Many countries and numerous NGOs have long sought to ban land mines. Diplomacy and advocacy resulted in the drafting and widespread adoption of the 1997 Ottawa treaty banning anti-personnel land mines. Ukraine signed and ratified the treaty. However, Russia has never adopted this treaty. It is important to note that the Ottawa treaty bans anti-personnel land mines. It does not cover anti-vehicular mines or command-detonated (detonated remotely by human command, rather than by means of a sensor) mines. Anti-personnel mines are harder to detect, easier to detonate, smaller, and have historically proven to be more of a post-conflict menace to civilian populations than anti-vehicular mines.

Russia appears to have started limited use of both anti-personnel and anti-vehicular land mines in 2014, when the conflict started. Ukraine was already suffering deaths and injuries from both historic and post-2014 mines and UXO well before the 2022 invasion began. Ukraine has used anti-vehicular mines, which are compliant with their treaty status, in some instances. Russian use is far more prolific, and Russia has made frequent use of both anti-vehicular mines and anti-personnel mines. Furthermore, Human Rights Watch, an NGO which monitors land mine usage in the conflict, notes that Russia has frequently used booby-trap devices on anti-vehicular mines, making them into de facto anti-personnel mines. Human Rights Watch also notes 6 types of anti-personnel and 5 types of anti-vehicular mine in widespread use by Russian forces.

Author

Dan Kaszeta is Managing Director of Strongpoint Security Ltd. and a regular contributor to ESD.

Credit: Kyiv City Local Government

Large swathes of Ukraine have been rendered unsafe due to the presence of landmines.

Land mines are having an effect on the conflict and are performing their classical role of hindering major advances and affecting Ukrainian mobility on the battlefield. The progress of the current Ukrainian counteroffensive has been slowed by mines and other traditional obstacles. Behind the lines, mines and other remnants have had an adverse effect on civilians and the economy. Wide swathes of agricultural land, in a country that relies heavily on its agricultural sector for export as well as feeding its own people, have become dangerous to use. Tractors are heavy enough to detonate anti-vehicular mines. Numerous casualties in the agricultural sector have been reported and many thousands of hectares of land will need systematic clearing. Given the impact on agriculture, it is fair to say Russia is using mines as a method of economic warfare as a secondary mission.

Other munitions are having effects somewhat similar to land mines. Both sides of the conflict make use of cluster munitions. Neither country is party to the ban on such weapons, and both sides have used them in this struggle. Part of the perennial issue of cluster weapons is the failure rate in their detonation, a problem particularly noted in Soviet and Russian-manufactured ordnance. This leaves a lot of unexploded munitions laying around. Furthermore, the failure rate on conventional munitions is not zero, so large swathes of Ukraine have potentially dangerous ordnance laying around. Unexploded Grenades, projectiles, rockets, bombs, and shells of myriad type have turned up and have caused casualties all over the country.

With regard to mine clearing, there is a fundamental difference between combat breaching operations and thorough post-conflict demining. Combat operations

broadly involve broadly locating minefields and breaching a lane through them where it is necessary. There simply are not enough sappers, time, or other resources to systematically clear minefields; the emphasis is on allowing manoeuvring forces to be able to operate. The exigencies of combat operations and mobile warfare mean that many, even most, of the mines will be left in place. Post-conflict demining seeks to return land to its former use, such as agriculture, and is thus far more through. Both sorts of mine clearing are underway in Ukraine and use similar technologies, albeit with different concepts of operation.

Finding the Problem

Locating landmines and minefields is the first component to demining. While some minefields are obvious, and even intentionally obvious so as to affect enemy plans, the location of individual mines is key to mine clearing. Often, the first indication of mines is a casualty or damage to a vehicle. Various technologies and procedures ranging from the rudimentary (mine probes – basically a sharp stick) all the way to the latest high technology.

Metal detectors are a primary component in both combat and humanitarian de-mining. CEIA in Italy and Vallon in Germany are industry leaders in this sector. The United Kingdom donated at least 1000 Vallon VMH3CS metal detectors for use in Ukraine, making this particular system one of the more commonly seen metal detectors in the conflict. Numerous CEIA systems are seen in use as well. Many have been bought by overseas donors or provided as military aid. Numerous systems from many other manufacturers have been seen at some point.

Ground-penetrating radar has long been used in humanitarian mine clearance around the world. Japan has donated the ALIS system, originally developed for use in Cambodia, which combines ground-penetrating radar and traditional metal detection in a single handheld unit. UK-based company Chelton is known to make a similar system. Rumours abound of research to put ground-penetrating radar onto drones.

Mine detection dogs have a reasonably good history of use in humanitarian demining, although they can be quite vulnerable in combat operations. The European Union has funded the procurement, training, and logistics to provide 50 explosive and mine-detecting dogs for Ukraine. Trainers from Austria, Belgium, Finland, Luxembourg and Malta are involved in the project. Norway has provided 14 mine detection dogs in April 2023.

Credit: CEIA

CEIA mine detection system in use in Ukraine.

Thermal imaging technology has proven useful in finding mines. HALO Trust, a long-standing mine clearance NGO, among others, pioneered the use of thermal cameras to help find mines in its operations in Africa. Using the heat difference between night and day, and the principle that mines will cool at a different rate than the surrounding soil, various thermal imaging devices have proven useful in locating mines. Various efforts have been made to put these devices on drones. It should also be noted that this technology will likely be less use in winter. Other technologies have been mooted for use in mine detection. Australia's CSIRO is known to be working on magnetic resonance as a technique.

Removing the Problem

Locating a minefield and plotting the location of individual mines is only part of the solution. It might be enough to know where a minefield is in order to plot a military operation, but military necessity may require a lane to be cleared through one or a route to be re-opened. Civilian use and re-occupation of land requires clearance, not just knowledge.

A large number of techniques are in use that are quite dangerous and labour-intensive. Grappling hooks and ropes can be used to remotely detonate mines, as long as their fuzes function. Small explosive charges can be manually placed on mines to destroy them. Bangalore torpedoes, which are long pole-shaped segmented explosive charges can be pushed into a minefield and will detonate to clear a lane. All of these techniques place the sapper performing them at great risk and, in combat breaching, expose them to enemy fire. Yet all have been seen in Ukraine.

An extremely useful technology, and one that is quite visibly seen in use on social media in Ukraine is the mine-clearing line charge (MICLIC). A MICLIC system uses a small rocket to fire a line charge – essentially a rope made of explosive material. The line charge detonates, clearing a lane through a minefield. A number of MICLIC systems are in use around the world. The US M58 system, which clears an 8 m wide lane 100 m long, has been donated to the Ukrainians and has been seen in use. The UK and Turkey both make systems of similar capability, but neither has been noted in the conflict so far. The same cannot be said for Russia's UR-77 line clearing vehicle. It is known that Ukraine has captured UR-77 units from Russia, and both sides appear to have used the UR-77 in combat.

Ploughs, flails, rollers, and tillers attached to heavy armoured vehicles have a long history in mine clearance efforts, both in direct combat roles and in humanitarian operations. The principle is simple – place something in front of a relatively survivable vehicle that will absorb the blast and explosion of the mine. These parts do take damage and need replacement over time but are literally cheap bits of chain or inexpensive steel parts. Such accessories can be put on the front of existing vehicles, such as tanks. Mine ploughs for T-72 tanks have been donated to Ukraine. Ukraine itself is a manufacturer of the KMT-series of mine ploughs and rollers for use on Soviet-vintage tanks. Open-source intelligence accounts on social media have noted the presence of mine rollers on US-supplied Stryker vehicles. The Russians use the TMT-S mine roller, which fits on any of its T-72 or later tanks.

Credit: US Army/Spc. Jacob Nunnenkamp

A MICLIC line charge detonation photographed during US Army training near Boleslawiec, Poland, 17 August 2023.

In addition, mechanical aids like flails and tillers are integral design features in dedicated mine clearance vehicles. A number of examples of such systems are in use in the current conflict. The German Keiler vehicle, made by Rheinmetall is a classic example. The base platform is an old US M48 tank hull, and it uses a chain flail to clear mines. The Bundeswehr procured 24 of these systems decades ago but has donated four of them to Ukraine. The Wisent, by Germany's FFG is based on the Leopard 1 chassis and uses a large mine plough in front of it. The plough itself is made by Pearson Engineering in the UK. Six Wisent systems are reported to have been transferred to Ukraine earlier this summer.

Hydrema of Denmark produces a truck-based system, less survivable in direct enemy contact but still useful, called the 910MCV. Several are believed to be in use and Hydrema is believed to be negotiating to produce systems in Ukraine. At least one mine-clearing system from UK company Armtrac, which uses tillers and flails, has been sent to the Ukrainian government. At least one more Armtrac system is in use with an NGO for humanitarian mine clearance.

Robotics

The inherent dangers in mine clearing have long made it a ripe sector for unmanned ground vehicles (UGVs). Many dangerous tasks can be done remotely, and some scarce skilled labour can be preserved for other tasks. By engineering the human occupant out of a demining system, its survivability in both combat environments and humanitarian demining can be greatly increased.

A key industry leader in this space is DOK-ING, a Croatian firm based in Zagreb with several decades of experience making heavy robotic systems for demining, combat engineering, and other tasks such as firefighting. Their MV-4 system was adopted by the US Army as the M160 some years ago, and is highly useful in anti-personnel mine clearing and various sapper tasks. It proved to be extremely robust in combat engineering and counter-IED operations in Afghanistan. DOK-ING's larger MV-10 is designed against anti-vehicular as well as anti-personnel mines. It weighs approximately 21 tonnes, is powered by a Caterpillar diesel engine, and uses a dual flail and plough system. Both have a credible track record in de-mining operations around the world. A number of DOK-ING systems are known to be in use, with a reported total of at least 25 systems being planned for delivery by the end of 2023. Some reports indicate that DOK-ING might even open a plant in Croatia, in conjunction with the Ukrainian firm A3Tech.

DOK-ING is not the only player in unmanned systems. Their main rivals appear to be Global Clearance Solutions from Switzerland, who make the GCS-100 and GCS-200 robotic vehicles for de-mining. As of March, 2023, at least five GCS systems were in use in Ukraine and in July, the company reported opening an in-country support presence in Ukraine. Reports indicate that at least 20 systems will be delivered by the end of the year. Another manufacturer is the Slovak firm Božena. Their Božena-4 and Božena-5 systems were originally designed to meet Czech requirements. The Slovak defence ministry reports that 8 Božena-4 and 2 Božena-5 systems are in service in Ukraine.

Russia operates some UGVs for demining. Russia has been seen using the Uran-6 unmanned system, which is a copy of the Croatian DOK-ING MV-4 system. At least one such system has been lost in combat by the Russians. Another system is the Prokhod-1, which is a robotic armoured vehicle with a BRM-3MA chassis as its base and a TMT-S mine-roller.

The Future

The mine problem seems set to get worse long before it will get better. Russia certainly has not stopped laying mines and a renewed Russian offensive might see Ukraine use more anti-vehicular mines. If the ground war threatens to enter Russia itself, we may have the prospect of mines within Russia that will also need eventual clearing.

What is certain, though, is the scope of the problem is gigantic. Ukraine is short on trained sappers and technicians for humanitarian mine clearance, so there is much scope for efforts to increase the number of people working on the problem, both right now and into the future. Even optimistic observers will probably concede that the real work cannot fully begin until the conflict is over, and that clearance of mines will take many years. There will certainly be scope for new technologies, large government and NGO efforts for mine clearing, and a large demand for the whole spectrum of mine clearance products. ■

Caption: Credit: Dan Kaszeta

The Croatian DOK-ING MV-4 is capable of clearing antipersonnel mines and is in use in Ukraine.

Sniping Evolution

David Saw

Sniping was once a much less complicated undertaking than it is today. The reason lies in the expansion of the performance of sniper rifles and supporting optics to previously unachievable levels. In turn, this has seen the sniper's mission evolve significantly and, in parallel, a growth in understanding of the operational advantages that a high-quality sniping capability brings in terms of detecting, engaging and neutralising targets. Beyond that, sniping has also evolved to become a high-value reconnaissance asset for ground commanders.

Before discussing what sniping entails today and the tools necessary for its success, it is necessary to provide some brief background on the modern sniping environment and how it has evolved. Sniping used to be all about the operator, the weapon, the optic and the associated ammunition. As marksmanship was considered a central element in training soldiers, this provided an ideal structure to identify those with the potential to become a sniper. This group would then be given more specialist training and after selection, you would have the basis of a sniper.

This leads to the choice of weapon for the sniper and for a considerable period this was really not a sophisticated process. During manufacture of the standard service rifle, for many years a bolt-action weapon was used, the best and most accurate examples were identified and put to one side for sniper use. At that point, a scope mounting point and scope were added. Then, match-grade or other high-quality ammunition was provided, and your sniper capability was ready to go.

Credit: USMC

US Marine Corps snipers with their M40A5 7.62 × 51 mm sniper rifle on the range at the Puckpunyal Military Area in Victoria, Australia. The M40 is based on a modified Remington Model 700 rifle that was originally developed in the 1960s. The M40 was the standard Marine Corps sniper rifle for more than 40 years.

Evolutionary Path

This was certainly the British Army approach, but when the 7.62 × 51 mm became the standard NATO round they decided to modify their existing No.4 Mk.1 (T) and Mo.4 Mk.1* (T) sniper rifles from 7.7 × 56 mmR to accommodate the new NATO round and then added other modifications to create the L42A1 sniper rifle. By contrast, the US Army decided to create a sniper system based on their then new 7.62 × 51 mm M14 battle rifle. Outstandingly accurate M14s were identified in manufacture to provide the basis for the M21 sniper rifle; they were converted to semi-automatic operation, their furniture was modified, scope mounts attached, and a scope fitted.

The US Marine Corps (USMC) took a different approach to meeting its sniper rifle needs, selecting the Remington 700 bolt-action rifle as the basis for the M40 sniper rifle in 7.62 × 51 mm. The rifle has a Mauser action and is based on the P14 rifle that Remington manufactured for Britain during World War I. The US Army would later replace its M21 sniper rifles with the M24, which was essentially a Remington 700.

These were effective weapons, but in comparison to what can be achieved with modern sniper systems they were actually somewhat limited. When the British Army looked to replace the L42A1, the competitive evaluation for successor weapons was based on meeting the performance of the L42A1 as a baseline; this was an effective range of 600 m and harassing fire out to 800 m. Today, the Australian Army EF88 rifle in 5.56 × 45 mm, when fitted with a Raytheon Elcan Specter DR 1-4x optic, is so accurate the range qualification now goes out to 600 m with standard rounds. This shows the difference that a modern optic can make.

Using M118 special rounds, the US Army M21 had an effective range of 690 m, while the USMC M40 could reach 800 m with the M118. The selected successor to the British L42A1 was the Accuracy International (AI) Precision Marksman (PM) which received the L96A1 designation. Arguably the first of the truly modern sniper rifles, the L96A1 in 7.62 × 51 mm could effectively engage targets out to 900 m and provide harassing fire to 1,100 m.

At a certain point, there was a notable increase in demand for more performance and for enhanced on-target effects, which led to a jump in calibres on offer. Commercially there had always been a profusion of large-calibre rounds, with varying performance levels, such as for hunting large game. Then there was competitive shoot-

ing which also saw people experiment with new rifles and ammunition. Applying what was known in the commercial sector to the military marketplace would see a new category of sniper system emerge. In the lead was Barrett Firearms in the US with their idea to develop a 12.7 × 99 mm (.50 BMG) semi-automatic rifle for long-range engagements, anti-materiel and Explosive Ordnance Disposal (EOD) applications. By the end of the 1980s, they had a definitive design in the form of the M82, followed by the production M82A1 system.

The Swedish Army was one of the first operators to embrace this evolution of sniping capabilities when in 1989, they ordered around 100 M82A1 rifles from Barrett. Later, the Swedes looked to acquire a new sniper rifle in 7.62 × 51 mm, leading them to evaluate the British L96A1 from AI. The Swedish Army also asked AI to make changes to the rifle to meet the demands of their operational environment, which led to the development of the AI Arctic Warfare (AW) sniper rifle. Sweden

The Swedish M82A1 order really started the wider adoption of 12.7 × 99 mm anti-materiel/sniper weapons systems. The USMC then adopted the M82A1, with the US Army and US Air Force following suit. Other manufacturers would also field 12.7 × 99 mm weapons; AI developed L121A1 (AW50) and later the AX50. Barrett would continue to develop a range of large-calibre solutions, including the McMillan TAC-50, Steyr, with its large-calibre system, as did PGM in France. There were many others as well, and more exotic options became available in different calibres; Azerbaijan had the Istiglal system in 14.5 × 114 mm, the Soviet heavy machine gun and anti-tank rifle round. South Africa adopted the NTW-20 anti-materiel system in 20 × 83.5 mm, with a second variant of the weapon fielded in 14.5 × 114 mm. The 20 mm variant has a range in excess of 1,500 m, while the 14.5 mm version has a range of over 2,300 m.

Ammunition Developments

The arrival of the 12.7 × 99 mm weapon presented operators with a system that would have a range of 1,800 m or even further. As these weapons were acquired in large numbers, there were significant developments in terms of ammunition, and standard ball rounds were rapidly supplemented by more exotic natures. These ammunition developments are reflected by the wide range of 12.7 × 99 mm match grade ammunition offered by producers such as Nammo for anti-materiel/sniper applications.

Credit: Puolustusvoimat

The Finnish Defence Forces have selected the Sako M23 in 7.62 × 51 mm as their TKIV 23 sniper system, fitted with a Steiner M7XI 2.9-20×50 scope on a Spuhr mount, with a suppressor from Ase Utra in Finland. Another version of the M23, the KIV 23, has been selected as a Designated Marksman Rifle (DMR).

Available ammunition in 12.7 × 99 mm calibre from Nammo includes ball, ball/tracer, ball round with marker/spotter function (flash) and ball round with IR tracer for night engagements. There is an armour-piercing incendiary (API) round that offers 22 mm of rolled homogenous armour equivalent (RHAe) penetration at 700 m for anti-materiel applications, and a range of multipurpose rounds. For example, the NM140F3 multipurpose round offers AP performance and fragmentation effects; there are also multifunction rounds with tracer and with IR tracer. Alongside these, reduced range rounds are available for training and operations where reduced performance is desirable.

Sniping continued to evolve as new ammunition calibres entered the fray, offering an expanded performance envelope. Most popular of the 'new' sniper rifle calibres is .338 Lapua Magnum (8.6 × 70 mm), while others chose a different path. For example Germany, which used the .300 Winchester Magnum (7.62 × 67 mmB) round, in addition to the .338 Norma Magnum (8.6 × 64 mm) and necked-down versions (to .300 calibre) of the Norma Magnum and Lapua Magnum rounds are available. It should be noted that the baseline for the .338 Lapua Magnum was apparently the .416 Rigby round developed for hunting in 1911.

Depending on preference, there are a vast number of hunting rounds and rounds designed for long-range competition shooting that could be considered for sniping applications. Operators in military, paramilitary and police special units can often use these rounds to create bespoke sniping solutions, having specialist ammunition produced in limited runs, new barrels can be produced in the desired calibre, and both integrated with the chassis of a sniping system.

Exploiting Performance

Earlier in this article, we referred to the British Army replacement of the L42A1 sniper rifle with the L96A1, describing the latter as the first truly modern sniper rifle. The L42A1 could effectively engage targets out to 600 m, whereas the L96A1 could effectively engage out to 900 m. The arrival of new larger-calibre weapons and improved ammunition types led to a dramatic increase in the operational performance of sniper weapons.

The South African NTW-20 certainly fitted the bill for anti-materiel applications, even though its 20 × 83.5 mm round was originally developed in Germany in the 1930s for the MG 151 aircraft cannon. The other variant of the system, the NTW-14.5, in 14.5 × 114 mm appeared to be a far more flexible weapon system – it was an anti-materiel system, but also a classic sniper system. In August 2013, a South African sniper attached to the UN mission in the Democratic Republic of the Congo, neutralised a target at a range of 2,125 m with an NTW-14.5.

In Iraq and Afghanistan, the Barrett M82A1 certainly proved itself; in Iraq in October 2004, a US sniper carried out a successful engagement at 2,300 m, while an Australian sniper successfully engaged a target at 2,815 m in April 2012 in Afghanistan. The McMillan TAC-50 in 12.7 × 99 mm has also demonstrated exceptional performance in the sniping role for the Canadian Forces; in March 2002 in Afghanistan, Canadian snipers successfully engaged targets at 2,310 m

and 2,430 m. In May 2017 in Afghanistan, a Canadian sniper neutralised a target at a range of 3,540 m with a TAC-50. More recently, in November 2022, a Ukrainian sniper using an indigenous XADO Snipex Alligator rifle in 14.5 × 114 mm was successful at a range of 2,710 m.

Long-range engagements are not confined to large-calibre sniper weapons, as proven by a British Army sniper in Musa Qala, Afghanistan in November 2009. Utilising an AI L115A3 sniper rifle in .338 Lapua Magnum, with a Schmidt & Bender 5-25×56 scope, a successful engagement was recorded at a range of 2,475 m. The L115A3 can also deliver long-range engagement capabilities at night or in limited visibility conditions, as its scope can be integrated with both image intensification and thermal systems. British snipers operate in two-person teams, with spotting scopes, laser rangefinders and other systems to enhance target acquisition and engagement among the equipment they carry.

Credit: UK MoD

A British two-person sniper team from 2nd Battalion, The Parachute Regiment on Exercise Joint Viking near Bardufoss, northern Norway, in March 2023. The Accuracy International L115A3 sniper rifle in .338 Lapua Magnum, has a Schmidt & Bender 5-25×56 scope and is shown here with a suppressor.

Performance Growth

Listing these successful extended-range engagements illustrates how the performance envelope of sniper systems has grown in recent years. Sniper systems have grown in flexibility as well, and this is evidenced by Tranche 1 of Australian Defence Force (ADF) LAND 159 Lethality Systems Project to acquire new small arms. As a part of this project, there was the new ADF Sniper System, which called for the acquisition of a medium-range and long-range anti-personnel sniper capability, as well as an anti-materiel sniper capability. The latter requirement was to replace the Barrett M82A2 and this saw the Barrett M107A1, in 12.7 × 99 mm, selected.

To meet the other sniper requirements, the ADF took advantage of a new trend in sniper rifle design, with the rifle capable of being converted between different calibres. This saw the selection of the AI AX-SR, with the weapon capable of switching between 7.62 × 51 mm, .338 Norma Magnum (8.6 × 64 mm) and .338 Lapua Magnum (8.6 × 70 mm). This solution supports mission flexibility, as well as allowing live-fire training with the most cost-effective calibre.

Other areas where the flexibility of sniper systems has been enhanced is in the realm of sighting systems. Optical performance has grown exponentially, with systems offering obvious operational advantages; it also means that more people can meet basic sniper qualification criteria. There is much more to sniping than being the best shot, as a sniper has to be extremely tactically astute to get into position to engage a target and then move to a new location after engagement. A sniper is also a high-value reconnaissance and intelligence asset, as one can see far more through a sniper optic and when moving through terrain, knowing what information is important and passing it up the chain of command is also important to the mission.

Technology will add more possibilities to support and enhance sniping capabilities. As previously noted, sniper scopes are being integrated with image intensification and thermal sights, laser rangefinders are used, as are meteorological sensors, often with ballistic calculators included. British sniper teams use the Leupold Mark 4 12-40×60 mm tactical spotting scope and a handheld thermal surveillance sight.

Potentially though, the future could see the integration of the sniper rifle with a digital fire control system. The next-generation US Army rifle, the XM7 (previously known as the XM5), and the XM250 automatic rifle, essentially a squad support weapon, will come equipped with the Vortex Optics XM157 fire control system (FCS) that has an optic, a laser rangefinder, visible and infrared aiming lasers, ballistic calculator, meteorological sensor suite and a digital display overlay. Raytheon Elcan in Canada has also developed a digital fire control system in the Specter Digital Fire Control Sight (DFCS), and a number of NATO member countries' ground forces have expressed an interest in evaluating the system.

Logically, the future for sniping will see the rifle integrated with a complete FCS solution. The technology to achieve such a solution is already mostly available; all that remains is the integration task to deliver an FCS solution that is sniper-centric. ■

Credit: US Army

The M107A1 12.7 × 99 mm weapon is described as a 'Precision Rifle' by the US Army. It is shown here in July 2023 on a range in Alaska. The M107A1 was selected by the Australian Defence Force (ADF) to meet the anti-materiel sniper capability segment of their new sniper system.

Forward Observers – Highly Skilled, Highly Trained

Tim Guest

Arguably one of the most important jobs on any battlefield – directing artillery fire onto a target as a forward observer – is an intense, highly demanding job. Typically conducted by artillery personnel operating in sight of enemy lines, the job requires nerve and attributes more akin to special operatives, as well as a skillset for which specialist training and latest techniques are essential.

This article examines the types of training required to make an effective Forward Observer (FO), as well as at the role itself, the skillsets expected and a few of the industry simulation and training systems available and in service to deliver those skills.

Crucial Artillery Skillsets

Artillery is a battle-winning asset. However, for it to achieve its maximum effect, it requires the right information about enemy targets – precise location, type, numbers – at the right time for any fire mission. That is the job of the FO. Being an FO and part of a forward observation team is one of the most exacting and important manpower assets in the whole gunnery ecosystem. As an indirect-fire weapon system, artillery is typically located tens of kilometres behind the front lines and the FO team serves as the eyes of the guns, calling in target locations and adjustments to the relevant battery/regimental command posts, or Fire Direction Centre (FDC).

Before going any further, some nomenclature clarification is needed, (and for this article we'll stick with US and UK examples). In some circles, the officer commanding FOs is sometimes still referred to as the Forward Observation Officer (FOO), though in the US Army forward observers fall under the team term, Fire Support Team, or 'FIST', and in the UK's Royal Artillery, since 2002, as 'FST'.

Regardless of which we refer to here, the skillsets required of FOs are fundamentally the same the world over. There may be some procedural differences, but with Allied interoperability and co-operation in mind, these are few. FSTs are considered high-priority targets by the enemy, because they control a huge amount of firepower and are within visual range of the enemy,

Credit: US Army/Staff Sgt Whitney Houston

US Army 1st Lt Elyse Ping Medvigy, the first female company fire support officer to serve in an infantry brigade combat team, conducts a call-for-fire mission south of Kandahar Airfield, Afghanistan, August 2014.

even, sometimes, located deep within enemy territory. FOs must, therefore, not only be adept at fire direction, but also in all aspects of fieldcraft, stealth and, if necessary, direct combat. Trained to the highest levels, their intelligence, adaptability, and broad range of combat skills often make FO operatives good candidates for special forces units and training. It is also worth noting that artillery observers are often deployed with combat arms manoeuvre units, typically infantry companies, or armoured squadrons.

A simple FO overview starts with an FST commander performing map reconnaissance to locate what looks like a suitable place for an observation post (OP), followed by on-the-ground reconnaissance, just in case the real situation reveals some unforeseen negatives. Once the physical reconnaissance reveals a suitable area, an OP will then be selected and the team will set about developing visibility and capability diagrams, orienting maps using optical devices and a compass; establishing communications to supported units, FDCs, or battery command posts in preparation for fire missions. The team commander will then locate and identify enemy targets, compute necessary data of bearing/direction to target and will then initiate a fire mission on targets for which a series of radio communications are sent. The first is to identify the observer to the command post, the next a warning order in which the type of mission is given, such as 'adjust fire', 'illumination', or perhaps 'fire for effect', as well method for target location, with grid being the preferred method. This transmission is repeated verbatim by the command post officer at the FDC. The next transmission provides detailed location information,

Credit: US Army/Sgt Alex Soliday

German FOs assigned to the German 1st Battle Company supporting NATO's enhanced Forward Presence Battle Group Poland, with US fire support specialists assigned to 1st Battalion, 9th Cavalry Regiment, 1st Cavalry Division, supporting the 4th Infantry Division during Exercise Furious Wolf, Poland, 8 August 2023.

preferably a grid reference, which is also repeated to ensure that errors can be corrected by the FO.

The next transmission with be a target description, which might include details such as: "Three infantry squads", "two BTRs, one BMP, two squads dismounted" or even "one fortified compound". Levels of protection are also communicated, such as: "In the open", "dug in", or "in bunkers". And the size and shape of the target may also be communicated at this point. Once the description has been conveyed, the same transmission will include the method of engagement, namely ammunition type, such as High Explosive (HE), smoke, or white phosphorous (WP), although if this is not specified the FDC will decide based on the target description. Numbers of rounds can also be requested, as well as multiple ammunition natures. Duration and rounds per minute may also be stipulated and, if in a scenario where friendly troops are involved and close to fall of shot required, then the mission may be deemed 'Danger Close' by the FST commander. Once this full target information has been conveyed, the final aspect of this communication is the method of control, such as 'fire when ready', or 'at my command'. Time of flight, splash/fall of shot, and time on target, can also be communicated in this exchange between the FST commander and FDC.

This sequence highlights what the FST role is all about; in short, to call in accurate fire onto the enemy. However, were it that simple, for the FST may also be involved with fire direction for mortars, naval gunnery assets, or aerial fire from fixed-wing or rotary-wing aircraft. These teams may also have to prepare detailed – and intensely stressful – fire-support plans for major offensive and defensive operations. These teams must also be capable of conducting night operations using night observations devices, or coordinated illumination methods, and be skilled in using a wide-range of devices and equipment, as well as vehicles, which may be their equipment of need/allocation for a particular mission.

To achieve success and prowess of all the above operational skills, and more, all FST members require extensive training in both classroom and practical, real-world settings. However, in times gone by, practical settings meant only one thing – actually heading out onto the ranges and expending huge numbers of man-hours by employing a battery of guns and requisite ammunition – today's restrictions on expensive ammunition resources, wear and tear on the gun barrels, in addition to expensive fuel costs, means that heading out onto the ranges, just to train, happens less frequently than in the past. Fortunately, technological advances, in the form of sophisticated forward observer simulator set-ups from a number of defence industry companies, have saved the day when it comes to training forward observers, and are used by militaries in FO training the world over. We will examine some of those shortly, but first we will get an overview the Royal Artillery's training course for its FST commanders.

FST Commander Course

The British Army's Royal School of Artillery (RSA) at Larkhill, runs a selection of courses to train FOs/FSTs. These include an 11-week Fire Support Team Commander course run by the Joint Fires Branch, Close Support (CS) Wing at the school. Aimed at the Lieutenant to Major levels, the course is designed to develop the requisite skills and knowledge of officers selected so they are able to perform the required FST tasks. Such tasks include the supervision and operation of

Credit: US Army/Sgt Gavin Ching

US Army 8th Cavalry Regiment, 3rd Armored Brigade Combat Team, 1st Cavalry Division, alongside British soldiers of N Battery The Eagle Troop, Royal Horse Artillery during a live-fire exercise with soldiers assigned to the Bull Battery, 2nd Battalion, 82nd Field Artillery Regiment, Poland, November 2022.

specialist OP equipment and being able to understand and brief personnel on such kit, including the Precision Strike Suite for special operations forces support, surveillance and target acquisition (STA) equipment including radar, and observation post vehicle (OPV). They must also be able to apply the principles of CS technical gunnery focusing on a variety of mission sets enabling students to become technically proficient and able to supervise subordinates. They must also learn how to coordinate and direct joint fires, primarily involving joint fires assets at company/squadron level, with students learning and practising standard and non-standard missions, fire planning, as well as ROE (rules of engagement) and CD (coefficient of drag) factors.

The course also instructs the FST commander in how to liaise with and advise the manoeuvre arm to which an FST commander might be attached, essential if he/she is to advise on OS, FST employability and risk. The commander will also learn aspects of training support from the course, in order to be able to deliver and evaluate training conducted in accordance with the UK's Defence Systems Approach to Training – DSAT.

Other key aspects of this particular RSA training course, include: learning how to recce and select an OP, supervising and operating specialist OP equipment, tasking intelligence, surveillance, target acquisition and reconnaissance (ISTAR) assets, acquiring and transmitting tactical information, coordinating and directing joint fires, communicating as an FST, and operating within a CS regiment.

The RSA also runs two further relevant courses for the UK's FSTs; its 5-week Fire Support Team Battery Commander's Assistant course aimed at SNCOs/Sgt level, and covering much of the aforementioned FST Commander's course, though with some differences; and a 4-week Fire Support Team Detachment Commander's course, aimed at NCOs/bombardier-level members of an FST.

The course contents for FST FOs at the RSA, and the skillsets needed to make the best FOs in the business, are increasingly reflected in a growing number of industry training and simulation solutions, a few of which are mentioned below.

Industry Simulation and Training Solutions

US MAK Technologies introduced a portable training system late 2022, that it says delivers effective call for fire (CFF) training and is designed specifically to develop and reinforce skills for FOs. The system offers the highest levels of FO fire mission training including target detection, fire request, and fire organisation Additionally, on-site, instructor-led, classroom training can be conducted. The training system can be configured in US and international versions. For FO/FST team individual students, MAK FIRES can be run on a single laptop where the student interacts with an AI, voice-activated, simulated FDC. This single trainee mode is designed to offer additional practice to students who either need a quick refresher, or require additional time to learn CFF fundamentals. In the instructor/student configuration, the instructor portrays the role of the FDC, and the student initiates a CFF mission with the instructor over radio, progressing through all communication stages, such as call sign, warning order, method of target location and target location. The instructor uses the CFF Mission Graphical User Interface (GUI) to input and execute the student's CFF mission. In the classroom, MAK FIRES can handle 8, 12, and 16-seat configurations, or can be customised to meet specific end-user requirements. It supports all primary training tasks for FOs, including OP selection; target location by grid, polar, or shift from known point; surface-to-surface fire missions for adjustment of fire, fire for effect, suppression, smoke, and others.

US FISTERS recertify in Ukraine, January 2021

US Forces were actually conducting FO training in Ukraine at the start of 2021, roughly a year before the Russian invasion, including using Ukrainian military simulator assets in the process. The troops were FOs from the 33rd Infantry Brigade Combat Team who needed to recertify on artillery fire direction and field craft through a combination of classroom, simulator and field exercise training. The training comprised several phases, beginning with classroom instruction and ending with practical exercises and written tests.

A 33rd spokesperson said, "FIST stands for Fire Support Team and personnel are known as 'FISTERS' and are members of the US Army's Artillery Corps. While calling in fire in its basic form is a skill all soldiers should be able to do, FOs take this to a further level. Map reading training is a key skillset and being able to know where you are on the ground and how to get to where you're going is an essential FO/FISTER requirement, as well as calling in fire onto the right grid reference.

"Vehicle identification is another crucial skillset for the FO. Knowing what vehicles are seen and being able to ID them as enemy and what kinds they are is crucial. Items on FO target lists are often vehicles and being able to ID them quickly is important. Distinguishing between friendly and enemy vehicles can be a challenge, as many countries share the same platforms, so proficient ID is a must to avoid targeting friendly forces."

During the January 2021 FO training in Ukraine, simulators were provided by the Ukrainian Army that gave valuable hands-on and supplemented classroom instruction for the US FISTERs.

We are going GREEN, BEIGE, and BROWN!

KALLMAN WORLDWIDE, INC.

You may not always see us,
but we've always got your back!

LAST CHANCE TO BOOK YOUR SPACE AT THE WORLD'S BEST DEFENSE SHOWS THIS FALL!

MSPO
Kielce, Poland
Sept 5-8, 2023

DSEI EXCEL - LONDON
London, UK
Sept 12-15, 2023

Seoul ADEX
Seoul, South Korea
Sept 17-22, 2023

Defense & Security
Bangkok, Thailand
Nov 6-9, 2023

DUBAI AIRSHOW
Dubai, UAE
Nov 13-17, 2023

Milipol PARIS
Paris, France
Nov 14-17, 2023

Expodefensa
Feria Internacional de Defensa y Seguridad
International Defense and Security Trade Fair
Bogotá, Colombia
Dec 5-7, 2023

Milipol Singapore

DSA 18th DEFENCE SERVICES ASIA EXHIBITION & CONFERENCE SINCE 1988
Kuala Lumpur, Malaysia

LandForces INTERNATIONAL LAND DEFENCE EXPOSITION
Australia

LAAD DEFENCE & SECURITY
Rio de Janeiro, Brazil

Milipol QATAR
Doha, Qatar

DSEI JAPAN
Chiba, Japan

defexpo INDIA
India

VISIT KALLMAN.COM TO SECURE YOUR SPACE IN THE PARTNERSHIP PAVILION AT THESE UPCOMING DEFENSE SHOWS

USA PARTNERSHIP PAVILION

CANADA PARTNERSHIP PAVILION

Credit: Zen Technologies

The ArtyFOS simulator eliminates traditional FO training resource challenges such as ammunition use and logistics, while ensuring ready-for-battle standards of participating students.

Indian company Zen Technologies offers its Artillery Forward Observers Simulator, ArtyFOS, to train artillery OP officers and FOs, as well as all other officers of combat wings of the Indian Army who may be required to fire long-range, indirect fire weapons, including mortars, guns, howitzers, rockets and missiles. ArtyFOS has an Instructor Station and an OP Officer's Trainee Station. It facilitates target engagement from a single gun to the guns of an artillery brigade. It also has a module to train the trainers, which allows standardisation of training across the whole force. The company says that with artillery training being a cumbersome logistics and resource-intensive process, the ArtyFOS simulator eliminates these resource challenges, while ensuring ready-for-battle standards of participating students. The system recreates a wide range of terrains and scenarios expected to be faced by trainees in actual war. It also enables trainees to fire the guns applying different procedures, with year-round training possible. The simulator experience includes: recreating field firing-ranges indoors; allows simultaneous application of multiple environmental effects; enables nine fire units to fire at a time; includes dispersion zones, meteorological conditions, shell-to-shell variations; displays actual ballistic trajectories and fall of shot; contains maps, binoculars and aids to firing; has provision for obtaining magnetic bearing; simulates numerous artillery shell blast effects.

Turkish defence player, Havelsan, together with its US subsidiary, Quantum3D, and other Havelsan subsidiaries, market Havalsan's Artillery Forward Observer Training Simulator (AFOS), configured and customised appropriately for different markets and customers. The system is a computer-based trainer for FOs and FDC Personnel and teaches targeting, fire requests and management of fire missions across a

Credit: MAK Technologies

All FO primary training tasks are supported by MAK FIRES including: selection of OPs; target location by grid, polar, or shift from known point; surface-to-surface fire missions for adjustment of fire, fire-for-effect, suppression, smoke and more.

range of training scenarios; it can simulate varied training environments, including a wide range of static and moving targets, custom terrain and land views and realistic meteorological effects. It uses accurate ballistic physics models and integrates realistic visual cues and sound effects to create a realistic training environment. A built-in after-action review system, allows trainees to review and evaluate performance and identify areas for improvement once training is over. The system is designed for portability and transportability so it can be deployed worldwide and can also be set up in a permanent classroom setting.

According to the company, the system offers multiple levels of FO fire mission training, including target detection, fire request, and fire organisation; and training management. It also includes: creating scenarios with static and moving targets in a variety of terrains; observers are trained to become faster and more precise while developing observer skills by working with firing control centre personnel; simulation of real battle conditions with realistic visual and sound effects; artillery/guns of all sizes are simulated and various ammunition and fuse combinations are used to observe impact on static and moving targets. One of its key resource-saving attributes is that it saves users from wasting ammunition as well as time resources. Havelsan has stated that its AFOS training systems are used by many armed forces worldwide 'to provide necessary training to FOs and gunnery personnel to use artillery firepower in the most appropriate place and time'. According to the manufacturer, AFOS can provide training for up to 40 people simultaneously, and has a simulation database compatible with NATO and Russian artillery techniques, all artillery and mortar weapons and all the ammunition natures that can be fired from these weapons.

Bytes for the Fight

Thomas Withington

The US Army is enhancing its offensive and defensive cyberoperations capabilities across the board, but is doing so largely in the shadows.

In 2023, the United States Cyber Command (USCYBERCOM) became a teenager, having plied its trade since May 2010. In its own words, USCYBERCOM's mission "is to plan and execute global cyber operations, activities and missions to defend and advance national interests in collaboration with domestic and international partners across the full spectrum of competition and conflict." Broadly speaking, these "operations, activities and missions" include protection of the US Department of Defence's Information Network (DODIN). DODIN comprises all the DOD's non-classified and classified computer networks the department depends on daily. Alongside protecting DODIN, USCYBERCOM responds to cyberattacks against the US and her Critical National Infrastructure (CNI). Beyond these two defensive missions, USCYBERCOM has an offensive remit performing cyberoperations for the US military. These operations focus on ensuring "the security of networks, data and weapon systems across the world." The command can also be called upon by its political and military masters to "disrupt, degrade and destroy the capabilities of malicious cyber actors and foreign state adversaries as directed."

One could be forgiven for thinking this impressive list of tasks and missions is achieved with legions of trained personnel working from desktop computers and laptops connected to large banks of servers. This is partially true. However, like the US armed forces and other militaries around the world, USCYBERCOM does procure dedicated capabilities. One such programme is 'Starblazor' which media reports state may have commenced in 2020. Little is known about the initiative. Some commentary has said that Starblazor was realised in conjunction with the US Army's Cyber Centre of Excellence. The crux of the initiative was to rapidly develop and deliver Electronic Countermeasures (ECMs) and cyber effects. Stefan Soesanto, senior researcher at the Centre for Security Studies at the ETH Zurich research university in northern Switzerland, has produced an intriguing report entitled 'A Digital Army: Synergies on the Battlefield and the Development of Cyber-Electromagnetic Activities.' Published in 2020, he wrote that Starblazor was focused on embedding coders and software developers at the tactical edge. The logic behind this pilot programme was to provide extremely agile responses to battlefield cyber threats and/or to support manoeuvre using cyber effects. The army considered this much more responsive than having to go up and down echelon to request and receive cyber capabilities as and when needed. In addition, Starblazor also allows Electronic Warfare (EW) and cyberoperations cadres to work closely together at the tactical edge, which makes sense.

Today's and tomorrow's military operations will be performed in electromagnetically congested environments. Take the ongoing war in Ukraine as an example. According to Worlddata, a German research company, as of 2021 almost 56 million mobile phones were in use in Ukraine. That corresponds to 1.3 per person. Mobile phones routinely use frequencies of circa 850 MHz to 1.9 GHz. This spans much of the Ultra High Frequency (UHF) waveband (300 MHz to 3 GHz). Armies, Russia's and Ukraine's included, routinely use UHF frequencies for land forces tactical communications. If we take Motorola's SRX-2000 squad radio, this uses frequencies of 700-800 MHz, according to the manufacturer. The challenge in an operational theatre will be finding military radio signals in the morass of electromagnetic noise caused by everyday mobile phone use.

Such tasks get more vexing when Communications Intelligence (COMINT) experts are trying to locate high value individuals such as opposing senior offices from the red force via their mobile phone signals. In January 2023, CBS reported that mobile phone signals from Russian soldiers helped Ukrainian artillery locate hostile troops. Rudimentary Communications Intelligence (COMINT) systems could detect and locate the signals. That these signals came from Russian troops could have been corroborated with imagery intelligence. For example, live video footage from an Unmanned Aerial Vehicle (UAV) could have confirmed the troops' location. The video footage may have even shown to them using their mobile phones. Then, it is a matter of sharing the latitude and longitude coordinates of the targets with Ukrainian artillery which then does its deadly work. As the CNN report stated, even the Rus-

Credit: US DOD

Cyberoperations are now of such importance to the US Department of Defence that USCYBERCOM is now one of the US military's dedicated combatant commands.

Author

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

sian military admitted that unauthorised mobile phone use by their own troops had contributed to a lethal Ukrainian attack in early January 2023 which killed 89 soldiers. Sources from the Electronic Warfare (EW) world have told this author that Ukraine has enjoyed success against several senior Russian Army commanders. These commanders have been located via their mobile phone use and then killed by artillery.

As of 11 July 2023, the Russian military has confirmed that six of its generals have been killed during the invasion. The sources continued that techniques and technologies developed by the US and her allies during counter-insurgency operations in Afghanistan and Iraq have been instrumental in helping locate these generals via their electronic emissions. Activating one's mobile phone in a warzone is tantamount to giving the enemy not only your location, but most probably also that of your comrades. One potential task of USCYBERCOM could be to employ its vast computer resources to comb through torrents of radio signals to find that all-important signal of interest.

Credit: US DOD

The US Army places a high emphasis on embedding cyberoperations expertise at the tactical edge to ensure that cyber effects can be exploited at this level.

Strategic Cyber Posture

The US Army is an enthusiastic adopter of cyberwarfare capabilities which feed into the overall missions of USCYBERCOM discussed above while also supporting the US Army manoeuvre force. The Department of the Army's Management Office – Strategic Operations (DAMO-SO) supervises the digitalisation of army warfighting systems according to reports. DAMO-SO's mission covers all levels of war, from the tactical edge to the strategic level. The organisation was known as DAMO-CY until 2020, the 'CY' standing for cyber. The change to 'SO' was made to reflect the army's embrace of Multi-Domain Operations (MDO). This is part of the wider MDO direction of travel of the US DOD and America's armed forces.

To summarise MDO in brief, these strive for the full intra- and inter-force connectivity of every person, platform, base, weapons system, sensor and capability (henceforth known as assets), at all levels of war. The goal of MDO is to achieve a better quality and pace of decision-making vis-à-vis one's adversary. Requisite levels of connectivity will see an unprecedented reliance on communications networks. Robust, efficient and redundant networks will be needed to carry data between these assets. As DOD discussions on MDO make clear, cloud computing plays a key role in this vision. 'Combat Clouds' will be the battlespace repositories where intelligence, surveillance and reconnaissance (ISR), and command and control (C2) data are shared across these assets. Securing MDO networks and combat clouds against cyberattacks will be paramount. It makes sense for the army to fold its strategic cyber posture into its wider strategic MDO-focused digital transformation. Soesanto explained that DAMO-SO "serves as a policy integrator, whose task is to figure out how to better organise, restructure and resource the army in the non-kinetic realm."

Operational level

While DAMO-SO is arguably concerned with the wider strategic orientation of the US Army's digital posture, the force's Cyber Support to Corps and Below (CSCB) initiative moves cyber capabilities into the manoeuvre force. CSCB is primarily concerned with cyberoperation from the corps level downwards. Soesanto wrote that initial army plans called for the CSCB to embed cyber specialists at the brigade level. There, they would support training and exercises. Army exercises performed in 2016 at Fort Irwin, North Carolina, proved instructive by indicating desired cyber specialist numbers to support brigade- and company-level manoeuvre. Plans called for up to 45 specialists to be deployed with a brigade, with a company having up to three dedicated cyber personnel. One of the takeaways from these exercises was that cyber specialist numbers were insufficient to support the brigade during the exercise. CSCB has since been renamed to stand for 'Cyber and electromagnetic activities Support to Corps and Below'. Soesanto says this name change reflects lessons learned from army exercises, chiefly that cyber specialists must also have military intelligence, EW and even space warfare skills.

As Ukraine has illustrated, electronic warfare capabilities like COMINT will need to be tightly integrated with other disciplines such as human intelligence (HUMINT) or Imagery Intelligence (IMINT). Let us suppose the intention is not to use COMINT and IMINT to fix and kill hostile troops via their mobile phone signals. Instead, a plan is hatched to deliver false or demoralising information to these mobile phones to attrit enemy morale. This plan may call for malicious code to be delivered to these phones via a radio signal transmitted from the force's EW equipment. One immediately sees how important the synergy between these respective disciplines is. It is instructive that one of the training systems the US Army has at its Muscatatuck Urban Training Centre in Indiana is the Social Media Environment Internet Replication (SMEIR) system, which creates a social media environment to support urban warfare training exercises. This is particularly important as battles for hearts and minds are now largely fought on social media. SMEIR allows US Army cyberoperations experts to hone skills and tactics in the social media sphere as much as on the battlefield.

While the CSCB is arguably concerned with cyberwarfare at the operational level, with some overlap into the tactical domain, the latter is the preserve of the army's new Cyber Battalions. On 15 December 2022, the 11th Cyber Battalion (11th CYB) became the army's first Cyber and Electromagnetic Activities (CEMA) battalion. Reflecting the synergy of the cyber and EW missions in the Army's own words, this new unit "can deliver a range of non-lethal, non-kinetic effects – including offensive cyberspace operations and EW capabilities." The activation of the 11th CYB, as the unit is known, followed the deactivation of the 915th Cyber Warfare Battalion. This latter unit had been raised as a result of the CSCB's activities. The 915th was intended to support tactical formations of Brigade Combat Team (BCT) size and below. The Starblazor pilot programme discussed above was originally earmarked for the 915th, wrote Soesanto. It seems reasonable to assume these capabilities have now transitioned into the 11th CYB.

An official army press release announcing the activation of the 11th CYB described it as the force's first and only CEMA battalion. The press release continued that the 11th CYB's

Credit: US DOD

The US Army is working on the closer synergy and coordination of cyber and electronic effects, particularly at tactical and operational levels. While the potential convergence of these disciplines is a hotly debated topic in both the cyber and EW communities, both are clearly complementary.

order-of-battle includes three companies and an eventual twelve expeditionary CEMA Teams. It appears the 11th CYB will be an independent formation with its expeditionary CEMA Teams and companies supporting the manoeuvre force in scaled fashion. The US Army is in the midst of a reorganisation which sees it adopting the division as the principal manoeuvre unit. This reconfiguration is the result of the revival of strategic great power competition, the Army has said. Larger formations are needed to challenge the military power of rivals such as the People's Republic of China (PRC) and Russia. This marks a break from the BCT as the primary unit of manoeuvre, which had been developed as a result of the US-led counterinsurgency operations in the Afghanistan and Iraq theatres, both of which required agile, rapidly-deployable manoeuvre units.

Operational/tactical level cyberoperations are also facilitated by the army's experimental Intelligence, Information, Cyber, Electronic Warfare and Space (I2CEWS) battalion-sized units. One I2CEWS battalion equips each of the army's Multi-Domain Task Forces (MDTFs). In some ways, the MDTF concept represents an early embodiment of the MDO Eldorado. According to a 2023 report by the US Congressional Research Service, the function of the MDTF is to provide "theatre-level manoeuvre elements designed to synchronise precision effects and precision fires in all domains against adversary anti-access/area-denial [A2/AD] networks in all domains, enabling joint forces to execute their operational plan." The I2CEWS battalion joins the MDTF's strategic fires, air defence and brigade support battalions. These latter three battalions provide long- and medium-range fires, air defence for the MDTF and allied assets, and combat support elements. Constituent units of the I2CEWS include two military intelligence companies, a signal company, information defence company and an extended-range sensing and effects company.

To date, three MDTFs have been activated with two focused on the Asia-Pacific and one focused on Europe. Speaking in March 2023, General James C. McConville, then the Army's chief of staff, articulated his desire to generate a further two MDTFs. McConville envisaged an additional task force being deployed to the Asia-Pacific. His desire no doubt reflects the tensions existing between the People's Republic of China, and the US and her allies in the region. McConville added that an additional MDTF could be raised, which would be able to respond to contingencies outside the Asia-Pacific and Europe as and when they occur. The Army has also made efforts to enhance the size of its cyberoperations and EW cells at the operational and tactical levels. As Soesanto makes clear, the brigade-level cyber cell has doubled from five to ten. Meanwhile, its division level equivalent has increased from five to nine.

Outlook

Much remains opaque about the US Army cyber capabilities supporting the manoeuvre force. Equipment-wise, the Army has said that the new Terrestrial Layer System (TLS) series of EW systems support cyber operations. The Army is acquiring two specific platforms and has stated that the Terrestrial Layer System–Echelon Above Brigade (TLS–EAB) supports tactical/operational level cyberwarfare. Lower down, the Terrestrial Layer System–Brigade Combat Team (TLS–BCT) provides EW and cyberoperations capabilities at the tactical level, primarily for the brigade combat team and below, according to the Army. Lockheed Martin is providing the prototype TLS-EAB with the production version potentially entering service after 2025. Both Lockheed Martin and General Dynamics are working on designs to satisfy the TLS-BCT requirements via Army contracts awarded in 2022. The TLS-BCT capability could enter army service in a similar timeframe to the TLS-EAB.

Beyond the TLS family, there is little information in the public domain on the other tailored capabilities the US Army has, or is planning to procure, for cyberoperations. Requests for information from USCYBERCOM to this end went unanswered. This reticence for discussion is perhaps not surprising. Cyberoperations, like their EW counterpart, are often shrouded in secrecy. The good news is that the available information in the public domain suggests that the force takes the potential of cyberoperations to support army and joint manoeuvre very seriously. ■

Credit: Lockheed Martin

An artist's rendering of Lockheed Martin's offering for the US Army's TLS-BCT requirement. This platform will be able to direct cyber effects against adversaries as well as perform electronic warfare.

Operations in Denied Environments

Tim Guest

Denying an adversary the chance to operate effectively in a given battlespace can be achieved by a variety of means. The denial of positioning, navigation and timing (PNT) data supplied by global navigation satellite systems (GNSS) such as GPS, and on which so many NATO ally platforms rely, has become one of the most significant threats to effective operations on today's battlefield.

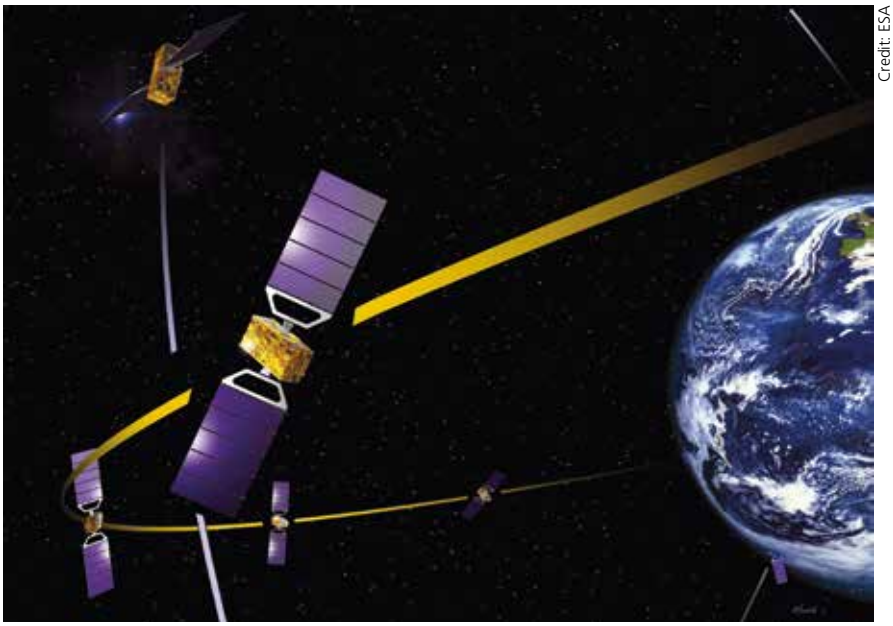
Denied environments come in all shapes and sizes. Obstacles and other defensive emplacements may have been prepared to deny an opposing force ease of manoeuvre in a land-based scenario; defending against a counter-offensive, for example, where the defender uses a variety of barriers, such as minefields and wire and 'dragon's teeth', often creating kill zones by pre-zeroed in artillery and other kinetic weapons. Anti-access/area denial (A2/AD) at sea, too, where maritime routes, regions and straits, for example, are 'covered' and in range using weaponry such as land-based, anti-ship missiles, unmanned surface vessels (USVs) and unmanned underwater vessels (UUVs), denying an opposing force the chance to safely operate in such waters.

Yet, whether on land, at sea, or in the air, combatants and their sophisticated platforms, weapons and sensors have all come to rely on satellite and communications technologies and services for their PNT and command and control (C2) requirements. Countering these technologies and services has grown into a battlefield game-changer. As the war in Ukraine has shown, electronic warfare can be used to effectively degrade or deny services as GPS and many forms of communications.

This article looks chiefly at the increasing threat of GPS-denied environments, how operations are affected in the real world, current experiences on the battlefield, as well as a handful of the systems and technology currently being developed by industry and marketed to address this threat to allow allies to continue operating in denied environments effectively. Mention is also made of maritime A2/AD.

Author

Tim Guest is a freelance journalist, UK Correspondent for ESD and a former officer in the British Forces.



Credit: ESA

Artist's impression: Galileo satellites. Multiple cases of jamming and spoofing of satellite navigation signals were reported in 2019, and not just of GPS, but also signals from Beidou, Galileo and QZAA.

Denial of GNSS

Any satellite constellation that provides PNT services, either on a global or regional level, is described as a GNSS, and while the US Global Positioning System (GPS) is the most widely used GNSS, there are other systems that provide complementary and/or independent PNT capabilities to GPS fielded by other nations. These include: China's BeiDou (often referred to as BDS) constellation comprising 35 satellites; the EU's Galileo constellation currently comprising 23 satellites, with an eventual target of 30; Russia's GLONASS constellation comprising 24+ satellites; 'Navigation with Indian Constellation' (NavIC), a regional Indian constellation comprising seven satellites; and Quasi-Zenith Satellite System (QZSS), a small Japanese constellation to complement and improve GPS coverage in East Asia and Oceania, which is expecting to reach its seven-satellite target in late-2024.

These constellations illustrate the huge importance that the global community places on its need for PNT information, with militaries the most critical users. It also highlights the fact that while our adversaries will, in times of conflict, be doing their best to interfere with our PNT, such as blocking GPS signals, Allied forces, will have the same aims in mind regarding any opposing GNSS system.

This is where GNSS denial (for the purposes of this article, GPS) creates a denied environment. This happens when a receiver, perhaps in a vehicle navigation system, in a missile GPS guidance system, or in a GPS-guided artillery round such as the M982 precision-guided 155 mm Excalibur artillery shell, for example, is unable to provide PNT to a platform, because satellite signals are unavailable and cannot be reached. As a result, none of those GPS-reliant platforms will be able to either find their way, or prosecute their missions. As to why no GPS signal reaches those respective receiv-

ers, depends on whether it is intentional or deliberate interference, spoofing, signal blockage/jamming, or constellation failure for various reasons, some accidental, others deliberate.

Signal interference, for example, can be wholly unintentional, with the source being something like a faulty radio or antenna, or maybe a result of dust or water ingress into component parts creating signal noise (passive intermodulation). Ways of overcoming short-term interference include the use of additional navigation sensors, such as Inertial Measurement Units (IMUs), Inertial Navigation Systems (INS), odometers, and/or altimeters.

Credit: IAI

A technology centre dedicated to developing and producing non-GPS navigation systems was opened in 2021 by the Israeli Directorate of Defense Research & Development (DDR&D), and Israel Aerospace Industries (IAI), to develop and manufacture highly-accurate inertial sensors to equip the next generation of navigation systems.

It is also important to note, that those GPS signals reaching a receiver, having crossed huge distances from orbiting satellites, will be very low in power, which makes them susceptible to interference from other signals transmitted in the GPS operating frequency range. If these other signals are sufficiently powerful and are potentially deliberate jamming signals, it will be very difficult for a GPS receiver to detect the low power, incoming GPS signals from the satellites.

To counter such intentional jamming, one approach is to deploy anti-jam antenna systems, which consist of controlled reception pattern antennas and advanced electronics, to control the amount of signal received from a particular direction. If interference from one direction is sensed by the antenna system, it turns down the antenna gain for that direction, thereby reducing the amount of interference received. As a result, true GPS signals from other directions can reach receivers in the area. Another approach being taken is the employment of new forms of GNSS signalling, as in the case of GPS using the M-Code waveform currently being rolled out, which is more resistant to jamming than the C/A Code, and P/Y Code waveforms.

Alongside jamming, an opponent can also spoof GPS signals, deceiving GPS receivers into reporting bogus PNT data. Spoofing does this by introducing a false signal – either using a signal generator, or by rebroadcasting an actual recorded GPS signal – which has the same structure and frequency as the GPS signal, but with the spoof signal controlling its transmitted power level to ensure the receiver locks onto it rather than the real, weaker, GPS transmission. The information contained in the body of the spoofed signal results in the receiver calculating and providing incorrect PNT data to its users.

The whole process of spoofing GNSS signals is complex and requires sophisticated equipment to execute, as well as precise information regarding the velocity of the targeted receiver, for instance, whether it is aboard a GPS precision-guided munition or missile. Spoofing complexity increases further if the attacker attempts to simultaneously spoof more than one GNSS frequency or constellation. That said, it is possible to protect against spoofing using a receiver able to track multiple frequencies and/or multiple constellations, as it will be able to detect and overcome spoofing attempts. Navigation sensors such as GNSS combined with an inertial navigation system (INS) can also be used to detect and overcome a spoofing attempt, as inertial measurement unit (IMU) signals cannot be spoofed.

Beyond the threats of interference, jamming and spoofing, operatives may find themselves in a GPS-denied environment simply for topographical reasons, perhaps a cluttered urban setting in which high-sided buildings and skyscrapers obscure clear line-of-sight to the satellites being tracked by the receiver, or thick forest, etc. Without the ability to track/see several satellites in a given constellation, a receiver will be unable to calculate its required PNT information. However, by tracking more than one constellation, more satellites will be available to 'be seen', thereby increasing the chance of finding enough to calculate PNT details. This is where using multiple navigation sensors, including having an IMU alongside a GPS receiver, allow signal outages due to physical obscuration to be overcome.

One final, less likely circumstance creating a GPS-denied situation, is the worst-case scenario of a complete constellation failure. Certainly, having receivers that can track more than one constellation will provide some protection from this unlikely occurrence, nevertheless, it is a scenario Western allies need to train for due to its increased likelihood in the event of a major conflict between major world powers. At such a juncture, normal services will be anything but, and they'll also be unlikely to resume anytime soon.

Ukraine highlights operations in GPS-denied environments

For years now, and well before Russia's invasion of Ukraine, it has been recognised by the US, Allied and NATO commanders, that in the event of a serious conflict with a major power, such as China and/or Russia, the West would be extremely vulnerable to having most of its satellite and ground-based electronic communications shut down by electronic warfare systems and other enemy actions, including space-based weapons. Wargames have shown US and Western forces to be far more vulnerable than originally presumed. Indeed, analysis has shown that methods for disrupting access to GPS and Allied satellite resources, while minimising potential damage to their own satellite capabilities, have been developed and pursued by China, with its forces also training to ensure they can continue to operate in communications and GNSS-denied environments.

In Ukraine, a new barrage jammer was used by the Russians earlier this year to broadcast electronic interference across a broad range of frequencies at greater distances than previous systems. The apparent intention was to disrupt Ukrainian GPS-guided weapons such as GMLRS rockets and JDAM bomb guidance kits. US platforms and weapons were also equipped with INS back-up systems to the prime, GPS receivers, so they could continue to provide accurate guidance if GPS signals were disrupted or jammed. It appears that in this case, the barrage jammer was capable of reducing the effectiveness of the INS back-up through its ability to jam GPS signals quickly and from greater distance. As a result, the INS received incorrect location updates and failed to perform as an effective GPS back-up.

This scenario had been anticipated within the defence industry. A year prior to the Russian invasion, one development came from the Israel Defense Forces (IDF), together with Israel Aerospace Industries (IAI), announcing a new Advanced Navigation Technology Centre, as a division of IAI, which has been a maker of INSs for years. Interestingly, the new centre is intended to develop a new generation of INS technology to complement, or even replace, satellite guidance.

Credit: Rafael

Rafael's FOOTPRINT navigation system for operations in GPS-denied scenarios enables highly accurate and continuous real-time, self-positioning information when GPS signals are jammed or obscured. Pictured: FOOTPRINT connected to CIV-TAK.

Other new INS technology has emerged from other Allied defence industry players, which can now be used for more effective monitoring of GPS signals, with greater capability to alert users that a GPS signal has either developed a problem, is being jammed, or has been spoofed. In addition, new INS systems have proven effective for certain high-velocity, manoeuvrable missiles, which sometimes lose their GPS signal in flight.

Credit: Rafael

Rafael's FOOTPRINT operating in a GPS-denied basement.

Despite the threats to GPS, US DOD and NATO officials have voiced a degree of confidence that current anti-jamming efforts will be sufficient to keep military GPS use viable for some time. That said, jamming and spoofing sophistication over the past five or more years is accelerating beyond expectations. Indeed, episodes of Russian jamming or spoofing of GPS signals since 2017 have been numerous. In early 2019, it was reported that nearly 10,000 cases had recently occurred of an actor (Russia was seen as the likely culprit) jamming, but mainly spoofing, satellite navigation signals, and not just those of the US GPS, but also signals from Beidou, Galileo, QZAA and even some instances affecting GLONASS, the latter possibly as a deceptive distraction.

Spoofing was a particularly common act used by Russian forces in Syria, and has now been impacting GPS systems in Ukraine, where false signals have diminished the accuracy of GPS-guided munitions. While INS is meant to solve this problem, Russian spoofing in Ukraine appears to have been capable of impacting at least some systems equipped with an INS backup.

Enabling Operations in GPS-Denied Scenarios

The defence industry is aware of the threat posed by GNSS denial and many players have developed or are developing solutions to mitigate and overcome such scenarios. However, there are two companies whose solutions highlight the positive steps and systems available to ensure Allied ground troops remain effective even under such testing operational scenarios – these are French industry giant Safran's Orolia and Israel's Rafael.

In July 2022, Safran announced it had acquired PNT company, Orolia. The latter has experience developing technologies for GNSS-denied environments and has introduced its Simulation and Interference Detection & Mitigation (IDM) portfolio in this regard, which offers an array of GNSS spoofing and jamming simulation, detection, suppression and countermeasures technologies. These capabilities are built on Orolia's resilient PNT offering, together with those of Skydel Solutions and Talen-X, companies which Orolia had acquired and whose GNSS testing and simulation have been used by US and Allied forces. These have previously included anti-jamming antennas and secure/alternative signals, as well as GNSS threat detection, interference suppression and countermeasures.

In order to address operation in GPS-denied environments, Israel's Rafael has designed required resilience into many of its systems so they can continue to perform their functions should GPS services be denied. In this vein, in late 2022, as part of the British Army's Warfighting Experiment (AWE), British Army ground troops conducted a set of trials with Rafael's FOOTPRINT navigation system for operations in GPS-denied scenarios. FOOTPRINT consists of a suite of passive sensors – including IMUs, magnetometers, barometers, and other sensors – which are integrated together into a wearable package strapped to the soldier's leg above their boot. This is linked to existing communication systems and works by fusing data from the various sensors, which is then fed into the software to provide an accurate 3D location for the soldier.

The British soldiers taking part in AWE tested the Israeli system between and inside buildings, in basements, as well as in open areas. As part of the trial, FOOTPRINT was connected to the CIV-TAK (Civilian Team Awareness Kit) software. The trials were deemed successful, with commanders able to obtain an accurate picture of the location of every soldier, giving them a detailed picture of the operational situation. In early 2022, the system was selected by the IDF for its ground troops, where it will be integrated into the force's existing battle management and soldier communication systems, allowing troop locations to be shared with commanders.

For vehicle navigation, Rafael offers the CT-Mentor system, which uses a suite of cameras fitted to the host vehicle and preloaded maps. The cameras translate their observed environment into a cloud of datapoints, which is then matched against the datapoints contained in the pre-loaded map. Company representatives have previously stated that the system will continue to work in an urban environment even if approximately 30% of the urban environment has been damaged.

Elsewhere, the US DOD's Advanced Research Projects Agency (DARPA) has conducted several programmes addressing operations in GPS-denied environments and how to overcome such scenarios. Some 10 years ago, the agency's researchers looked into what would happen if GPS suddenly became unavailable due to malfunction, enemy action or simple interference. Significant progress was made with a single chip timing & inertial measurement unit (TIMU) that contained a six-axis IMU (with three gyroscopes and three accelerometers) and integrated a highly-accurate master clock into a single miniature system smaller than a penny. The agency said that the TIMU was sufficiently small and robust for personnel tracking, handheld navigation, small munitions and small airborne platform applications. ■

Reinventing Sustainment on the Contested Battlefield

Tamir Eshel

Despite their critical role in warfare, logistics and sustainment have always been given a lower priority in military affairs, as the greatest attention was paid to 'sharpening the edge' – namely, combat systems, weapons, and the training of troops and formations. However, as the war in Ukraine has emphasised, sustainment emerges as a critical factor in the ability of an army to remain effective, equipped with ammunition, energy, liquids, food, medical support, and the repairs necessary for combat units to keep fighting, with their combat systems, human resources and, soon – its robots.

Keeping combat forces supplied is not only a logistical challenge, but it also has implications for the survivability of the supported units, the transportation systems they use, and the supplies carried. There are also implications for command, control, and intelligence. Traditional logistics operations rely on commercial principles – the production, procurement, and stockpiling of supplies at large depots and distribution of those to forward units using ships, cargo planes, railways, and trucks to deliver the stores to forward distribution centres from where goods can be pushed to the combat units according to operational plans or based on demand, waiting for the units to pull the supplies they need, using their own transportation means. Refuelling and rearming are performed at resupply points, where fuel tankers and ammunition trucks distribute their loads to combat vehicles.

These traditional systems have worked for decades. Until now, the sustainment pace has determined the warfighting endurance of units, relying exclusively on their own transportation, refuelling, rearming, and stockpiling capabilities. Fighting a full-scale war is all about consumption on a mega scale. A corps-sized force could require an estimated 7.57 million litres of fuel daily and enough food to sustain up to 45,000 soldiers. In Ukraine, the daily artillery ammunition consumption is estimated at 6,000 rounds or about 270 tonnes. These supplies must be delivered continuously, reach their destination on time, and, sometimes, survive enemy fire. Failing to sustain the fighting edge would bring an entire campaign to a standstill in hours or a few days

Contested Logistics in a Transparent Battlespace

In a transparent battlespace, lacking effective air and counter-artillery defences, these distribution and resupply points could soon become primary kill zones, where complete formations can be effectively wiped out by precision fires and loitering munitions. Therefore, planners should seek an overhaul of future sustainment in contested environments. Aware of the changing paradigm, the US Army has recently established a new cross-functional team (CFT) focused on contested logistics, in addition to the seven CFTs established by the US Army Future Command in 2018. The new CFT represents a team effort across the four Army commands to understand better and define logistics on the future battlefield. It is focused on the divisional level and below, and its goal is to deliver capabilities by the 2030 timeframe.

The changing battlespace landscape and the widespread availability of surveillance satellites and drones provide a detailed and elevated view, enabling the opponent to find, locate, and track every movement and change. As the sources of supplies are often associated with large depots, monitoring traffic along highways or railway lines provides early warning of such movements. Radars providing Ground Moving Target Indication (GMTI) can easily spot and track trains loaded with supplies or a truck convoy moving on highways hundreds of kilometres away. The ability to perform persistent surveillance provides intelligence analysts the means to look 'into the past' and uncover forward supply hubs even when they are concealed in civilian warehouses or highly camouflaged stockpiles. Such an ability has been clearly observed in the Ukrainians targeting forward ammunition dumps in Donbas and the Zaporizhzhia region.

Credit: Corvo

The Precision Payload Delivery System (PPDS) provides point-to-point 'microdeliveries' of a few kilogrammes.

The consequences of operating conventional means of transportation in such a 'transparent battlespace' are dire, as long-range fires target convoys en route to the front line or, if they reach their destination, the supplies they delivered are destroyed by artillery fires. Logisticians seeking to overcome this problem may find alternatives that are not necessarily the most effective economically (rated by the least cost of supply, like business logistics), but those representing assured sustainment, considering the probability of survival of the delivered supplies, bringing the most necessary supplies to the unit, on time. Within such parameters, cost is important but may not be the determining factor. Bulk delivery by trucks or pallets may not be the best solution to supply a battalion, but rather smaller, lighter parcels delivered by autonomous delivery systems straight to the user may be a better solution. These could offer redundancy of supplies and reliable delivery, meaning that trusted replenishment of an artillery fire unit, a tank, or an infantry squad can be phased over time. Unmanned trucks could transform from a means of delivery into mobile storage platforms, keeping essential supplies hidden, on the move, and hard to target.

Reinventing Sustainment?

Many armies are studying these methods under various experimentation programmes, exploring the use of 'direct air delivery' and 'last mile' sustainment using various robotic systems. Most of these systems use forward logistics hubs supplied by unmanned convoys delivering large volumes of supplies, then distributing the supplies according to predictions based on operational plans and consumption levels of fuels, ammunition, energy, water, and food. The same platforms pushing the supplies can bring back discharged batteries or evacuate casualties without exposing large movements to enemy observation and fires, or risking additional forces to secure large convoys. A major advantage of this 'Hub and Spoke' method is the elimination of large static hubs that become an easy target. Instead, supplies are stored and carried by moving platforms, making it harder to find, strike, and destroy large amounts of ammunition and supplies. Such autonomous convoys were developed to address the risk of ambush and IEDs encountered in Iraq, Afghanistan, and Central Africa, but the war in Ukraine has demonstrated new challenges to logistics operations that unmanned transportation may be able to alleviate.

In Ukraine, both sides rely on trucks to replenish front-line units, but unlike the asymmetric threat of IEDs and ambushes, the main threat is from artillery, mortars, and drones. Conventional movement of military trucks in convoys poses a distinct signature, and the line of trucks under attack behaves predictably. Unlike human drivers, a convoy of unmanned ground vehicles (UGVs) behaves as programmed, it can be packed or spread out according to the operator's will and move along different roads toward a given merging point without the navigational errors that are often caused by humans. An example of distributed supply is operating smaller driverless vehicles (5-tonne trucks, for example), rather than large, heavy trucks hauling supplies between hubs, that require experienced drivers to control and take more time for specialised equipment to load and unload. Smaller trucks can avoid grouping and thus become less of a target than a convoy of heavy trucks. Furthermore, carriers can be programmed to group together or break up to form sub-groups that distribute the supplies to present the least probability of destruction by enemy indirect fire, and the fastest delivery to their destinations. The key to effectively operating such concepts is data-driven precision sustainment, monitoring the level of ammunition and fuel on every vehicle, and recommending condition-based maintenance over the periodical maintenance currently performed.

Once they reach their destination, the carriers can be used as ad hoc mobile storage containers, concealed under prefabricated camouflage nets to minimise exposure to enemy surveillance while remaining alert to move to an alternate location if targeted. Offloading supplies can leverage onboard equipment or robotised off-loaders. Such a complex operation can be managed effectively only by automated AI systems. When fully implemented, such activities could employ deception as an integral part of the operational plan, using inflatable dummies to mimic vehicles departed on missions or 'fill' empty stocks with 'supplies' to distract enemy attention from tracking changes to known locations.

'Last mile' delivery is equally challenging. Some models of UGV can be used to carry 700–1,000 kg of payload, collect a supply package to address specific demands, formed for 'just in time' delivery. Heavy loads would be assigned to robotised trucks, while urgently needed supplies would be

Credit: USAF

In February 2023, US Army 1st Special Forces Group (Airborne) loaded and dropped the Silent Arrow GD-2000 from a USAF C-27J Spartan.

Credit: USAF

The Silent Arrow GD-2000 glider after landing at its destination.

dispatched using unmanned aerial vehicles (UAVs). Examples of such a mix can include a combination of a large supply of small arms ammunition, anti-tank missiles, charged batteries, as well as food and water for a dismounted infantry platoon, or fuel, 30 mm cannon rounds, small arms ammunition, plus food and water for a cavalry squadron. The logistics system would direct each UGV to collect the supplies it needs, plan the route to carry it directly to the meeting point with the unit's logistician and alert the receiving unit on the time and location where they can collect the supplies, thus avoiding exposure of their location. Following completion of the delivery, these UGVs can then return to the hub autonomously, or deploy as a combat support element, providing ISR, or fire support to the unit it came to support.

Disposable Aerial Delivery Platforms

Unmanned sustainment systems enable armies and logisticians to explore different methods and supply models. For example, manned/unmanned aerial delivery is becoming feasible with the introduction of low-cost glider platforms.

Originally developed under DARPA programmes, such methods were considered mainly for special operations, but the US Marine Corps (USMC) also tested them. These expendable platforms are built with low-cost materials such as plyboard and cardboard and use commercially available electronics to lower unit costs. The results are platforms offered at about half the cost of parachute-based precision delivery systems, which are also considered a one-time use in full-scale combat.

These gliders emerged in response to the USMC's search for an alternative to the Joint Precision Air Drop System (JPADS). Utilising a guided parachute delivery system, JPADS tend to have limited manoeuvrability, making them less accurate, especially over long distances or in high-wind conditions.

In 2021, the US Air Force acquired 15 Silent Arrow Precision Guided Bundle (SA-PGB) units. These systems were initially developed as an autonomous single-use delivery glider, but under the Air Force contract were enhanced into wider body airframes capable of delivering 750 kg of cargo over 50 km, when released from an altitude of 12.2 km (40,000 ft), thereby enabling a transport plane or helicopter to remain outside contested airspace, beyond the range of short- or medium-range air defence systems. Up to 80 Silent Arrows can fit into a 12.2 m (40 ft) ISO container for transport into theatre, while up to 20 can fit onto a C-130 for multiple drop missions.

Another company delivering disposable delivery systems is Logistic Gliders Inc., which offers the LG-1K TACAD, whose development was sponsored by the Marine Corps Warfighting Laboratory (MCWL), and is capable of carrying a payload of 320 kg, with a wing aspect ratio of 15.5:1 and a glide ratio of 12:1. The company also offers the larger LG-2K Rain Glider, which is capable of carrying a payload of up to 725 kg, with a wing aspect ratio of 18.1:1 and glide ratio of 13.6:1. New wings are being developed for both the LG-1K and LG-2K, which is set to improve their glide ratios to 13.5:1 and 15.5:1 respectively. When dropped from an altitude of 7.6 km (25,000 ft), the new wings should give the LG-1K a range of 103 km, and the LG-2K a range of 118 km, with a circular error probably (CEP) landing accuracy of around 15.2 m (50 ft) when landing using a parachute, or 91.4 m (300 ft) when belly landing.

While wooden gliders are designed to enable air delivery to support forces in a contested area, the Australian company Corvo has developed the Precision Payload Delivery System (PPDS), delivering a few kilogrammes from point to point, using disposable gliders made of cardboard. Delivered in a flat pack 760 × 510 mm, PPDS weighs only 2 kg, including the battery. Upon assembly, the glider can either be launched by hand or using a catapult. Its flight is fully autonomous with a cruising speed of 60 km/h and navigation via GNSS; once it reaches its destination, the glider performs a belly landing. The maximum range varies from at a distance of 40 km to 120 km, depending on a combination of payload weight and the battery used. Each PPDS glider can carry up to 3 kg, and the company also offers the larger PPDS-HL (Heavy Lift) variant, which can carry 6 kg of payload up to 80 km, or 3 kg of payload out to 200 km. Both of these are relatively small payloads when considering heavy artillery ammunition or fuel supplies, but both are nonetheless more than the ammunition load carried by a single soldier. Therefore, such micro-logistics deliveries could mean a lot for ground troops and small units running low on ammunition and in contact with the enemy.

Heavy Loader Drones

While the aforementioned disposable gliders are designed to supply front-line units from tens or the low hundreds of kilometres, UAV-based platforms are being considered to support troops at shorter ranges, hauling supplies over just a few kilometres and connecting a forward unit with the local hub. As a hobby gadget and a commercial platform, multi-rotor drones have evolved to become agile cargo carriers, with some of the latest models capable of lifting hundreds of kilogrammes. However, these platforms are not yet rated for military use. One of the pioneers in this area is the UK-based Malloy Aeronautics, offering cargo drones in three classes — the TRV80 (30 kg payload), TRV150 (68 kg payload), and the TRV400 (180 kg payload). Malloy's T400 is the heaviest model in their range, using eight rotors mounted coaxially on four arms, and powered by removable batteries. The UAV has a range of 70+ km and a cruising at a speed of 35 m/s (126 km/h,) varying depending on the payload.

The USMC is already evaluating the TRV150 for its Tactical Resupply Unmanned Aircraft System (TRUAS). Designed to provide rapid and assured, highly automated aerial distribution to small units operating in contested environments, TRUAS will enable flexible and rapid emergency resupply, routine distribution, and a constant push and pull of materiel in order to ensure deployed forces a constant state of supply availability. The TRUAS will require only two Marines to operate the system, and be capable of carrying a payload of roughly 70 kg of supplies over a 14 km range.

Credit: Logistic Gliders Inc.

The LG-1K is capable of carrying a payload out to 103 km, and landing within 15.2 m of its target.

Credit: USMC

The TRUAS will be capable of carrying a payload of roughly 70 kg of supplies such as batteries, medical supplies, food, and ammunition over a 14 km range.

Malloy and BAE Systems are also working on a larger T-650 concept drone vehicle able to carry payloads up to 300 kg, and up to a distance of 30 km. A vehicle of this kind is intended for both land and maritime applications, including replenishment, casualty evacuation, and various maritime missions, including anti-submarine warfare (carrying a Sting Ray lightweight torpedo) and maritime mine countermeasure missions (carrying the Archerfish expendable mine neutraliser).

Robotic Mules

Robotics are also set to support 'last-mile' sustainment on the ground. While many considered using UGVs as 'Robotic Mules' for over a decade, these tools have yet to be widely integrated, primarily due to a lack of integration within the combat formations, as these robots still need a 'shepherd' to operate reliably. Among the methods being considered is using voice commands or even plain language commands to control robots. Several start-up companies, including US-based Primordial Labs and Israeli company Third Eye Systems, have already demonstrated how operators can command UAVs through speech. Soon, similar capabilities could also help troops command ground robots.

One of the first operational platforms, Milrem's THeMIS Cargo, is intended to support dismounted troops by carrying everything soldiers normally carry, allowing them to concentrate on the mission. THeMIS Cargo demonstrated its versatility as a load carrier and support platform on operation in Central Africa and on numerous operational evaluations of manned-unmanned teaming, but has yet to become an integral part of operational units. The modular construction of the base platform has a cargo deck that allows it to be modified as required, delivering cargo, evacuating casualties, or transporting weapon systems such as an 81 mm mortar and ammunition, enabling rapid redeployment immediately after a short fire mission. The cargo deck can also be outfitted with various tie-downs and restraints to prevent load shifts. Each platform can carry 725 kg to 1 ,200 kg and is powered by electric motors, with a diesel generator which can be used to extend mission endurance. The extensive experimentation has brought Milrem to mature a proprietary Intelligent Function Integration Kit (MIFIK). THeMIS UGVs can be driven autonomously using waypoint navigation, remote control, or following a human leading it on the march. The capability to employing multiple UGVs in a group is currently being developed.

MIFIK includes all the hardware and software modifications necessary for implementing full unmanned control and safety functionality for any platform, including conventional vehicles. MIFIK addresses secure, tactical MIMO Mesh IP radios for remote control, supporting direct or beyond line-of-sight control, platform and payload behaviour, understanding the environment, mission planning, safety, and fleet management.

The Mission Master platform family from Rheinmetall are designed to carry relatively heavy loads, ranging from 600 kg on the Mission Master SP, to 1,000 kg for the Mission Master CXT and Mission Master XT. The Mission Master SP has recently demonstrated cross-country obstacle avoidance, mobility, and manoeuvrability in UGV autonomy trials held from 28-29 June 2023 in Läsna, Estonia. The Mission Master SP is a fully electric UGV employing Rheinmetall's AI-powered autonomy and navigation system known as PATH. Built as a modular system to support small, dismounted infantry units, the Mission Master SP can be reconfigured to assume different roles, including load carrier, fire-support platform carrying machine guns or missiles, an unmanned scout using ISR sensors or a casualty evacuation platform.

The larger and offroad-oriented Mission Master XT recently completed a series of challenging Arctic mobility trials in Finland, demonstrating the autonomy and mobility of the vehicle can be trusted even in Arctic conditions. Despite a challenging environment and temperatures as low as -30°C, the vehicle successfully navigated icy rivers and climbed up slippery banks. The trials demonstrated the ability of the vehicle to meet the operational needs of Artic users, and following these trials, Norway has ordered the vehicles to support winter operations. Weighing in at 2,217 kg, this autonomous UGV can enable troops to transport 1,000 kg of equipment to hard-to-reach locations. The diesel engine allows it to travel 750 km without refuelling, while internal batteries enable up to 6 hours of silent watch operation. Another key feature of the Rheinmetall Mission Master XT is its central tyre inflation system (CTIS), which adjusts the tyre pressure according to the terrain.

A Glimpse into the Future

Logistics and sustainment are critical issues, but logistics vehicles are vulnerable to precision strikes in modern transparent battlespaces. This article has explored how militaries could reinvent logistics using autonomous unmanned systems and how robotic UGVs, UAVs, and artificial intelligence enable distributed resilient supply networks, where modular UGVs act as mobile warehouses keeping essentials on the move. Through flexible manned-unmanned teaming, these new systems promise to deliver efficient and survivable supply over the last tactical mile to support combat units. By networking autonomous systems, armies could sustain their combat forces with minimal risk, even under persistent surveillance, and within range of enemy fires. ■

Credit: Rheinmetall

The Mission Master XT UGV from Rheinmetall is designed to carry heavy loads cross-country and offroad.

ESD European Security & Defence

Exhibitions & Conferences 2024

January		
22.-25.01.	**IAV (International Armoured Vehicles)**	London / UK
23.-24.01.	**DWT – Prospects for the Defence Industry 2024**	Bonn / Germany
24.-25.01.	**Mobile Deployable Comms**	London / UK
February		
04.-08.02.	**WDS**	Riyadh / Saudi Arabia
26.-29.02.	**Enforce Tac / IWA / U.T.SEC**	Nuremberg / Germany
27.-29.02.	**Int'l Mil Helicopter**	London / UK
March		
tbc	**ISDEF**	Tel Aviv / Israel
04.-05.03.	**Defence Logistics CEE**	London / UK
04.-06.03.	**DIMDEX**	Doha / Qatar
05.-06.03.	**Future Indirect Fires / JMTS**	Bristol / UK
11.-13.03.	**DGI**	London / UK
11.-13.03.	**Future Soldier**	London / UK
12.03.	**Parliamentary Evening**	Berlin / Germany
12.-14.03.	**Combat Engr/Log**	Warsaw / Poland
19.-21.03.	**DWT – Applied Research for Defence and Security in Germany**	Bonn / Germany
April		
09.-11.04.	**IT²EC / UDT / MILSIM CEE**	London / UK
May		
tbc	**IDEB**	Bratislava / Slovakia
06.-08.05.	**GPEC**	Leipzig / Germany
06.-09.05.	**DSA**	Kuala Lumpur / Malaysia
06.-09.05.	**SOF Week**	Tampa / US
07.-08.05.	**DWT – Multi-Domain Ops**	Bonn / Germany
07.-09.05.	**SEDEC**	Ankara / Turkey
13.-15.05.	**AOC Europe**	Oslo / Norway
14.-16.05.	**Aerospace Seville**	Seville / Spain
21.-23.05.	**CNE**	Farnborough / UK
22.-24.05.	**BSDA**	Bucharest / Romania
29.-30.05.	**CADSI**	Ottawa / Canada

June		
05.-08.06.	**Hemus**	Plovdiv / Bulgaria
05.-09.06.	**ILA**	Berlin / Germany
17.-21.06.	**Eurosatory**	Paris / France
26.-27.06.	**AFCEA**	Bonn / Germany
July		
02.-04.07.	**DCC Shrivenham**	Shrivenham / UK
22.-26.07.	**Farnborough**	Farnborough / UK
26.-27.07.	**Helicopter Forum**	Bückeburg / Germany
September		
02.-06.09.	**SOFEX**	Aqaba / Jordan
08.-11.09.	**MSPO**	Kielce / Poland
23.-25.09.	**DWT – MarineWorkshop**	Linstow / Germany
tbc	**SPIE**	Berlin / Germany
tbc	**DVD UK**	Millbrook / UK
October		
08.-09.10.	**DWT – Energy Transition in the Military Context**	Bonn / Germany
14.-16.10.	**AUSA**	Washington D. C. / US
16.-18.10.	**Future Forces Forum**	Prague / Czech Republic
22.-26.10.	**SAHA**	Istanbul / Turkey
November		
04.-07.11.	**Euronaval**	Paris / France
08.-11.11.	**Indodefence**	Jakarta / Indonesia
19.-22.11.	**IDEAS**	Karachi / Pakistan
26.11.	**Parliamentary Evening**	Berlin / Germany
tbc	**NIDV**	Rotterdam / Netherlands
December		
10.-11.12.	**DWT – IT Conference**	Bonn / Germany
tbc	**I/ITSEC**	Orlando / US
tbd	**International Fighter**	tbd

MITTLER REPORT

Mittler Report Verlag GmbH
Beethovenallee 21 • 53173 Bonn • Germany
info@mittler-report.de
www.mittler-report.de • www.euro-sd.com


READY TO GO
BEYOND THE AGE
IN CENTENNIAL YEAR
www.aselsan.com
aselsan
TECHNOLOGY SERVING PEOPLE & PLANET