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ARMADA INTERNATIONAL

APRIL-MAY 2024. ISSUE 02.

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Saab's Barracuda Soldier System shows the extent that is often required in order to hide forces from an enemy, particularly those who use ground or airborne thermal sensors. (Saab)

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Editorial

FLRAA WITHOUT FARA

The cancellation by the US Army of its Future Attack and Reconnaissance Aircraft (FARA) is perhaps an inevitable result of the rapid pace of defence technology development since its conception, added to the lessons being learned from the war in Ukraine.

The return of 'Great Power Competition' and campaigns with more recognised linear battlefields with forward lines of own troops (FLOTs), rather than the asymmetric wars in Iraq and Afghanistan at the start of this century, sees a return to the high threat posed to any aircraft flying near or over the battlefield and beyond. The asymmetric conflicts against less well equipped enemies, especially with only rudimentary ground based air defence, allowed gunships to arrive at a time and location of their choosing, with little chance of interdiction.

In the Cold War era, the Boeing Apache AH-64 was conceived to fulfil its main role of killing Soviet armour using its 16 Lockheed Martin Hellfire missiles. The British Army's (then Westland) Lynx with its eight BGM-71 TOW wire-guided missiles was to perform a similar role. However, once engaged, the chances of survival were not considered great.

The cancellation of FARA has immediate ramifications for the recently confirmed Future Long-Range Assault Aircraft (FLRAA) which is due to gradually replace the UH-60 Black Hawk fleet, starting around the early to mid-2030s.

One immediate problem is the fact that the Bell V-280 Valor tiltrotor has a cruise speed of around 280 knots and a combat range of around 900 miles (1,480 kilometres). The Apache cruises at around 145 knots with a combat range of 300 miles (480km). The disparity in performance is obvious.

While Bell's FARA entry, the 360 Invictus, would have had a speed around 180kts (330km/h), the Sikorsky RaiderX would have been faster around 230kts (460km/h) with a combat load.

During the war in Afghanistan, I watched Apaches taking off 10-15 minutes ahead of the Boeing Chinook assault force to ensure they could coordinate their arrival in the target area together. And mostly those targets were under one hour away.

With the Apache destined to remain in service now until the 2060s (likely beyond with the cancellation of FARA), perhaps the Army must now turn to the development of an armed, long range, uncrewed aerial vehicle (UAV) that can escort the V-280s at speed, protect them when required, and remain in the target area until the V-280s have inserted their assault troops.

Andrew Drwiega,
Editor-in-Chief

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EW LIVE Prevailing in the EME

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EWLive has become a 'must attend' event for Defence and Security Industry stakeholders to gain knowledge through a live demonstration setting.

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2019

Algeria, Bahrain, Croatia, Czech Republic, Estonia, Finland, France, Germany, Hungary, Indonesia, Latvia, Lithuania, Morocco, Norway, Poland, Qatar, Saudi Arabia, Singapore, Spain, Sweden, Taiwan, UK, USA

2021

Algeria, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Georgia, Germany, Latvia, Lithuania, Netherlands, Romania, Slovenia, Spain, Switzerland, Sweden, Türkiye, UK, USA

2022

Australia, Austria, Bahrain, Belgium, Croatia, Czech Republic, Estonia, Finland, France, Georgia, Germany, Greece, Hungary, Italy, Japan, Kuwait, Latvia, Lithuania, Morocco, Netherlands, Oman, Poland, Romania, Saudi Arabia, Slovakia, Singapore, Slovenia, Sweden, Türkiye, UAE, UK, Ukraine, USA

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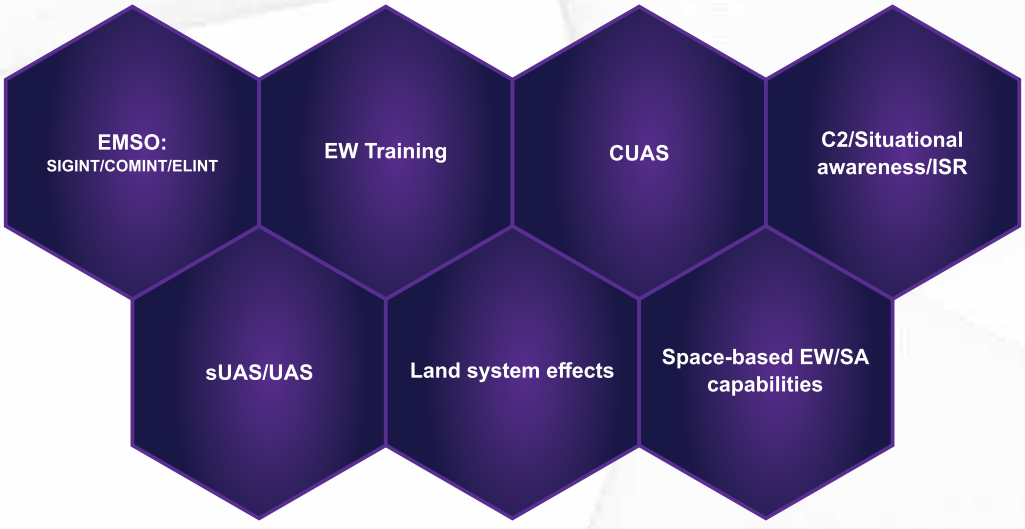

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THE OVERWATCH CHALLENGE: 50 MILLION SQUARE MILES OF OCEAN

The mission of Patrol and Reconnaissance Wing 10 is to man, train and equip the US Navy's six Boeing P-8A Poseidon-equipped patrol squadrons, and one Lockheed EP-3E Aries-equipped reconnaissance squadron. Commodore Mike Martinez explains how this is achieved.

Mark Ayton

Commander Patrol and Reconnaissance Wing 10 (CPRW-10) is the immediate superior in command of all seven active-duty squadrons and Tactical Operations Support Squadron 10 (TOCRON-10) which oversees tactical operations centres at Naval Air Station Whidbey Island and Marine Corps Air Station Kaneohe Bay, and six Mobile Tactical Operations Centers (MTOCs), in support of CPRW-10 squadrons.

Situated on Whidbey Island, Washington, USA, the base is also the home station of one US Naval Reserve P-8 squadron. The administrative chain of command of the squadron lies in the Maritime Support Wing. Operationally, the squadron also falls under the command of Commodore Martinez. Currently in transition to the P-8, the squadron can call upon the expertise resident in CPRW-10.

CPRW-10

"Typically, a patrol squadron will be at Whidbey for about a year before undertaking its certification work-up. Once certified, the entire squadron deploys to a base located in the area of responsibility (AOR) of a numbered fleet for about six to seven months. Each numbered fleet is the consumer of the readiness generated by the squadron, explained Commander Martinez. "We send folks to Naval Air Station Sigonella, Sicily; Keflavik, Iceland [both 6th Fleet locations]; and Bahrain [a 5th Fleet location] to name a few examples.

CPRW-10's staff work with each individual squadron to prepare and certify the unit for deployment in accordance with the fleet response training plan.

However, once a patrol squadron returns from a six-month deployment its inter-deployment training cycle begins again.

"CPRW-10 taps into the data collated during overseas operations, and uses this data to create realistic high-fidelity training for other squadrons preparing to deploy. This helps to keep CPRW-10 in lockstep with the task force commanders (CTF) based around the world."

Squadrons provide information to the wing's training department where the assigned weapons tactics instructors

Naval Air Systems Command

A captive carriage Mk54 torpedo fitted with a HAAWC air launch accessory kit with dozens of reference marks applied for photogrammetry during a store separation test.

(former instructor pilots and operators who attend the Maritime Patrol and Reconnaissance Weapons School at Naval Air Station Jacksonville, Florida) develop the training programme, the training environment, and the training scenarios. "These are all directly tied into operational activity experienced by the squadron flight crews during deployment, which is quickly included in the training provided to squadrons preparing to deploy."

PRIMARY MISSION ASW

Discussing the challenges faced by US Navy P-8 crews, especially those that involve aircraft assigned to the Peoples Liberation Army Air Force (PLAAF) over the South China Sea, Commodore Martinez told *Armada*" After 911 [the 11 September 2001 terrorist attacks], the US Navy patrol community made a conscious decision to focus more on overland ISR [Intelligence, Surveillance and Reconnaissance]. Our platform at the time, the Lockheed P-3 Orion, was designed and built to meet the requirements for anti-submarine warfare which is a perishable skill. If you're not practicing it, on a day-to-day basis, you're not going to be very good at it. Once the US Navy decided to recapitalise the P-3 Orion fleet with the P-8 Poseidon, an aircraft designed and built for anti-submarine warfare, the patrol community dropped the overland ISR mission. The patrol community is focused on anti-submarine warfare (ASW), our primary mission which is being executed on a day-to-day basis in a real-world environment." said Martinez.

"We're also able to learn and share lessons with allies and partners as they recapitalise their maritime patrol aircraft fleets. Crews in training today, around the lieutenant level [in rank] have hundreds and hundreds more hours of ASW experience against our adversaries compared to when I was in training shortly after 911. To me, that's a good thing."

AIRCRAFT CONFIGURATIONS

Most of the P-8 aircraft assigned to CPRW-10 are configured to a similar standard. New updates are rolled out to squadrons assigned to CPRW-11 based at Jacksonville because Patrol Squadron 30 (VP-30), the

US Navy/Anthony Lagunes

A P-8A Poseidon from Patrol Squadron 40 (VP-40) flies near the aircraft carrier USS *Nimitz* (CVN 68) while underway in the Pacific Ocean.

Commodore Mike Martinez is Commander Patrol and Reconnaissance Wing 10 (CPRW-10), a responsibility that includes command of seven active-duty P-8A Poseidon squadrons.

P-8A training squadron, and the Maritime Patrol and Reconnaissance Weapons School (MPRWS) are based there, and the necessary infrastructure required for transition is centralised at Jacksonville. VP-30 trains pilots, naval flight officers, and enlisted aircrew from the US Navy and from across the world through the Foreign Military Sales (FMS) programme.

In April 2016, Under Secretary of Defense for Acquisition, Technology and Logistics approved a revised P-8 acquisition strategy that incorporated all the Increment 3 (previously called Spiral 2) enhanced capabilities into the baseline P-8A. Consequently, all capabilities are now developed and delivered as a series of engineering change proposals (ECPs), which incrementally increase combat capability. Those included are ECP 4, ECP 5, ECP 6 and ECP 7.

ECP 4 comprises upgrades to the demand-assigned multiple access UHF satellite communication integrated waveform, and the aircraft's targeting capability.

ECP 5 includes Link-16 messaging for net enabled weapons, third party targeting, and electronic warfare coordination, high frequency radio internet protocol, a new integrated broadcast service (IBS) receiver, IBS filtering, and integration of the upgraded network-capable Boeing AGM-84 Harpoon II+ anti-ship missile.

ECP 6 incorporates a new open system architecture, ASW signals intelligence, improvements to the combat system's ability to process and display classified information, wideband SATCOM, and a software upgrade of the Minotaur track management and mission management system. Minotaur disseminates and fuses data fed from various sensors into a comprehensive battlespace picture, and via the network, shares the information with other aircraft and vessels.

ECP 7 incorporates enhanced Multi-static Active Coherent system capabilities via the combat system architecture.

Components of ECP 6 and ECP 7 are in various stages of development and scheduled for release to the fleet in FY2025.

Baseline capabilities include surface radar tracking, sensor display and track management, sensor bias correction, sensor control and mission replay.

ATTACK FROM ON HIGH

The standard Raytheon Mk54 torpedo is also being upgraded to one capable of high altitude launch when fitted with the High-Altitude Anti-submarine warfare Weapon Capability (HAAWC) air launch accessory. This independently procured adapter kit comprises folding wings, a tail and a GPS-

US Navy/Amariv Perez

Two P-8A Poseidon aircraft assigned to Patrol Squadron 4 (VP-4) parked on the apron at Keflavik Air Base following a snowstorm while forward deployed to the 6th Fleet area of operations, headquartered in Naples, Italy.

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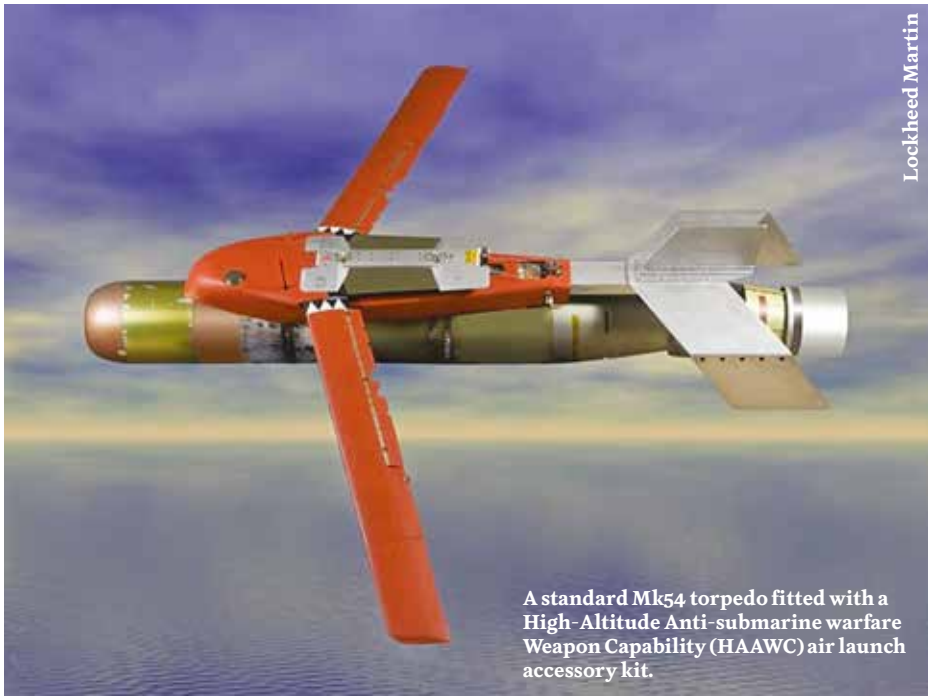

Lockheed Martin

A standard Mk54 torpedo fitted with a High-Altitude Anti-submarine warfare Weapon Capability (HAAWC) air launch accessory kit.

guidance section interfaced to the aircraft. The kit permits long-range, high-altitude, GPS-guided deployment of the weapon by a P-8A aircraft. Once the wings are deployed, the torpedo flies to a pre-programmed release point at a specific altitude where the torpedo separates from the kit, deploys a parachute, and falls to the ocean surface, enters the water and initiates as a torpedo.

HAAWC is the latest kinetic weapon to be assigned to CPRW-10, which is currently going through transition: fielding of HAAWC-capable units is scheduled to continue through 2024.

COMBINED TASK FORCE 32

Commodore Martinez also serves as the commander of Combined Task Force 32 (CTF-32), an organisation assigned to the 3rd Fleet with responsibility for commanding and controlling maritime patrol forces in the 3rd Fleet's area of responsibility. That area extends, pole-to-pole from east of the International Dateline in the Pacific to the coasts of North and South America amounting to 50 million square miles of ocean.

Discussing CTF-32, Commodore Martinez commented: "We have had to think through how we apportion our resources between commanding CPRW-10 and CTF-32. How do we put the right person in the right place at the right time so that we can continue to man, train and equip and still execute real world operations? How do we train a squadron and certify it for deployment and still conduct real world operations at the same time. Figuring out that balance has been a challenge.

"When we deploy a squadron to the 6th Fleet, it falls under CTF-67 which is a land-based organisation that deploys forces to where they need to be around the European theatre. CTF-32 operates in the same construct, we just don't have as big a team to conduct for example operational planning, so we're picking that up and learning. Essentially the same staff assigned to CPRW-10 are part of the CTF-32 staff, which adds extra workload for them."

During the biennial Exercise RIMPAC, CTF-32 staff relocate to Hawaii to cover the six-week period, such is the demand for patrol. "It's very convenient for us to relocate there and garner good joint training with our allies and partners," he said.

6TH FLEET OPERATIONS

Naval Air Station Sigonella on the Italian island of Sicily is the main operating base for US Navy P-8A squadrons in the 6th Fleet, European area of responsibility. Located in the middle of the Mediterranean Sea, it's a good location for aircrews to operate over hot and cold-water environments.

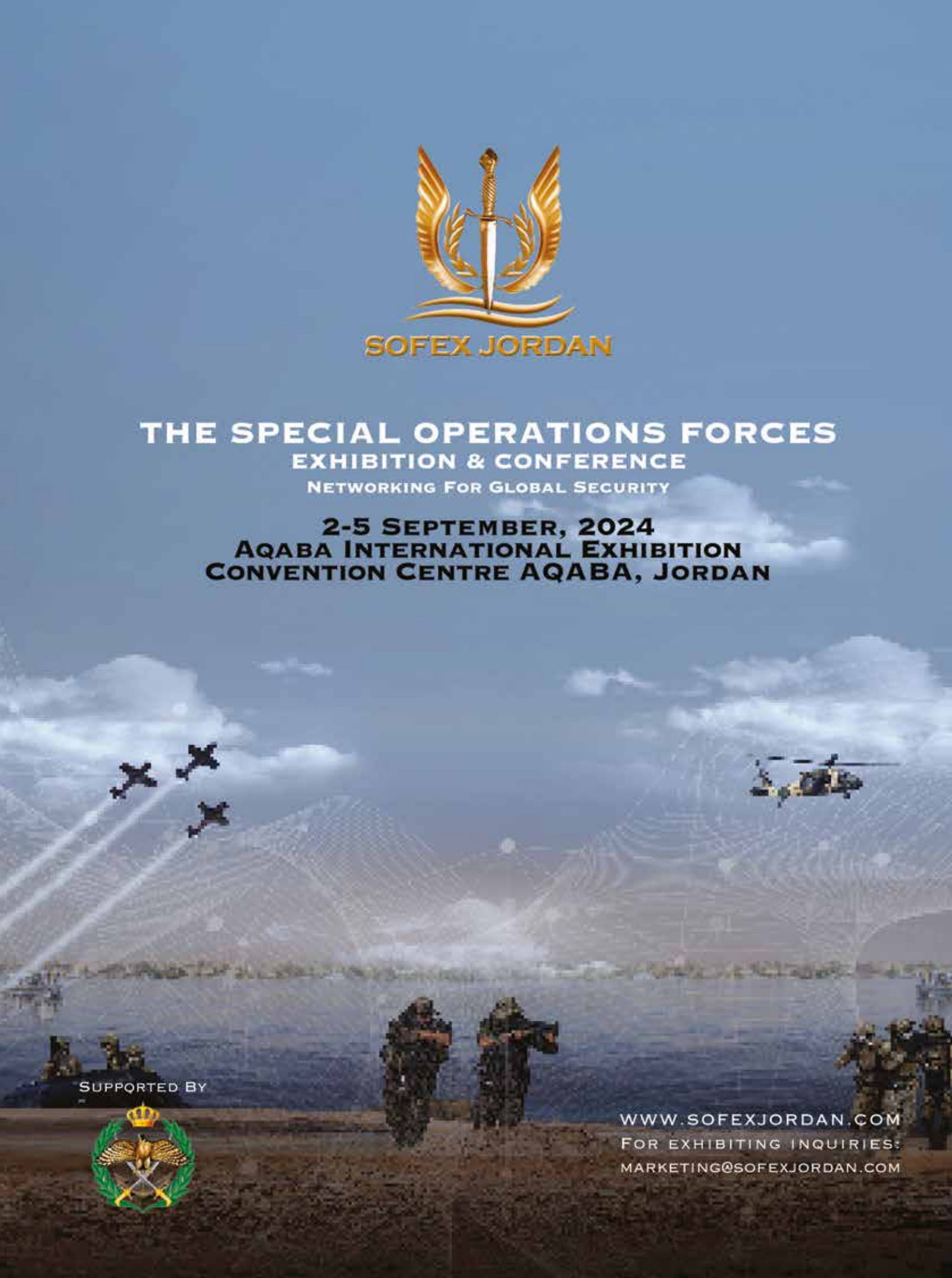
Sigonella is home to CTF-67 and has the necessary infrastructure to support the P-8 aircraft from where a patrol squadron is typically deployed for six-months. The CTF-67 commander manages P-8 detachments throughout Europe including those to Keflavik, Iceland.

According to Commodore Martinez: "It's very much a throwback to the Cold War when the US Navy had a permanent presence at Keflavik. CTF-67 is doing a lot of work there and is learning the skills required for operating in the harsh weather environment, ones that faded during the years from when we left Keflavik. We know how to conduct the mission, it's the operating environment that presents the biggest challenge to aircrews."

CPRW-10's staff are currently working toward introducing the Northrop Grumman MQ-4C Triton to Whidbey Island with the stand-up of Unmanned Patrol Squadron 31 (VUP-31) and the follow-on sundown of the EP-3E Aries II-equipped Fleet Air Reconnaissance Squadron 1 (VQ-1). To develop the Triton mission CPRW-10 staff are using the expertise resident in VQ-1. A


US Navy/Amariv Perez

Sailors assigned to Patrol Squadron 4 (VP-4) perform a turnaround inspection on a P-8A Poseidon at Keflavik Air Base, Iceland.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Leonardo's AW149

Leonardo

UK GETS SERIOUS ABOUT NMH

The UK's New Medium Helicopter competition moved up several gears in February when the UK Minister for Defence & Procurement announced his Invitation to Negotiate.

By Andrew Drwiega

On 27 February, James Cartlidge, the United Kingdom's Minister of State for Defence & Procurement, announced that he was initiating an invitation to negotiate with all three helicopter primes who had submitted proposals to build the next generation of New Medium Helicopters (NMH) for the Armed Forces. The announcement was made on 27 February on the first day of the DefenceIQ International Military Helicopter conference in London. This followed a contract notice in May 2022 which officially started the competition for up to 44 new helicopters.

After passing pre-qualifying, the the three contenders are: Airbus Helicopters UK offering its H175M, Leonardo Helicopters UK with its AW149, and lastly Lockheed Martin/Sikorsky UK and the S-70M Black Hawk, a modern derivative of the UH-60.

The original pre-qualification requirement envisaged that the NMH programme would replace 23 Airbus Puma HC2 that had already had one life extension carried out in Romania, three Bell 412 Griffin, three Bell 212 and six Airbus AS365. However, the UK Ministry of Defence announced in November 2023 that it was acquiring six Airbus H145 helicopters (known as Jupiter HC2s) to replace the Bell 212 and Bell 412s in Brunei and Cyprus.

Cartlidge said that he hoped the acquisition would reflect the ongoing reform of the acquisition process and would stand as "a beacon of smarter procurement...built around affordability and future proofed by factoring adaptability and spiral development at the concept stage." He added that lessons from Ukraine in terms of identifying "vulnerabilities" in the supply chain 'while strengthening UK defence skills and production" would have a role to play.

The decision not to include replacement helicopters for the bases in Cyprus and Brunei in the requirement for NMH was justified said Cartlidge, in that such rotorcraft would not to be as highly specified as those that would operate in a war zone which would represent a cost saving. However, another way to examine this decision is that they would then be underspecified to act as replacements should they be needed in times of conflict, leading some to consider this a cost-saving in the short term for a lack of adaptability in the medium term. The new requirement is expected to be for around 35 helicopters, although this figure is not finally confirmed.

The Minister also said that the NMH concept would allow the "spiral development" of whichever rotorcraft was chosen, thanks to all contenders representing 'off-the-shelf' models with open system architecture. "We can sprinkle [these] with enhanced capabilities to meet different operational needs or to accommodate new innovations, meaning our new medium helicopter will be adaptable and future proofed," stated Cartlidge. The use of the word 'sprinkle'

conjures up some kind of 'fairy dust' that will quickly and easily transform them into whatever mission capability is required. Even acknowledging the steps forward represented by the adoption of open systems, the UK procurement process does not have a great record when it comes to adapting acquisitions to a UK specification.

The final consideration, said Cartlidge, was how the winning bid would "strengthen the UK defence industrial base" - this would account for 15 percent of our overall procurement decision which would be made on a points basis. He added that a further element of the ultimate selection process would "advantage those platforms with export potential by using an export criteria that is worth 20 percent with the UK industrial contribution weighting." This would allow the UK to both secure its 'indigenous skills base' and remain as an exporter of rotorcraft internationally. Cartlide said that the NMH programme was "one of the very first to have this pro export component built into our selection criteria."

In further comments, Cartlidge hinted that the government was already moving to incorporate lessons being learned from the fighting in Ukraine, "turning intelligence from the battlefield [into] solutions in the factory." He stated that the US Army's decision to cancel its Future Attack and Reconnaissance Aircraft (FARA) programme "was in large part a reflection of this new reality and aligns with our own thinking."

His conclusion was that whichever platform was chosen as the NMH, it would "deliver a Swiss Army Knife platform, future proofed and procured in a way to give the UK armed forces and our defence sector maximum clout and flexibility; a 21st century platform delivering on our modernisation agenda."

INDUSTRY RESPONSE

The helicopter manufacturers - Airbus, Leonardo and Lockheed Martin/Sikorsky - swiftly responded to the announcement to reaffirm their commitment to meeting the criteria necessary for a winning bid set out by the government.

A statement from Leonardo UK was the most detailed, re-enforcing its commitment "that more than 60 percent of total AW149 production will occur in the UK, at ... Yeovil and through its nationwide 'Team AW149 UK' supply chain." Through this, Leonardo has said that "AW149 work will directly create or sustain 1,500 highly skilled jobs nationwide and support more than 12,000 helicopters jobs across Leonardo's established supply chain."

It added that " the majority of the AW149's structural design was undertaken at Yeovil and the company has already made a multi-million pound investment in a new AW149 production line at the site, as well as platform-specific training for the company's experienced helicopter engineers."

In terms of the export potential, Leonardo stated that it had identified an export potential "for more than 500 medium multi-role helicopters that could be satisfied with UK-made AW149s" and that "should AW149 be selected for NMH, future exports will be from the UK build line. The company has committed that 60-70% of the platform's content and through-life support will be carried out onshore in the UK."

Airbus was also confident in its offering of the H175M calling it a "low risk solution with outstanding technical and safety specifications, already operating successfully in a range of demanding roles and environments."

The S-70M Black Hawk

Sikorsky

The H175M

Airbus

One specific point made by the company was that of cockpit commonality, as the Royal Air Force already trains its pilots on the H135 Juno (Juno HT1) and H145 (Jupiter HT1) helicopters at RAF Shawbury.

Similar to Leonardo, Airbus commits to making and servicing the H175M in the UK by its H175M Task Force, comprising of key partners Boeing Defence UK, Babcock, Spirit AeroSystems and Pratt & Whitney Canada. "Design work will be performed in Belfast, it will be made at Broughton in North Wales, and supported in Scotland and at military bases creating hundreds of jobs and helping to drive competition and innovation in the UK helicopter industry," read a company statement.

Lockheed Martin/Sikorsky also expressed its delight at the Invitation to Negotiate for the NMH. "We believe Black Hawk is the best solution for UK Defence and UK industry, delivering a 100 percent military helicopter used by and interoperable with 35 allied nations, technology transfer, decades of export potential and over 600 jobs to the UK."

The S-70M Black Hawk Team includes Standard Aero based at Fleetlands in Gosport, a location steeped in connections with the UK military. Starting life as a Royal Navy fighter base, it transformed into the Defence Aviation Repair Agency (DARA) in 2001. amalgamating the RAF Maintenance Group Defence Agency (MGDA) and the Naval Aircraft Repair Organisation (NARO). This is where the S-70M would be assembled. GE Aerospace would provide its T701 engine while Lockheed Martin would partner in through-life support.

However, with the S-70 already in production at Sikorsky subsidiary, PZL Mielec in Poland, as well as the T-70 built under license by Turkish Aerospace Industries, its export potential from the UK has still to be defined. A

Russia has lost almost half its operational fleet of Kamov Ka-52 Hokum attack helicopter since it invaded Ukraine.

RUSSIA'S DESPERATE SEARCH FOR HELICOPTER ENGINES

Moscow is having to source helicopter engines it previously sold to other countries.

By David Oliver

Russia, the second-largest supplier of military equipment behind the United States, is ramping up military production to replenish its depleted arsenal of military hardware, ammunition and helicopters in its war against Ukraine.

More than 130 Russian military helicopters have been written off in the last two years including more than 50 Mil Mi-8/Mi-17 Hip transport helicopters, 20 plus Mil Mi-24/35 Hind, 8 Mil Mi-28N Havoc, and 55 Kamov Ka-52 Hokum attack helicopters. All these helicopters are twin-engined and in April 2023 Russia admitted that despite the announced annual production target of 300 VK-2500 engines, demand was exceeding that at no less than 500 per year. As a result of this disparity, Moscow is attempting to buy-back helicopter engines supplied to export customers. These include the 2,100shp (1,555kW) TV3-117 turboshaft engine that powers the Mi-8s, early Mi-24D/V Hind variants and the Mi-28, and the 2,400shp (1,788 kW) VK-2500 that powers the Mi-35M and Ka-52.

The break-up of the Soviet Union in 1991 had a profound effect on Russia's aero-engine industry. Some Soviet engine contractors became Ukraine companies, such as Motor Sich based at Zaporizhzhia. The TV3-117 turboshaft engine was developed in the 1970s and more than 30,000 had been supplied by Motor Sich assisted by the Russian Klimov design bureau. In 2001, production of the uprated derivative of the TV3-117VMA, the VK-2500 was planned to be shared between Klimov in St Petersburg

and Motor Sich, with the Russian company assembling engines for military customers from modules produced at Zaporizhzhia. However, in 2009 Russia announced that VK-2500 production would be switched from Ukraine to St Petersburg.

Motor Sich severed ties with Russia in 2014, its biggest client, and following Russia's invasion, the company was nationalised by Ukraine's government and its Zaporizhzhia plants were bombed by Russia in May 2022 and again in August 2023, although production and overhaul of the TV3-117VMA-SBM1V continues.

It has been reported that Russia has approached Egypt, Pakistan, Brazil and Belarus for helicopter engines. Last April, a delegation of Russian officials visiting Cairo asked Egyptian President Abdel Fattah Al Sisi to give back 150 spare engines from its Russian helicopter fleets. These include 40 Mi-8Ts, three Mi-17-1Vs, and 12 Mi-24Vs as well as 46 Ka-52As, the first of which was delivered in 2017. In return, it was said that Russia will forgo some past debts incurred by Egypt for Russian multirole fighters, the attack helicopters and surface-to-air missile (SAM) systems and will continue sending shipments of wheat, a massive staple of the Egyptian diet, which has been in short supply for several years. However, the threat of sanctions by the United States and others may lead the proposed deal to stall.

Pakistan only has a small fleet of four Mi-35Ms and it is not clear if they are still operational. If they are in storage, their engines may be surplus to requirements and available for Russia. In December 2006 Brazil signed a $326 million contract with the Russian arms export agency Rosoboronexport for 12 Mi-35M4 helicopters, designated in Brazilian Air Force service as the AH-2 Sabre. The type proved unpopular with Air Force officers, suffering from serviceability and quality issues. In April 2021 Russian Helicopters announced that it has signed a contract the Brazilian company IAS to tackle technical issues to enable the AH-2s to resume operations. After Russia's invasion of Ukraine, this contract was cancelled and the AH-2s were withdrawn from service and put up for sale. Brazil has refused Russia's request for their VK-2500 engines.

David Oliver

As production fails to meet demand, Russia needs more VK-2500 turboshaft engines.

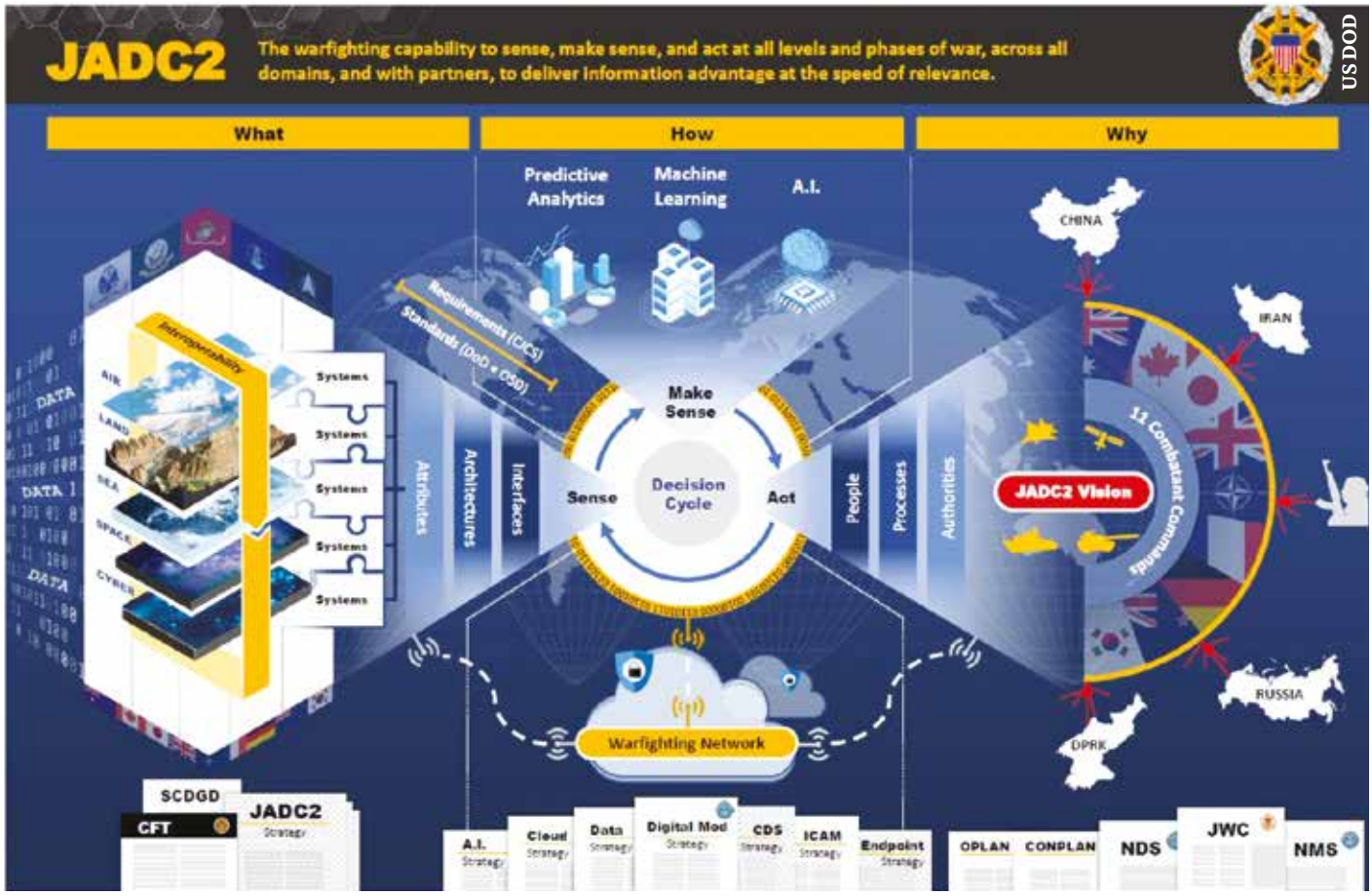
David Oliver

Brazil has refused Russia's request for engines from its retired fleet of Mi-35M attack helicopters.

Belarus, a close ally of Russia, has a mixed fleet of 12 Mi-24P and Mi-24Vs which remain in service plus a few Mi-24Ks. In 2016 some of them were upgraded by the Belarusian Orsha Aircraft Repair Plant, and a few were test flown with TV3117VMA-SBM1V engines supplied by the Ukrainian company Motor Sich. These may be amongst those offered to Russia. In 2020, Belarus ordered in initial batch of four Mi-35M helicopters, the first of which was to be delivered at the end of 2021.

It is not clear if any of the returned engines will be new spare power plants or used units that will have to be reconditioned.

Although the production of Russian helicopter engines has been boosted, the priority is for them to be delivered to the military and as a result, many of the country's numerous commercial operators such as UTAir and Gazprom Avia are suffering from shortages and delays in acquiring new helicopters or servicing their existing fleets. A



In a nutshell, JADC2 encompasses the inter- and intra-force connectivity of all military assets at all levels of war to manoeuvre across the entire spectrum of conflict by taking better decisions at a faster pace than one's adversary.

FORMING AND SHIELDING THE COMBAT CLOUD

Data has never been more vital on the battlefield. Its importance will only deepen in the future making its protection paramount.

Thomas Withington

The Multi-Domain Operations (MDO) concept was first enshrined in a 2018 United States Army publication entitled The US Army in Military Domain Operations 2028. The MDO concept was a response to the US 2018 National Defence Strategy. Known as the NDS, this document is drafted by the US Secretary of Defence's office and takes the Presidential National Security Strategy as its basis. The strategy is published roughly every four years. The document articulates the country's security priorities and how they will be addressed by the administration of the day. The NDS takes the National Security Strategy and translates its priorities into guidance for the US military. Guidance enshrined in the NDS includes how America's armed services will organise their forces. Force organisation priorities are complemented by force posture and modernisation goals; all of which must meet the National Security Strategy goals.

The 2018 NDS highlighted the strategic threats of a regionally ambitious People's Republic of China (PRC) and a regionally aggressive Russia. These are not the only two threats the US must address. Similar challenges are presented by the Islamic Republic of Iran and the Democratic Republic of Korea. Both these states are also keen proliferators of weapons of mass destruction. Meanwhile political violence, the climate crisis and its fallout

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The 2018 US National Defence Strategy highlighted the strategic threats the country faces and how these will be addressed. To this end, US rivals are expected to deepen their embrace of technology, including the means to exploit space as domain of warfare.

and transnational crime can be added to this list: "This increasingly complex security environment is defined by rapid technological change," the NDS emphasised. The solution, is to be found in a "lethal, resilient and rapidly adapting Joint Force."

At the strategic level, the strategy prizes "the seamless integration of multiple elements of national power – diplomacy, information, economics, finance, intelligence, law enforcement and military." Regarding this latter lever of power, "our dynamic force employment, military posture and operations must introduce unpredictability to adversary decision-makers." The overriding goal is to use all instruments of national power to "challenge competitors by manoeuvring them into unfavourable positions, frustrating their efforts, precluding their operations while expanding our own and forcing them to confront conflict under adverse conditions."

MDO is the military philosophy upon which the ability to challenge competitors through manoeuvre into adverse conditions rests. The strategy emphasised the importance of investing in Command and Control (C2) capacity to develop "resilient, survivable, federated networks and information ecosystems from the tactical level up to strategic planning." Moreover, "(i)nvestments will also prioritise capabilities to gain and exploit information (and) deny competitors those same advantages."

MDO DEFINED

While the National Defence Strategy articulated the wider strategic vision of the US, and the steps needed to achieve these goals therein, the US Army's 2018 publication helped define Multi-Domain Operations. The document extolled "the American way of war" which emphasises "joint and combined operations; technological dominance; global power projection; strategic, operational, and tactical manoeuvre; effective joint fires; sustainment at scale; and mission command initiative." At the same time, the publication noted the influence that technologies like Artificial Intelligence (AI) and machine learning (ML), hypersonics, robotics and nanotechnology are having on the future of warfare. Pursuits of these technologies are not confined to the US and allied nations. Strategic competitors like the PRC and Russia are working to develop and weaponise these capabilities, potentially threatening the US's ability to wage war in the ways listed above.

What is MDO? At its simplest, it is the rapid and continuous integration of all domains of warfare, explains the army's publication. Your correspondent summarises it as the intra- and inter-connectivity of all assets (personnel, platforms, bases, sensors, weapons systems and capabilities) across all manoeuvre forces (sea, land, air, space and cyberspace) at all levels of war to perform synchronous combat. The goal of MDO is to receive and process relevant information, take better quality decisions and implement those decisions at a faster pace than one's adversary. The US Department of Defence's (DOD's) MDO vision is to be implemented via an overarching networking environment called the Joint All Domain Command and Control (JADC2) system.

The rapid and efficient flow of information around the battlespace is fundamental to MDO and will be facilitated via JADC2. The DOD is steering a variety of efforts to evolve existing strategic, operational and tactical intra-force communications systems into inter-force configurations. Each of America's

Combat clouds, as depicted in this graphic, have the potential to greatly accelerate sensor-to-shooter cycles and, as such, are emerging as a vital piece of the MDO jigsaw.

armed services has its own work strand in this regard. The US Army's Project Convergence is one, the US Air Force has the Advanced Battle Management System and the US Navy's Project Overmatch is working for similar goals. JADC2 is being managed by the US DOD's JADC2 Cross Functional Team (CFT). One of the CFT's lines of effort is to ensure that the JADC2 can link outwards to allies and vice versa. Achieving this interoperability will depend on common data standards. NATO (North Atlantic Treaty Organisation) will no doubt be instrumental in helping achieve these.

It is axiomatic that MDO relies on eye-watering quantities of data which must be acquired, stored, managed and distributed to those who need it, and kept away from those who do not or must not have access. Managing data is essential because for these to be useful information overload must be avoided. It will not surprise readers to learn that artificial intelligence is being eagerly embraced for MDO. A report penned by Dr. Dan Cox entitled Artificial Intelligence and Multi-Domain Operations: A Whole of Nation Approach Key to Success, published by the US Army University Press in 2021, highlighted the role AI has to play. Dr. Cox is a professor of political science at the US Army School of Advanced Military Studies. His paper flagged the inherent risks of AI in a military context, warning that "military leaders overestimate the power of AI – believing it approaches something akin to 'magic' with high levels of infallibility." Nonetheless, Dr. Cox concluded that "AI is coming to the battlefield." Managing torrents is data is but one challenge, storing this data so that it can be accessed easily by those who need it presents another problem.

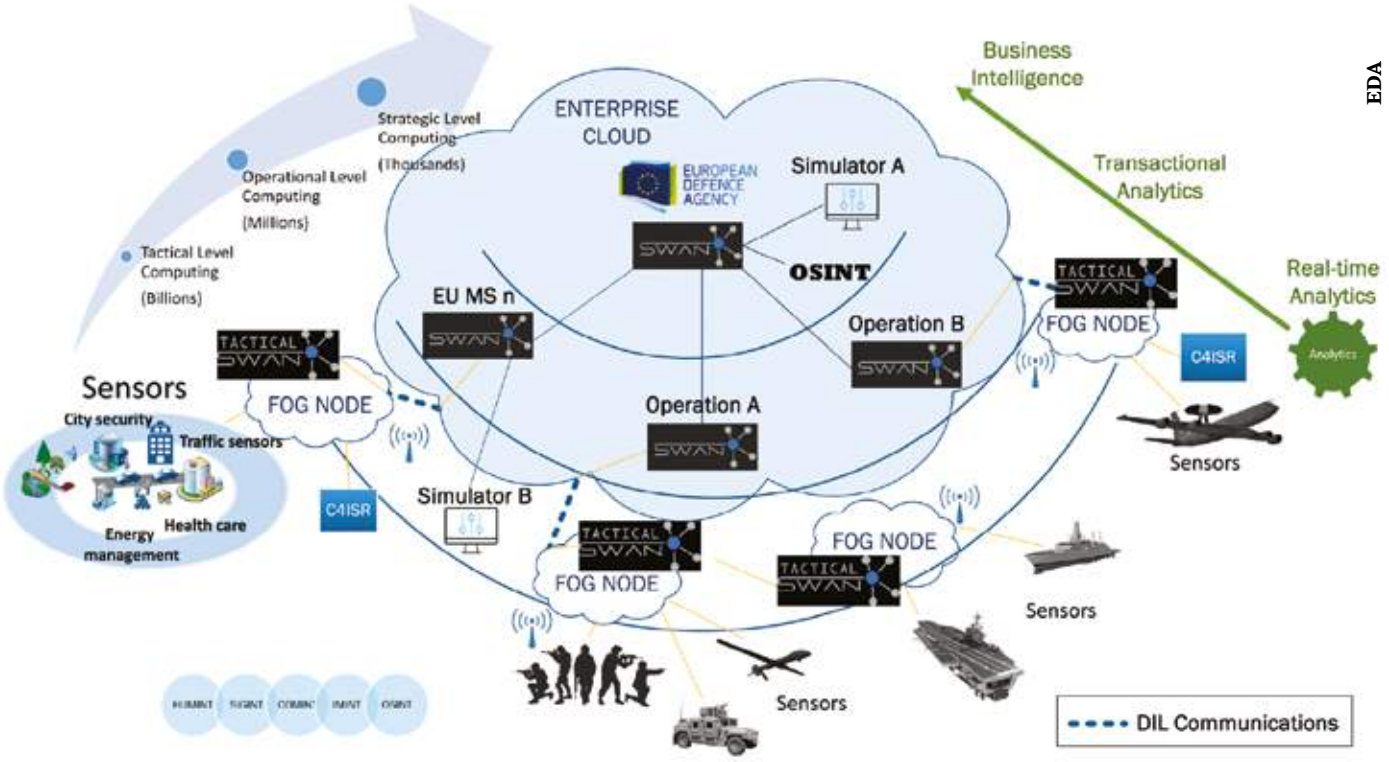
Cloud computing is seen as the solution to this vexing issue, but what exactly is it? Amazon Web Services describes cloud computing succinctly as "the on-demand delivery of (information technology) resources over the internet." These resources can include servers, storage space, databases, networking, software and analytics according to Microsoft. Militaries have been thinking about their own version of this arrangement known as the Combat Cloud.

To understand how the combat cloud might work in practice, consider this scenario: A warplane's radar detects a hostile self-propelled howitzer while the jet is on a sortie to hit a red force command centre. Algorithms in the radar determine the target is a howitzer based on its Radar Cross Section (RCS) and deem it tactically relevant. Data regarding the howitzer such as its RCS, location and possible type as derived by the radar's software are sent across a datalink to the combat cloud where the information is stored. Software managing the cloud immediately determines data on a new potential target has been uploaded. By interrogating the howitzer's data, the cloud's software ascertains where on the battlefield it is located. The cloud alerts the command centre responsible for that sector of the battlefield of the potential target. The command centre download's the target's details. Realising that the red force howitzer can be engaged rapidly with its organic artillery, the command centre drafts a call for fires. The unit which will engage the red force howitzer receives its tasking and downloads data on the offending howitzer from the cloud. The fire mission is performed successfully in minutes.

Combat clouds are not the stuff of science fiction. Companies like Airbus, Elbit Systems, Hensoldt and Thales, to name just four, are evolving this technology. Cloud computing is also at the core of the MDO approach that will be facilitated by JADC2. Although the above example focuses predominantly on land warfare, cloud computing is relevant to all combat domains: "Collaborative fighter and reconnaissance aircraft, connected by the services of an air combat cloud, represent a paradigm shift in military aviation," Hensoldt told Armada in a written statement: "These state-of-the-art airborne weapon systems are designed to work in unison, forming a networked combat system that maximises efficiency, situational awareness and overall combat effectiveness." The key point is for this ensemble of networked platforms, sensors, weapons and other capabilities to be stronger than its constituent parts to create "a tightly integrated fighting force." Hensoldt's statement notes that avoiding deluges of potential spurious data being uploaded to the cloud is imperative. Too much data is arguably as bad as none. Edge computing where individual sensors, weapons, platforms or capabilities process raw data as they are received is invaluable. In our above scenario, the combat aircraft's radar detected a target on the ground. It was the radar's processing algorithms that determined the target was a howitzer and not a delivery truck. This avoided spurious information being uploaded to the cloud and helped avoid what could have been potentially lethal collateral damage.

VULNERABILITIES

The tactical, operational and strategic implications of the combat cloud and JADC2 when coupled to multi-domain operations philosophies are almost unimaginable. Nonetheless, every military advantage risks becoming a Clauswitzian centre-of-gravity without which one's own side will struggle to fight and win. Data centres like combat clouds could present lucrative targets. The "principal threats in a cloud computing environment are those which could severely impact



EDA

This EDA schematic shows how cloud computing could contribute towards military operations. The SWAN capability marked herein refers to the software analysis platform the EDA has developed to demonstrate cloud-based capabilities.

the information security principles of confidentiality, integrity and availability," the European Defence Agency (EDA) told Armada in a statement. The EDA is a European Union (EU) body supporting member states in enhancing their defence cooperation and military postures.

Key threats to military data centres include cyber and electromagnetic activities. Better known as CEMA, the fusion of Electronic Warfare (EW) and cyberwarfare is a concern. Rather than just jamming to disrupt, degrade or destroy radars, radios and radio networks, EW systems can potentially deliver malicious code. Nefarious zeros and ones can enter electromagnetically-dependent systems and networks via their antennas, much like a human inhales viruses or bacteria. CEMA offers a wider array of non-kinetic effects, beyond conventional jamming: "Adversaries may exploit these weaknesses through tactics such as denial of service attacks; deliberate jamming or interference in the electromagnetic spectrum: hardware tampering, network eavesdropping, and supply chain compromises," warns the EDA.

The paradox is that the combat cloud must be easy to access to those who need its data, but difficult for adversaries: "(T)he advantage of ease of access in a tactical cloud environment raises threats related to identity and access control management ... in order to give unauthorised access to adversaries." Data security must be paramount given that the encryption protocols the cloud relies on could come under attack, particularly from AI-enabled malware intended to break such protocols." The EDA "is exploring some collaborative work on new emerging technologies like data-centric security and zero-trust architectures" which may bolster combat cloud information security principles. Two EDA initiatives, DARC (Data Centric Security) and ZTA (Zero Trust Architectures), are ongoing to this end. An EDA working group is looking at how DCS and ZTA can be used in the military context: "The level of maturity for commercial solutions related to data security and zero trust architecture is quite high but it hasn't been tested in military conditions at the tactical level," the EDA statement continued, although it added that work is ongoing in this regard.

Despite its potentially hostile utility in attacking cloud computing encryption, AI has a role to play to assist "early detection, advanced situational awareness and threat prediction." Artificial intelligence also holds promise in assisting the "automation of incident response processes that will give an additional advantage for operational continuity." Although not a panacea, AI "will assist significantly threat and cyberattack detection by processing the huge amount of data being collected in a tactical cloud environment." Moreover, "Dynamic risk assessment with AI support can improve the early and more accurate detection of cyber threats offering an enhanced and even real-time situational awareness picture leveraging the benefits of edge computing ... making that picture available and accessible at the warfighter level," the EDA concludes.

OUTCOMES

MDO could potentially revolutionise warfare much as precision bombing, uninhabited systems, Blitzkrieg, nuclear weapons, submarines, battleships and even the railways did. Out-deciding and out-performing one's enemy at pace is arguably not a new idea, some would say it is as old as war itself. Nonetheless, the digitisation of combat and military affairs is making this a reality. It is imperative that the data repositories multi-domain operations will rely on are as strong and robust as the citadels of yesteryear. A

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Polish MND

Poland's MSBS Grot assault rifle is locally developed and manufactured. It comes in a range of variants optimised for various roles by interchanging barrels in length.

WEAPONS DESIGN FOR TODAY AND TOMORROW

Technology advances are playing an ever growing part in the current and future development of individual shoulder-fired weapons.

By Stephen W. Miller

With each next generation of weapon, militaries must weigh the potential benefits provided against the training impacts, logistics and support needs, financial investment required, and possible tactical implications.

As a result the decision to adopt a new individual weapon should be taken with careful deliberation. Yet, as Ronen Hamudot, vice president sales and marketing at Israeli Weapons Industries (IWI) observed: "The basic form of the military shoulder-fired individual small arm has not significantly changed over the past decades." Still there has been continuous evolution as advances in technology and design innovations have been applied. On occasion these new capabilities have prompted changes in unit structures and combat tactics.

Weapon manufacturers are primarily those that innovate weapon designs and identify, as well as develop various new technologies that can improve the arms that they offer. However, while serving military customers they are obligated to address the requirements as defined by the procuring agency. Specific end-users such as special forces units have more freedom to select specific weapons offered by industry, although usually in small numbers.

Supplying a weapon for an entire army entails accommodating a host of additional factors such as provisions related to repair, spares, support, training, and potentially the type of ammunition available. The large quantities required to equip each soldier necessitates a more formal and structured acquisition approach. In the end, though, the specifics in the requirement issued will reflect the understanding of that military in addressing the missions, enemy, and terrain that they expect to face. Often these views are largely drawn from the most recent battlefield experience. The inherent drawback in this can be a tendency to 'fight the last war' rather than anticipate the possible nature of a future conflict.

CURRENT WEAPONS PROGRAMMES

The last few years have seen initiatives by a number of militaries to move to new weapons. These have included the US Army and Marine Corps, the French, German, Polish, Israeli, Republic of Korea, Japanese, Peoples Liberation Army (mainland China), and others. Some of these efforts have been underway for a few years while others are in the initial stages. Each reflects the potential introduction of new designs and, in some cases, significant shifts in the weapon approach as laid out in the requirement documents. Another factor in the fielding of a domestically developed and manufactured service weapon can also be a matter of national pride. Thus, the weapons adopted by militaries of various countries are often influenced by a wide range of factors.

ARAD - IWI

The nature of small arms, unlike major weapons systems such as aircraft or combat vehicles, provides opportunities for smaller companies to successfully introduce innovative designs. The IWI ARAD assault rifle design is the result of direct inputs from the Israeli Defense Forces (IDF) reflecting their specific priorities on its capabilities and performance. As Hamudot at IWI explained: "The IDF was able to strictly focus on its exact needs within its known combat and operating environment. Number one was that the weapon be above all simple. It should reliability operate in the worst conditions without any care. It needs to fire despite not even receiving basic cleaning for days. Next it should be lightweight and easily handled in close combat situations. Additionally, provisions must be provided to power the increasing numbers of external accessories that are becoming common. The ARAD was developed against these exacting requirements.

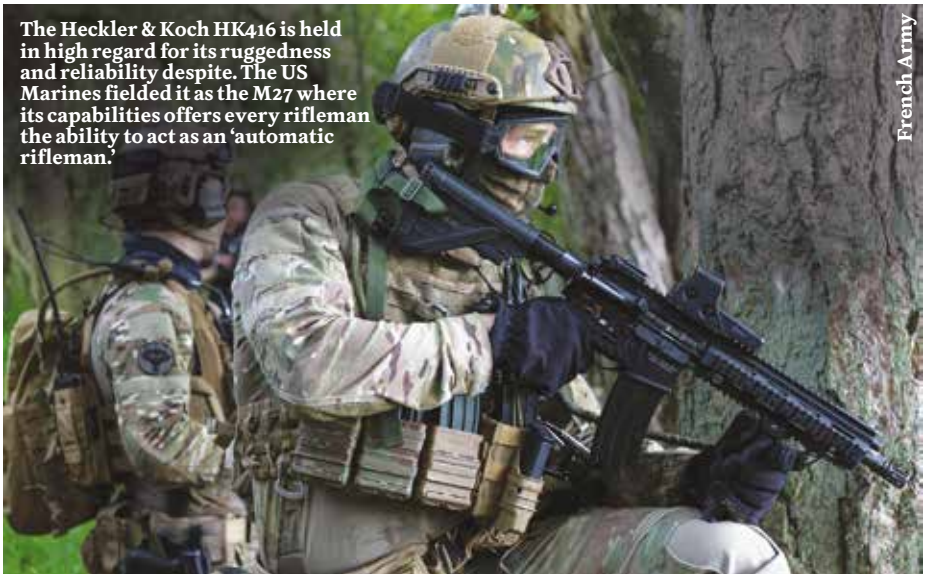
The weapon itself, which was introduced in 2019, is based on the AR-15 platform but features a short stroke gas piston operating system. A three-position gas regulator also provides for smooth operation in adverse conditions or suppressed fire. Ambidextrous controls (which are becoming common), integrated Picatinny accessory rail and an adjustable length stock offer individual user flexibility. ARAD is offered in barrel lengths of 11.5inches (292mm), 16 inches (368 to 404mm) with the latter weighing 6.6 pounds (3.0 kilograms). The weapon is offered in 5.56 NATO, .300 AAC and 7.62X51 (later in the the ARAD7). The 5.56 is used by the IDF. Hamudot shared that IDF soldier experience with the ARAD has been highly positive particularly regarding its reliability in the dust and dirt of both urban and desert conditions. It is typically employed with the Meprolight reflex sight.

IWI/IDF

ARAD was developed by IWI in close collaboration with the Israeli Defense Force (IDF) to provide an individual assault rifle optimised for its specific combat situations and operating environment.

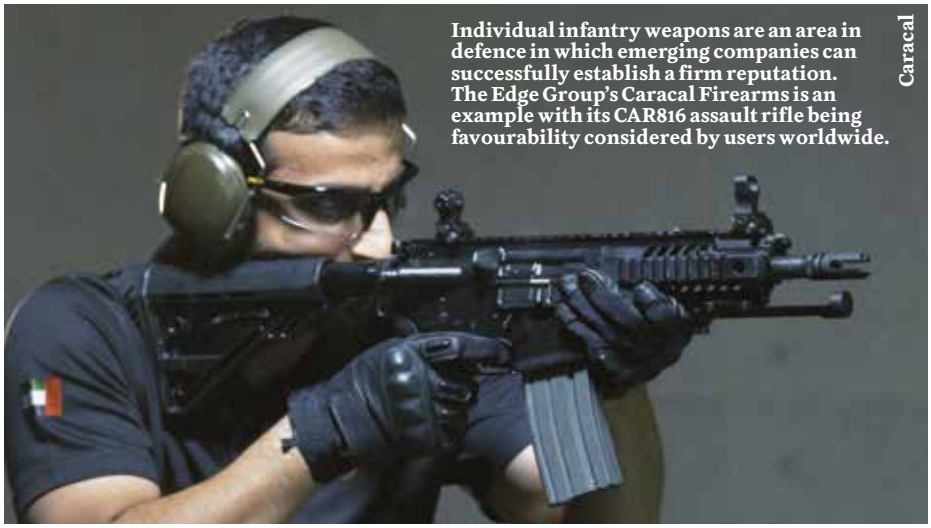
MSBS GROT

The MSBS Grot originated with the Military University of Technology in Warsaw as a Polish individual weapon to replace previous Kalashnikov based designs. At its heart is its significant degree of modularity achieved by a common receiver which accommodates a range of stock models, barrels of different lengths, and various accessories. The Grot can even be configured as either a classic MSBS Grot C (magazine forward of the trigger) or 'bullpup' (magazine behind the trigger), the MSBS Grot B. Thus far only the Grot C in a 16 inch (406mm) barrel version has been fielded by the Poles. However, both a carbine model with 10 inch (25mm) barrel, as well as a 20 inch (508mm) designated marksman rifle are available. In addition,



French Army

The Heckler & Koch HK416 is held in high regard for its ruggedness and reliability despite. The US Marines fielded it as the M27 where its capabilities offers every rifleman the ability to act as an 'automatic rifleman.'



Individual infantry weapons are an area in defence in which emerging companies can successfully establish a firm reputation. The Edge Group's Caracal Firearms is an example with its CAR816 assault rifle being favourability considered by users worldwide. Caracal

a version with a heavier barrel, allowing sustained automatic fire and flash suppressor, can be provided. The weapon is further designed from inception to use a holographic sight or scope, anticipating what is nearly standard practice by advanced militaries. The MSBS Grot in 5.56x45mm is in broadest use. However, capitalising on its modularity a 7.62x51mm can be configured. This can even be conducted using a conversion kit. In January 2023 the Polish MND ordered an additional 70,000 MSBS Grots. The Łucznik Arms Factory (Fabryka Broni Łucznik – Radom) celebrated its manufacture and delivery of 100,000 weapons in November 2023.

HK416/417 – HECKLER & KOCH

Despite, or maybe because of, its origin in the 1990's as a joint project instigated by the US Delta Force to provide an improved weapon over the US M4 Carbine, the Heckler and Koch HK416 has continued to ring up endorsements by military forces worldwide. By the latest count over 20 organisations have adopted it including service wide fielding by the French, Norwegian, and German Armies, as well as the US Marines and numerous special and elite units. Its use of a patented gas piston system, derived from the company's G36, reduces malfunctions and demonstrates enhanced reliability. In tests the HK416 experienced only 223 stoppages in firing 60,000 rounds (versus 882 by the M4). With fire selection, slide catch and magazine release levers available on both sides, the weapon is comfortable for both left and right-handed shooters. The weapon is highly adaptable with at least nine versions offering barrel lengths of 11 inches (264mm) to 20 inches (505mm) and overall compactness as low as 31.9 inches (797mm)/28 inches (701mm) with telescopic stock collapsed. Weapons have Picatinny rail on four surfaces while tool-free gas adjustment allows for accommodating a suppressor.

It is its dependability that particularly recommends the HK416 to combat applications. Its short stroke piston system vents the gas outward making the rifle run much cleaner and cooler. Even after firing 30 rounds on fully automatic, the bolt remains so cool it can be handled by bare hands. This decreases fouling which increases dependability and reduces stoppages. It also facilitates sustained rapid firing. Thus, a standard issue 416 in the hands of any member of a squad can assume the traditional role of the 'automatic rifleman' – previously a role for a dedicated individual. Similarly, every member of the small unit can equally contribute to the close-fight or urban clearing carrying the HK416 (something not possible when equipped with a light machine gun). This adaptability offers major tactical advantages.

QBZ-191 – PLA

The Peoples Republic of China has taken pride in developing and fielding its own domestic small arms. Its QBZ-95 Bullpup was a major differentiation from the previous Type 81which derived from the Kalashnikov. The QBZ-191'light weapon (Qīng Wǔqì) - rifle (Bùqiāng) - automatic (Zìdòng)' was first publicly displayed during a 2019 parade. It reflects a conventional configuration with improved ergonomics, an ambidextrous design, and enhanced reliability in line with other modern assault rifles. Designed as a family, the platform features various barrel lengths and handguard configurations. Three variants have been observed including a short 10.4 inch (260mm) barrelled carbine, a standard issue rifle with 15 inch (370mm) barrel, and a designated marksman version, with 22 inch (550mm) heavy barrel. In other respects each is similar. The QBZ-191 uses a short-stroke gas system reflecting an attempt to achieve enhanced field reliability. The weapon, like its predecessor, employs the PLA developed 5.8x52mm Type 10 ammunition which is claimed to have superior performance to 5.56mm NATO rounds. Each weapon has a Picatinny like accessory rail with most general issue weapons being observed with a 3X power prismatic optic while the marksmen model has a 4-15X power variable sight. By 2021 the QBZ-191 appeared to be issued to front-line units and is expected to be fielded across the PLA.

CAR817 AND CAR818 - CARACAL

Another example of innovation by emerging industry are the CAR817 and CAR818 by CARACAL Firearms, a member of the EDGE Group. Drawing from a common design these are chambered in 5.56x45mm and 7.62x51mm respectively. Hamad Alameri, CEO of CARACAL explained: "Aimed at the dynamic operational scenarios of customers, the rifles feature tailored characteristics at the nexus of ergonomics, adaptability, and performance." The weapons are designed for adaptability being offered in various barrel lengths but also reflecting extensive use without maintenance, use with underpowered ammunition, as well as suppressed firing. Features such as a flared magazine well with gripping groves that eases reloading in no-light conditions and a patented ejection port cover offer soldier-friendly attributes that can be critical in combat.

BERETTA NARP

Baretta chose the 2023 DESi Defense Expo to debut its New Assault Weapon Platform (NARP). Carlo Ferlito, CEO and GM at Beretta Italy and VP of Beretta Defense Technologies (BDT) shared on the new weapon, "Thanks to close interaction with elite forces, we designed a weapon with unparalleled performance, that marks an important step forward in the evolution

USArmy

The US Army in its Next Generation Squad Weapon chose to not only move to a new infantry shoulder-fired weapon but it also stipulated an entirely new 6.8mm caliber. Sig Sauer's MCX Spear based rifle was selected and is now being initially fielded as the XM7.

not only of Beretta's Defense department, but in the entire defense industry." NARP emphasises modularity, versatility and enhancing both soldier effectiveness and survivability. The former are encouraged by its 7.2lb (3.3kg) weight (without magazine), ambidextrous controls, under 35 inches (900mm) length, proprietary grips, as well as telescoping, folding, and collapsible stocks. The latter is achieved by its muzzle flash reducer system and improved thermal signature reduction. These integrated with the new Beretta B-Silent sound suppressor significantly reduce the NARP firing signature. As a result soldier visual and aural discretion is increased reducing the probability of being detected and located by an opponent on the battlefield.

XM-7 NGSW – SIG SAUER

The US Army has begun initial fielding of a replacement for its 5.56mm M4A1. The Next Generation Squad Weapon (NGSW) competition required not only the consideration of a new assault rifle using a new 6.8mm caliber projectile but also a squad automatic weapon. Sig Sauer's entry, based on its MCX-SPEAR, was finally selected. The Army required use of the 6.8 caliber reflecting its concern of being able to defeat advanced individual body armour anticipated on a near peer opponent on a future battlefield. The larger 6.8x51mm ammunition influences the performance and handling of the weapon. It reflects the trends in other new assault rifles with ambidextrous controls, adjustable two-position gas regulation, collapsible stock, and Picatinny rails. The Army also called for its standard, rather than occasional use, with a suppressor. Its larger size ammunition reduces the magazine capacity to 20 rounds (using the issue mag-pouch). This is a point of some concern as it reduces the amount of ammunition that a soldier can carry and have access to in a firefight from 210 rounds in 5.56mm to around 140 in 6.8mm. Army officials have suggested the anticipated increased single round accuracy (when equipped with a new advance fire control/sight) will compensate for this. The validity of this argument in actual combat by the typical rifleman (rather than a Designated Marksman – DMR), for whom suppression fires may be more common than engaging clear targets, remains to be demonstrated. Independent evaluations support its overall reliability, but similarly many of these express concerns over the XM7's overall weight. It is 14.54lb (6.6kg) with the suppressor, loaded 20-round magazine, and proposed Vortex digital fire control sight.

The mentioned Vortex sight is itself a dramatic shift in providing aiming for the average rifleman. As described by the Army Cross Functional Team for Soldier Lethality: "This ruggedised fire control increases accuracy and lethality... integrates a number of advanced technologies, including a variable magnification optic, backup etched reticle, laser rangefinder, ballistic calculator, atmospheric sensor suite, compass, Intra-Soldier Wireless, visible and infrared aiming lasers, and a digital display overlay,". Vortex explains that "the 1-8x30 optic is built around our revolutionary Active Reticle". This level of fire control sophistication is comparable or beyond that of many dedicated marksmen or snipers. Yet, the current US Army plan is to provide it to every squad rifleman who previously employed at best a variable Direct View Optic (Sig Sauer's TANGO6T) with 1 to 6x24 day optics. The Vortex is intended to allow precise engagement from 2,000-2,600 feet (600-800 meters). This could reflect a significant redefinition of the role of the rifleman and of the individual shoulder-fired combat weapon.

NEXT GENERATION

The question of what characteristics and capabilities should define a 'next generation' weapon is difficult to separate from how the next battlefield might be envisioned by those in the military that generate the requirements. Industry weapons developers emphasise that they design weapon systems that respond to the needs of military customers. However, it is possible to isolate certain trends and direction that could reasonably be anticipated. These include the increasing integration of further capabilities into the weapon platform itself. Currently aspects such as laser aiming, ranging, and even suppressors are added onto the weapon platform, in time these could become an integral part of the design. Doing so, IWI's Hamudot suggests, offers potential benefits such as lower weight. The expanded application of the concept of modularity and the weapons family could also be foreseen. He also pointed out that the incorporation of lessons learned from actual combat operations may well influence future requirements. For example, the IDF has begun to recognise the contribution that grenade launchers are providing it its Gaza actions. The application of digital technology and data processing is also likely. These offer the potential to enhance the efficient application of fires on a target, for example, by supporting enhanced target recognition and identification or by regulating the rate of fire of a weapon based on the specific engagement conditions and desired result. In addition, there is always the forever goal so often expressed of 'reducing the soldiers load'.

The possibility of chasing technologies as an end unto itself is something to be carefully avoided, yet an always present pitfall. Foremost in mind should always be the recognition that any changes or seeming improvements must contribute to the manner in which combat on the ground, the rifleman's techniques and small units' tactics will be conducted. A

TIME TO DETECT ENEMY RADIOS

The ongoing war in Ukraine is highlighting innovative and effective ways of detecting hostile radios on the battlefield.

Thomas Withington

Figure 1

For this hypothetical demonstration of emitter location techniques, the Russian Army's 428th Motorised Rifle Regiment has deployed a reconnaissance squad to the northeast of the town of Netailove, close to the frontline.

As of late February, the Russian Army's 428th Motorised Rifle Regiment was deployed in the vicinity of Adviika, eastern Ukraine. Russian forces were successful capturing the city on 17 February. Knowing the location of the 428th lets us demonstrate how Electronic Warfare (EW) techniques are unfolding in this ongoing conflict.

We will suppose that the 428th had a deployed squad of troops near the town of Netailove, just over 6.5 miles (12 kilometres) southwest of Adviika, to perform reconnaissance near the frontline. The squad's commanding sergeant has commandeered some local farm buildings as shown in figure 1. The sergeant is using a standard handheld tactical radio to communicate with higher echelons of command.

HYPOTHETICAL SCENARIO

We will assume that the sergeant is 5.9 feet (1.8 metres) tall and that their radio has a 3.3ft (1m) long antenna. As the sergeant is located on the first floor of the commandeered farm buildings this adds another 9.8ft (3m) to their overall height. The farm buildings are about 574ft (175m) Above Sea Level (ASL). Taken together, the sergeant and their radio have combined height of almost 594ft (181m) ASL. Why is height so important? Simply because the higher a radio is the further its signals can travel.

Height is not the only determining factor, as the power of the sergeant's radio and the radio's antenna play their part. Transmitting on a frequency of 560 megahertz/MHz, the sergeant's radio produces five watts of power. The antenna has a gain of three decibels-per-milliwatt (dBm). The sergeant's radio signals have 37dBm of power as they leave the antenna. Gain can be complex to explain but determines how much signal power an antenna can concentrate in a specific direction. An analogy would be how a magnifying glass can concentrate sunlight

Figure 2

A Ukrainian COMINT detachment has deployed to the town of Hirnyk to monitor the spectrum for Russian Army radio signals with the purpose of determining the location of enemy units close to the tactical edge.

Figure 3

The line-of-bearing between the Ukrainian COMINT unit and the Russian reconnaissance squad is clearly shown in this image depicted in the yellow dashed line.

onto a specific spot. Radio signals are like long distance runners, the further they travel, the more power they lose.

Unluckily for the sergeant and their squad a Ukrainian Army Communications Intelligence (COMINT) unit has deployed several kilometres away as shown in figure 2.

The Ukrainian detachment is tasked with monitoring the electromagnetic spectrum for Russian radio transmissions. The unit is deployed just outside the town of Hirnyk, around 10.6 miles (17km) southwest of the Russian squad's position. Equipped with a COMINT Electronic Support Measure (ESM) the unit has a 65.6ft (20m) antenna. Both the antenna and the Ukrainian's position are well camouflaged. Visual detection by Russian Uncrewed

Figure 4

By deploying a second COMINT antenna it is possible for the Ukrainian COMINT unit to improve their ability to precisely locate the source of the Russian radio signals. However, line-of-bearing margins-of-error can still create challenges in precisely determining the signal's point-of-origin.

By drawing circles around the radio receivers deployed across an area to detect hostile radio transmissions, one can determine the point-of-origin of these signals by determining the point where these circles converge.

Aerial Vehicles (UAVs) is a constant worry.

Hirnyk is 640ft (195m) ASL. Add the antenna height and this places the Ukrainian unit 705ft (215m) above sea level. The ESM is especially sensitive detecting signals as weak as -105dBm. This is bad news for the sergeant. The latter's signals lose just under 113dBm of power as they move through the ether. By the time the signals reach the Ukrainian COMINT unit, they have a strength of -76dBm. As the cutoff point for the Ukrainian's ESM equipment is -105dBm, the Russian radio signals are relatively easy to detect.

Nonetheless, the Ukrainian unit can only exploit these signals for relatively limited intelligence. Their single antenna reveals that the source of the signal is on a bearing of circa 72 degrees (see figure 3).

Their ESM has a three-degree margin-of-error for any Line-of-Bearing (LOB). At a range of 10.8 miles (17.5km), this margin can equate to 1,503ft (458m) either side of the LOB. With a potential 3,005ft (916m) margin-of-error it is difficult to pinpoint the exact location of the source of the radio signal. This is problematic if the Ukrainians want to engage the Russian position with artillery using the signal source as the aimpoint.

SHARPENING THE PRECISION

How can the Ukrainian unit refine the Russian sergeant's location? A second COMINT antenna could be deployed, as shown in figure 4.

This second antenna is deployed to the east of Hirnyk, 7.3 miles (11.8km) from the source of the Russian sergeant's transmission on a bearing of 61 degrees. The addition of a second antenna has improved accuracy with which the source of the Russian radio transmissions can be located. Now it is merely a process of triangulation. In theory, the source of the transmission should be where the two LOBs from the two COMINT antennas meet.

An alternative approach is to use several radio receivers deployed over a large area. These receivers can be relatively inexpensive, discreet, easy to deploy and left unattended. The receivers are networked into the Ukrainian COMINT unit's ESM, in this case by cable, to avoid Russian troops detecting the former's signals. The Ukrainian team has one radio receiver deployed at its location, where the ESM is situated, outside Hirnyk. A second receiver is deployed roughly to the south of the Russian position, just north of Lozove. The problem with the receivers is that they can only determine that a signal is out there somewhere. The ESM does the clever work determining the 560MHz signals being received by the two antennas are in fact the same.

The radio receivers cannot provide lines-of-bearing as their antennas are not directional. Nonetheless, the ESM can derive more data from the incoming signals. All radio signals travel at the speed of light; 186,000 miles-per-second (299,274 kilometres-per-second). It will take the sergeant's radio signals 0.058 milliseconds to travel the first radio receiver at Hirnyk. It takes the same signals 0.036 milliseconds to travel to the second radio receiver. The difference between the time of the signal's arrival at the first and second radio receivers is 0.022 milliseconds, corresponding to around 4.1 miles (6.6km).

The more radio receivers are deployed, the sharper the precision becomes. If we add a third receiver (shown in figure 5) the Russian signal will travel 8.2 miles (13.2km) on a bearing of almost 101 degrees. It will take the Russian radio signal 0.044 milliseconds to reach this receiver. As figure 5 shows, it is possible to determine the location of the radio as the point where

all the circles fanning out from the radio receivers converge.

The technique discussed above is relatively simple, yet effective. Relatively simple and inexpensive equipment, in this case radio receivers, can be networked to provide good geolocation accuracy. The more receivers are deployed over a specific area, the better the geolocation accuracy. The receivers can be left unattended relatively close to the tactical edge, or indeed across any area where COMINT must be gathered. Unattended sensors have the added benefit of not needing the continuous deployment of COMINT troops too close to the frontline helping to reduce casualties. A physically small unit with a well-camouflaged antenna will not be easy to find on the battlefield. Moreover, if the radio receivers are networked using cables, they are not emitting any radio signals and cannot be located by hostile COMINT cadres.

Graceful degradation is another important consideration. Let us suppose, for the purpose of our scenario, that the Ukrainian COMINT cadres deploy scores of radio receivers close to the tactical edge. Perhaps some of these will be found, and destroyed, by Russian reconnaissance troops. Other maybe destroyed kinetically. The loss of a handful of receivers will degrade geolocation accuracy, but not excessively. Furthermore, these receivers can be replaced relatively easily and inexpensively. Placing scores of receivers over a large area means that scores of hostile signals can be detected and geolocated. UAVs can also be used in a similar fashion providing similar geolocation of both static and moving signals.

BEAUTY IN SIMPLICITY

Relatively inexpensive, easy-to-deploy sensors such as the radio receivers discussed in this article can be powerful EW tools to help pinpoint hostile units. Find the point of origin for the radio signals of a soldier, vehicle or base and you find a target. At the time of writing (February 2024), the war in Ukraine is entering what may prove to be its most difficult stage since the February 2022 invasion. The Ukrainian military desperately needs quality materiel in quantity to begin the process of evicting Russia from the Ukrainian lands she occupies. Simple, reliable and effective solutions like those discussed herein, have their place on the battlefield. Ukraine's allies must get such capabilities into theatre before it is too late. A

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The BAE Systems 155mm/39 cal M777. Alongside is a 155mm projectile with a Northrop Grumman Precision Guidance kit. US Army

UKRAINE SUPPORT CAUSES ARTILLERY DILEMA

The supply of artillery to Ukraine by many nations has resulted in an international demand for newer systems to replace them.

Christopher F Foss

It is now some two years since Russia invaded the Ukraine in February 2022 and while the Ukraine has been successful in retaking some of its lost terrain, especially north of Kiyv, only limited gains have been made elsewhere.

Before the invasion the Ukraine stated that around 80 percent of its casualties in earlier fighting had been caused by artillery fire, which includes towed and self-propelled (SP) artillery, mortars and ARS.

Until recently the Ukraine was equipped with Russian artillery systems which fired mainly 122mm and 152mm natures of separate loading ammunition which was manufactured in the Ukraine.

Western aid has since flowed into the Ukraine in considerable quantities with the largest supplier being the United States, who by early 2024 had supplied BAE Systems M777 155 mm/39 cal towed artillery, M109 series 155mm /39 cal SP and 105mm M119 towed artillery systems as well as Lockheed Martin 227mm M142 High Mobility Artillery Rocket Systems (HIMARS).

They have also supplied significant quantities of artillery ammunition including 2,000,000 155mm rounds, 800,000 105mm rounds as well as small arms ammunition and 25mm ammunition for the M2 Bradley infantry fighting vehicles (IFV).

Many other countries have also supplied artillery systems and ammunition to the Ukraine with the UK providing 105mm L118 Light Guns and AS90 155mm/39 cal SP guns, France Nexter CAESAR (6x6) 155mm/52 cal SP guns, Germany and the Netherlands 155mm/52 cal PzH 2000 SP guns, Denmark Nexter CAESAR (8x8) 155mm/52 cal SP gun, Poland Crab 155mm/52 cal SP guns, Sweden BAE

Systems Bofors 155mm/52 cal Archer and a number of countries surplus M109 155mm/39 cal SP series to name but a few.

In most cases these weapons have been taken from deployed units as most countries in Europe today have few reserve weapons available for transfer.

Some countries in Eastern Europe still have the capability to supply 125mm tank ammunition for the T-64/T-72/T-80 tanks used by the Ukraine as well as 122mm and 152mm artillery ammunition.

The role of artillery is to provide suppressive firepower using high-explosive (HE) natures of ammunition as well as smoke and illuminating. In addition, counter battery fire is another key role.

BAE Systems

Sweden has supplied its BAE Systems Bofors Archer (6x6) 155mm SP artillery system to the Ukraine on the Volvo chassis.

Both sides have used uncrewed aerial vehicles (UAV) for reconnaissance and post strike assessments as well as artillery locating radars (ALR).

This has meant that rather that staying in the same position once a fire mission has been completed, they rapidly move to another fire position to avoid counter battery fire and replenish ammunition.

REPLACEMENTS

As a result of the war in the Ukraine and tensions between NATO and Russia, a number of countries in Europe are expanding their artillery capability and placing contracts for new artillery systems to replace those supplied to the Ukraine.

Denmark, for example, has passed its complete fleet of 19 brand new Nexter Systems CAESAR (8x8) 155mm/52 cal artillery systems to the Ukraine and placed a contract with Elbit of Israel for 19 new ATMOS 155mm/52 systems.

Vickers Shipbuilding and Engineering (VSEL) supplied the British Army with 179 AS90 155mm/39 cal SP artillery systems which were to have been upgraded under the Extended Range Ordnance/Modular Charge System (ERO/MCS) programme. This would have included a new 155mm/52 cal ordnance to enable a longer range to be achieved. This programme was however cancelled many years ago.

For some years the UK has had an AS90 replacement programme called the Mobile Fires Platform (MFP) which will be a 155mm/52 cal system, tracked or wheeled, and as of early 2024 was still on going.

Following the supply of 30 AS90 to the Ukraine the UK has purchased 14

BAE Systems

Future production BAE Systems Archer (6x6) 155mm system will be mounted on the Rheinmetall MAN Military Vehicles HX (8x8) cross country chassis.

BAE Systems Bofors 155mm Archer (6x6) from Sweden with the first of these being delivered in 2023. This is sufficient to form two batteries of six guns plus two for training which will give the Royal Artillery an interim capability until MFP is fielded.

There are a number of potential contenders to meet the MFP requirement for 116 systems including Team Thunder with the latest South Korean Hanwha K9A2 155mm/52 cal tracked SP artillery system.

The K9 has now become the best-selling tracked artillery system and has been ordered or in service with Australia, Egypt, Estonia, Finland, India, Norway, South Korea, Turkey and Poland with over 2,400 under contract or delivered.

In addition there is the K10 Ammunition Resupply Vehicle(ARV) and K10 Fire Direction Control Vehicle (FDCV).

Team Thunder includes Lockheed Martin UK who would build the turret and Pearson Engineering who would build the chassis with Lockheed Martin integrating chassis and turret plus Leonardo, Horstman and Soucy International.

Pearson Engineering has the former Vickers Defence Systems Armstrong Works where production of the Challenger 2 MBT and many other AFVs was undertaken.

BAE Systems is also bidding for the MFP with the BAE Systems Bofors Archer but mounted on a Rheinmetall MAN Military Vehicles (RMMV) HX (8x8) chassis with the team called Archer Artillery Alliance.

This includes not only BAE Systems UK but Babcock and RBSL who are already working on the Boxer (8x8) Mechanised Infantry Vehicle (MIV) and Challenger 3 MBT for the British Army.

Germany and the Netherlands have supplied the Krauss-Maffei Wegmann PzH 2000 155mm SP artillery system to the Ukraine

Technology would be transferred from Sweden to the UK and BAE Systems would establish and manage the Assembly, Integration and Test (AIT) facility with

Babcock International Group being responsible for consolidation of the superstructure and ammunition resupply system.

BAE Systems would also aim to restart barrel production at Barrow-in- Furness as today the UK cannot manufacture tank or artillery barrels following the closure of ROF Nottingham many years ago.

Now entering production is the RCH 155 integrated onto the ARTEC Boxer (8x8) MRAV for the Ukraine

Under the original plan 24 Archer were for Norway and 24 for Sweden but in the end Norway pulled out so Sweden has taken all 48 plus placed an order for and addition batch of 48 which includes the 14 for the UK and eight to the Ukraine.

New production Archer will use the RMMV chassis and Archer is one of the two contenders to meet the Swiss requirement to replace its upgrade M109 155mm/47 cal SP weapons with the other contender being the RCH 155 mentioned later.

Using private venture funding the German company of Krauss-Maffei Wegmann (KMW) developed the 155mm/52 cal Artillery Mission Module (AMM) which has been tested installed on a number of platforms.

The latest version is integrated on the rear platform of the ARTEC Boxer (8x8) Multi-Role Armoured Vehicle (MRAV) which is being adopted by an increasing number of countries including Australia, Germany, Lithuania, Netherlands and UK for an expanding number of battlefield missions.

This combination is known aa the Remote Controlled Howitzer 155 (RCH 155) with the remote controlled turret installed on the rear of the Boxer platform and controlled by the crew seated in the front drive module.

This is provided with 30 rounds of 155mm ammunition which compares with 60 rounds for the heavier PzH 2000 and both use the Rheinmetall 155mm/52 cal

The best-selling 155 mm/52 cal tracked artillery systems is the South Korean K9 Thunder, this is the K9A1.

ordnance and elevating mechanism from the PzH 2000.

The first customer for the RCH 155 is the Ukraine who will take delivery of 18 systems funded by Germany and the German Army is expected to order up to 200 systems in the future.

The German Army took delivery of 185 PzH 2000 155mm/52 cal SP artillery systems from the now KMW production line in Kassel but some of these have been passed onto other countries as the German Army has downsized since the end of the Cold War.

These include Croatia (12), Lithuania (21) and more recently the Ukraine. Brand new PzH 2000 have been sold to Greece (24) and Italy (2 from Germany and rest made under licence) and the Netherlands (57).

So far the Kassel production line has been re-opened twice, once for Qatar (24) and more recently for Hungary (24 units) and has reopened again as Germany has placed an initial contract for 10 PzH 2000 for delivery by 2025 plus options for an additional 18 in three batches of six.

For the MFP Elbit of Israel could bid their ATMOS 155mm/52 cal system which can be mounted on a 6x6 or 8x8 platform or potentially their new SIGMA 155mm/52 cal system which is being developed for the Israel Defense Forces (IDF) and based on an 10x10 platform with 40 155mm projectiles and associated charges in the magazine.

Nexter could offer the CAESAR in 6x6 (which carries 18 rounds of ammunition) or 8x8 configuration with the latter being based on a Tatra chassis with more ammunition capacity.

In February 2024 the French Army placed a contract for 109 brand new CAESAR MkII systems for delivery from 2026 which will replace older CAESAR MkI and last AUF1 tracked systems.

AMMUNITION

The Ukraine has been using huge amounts of artillery ammunition with some weapons firing up to 100 rounds of 155mm ammunition a day.

As a result of downsizing and the increased use of simulators the number of contractors in Europe and other countries who can manufacture ammunition has declined.

Artillery ammunition consists of three parts, the actual projectile, the nose mounted fuze and the charge system. The latter can be the traditional bag charge system but most of the more recent artillery systems use a Modular Charge System (MCS) or to be more specific a Bi-MCS.

For a 155mm/39 cal artillery system a

Christopher F Foss

France has supplied Ukraine with some of its Nexter CAESAR (6x6) 155mm SP artillery systems.

maximum of five MCS would be used while for a 155mm/52 cal system a maximum off six MCS would be used.

As NATO has adopted a Joint Ballistic Memorandum of Understanding (JBMOU) with a 155mm 23 litre chamber for its current artillery systems.

The types of 155mm ammunition are numerous and include the old US M107 HE but there are also HE hollow base, base bleed (BB), rocket assist and combined rocket assist and BB projectiles. In addition there are smoke, illumination and top attack projectiles with the latter including the German SMArt 155 and Swedish Bonus plus precision guided munition (PGM) such as the US Raytheon M982 Excalibur which has also been supplied to the Ukraine.

US and European contractors are now ramping up the production of 155mm artillery munitions but this means additional machinery plus raw materials and labour, all of which has been in short supply.

The US, for example was producing around 10,000 155mm artillery projectiles a month but is ramping up production with an eventual target of 85,000 a month later this decade.

Other European contractors such as Nammo, Rheinmetall, BAE Systems and Nexter have also stepped up 155mm and other ammunition production as a result of the war in Ukraine as well as replenishing existing stocks which have been allowed to run down. While some contractors can double shift there can be shortages in the supply chain with materials, explosive, propellant to name but a few.

In peace time artillery system fire very few rounds so that their barrels do not wear out. Experience in the Ukraine and other combat areas has shown that when firing at maximum range and using top charge barrels can wear out when they have sometimes fired 1,000 rounds or less. These barrels have to be replaced and the number of contractors in Europe who can make replacement barrels has also declined.

The large number of different artillery systems used by the Ukraine makes training and maintenance that more difficult and the long term objective for the Ukraine would be to standardise on 155mm ammunition and a smaller number of platforms.

An artillery system is however more than just the platform and its suite of extensive ammunition as it also includes ammunition resupply, target acquisition, command and control and other elements. A

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SAAB

KEEPING SOLDIERS CAMOUFLAGED, PROTECTED AND VISUALLY AWARE

What are the advances being made in three pieces of kit used by every soldier - uniforms, helmets and increasingly night vision devices?

by Andrew White

Since Russia's latest invasion of Ukraine on 24 February 2022, the nature of modern warfare has changed significantly, shifting away from the counter-insurgency campaigns witnessed in Afghanistan and Iraq over the past two decades towards a peer-on-peer conflict.

As governments consider how to operate in this new age of strategic competition, armed forces around the world are upgrading soldier equipment, tactics, techniques and procedures to handle a very different and equally as complex operating environment.

Armada International considers the latest soldier modernisation efforts in terms of uniforms; combat helmets; and night vision systems and how these important pieces of equipment can optimise the operational effectiveness of dismounted warfighters deployed in even the most contested of battlefields.

UNIFORM DESIGN

The role of warfighter uniforms continues to be fluid, whether it be to conceal troops from enemy forces; ensure easy and rapid movement; or contribute to the survivability of personnel.

However, as the UK's Royal United Services Institute (RUSI) warned in several papers regarding lessons learned from the war in Ukraine, there appears to be an oxymoron regarding demands for contemporary uniforms which range from helping warfighters remain undetected by mature sensor technologies through to identifying friend from foe on the battlefield.

As described in Preliminary Lessons in Conventional Warfighting from Russia's Invasion of Ukraine: February–July 2022, published on 30 November 2022, RUSI analysts highlighted how "pervasive ISTAR [intelligence, surveillance, target acquisition and reconnaissance] on the modern battlefield and the layering of

Former commander of Ukrainian SOF stands with operators under his command, most of which are dressed in camouflage uniforms with some also wearing green tape as an identifier for friendly forces.

multiple sensors at the tactical level make concealment exceedingly difficult to sustain".

"Survivability is often afforded by being sufficiently dispersed to become an uneconomical target, by moving quickly enough to disrupt the enemy's kill chain and thereby evade

engagement, or by entering hardened structures," the report continued. But it concluded that Ukrainian troops had "tended to sacrifice camouflage for clear identification (using coloured bands) for their manoeuvre forces, relying on speed rather than concealment for survivability".

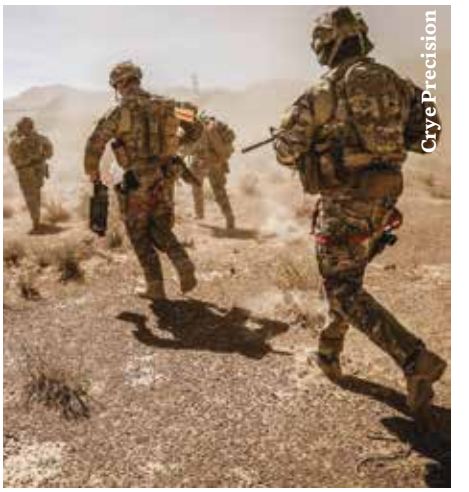
Such juxtaposition is clear to see on social media channels where members of the Ukrainian Armed Forces (UAF) wear 'Multi-Cam' uniforms to blend into local surroundings but then attach bright blue or yellow bands around their arms or helmets.

Defence sources explained to Armada International how these bands (Russian forces also typically use red and/or orange for the same purpose) would help identify friend from foe, particularly during close quarter battle (CQB) where dismounted personnel can find themselves 'up close and personal' with an adversary.

Sources also noted certain Russian special operations units could also wear similar uniform designs to those worn by UAF personnel, making accurate detection even more difficult to achieve, particularly in high-stress combat conditions.

But in order to evade detection by enemy forces operating modern surveillance and reconnaissance sensor systems, dismounted personnel must also be able to reduce their visibility across the full breadth of the electromagnetic spectrum (EMS).

Specific threats being observed in Ukraine include the detection of dismounted warfighters by thermal imaging (TI) or Infrared and image intensification (I2) sensors which can be mounted on board uncrewed aerial vehicles (UAVs) of all shapes and sizes.



MultiCam is a camouflage pattern originally designed by Crye Precision for use in a wide range of environments and conditions.

The global soldier modernisation market is witnessing significant uptake in multi-spectral clothing and coverings which can be easily donned and taken off whenever operating in a high-threat environment.

Examples include Saab's Special Operations Tactical Suit (SOTACS) as well as the company's latest offering, the Barracuda Soldier System (BSS) which provides the dismounted warfighter with protection from sensors operating in near infrared; short-wave infrared; ultraviolet; and visual frequency ranges across the EMS.

Depending upon operational requirements, the 2x2m BSS can be supplied to customers in a variety of camouflage patterns suited for Arctic; Urban; Desert; and Woodland environments.

Saab officials described to Armada how the solution could be worn as a poncho for on-the-move protection but also used as a protective cover for static use. Other providers currently in the marketplace include Germany company Ghosthood and Israeli-US company, Fibrotex.

MKU

At Milipol. Indian company MKU unveiled its Kavro Doma 360 combat helmet as a more protective solution over MICH solutions which have risen to prominence over the last two decades of counter-insurgency and counter-terrorism campaigns around the world.

Beyond multispectral protection, many armed forces are also witnessing increasing levels in demand for flame- and/or fire-proof uniforms, defence sources confirmed to Armada.

Elsewhere, armed forces around the world are copying special forces trends which see warfighters wearing camouflage uniforms featuring integrated protective pads for arms and knees- particularly useful for protecting the soldier in urban and mountainous environments.

Examples include Crye Precision's family of G3 and G4 combat trousers and shirts which feature the company's joint protection solutions including Airflow knee and elbow pads.

Similar solutions are provided by Patagonia and Arc'teryx which ensure warfighters are able to adopt the correct fire positions even when operating amongst rock and debris for example, sources added.

Finally, particular attention must be paid to operating environments which dictate the type of camouflage worn. Examples include arctic, desert, tropical and rural patterns although many armed forces today operate some kind of 'Multicam' type pattern.

Galvion

In March 2023, Canadian Army's Dismounted Infantry Capability Enhancement (DICE) programme selected Galvion's Batlskin Caiman system- a MICH variant, with up to 8,400 solutions scheduled to be delivered over a five year period.

The Multicam design was first developed in the early 2000s by Crye Precision and the US Army Soldier Systems Center as a potential solution for multiple environments with its mix of seven colours.

Since then, it has become the preferred camouflage pattern for special operations forces around the world as well as conventional forces in the US, Europe and Asia-Pacific, including use by the Ukrainian Armed Forces.

HELMET DESIGN

With more than two decades of counter-terrorism and counter-insurgency campaigns waged around the world, many armed forces followed special operations preference in terms of combat helmets.

One of the most popular solutions, which continues to proliferate across SOF and even conventional forces, has been the Modular Integrated Communications Helmet (MICH), essentially a high-cut ballistic helmet which enables easier integration of over-the-ear communications headsets such as those designed by Peltor.

Defence sources explained to Armada how these helmet types also allowed warfighters to attach a greater amount of accessories ranging from night vision

goggles and tactical torchlights through to combat identification beacons.

One of the most prominent MICH examples is Gentex's Ops-Core Fast SF High Cut helmet which has been selected by the US Special Operations Command and other SOF units across NATO.

Protecting personnel from 9mm rounds, the Fast SF MICH is designed as a lighter weight combat helmet at just 1.7lb (655 gram) to reduce physical burden on operators on the battlefield. Lighter weight encourages greater mobility in an area of operations at the expense of protection.

Examples of armed forces selecting MICH for their conventional units include the Australian Defence Force (ADF) which switched from the Enhanced Combat Helmet to Team Wendy's Exfil ballistic helmet in 2015.

Other MICH solutions include Galvion's Batlskin Caiman system which in March 2023 was selected for the Canadian Army's Dismounted Infantry Capability Enhancement (DICE) programme.

Galvion is scheduled to deliver an initial tranche of 2,100 combat helmets in two camouflage patterns to the customer with additional options for a total amount of 8,400 helmets over a five year period.

"Developed over a number of years with extensive SOF community collaboration and feedback, the Caiman helmet system has been tried and tested on operations and is in service across multiple countries, delivering unmatched levels of weight and comfort, and is expressly designed to incorporate electronics, communications headsets, and other critical equipment needs, now and into the future," a company official explained to Armada.

On 8 September, Galvion announced the opening of a European production hub in Gdansk, Poland which was scheduled to become operational by Q1 2024. By the end of 2025, the company estimates it will have nearly 1.5m helmets in service across Europe and NATO nations.

But recognising the evolving battlespace, Galvion also continues to manufacture 'full cut' combat helmets including the Viper A5 which weights up to 2.8lbs (1.36kg) and has been designed to provide protection from blunt force and ballistic trauma.

Given the evolving nature of warfare and the pivot to potential conflict against peer adversaries, some companies are reverting back to combat helmet technologies which retain the over-the-ear ballistic protection. Examples include Indian company MKU which unveiled its latest combat helmet offering to the world at the Milipol exhibition in Paris on 15 November 2023.

According to defence officials, the Indian company has been attempting to reverse these current preferences for MICH technologies through the upgrade of legacy Advanced Combat Helmet (ACH) designs through optimised manufacturing processes and accessories to promote its benefits of increased surface area protection.

Defence sources associated with MKU's inventory of combat helmets said that ACH solutions could more efficiently reduce the effects of Behind Armour Blunt Trauma (BABT)

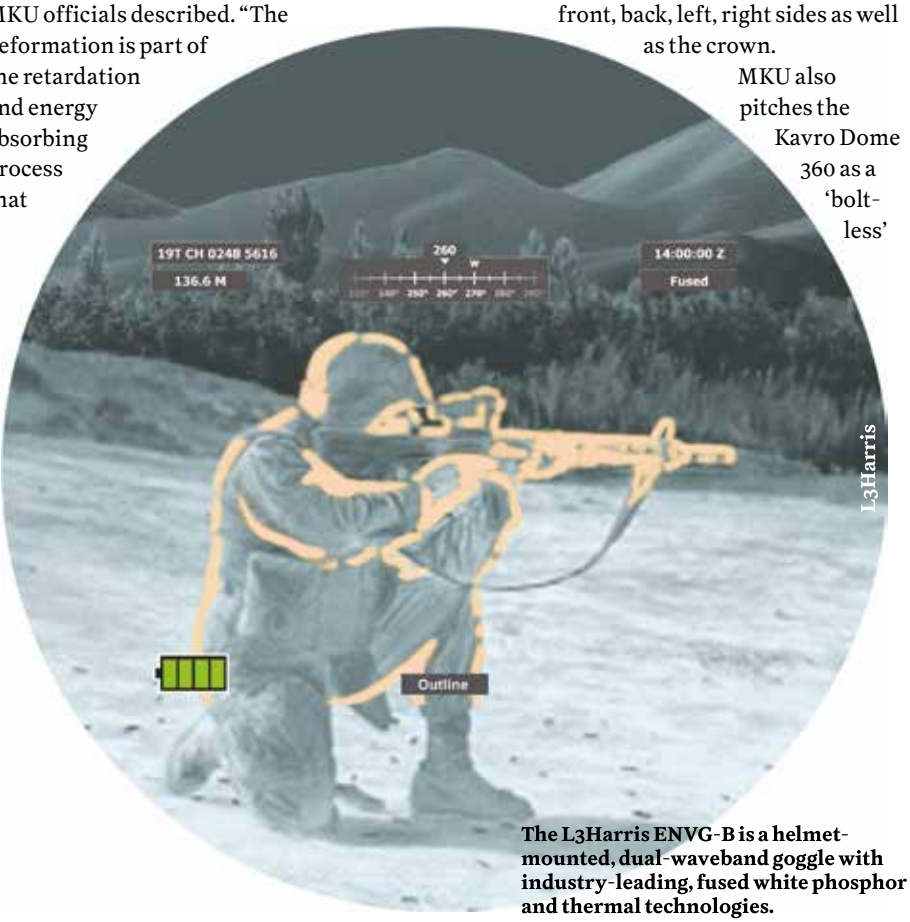
Anywhere between 40 and 90 percent, compared to MICH solutions. Diagnosed as a non-penetrating injury, BABT is often associated with the rapid deformation of body and helmet armour on the body.

"The deformation of the surface of armour in contact with the body wall or head arises from the impact of a bullet or other projectile on its front face," MKU officials described. "The deformation is part of the retardation and energy absorbing process that captures the projectile. In extreme circumstances, the BABT may result in death, even though the projectile has not perforated the armour."

Numerous special operations forces have selected Modular Integrated Communications Helmets such as Gentex's Ops-Core Fast SF High Cut helmet.

The Kavro Doma 360 is designed to protect warfighters from heavier small arm calibres including 7.62x39mm rounds with company officials claiming the combat helmet can withstand five rounds across different areas of the head including the front, back, left, right sides as well as the crown.

MKU also pitches the Kavro Dome 360 as a 'bolt-less'



The L3Harris ENVG-B is a helmet-mounted, dual-waveband goggle with industry-leading, fused white phosphor and thermal technologies.

U.S. Army

A soldier demonstrates the capability of the L3Harris ENVG-B by not having to look at the range directly to aim at his targets. The remote sight of the ENVG-B feeds its image to the advanced combat helmet mount, allowing the soldier to view their target without having to look at it.

combat helmet which does not include any metal parts."When a helmet is bolted, the risk of the bolt penetrating the skull on impact is higher due to weakened areas. Furthermore, there are no rifle-rated bolts at the moment. The Kavro Doma 360 has a bolt-less shell which means it provides 40 percent more protection area against even AK-47 assault rifles than standard helmets," a company statement declared.

Additional features include a back face signature of less than 20mm which measures how a combat helmet deforms or indents on the inside due to the impact of a high energy bullet. "The Kavro Doma 360 absorbs impact, substantially reducing the risk of injury due to resulting trauma to the wearer's head," the statement added.

Furthermore, the new combat helmet system comes with a harness system which is designed to support rotational or angular impacts known to cause concussions or brain injuries, MKU offiicials continued to explain.

Weighing 3.2lbs (1.45kg), the Kavro Dome 360 is designed to feature agnostic accessory technologies including helmet-mounted devices including night vision; communications headsets; masks and mandible protection; and torches.

Describing how the helmet had been in design for five years, MKU's managing director Nerraj Gupta called the new solution as a "transformative leap in protective headgear for high-risk scenarios".

NIGHT VISION SYSTEMS

As the war in Ukraine continues to illustrate, capability to operate in low and zero light conditions remains a critical requirement for the modern warfighter.

Whether helmet-mounted or handheld, night vision devices have traditionally featured Image Intensification (I2) tubes providing the warfighter with a green phosphor sight picture. However, such capability has started to evolve towards white phosphor sight pictures which provide increased levels in contrast, in addition to the fusion of I2 technologies with Infrared (IR) solutions, also referred to as Thermal Imaging (TI).

Examples include the US Army's Enhanced Night Vision Goggle-Binocular (ENVG-B) which is currently in service with dismounted personnel. As Armada went to press, the US Army has received thousands of units with dozens of soldier touchpoints conducted to continue to upgrade the capability in line with emerging demand signals from the customer.

Speaking to Armada, a company spokesperson for L3Harris Communications described how ENVG-B provides the warfighter with "...superior abilities to target, engage and neutralise threats, enhancing mission success and operator safety".

As a helmet-mounted system, ENVG-B provides end users with a white phosphor sight picture with fused I2 and IR technologies when necessary. This, according to the spokesperson, enables the warfighter to benefit from "...real-time, actionable intelligence through the fusion of Image Intensified (I2) white phosphor tubes and thermal imaging".

ENVG-Bs also benefit from augmented reality technology with iconography overlaid sight pictures which enable the warfighter to "keep eyes on target without having to look down to read maps or check radios for critical information", the spokesperson continued.

The official also highlighted how ENVG-B can support more rapid target acquisition, meaning warfighters can "see around corners without risk of exposure" and enabling them to "identify, assess and engage targets with greater accuracy and speed".

"ENVG-B provides targeting and identification in all battlefield conditions as well as light levels including degraded visual environments such as smoke, fog and debris. The goggle includes white phosphor image intensification technology fused with thermal imagery; thereby bridging the gap in performance and capability for both of these sensors.

"This is the [US] Army's first heads-up display that is both day and night capable, fusing white phosphor and thermal vision at the push of a button. This cutting-edge night vision technology includes an embedded Inner Soldier Wireless Network to deliver real-time video and target asset information within the goggle display which interfaces with the US Army's Nett Warrior programmes," the spokesperson concluded.

Elsewhere, the US Army awarded Leonardo DRS a $134m contract for ongoing production of its Family of Weapon Sights-Individual (FWS-I) on 6 November 2023.

The weapon-mounted, clip-on sight connects "wirelessly to helmet-mounted vision systems including the ENVG-B

and the next-gen integrated visual augmentation system (IVAS) and provides rapid target acquisition capabilities to the soldier. It gives users the ability to acquire targets day or night and in smoke or fog, which provides strategic and tactical advantages to the soldier," according to a company statement.

"The FWS-I combines rugged, lightweight, modular construction with thermal imaging technology to give today's warfighter the capability to maintain uncompromising performance in day or night and in smoke or fog, significantly increasing survivability and decisive operations on the battlefield.

"The Rapid Target Acquisition (RTA) capability enables rapid offensive targeting during Close Quarters Battle (CQB), in all battlefield conditions, by reducing target acquisition and engagement timelines, without the use of active lasers," the statement continued.

According to Leonardo DRS, the FWS-I provides 1x-3x magnification and can be used as a standalone or in-line weapon sight, the latter of which would see it lined up ahead of a day view optic or DVO.

Members of Ukrainian SOF and conventional units rely heavily upon helmet-mounted night vision devices to 'own the night' against their peer adversary, Russian Armed Forces. This image illustrates a variety of Modular Integrated Communications Headsets and Night Vision Goggles including L3Harris Corporation's Ground Panoramic NVGs.

LOOKING AHEAD

According to L3Harris officials, the company continues to work towards its 'Shooter-as-a-Sensor' concept which features a mix of its night vision, intelligence-gathering and connectivity solutions including ENVG-B and Ground Panoramic Night Vision Goggles (GPNVGs).

Company sources describe how the concept helps dismounted warfighters to identify and share points of interest on the battlefield; view and exploit overhead feeds from uncrewed aerial vehicles as well as tactical ground vehicles.

"All this information can be provided to the warfighter who is also collating data in real time and receiving spot reports from sensors on their own weapon system, meaning information flowing quickly and accurately around the battlefield," the company source suggested to Armada.

Benefits, the source added, included more rapid decision making, increased survivability and greater levels in lethality-particularly applicable when engaging with highly capable, peer adversaries.

As a result, L3Harris officials described how the company continues to update its ENVG-B capability with improved machine learning and artificial intelligence algorithms in addition to ongoing improvements in size, weight and power specifications to reduce the physical burden of sensor systems.

Finally, the company is in the process of rolling out its Mission Augmented Vision Information System (MAVIS) which essentially provides all the benefits of ENVG-B and other fused night vision devices but in daylight conditions. The see-through and flip-down MAVIS sight (which could either be a monocular or binocular design) presents positioning and navigation icons to the dismounted warfighter, thereby negating any requirement to wear night vision goggles in daylight conditions.

Weighing less than 2lbs (1kg), MAVIS is supported by a smart battery pack and integrated user control solution which runs on WiFi or Bluetooth and can be attached to the rail adaptor system of a personal weapon system.

"MAVIS can show the warfighter waypoints and the direction they are facing in addition to projecting routes to target. So that's where we see the benefit of this capability allowing the warfighter to move faster without conducting compass and map checks. So the speed of going from one place to another, we see as being a huge increase," said a representative.

"MAVIS's unobtrusive display technology minimises visual and mechanical obstructions, providing intuitive visualisation of mission-specific data to reduce cognitive burden. It's not a kind of ski goggle solution which can fog up and be claustrophobic. This is meant to be something lighter that that can be moved out of the way so the warfighter can use it as and when they need to or want to," it was added.

"Depending upon customer requirements, it could operate directly off an ENVG-B battery pack so it wouldn't need a separate processor. Moving forward, we would like to have a universal processor and battery pack for all of the visual augmentation systems that the helmet may be hosting," the source said.

L3Harris confirmed it is continuing to improve MAVIS with technology areas of interest ranging from extension of battery life through to user interface improvements and optimised ergonomic features. L3Harris said MAVIS had successfully achieved Technology Readiness Level 7 by the end of 2023. A

A DIFFICULT TRUTH

"You didn't pay? You're delinquent? ... No, I would not protect you, in fact, I would encourage them to do whatever they want. You gotta pay." Mr. Trump was sharing his response to a question asked by an undisclosed NATO leader as to whether the US would help that country if attacked by an aggressor.

As a NATO member the US is subject to Article 5. This clause of the 1949 Atlantic Treaty, NATO's constitution, clearly states that "(t)he Parties agree that an armed attack against one or more of them ... shall be considered an attack against them all." The US remains the only country to have triggered Article 5 which she did in the wake of the 11th September 2001 attacks against New York and Washington DC.

Along with Article 5 NATO has a non-binding stipulation that all members spend two percent of their Gross Domestic Product (GDP) on defence. Some do, some don't, and the inability of a coterie of nations to pay above this threshold is a perennial bugbear. Taken together NATO's European members pay an average of 1.9% of their GDP on defence according to the alliance's own figures for 2023. Not quite the two percent target, but not far off. Moreover, defence spending levels across the alliance are set to rise this year driven in no small measure by the threat from Russia.

Since Mr. Trump's comments, there has been speculation in the media about whether Europe could go it alone if the US quits the alliance under his watch should he become president in November. This is only part of the issue. Europe is home to capabilities that the US relies on for her protection and these are evident in the electromagnetic domain.

The PAVE PAWS ballistic missile early warning radar at the Royal Air Force's base at Fylingdales, northeast England, feeds radar imagery into the US Ballistic Missile Early Warning System (BMEWS). Fylingdales would be one of the first radars to see any incoming strategic nuclear attack against the US coming from Russia providing important early warning time. Rota naval base in southern Spain hosts US navy warships providing radar coverage and missile protection against ballistic missile attack. These ships form part of the NATO missile defence system. As well as protecting NATO members, the ships help feed information into the US BMEWS infrastructure. Turkey hosts an AN/TPY-2 radar which watches for ballistic missile launches from Iran. Iranian missiles maybe directed against US targets and interests in the Middle East. US Air Force F-16CJ Viper Weasel air defence suppression aircraft are based in Germany. Not only do these help protect NATO's European members but they are much closer to the action if they are needed in the Middle East or Africa. These are just a handful of the European capabilities the US relies on. Would a US withdraw, or downsizing of her commitment to NATO bring a response in kind from the alliance's European members?

The reality is that any wavering commitment to NATO by any future US administration risks being as strategically damaging to America as it is to Europe. Something to think about as the campaign season gains momentum on the other side of the pond.

by Dr. Thomas Withington

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EW ROUND-UP: MARCH SITREP

March Spectrum SitRepArmada's monthly round-up of all the latest electronic warfare news in the product, programme and operational domains.

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22 REASONS WHY

The Taiwanese military is to receive a major communications enhancement following approval by the US State Department of the potential sale of the Link-22 Tactical Datalink (TDL). The news was announced in late February. Link-22 is an enhancement of NATO's erstwhile Link-11 tactical data link which is mainly used to support naval operations. The datalink is slowly being rolled out across several NATO and allied nations and will eventually replace Link-11 in the early 2030s.

It is noteworthy that the US has also decided to furnish Taiwan with Link-16 which is chiefly supports air operations. The acquisition of both Link-16 and Link-22 by the Taiwanese military has important implications for the threatscape in east Asia. First, it will significantly improve the networking and synergy of Taiwan's armed forces. Second, it will help network the country's military to those of regional allies, notably the United States, Australia and Singapore, among others. Both these factors are important as Taiwan continues to face an existential threat from the People's Republic of China (PRC).

Previous US- and NATO-led conflicts in the Balkans, Iraq and Libya, and ongoing operations in the middle east, have underscored the important contributions TDLs like Link-16 and Link-22 can make. Achieving overmatch with the PRC is as much a question of technology as it is a question of materiel quantity. Providing Taiwan with the latest communications technology being fielded across the US and allied militaries exemplifies this reality. It also sends a powerful message to the PRC: Washington will not only protect its allies but ensure they can fight in a synergistic fashion.

by Dr. Thomas Withington

TACTICAL RADIO & C2 SYSTEM.

Bowman's life to be extended ... again!
The UK MOD's saga to replace the Bowman tactical radio and C2 system used by British land forces enters a new chapter.

DRONE COMMUNICATION

Clear Channels.
An innovative approach to radio communications promises to enhance the survivability of Ukrainian uninhabited aircraft in a conflict increasingly characterised by the widespread use of UAVs.

RUSSIAN FPV DRONES

Check the Manual
Armada has obtained a Russian language military manual providing guidance on tactical first person view uninhabited aerial vehicle employment by Russia's land forces.

MARCH RADIO ROUNDUP

Armada's monthly roundup of all the latest news in the military communications product, programme and operational domains. This month: DPAAS Evolves, New Radio Support ACE Concept, SATCOM Terminals.

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