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4/2022

International Security and Defence Journal

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April 2022 • www.euro-sd.com • ISSN 1617-7983

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EU, NATO and Ukraine

Photo: author

Beyond the extension of sanctions, the EU, in an unprecedentedly swift and unanimous response to the Russian war on Ukraine, decided to provide Kiev with military assistance totalling one billion euros. On 28 February, the Council already took the relevant decisions for two assistance measures under the European Peace Facility in support of the Ukrainian armed forces: a €450M package for military equipment and platforms for the use of lethal force, and a €50M package to finance supplies such as fuel, protective equipment and emergency medical care. The proposal by High Reptresentative Josep Borrell for a further €500M euros was endorsed by the heads of state and government at the informal summit in Versailles, 10 and 11 February. For the first time in its history, the EU is now using a special, albeit extra-budgetary, instrument to finance lethal military equipment for a third country. Delivery is the responsibility of member states. Even earlier, on 2 December 2021, the decision was taken to provide €31 million for non-lethal assistance measures to Ukraine. The European Union Military Staff (EUMS) plays the role of a clearing house to coordinate supply and demand. With member states and with partners (Australia Japan, Canada, New Zealand, Norway, the USA, the United Kingdom and South Korea), Ukrainian needs are matched.

And so European sovereignty, Emmanuel Macron's catchphrase for the French presidency, is sailing upwind. Albeit differently than expected. Originally, the French president was committed to economic, industrial and military sovereignty, almost autonomy. In Versailles, the member states committed themselves to greater military and economic independence as well as to the geopolitical significance of digital sovereignty. And they committed themselves to a readjustment of defence policy. Consequently, the Neue Züricher Zeitung asks - very much in the spirit of Macron: Will Putin, with his Ukraine war, become the midwife of a European military union? At the seat of the Sun King, the 27 surprised with their decisiveness and unity. Is the EU, which has so far tended to rely on soft power, a (global?) power factor after all?

But even as the heads of state and government congratulate themselves for their quick and tough reactions to the tectonic changes in Europe, scepticism remains as to what the measures will achieve. While arming Ukrainian fighters and strangulating Russia's economy, the question remains how to end the war. The West's options to end the conflict are limited. The reactions of the US, NATO and the European Union are driven by the hope of getting Russia out of Ukraine. On the other hand, there is no reason to believe that President Putin will be shaken in his determination to bring westernised Ukraine, 'his' former Soviet republic and the cradle of Russia, into Moscow's sphere of influence. He has formulated his minimalist goal, a surrender. Neither the high economic toll nor the military losses seem to dissuade him. In contrast, the West, EU and NATO, does not want to take any risks in defence of a non-member.

Yet Russia and Europe are interrelated. We Europeans cannot be indifferent to the fate of our neighbouring nuclear power.

In the meantime, Evere is not only looking for a new host. They are also looking for the reset button. Comments about the overdue review of strategic priorities and structures are mounting. The war waged by Russia in Ukraine makes the overdue realignment obvious. Observers have already noted that NATO has struggled to adapt to hybrid conflicts and warfare in cyberspace. Long before the Russian troop surge, Ukraine was exposed to cyber attacks. At horrendous cost. But the reorientation should go further: the possibilities of nuclear and conventional deterrence should be put to the test. After all, the attack on a non-member country on the borders of NATO (and the EU) shows that the concept of conflict de-escalation or escalation does not meet the requirements of the 21st century. Europe, including NATO Europe, will have to face uncomfortable questions in order to establish NATO as a European institution to which the US contributes.

Hans Uwe Mergener

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Lockheed Martin/IAI Air Defence Partnership

(jh) Lockheed Martin and IAI have agreed to partner to jointly promote a Ground Based Air Defence (GBAD) system centred around

Photo: IAI

the Lockheed Martin United Kingdom SkyKeeper and the BARAK MX system, the companies write in a press release. As part of the partnership, Lockheed Martin and IAI intend to promote their technological and manufacturing expertise in air defence solutions. This new cooperation is a direct result of a Memorandum of Understanding (MoU) signed between the companies in July 2021 and after a review of relevant business opportunities.

Oliver Burkhard New CEO of Thyssenkrupp Marine Systems

Photo: Thyssenkrupp Marine Systems

(jh) In an extraordinary meeting today the Supervisory Board of Thyssenkrupp Marine Systems appointed its former Chairman Oliver Burkhard as the new CEO of Thyssenkrupp Marine Systems, the company writes in a press release.Oliver Burkhard will take up the role on 01 May 2022 and perform it from his position as Executive Board member of Thyssenkrupp AG. The dual role - CEO of a unit and member of the Executive Board of Thyssenkrupp AG - reflects the importance of Marine Systems for the Thyssenkrupp Group. With this decision, Marine Systems will be directly represented on the Executive Board of Thyssenkrupp AG. At the same time the aim is to achieve greater independence for the businesses in the "group of companies" in the long term. This will allow all meaningful options for Thyssenkrupp Marine Systems to be resolutely pursued. Oliver Burkhard succeeds Dr Rolf Wirtz, who will remain with the company as a consultant. With the appointment of Oliver Burkhard, the chairmanship of the Supervisory Board of Thyssenkrupp Marine Systems has passed to Dr. Klaus Keysberg, CFO of Thyssenkrupp AG. In his role as member of the Executive Board of Thyssenkrupp AG, Burkhard was responsible for the Marine business since 2018 and Chairman of the Supervisory Board of Thyssenkrupp Marine Systems GmbH since 2017.

Rheinmetall Achieves Record Figures in FY 2021

Photo: Rheinmetall

(jh) Rheinmetall continued on its profitable growth trajectory and closed fiscal 2021 with record figures, the company announced in the scope of its press conference on annual results. New record highs were set for both the operating result and operating free cash flow. Thanks to high-volume major orders from military customers and because international automotive manufacturers were awarding more contracts again, the order backlog is also at an all-time high. Consolidated sales increased mainly in the civilian business, which was characterised in 2021 by increasing demand in the global automotive industry. Rheinmetall forecasts continuing sales and earnings growth for fiscal 2022. In the altered security policy situation, the group considers itself to be in an auspicious position to play an important role in the imminent increase in defence capabilities with military products in Germany and partner countries. Armin Papperger, Chief Executive Officer of Rheinmetall AG, comments: "Rheinmetall is on a very good course. Thanks to the strategy program concluded in 2021, we have completed the development into an integrated technology group in organizational terms. This is now paying off: For the first time, we have generated a record operating margin of more than half a billion. We are very proud of this achievement, which is based on all five of our divisions."

Changes on Hensoldt's Management Board

(jh) Hensoldt AG has announced changes on its management board. In the course of long-term succession planning, the supervisory board has approved the early termination of the appointments of Axel Salzmann (CFO) and Peter Fieser (CHRO) as members of the management board by mutual agreement. Axel Salzmann will leave the management

Photo: HENSOLDT

board on 30 June and Peter Fieser on 30 September. Each of them will subsequently remain available as advisors to the company for a further three months.
The current Head of Group Controlling & Investor Relations, Christian Ladurner, is to take over as CFO on 1 July. Peter Fieser will be succeeded by Dr. Lars Immisch, currently Executive Vice President HR of Airbus Defence and Space, who is planned to take office as of 1 October 2022.

Pearson Engineering Sets Out Asia-Pacific Growth Plans

(jh) Pearson Engineering has established a new Singaporean entity to support ongoing opportunities across the Asia-Pacific (APAC) region. Following a number of significant projects in the region, including in India, Australia and the Republic of Korea, Pearson Engineering has taken the step of opening Pearson Engineering Singapore in order to further develop future business, the company writes in a press release.

Photo: Pearson Engineering

The APAC Office will be headed up by Pearson Engineering's experienced Business Development Manager David Addy, in a new role of Regional Manager APAC. According to Pearson, the company has exported equipment around the world since 1985 with approximately 90 per cent of turnover attributed to overseas sales in the last five years.

Expal Signs Saudi MoU

(jh) Expal Systems has announced a Memorandum of Understanding (MoU) with Saudi Chemical Company Holding (SCCH) through

its subsidiary Saudi Chemical Company Limited for the localisation of ammunition filling. The objective of this MoU is for both companies to define a joint business model to localise the filling of artillery products in order to improve the service to the Saudi Armed Forces through the integration of supply chains and production capabilities. With this agreement, Expal aims to increase

Photo: Expal

its local presence in the Kingdom of Saudi Arabia in alignment with the Vision 2030 goals, the company writes in a press release. This announcement was made at the World Defence Show 2022, where EXPAL was present as an exhibitor.

Rheinmetall Plans LYNX Production Facility in Slovakia

(gwh) A production facility for the LYNX KF41 Infantry Fighting Vehicle (IFV) is planned to be built in Moldava nad Bodvou in eastern Slovakia near the Hungarian border, where other combat vehicles can also be overhauled. At a press conference on Thursday, Rheinmetall announced details of the plans. A production area with 12,000 m² and a test area with 15,000 m² are to be built for €30M. The plant is to be the centre of a widespread Slovakian partner network of Rheinmetall, which extends across the entire country, Rheinmetall announced. Together with the partners, the plant will be used to manufacture chassis and turrets for the LYNX IFV, system integration and acceptance tests. Rheinmetall's joint venture with the DMD Group is in charge of production, which is to have Slovak defence industry participate in response to respective offset and compensation requirements. The priority task of the plant will be the production of 152 LYNX KF41 for the Slovakian Army. The Slovak Ministry of Defence intends to replace the obsolete Soviet-era BVP-2 fleet at a cost of €1.7Bn. Rheinmetall, together with the Hungarian Government, submitted a competitive bid for the project, which is planned to be based on a government-to-government MoU.

Photo: Rheinmetall

Beretta to Acquire RUAG Ammotec

(jh) RUAG International has concluded an agreement on the sale of its Ammotec business unit to the Beretta Holding, RUAG writes in a press release. As envisaged by the Swiss Federal Council, the Ammotec division will be divested – with site assurance for Thun and transfer of all employees. The closing of the transaction is subject to regulatory approvals. The parties have agreed not to disclose any financial terms. As envisaged by the Swiss Federal Council in its divestment strategy, RUAG International's small-calibre ammunition business will be sold. The decision was made in favour of the Beretta Holding, taking into account all conditions made by the Swiss Federal Council. The Beretta

Photo: esut.de

Holding will take over all 2,700 employees at all production and sales sites. The Beretta Holding has committed itself to maintaining the Thun site with around 400 jobs for at least five years.

Rheinmetall Italia and MBDA Italia Sign MoU to Cooperate in Air Defence

(jh) MBDA Italia and Rheinmetall Italia have signed a Memorandum of Understanding to explore possibilities for collaborating in the area of air defence, including disruptive technologies in the national and European defence funds domain, Rheinmetall writes in a press release. During a two-year timeframe, the two companies intend to study ways of working together with the objective of developing joint business opportunities in Italy and the international marketplace. MBDA Italia and Rheinmetall Italia plan to create joint working groups tasked with identifying

Photo: Rheinmetall

possibilities for joint technological development and business opportunities.

RUAG Expands Maintenance Capacity for Helicopter Components

(jh) RUAG is strategically targeting new markets in the helicopter sector and investing in optimising the maintenance of dynamic components. The upcoming investments in the future of the dynamic component workshop at the Alpnach site are expected to improve planning, adherence to schedules and reliability of maintenance work, the company writes in a press release. At the Alpnach site, the overhaul of dynamic components for the SUPER PUMA, AS332 and AS532 MKI is one of the core competencies at this location. Improving throughput times in the component shop and the availability of spare parts needed at short notice are believed to be success factors for ensuring the shortest possible delivery times. By optimising internal processes and ensuring the availability of exchange parts and components, this key requirement is expected to be met better in the future. The groundbreaking ceremony for the new rotor blade shop took place on 11 February 2022. From the end of summer 2022, the building is to be ready for rotor blade maintenance.

Photo: RUAG

Overhaul of PzH 2000 SP Howitzers for Lithuania Completed

(gwh) The NATO Support and Procurement Agency (NSPA) delivered the last overhauled PzH 2000 self-propelled howitzer to the Lithuanian Armed Forces in mid-March. According to NSPA, a joint project team from

Photo: NSPA

NSPA and the Lithuanian Armed Forces led the procurement project. This included the implementation of a new fire control system as part of the howitzer overhaul, as well as the integration and procurement of new sensors and optronic systems for the observers and tactical air surveillance units. In addition, the associated M577 command post vehicles and BERGEPANZER 2 armoured recovery vehicles were adapted and modernised. Last but not least, the required ammunition was also procured. The PzH2000 is a self-propelled howitzer with the NATO standard 155 mm cannon. Modern ammunition allows for a firing range of more than 50 km. In 2015, Lithuania acquired 21 PzH2000s from German Bundeswehr stocks, 16 of which are intended for combat, two for gunnery and driving training and three for spare parts cannibalisation. In addition, 26 M557 command post vehicles (based on M113) and six BERGEPANZER 2 armoured recovery vehicles (based on Leopard 1) were procured.

CH-53K on Course for Operational Readiness

(gwh) The US Marine Corps' CH-53K programme reached an important milestone in early March. The project phase "Initial Operational Test and Evaluation" (IOT&E) was successfully completed, as the manufacturer Lockheed Martin announced. This has created an important prerequisite for achieving Initial Operational Capability (IOC). To meet this criterion, the squadron must have four CH-53K helicopters with combat-ready personnel, as well as support equipment, including spares, repair support and training curriculum. During the IOT&E phase, the helicopter underwent intensive testing in numerous Marine Corps-specific missions under battlefield conditions. According to Naval Air Systems Command (NavAir), these included operations in degraded visibility conditions, take-offs and landings from and on naval vessels, ramp and door firing, and aerial refuelling of helicopters both day and night. In a second phase of the IOT&E, the helicopter will be further tested to gather insights as the basis for a full assessment of the survivability of the CH-53K against operational threats. The requested funding of US$257M has been allocated for this purpose. Approval for series production is expected in November, followed by crossing the Full Rate Production (FRP) threshold in May 2023.

Photo: USMC

Elbit Awarded Ammunition Contract from Sweden

(jh) Elbit Systems has announced that it was awarded a contract in the amount of approximately $27M by the Swedish Defence Materiel Administration, to provide the Swedish Armed Forces with M339 rounds, a 120mm ammunition, and data setting units, for its LEOPARD Main Battle Tanks (MBTs). The contract will be performed over a period of ten months. Suitable for all NATO 120mm smooth bore gun MBTs, the M339 is a high-accuracy, multi-purpose 120mm tank ammunition that complies with the applicable standards of the US Military and NATO, Elbit writes in a press release. The Swedish Armed Forces selected the M339 to improve the firepower and the ability of the battle tanks to engage different types of targets.

Photo: Elbit Systems

Kongsberg to Supply Air-to-Air Pylons for the F-35 Programme

(jh) Kongsberg Defence & Aerospace AS has signed an agreement with Marvin Engineering (MEC) worth 240 MNOK to supply air-to-air pylons for the F-35 Joint Strike Fighter programme, Kongsberg writes in a press release. The agreement covers the next three production lots (15-17) for all variants of the aircraft.

Photo: Kongsberg

Indra Delivers Mobile Laboratory to the Spanish Army

(jh) Indra has delivered an advanced mobile chemical analysis laboratory to the Spanish Army that is to provide increased security for Spanish soldiers, allow for the protection of the civilian population in international conflicts, and increases response capabilities in case of an industrial accident in Spanish territory, the company writes in a press release. The 1st CBRN Defence Regiment "Valencia" is responsible for deploying in the area of operations and establishing a rapid alert system in the case of nuclear, biological or chemical attacks. While these weapons are prohibited, they have nevertheless been detected in various international situations and terrorist attacks in recent years. Until now, this specialised army unit has been operating mainly with VAMTAC (high mobility tactical vehicle) reconnaissance vehicles and BMR 6x6 armoured vehicles suitably adapted for the mission with Sampling and Identification of Biological, Chemical and Radiological Agents (SIBCRA) equipment. The new mobile chemical laboratory is equipped with advanced instruments and mounted on a military truck that ensures maximum mobility and the ability to travel to the area of interest, according to Indra.

Photo: Indra

Lockheed Martin Joins Team Thunder

(jh) Lockheed Martin UK has signed a teaming agreement to join "Team Thunder" led by Hanwha Defense, the latter writes in a

press release. The team, which also includes Pearson Engineering, Horstman Defence Systems, Leonardo UK, and Soucy Defense of the Soucy Group, will build an advanced variant of the K9 Self-Propelled Howitzer for the Royal Artillery, as part of the Mobile Fires Platform (MFP) programme for the UK Ministry of Defence (shown is the K9A1). Team Thunder plans to locally manufacture the K9A2, creating hundreds of new highly-

Photo: Hanwha Defense

skilled jobs across the UK supply chain. The advanced version will be an upgrade of the existing 155mm/52-calibre K9A1 Self-Propelled Howitzer, as it is to feature improved lethality, mobility and survivability.

TechNet 2022 – Peering into the Crystal Ball

(jh) At TechNet International 2022, AFCEA Europe welcomes interested parties to a forum for the ethical exchange of information and knowledge sharing across Europe and various domains in the field of IT in defence and security, the organisers write in a press release. With the objective to foster the relationship between NATO, EU, industry, and academia, AFCEA Europe organises TechNet International 2022 as an in-person event on 17 – 18 May 2022 in Brussels, Belgium under the title "Peering into the Crystal Ball - New Trends in Defence and Security IT". Among many other topics, Cyber Security, C4ISR, Data Analytics, Cloud Services, Emerging Technologies, Edge Computing, Mobile CIS solutions, and Quantum will be discussed with representatives of the Brussels-based NATO and EU institutions. TechNet International 2022 Expo & Forum expects to host specialists from national governments, defence and security bodies, NATO and EU, as well as industry and academia. More information: https://eu.eventscloud.com/website/7015/, https://www.afcea.org/europe

Logo: AFCEA Europe

Lockheed Martin Delivers the 500th C-130J

(gwh) Lockheed Martin has delivered the 500th C-130J SUPER HERCULES airlifter, 26 years after the version's first flight. The user of the jubilee aircraft is the 130th Airlift Wing in Charleston, West Virginia, which is currently converting its inventory of C-130s to C-130Js. The C-130J is the current production model of the legendary C-130 HERCULES, Lockheed Martin writes The global C-130 fleet is in service with 26 operators in 22 countries and has logged more than 2 million flight hours. According to Lockheed Martin's description, compared to the C-130 HERCULES, the C-130J has significantly improved all performance metrics. Most notably, payload and range have been increased while fuel burn has been reduced. Other features include digital avionics and reduced crew.

Photo: Lockheed Martin

KAPLAN MT Medium Tank Production Completed

(jh) The KAPLAN MT Medium Tank Project is based on a government MoU between the Turkish SSB procurement agency and the Ministry of Defence of Indonesia.

Photo: FNSS

In 2015, a corporation agreement was signed with the objective to develop two prototype vehicles. Within the scope of the project under the KAPLAN MT (HARIMAU) Medium Weight Class Tank Serial Production Long-Term Collaboration Agreement signed between FNSS Savunma Sistemleri A.Ş. and PT Pindad in 2019, FNSS has completed the production of the first batch of vehicles in serial production configuration. Following the KAPLAN MT Medium Tank Platform Production Completion Ceremony held in FNSS' facilities, all tank platforms will be shipped to Indonesia for final turret assembly and deliveries to the Indonesian Army after final acceptance.

Germany to Purchase F-35

(jh) German Defence Minister Lambrecht has announced plans to procure F-35 stealth fighters to replace the Luftwaffe's old TORNADO Multi-Role Combat Aircraft Fleet. The decision has been in the

Photo: German MoD

pipeline for some time, but it is also understood as a response to the new threat environment resulting from the war in Ukraine. This acquisition effort is expected to be the first major procurement project after the Russian attack on Ukraine. Up to 35 aircraft from US manufacturer Lockheed Martin are planned, as Defence Minister Christine Lambrecht confirmed corresponding media reports in Berlin. Lt Gen Ingo Gerhartz, Chief of the German Air Force said, "The F-35 is the most modern fighter aircraft in the world, and many of our European partners have also chosen this aircraft. It strengthens our ability to work with them to secure NATO air space and defend the Alliance. With the F-35, we are procuring a marketable 5th generation fighter aircraft". Observers assume that Germany will receive the most modern Block 4 version, which is also intended for Finland. While the F-18 SUPER HORNET would have to be specially certified to carry nuclear weapons for Germany, the US Armed Forces have already earmarked this role for the F-35. As a statement from the US Department of Defense indicates, the certification process is to be completed in time for the nuclear sharing capability to be available to NATO partners from January 2024. For this reason, the so-called design certification date has been brought forward to January 2023. The test programme required for certification is intended to ensure that the F-35A can safely transport and deliver a B61-12 thermonuclear free-fall bomb to the target.

Safran to Supply Optronics to the Australian Defence Force

(jh) Safran Electronics & Defense Australasia has announced that it has been awarded a contract by Collins Aerospace to provide portable optronics to the Australian Defence Force (ADF) as part of the LAND 17 Phase 2 Digital Terminal Control Systems

Photo: Safran – A. Daste

(DTCS) Capability Assurance Programme, the company writes in a press release. Safran is to complete delivery of this equipment by mid-2023. Safran's JIM Compact, MOSKITO TI and STERNA systems, along with tripods, will all be integrated by Collins Aerospace into the ADFs next generation DTCS. Safran offers a portfolio of portable optronic products, including multi-spectral binoculars, target locators and laser rangefinders, all deployed worldwide by Joint Fires Observers (JFOs), Joint Terminal Attack Controllers (JTACs) and special forces, the company emphasises.

MILDS Block 2 for German C-130Js

(jh) In the scope of the procurement effort for three Lockheed C-130J-30s and another three KC-130J SUPER HERCULES aircraft, the German Bundeswehr has decided to equip all aircraft with Hensoldt's defensive sensor technology, the company writes in a press release. With MILDS Block 2, Hensoldt is to supply a total of 35 sensors (five per aircraft and five units for lab use) to the Danish company Terma A/S, which is managing the integration of the systems at Lockheed Martin through Terma Inc. The contracts, with a scope of €2.9M were signed in 2020.

Photo: Hensoldt

So far, 20 sensors and desiccant-kits have already been delivered. By January 2023, the remaining 15 sensors are scheduled for delivery. The first SUPER HERCULES for the German Air Force was handed over in Évreux/Fauville (France) on 19 February 2022 to the Franco-German air-transport squadron. MILDS Block 2 is a passive, true imaging sensor system optimised for detecting emission signatures in the UV solar blind spectral band emitted from an approaching missile exhaust plume. The sensor is designed as the successor to the MILDS AN/AAR-60, offering increased sensitivity and additional applications.

Hensoldt to Supply EO/IR System

(jh) Hensoldt has received an order from aerial services provider QinetiQ GmbH, Mönchengladbach, Germany, to supply two complete systems for electro-optical reconnaissance, the company writes in a press release. The reconnaissance system consists of the ARGOS-II HD Electro-Optical Infrared System (EO/IR) and the EuroNAV control and evaluation software. These elements will be pre-integrated by Hensoldt and scaffolded by QinetiQ for ISR Services and training of national and international JTAC customers and operators with the DA62MPP aircraft

Photo: Hensoldt

manufactured by Diamond Aircraft Industries, Austria. According to Hensoldt, the mission system designated MissionGrid can be used on fixed-wing aircraft, helicopters and UAVs. In addition to air and naval forces, it is used for border protection, search and rescue, maritime patrol, law enforcement and asset protection. The German Federal Police use it to combat smuggling, illicit trafficking and border security operations. The reconnaissance system covers a range of up to 40 km and can detect ships as well as small inflatable boats or individual swimmers day and night as well as in bad weather. A thermal imaging camera records the images and transmits video and data in real time to base stations on the ground. The MissionGrid system can also be supplemented with the PrecISR reconnaissance radar, as well as the Hensoldt self-protection equipment AMPS.

Artificial Intelligence – Teledyne Flir Introduces CONSERVATOR

(jh) CONSERVATOR is a new cloud-based Data Lifecycle Management (DLM)-application designed to optimise the evaluation of data records. It provides access to an annotated library of infrared and visible data for training neural networks and working with

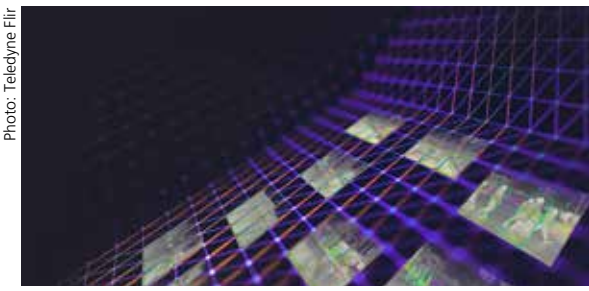


Photo: Teledyne Flir

data models, the company writes in a press release. CONSERVATOR enables the development of data sets that developers can use to train neural networks with thermal imaging data in the infrared and visible range. Subscribers to the software also gain access to application-specific sections of Teledyne Flir's annotated image database, which – according to the company - includes more than one million images with more than 100 object label categories. CONSERVATOR was designed in response to the needs of data scientists in the automotive, defence, security and smart cities sectors. The application is said to be scalable to support corporate AI development teams in the research and development of object recognition models.

John Cockerill Introduces COCKERILL i-X

John Cockerill used the World Defense Show 2022 in Riyadh, Saudi Arabia, to unveild the COCKERILL i-X ("i" for "interceptor" and "X" for "modular") weapon systems. According to the company, COCKERILL i-X is the first ever ground interceptor designed for territorial defence interception to engage and defeat incoming threats before they reach their target.

Photo: John Cockerill Defense

The vehicle is capable of moving at very high speeds on-road and off-road (with a thermal or hybrid thermal-electric drive train), the company writes in a press release.

Signature management capabilities include adaptive camouflage, and modification of IR and acoustic signature. Reportedly, the system integrates multi sensor data fusion technology, acoustic gunshot detection and localisation, and can integrate a variety of weapons including 25mm and 30mm guns, missiles, and rockets.

New TI Cameras from Vected

(jh) Vected has introduced two new thermal imagers, the 640-50 and 640-60. The devices are suitable both as observation devices as well as attachments in front of a riflescope or as target devices for mounting on a weapon alone, the company writes in a press release. Operating in the 8 to 14 µm (LWIR) range, the devices have fields of view of 8.8° x 6.6° / d 11.0° (50s) and 7.3° x 5.5° / d 9.1° (60s), which are projected onto a 640×480 respectively 1280×960 pixel display. With a sensor NETD of less than 40 milli-Kelvin, the uncooled, compact devices, weighing less than 600g, are highly sensitive and can detect people at distances of up to three kilometres. Both devices feature USB-C interface for charging or outputting live video to an external monitor, can take photos and videos and store them internally, and optionally communicate via Bluetooth or Wifi.

Photo: Vected

ARROWHEAD 140 Selected for MIECZNIK

(hum) Babcock's ARROWHEAD 140 design has been selected as the preferred solution for the Polish MIECZNIK frigate procurement effort. This was announced by the Polish Ministry of Defence via twitter on 4 March 2022. The consortium responsible for the construction, led by holding company Polska Grupa Zbrojeniowa (PGZ), announced that "strategic cooperation agreements" had been signed with Babcock and UK subsidiaries of Thales and MBDA. PGZ added that the signing of the contract; "marks the phase of preparation for production under the programme to acquire three multi-purpose frigates for the Polish Navy". Poland initially plans to build only one frigate from 2023. After commissioning in 2028, the design is to be subject to field testing, following which the test results are to be considered for the construction of the second and third frigates. The MIECZNIK programme is to be completed by 2034. The cooperation agreement between PGZ and Babcock provides for the MIECZNIK units to be built in Polish shipyards with "significant participation of Polish suppliers and Babcock's global supply chain". In addition, Babcock is to continue to support construction in Poland through a licensing agreement after production is completed.

Photo: esut.de

Alongside Babcock International, Kiel-based Thyssenkrupp Marine Systems had been shortlisted for the Polish MIECZNIK (SWORDFISH) frigate procurement programme. The programme, which amounts to about PLN8 Bn (US$2Bn) will replace the two OLIVER HAZARD PERRY-class frigates ORP 272 GENERAŁ KAZIMIERZ PUŁASKI and ORP 273 GENERAŁ TADEUSZ KOŚCIUSZKO. ARROWHEAD 140, 138.7 metres long at a displacement of 5700 tonnes, traces its origins to the Danish IVER HUITFELDT frigate class. With four MTU diesel engines of 8.2 MW each, she is said to reach a speed of 26 knots, and the variant in service with the Royal Navy is equipped with the MBDA SEA CEPTOR surface-to-air system with two vertical launchers, a 57-mm turret and two 40-mm guns. Furthermore, ARROWHEAD 140 is capable of accommodating a helicopter and a UAV. In terms of electronics, Thales UK is to supply the TACTICOS combat system in conjunction with the NS110 3D radar. According to Babcock, the design and planning work now to be taken up for the system integration will be completed before the end of 2022.

Airbus to Develop TIGER MKIII

(jh) On behalf of the French and Spanish procurement authorities, OCCAR has awarded a contract to Airbus Helicopters for the development, production, and initial in-service support of the TIGER MkIII attack helicopter upgrade programme, Airbus writes in a press release.

The contract covers the upgrade of 42 aircraft for France (with the possibility to add another 25 helicopters) and 18 for Spain. In addition, the contract provides the possibility for Germany to later join the TIGER MkIII programme. The first prototype is scheduled for an inaugural flight in 2025. First delivery to the French DGA will take place in late 2029 followed by a first delivery to Spain in 2030. Development and upgrade work will be conducted in Airbus Helicopters facilities in Albacete (Spain), Marignane (France) and Donauwörth(Germany).

The TIGER MkIII standard configuration will include:

- the integration of the Safran STRIX NG sights
- the Thales FlytXavionics suite
- he TOPOWL DD helmet-mounted sight display
- an Indra IFF upgrade
- Thales GNSS
- Safran's inertial navigation system

The communication suite will be upgraded with Thales' CONTACT/SYNAPS radio and data links dedicated to manned/unmanned teaming. Moreover, for Spain Link16 and SATCOM functionalities will be included.

Photo: Airbus

The Spanish TIGER MkIII will be equipped with a battlefield management system and countermeasures provided by Indra, whereas the French aircraft will be equipped with a battlefield management system by Atos and countermeasures provided by Thales. The new weapon package for France will include the MBDA MAST-F (Future Tactical Air-to-Surface Missile) and MISTRAL 3 air-to-air missile. For Spain, new capabilities will include 70mm guided rockets and a new air to ground missile.

MQ-9A Passes Two Million Flight Hours

(jh) According to General Atomics Aeronautical Systems (GS-ASI) the MQ-9A Remotely Piloted Aircraft (RPA) has surpassed 2 million flight hours in support of global customers. When combined with the flight hours of other GA-ASI aircraft, which includes PREDATOR A and PREDATOR XP; PREDATOR B Extended Range (ER), GUARDIAN, GRAY EAGLE and GRAY EAGLE ER; PREDATOR C AVENGER; and MQ-9B SkyGuardian and SeaGuardian, the total flight hours for the GA-ASI fleet exceed 7.2 million sup-


Photo: GA-ASI

porting close to 500,000 missions. GA-ASI aircraft average more than 48,000 hours per month supporting the US Air Force, US Army, US Marine Corps, NASA, the Italian Air Force, the UK Royal Air Force, the French Air Force, the UAE Armed Forces, the Indian Government, and new MQ-9As are being delivered to the Royal Netherlands Air Force now, the company writes in a press release.. Missions include helping protect ground units on the battlefield; supporting first responders in the wake of natural disasters; and providing critical ISR around the world.

More CV90 Mortars for Sweden

(gwh) The Swedish procurement agency Försvarets Materielverk (FMV) has ordered another 20 CV90 mortars from BAE Systems Hägglunds. The vehicles, worth SEK500M (approximately €47M), are to be delivered between 2023 and 2025, the FMV writes in press release. In June 2021 that the Swedish Armed Forces received the last of 40 new CV90 mortar vehicles ordered previously. The turret with the 120 mm mortar can be rotated by 30 degrees to either side. The semi-automatic mortar is loaded and fired by the crew from the protected interior. The mortar is ready to fire within two minutes and ready to move off again one minute after firing the last shot. This high operational speed is an additional protection for the four-man crew with driver, commander and two gunners. The command of the firefight and integration into the command and control system is supported by integration of the Army's new command support system, LSS MARK. Saab is supplying the hardware for LLS MARK, starting this year. Sweden has recently fully modernised its fleet of CV90 infantry fighting vehicles.


Photo: FMV

MCL & IAI Awarded THESEUS Contract

(jh) Marlborough Communications Limited (MCL) and its technology partner Israel Aerospace Industries (IAI) have been awarded a contract to deliver demonstrations of their automated ground and air resupply network as part of Project THESEUS, IAI writes in a press release. This contract is the second contract win for MCL and IAI. Through Project THESEUS the UK Ministry of Defence (MoD) aims to investigate the potential to apply autonomy to the ordering, planning, and delivery of supplies as well as the ability to increase the flow and efficiency of delivery on the battlefield. According to IAI, this will see MCL and IAI define and deliver an end-to-end, automated ground and air resupply network, which is enabled by a logistics information system and operational 24 hours a day, seven days a week, in all conditions. The capability is to be facilitated by land and air robotic and autonomous systems, a mission planner, battlespace management applications and logistics information system to provide tactical last-mile


Photo: IAI

resupply to dismounted forces. The resupply network will incorporate the REX MK-2 uncrewed ground vehicles to provide means of autonomous delivery, as well as uncrewed aerial vehicles and a mission management command control system with autonomous decision-making capability. The solution will also be tasked through a human-portable user interface system, enabling operator intervention if required. The two companies will also have to deliver improvements to the system throughout the contract, with the improvements and final demonstration.

HX 8×8 EXCAVATOR For Military & Civilian Roles

(gwh) By combining two available subsystems, Rheinmetall MAN Military Vehicles (RMMV) and Slovakia's CSM Industry have collaborated to create the new HX 8×8 EXCAVATOR multipurpose vehicle. RMMV contributed the 8×8 chassis from the HX series for mobility. The military-off-the-shelf vehicle is designed for the toughest military operations and offers excellent mobility even in demanding terrain, Rheinmetall describes the vehicle. The company sees combat engineer and disaster relief forces as potential users. The vehicle, which weighs 28 tonnes including crane, is powered by a 387 kW engine. According to Rheinmetall, it can reach a top speed of 90 km/h on the road. Overcoming gradients of up to 60 per cent and fording waters up to 1.5 m deep, the all-wheel-driven vehicle thus can reach almost any deployment site thanks


Photo: Rheinmetall

to its comparatively low weight. For military requirements, the vehicle can be fitted with a STANAG-compliant, protective-ventilated cabin, which Rheinmetall offers under the name Integrated Armoured Cabin, or it can be prepared for equipping. In addition, a remote-controlled weapon station could be integrated. The total weight then increases by about two tonnes to 30 tonnes. The UDS 214 excavator superstructure from the Slovakian crane and excavator manufacturer CSM Industry was placed on the chassis in such a way that it can be rotated 360 degrees. The telescopic arm can be extended to a length of up to 14.60 metres, writes Rheinmetall. It can be used with various tools – not only excavator shovels but also hooks or hydraulic drum cutters (for making round, deep holes). Used as a makeshift crane, the HX 8×8 EXCAVATOR can lift loads of up to 7.5 tonnes.

Bell Begins Czech AH-1Z Production

(jh) Bell Textron has started production of the first AH-1Z VIPER for the Czech Republic at Bell's Amarillo Assembly Centre, the company writes in a press release. The production of the VIPER joins UH-1Y production as part of the Czech Republic Foreign Military Sale (FMS) of a mixed fleet aircraft. Bell's work beyond aircraft manufacturing includes building a flight training device for the Czech Republic. Bell began production on the Czech Republic UH-1Y in 2021, marking the first production for an international operator of this type of aircraft. The Czech Republic's purchase of both the AH-1Z and UH-1Y takes advantage of the 85 per cent commonality between parts and enabling mission capabilities between both aircraft. In addition to the Czech Republic, Bell is actively producing AH-1Zs for the US Marines Corps and the Kingdom of Bahrain. In total, the H-1 programme is on track to produce 217 AH-1Zs and 168 UH-1Ys, with more than 100 consecutive H-1s delivered on time for the USMC and FMS customers.


Photo: Bell

The Path to and Consequences of the Ukraine Crisis

David Saw

The war in Ukraine is an avoidable tragedy. However, the unintended consequences of these events are extraordinary.

This is what happens when deterrence fails. This is what happens when Western politicians are unable to generate the necessary will to convince an opponent that there will be real consequences if deterrence fails. Yet here we are with Ukraine under attack. There will be consequences, most likely unpleasant consequences for Western nations and the liberal international order that they have constructed, unless the West becomes serious about defence, deterrence and energy security.

Aggression of the nature that we are witnessing in Ukraine today will not stop here. Others will be emboldened, potentially seeing us descend into an era of conflict. This is unless Western nations rapidly learn the lesson that you need both soft and hard power in your diplomatic arsenal. The era of disarmament by neglect must end. How many European nations could generate a properly equipped brigade or even battalion-sized formation for rapid deployment? Even if they could, would their political leadership have the will to actually sanction the deployment of troops?

Our starting point is to discuss the Russian attack on Ukraine and what motivated Russia to act as it did. Beyond that, we need to look at how the US and Europe failed to comprehend what was happening, failed to support Ukraine until it was too late, and failed to deter Russia.

At the time of writing, it is still too early to predict how this conflict will evolve, but it is clear that the first days have not gone according to the expectations of Moscow. Their operational concept appears superficially sound, multiple axes of advance to dominate the battle space and maintain constant pressure on Ukrainian forces, in addition to strikes on political and military targets to decapitate the Ukrainian leadership and attacks on communications infrastructure. The intention is to disrupt and/or destroy the Ukrainian command, control and communications (C3) capabilities, by both active and cyber means, and make them unable to organise their forces to effectively respond to advancing Russian troops.

Photos: MoD Ukraine

Ukrainian soldiers launching a JAVELIN anti-tank missile

Control of the air was to be quickly secured by the Russian Air Force combined with air-mobile operations into the strategic depth of Ukraine against critical targets in order to further weaken resistance. Attacks against military locations, barracks, storage sites and ammunition dumps would further reduce the Ukrainian potential to react to the Russian assault. As if that were not enough, Russia conducted amphibious operations in the Sea of Azov in the vicinity of the city of Mariupol, the most important remaining area of Ukrainian control in the Donetsk Oblast. Amphibious operations continue against other Ukrainian coastal targets.

Context

The balance of forces inevitably favours Russia. They have more troops and more, and arguably better equipment, in many respects. There were no mysteries as to the areas that they intended to operate in and plenty of reconnaissance assets, both human and otherwise, to inform them of the forces that they were facing and their disposition. If you were sitting in Moscow before the conflict started, you would believe that you held all of the advantages. Your operational plan maximises those advantages and the assumption is that the initial attack will inflict paralysis on the Ukrainian military, allowing a rapid decision to be reached either by the capture of Kyiv or a surrender by whatever remains of the Ukrainian Government and/or military authorities. The conflict would be quick and the results would be decisive - in a matter of a few days it would all be over.

It was a good plan. Russia certainly had the means to carry it out, but it is plain that they failed to decapitate the Ukrainian leadership and disrupt their C3 structure. It also failed to take into account that the Ukrainian military would fight with conviction and unanticipated effectiveness. Or that the Ukrainian population would be so supportive of its government and its military. Undoubtedly, Russia had intelligence assets on the ground in Ukraine, and they would also have access to all Ukrainian print and electronic media; in short, virtually

everything they would need to gauge the mood of the Ukrainian people. Clearly, they had drawn the wrong conclusions as to the likely reactions to their invasion.

What is most surprising is that despite all of the advantages that the Russian forces possessed, they appeared not to be mission ready. Bear in mind that the Russian military proved itself perfectly capable of managing operations in the Crimean peninsula, and also the Donbas and Luhansk regions in their actions in Ukraine in 2014/2015. This time they had plenty of time to prepare, with forces starting to deploy along the Ukrainian border as early as March 2021 and by May 2021, it was estimated that there were 100,000 Russian troops bordering Ukraine. Come December 2021, the Russian force had grown to some 150,000 troops, more than enough to deliver the desired military objectives.

On 24 February, when Russia launched active military operations, it must have done so highly confident of a swift victory and a Ukrainian collapse. Since that time, it is clear that things have not gone according to plan. Having multiple axes of attack requires coordination and this has not been apparent; it is as if there was an assumption that there would be no real fighting and the Ukrainians would just throw down their arms and give up. In many respects, Russian operations appear disorganised and leadership appears to be weak at all levels. Bearing in mind how long they have had to prepare, logistics should not have been an issue, and units should not be running out of fuel so rapidly after the start of operations and resupply ought to be readily available. Another noticeable factor is that many of the Russian troops seem badly prepared and unmotivated for combat.

For the Russian military there is a solution to these problems - they can simply deploy more troops, tanks, armour and artillery and make sure that they have command of the air. They will take casualties, but they will eventually overwhelm the Ukrainian defenders. It will not be subtle, indeed it will be brutal and Moscow can achieve its victory, but at what cost? Russia's international reputation will be in ruins, its economy will be in turmoil and it is very difficult to see how Russia will be able to turn Ukraine into an obedient satellite state after fighting a war through it.

Motivation

This leads us to a critically important yet simple question: What is motivating Russia to do this? There are a number of complex factors involved in answering the question, but a good place to begin is a speech given by Russian leader Vladimir Putin in 2005 when he described the fall of the Soviet Union in 1991 as the "greatest geopolitical catastrophe" of the twentieth century. This does not mean that Putin is nostalgic for the Communist Party of the Soviet Union and its ideology, nor does he yearn to be Stalin. Put simply, Putin is a Russian nationalist.

The ideological underpinning for the strain of Russian nationalism espoused by Putin is credited to Alexander Dugin and Alexander Prokhanov. Dugin is a professor at Moscow State University and the author of numerous books. He talks of the "Fourth Political Theory" superseding discredited theories such as liberalism, communism and fascism. He envisages a superpower-free multipolar world, in which Russia is the dominant power in what is described as the Eurasian Union, essentially the territory previously controlled by the Soviet Union. His philosophy is based on the struggle of tradition and religion, which he supports, against modernity and globalisation which he abhors.

An American analysis quotes from Dugin's influential book "Foundation of Geopoli-

A Ukrainian soldier undergoing NLAW training

tics" published in 1997: "It is especially important to introduce geopolitical disorder into internal American activity, encouraging all kinds of separatism and ethnic, social and racial conflicts, actively supporting all dissident movements – extremist, racist, and sectarian groups, thus destabilising internal political processes in the US. It would also make sense simultaneously to support isolationist tendencies in American politics…" Dugin became a known quantity in the US because of the now discredited effort to paint Trump as at best a Russian tool or at worse an agent of influence. Ironically, the situation described in the Dugin quote seems to apply to the current state of US political discourse. Dugin believes that it is in Russia's interest to separate the US from Europe. As for Alexander Prokhanov, he is politically on the extreme right and is a newspaper editor and author. His idea is that Russia must move to become the 'Fifth Empire,' and it will achieve this through Russia taking control of all of the areas that used to be part of the Soviet Union.

The objective of this nationalist ideology was the restoration of Russia to its leading role in what was once the Soviet space, indeed some would look further and look to regain the territories that were once held by Imperial Russia. To achieve this, Russia, Belarus and the Ukraine would need to become a single entity and the move to its 'traditional borders' would commence, with Moldova being the next territory to join the new Russia. The end result is that the new Russia becomes a dominant power.

Therefore, what a nationalist Russian leadership intends to achieve is now clear; their challenge was how to make all of this a reality. Recent events seemed to indicate that the correlation of forces has suddenly swung in their favour, as there was a real opportunity to make the dream of a new and greater Russia a reality. The reasoning behind this was the weakness of the Biden administration, while the US Democratic party had been willing to use issues such as collusion between Trump and Russia and using Ukraine as a means of trying to impeach Trump, in government they were seemingly uninterested in confronting Russia or providing significant support to Ukraine. From Moscow's perspective, US foreign and strategic policy was one of appeasement or just simply incompetence, as evidenced by the collapse of Afghanistan.

By mid-2021, the Biden administration had removed sanctions on the Nord Stream 2 pipeline thus clearing the way for Germany to become overly dependent on Russian gas. The US also delayed a US$100M military assistance package to Ukraine in June 2021 around the time of the Biden-Putin summit as a gesture to persuade Russia to remove troops from the Ukrainian border; no troops were withdrawn.

Then there are some other energy security related issues to consider. The US Government places far more emphasis on environmental factors than ever before, putting obstacles in the way of both US onshore and offshore oil and gas production. While Canada is the largest oil supplier by far to the US, Mexico is in second place supplying 711,000 barrels per day, with Russia in third place supplying 672,000 barrels per day. With oil in the US$100 a barrel range at present, that is a substantial contribution to the Russian economy on a daily basis. Russian oil sales to the US have not been impacted by sanctions against Russia.

Elsewhere, the environmental concerns of the Biden administration outweighed energy security requirements. This has been demonstrated by their withdrawal of support for the EastMed pipeline that would have moved gas from Israeli offshore gas fields, connect to gas fields off Cyprus, and deliver gas from both to Greece and eventually to Italy (the second largest gas importer in Europe with the majority of supplies from Russia). The lack of US support killed the ability of the pipeline to attract external financing and the project is now stalled.

A Ukrainian BMP-1 firing

Failed Diplomacy

In recent months, it has become quite common to hear from the extremes of the political left and right in Europe and the US, that efforts to expand membership of the EU or NATO to the East are somehow provocative to Russia. Would this be the same Russia that signed the 1994 Budapest Memorandum where the signatories agreed to not threaten or use force against the territorial integrity or political independence of Ukraine? Then there was the Friendship Treaty of 1997 between Russia and Ukraine

that recognised the existing borders and territorial integrity of both states. Ukraine withdrew from the Friendship Treaty in 2019, somewhat inevitably after the loss of the Crimea, Luhansk and the Donbas in 2014/2015.

There are no treaties or undertakings that gave Russia the right to block another sovereign nation, in this case Ukraine, from joining the EU or even NATO. One can understand that joining NATO might be considered provocative by Russia, and that some NATO members would be reluctant to sanction Ukrainian membership. However, it was never beyond the realm of possibility to develop a solution where Ukraine had a defence relationship with NATO that was just short of full membership.

This brings us to the EU and its relationship with Ukraine; the EU has been very quick to encourage the development of democratic forces in Ukraine and to help the evolution towards a liberal democratic state. As to EU membership for Ukraine, that is a different matter. Ukraine does not meet a number of EU membership criteria. One might have thought that a solution could be found, but no. It is only since the Russian invasion that EU membership has gained real momentum, with President Volodymyr Zelenskyy signing an EU membership application on 28 February requesting immediate EU membership, with eight EU nations supporting accelerated membership. It is all too little too late. Had Ukraine been an EU member state, perhaps that might have dissuaded Moscow. Another point worth exploring is how quiet the EU was prior to the Russian invasion; it is very difficult to be influential if you cannot muster the energy to raise your voice and be heard. An important lesson for the future for Brussels.

Without doubt, if this aggression against Ukraine was going to be deterred then there was only one nation that could do so and that was the US. The fact that this objective was not achieved must be considered as a political and diplomatic failure of immense proportions by Washington. What was needed was for the US to assume a leadership role, and there would be those in Europe who say Europe should have taken the leading role, but who would do the leading in Europe and what sort of response could they lead? Being realistic, it is at times like these that the US must assume the mantle of leadership, when they fail to do so, things fall apart as they did this time.

It was as if the US administration was unable to grasp what was happening in Russia and its motivations as regards Ukraine. It also failed to understand how its policies and actions made it look so weak and clueless that it virtually encouraged aggressive intentions. With the best will in the world, it is hard to picture President Biden as a commanding international figure! Can one really see the leaders of China and Russia being convinced that Biden is a serious adversary? Even if Biden is just a figurehead, the foreign and strategic policies of the US Government are becoming increasingly inexplicable to both allies and opponents alike!

Ukrainian soldiers unearthing a weapons cache by pro-Russian separatists in eastern Ukraine

Media reports stated that the US was so desperate to come to a nuclear agreement with Iran that it has become increasingly reliant on the good offices of Mikhail Ulyanov, the Russian negotiator at the Vienna talks, to bring about an agreement. Perhaps this explains why the US is making so many concessions to Iran. Then the US decided that it would turn to China to persuade Russia not to invade Ukraine, sharing intelligence information that they had of Russian intentions. It seems China was not disposed to help the US and was quite happy to pass on the information that the US had shared with them to Russia! All of this is was hardly likely to generate respect for American diplomacy from either Russia or China.

In the final analysis, American diplomacy was seemingly obsessed with not being provocative towards Russia and never gave the impression that they considered Ukraine or its territorial integrity as being that important. As a result, Russia believed that it had an historical opportunity to bring Ukraine into the new Russia as a prelude to expanding across the former Soviet space. With the US uninterested and the Europeans too dependent on Russian energy to provide any serious opposition, for Moscow this was the moment to move on Ukraine.

An Avoidable Tragedy

The invasion of Ukraine was an avoidable tragedy. However, the unintended consequences of these events are extraordinary. Tone-deaf Russian diplomacy has created a situation where Finland, usually so careful not to offend Russia, is interested in NATO membership. Even traditionally neutral Sweden is considering going beyond neutrality and flirting with NATO! Germany has suddenly woken up to the fact that appeasing Russia was a bad policy and that they had neglected their defence capabilities for far too long and would be spending more on defence up to the NATO target of 2 per cent of GDP. Across Europe, there is suddenly awareness of how vulnerable they are in terms of energy supply; energy security is now a serious issue.

One of the most important developments since the Russian invasion is that it has demonstrated to the world that the Ukrainian Government, military and people are prepared to fight to protect their country and their way of life. For years, Ukraine has been treated as some kind of corrupt backwater on the edge of Europe; that might have been true once, but in recent years, democratic institutions have taken root and Ukraine was well on the way to becoming part of the European mainstream. It is now clear that the West should have done more to help Ukraine. Now the West must honour the country's sacrifice and support it, pledge to rebuild it in the future, and finally bring Ukraine into Europe!

Black Sea Security in Times of War

Eugene Kogan

There is no doubt that the ongoing Russian military action against Ukraine profoundly affects the rest of the Black Sea littoral states: Bulgaria, Georgia, Romania and Turkey. The tense standoff of recent weeks placed each of them in a difficult position between apprehension and, particularly with Turkey, a kind of peacemaker or rather mediator, which Russia now ignores completely.

Romanian Defence Minister, Vasile Dincu, said in January 2022 that "Russia, at the moment, is not a direct threat to Romania, but it is [rather] a threat to security in the [Black Sea] area". The author disagrees with the minister's statement since the Russian military, which is stationed on the occupied Crimean peninsula - not much more than 100 km from the Danube Delta - is a direct threat to Romania, even though Russian officials will blame the other side for posing a threat to Russia. Furthermore, the region's three NATO member countries, namely Bulgaria, Romania and Turkey, have until today been unable to create and implement a comprehensive Black Sea security strategy together with NATO aspirants Georgia and Ukraine to counter the challenges posed by Russia. The latter, however, successfully implemented its divide and rule policy in the region.

Photo: U.S. Army / Staff Sgt. Lawree Roscoe Washington Jr.

Romanian soldiers during final checks before movement onto the range to conduct joint marksmanship training being instructed by US Marines, at Babadag training area, Romania, in June 2010. The Black Sea Rotational Force is deployed to Eastern Europe to promote regional stability and help increase the military capabilities of partner nations in the Black Sea regions.

Bulgaria

Despite pressure on Bulgaria to ratify a treaty signed with neighbouring Romania on 18 March 2021 that would allow NATO cross-border air policing operations, the Bulgarian interim and new governments have hitherto not done so. While Romania has traditionally championed or supported initiatives to boost NATO multinational military efforts in the Black Sea region, Bulgaria has been more reluctant. This is due, among other factors, to its historical affinity with Russia and Russian economic interests in Bulgaria. It needs to be remembered that 70 per cent of Bulgaria's gas needs and 90 per cent of its oil needs are imports from Russia. In addition, Russia supplies fuel to Bulgaria's Kozloduy Nuclear Power Plant. As a result, it puts Bulgaria under pressure since the latter managed to diversify its gas imports only slightly and failed to diversify its oil imports altogether.

Former Romanian defence official and international security expert, Claudiu Degeratu, also mentions the "reluctance of Bulgaria and Turkey to share information about their airspaces with other governments in the region." Besides, Turkey has been and still is reluctant regarding a Western military presence in the Black Sea and it shares close but complicated ties with Russia. All that despite the three countries being NATO members. So much for the common position that ends in tatters.

Once ratified, the aforementioned treaty will allow NATO air forces stationed in the Mihail Kogalniceanu Air Base to conduct policing operations in both countries. Situated near the Black Sea, the air base is the main hub for NATO aircraft in south-eastern Europe.

The country's new Defence Minister, Stefan Yanev, caused a negative reaction in December 2021 after dismissing the need for more NATO troops in Bulgaria in the context of increased tension between NATO and Russia over Ukraine. Yanev said "the increased tensions call for a unified approach by NATO, but this might lead to unnecessary escalating tensions [with Russia]. At this stage, there is no reason to consider the observed processes as a direct threat to the [NATO] alliance and the security zone. In this sense, I do not believe there are the necessary circumstances that can justify a decision related to the deployment of additional troops on our territory. Such a decision would correspond neither to the union interests nor to the national interests of Bulgaria."

Prime Minister Kiril Petkov announced in January 2022, "the country was ready to accept troops from NATO partner countries but within a joint battalion battle group with Bulgarian troops. This is part of the official Bulgarian position on the crisis in Ukraine which the government adopted" after the debate between the government coalition partners. One important point which needs to be stressed is that Bulgarian armed forces lack 21st century equipment

Author

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

to defend the country and they need to increase their combat training and readiness.

Georgia

The country's political leadership is trying to maintain a good rapport with NATO. However, at the same time, it is doing its utmost not to irritate President Putin's administration. This balancing act shows the indecisiveness and inability to reach the right decision. There is a lack of understanding within the Georgian Dream-led coalition government, namely that if Moscow achieves its goals in Ukraine, the next target will be Georgia where the Kremlin has some unfinished business to complete after the end of the August 2008 war.
Despite improvements to its land forces, Georgia lacks well-trained reserve, air, and naval forces to complement the land forces and the National Guard in a war situation. The country's Coast Guard is not equipped for a military conflict or war since that is not its mission, but there are no mechanisms for ensuring coastal protection that can be easily overrun or blockaded by Russia. As a result, Georgia remains vulnerable to a Russian naval attack. Whether or not a well-equipped and trained naval force is possible is not yet clear. Such a programme would be expensive for a small country like Georgia, and for now, it is uncertain whether the UK or the US would provide financial support. In addition, it lacks a sufficient number of air defence systems that can withstand attack from the Russian air force. Finally, Georgia remains vulnerable to Russian cyber-attacks, even though it has experienced Russian cyber-attacks in the past.
In other words, Georgia is not militarily prepared for a potential Russian offensive and the Kremlin knows that it can bully Georgia and continue the unobstructed 'borderisation' process along the administrative boundary line (ABL) between Georgia proper and the [Russian] occupied region of South Ossetia.

Photo: US Marine Corps / Sgt. Devin J. Andrews

US Army Green Berets assigned to 10th Special Forces Group display capabilities with Bulgarian special forces to Herro Mustafa, the US Ambassador to the Republic of Bulgaria, in August 2021.

Romania

The Romanian National Defence Strategy for 2020-2024, signed by President Klaus Iohannis in June 2020 and approved by the Parliament the same month, defined Moscow as an "aggressive" threat. The proposed Defence Strategy stated that Russia had contributed to "the deterioration of regional stability with its "offensive positions and aggression in the last years." It added that Moscow had strengthened its "offensive military capabilities in the Black Sea" and had created a system capable of "restricting access" to the Black Sea in order to "counterbalance" the development of NATO capabilities on the Alliance's eastern border. As expected, the Kremlin flatly rejected these accusations, and claimed that the new strategy presented by Romania would be used to intensify the military presence of the US and NATO in the Black Sea.
Furthermore, Foreign Ministry Spokesperson, Maria Zakharova, stated, "Bucharest, instead of acting as a provider of stability, contributes to further increasing tensions and distrust in the region." Foreign Minister Bogdan Aurescu explained that "Romania does not believe that Russia is a hostile state, rather that it is simply drawing attention to the aggressive actions it has undertaken in recent years, some of which have violated international law." Aurescu's assertion is dismissed by Moscow.
Following the approval of the Defence Strategy by the Parliament, the country's Ministry of National Defence (MApN) decided to boost the military intelligence, surveillance and reconnaissance (ISR) capabilities by acquiring new UAVs, ensuring the country's armed forces can efficiently monitor Romania's borders.
The British company U-TacS and Romanian company Aerostar signed a cooperative agreement to start production of the WATCHKEEPER UAVs in July 2021. In addition, Israel Aerospace Industries (IAI) and IAR-Brasov have signed a cooperation agreement to manufacture IAI's Tactical HERON UAV in Brasov in October 2021.
Besides acquisitions of UAVs, during the visit of the French Armed Forces Minister, Florence Parly, to Bucharest in January 2022, she said, "President Emmanuel Macron indicated France's willingness within the NATO framework to engage in new

Photo: US Army / Spc. Yon Trimble

While deployed to Eastern Europe in support of exercise "ATLANTIC RESOLVE" and conducting a training mission, a US Army Scout Platoon prepares to infiltrate an unsecured area once the UH-60 BLACKHAWK helicopters land at Novo Selo Training Area, Bulgaria, in March 2019.

enhanced forward presence missions, especially in Romania, if these missions are decided by NATO." In February 2022, US President Biden ordered the deployment of about 1,000 troops to Romania to deter any possible Russian aggression against it. Finally, three German Air Force EUROFIGHTER aircraft were integrated into the Italian Air Force contingent in Romania in February and March in the context of NATO members increasing their presence in Eastern Europe in the event of a Russian invasion of Ukraine.

Photo: US Air Force / Senior Airman Daniel Phelps/Released

US Army soldiers check the settings of a PATRIOT launching station in February 2013, near Gaziantep, Turkey. The PATRIOTs are deployed to Turkey as part of NATO's effort for a cooperative solution to promote regional stability and augment Turkey's air defence capabilities.

Russia

To harass Romania in particular, Russian aircraft have increased their patrolling over the Black Sea, some of them periodically violating Romanian airspace. In July 2018, then Defence Minister, Mihai Fifor, acknowledged that Russian incursions in Romanian airspace had increased. The overall situation with the Russian air incursions into Romanian airspace has not changed for the better.

For instance, RAF TYPHOONs on the NATO Enhanced Air Policing mission scrambled in August 2021 as a Russian aircraft was detected entering the Bucharest Flight Information Region and heading towards Romanian territorial airspace. As with many Russian military sorties, the aircraft had not filed a flight plan and was not speaking with Romanian Air Traffic Control, thereby creating a flight safety hazard to all air users.

The overall Russian goal in the Black Sea is to sow distrust between NATO allies, Bulgaria, Romania and Turkey, isolate and subject Georgia to its will and destabilise Ukraine by taking advantage of the lack of a strategic and comprehensive day-to-day NATO presence and strategy.

To reinforce its goals in the Black Sea, Russia's Southern Military District announced in January 2022 that the country's Black Sea Fleet would hold major drills in "the waters of the seas adjacent to the Russian territory, as well as operationally important areas of the World Ocean."

Military experts have warned that the Black Sea Fleet's warships and submarines could play a significant role in any Ukrainian conflict, threatening the country's coastal cities (most likely Berdyansk, Mariupol and Odesa) and military infrastructure with missile strikes, use of cyber and electronic warfare systems.

Turkey

Even though President Erdoğan offered to mediate between the Russian and Ukrainian Presidents, Vladimir Putin and Volodymyr Zelenskyy in January 2022, Putin was disinclined to accept the offer. Erdoğan's said that the "conflict in the east of Ukraine should be resolved on the basis of Ukraine's territorial integrity and rejected Russia's illegal occupation of Crimea" – made him an unlikely mediator in the Kremlin's eyes.

Erdoğan did his utmost to maintain a balancing act between the obligation of Turkey to NATO to be a reliable ally and his friendly relations with the conflicting sides. However, such a balancing act is untenable since Erdoğan is not willing to make a decision, and ultimately, he will steer Turkey to a position of neutrality. That was and still is Putin's aim, to keep Erdoğan's Turkey a neutral actor around the Black Sea region in case of a Russian invasion of Ukraine.

As the implementer of the 1936 Montreux Convention, Turkey is responsible for keeping track of any violations of the Treaty. But under tacit pressure from Moscow, Ankara allows Russian submarines assigned to the Black Sea fleet to transit the Bosphorus to patrol in the Mediterranean, thereby putting Russian submarines on a potential collision with NATO naval forces. Such an act puts Turkey squarely in the camp of Russia and exposes its weakness as a NATO ally.

Finally, energy security needs to be brought into the equation. Turkey, despite previous claims of becoming a major gas hub, remains dependent on Russian gas deliveries and the latter can turn the unpleasant winter season 2022 in Turkey into a freezing nightmare. Azerbaijan, as Turkey's ally, is unable to substitute gas deliveries from Russia to Turkey since it lacks capacity.

Ukraine

The country stands at the very centre of the standoff between Russia and NATO since Putin demands clear and binding guarantees from the Alliance that Ukraine will not become a NATO member. As the world has witnessed, since the beginning of Russia's invasion of Ukraine, which began on 24 February, the country has been fighting hard for its independence and sovereignty.

It is equally obvious that the Kremlin has severely miscalculated and underestimated the resilience and resistance of the Ukrainian armed forces and civilian population. If Moscow though that an invasion would be a piece of cake, it has very badly miscalculated.

It should also be emphasised that Ukraine has actually been at war since March 2014 and its land forces are combat proven and experienced. However, the main problem for Ukraine remains its lack of potent air-defence systems and a weak Air Force and Navy. Russia, however, possesses superior armed forces, with superior air and naval forces, in particular. In addition, despite improvements in its cyber security, Ukraine lags behind Russian capabilities in cyber security operations.

Whether or not the imbalanced state of military affairs will lead to the rapid defeat of Ukraine in its war with Russia is not a foregone conclusion. What is known now, is that Ukraine is resisting Russia's invasion on its own, since it is not a NATO member.

Conclusion

It is clear that the normally calm waters of the Black Sea have become very stormy over a short period of time with an aggressive Russia able to operate from its well-fortified Crimea-based Black Sea Fleet naval base and the Southern Military District in Rostov. Ukraine is fighting hard since it knows what the cost of surrender is; namely to become a pawn of Putin's Russia for the foreseeable future. As for the three NATO member countries in the region, as long as they are not directly involved in the conflict, they will behave differently since they lack any common position. The Georgian government's position can be summarised as follows – not to have any position and to avoid a clearly stated position. This strategic ambiguity will not save Georgia if Moscow achieves its goals in Ukraine. ■

Strategic Competition in the Middle East – Uncertainty Continues

David Saw

There is an old English proverb: "The road to hell is paved with good intentions." This would appear to be true, since for more than 50 years, US and Western policy towards the Middle East has been long on good intentions and very short on demonstrably positive results.

Yet, the foreign policy establishment persists with many of these policies that have failed time after time. Moreover, they appear wedded to stratagems that increasingly do not reflect the realities on the ground. The fact of the matter is that the Middle East is a far more complex strategic environment than previously, with further complications added by the increasing involvement of non-regional actors.

From a western perspective, the ideal situation in the Middle East would be for all parties concerned to sign up to a solution predicated on a rules-based international order. This scenario has important roles for the United Nations (UN) and other international organisations, as all concerned sign up to the zeitgeist of the progressive liberalism of the international community. This of course assumes that everybody is desperate to sign up to this rules-based international order. The reality of the situation in the Middle East is that many of the nation states in the region have no wish to be a part of the current international order. Instead, they see this approach as an obstacle to their ambitions. Then there are the non-state actors in the region - for many of them the current international system is an abomination that they seek to destroy.

In the past, there was an assumption that conflict in the Middle East was just another facet of the era of superpower competition between the Soviet Union and the United States. Added to this, you had the ongoing issue of Israel and the Palestinians, a conflict that predated broader superpower involvement in the Middle East, but one which was also seen as part of the overall superpower conflict. As if that were not enough, there was also a school of thought that seemed to believe that if only all of the issues between Israel and the Palestinians could be resolved, then as a consequence, all other issues in the region would quickly move towards a solution. This evidence-free suggestion of the centrality of Israel/Palestine to peace in the Middle East still has some devotees in foreign policy circles and large sums of foreign aid continue to flow to the Palestinian Authority (PA) and its leader Mahmoud Abbas, who is in year 16 of the four-year term he was elected to in 2005.

Photo: US Air Force

A Dassault RAFALE EQ of the Qatar Emiri Air Force (QEAF) in a refuelling exercise with the US Air Force. The QEAF will eventually have a fleet of 36 RAFALE EQ, 72 Boeing F-15QA and 24 Eurofighter TYPHOONs. However, it is Qatar's use of soft power that makes it a key strategic factor in the region.

Ramallah and Gaza

The Palestinian issue does remain relevant though, except the centre of gravity has moved from Abbas and the Palestinian Authority in Ramallah to the Hamas regime in Gaza and to those states who are actively supporting Hamas. Hamas was founded in the late 1980s as an offspring of the Egyptian wing of the Muslim Brotherhood; it is an Islamist group and one of its primary objectives, as outlined in the Hamas Charter of 1988, is the destruction of Israel and its replacement by an Islamic state.

Israel withdrew from Gaza in 2005 and in 2006, at the behest of the international community elections were held in Gaza, which Hamas won. Arguably, it was the corruption of Abbas and the PA that delivered the election to Hamas. On the other hand, both Hamas and the PA have one thing in common regarding elections - they very much believe in "one man one vote, but one time only!" Hamas receives support from the Muslim Brotherhood and significant aid from Qatar and Turkey, as well as financial and military aid from Iran.

In the wake of the 15-day conflict in May 2021, when Hamas and other Jihadist groups launched over 4,000 rockets into Israel and Israel retaliated, it should be noted that Hamas has received and been promised humanitarian aid and reconstruction assistance from the UN, the EU, the US, Germany and UK, amongst others. Money has not been a problem for Hamas, as in August

Photo: Office of the Supreme Leader

The Ayatollah Sayid Ali Khamenei is the Supreme Leader of Iran, its head of state and the supreme commander of its military. Iran and its proxies continue to undertake military action across the Middle East, while its broader strategic position has been strengthened by US concessions as they seek a nuclear deal with Iran.

Photo: US Air Force

A Boeing F-15SA of the Royal Saudi Air Force (RSAF) taking part in a joint exercise with the US Air Force. Under the Biden administration, relations between the US and Saudi Arabia have become much weaker, leading Riyadh to explore other strategic options to reinforce its security position.

last year, German media reports revealed that Hamas had share holdings valued at over US$500M in companies based in the Middle East and North Africa. European financial services companies have become aware of these Hamas holdings and have become unwilling to do business with the entities involved, thus costing Hamas money. On the other hand, Qatar is reported to have donated US$500M to Hamas in the wake of the May 2021 events.

Another Islamist grouping in Gaza that grew out of the Muslim Brotherhood is the Palestinian Islamic Jihad (PIJ), which was established in the early 1980s with its fundamental purpose being the destruction of Israel. PIJ has a de facto understanding with Hamas, hence it is able to conduct operations out of Gaza. It is also operationally active in the West Bank. The PIJ receives significant funding and military support from Iran and from Iran's primary proxy in the Middle East, Hezbollah in Lebanon.

The situation in Gaza is instructive, neither Hamas, nor the PIJ can seriously damage Israel. All they can really achieve, apart from continuing to impoverish the population of Gaza, is to apply their own pressure on Israel and hope that their external sponsors can add to that. For them, their attitude is that they are winning as long as they are not losing. Fundamentally, however, Hamas and the PIJ have become pieces in a much larger strategic jigsaw, where three primary groupings struggle for supremacy. Beyond that, you have the role of external powers to take into consideration. Inevitably, these external powers are not acting out of the goodness of their heart, since they have their own strategic objectives and those might not necessarily fit in with those in the region who they are supporting. Put simply, it's a complicated environment where deceit and self-interest are the default settings.

Regional Fractions

As noted above, there are three main groupings contesting strategic competition in the Middle East. The first of these is a Sunni Islamic grouping led by Turkey, Qatar and the Muslim Brotherhood, which seeks change in the region to benefit themselves and their proxies, such as Hamas. Then there is the Shia Islamic grouping helmed by Iran, with its primary proxies in the form of Hezbollah in Lebanon and the Houthi in the Yemen, added to which there are alliances and links with government, political parties and paramilitary organisations in Syria and Iraq. Then there are the status quo powers of Saudi Arabia, the United Arab Emirates (UAE) and Egypt for example, none of whom want the revolutionary change on offer from the other two groupings. The status quo powers are also willing to support their own proxy groups with funding and weaponry.

The above listing covers the governments and quasi-governments in the Middle East, but it does not cover the totality of non-state actors. Although they only have a fragment of the territory that they once used to control, the Islamic State, otherwise known as Daesh, continues to be a factor in the regional security picture. They remain a potent force in both Syria and Iraq, with Daesh retaining an ability to act internationally and to inspire support. There are also a host of other armed Jihadist groups around the broader region that manage to attract external support, keeping them as a threat and as a useful tool for their foreign sponsors to utilise as needed.

The confused reaction of the Obama Administration to the Arab Spring in 2011, which led to the Syrian Civil War, were the circumstances that led to Russia's return to the region. The Soviet Union had been sup-

plying arms to Syria since the mid-1950s and in the early 1970s, the Soviet Navy were given basing facilities at the port of Tartus, but following the collapse of the Soviet Union, the Russian naval presence was minimal. However, Russia still had strategic interests in the Eastern Mediterranean and the Middle East and Syria remained a friendly power. Relations between Moscow and Damascus were strengthened in 2005, when Russia wrote off a significant amount of foreign debt owed by Syria to the former Soviet Union (allegedly some 73 per cent of US$13.4Bn).

After this, Russia supplied weapons to Syria and by 2009, had started modernising and expanding its port facilities at Tartus. In 2011, after the Syrian Civil War broke out, Russia supported the Syrian Government via the supply of systems, equipment, spares and munitions. Then came advisors and technicians and, as Russian involvement increased, military contractors and eventually direct Russian military involvement on the ground and in the air followed. Syria then struck a deal under which Russia would have a 49-year lease of the port at Tartus, with the port being treated as sovereign Russian territory, and north of Tartus in Latakia Province, Russia has established a major air base at Hmeimim.

All of this makes Russia a factor on the ground in the Middle East, but it also strengthens the understanding between Russia and Iran. Iran wanted to preserve the Assad regime in Syria to keep its objective of a 'Shia Crescent' encompassing Iran, Iraq, Syria and Lebanon as a viable proposition. However, there are both positive and negatives for Iran in sustaining this proposition. While Hezbollah, Iran's primary proxy in the region, effectively dominates Lebanon, the problem is that Lebanon is on the way to becoming a failed state. Its economy is on the verge of collapse and trust in state and other institutions is non-existent. If the state collapses, then internecine conflict is inevitable.

Iran and Iraq

Dealing with the subject of stability brings us to the question of Iraq, or more precisely to the level of Iranian influence over the government and the military in the country. A recently issued report shed light on the situation: "Operation Inherent Resolve - Lead Inspector General Report to the United States Congress, October 1, 2021 - December 31, 2021." The report points to the continuing presence Iranian-aligned militias in the country, but more seriously contends that the Interior Ministry (MOI), which controls the Federal Police and Police Special Forces, which are equipped for counter-insurgency missions, are under heavy Iranian influence. Indeed, the Police Special Forces are said to be heavily infiltrated by the Badr Organisation, which is supported and often led by the Iranian Revolutionary Guard Corps (IRGC). In addition, two Iraqi Army divisions are said to be under Iranian influence, with Iranian operatives/sympathisers widely present across the other elements of the Iraqi military and security forces. The irony is that the US continues to fund the Iraqi MOI, elsewhere it also funds the Lebanese Armed Forces (LAF) and the Internal Security Force (ISF), with both organisations also increasingly Iranian-influenced.

We have mentioned Iran numerous times in this article and it is clear that the regime in Tehran seeks to change the strategic dynamic of the Middle East to suit its own purposes in that it aims to become the leading power in the region. At the time of writing, talks continue in Vienna on a nuclear agreement with Iran, an agreement that the US appears desperate to make a reality, hence their removal of sanctions on Iran and even the removal of the terrorist classification of Iran's Houthi proxy in the Yemen. This nuclear agreement will not stop the Iranian march towards nuclear weapons, indeed most estimates are that Iran will be nuclear capable in 36 months.

Both China, which has major commercial interests in Iran and is a major customer for Iranian oil, and Russia, which has a strategic understanding with Iran seemingly have no problem with Iran's nuclear weapon ambitions. The US and Europe should be resolutely opposed to a nuclear Iran, yet they are ambivalent to what could be one of the most destabilising strategic events in the Middle East. From the perspective of the Arab nations, US policy as regards Iran seems to enable Iran and its proxies, as demonstrated by the recent missile attacks on the United Arab Emirates (UAE) from the Houthi in Yemen and the ongoing attacks on Saudi Arabia.

The US was once the stabilising factor in the Middle East, but under the Biden administration, it is unpredictable. New strategic relationships are emerging though with both the UAE and Bahrain, which established diplomatic relations with Israel under the Abraham Accords signed in September 2020, are expanding their links, both in the economic and security fields with Israel. The UAE has also responded by enhancing its defence capabilities, announcing the acquisition of the KM-SAM from the Republic of Korea (ROK) in a US$3.5Bn programme, while turning to traditional supplier Dassault for the supply of 80 RAFALE F4 aircraft in a contract worth some €17Bn.

Recent events have demonstrated that we are in a dangerous era of strategic instability. Matters are not helped by the inexplicable emphasis of the US on obtaining a 'nuclear deal' with Iran seemingly at any cost, a deal that makes a new nuclear weapon state inevitable. How long before the Arab States have their own nuclear weapons in response? Multiple nuclear weapon States in the Middle East are hardly likely to encourage strategic stability in an already troubled region.

Photo: LIG Nex1

In November 2021, the United Arab Emirates (UAE) announced that it intended to acquire the KM-SAM CHEONGUNG II from LIG Nex1 of the Republic of Korea (ROK), in a contract that could be worth US$3.5Bn. This air defence system combines technology and systems from both the ROK and Russia, and its acquisition demonstrates that the UAE intends to further diversify its defence suppliers.

The Strategic Bond between Turkey and Pakistan in 2022

Andreea Stoian Karadeli

This year marks the 75th anniversary of the establishment of diplomatic relations between Turkey and Pakistan, a partnership that has strengthened over time, proving its endurance in various international and regional contexts. As challenges rise on the world's political scene, the two countries are joining their efforts to develop a strategic partnership for both individual and common interests.

In February 2022, representatives from Turkey and Pakistan met in Islamabad to review bilateral relations and ways to further strengthen cooperation in several areas, including trade, investment, and regional security. Turkey and Pakistan base their partnership on deep historical, cultural, social, and religious roots, as the two non-Arab Sunni Muslim-majority countries' ties predate, in fact, Pakistan's independence in 1947. The foundation of the Ankara-Islamabad bond is a common identity shaped around religious-cultural affinity, driven by their secular founder-leaders, Mohammad Ali Jinnah and Mustafa Kemal Atatürk, who thought deeply of the intersection of Islam, constitutional rights, and governance.

The Treaty of Friendship signed in 1954 between the two countries further built the bilateral relations on the existing historical, cultural, social, and religious platform. It emphasised for the first time the cooperation in the field of defence: exchange of information for the purpose of deriving joint benefit from technical experience and progress, and endeavours to meet, as far as possible, the requirements of the parties in the production of arms and ammunition.

The partnership between Ankara and Islamabad has grown stronger especially in the post-9/11 period, again with an emphasis on the defence element - common security and strategic interests. In the aftermath of the terrorist attacks, the focus of the cooperation has been the intersection of counter-terrorism, the Pakistan-Afghanistan-Turkey Trilateral Summits (PATTS), and long-term defence cooperation. Many argue that the strong emphasis on the defence partnership has deprived Turkish-Pakistani bilateral relations of a strong emphasis on common economic interests and, as a result, this situation has left little space for the institutionalisation of a concrete, consistent, and lingering political partnership. Taking into consideration both states' foreign policy strategies and the most recent developments, the bond between Turkey and Pakistan proves an interrelated complex strategy that no longer treats the political, economic and defence sectors separately, but sees them as interconnected dimensions of collaboration.

Photo: President of Pakistan

A MILGEM-class corvette named PNS BABUR built in Turkey for the Pakistan Navy was launched in a ceremony attended by President Recep Tayyip Erdogan and his Pakistani counterpart Arif Alvi in Istanbul on 15 August 2021.

Political, Economic and Defence Dimensions

According to official declarations, the most recent consultations between the representatives of the two countries have provided the opportunity for a wide spectrum of bilateral relations that have once again revealed opportunities to further strengthen cooperation in diverse areas including trade, investments, and economic cooperation, while emphasising the importance of peace, technology development partnerships, and connectivity. The two sides exchanged views on the ongoing preparations for the 7th Session of the High-Level Strategic Cooperation Council (HLSCC) and the implementation of the Strategic Economic Framework (SEF), signed between the two countries in February 2020. SEF covers a broad spectrum of cooperation in science and technology, defence, tourism, education, and health, including a free trade agreement that is yet to be fully implemented. So far, the two countries had increased the trade volume from US$600M to more than US$800M before President Erdoğan's visit to Islamabad in 2020. During the visit, the new bilateral trade volume goal has changed to US$1Bn in the near term, expected to reach the final goal of US$5Bn by 2023. As a matter of fact, I was in Islamabad during the Turkish President's visit and I witnessed a clear image of

Author

Dr Andreea Stoian Karadeli is an independent researcher based in Turkey, an Associate Fellow at the Geneva Centre for Security Policy and a Visiting Researcher at the University of South Wales. Her interdisciplinary research varies from cultural and intercultural studies to conflict resolution and focusses on national security and terrorism, with a specific expertise in the Middle East.

Photo: President of Pakistan

Pakistani President Arif Alvi, along with Turkish President Recep Tayyip Erdogan, at the venue to jointly inaugurate the first MILGEM ship, PNS BABUR, being built by Turkey in Istanbul.

the "Pakistan-Turkey brotherhood": all main streets had pictures of both Turkish and Pakistani presidents, while welcoming messages in both Turkish and Urdu could be seen in all public places. This brotherhood goes beyond the state level, being visible among Turkish and Pakistani people. It is a combination of a mixture of factors, that encompass cultural and historical values, religion, mutual trust and support, and the will to further develop their relations for the benefit of both nations.

In this regard, both Turkey and Pakistan have understood that connectivity with neighbouring countries and beyond is equally important. Furthermore, the recent resumption of the Islamabad-Teheran-Istanbul (ITI) goods train service is an important development. The ITI cargo train, with a capacity of 22 tonnes, started its journey from Islamabad on 21 December 2021, and arrived in Ankara in around 13 days. After a 10-year halt, the relaunching of the cargo train service between Turkey, Iran, and Pakistan is a major boost for trade among the three countries and within the region. Departing from the Margalla station in Islamabad, the train travelled 5,981 km (3,666 miles) in 12 days and 21 hours. Other ongoing projects in regional connectivity include the Trans-Afghan Railway project, CASA-1000 and the Turkmenistan-Afghanistan-Pakistan-India (TAPI) gas pipeline.

In recent years, Turkey has been developing its domestic arms industry, moving from being the world's third-biggest receiver of weapons to the 14th-biggest arms exporter, and aiming to achieve defence autarky. Turkey currently exports 228 different types of defence industry products to 170 countries around the world and targets becoming a top six country in the world in terms of defence and aerospace exports. Turkish arms transfers to Pakistan were estimated at US$112 million from 2016-2019, according to the Stockholm International Peace Research Institute (SIPRI). During this period, Turkey was Pakistan's fourth-largest source of arms, surpassing the United States, and Pakistan was Turkey's third-largest arms export market, according to SIPRI. These numbers have grown since 2018, when Turkey received orders from Pakistan exceeding US$3Bn. As part of the 2018 purchase, Pakistan will receive four (MiLGem) ADA class corvettes (due by 2024), two of which are being built in Pakistan, reflecting the collaboration in the field of defence technology transfer between the two states. Also, Turkey will deliver 30 T-129 Advanced Attack and Tactical Reconnaissance Helicopters (ATAK), by the end of 2022. These are intended to replace Pakistan's ageing fleet of American AH-1F COBRAs. Pakistan has also purchased Turkish armaments for its JF-17 fighter jet, jointly manufactured with China, Islamabad's main source of imported defence hardware. Most recently, the Turkish Aerospace Industries (TUSAS) CEO Temel Kotil announced the Turkish Fighter Experimental (TF-X) will be a joint Turkish-Pakistan project. The TF-X, first announced in 2016, is envisioned to be a twin-engine multirole aircraft focused on air-to-air capabilities but will also have air-to-surface roles. While the news has been confirmed by both sides, details regarding the cooperation are still to be released.

Foto: Bundeswehr

The fourth ship of PN MİLGEM, the biggest export project realised by the Turkish defense industry, was laid down with a ceremony at Karachi Shipyard on 5 November 2021.

Defence Cooperation

For its part, Ankara has procured training aircraft, drone parts, and bombs from Islamabad. Moreover, the two countries are also increasingly pursuing technological cooperation, as it was emphasised in the case of the MILGEM ADA class ship deal. Moving the defence technology development cooperation forward, Turkish Aerospace Industries (TAI) has also secured an agreement with Pakistan's premier engineering school, the National University of Science and Technology, for research and development cooperation and faculty and student exchanges. TAI has agreed to set up an office at Pakistan's National Science and Technology Park, a section of which will focus on defence projects, including cyberwarfare, drones, and radar technology. Both partnerships are currently implemented, reflecting the different dimensions of the so-called "defence oriented" strategic partnership between the two countries.

Turkey and Pakistan are aware of their individual and common strengths and vulnerabilities, which bring them closer to each other. While the emphasis has apparently been on the defence dimension of their partnership, Ankara and Islamabad acknowledge the strategic importance of prioritising economic cooperation centred on trade, financial partnerships, development projects, and tourism. This would not require any of the two sides to lower their security goals, but can, instead, empower the two sides and provide a stronger platform for further defence cooperation. As a matter of fact, President Erdoğan has addressed the parliament four times, exploring an economic dimension within the bilateral relationship. And there is no better time to improve the strategy to encompass all the interrelated dimensions of the strategic partnership between the two states. In the current international context, leaving behind a pandemic, stepping outside Afghanistan, and waking up to the reality of the Russia-Ukraine war, both Turkey and Pakistan have to accommodate their changing international roles into their strategic bond. ■

Viewpoint from Cairo

Photo: author

America's Egyptian Dilemma

J. C. Menon

The Egyptian military has been on a dramatic expansionary trajectory since President Abdel Fattah el-Sisi assumed office in 2014.

Between 2015 and 2020, Egypt's arms acquisitions increased significantly compared with the previous five years. The interesting aspect is, of late, Egypt is purchasing fewer weapons from the United States and more from European countries, mainly Germany and France. Early last year, Egypt announced an agreement with France to purchase 30 Dassault-built F3-R RAFALE fighter jets in a deal reportedly worth US$5Bn. The deal brings the total Egyptian Rafale fleet to 54 aircraft. The deal attains significance as it has opened the gates for more arms deal with Paris. Recently, Cairo also acquired four GROUND MASTER 400 (GM400) digital 3D air defence radars from another French companyThales.

Now Egypt is planning to buy additional military equipment, including a FalconEye observation satellite and Airbus A330 multi-role tanker transport (MRTT) aircraft. This will enable Egyptian air force to have air-refueling capabilities for the first time ever. Besides the aircraft deals, France is also expecting several naval dals from Egypt, including a contract to sell 20 new ships ranging from fast missile crafts to light frigates, corvettes and submarines to replace the ageing fast-attack crafts Tiger, October and Ramadan.

France's MBDA also was awarded a contract from the Egyptian Navy for the VL MICA NG (New Generation) air defence system to equip its corvettes. The Egyptian Navy already equips its four GOWIND class corvettes, recently procured from the French Naval Group shipyards, with systems from the VL MICA family.

Another European country benefitting from Egypt's military build-up is Germany. Just after last Christmas, the outgoing government had approved the export of armaments worth €5Bn during its last days in office, taking the overall volume of authorisations for arms exports in 2021 to €9Bn, the highest amount ever approved in one year. And the largest part of these exports were to Egypt.

A new arms deal is also reportedly under negotiation between Egypt and Italy. Despite their unpredictable relations, defence observers feel that the delivery of the first of two multi-role FREMM frigates by Italy in December 2020 could have marked the first step towards completing an order that could herald a much larger deal between the two countries.

Though US President Joe Biden's administration has approved a massive arms sale to Egypt valued at about US$2.5Bn, President el-Sisi doesn't have the faith in Washington as the latter keeps raising human rights questions before releasing military aid and hardware to the country. The Biden administration in January decided to halt US$130M of military aid to Egypt over human rights concerns. Egypt's involvement in the wars in Libya and Yemen is one of the most frequently cited reasons for criticism of arms deals with the country. Another point of criticism is Egypt's horrific human rights record. Egypt has become increasingly authoritarian since the military coup in 2013, and individual freedoms and liberties are harshly repressed. In reaction, the Egyptian regime at first harshly criticised the decision of the U.S. administration, but soon after began to actively try to improve its image.

The US decision comes close on the heels of an announcement approving a potential sale of air defence radars and C-130 SUPER HERCULES aircraft to Egypt for a combined value of more than US$2.5Bn. Rights groups have been calling on the Biden administration to block the entire US$300M of foreign military financing and the proposed sale of equipment to the Egyptian government.

The US tries to play a balancing act as the relationship with Egypt is very complex. The most populous Arab country is a vital ally and the defence deals actually serves US interests.

Probably, this uncertainty has forced the former Egyptian general to look towards more soft European nations for firepower to maintain the Egyptian army's reputation as one of the region's largest and standing forces.

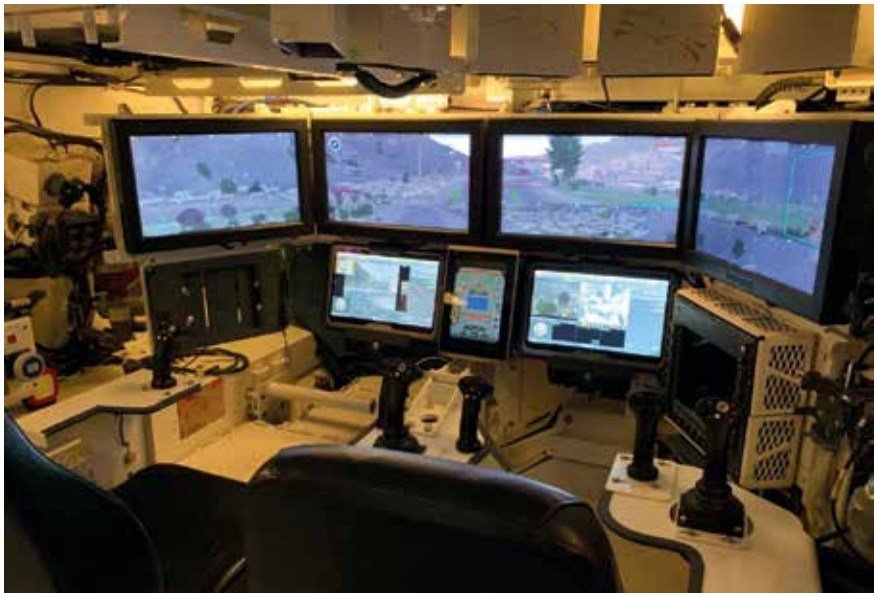
Sensor Fusion for Land Combat Vehicles

Tamir Eshel

Combat systems add more layers to battlespace perception when they rely on sensors, which expand situational awareness, electronics systems, networking, and cyber capabilities. They also help to process, disseminate and exploit information to overcome the hidden enemy from a distance in order to deny them the element of surprise.

Warfare has changed in the 21st century. For centuries, military forces have confronted each other on the battlefield, where sheer military might, size, troop numbers, and firepower have determined the outcome of the battle. The few examples where great leaders have won battles manoeuvring their small forces to surprise and overwhelm the enemy were the exception. The development and deployment of small anti-tank and anti-aircraft weapons, and also missiles able to achieve pinpoint strikes at long ranges, and the military and terrorist groups' use of urban areas, have brought about a significant change in modern warfare – the 'empty battlespace.' It is where the invisible enemy is hiding undercover, disguised as civilians, concealed underground or in urban dwellings, snipers, and anti-tank missile squads. Most of these are hardly seen by the human eye or optical sensors. They can launch coordinated attacks in multiple dimension strike vehicles from below by operating remotely operated improvised explosive devices or mines. Long-range missiles or loitering weapons or weaponised drones also strike from above. A conventional force facing such a hidden enemy is likely to be surprised, suffer significant losses and risk decimating its power before its units can reorganise and respond to the threat.

Photo: Rafael



At IAV 2022, Rafael displayed the Advanced Vehicle Integrated Combat Systems (A-VICS). A complete combat suite for armoured vehicles integrated around the Hypercore AI-Based Management System.

Locate the Enemy

Awareness of the threat requires soldiers to be able to detect and locate the hidden enemy. In the past, combat systems were characterised by their firepower, mobility, and survivability. Today, combat systems add more layers to their battlespace perception - sensors that expand situational awareness, electronics systems, networking, and cyber capabilities, to process, disseminate and exploit the information to overcome the hidden enemy from a distance, thus denying them the initial surprise. This advantage helps defeat the enemy with direct and indirect fires, employing manned-unmanned teaming to minimise warfighters' exposure to the threat.

The new concept offers an advantage over peer enemies, as it allows for a decisive engagement from long-range, delivering more accurate and lethal attacks. The land forces, especially the tactical elements, need real-time capabilities to locate those low signature threats.

Traditionally, combat vehicles have used optical and imaging sensors that assisted the crew in scanning the scene and detecting targets. However, against a hidden enemy, these means are no longer helpful. Multi-spectral sensors are required to see such low-signature targets from a distance. Operating in different wavebands, visual, thermal, acoustic, and millimetre-wave can spot an enemy presence and activity signatures and locate and engage those targets from a stand-off range.

Photo: Curtiss Wright

This 8-slot, user integration-ready powered enclosure uses natural convection cooling and is aligned to serve as part of the A-kit hardware infrastructure of the Modular Open Systems Approach (MOSA) for all future military platforms.

Sensors for Combat Systems

Most sensors used on combat vehicles employ passive imaging sensors – today, different sensors use bespoke displays for panoramic cameras, gunner and commander sights, driver vision systems, and optronic sensors mounted on weapon stations. These sensors can be connected to the crewmembers' displays that show the most relevant picture to address the user's interest. Moreover, by employing machine learning and artificial intelligence analysis on the live sensor feeds, the automated system constantly analyses the situation in search of signatures and patterns to spot and alert targets all around, even in sectors uncovered by the crew.

Radars are other sensors that can be employed in modern combat systems. The radar provides an active sensor, detecting missiles, drones, and other threats directed at the vehicle. As an active sensor, radar may be used in silent mode, be maintained in a standby mode, and triggered by other sensors, such as a laser-warning sensor or electro-optical fire locator. Tracking a moving target, the radar can plot the ballistic trajectory of the target, predict the impact point, and calculate the point of origin to enable a quick counterstrike against the launcher. Other sensors use acoustic sensors designed to detect and locate hostile fire sources, such as sniper, gun, or rocket launches. Such information can be correlated with other sensors to refine alerts and situational pictures.

Other sensors that may be employed are signals intelligence (SIGINT), detecting human activity in the radiofrequency (RF) spectrum. Such signals include cellular or radio electronic signatures depicting enemy activity. Tactical SIGINT sensors may geolocate such signals and assist in the target location, early warning, and situational awareness.

Connecting the Edges

Situational awareness cannot be developed based on sensors alone, as excessive information clutters the view and disrupts the crew's situational perception. Combining multiple sensors feeds into a single situational map. The user interface should

be simplified and decluttered, presenting the user the clearest, most relevant information for decision-making and response. Sensor fusion is complex, as it requires significant computing power and high-speed connectivity to transfer and process large files in real-time. With multiple sensors mounted on combat vehicles, it is an even more complicated task, with Space, Weight, and Power (SWaP) constraints.
Connecting all onboard sensors to a central processing unit is a complex and costly business, mainly when the sensor delivers raw images to the processor, which requires effective high bandwidth local network connectivity. To reduce the bandwidth needed for data transfer, sensors employ edge processing, with a local processor coupled with the sensor to perform essential image processing and compression functions that significantly reduce the volume of data transferred to the vehicle's sensor fusion processor, where more complex algorithms are employed, along with AI/ML computing.

Photo: HENSOLDT

Open Systems Standards

Systems designed with the Modular Open System Approach (MOSA) to weapon systems set the standard to rapidly share such information from machine to machine, both at the edge and centre. Such systems provide the rugged, physical hardware, power, cooling, and RF connectivity, with standards-based slots ready to receive electronic commercial off-the-shelf (COTS) subsystems driving software-based mission-specific functions. As COTS hardware, these cost-effective building blocks provide the interoperability and flexibility needed to deploy systems across land, air, and sea platforms. On the sensor side, the Sensor Open System Architecture (SOSA) provides the standard framework for transitioning sensor systems to an open systems architecture. While SOSA is a voluntary recommendation assumed by more than 50 consortium members, it gives users flexibility in selecting and acquiring sensors and subsystems for sensor data collection, processing, exploitation, communication, and related functions over the complete life cycle of the systems.
While bespoke solutions often provide higher performance than COTS-based systems, adhering to COTS and open standards enables more frequent upgrading and enhancements of electronic and electro-optic systems, adding more advanced capabilities over time at a much faster pace and lower cost. For example, machine learning applications take signal processing and threat identification capabilities to new levels of speed and intelligence. This type of application compares actual world data from sensors to millions of examples it has been trained to identify. The application uses the result of the comparisons to make decisions, take actions, and provide warfighters with the insight they would not otherwise have.
The advanced software in a machine learning application relies on complex algorithms that can quickly process large volumes of data. To execute that advanced software depends on the speed and processing power provided by specialised hardware that likely isn't available on the platform today. When all system components follow MOSA, the processor card driving the traditional image processor application can be replaced with a more sophisticated card that drives a machine learning application. With updated software and a simple card swap, warfighters can access essential new threat identification capabilities with minimal disruption and no increase in SWaP.
While machine learning is a specific example of the need for speed in the field, the requirement to more quickly process ever-increasing volumes of data from more sources applies to almost every application in use today. With the ability to almost instantly upgrade any card type that performs any function, in any system, with a faster, more powerful replacement,

Photo: Tamir Eshel, Defense Update

This integrated camera module (ICM) is part of the SETAS (see-through armour system) from HENSOLDT. The camera views can be displayed on digital screens or in augmented reality on helmet-mounted displays shown above the ICM.

warfighters have new opportunities to stay ahead of threats and increase their tactical advantage.

Such upgrades may use Field Programmable Gate Array (FPGA) cards optimised for radar, electronic warfare, signal intelligence, radar warning receivers, or software-defined radio applications. Image processing may use General Purpose Graphics Processing Units (GPGPUs) that bring TFLOPS of processing power to Electro-optical/infrared (EO/IR) applications. These GPGPUs are essential to capture and manipulate substantial data streams from gigapixel cameras. Software-defined radio modules and Position, Navigation, and Timing (PNT) timing cards also eliminate the need for disparate PNT services for each system. Having a CMOSS-aligned timing card embedded in the central processor enables all connected systems to be interoperable with each other, ensuring a consistent and standardised positioning and timing reference. It is possible to significantly reduce SWaP-C by replacing large, individual radio boxes with a small card requiring only one chassis slot.

NATO vetronics standards follow the Generic Vehicle Architecture (GVA) and NATO GVA (STANAG 4754) standards.

Saab offers several Rugged series systems designed to comply with the GVA and NGVA standards. The Rugged Vehicle Computer (RVC) is a high-performance vehicle computer unit based on the 7th Generation Single board computer platform designed to comply with contemporary vetronics standards. Another computer, the Rugged Vehicle Computer-Embedded, RVC-E, is a fully rugged, super compact, high-performance computer unit developed for powerful applications driven by an NVIDIA Jetson TX2-platform. The RDC10 display packs an Intel Core i7 CPU platform, several external interface ports, and customised connector housing/ connector configuration. Both are designed to meet DEF STAN 23- 09 GVA and STANAG 4754 NGVA.

Next-Generation Combat Vehicle Vetronics

Vetronics applications can be implemented during vehicle upgrades but are often implemented to a larger scale in new vehicle designs. One such example is Elbit Systems Torch-X Mounted, designed to comply with Generic Vehicle Architecture (GVA) vetronic standards. The system provides a centralised user interface that combines all platform sensors and effectors, providing the commander and crew with a single interface for unified and integrated situation awareness based on all the vehicle's and combat team's sensors and effectors. The system's AI-based decision support optimises the use of sensors and effectors.

Another example of future programmes is the Franco-German Main Ground Combat System (MGCS), replacing Germany's LEOPARD II and France's LECLERC Main Battle Tanks (MBT). MGCS is driving the requirements that would implement AI-empowered sensor fusion. MGCS is not seeking to replace the MBTs one-to-one as was the case with new tank programmes, but rather will employ a system-of-systems approach that incorporates manned and unmanned ground vehicles and unmanned aerial systems with advanced automatic targeting and self-protection capabilities. Connectivity between the vehicles, sharing situational awareness, and targeting requires fusion and AI not only on board each vehicle, but also extend across sensors and vehicles through a high-speed broadband network.

German electronics system house HENSOLDT is one of the solution providers positioned to deliver such an integrated sensor fusion network. The company already provides the see-through armour system (SETAS) that offers a 360-degree view for the crew, even in areas the users are not looking at. SETAS can integrate and communicate with other systems; for example, sharing geo data-based objects to a neighbouring vehicle; this data can be collected from different battlefield areas and fused into a multi-dimensional situational picture. Onboard processing makes this possible because it is carried out close to the sensor and does not require data transfer elsewhere.

Elta Systems' Athena AI core represents an innovative approach for optionally manned fighting vehicles. The system was implemented on the Carmel technology demonstrator. Athena autonomously combines all data received from external and internal sources, including EO, radar, and SIGINT. Then, it analyses and classifies targets, prioritises the response, and displays the situational picture to the crew for assessment and decision-making. Athena also provides recommendations for action and follows those decisions by closing the operative loops with the appropriate effectors on and off-board.

AI will ultimately have the most significant impact in instances where it is emulating a human's abilities rather than just those of the human brain – that is, where it can assess information in the same way a human can. AI's ability to conduct sensor fusion and track correlation – drawing on a wide range of inputs and far quicker than human operators – will bring a step-change in capabilities. ■

HENSOLDT Battlespace Sensor Fusion – Removing the "Fog of War"

In recent weeks the world has been reminded of how critical it is to have a robust and capable defence and security solution that ensures our current and future way of life can be protected. Continually evolving threats must be effectively countered and the adversaries' weaknesses exploited to ensure success within any contested battlespace. This must also be achieved with minimal collateral damage. This emerging technology must also be made available to any future commander and fully integrated to make the best use of its capabilities on the battlefield. Now more than ever some of this technology has a decisive effect not just during but also before the battle!

During a prolonged period of relative "quiet" it is clear that many standing armies have potentially neglected their conventional war fighting capabilities. During this time technology and innovation has been focused on predominantly asymmetric threats, peaceful and civil applications. During these periods these significant advances are used by irregular and terrorist entities as a cheap and accessible tool that bypass many of the now obsolete equipment used by conventional forces. The widespread use of small UAV for intelligence gathering and even attacks on armoured vehicles is a good example of this.

Hybrid warfare methods are increasingly emerging, manipulating opinion-forming and decision-making mainly through actions in cyberspace, social media and not least through significant misinformation. Digital tools used for co-ordination are becoming more potent and are even utilised by irregular forces. We must, in this new global situation, rapidly embrace this new technology to ensure the relevance of our defensive capabilities. The digitalisation of the world has accelerated data gathering processes and increased the availability of information. Today decision-makers have more information at their disposal than in the past, which doesn´t necessarily mean a better picture of the situation, because time pressure has increased proportionally with this added information. As a result, modern data fusion techniques must be applied in order to condense all data and information in time.

This is precisely why we need to use digitalisation in a pre-selective and targeted manner for our armed forces. By using new technologies, we can evaluate and condense data so that decision-makers gain time for their actual task of assessing the situation and deriving options for action.

We must allow a commander more time to make the right decision by accelerating the situation awareness process through assistance systems.

HENSOLDT is able to network a wide variety of heterogeneous sensors and automatically evaluate the data obtained. Our systems provide a significant advantage in the situation determination process. The user is now able to significantly reduce effort in the sensor gathering phase to employ this extra capacity in timely decision making based on a much greater tactical appreciation than ever before.

HENSOLDT is pursuing a bottom-up approach by first networking all the reconnaissance sensor technology within a vehicle. We also ensure the sensor data obtained can be networked across multiple vehicles. This incremental approach safeguards that we always keep the big picture in mind, but that decisive capability gains can be achieved in the short term.

The detection, classification and localisation of the operator's sensor fields of view is done using image processing and machine learning algorithms. The sensor data fusion hardens the information obtained and reduces false alarms enormously. In this way, a process that today takes minutes can be shortened to milliseconds. What one operator sees; is now available to everyone instantly if required or relevant.

For the realisation of this system, HENSOLDT has the necessary and specific understanding of sensors of the entire spectral range. **We accelerate the situational awareness process for planning and decision making through the automatisation of fused multiple sensor data.**

Why HENSOLDT is the best partner for Sensor Data Fusion for Land Applications:

- HENSOLDT = Solution developer and provider
- Understanding of the operator's capability requirements and challenges
- In-house sensor competence in every wavelength
- Sensor-based reconnaissance in all spectral ranges
- Extensive experience in huge automated sensor networks
- Expert in processing and evaluating various sensor data
- Working closely with emerging technologies to ensure we are always at least one step ahead

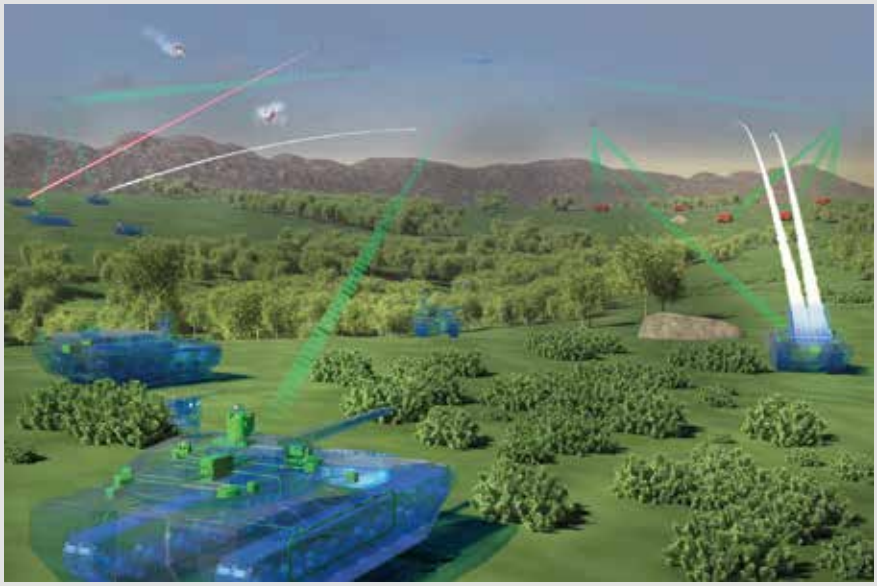


Photo: HENSOLDT

For HENSOLDT, Sensor Data Fusion is also a big part of the Ground Combat System (MGCS). At the core of MGCS lies the networking of optronics, radar, self-defence, electronic warfare capabilities and laser communication. The sensor solution specialist, as a one-stop shop that covers all of these areas, enables flexible, modern system design.

Manned-Unmanned Teaming: Airborne Systems

Sidney E. Dean

Unmanned aerial systems (UAS) and other relevant technology (artificial intelligence or AI, wireless data networking, electronic support measures to defeat adversarial electronic warfare) have progressed to a point where UAS are considered capable – in principle – of performing almost any mission currently conducted by crewed aircraft.

As a consequence, numerous armed forces are actively experimenting with manned-unmanned teaming (variably abbreviated as MUM-T or MUMT). By deploying manned and unmanned assets as a unit rather than separately, the uncrewed element maximizes its value as a force multiplier, enhancing lethality and survivability in highly contested airspace. Direct control of the UAS can rest with the manned element of the flight, or with a separate airborne, ground or maritime command centre. Over time, advances in AI should permit the uncrewed team elements to perform a significant portion of their missions autonomously. This could ultimately reduce human intervention to input of mission goals, definition of rules-of-engagement, and authorization of weapons release. In fact, such autonomous capabilities will be essential to the MUM-T concept to prevent human pilots from becoming overwhelmed with additional tasks controlling the UAVs. Primary applications for the UAS include targeting reconnaissance and battle-damage assessment for the manned aircraft; electronic warfare; data and communications relay/interface between various manned or unmanned platforms; and armed escort. In the latter role, the UAS can either suppress enemy air defences (SEAD role) in advance of the manned platform, or serve as an external arsenal enabling a single manned plane to attack a significantly larger number of targets per mission.

Photo: GA-ASI

The Boeing AH-64E APACHE helicopter and the General Atomics optionally armed MQ-1C UAV form the core of the US Army's current aviation MUM-T programme.

Photo: Schiebel

Various continental armies are pursuing MUM-T capabilities. In 2018, an Airbus H145 manned helicopter and a Schiebel S-100 CAMCOPTER demonstrated Level 5 teaming (the helicopter crew controlled all aspects of the UAV's flight including take-off and landing), with the UAV conducting reconnaissance ahead of the H145.

Rotary Systems

US Army MUM-T

The acronym MUM-T was originally coined by the United States Army, which conducted first experiments in 2009. Current efforts center on teaming the AH-64E APACHE GUARDIAN attack helicopter with fixed-wing UAS. MUM-T will also be an integral element of the US Army's Future Attack/Reconnaissance Aircraft and Future Long Range Assault Aircraft, which are discussed separately in this issue of ESD.

The AH-64E APACHE GUARDIAN is the latest and presumably final iteration of the APACHE attack helicopter family. The "E" variant is specifically designed for the requirements of peer and near-peer warfare. In addition to numerous sensor and avionics upgrades, the new variant has significantly upgraded networking capabilities to support MUM-T operations. Like

earlier APACHEs configured for manned-unmanned teaming, it is equipped with the MUMT-2 data link which permits seamless sensor and targeting data transfer between manned aircraft and UAS. The manned helicopter can also relay sensor data from UAVs to ground forces, contributing to a comprehensive situational awareness and operations network. A planned improvement will replace the MUMT-2 with the MUMT-X data link currently being developed by L-3 Communications. It will include a ROVER 6 transceiver, multiband radio-frequency equipment and a multidirectional antenna capable of transmitting multiple high-definition video streams simultaneously. MUMT-X will increase available bandwidth and extend communications range, enhancing situational awareness and combat efficiency of both the airborne team and friendly forces.

Photo: KAI

Flight testing of the Korean Army's new Light Armed Helicopter prototype. Development of the LAH is expected to be complete by late 2022. It will subsequently be equipped with MUM-T capability.

Advancing Capabilities

The US Army conducted its first operational deployment of manned-unmanned teams in 2015, with AH-64s of the 101st Airborne Division successfully integrating with US Air Force MQ-1C UAVs. The unmanned aircraft – which were controlled by ground operators – were able to locate and illuminate targets for APACHEs' missiles while the manned helicopters remained at standoff-range or raced in for the kill. The teaming resulted in the elimination of multiple mobile targets, some of which were detected while 100 kilometres away from the waiting AH-64.

Since then, increasingly sophisticated and complex operational capabilities have been achieved. The crew of an AH-64E APACHE helicopter can currently control up to three

Photo: USAF

A US Air Force F-22 RAPTOR and F-35A LIGHTNING II fly in formation with the XQ-58A VALKYRIE UAV during a series of tests in December 2020.

Photo: courtesy AFRL

The XQ-58A VALKYRIE demonstrates the separation of the ALTIUS-600 small UAS in a test at the U.S. Army Yuma Proving Ground test range, Arizona. This test was the first time the weapons bay doors have been opened in flight.

Photo: AFRL

A VALKYRIE prototype utilising Rocket-Assisted Take-Off (RATO) to operate from short or improvised runways

armed MQ-1C GRAY EAGLE UAVs or three unarmed RQ-7B SHADOW UAVs. This includes full control of flight operations (except for take-off and landing, which the UAVs conduct autonomously), sensors and weapons, and constitutes the highest interoperability level (Level 4 Teaming).

In October 2020, the US Army announced that a new milestone had been reached at the Dugway Proving Ground (DPG) test range. It was the first instance of a three-aircraft team operating together to destroy a target. The team consisted of an AH-64E, an RQ-7B and an MQ-C1. Some 50 kilometres separated the aircraft during the actual engagement. The unarmed RQ-7B reconnaissance UAV detected a target and relayed the coordinates to the pilot of the APACHE. The pilot assumed control of the drone's laser targeting system and illuminated the target, while directing the MQ-1C to fire a HELLFIRE missile. The successful test was repeated a few days later, this time firing a Small Glide Munition.

"Demonstrating this level of interoperability is a big step forward for MUM-T possibilities," said Doug McDaniel, a senior engineer with the Rapid Integration and Acceptance Center (RIAC), a tenant organisation at DPG who helped orchestrate the flight tests. "At some point, these kind of cooperative engagements will be used in combat. This is a big first step." Enabling the manned helicopter to engage targets from beyond line of sight – including from behind visual barriers such as hills or mountains – using UAVs as surrogate sensor and weapons platforms will not only enhance force protection. A single manned crew can cover an area of operations which previously required multiple gunships, permitting a squadron to disperse its manned forces and engage a larger number of enemies in a shorter time.

Several European land forces – including the British and Netherlands armies – are acquiring the AH-64E and will also pursue the MUM-T capability.

South Korea

The concept is being pursued in Asia as well. The South Korean Army's new Light Armed Helicopter (LAH) and the new Surion Maritime Attack Helicopter (MAH) will both have a MUM-T capability currently being developed by Korea Aerospace Industries (KAI). The development contract between the South Korean Defense Acquisition Program Administration (DAPA) and KAI calls for development of the MUM-T system to be complete by December 2022, with subsequent testing aboard a Surion helicopter. Both manned helicopter types

are expected to be paired with domestically developed multimission UAVs. "The MUM-T will be available in four different modules, each designed for one of the following four roles: reconnaissance, electronic warfare, deception, and suicide missions," a KAI spokesman said in October 2021 during the ADEX 2021 exposition in Seoul.
Up to four UAVs will be carried aboard the manned LAH in externally mounted launch canisters. A full-scale MAH mock-up presented at ADEX 2021 featured 13 UAVs, including nine mounted inside the aft fuselage. KAI has released an animated video showing the UAVs unfolding wings after launch and deploying as reconnaissance assets, relaying sensor data to an operator in the back of the manned helicopter. When viable targets are identified the operator can convert the UAVs to attack munition mode. According to DAPA, the launch system could be ready for deployment by 2026. KAI also unveiled a more sophisticated concept during ADEX 2021. An animated video showed an unmanned variant of the LAH which could operate jointly with manned aircraft. The company suggests that several unmanned UAS could deploy together with a single manned helicopter, multiplying firepower and sensor capabilities while reducing risk to human crews. The unmanned LAH could also team with the Korean Army's AH-64E APACHE GUARDIAN, acting as a scout or neutralising enemy air defence systems in advance of the manned helicopters.

Tactical Fixed Wing Aircraft 8800

A technologically more ambitious concept seeks to pair fixed wing manned and unmanned jet aircraft for joint missions. The United States Air Force (USAF) has taken the lead here.

Photo: US DoD

The General Atomics MQ-20 AVENGER UAS has an internal weapons bay and six external hardpoints. It has a 2,950 kg payload capacity and carries a wide range of ordnance and sensors.

Photo: USAF

The General Atomics MQ-20 AVENGER UAS hosted the SKYBORG Autonomy Core System for testing during Orange Flag 21-2 exercise in June 2021.

Photo: Commonwealth of Australia Department of Defence

Testing the Boeing Airpower Teaming System – AKA LOYAL WINGMAN – over Australia's Woomera Range Complex in February 2021

Photo: Boeing

Boing developed the Royal Australian Air Force's LOYAL WINGMAN prototype.

USAF SKYBORG

USAF's initiative was originally dubbed the "LOYAL WINGMAN" to reflect the UAS' support function for manned combat aircraft, but has been redesignated as the SKYBORG programme. The term SKYBORG actually refers to the AI control system being developed for the UAS. The future airframes per se are being developed under the Low-Cost Attritable Airframe Systems or LCAAS programme.

To be clear, the terms "low cost" and "attritable" do not mean that the unmanned aircraft are considered "disposable" assets. The unmanned units will be configured for a service life stretching over several years. Significant investments are being made to develop sophisticated capabilities. However, the estimated acquisition cost of circa US$3M per unit will be significantly lower than those of crewed aircraft with similar mission profiles. This will permit acquisition of a larger number of airframes, and will make loss of aircraft acceptable if the tactical or strategic goal of the mission warrants, or if sacrificing the UAV secures a manned unit. Effectively, "suicide missions" against high value targets will become an option. Since UAS are configured for a shorter service life, they will not require depot-level maintenance or service life extensions. Aside from the cost savings, the shorter service life also will enhance aircraft capabilities. New UAS will be acquired at shorter intervals, ensuring that incoming airframes (or even new designs) will reflect the very latest technology and operational concepts.

Whichever fuselage design and payload packages are eventually selected, the true key to successful MUM-T integration lies with the SKYBORG AI system being developed by the Air Force Research Laboratory (AFRL). The software suite, which will enable the UAVs' autonomous flight as well as their flawless response to external control, is formally designated as the SKYBORG AUTONOMY CORE SYSTEM or ACS. The ACS was validated during a multi-months test series in 2021, culminating in participation in the Orange Flag 21-2 Large Force Event in California in June of that year. Operating autonomously during that event, the ACS accomplished basic aviation behaviours and responded to navigational commands, while reacting to geo-fences, adhering to aircraft flight envelopes, and demonstrating coordinated manoeuvring.

During the multi-months validation phase, the software was successfully integrated on two very different UAVs, the Kratos UTAP-22 MAKO and the General Atomics - Aerospace Systems Inc. (GA-ASI) MQ-20. "Flying the SKYBORG ACS on platforms from two different manufacturers demonstrates the portability of the Government-owned autonomy core, unlocking future multi-mission capabilities for the Joint Force," said AFRL commander Major General Heather Pringle.

Moving to a Programme of Record

The next stage is testing the ACS on operational or developmental prototype UCAVs which might eventually be selected as MUM-T assets. Three competing firms had been selected in December 2020 to test ACS

Photo: Boeing

Artist concept of the Boeing ATS operating with a manned fighter

on their airframes. Boeing is participating with the Airpower Teaming System already being developed for Australia; GA-ASI is using the MQ-20 AVENGER UAS; and Kratos is employing the XQ-58A VALKYRIE UAS.
The first phase under these two-year contracts saw the firms prepare and deliver the test aircraft. In August 2021, USAF announced the beginning of the next phase. Both GA-ASI and Kratos will integrate ACS on their aircraft and deploy them in various large-force exercises. ACS will also be flown on the Boeing ATS during 2022, according to the SKYBORG Program Executive Officer for Fighters and Advanced Aircraft, Brigadier General Dale White. During testing, the UAV will be controlled by a highly modified F-16D previously used to train test pilots. This aircraft has been redesignated the X-62A.
Speaking in August 2021, General White confirmed USAF's goal of transitioning SKYBORG to a programme of record in 2023, although he expressed concerns regarding budget approval. In December 2021, Air Force Secretary Frank Kendall declared that the 2023 budget request will include funding for two MUM-T specific UAS acquisition programmes. Both programmes remain classified, but Kendall stated that the UAS are intended to serve as escorts for manned fighters and bombers. He did not specify a timeline for introducing the new capability into the force, but said that preparations for the new programme of record were underway. "The technology is there now, where we can talk about a formation of a manned aircraft controlling multiple unmanned aircraft," Kendall said on 19 January 2022 during a forum with the Center for a New American Security. "There's enough technology in existence from programmes that we have already conducted, it convinces me that's not a crazy idea."

ATS / LOYAL WINGMAN

Other nations are pursuing LOYAL WINGMAN programmes analog to the USAF project. The Royal Australian Air Force (RAAF) is currently testing two prototypes of the Boeing Airpower Teaming System (ATS) at the Woomera Test Range in the nation's south. First flight of the UAS took place in February 2021. The focus of testing is currently on integration of AI systems inti human-led teams.
The prototypes, which were designed and built in Australia by Boeing, have a range of 3,700 km. The nose section can accommodate various payloads. While the airframe could be configured to carry weapons, the RAAF is officially planning to employ the UAV as a reconnaissance and targeting asset for its manned partner aircraft. Australia has already placed orders for six units. Boeing plans to market the ATS globally.

Photo: UK MoD

Artist concept of manned-unmanned combat aircraft teaming. The RAF plans to deploy flights of one manned and three unmanned fighters.

Photo: Airbus

At the heart of FCAS, manned New Generation Fighters teaming with unmanned Remote Carriers as force multipliers will form the Next Generation Weapon System or NGWS.

Photo: UK MoD.

Artist's concept of an RAF MOSQUITO LOYAL WINGMAN operating alongside an F-35

RAF MOSQUITO

The British Royal Air Force (RAF) LOYAL WINGMAN programme is also known as Project MOSQUITO. The UK MoD issued a three-year prototype design and manufac-

Photo: Airbus

Artist's concept of the Future Combat Aircraft System encompassing manned aircraft and unmanned Remote Carriers controlled via satellite link

Photo: Airbus

Remote Carrier UAVs of the Future Combat Aircraft System

Photo: Airbus

Networked flight including manned EUROFIGHTER and NGF fighters and unmanned Remote Carriers

ture contract in January 2021. The prime contractor and airframe designer, Belfast-based SpiritAerosystems, is partnering with Northrop Grumman UK (AI, networking, human-machine interface), and Intrepid Minds (avionics and power). The RAF's Chief of the Air Staff, Air Chief Marshal Sir Michael Wigston, is on record stating that the prototype is expected to fly by the end of 2023. "Project MOSQUITO, our autonomous combat aircraft has continued to advance at pace, building on the £30m contract awarded to the Spirit Aerospace-led Team MOSQUITO to design and manufacture a demonstrator that could form part of the Combat Air force mix," he said during the September 2021 DSEI exhibit. "This is a game-changing project, in every sense, and it is going really well. So much so, that I'm confident enough to announce that we will see the MOSQUITO demonstrator flying in UK airspace by the end of 2023, perhaps even for DSEI 23." The LOYAL WINGMAN will deploy both air-to-air and air-to-ground weapons, and team with the RAF's TYPHOON, F-35 LIGHTNING II, and future TEMPEST manned fighters. The ratio of manned to unmanned aircraft per flight is expected to be 1:3.

FCAS – Future Combat Air System

MUM-T is also at the heart of the Anglo-French Future Combat Air System or FCAS being developed by Dassault and Airbus. It will consist of a manned combat aircraft (the Next Generation Fighter – NGF) and a variety of UAS designated collectively as Remote Carriers (RC). Various classes of RC will be included, ranging from small loitering munitions to large, sophisticated LOYAL WINGMAN type aircraft capable of deploying air-to-air, air-to-ground, and electromagnetic weapons. The NGF and the RCs will be seamlessly networked to form the Next Generation Combat System (NGWS). The full FCAS concept – with the NGWS as its core – is expected to be operational by 2040. However, Airbus and Dassault are developing interim MUM-T options for European air forces. The upgraded EUROFIGHTER TYPHOON LTE (Long Term Evolution) variant is expected to team with first-generation RCs in the early 2030s. A major milestone in that direction was achieved in June 2020 during the German Air Force's Timber Express exercise. Both EUROFIGHTER and TORNADO aircraft were able to identify and assume control of Airbus Remote Carrier prototypes via Link 16, commanding the UAVs to attack specific targets. No technical modifications to either the manned aircraft or the RCs (which currently are equipped with the Compact Airborne Networking Data Link or CANDL) were necessary.

FCAS – French PA-NG

FCAS will also deploy on the French Navy's next generation aircraft carrier (Porte Avion Nouvelle Génération – PANG) which is expected to be completed by 2038. However, the unmanned elements of FCAS will likely not be added to the carrier air wing immediately. That being said, the French Navy has already tested the viability of the maritime LOYAL WINGMAN concept. Dassault's nEUROn UCAS technology demonstrator has conducted numerous test flights over the Mediterranean since 2016. This includes scenarios in support of the French aircraft carrier Charles de Gaulle, as well as simulated strike missions against the carrier group (at no time did the nEUROn land on the de Gaulle). The UCAS is remote controlled from a ground station or from manned combat aircraft, making it MUM-T capable.

US Navy MUM-T

The US Navy (USN) is pursuing numerous high-performance unmanned jet programmes for service on aircraft carriers.

USN MQ-25 STINGRAY Tanker

The US Navy plans to introduce a carrier-based unmanned refuelling aircraft, with

the first four MQ-25A STINGRAY UAS scheduled to achieve initial operational capability (IOC) in 2024. Initial planning calls for six STINGRAYS per carrier air wing. Performance parameters include a fly-out range of 930 kilometres from the host ship; the UAS are expected to extend the operational range of manned F/A-18 and F-35 combat aircraft by up to 500 km. The STINGRAYS will also be capable of secondary missions including communications relay, reconnaissance and battle damage assessment, although the Pentagon denies plans to utilize the UAS in these capacities during the first years of operation.
The MQ-25 will not be a true MUM-T asset, as it will not be integrated into or controlled by flights of manned aircraft. Specialized Unmanned Aviation Warfare Centers (UAWC) are being installed on all US Navy FORD class aircraft carriers, and retroactively on NIMITZ class carriers, to provide command and control for the STINGRAY.

Unmanned F/A-18 Testing

However, other MUM-T capabilities – including UCAS – are being developed for the fleet. In early 2020 Boeing announced that the Navy Warfare Development Command successfully flew two autonomously controlled EA-18G GROWLER electronic warfare (EW) aircraft as unmanned air systems using a third (manned) GROWLER as a mission controller for the other two. Over the course of four flights, 21 demonstration missions were completed. The demonstration "allows Boeing and the Navy the opportunity to analyze the data collected and decide where to make investments in future technologies," said Tom Brandt, Boeing Manned-Unmanned Teaming demonstration lead. "This technology allows the Navy to extend the reach of sensors while keeping manned aircraft out of harm's way [and] enables a single aircrew to control multiple aircraft without greatly increasing workload."
The test also proved that the current state of technology is sufficient to convert high-performance manned aircraft into UAS. Since the conventional F/A-18 SUPER HORNET and the GROWLER enjoy 90 percent commonality, the experiment also implies that the US Navy could soon be capable of fielding unmanned strike fighters as well as EW aircraft equipped with jammers and anti-radiation missiles. Such a configuration could be deployed against enemy anti-access/aerial denial installations without endangering human aircrews. The demonstrated MUM-T capability is significant in this context, as the manned escort could control the UAS via jam-proof short-range communications.

Photo: Dassault

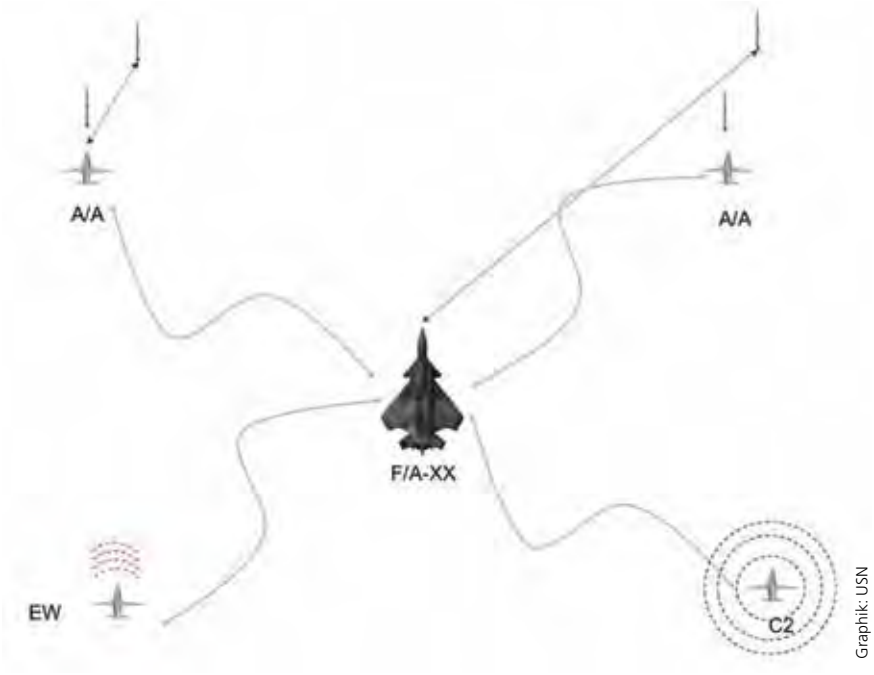
nEUROn and Rafale M side by side over the aircraft carrier CHARLES DE GAULLE

Photo: Kevin Flynn/Boeing

The Boeing MQ-25 T1 test asset transfers fuel to a US Navy F/A-18 SUPER HORNET in 2021, marking the first time in history that an unmanned aircraft has refuelled another aircraft.

Photo: USN

A MQ-25 test aircraft uses the probe-and-drogue method to refuel an F-35 combat aircraft in September 2021.



Graphik: USN

Concept of a US Navy carrier based NGAD flight. This notional configuration centres around a manned combat aircraft supported by two unmanned escorts armed with air-to-air missiles, and receiving further support from unmanned electronic warfare and command and control assets.

Photo: AFRL

Artist concept of a SKYBORG UCAV

Photo: USAF

The SKYBORG autonomy core system launches aboard a Kratos UTAP-22 tactical unmanned vehicle at Tyndall AFB, Florida.

USN Next Generation Air Dominance

The US Navy is currently developing plans for a carrier-based Next Generation Air Dominance (NGAD) aircraft family to begin replacing the F/A-18 in the 2030s. Not to be confused with the US Air Force programme of the same name, this NGAD will consist of a (presumably) manned core aircraft (currently designated F/A-XX) supported by various UAVs. The unmanned planes will be configured for various mission-types. Equipment options will include reconnaissance sensors and, communications links/relays, as well as kinetic and electromagnetic weapons. Armed unmanned elements are expected to engage both aerial and surface targets.

NGAD's integrated MUM-T formation is considered a major tool to counter sophisticated Anti-Access/Area Denial (AA/AD) networks such as those being established by China in the East and South China Seas. Both the manned aircraft and the unmanned wingmen are expected to have low-visibility characteristics, enabling them to close on enemy positions, ships and aircraft. Controlling multiple platforms will enable the crew of the F/A-XX to engage a broader range of targets per mission, and send UAVs against heavily defended targets. In this way, the carrier-based MUM-T flights can open gaps in enemy AA/AD systems, which can subsequently be exploited by other manned aircraft and by ships.

NGAD is currently in the concept development phase. The programme office was formally established in May 2020. The USN is currently refining requirements for NGAD, and expects to have a better idea regarding composition and capabilities profile by 2024.

Face of the Future

Adversial forces are pursuing on their own MUM-T programmes. Russia 's Kronstadt Group publicly presented the GROM UCAV in September 2020. The company cited a cruising speed of 800 kph and a sprint speed of 1,000 kph. The UCAV is designed to team with the manned Su-35 and Su-57 fighter aircraft. With up to 2,000 payload capacity, it could be deployed for SEAD and general strike missions. The PRC is known to be pursuing several LOYAL WINGMAN category projects. China reported in 2019 that its developmental SKY HAWK UAV had demonstrated the ability to communicate and collaborate with manned aircraft. The supersonic DARK SWORD UCAS resembles a cockpitless version of the manned CHENGDU J-20 stealth fighter, which entered service in 2017. The current status of the DARK SWORD is unknown. However, images of a two-seat variant of the manned J-20 were published in 2021. Western analysts speculate that this variant is designed for operational control of high-performance UCAVs.

Once the realm of science fiction, aerial MUM-T systems are entering service within the next decade. While far from signalling a future restricted to robotic warfare, the capabilities inherent in hybrid formations will impact operational concepts, potentially shifting the tactical advantage from air defence back to offensive air forces. ■

Winning Against Drones

John Antal

Masking is vital to a credible C-UAS defence. It is the full-spectrum, multi-domain effort to deceive enemy sensors and disrupt enemy targeting.

Photo: Ukrainian Ministry of Defence

Images of a TB2 Unmanned Aerial Combat Vehicle (UCAV) attacking a Russian convoy in Ukraine at the beginning of the Russian invasion

Hunter and prey in the Ukrainian battlespace: A BAYRAKTAR TB2 Unmanned Combat Aerial Vehicle (UCAV) flew within range of a Russian BUK Air Defence System (NATO reporting name SA-6 GAINFUL) that was halted along a road near Zhytomyr, Ukraine. The Ukrainian TB2 pilot recognised there were no active Russian air defence countermeasures. As the TB2 swooped into missile range, the drone's high-resolution camera zeroed in on the target and the operator launched its deadly payload. In seconds, the SA-6 exploded into a brilliant fireball.

Robotic, top-attack systems like the Turkish-made TB2 play a critical role in modern warfare, which is only now being fully appreciated. UCAVs and Loitering Munitions (LMs) provide a relatively inexpensive sense-and-strike capability to speed up the kill-chain. These unmanned aerial sense-and-strike systems are hard to counter. They came of age during the Second Nagorno-Karabakh War in 2020, when Azerbaijan won a decisive 44-day victory over Armenia. Armenia held the high-ground and had prepared their defences in mountain strongholds for 26 years, but those advantages did not matter. The Armenians had no means to counter the Azeri UCAVs and LMs. Few expected the Russians to have a similar problem against such slow-moving drones, but the evidence is clear, as Ukrainian UCAVs have inflicted devastating attacks on the Russian army. High-end air defence systems that were built to detect fast-moving aircraft and missiles appear to have a difficult time identifying and engaging these slow-moving and relatively stealthy, drones.

Although Ukraine only has a limited number of TB2s, they are having a dramatic impact on the tactical situation. The TB2's camera transmits a real-time streaming video back to the operator. These videos confirm battle damage, and in consonance with information from other sources, render the battlefield transparent. Information from UAS and satellite images provided by commercial satellite companies such as Maxar have depicted the exact location of Russian movements. The battlefield is now "naked" and transparent, day and night, and everything on it can be seen by a wide range of sensors that are deployed by modern military forces. Unable to mask their forces, the Russians become extremely vulnerable to the accelerated kill chain. If the Ukrainians had invested in more UCAVs and LMs, they may have stopped the Russian invaders early in the war. Recognising this, the US offered shipments of AeroVironment's SWITCHBLADE to Ukraine on 17 March 2022. The SWITCHBLADE LM saw combat in Afghanistan with US Special Forces. Working together in small groups or swarms, the TB2s and SWITCHBLADEs are expected to form a deadly combination.

Masking and C-UAS

Masking is vital to a credible C-UAS defence. To move, fight and win in today's transparent battlespace and against a new array of cost-effective UCAVs and LMs, modern armies must develop tactics, techniques, and procedures (TTP) and field systems and organisations to mask their forces and defeat these threats. Masking is the full-spectrum,

Author

John Antal is a defence analyst and correspondent who has served as a member of the US Army Science Board. He retired from the US Army after 30-years in uniform. John has appeared on radio, podcast, and television shows to discuss military topics and is the author of 16 books and hundreds of magazine articles on military and leadership subjects.

Photo: SAAB

Military vehicles need new multispectral camouflage to neutralise threats. The SAAB Mobile Camouflage System (MCS) is a multispectral camouflage designed to reduce optical and thermal signatures while the vehicle is stationary or on the move.

multi-domain effort to deceive enemy sensors and disrupt enemy targeting. Military forces in the modern battlespace must train and equip to mask from optical, thermal, electronic, acoustic and quantum sensors. While quantum sensors are currently quite exquisite and primarily the concern of the most sophisticated stealth aircraft, masking in the optical, thermal, electronic, and acoustic areas requires immediate attention.

The Optical Spectrum

The optical spectrum is as old as warfare itself. UCAV systems, such as the TB2, see the battlespace with excellent optical sensors. Camouflage is the solution but few armies today are adept at it. Camouflage requires equipment, TTP, and leaders to enforce camouflage discipline. Antiquated camouflage netting does not hide from the unblinking eyes of the latest drones, as their sophisticated electro-optical cameras are too discerning. New multi-spectral camouflage netting and systems are required. Ineffective camouflage that cannot hide personnel and equipment in a transparent battlespace is a recipe for casualties.

Masking Thermal Signatures

As in the optical spectrum, masking thermal signatures demands new equipment and new thermal camouflage. We do not build armoured vehicles and trucks with masking in mind, nor design them from the start with the thought of reducing the system's thermal signature. The M1A2 SEPv3 ABRAMS Tank, the mainstay of the US Army's armoured force, has a powerful gas-turbine engine that is nearly impossible to hide from thermal sensors. Thermal camouflage is available that can reduce thermal signatures, such as the SAAB CoolCam Mobile Camouflage System, but this is expensive. Most assuredly, UCAVs, with state-of-the-art optical and thermal sensors, will spot unmasked vehicles and turn them into easy targets. The cost of destroyed armoured vehicles and the loss of personnel must be weighed against the price of effective, 21st century thermal camouflage.

Electronic Signatures

Electronic signatures are another, significant masking challenge. Today, nearly every piece of military equipment generates an electronic signature. UAS armed with electronic sensors see the electronic emissions from radios, radars, and electronics, and can target the source. During the Second Nagorno-Karabakh War, Azerbaijani HAROP LMs located and destroyed most of the Armenian radar, air defence, and command posts in the first few days of the war. Many of these targets were found by their electronic emissions. Masking electronic signatures, by fooling the enemy's sensor network with "false positives" and decoys, or hiding within the noise of a city, must become a training priority. Vehicles and command posts that cannot mask will not survive in a transparent battlespace. Masking, therefore, must become a criterion for systems design.

Acoustic Signatures

Targets can also be unmasked by their acoustic signature. Several UAS and C-UAS systems operate with acoustic sensors. Sydney-based DroneShield uses acoustic sensors as part of an AI-enabled C-UAS solution. DroneShield acoustic sensors use advanced detection technology capable of sensing drones that are invisible to radar or operate without radio-frequency links. Research in the acoustic arena, to both detect drones and for drones to detect targets on the ground, continues to advance. Autonomous systems researchers from the University of South Australia and Midspar Defence Systems recently announced that they had perfected a way to reverse engineer the bio-visual systems of hoverflies – an insect -- to detect drone movement up to four kilometres away. This bio-inspired processing is a glimpse into the future of UAS detection.

C-UAS Technologies

There are four general categories of C-UAS technologies: laser, microwave, electronic jamming, and kinetic attack. In January 2022, the director of US Joint Counter-Unmanned Aircraft Systems Office announced that the US Army will prioritise the development of non-kinetic technologies to combat the growing threat posed by unmanned aircraft. Tests in April 2022 will focus on high-powered microwave technology, directed-energy technology, and electronic warfare to build on existing capabilities. Despite this publicly announced priority, the US Army is also approving the development and testing of kinetic C-UAS weapons, which may be the most effective solution for the near term.

Laser

High-Energy Lasers (HEL) are almost ready for prime time – almost. An example is Lockheed Martin's Advanced Test High Energy Asset, or ATHENA. The system employs a 30-kilowatt laser weapon that combines the power of three 10-kilowatt fibre lasers into one 30-kilowatt beam. This system successfully knocked out multiple rotary small UAS (sUAS) in a demonstration at Fort Sill, Oklahoma, in 2019. ATHENA is a transportable system, but not yet a mobile system. In 2022, Israel has announced that it will produce IRON BEAM, a high-power solid-state laser system designed to intercept rockets, mortars, and UAVs to supplement its IRON DOME system. Lasers require a reliable and powerful energy source, making most of these systems suitable only for the defence of fixed areas and installations. To fill the tactical capability gap for ground manoeuvre forces, the US Army wants an armoured, mobile, laser C-UAS and contracted Raytheon Intelligence & Space in McKinney, Texas to build and deliver three combat-capable 50kW-class high-energy laser weapon systems mounted on eight-wheeled Stryker armoured fighting vehicles. Three, however, at a cost of US$123M, hardly fills the gap. As power source technologies improve, the use of powerful mobile lasers to knockout UAS and incoming projectiles at the speed of light will become a reality, but fielding a viable C-UAS today, rather than in 3-10 years, is a critical requirement.

Microwave

Advances in microwave technology offer another option for effective C-UAS weapons. An example is the Tactical High Power Operational Responder, or THOR, a high-energy microwave, laser directed-energy weapon. THOR, developed by the US Air Force Research Laboratory (AFRL), uses a focused beam of energy to counter UAS swarms. It is relocatable, but not a mobile air defence system. As with lasers, the requirement for a reliable and high-energy power source relegates most microwave or electronic beam weapons to protect bases and fixed locations.

Electronic Warfare (EW) Jamming

Electronic means to disrupt UAS involves the transmission of Radio Frequency (RF) signals to jam, interfere with, or take over the UAS control signal. Black Sage, an Idaho based C-UAS Defence company, has developed the GOSHAWK Long Range Jammer (named after a North American bird of prey). GOSHAWK is a directional non-kinetic effector that disrupts global navigation satellite systems, or GNSS, signals at a range exceeding 35 km. While GOSHAWK is transportable, it is not yet deployed in an armoured and mobile configuration that could keep up with advancing tactical formations. EW C-UAS are very promising and should be part of a layered air defence network, but newer UAS are being designed to operate without the need for GNSS and are fitted with anti-jam antennas which will make them much harder to disrupt.

Photo: Raytheon

The Raytheon produced COYOTE unmanned aircraft system (UAS) is a small, expendable and tube-launched Loitering Munition (LM). It can be deployed from the ground, air, or ship. The COYOTE can be operated individually or netted together in swarms, and it is adaptable for a variety of missions including surveillance, electronic warfare, and strike.

Kinetic

Kinetic C-UAS technologies offer an immediate, reliable, and cost-effective means to counter drones in the close battle area. Kinetic systems such as DroneBullet, developed by Canadian company ArialX, employ drones to hunt and destroy drones. DroneBullet is a beyond visual line-of-sight, "kamikaze" counter-drone solution that defeats enemy drones by crashing into them. DroneBullet is portable, fire-and-forget, and fully autonomous. It uses onboard Artificial Intelligence (AI) and advanced machine vision processing to destroy enemy drones. Another promising kinetic system, the Raytheon COYOTE Block 2+, is tube-launched, weighs 5.9kg (13lb) and can carry a variety of interchangeable payloads, including a proximity warhead to destroy enemy drones. It has a maximum airspeed of 70 kt and a cruising speed of 55 kt. It can fly at altitudes of 30,000ft and can operate up to one hour. The US Army recently selected the COYOTE drone for its near-term counter-UAS solution.

Winning against drones will require masking and fielding an effective network of new C-UAS weapons. The lessons of recent wars send a clear message: in the Second Nagorno-Karabakh War in 2020, and the current Russo-Ukrainian War in 2022, the lack of an effective C-UAS capability to protect ground forces led to heavy casualties and impeded ground manoeuvre. On March 16, 2022, a Jamestown Foundation analysis of the effectiveness of Ukrainian TB2 UCAVs against Russian forces reported: "Of the 15 SAMs eliminated by kinetic hits, 9 platforms were targeted by Bayraktar TB-2s. All in all, the Turkish drones secured about 30 percent of the total SAM kills, and 60 percent of the direct, kinetic salvos." The military force that understands how the methods of warfare are changing, and executes masking and fields C-UAS weapons in today's transparent battlespace, will gain a decisive advantage. ■

Countering the Swarm

Tamir Eshel

Swarms of unmanned vehicles represent a disruptive evolutionary phase of unmanned warfare. In this article, we regard swarms as groups of Unmanned Vehicle System (UXS) operating autonomously in a coordinated manner to carry out a mission. The UXS elements may be aerial, land-based, surface, or undersea robotic platforms carrying out tasks ranging from Intelligence, Surveillance, and Reconnaissance (ISR), Target Acquisition and Attack, or specific missions such as Suppression and Destruction of Enemy Air Defense (SEAD/DEAD), interdiction of high priority targets such as command posts, communications equipment, and radars. At sea, swarms of small boats or loitering weapons and unmanned submersible vehicles can be used to disable enemy vessels by taking out their vulnerable assets such as radar and communications or sonar. Swarms can also be used preemptively to suppress enemy activity in specific areas such as airfields, landing zones, or launching sites of ballistic missiles. Unlike attacks by individual drones or loitering weapons that require a human controller in the loop, drone warms receive the brief and pursue the mission autonomously, constantly coordinating their behavior based on the mission phase to achieve their goal most efficiently. For example, they can plan and maneuver to attack the target from different directions, strike multiple targets at once, or sacrifice some elements in the swarm to trigger the target to react and reveal itself before being hit. Human controllers are primarily in a supervising role and would intervene and instruct the drones only when needed or asked for by the swarm.

Photo: Anduril

Anduril's sentry towers connect to lattice C2 system to detect and track rogue drones threatening perimeters of military bases.

Drones acting in groups can be controlled individually by human controllers or operate fully autonomously as a group. Other operating methods follow herding behavior, in which some members serve as leaders while others act as followers.

Photo: DroneShield

Fitted on top of such all-terrain vehicles, Drone Sentry X provides a mobile protection bubble for vehicles and convoys.

UXS swarms are often controlled from a single multi-launcher and ground control station, thus simplifying and accelerating deployment. Once launched, the individual drone's operation is mainly autonomous, enabling a single operator to manage the whole swarm instead of flying each drone. Swarms may include many elements of the same platform (known as homogeneous swarms) or different players forming a heterogeneous group. Each drone may perform a similar role or have several specialized functions, such as information gathering, weapons deployment, or communications relaying. The key to their behavior is the network connecting all members. Typically, such a network enables the group to link all members by constantly retransmitting information, position, and navigation. Specific group members may assume control of the entire formation at different times to coordinate and prioritize actions, assign tasks, alert on obstacles or threats, or hand over power to other members. If a control node is eliminated, other members will take control based on the network's self-forming, self-healing algorithms.

Most commercial remote-controlled drones are controlled via frequency hopping spread spectrum (FHSS), using an advanced frequency-agile waveform, or by Wireless LAN (WLAN). Signals transmitted from the drone also use FHSS, wideband, or WLAN signals. Other

drones may rely on Radio Frequency (RF), cellular or satellite communications (SATCOM). Swarms often utilize ad-hoc networking technologies (MESH network) to communicate between the group members. This method is specifically advantageous when operating beyond visual line of sight and over broad areas where existing connectivity is not guaranteed. Individual drones may connect to and disconnect from the network all the time, making the decentralized ad-hoc network structure highly suitable for their operation.

Countering the Swarm

Despite their autonomous operation, drones and robots require comprehensive preparations before being sent into the mission. Route planning, pre-flight network setup, GNSS link establishment, coordination with controller and other group members are all done before takeoff to initiate an autonomous mission. Most of this activity has a distinctive electronic signature that can be detected by signals intelligence (SIGINT) activity. But some preparations are less visible than others. For example, loitering drones packed ready to launch on their carriers often perform this preparation in radio silence, without any emissions, testing, and setup are performed on the carrier. Once the swarm is launched and grouped, its members can maneuver into formations, making individual target detection more difficult. Navigation to the target could employ global navigation satellites (GNSS, GPS), inertial navigation, image-based scene matching, or a combination of several methods, making it more challenging to defeat. Group members can rely on each other to determine their position and location, thus maintaining sensor redundancy to overcome specific countermeasures such as GPS jamming.

Unlike unitary autonomous drones that can be completely isolated on their mission, a swarm has a significant vulnerability – the network it depends on. Swarm members must communicate continuously to share information, status, and tasks. Since these networks use specific waveforms, their activity could be detected by SIGINT to provide the first alert of swarm activity in the area. Therefore, SIGINT is considered the first line of defense against swarms, used as a part of a whole layered defense system.

Attack the Network

As the network signals are picked and tracked, and network vulnerability is assessed by SIGINT, the defender may decide to use electronic or cyber-attack against the threat. Given the extended range of such detection, relying on strategic airborne or space-based SIGINT assets, the defender can avoid surprises by preparing and executing a game plan against that threat. Detection and tracking of the individual swarm members pose another significant challenge since radar, and electro-optical sensors are limited in their ability to detect small, slow, and low-flying targets, particularly at long range. Detection of targets moving underwater is almost impossible. Moreover, detection of such targets on the move is limited due to the noise and clutter the sensors encounter.

C-UAS detection and countermeasures systems such as the ARDRONIS developed by Rohde and Schwarz (R&S) target the drone's RF signal activity using sensitive monitoring receivers to collect and disrupt the drone controls. According to R&S, the sensor can detect a DJI Phantom 4 mini drone from up to 5 km. When engaging

Photo: Epirus

Illustration depicting Epirus' LEONIDAS HPM effector mounted on a C-UAS STRYKER.

drones using FHSS, ARDRONIS compares the detected signals with an extensive library of drone profiles. This "monitor and match" process provides reliable early warning of any threats in the coverage area. The system also provides direction finding (DF) of the drone telemetry, video downlink, and the control unit, indicating the operator's location. The system also has an integrated jammer that disrupts the targeted drones or the communications between the drone and the controller, with minimum disturbance to other signals in the same frequency band.

Rohde & Schwarz and OpenWorks have teamed to establish an autonomous 3D detection and tracking system in counter unmanned aerial systems (C-UAS) missions. The system has been integrated through NATO's new "plug and play" protocol known as 'Sensing for Asset Protection with Integrated Electronic Networked Technology' (SAPIENT) and tested at the NATO Technical Interoperability Exercise (TIE) event in De Peel Airbase in the Netherlands. The ARDRONIS drone detection solution combined with OpenWorks' SkyAI Autonomous Optical technology and integrated with command and control systems and decision engines to match escalating UAS threats. ARDRONIS provides a primary detection capability to locate unmanned aircraft and remote controllers using a spectrum analysis approach. SkyAI takes this 2D data and combines it with information received from remote sensors through the SAPIENT network. It then takes control of the EO/IR camera associated with the system to search for UAS autonomously. Using real-time advanced AI target classification, the EO/IR sensor locks the target and streams high-quality video to the system operator for further threat analysis. The data from SkyAI ARDRONIS sensors is then fused to provide a full 3D location of the UAS being tracked.

Understanding the Situational Picture

Drone Guard from IAI represents another multi-layered solution for detecting and interception of drones and drone swarms. It consists of several passive and active sensor types that are integrated with soft and hard kill effectors through a unified C2 system. The detection and classification layer relies on a multi-mission 3D X-band AESA radar and SIGINT system that detects and exploits UAS data link communication for threat detection and classification. A day/night EO/IR sensor supports target classification and acquisition. Drone Guard uses various means of interception that include jamming or takeover as soft-kill measures and hard-kill measures such as precision rifle scope, rockets, or a drone-kill-drone (DKD) solution.

The system's core is the command and control element that collects data from the sensors, automatically correlates the information, defines priorities and creates a unified situational awareness picture that enables the timely deployment of countermeasures against the threats. The system consistently learns and adapts to new threat types through Machine Learning (ML) and is equipped with built-in, advanced decision-making and Artificial Intelligence (AI) algorithms for threat analysis and manual, semi-autonomous, or fully autonomous response.

Drone Dome from Rafael is another 'end-to-end' C-UAS solution having the counter-swarm capability that integrates various sensors in a multi-layered architecture. The system employs RADA's RPS-82 radar in a static or vehicular configuration, using four AESA radar panels to cover 360 degrees. In addition to target detection and tracking, the RPS-82 employs micro-doppler algorithms for target classification. The SIGINT element covers 70 MHz up to 6 GHz spectrum to localize the drone's position and its operator and process Difference Time of Arrival (DTOA) of detected signals to enhance situational awareness. Another automation layer is the systems' EO/IR sensors that support video motion detection (VMD), enabling automatic detection, recognition, and tracking of multiple targets based on drone patterns libraries.

The system generates a comprehensive map-based situational picture allowing a single operator to conduct scalable threat mitigation, employing reactive jamming (RJ) and GNSS countermeasures up to the use of high high-power laser, which has already demonstrated the engagement of swarm formations, defeating multiple drones in quick succession.

Awareness: The Key for Survival

Therefore, situational understanding is key to defeating the swarm as far and early as possible by targeting the networking mesh that turns it from a group of drones to an advanced and almost indestructible machine. Fusing many sensors and information sources into a situational awareness (SA) picture enables the defenders to act most efficiently, aiming at the swarm's weaknesses. Depending on the operating strategy, these could be the datalinks, the network itself, or the herders leading the group. Actions could employ soft kill such as offensive cyber, electronic combat (jamming, GPS denial). Kinetic measures range from deploying nylon streamers and fragments clogging the drone's propellers and rotors to directed energy effects of a high-power microwave or high-energy lasers, airburst munitions, and firearms autonomously commanded and controlled by the C-UAS system.

One of the most sophisticated command and control systems developed for C-UAS is the Lattice from Anduril. The system creates a shared understanding of the battlespace in real-time by autonomously parsing data from thousands of sensors and data sources and transforming it into an intelligent common operating picture. Using sensor fusion, computer vision, edge computing, machine learning, and artificial intelligence, Lattice detects, tracks, and classifies every object of interest in an operator's vicinity. This ambitious system

scales the situational awareness from the tactical level to the strategic view. Anduril aims to deploy Lattice across land, sea, air, and space as an all-domain mission engine. It employs its mesh network to ensure information flow even in remote and contested areas, enabling resilient information flow and cooperative teaming even when there is limited bandwidth.

Defeating the Drones

Other C-UAS systems such as D-Fend's EnforceAir and DroneShield's DroneSentry-X support tactical units to protect VIP, special forces, dismounted teams, individual vehicles, or convoys. EnforceAir automatically identifies rough drones in the vicinity and then automatically takes control of them using cyberattacks and lands them in a safe, designated area. According to D-Fend, this mitigation method employs target-specific protocols without causing interference to friendly communications or authorized drones' operations. The system can be used as a man-portable tactical kit or on a vehicular mount to support static or mobile operation, creating a moving 'bubble' of protection.

During the detection and identification phase, the system remains passive to enable covert forces to maintain radio silence. Since the drones are forced to land near the defended unit, military intelligence can exploit the captured drone data to learn which type of drones are used, where they are sent from, what their cameras are recording, etc. Drone takeover takes only a few seconds, enabling the system to engage small groups effectively.

DroneSentry-X is a different mobile C-UAS system as its defeat capabilities rely on jamming and do not involve protocol manipulation or 'cyber' tactics. The system can be operated in stand-alone mode and integrates sensors and a mitigator to disrupt UAS operations in its vicinity and protect the platform over 360 degrees.

Photo: Lockheed Martin

This ALTIUS 600 drone provides the platform carrying a reusable HPM effector used against UAS and drone swarms. As a tube-launched unit it can be deployed.

Both DroneShield and D-Fend employ 'surgical' actions against single or small groups of drones to bring them down before they reach their objectives. Other means using Electro-Magnetic Pulse (EMP) and High-Power Microwave (HPM) emitters use much more powerful and less selective means to eradicate all electronic systems and activity in the area. This action can take down many drones at once but also damage other systems that were not protected against such 'electronic shock treatment.' Several systems of this type have already appeared in the market, indicating the technology has matured to be integrated into UAV and C-UAV systems.

Such weapons are designed as 'sacrificial', meaning they are destroyed during the activation or 'reusable'. Engineers at the Naval Surface Warfare Center have conceptualized an explosively formed electromagnetic pulse that could be packed as a warhead inside missiles or drones, becoming a weapon that would enable an interception and defeat of UAVs. The EMP device, known as a 'flux compression generator', is constructed of a coil woven into an air-tight cylinder. The cylinder is filled with ionized lithium gas that establishes a strong magnetic field during activation. The cylinder is compressed by an explosive charge, accelerating the ionized gas molecules through an increased magnetic field that generates a powerful electromagnetic burst in the terawatt regime. The spherical EMP destroys the interceptor UAV and disables any electronic systems in its vicinity.

Photo: US Army

The DE variant of US Army STRYKER M-SHORAD mounts a radar, electro-optical cueing system and 60kW laser used as an air defence and counter-UAS weapon.

Reusable high-power electromagnetic effectors employ microwave emitters of different designs to deliver energy bursts that can disable electronic circuits from a distance. Initially, these were large, truck-sized systems that required powerful generators and cooling to produce the desired effect. Most land-based systems were directional, while the more compact systems covered a spherical pattern based on the explosive-generated power burst. Recent advancements in high-power solid-state HPM have matured new HPM effectors more suitable for tactical use.

One of these is the Leonidas, based on the SmartPower technology developed by Epirus Inc. It uses solid-state amplifiers to transmit directed energy at extremely high-power causing counter-electronics effects. Epirus utilizes artificial intelligence-enabled Gallium Nitride (GaN) semiconductors arrays to produce the extreme power density levels necessary for the HPM transmission without special cooling. The frequency-agile system rapidly fires a barrage of unique waveforms to exploit the specific frequencies that UAS targets are most susceptible to. This enables tactically relevant counter-swarm ranges beyond small arms fire, even against diverse swarms.

A full-size ground-based 'Leonidas' effector uses very high energy to deliver the effect from a distance, while a smaller version packed in a pod can be carried by a drone closer to the target. Since the system uses electrical power, Leonidas has deep magazines to enable continuous rapid firing for precision or area fires effects without overheating or reloading.

This technology has already been integrated with some of the air defense capabilities of the US Army. In 2020 Northrop Grumman Corporation announced a strategic supplier agreement with Epirus to offer Leonidas as a component of its Counter-Unmanned Aerial System (C-UAS) systems-of-systems solution offering. Northrop Grumman's C-UAS solutions already deliver a layered architecture with a full complement of kinetic and non-kinetic effects, aerial and ground sensors of the Forward Area Air Defense Command and Control (FAAD-C2) system selected by the US Army as the interim C2 system for counter-small-UAS capabilities. The agreement augments the systems' non-kinetic capacities to defeat UAS swarms. In another agreement, Epirus announced in late 2021 the company has teamed with General Dynamics to integrate Leonidas on the Army's IM-SHORAD systems that already provide C-UAS protection on the move to combat elements, enabling the Army to engage drone swarms.

Drones Vs Drone Swarms

Leonidas has also been shrunk to fit a small pod carried by a drone. The pod integrates with existing airborne systems to go where end-users want it to go, flying directly to the threat area. When deployed with ground-based Leonidas units, both systems work in unison to achieve greater power and range and create a layered defense forcefield.

Other C-UAS systems operating HPM include the MORFIUS C-UAS drone from Lockheed Martin. The company used the Altius 600 drone from Dynetics' Area-I company, packed with Lockheed Martin's HPM effector, MORFIUS, to engage drone swarms at range and speed. The tube-launched drone carries an HPM effector payload and a seeker, enabling it to home in on the target from a long distance. Both are recoverable and reusable. The tube-launched drone platform can be deployed from air, ground, or vehicle on the move, supporting a layered defense approach.

Raytheon has recently demonstrated a similar concept with its Coyote Block 3 turbine-powered C-UAS missile. In this demonstration, the Coyote took down a group of 10 drones using an unspecified non-kinetic effector. The targets group included drones that differed in size, complexity, maneuverability, and range; the test also proved the Coyote could be recovered and redeployed after the engagement. Coyote also has been demonstrated to deploy from vehicles, aircraft, helicopters, and drones.

High Power Lasers

High power lasers also provide an effective counter-swarm capability for their ability to rapidly defeat small and maneuvering targets by destroying the drone's airframe, energy source, optics, or electronic circuits. The ability to "fire" multiple shots in quick succession at low cost makes lasers suitable for Very Short-Range Air Defense (VSHORAD)missions and countering small swarms of several drones. Such lasers are already being integrated with some C-UAS platforms, such as the Stryker DE M-SHORAD, Raytheon's HELWS2, and Rafael's Laser Drone Dome laser effector that have already demonstrated the capability to defeat small groups of drones. Both lasers and HPM effectors offer a low-cost-per-shot option to operators, requiring only electrical energy for operation. However, lasers are limited by weather, as they cannot penetrate thick clouds, while HPM can cause collateral damage in its area.

Summary

Swarms of autonomous, AI-powered, and networked drones are becoming a disrupting military capability in their ability to carry out missions far beyond the size and capabilities of a single drone. There is no silver bullet to defeat a swarm, as countermeasures require a system of systems at least as advanced, sophisticated, and evolving as the drones themselves, leveraging some of the technologies employed by drones. ■

Reliable drone defence in the context of conventional air defence: Modular deployable multi-sensor multi-effector systems for successful combat against a dynamically evolving threat

As resource-efficient flying, driving or (sub) waterborne systems for reconnaissance, command and joint fires, unmanned technologies offer versatile deployment options. At the same time, due to their widespread use and easy availability, Unmanned Aircraft Systems (UAS) already pose a steadily growing threat to military units, security authorities and organisations. Conventional ground-based air defence systems are largely powerless in terms of detection and effectiveness against low and comparatively slow flying small and micro targets (low, slow, small (LSS)). This capability gap must be closed quickly and precisely, not least because of the accumulation of incidents with UAS in Yemen, in the Ukrainian border region and more recently in Nagorno-Karabakh.

In order to be equipped against the diverse technological threat of UAS, technical solutions must be modularly adaptable depending on the operational scenario. This ensures the best possible protection in the face of a dynamic and rapidly changing threat situation. Modern military counter-UAS systems offer a broad portfolio of state-of-the-art technologies for the detection of and de-fence against drones. The experience of recent years shows that only a comprehensive and complementary multi-sensor, multi-effector portfolio is effective. Drones and pilots are specifically detected even in dense and congested spectra by means of high-frequency, radar, video and acoustic monitoring. Here, automatic detection and classification, as well as early warning func-tions with a minimal false alarm rate, are essential.

On the defence side, it is important to ensure the greatest possible reliability in securing the pro-tected zone through various countermeasures. At the same time, the proportionality of the means must be considered and assessed both in terms of resource-saving deployment and potential collateral damage. At present, electromagnetic countermeasures such as jammers and high-power electromagnetics are the only solutions that meet these requirements; in future, however, kinetic countermeasures will also be considered for specific operational scenarios.

The Bundeswehr relies on mission-proven technologies to protect against threats from small Un-manned Aircraft Systems (C-sUAS): In the summer of 2020, the Federal Office of Bundeswehr Equipment, IT and In-Service Support [Bundesamt für Ausrüstung, Informationstechnik und Nutzung der Bundeswehr] commissioned ESG Elektroniksystem- und Logistik-GmbH to supply "systems for the detection, classification/ identification and defence against sUAS". The delivery scope comprises shelterized GUARDION systems for the early detection of and effective defence against drones for field camp protection in the operational and mission areas of the Bundeswehr and is primarily provided by ESG as prime contractor and system integrator. The processing of all sensor and effector data (high-performance radars, camera, radio direction finder and jammer) is carried out in the ELYSION core intelligence, which was specially developed for this application. ELYSION makes the complexity of the available information manageable for the user and dis-plays it in an intuitive map-based situation picture.

Systems that can be fitted into standard containers offer optimal protection for facilities such as field camps in operational areas, port infrastructure requiring protection, (military) airfields or other critical infrastructure.
Sensors and effectors can be positioned decentralised, climate-protected and, if desired, hard-ened against ballistic impacts, thus providing the best possible coverage and reconnaissance ranges.

Mission control and situation picture evaluation are carried out centrally by one operator, who can also monitor networked systems. In the intuitive command centre, all the technical threads come together in the ELYSION command & control system developed by ESG. The clear display facilitates quick decision-making. ELYSION is a further development of the ESG software core con-sisting of processing core intelligence and networked map-based situational display. The software was adapted to the requirements in the field through feedback from and in close exchange with customers and users. During development, the focus was on intuitive usability, automation and high-performance data processing. ELYSION now offers a visually appealing GUI with powerful data fusion, as well as additional operator support functions such as intelligent prioritisation of multiple targets or the suggestion of suitable countermeasures.

In addition to stationary deployment scenarios, unmanned aerial attacks also pose a considerable risk to military land vehicles, aircraft or ships in transit, necessitating modern convoy protection concepts for drone detection and defence on-the-move. In the future, this increased need for pro-tection will extend to every single land platform, making it necessary to build a bridge between stationary air defence and air defence for all troops. The networking of all available sensors on the battlefield and the alerting of threatened units, as well as the assignment of targets to the optimally positioned effector, will pose the greatest challenge in the coming years. For the future, the Bundeswehr demands integrated approaches for this, which justify comprehensive network-ing and seamless integration of different systems from different manufacturers. In line with these demands, ESG, as a hardware-neutral system integrator, is working on the further development of its solutions for the various target spectrums with different partners from the German defence industry.

Photo: ESG Elektroniksystem- und Logistik-GmbH

Shelterized GUARDION systems for field camp protection

Brazil's Nuclear Submarine Programme

Debalina Ghoshal

Brazil's recognition of the importance of having a strong navy is nothing new. The deployment of a nuclear powered submarine during the 1982 Falklands War had important repercussions on Argentina's neighbouring state, Brazil.

Brazil has learnt from the lessons from the Falklands War in which the sinking of the Argentine cruiser, GENERAL BELGRANO deterred the Argentine Navy from performing any further sorties for the duration of the war. It demonstrated the importance of nuclear submarines possessed with the capability of operating in waters for longer durations and with less risk of detection. Moreover, nuclear submarines maintain the element of stealth, thereby avoiding the hazards of refuelling, compared to conventional submarines, which are more susceptible to enemy detection and attack. Thus, Brazil has realised the necessity of nuclear submarines in order to gain greater influence in the "Blue Amazon" – Brazil's Exclusive Economic Zone (EEZ).

Photo: Naval Group

According to the Brazilian Government, the Submarine Development Programme (PROSUB) is one of the main strategic projects of the Brazilian Armed Forces and aims to increase the national defence structure and ensure Brazilian maritime sovereignty.

Brazil's Journey Towards a Strong Naval Capability

Brazil's quest for nuclear submarines has meant a focus on pressurised water reactors (PWRs) with low enriched uranium (LEU) for fuelling the submarines. To accommodate this PWR, a beam of 9.8 m, considerably more than a conventional class submarine, will be used, thereby facilitating the conversion of kinetic energy into heat. This will be coupled with a fully electronic propulsion system.

According to reports, Brazil has fully mastered the nuclear fuel cycle and is constructing a pilot unit for the production of uranium hexafluoride along with a land-based prototype project laboratory that will enable Brazil to maintain the PWR type reactor to be used in attack submarines. The prototype project will be replicated in the construction of their nuclear propelled submarines.

Brazil's nuclear heavy engineering company Nuclebrás Equipamentos Pesados (Nuclep) is reported to have commenced delivery of the structures of the Containment Vessel for the land-based prototype by December 2021. However, the submarine would also need to test the efficiency of the turbo-generators, electric motors and other electromechanical systems needed in the submarine in order to function credibly.

In January 2022, there were reports that Indústrias Nucleares Brasil (INB), the company that signed a Memorandum of Understanding (MoU) with the Brazilian Navy in November 2020, had jointly developed nuclear fuel pellets (equivalent to three barrels of oil), thereby displaying the progress that Brazil has made in the uranium production chain. Even though Brazil's nuclear submarine programme is assisted by France, its nuclear reactor and associated uranium fuel cycle are indigenous.

The Brazilian nuclear submarine ÁLVARO ALBERTO (SN 10), foreseen as the first of six planned nuclear submarines, would run on a 48-50 MWth reactor. In order to ensure safety and quality, the "First Partial Construction License (LPC1)" was signed by the Brazilian Navy's Directorate-General of Nuclear and Technological Development, the Naval Authority for Nuclear Safety and Quality and Fleet Admiral Marcos Sampaio Olsen. This programme though was due to commence in the 1970s, though actual work commenced in 2012. Ever since then, the submarine programme has taken off, though there have been several delays due to financial constraints in addition to political woes and corruption scandals.

This nuclear submarine is integral to Brazil's Submarine Development Programme (PROSUB). This would make Brazil the first non-nuclear armed country to possess a nuclear submarine. However, according to Janes, this nuclear submarine will be commissioned only by 2034 and the construction of the pressure hull will only commence in 2023.

However, Brazil will not just possess nuclear attack submarines, but also conventional submarines to complement its nuclear fleet of submarines. A perfect mix of nuclear and conventional submarines would provide Brazil the capability to exert more influence in the South Atlantic, to defend its oil and gas reserves and its

Author

Debalina Ghoshal, is a Non Resident Fellow, Council on International Policy and Asia Pacific Fellow, East-West Institute. Her areas of specialization is on issues pertaining to nuclear, missiles, missile defense, space and artillery issues. She is the author of the monograph 'Missile Development in the Middle East' with the Middle East Institute.

Photo: Naval Group

The basic design of the future nuclear-powered attack submarine (SSN) was approved in December 2020.

trade interests. This region is currently dominated by Britain and the United States.

Not only will a strong navy, supported by nuclear submarines, help Brazil exert greater maritime influence in the South Atlantic, and help protect its sea lines of communication (SLOC), it will also enable Brazil to possess an area access/ area denial (A2/AD) capability and strengthen its sea-based deterrence vis-à-vis adversaries. It could also be used by Brazil to disrupt adversaries' SLOCs.

Nuclear attack submarines become even more important and crucial in Brazil's ambitions of maritime dominance as its maritime coastal area extends beyond 7,400 km. This concern is also echoed by Brazil's President Michel Temer, "Brazil is building submarines because a nation with more than 7,000 km of coastline cannot do without [the] tools to defend its sovereignty and its marine wealth."

In addition, there is also a belief that nuclear attack submarines would provide Brazil greater scope in achieving permanent status in the United Nations Security Council (UNSC). Moreover, as the author has previously argued, nuclear powered submarines would provide Brazil greater leverage in BRICS (Brazil, Russia, India, China, South Africa) by matching naval capabilities similar to that of its BRICS counterparts (minus South Africa).

Considering that Brazil is concentrating on anti-ship cruise missiles, these missiles with longer-range versions can be launched from attack submarines for greater deterrence and combat capability. Long-range cruise missiles are a necessity for Brazil to possess deep strike capabilities and also allow it to possess stand-off capabilities without having to be close to adversaries' areas of influence in the seas.

Concerns

Brazil is a party to the Non Proliferation Treaty (NPT) and hence, there could be serious proliferation concerns in the future. Moreover, Brazil carries out its nuclear submarine development programme in restricted military areas with no scope for the International Atomic Energy Agency (IAEA) to have access to its submarine programme.

Hence, Brazil, though banned by its constitution, but concerned by its threat perceptions, could divert its enriched uranium programme towards developing nuclear weapons under the guise of submarine programme. Brazil's success in the SSN domain in the future could lead it to develop SSBNs for increased deterrence. ■

Product Feature: UAVLAS

Solving UAS Landing Challenges

Polish electronic engineering company UAVLAS develops sensors and software that provide a direct connection between drones and landing sites. The advanced systems ensure precise and safe landing in any conditions: absent or weak GPS signal, darkness, or complex weather conditions, such as gusting wind, fog and so on.

The system comprises two parts: the onboard receiver (10 grammes) and the ground unit (45 grammes). Its small size and the inclusion of several alternative interfaces facilitates integrating the landing system into almost all existing autopilots, and a simple protocol allows connecting autopilots as quickly as possible at the software level. Each module can be connected to a computer for device diagnostics as well as simple installation of fresh software updates.

The system does not require additional sensors for its work. The onboard unit can independently determine the distance to the landing site, which enables landing on platforms that are significantly elevated, or where the distance above the surface is significantly different from the actual height of the landing platform. The on-board receiver also does not require data from the drone inertial system and all changes do not depend on the inclination and speed of movement of the aircraft – this gives a stable work environment despite strong gusts of wind when the angular position of the drone changes very quickly.

Low power consumption (less than 0.3 watts for the onboard module and 1.1 watts for the ground module) allows the system to operate for a long time from a small power source. It is easy to change the approach path (to make it not vertical but at an angle) – which allows the vehicle to land in places where there is an obstacle to one side (for example, a balcony).

Photo: UAVLAS

Thus, the UAVLAS system has a huge number of applications: indoors; landing on moving, vibrating or shaking objects, like cars and ships; different procedures with difficult-to-reach objects (such as windmills or turbines) and, of course, all types of drone delivery.

Recent 30 mm to 105 mm Ammunition Developments

Christopher F Foss

The actual weapon tends to have a long life, with the main developments today being in the actual ammunition as new materials and propellants are developed as the end user wants increased performance including greater range and more target effect.

European Security and Defence (No 1/2022) included an article "More Punch for Medium Armoured Vehicles "which covered mainly actual medium calibre weapons. The land defence sector has seen a significant number of mergers and acquisitions in recent years including the ammunition sector.

Industry

Nexter took over Luchaire (France) some years ago and more recently MECAR (Belgium) and Simmel Difesa (Italy) were taken over by Nexter (France). Late in 2021 it was announced that these would be grouped under a new company called Nexter Arrowtech which can supply customers with a complete range of ammunition from 20 mm up to 155 mm.

Rheinmetall (Germany) has taken over ammunition contractors in South Africa (Denel) and Switzerland (Oerlikon) which has enabled them to supply a complete range of ammunition with the exception of small arms ammunition.

In the UK, Royal Ordnance is now BAE Systems Land with major facilities at Radway Green (small arms ammunition), Washington (projectile bodies) and Glascoed (load and pack and 81 mm mortar bombs).

The downsizing of ammunition facilities has occurred for a number of reasons including the reduction in ammunition requirements in Europe due to the reduced number of platforms and weapons deployed and a number of overseas countries are now manufacturing their own ammunition rather than importing ammunition.

Photo: CTAI

The CTAI 40 mm Case Telescoped Armament System fires a complete suite of ammunition and from left to right these are KE-AB, APFSDS-T, GPR-KE-T, GPR-PD-T, TP-T and TPRR-T.

Recent Developments

Recent 30 mm medium calibre and above developments include the fielding of armour piercing fin stabilised discarding sabot (APFSDS) and air bursting munitions (ABM) natures as well as using insensitive munition (IM) propellant and high-explosive (HE) and for APFSDS penetrators with increased armour penetrator capabilities. When compared to older munitions, these APFSDS and ABM rounds are more expensive to manufacture and are often kept just for combat use with cheaper rounds being used for training.

The larger calibre medium calibre rounds have longer ranges which means that existing firing ranges cannot always be used and this has led to the development of more specialised training rounds with a shorter range but with a ballistic match for combat ranges.

While the end user is demanding larger calibre weapons for its infantry fighting vehicles (IFV) this comes at increased cost and means less ammunition can be carried. On the other hand, larger calibre cannon can mean "more stowed kills." Many contractors for medium calibre weapons can also supply a complete suite of ammunition as part of a total weapon package while other end users have a separate competition for the ammunition to reduce costs. The end user however must make certain that if the ammunition is not obtained from the original and qualified supplier, there are risks.

Photo: CTAI

The CTAI 40 mm APFSDS-T round has a muzzle velocity of 1,500 m/s and will penetrate 140 mm of RHA at a range of 1500 m according to the company.

Author

Christopher F. Foss has been writing on armoured fighting vehicles and artillery systems since 1970. He has also lectured on these subjects in many countries as well as chairing conferences all over the world. He has also driven over 50 tracked and wheeled AFVs.

Supply

End users can encounter problems in ammunition supply when an armoured fighting vehicle (AFV) is phased out of service with its first and usually major customer. A good example is the British Alvis SCORPION Combat Vehicle Reconnaissance (Tracked) fitted with a two person turret armed with a 76 mm L23A1 gun manufactured by the then Royal Ordnance Factories (ROF) who also supplied a suite of ammunition. SCORPION was phased out of British Army service many years ago because of toxic problems in the turret when the weapon was fired.

The UK no longer manufactures 76 mm ammunition although MECAR (subsequently taken over by Nexter) has manufactured this ammunition as well as a wide range of ammunition from 20 mm upwards, including 105 mm and 115 mm (for Russian T-62 main battle tank) ammunition.

Countries can also encounter ammunition supply problems owing to changes in political relationships. For example, some members of the former Warsaw Pact (WP) are now members of NATO and have had to source ammunition for their Russian weapons that are still deployed.

Photo: Rheinmetall

Rheinmetall can supply a complete range of medium calibre ammunition including 30 mm APFSDS-T and ABM for the 30 mm cannon installed in the PUMA IFV deployed by the German Army.

30 mm Ammunition

30 x 173 mm ammunition is used in a number of 30 mm cannon including the South African Denel Land Systems 30 GI-30, US Northrop Grumman 30 mm MK44 and the German Rheinmetall (Mauser) MK 30-2.

There are many contractors supplying this 30 x 173 mm ammunition with a good example being NAMMO of Norway who have also invested in developing new rounds.

NAMMO are currently marketing high-explosive – incendiary (HEI), HEI - Tracer (HEI-T), HEI and HEI-T self-destruct (SD), semi-armour piercing HEI/SD (SAPHEI/SD), SAPHEI-T/SD and Multi-Purpose-T/SD which is designated the NM222 (MK264). They have also developed a 30 mm APFSDS-T designated the NM225 (MK258 Mod 0) which is claimed with penetrate 100 mm of rolled homogenous armour (RHA) at a range of 1,000 m which would enable most light and medium AFV to be neutralised.

Training rounds have not been neglected by NAMMO with a typical round being the 30 x 173 mm target practice – tracer (TP-T) designated the NM219 which is a ballistic match to the 30 mm NM222 (MK270) MP-T/SD and according to NAMMO "precision tests show superb accuracy out to distances of 3,000." More recent TPDS-T rounds are the NM245 (MK320).

Major investments have taken place in 30 mm Air Bursting Munitions (ABM) development with the round being programmed to burst over target for maximum effect. The German PSM PUMA IFV is fitted with a two person remote controlled turret armed with a 30 mm MK 30-2 ABM dual feed cannon which can

Photo: Northrop Grumman

Northrop Grumman manufactures a wide range of medium calibre ammunition including 30 x 173 mm and from left to right these are M239 TP-T, MK238, PABM-T and PGU-13 HEI.

fire an APFSDS-T or an ABM round which is programmed as it leaves the barrel for maximum target effect against dug in and dismounted infantry.

While the US Army BRADLEY is armed with a Northrop Grumman 25 mm M242 dual feed cannon, many foreign customers have opted for the Northrop Grumman 30 mm MK 44 dual feed cannon which can be upgraded to 40 mm.

The 30 mm MK44 can also be supplied to fire ABM which uses an integrated fuze setter in the ammunition feed system, an ABM fuze setter in the gun control unit and a ballistic algorithm integrated into the fire control system. This allows it to fire the 30 mm MK310 Mod 0 programmable ABM-T (PABM-T) and uses an aluminium cartridge case with a muzzle velocity of 980 m/s. The gunner can select airburst, point detonating (PD) and PD-delay which depends on the target set to be engaged.

Northrop Grumman also confirmed to European Security and Defence that they had developed a 40 x 180 mm ABM round using internal research and development funding.

Russian 30 mm Ammunition

While NATO and many other countries use 30 x 173 mm ammunition, the Russian 2A42 and 2A72 cannon fire 30 x 280 mm ammunition which is also manufactured by a number of other countries with NORINCO (China North Industries Corporation) making this on the export market.

MECAR developed a new 30 mm APFS-DS-T round for the Russian 30 mm 2A42 and 2A72 cannon which features a tungsten alloy cobalt free penetrator which is claimed to be able to penetrate 45 mm of RHA at an angle of 45 degrees at a range of 1,000 m with an m/v of 1,275 m/s.

35 mm

This 35 x 228 mm ammunition was originally developed for use by the now Rheinmetall Air Defence Oerlikon twin 35 mm air defence weapons with the latest round being the 35 mm Advanced Hit Efficiency and Destruction (AHEAD) which is highly effective against small targets. It can also be used in the Northrop Grumman 35 mm Bushmaster III dual feed cannon which is installed in the BAE Systems

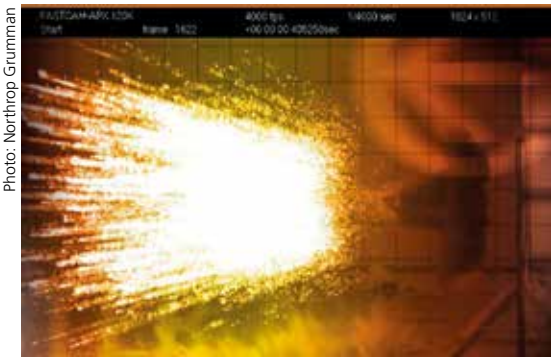


Photo: Northrop Grumman

An increasing number of users are now requesting air bursting munition capability for the 30 mm cannon

Photo: MECAR

MECAR (now Nexter Arrowtech) developed a complete family of 105 mm ammunition including from left to right M1061 HEAT-MPT, M1060A2 APFSDS-T, M393A2 HESH-T, M1057 TP-T and M1053HESH-TP-T

Hagglunds CV9035 IFV deployed by Denmark, Estonia and the Netherlands.

Other countries also market this 35 x 228 mm ammunition including NORINCO as China deploys a number of towed and self-propelled twin 35 mm air defence weapons, many of which are offered on the export market.

40 mm L/70

The only country to use BAE Systems Bofors 40 x 365 mm L/70 ammunition in an AFV application is the Swedish Army with its BAE Systems CV90 IFV, air defence, forward observer and command post versions with the weapon designated the 40 mm L/70B. Ammunition for this is supplied by BAE Systems Bofors and is

fed to the weapon from below with the empty cartridge cases being ejected out of the turret roof forwards.
Types of 40 mm include pre-fragmented HE (PFHE) which is optimised for use against aerial targets, HE-T, MP-T and a pre-fragmented programmable proximity fuzed round (3P). The latter has a muzzle velocity of 1,012 m/s and contains 0.975 kg of PBX HE. For engaging other AFVs, the 40 mm L/70B fires an IM compliant APFSDS-T round with a tungsten penetrator with a m/v of 1,495 m/s which is claimed with penetrate over 150 mm of RHA.
The latest 40 mm P3 round is the Mk 2 which is also IM compliant with a digital rather than electronics. The 3P Mk 2 has the capability of customising programming modes beyond the basic six modes, for example mode optimised for use against smaller UAVs.
Operational experience has shown that the 40 mm 3P arms too far away when fighting in an urban environment so BAE Systems Bofors has developed a new round called 2P Minimum Collateral Damage (MCD). This is armed at a range of around 30 m so can engage targets much closer than before and this is now in service with Swedish Army.
The Republic of Korean (ROK) deploys the Hanwha K21 IFV which is fitted with a two-person turret also armed with a 40 mm L/70 gun which is also used by Korea for naval applications and natures of 40 mm ammunition fired included APFSDS-T and HE-T. More recently, Hanwha of the ROK has developed the REDBACK IFV for the export marked and this is armed with a Northrop Grumman 40 mm MK44S dual feed cannon for which ammunition is available from a wide range of contractors.

40 mm CTAS

CTAI is a joint venture company between Nexter of France and BAE Systems of the UK to develop the 40 mm Cased Telescoped Weapon System (CTAS) with the first two customers being France and the UK. The former has installed the 40 mm CTAS in its JAGUAR (6x6) reconnaissance vehicle which entered service with the French Army late in 2021 and will also be deployed by Belgium for its JAGUAR vehicles.
40 mm CTAS is also mandated for the General Dynamics Land Systems UK AJAX reconnaissance vehicle whose entry has been delayed and the Lockheed Martin UK WARRIOR Capability Sustainment Programme (WCSP) which was cancelled in 2021. While production of the 40 mm CTAS weapon is undertaken in Bourges France, there are two


Photo: CTAI

Medium calibre ammunition (from left to right): 40 mm CTAS, 30 mm, 35 mm and 40 mm

load and pack production lines, one in La Chapelle (France) and the other in Glascoed (UK).
BAE Systems Global Combat Systems Munitions in statement said " we still have the capability to make 20 mm KAA, 30 mm RARDEN and 30 mm KCB ammunition."

50 mm

The US Army BRADLEY and US Marine Corps LAV-25 (8x8) are armed with a Northrop Grumman 25 mm M242 dual feed cannon and some of the STRYKER (8x8) have been fitted with a new remote controlled turret armed with a 30 mm cannon.
In the longer term, the US Army is expected to field a Next Generation Combat Vehicle (NGCV) fitted with the Advanced Lethality and Accuracy System for Medium Caliber (ALAS-MC) which is armed with a 50 mm XM913 dual feed cannon which will fire two main rounds, XM1204 HE Airburst Tracer and XM1203 APFSDS-T.

90 mm Ammunition

These were typically installed in the former Panhard (now Arquus) AML 90 (4x4) and more powerful 90 mm weapon installed in the Panhard SAGAIE (6x6) armoured which has just started to be phased out of service with the French Army. Ammunition for these can be supplied by Nexter Arrowtech as well as some other contractors. There are a number of 90 mm guns produced by the now John Cockerill Defense for installation in their two person turrets and ammunition for these is normally supplied by MECAR.

105 mm Ammunition

While most countries in NATO have fielded MBT armed with 120 mm smooth bore guns, there are still many users that still deploy MBTs armed with the British 105 mm L7 series rifled tank gun or its US equivalent, the M68 which has a different breech. The US phased out its 105 mm (M48A5/M60/M60A1/M60A3 and M1) armed tanks many years ago but the General Dynamics Land Systems STRYKER 105 mm Mobile Gun System (MGS) remained in service until very recently.
In the future, the US Army is expected to field the Mobile Protected Firepower Platform (MPFP) armed with a 105 mm gun. Against this background, Northrop Grumman is also evaluating a 105 mm Advanced Multi-Purpose (AMP) concept with internal research and development funding with the potential fielding by the US Army of a MPFP. A 105 mm AMP round would enable the MPFP to defeat enemy prepared positions, anti-tank guided missile (ATGM) teams, destroy enemy armoured vehicles, close with the enemy though fire and manoeuvre and ensure freedom of manoeuvre and action for in infantry in close contact with the enemy. According to Northrop Grumman, the 105 mm AMP cartridge will combine the capability of thee currently inventories round which are the M456 high-explosive anti-tank (HEAT), M393 high-explosive plastic (HEP) and M1040 canister, into one round to greatly enhance the capability and effectiveness of MPFP by allowing a single round to expand lethality in the limited vehicle ammunition stowage.
The Belgian company of John Cockerill Defense is supplying its latest C3105 two person turrets armed with a 105 mm rifled gun for installation on General Dynamics Land Systems Canada LAV (8x8) being supplied to the Kingdom of Saudi Arabia. More recently, John Cockerill Defense has supplied this turret for installation on the FNSS Savunma Sistemleri Kaplan medium tank being manufactured in Indonesia as the HARIMAU.
MECAR have developed a US Army qualified M393A3 HE-Plastic T round which in UK terms is a HESH-T. This features a dual safety base fuse, forged steel body with a stronger front end and can be filled with IM pressable explosive. This 105 mm round can breech the outer armour and then detonate inside the vehicle. In addition, it can still create spalls when fired against RHA. ■

Naval Ballistic Missile Defence: US, European and Israeli Solutions

Luca Peruzzi

The proliferation of short and intermediate ballistic missile inventories, together with anti-ship ballistic missile threats in recent decades, has resulted in the development of Integrated Air and Missile Defence (IAMD) capabilities for both naval and land applications.

The navies of NATO and European Union (EU) members are today increasingly contributing to the Alliance and 'Old Continent' Ballistic Missile Defence (BMD) operations. The US contribution to NATO's missile defence is conducted through the European Phased Adaptive Approach (EPAA). This happens together with the Maritime Theater Missile Defence Forum, which includes Australia, Canada, Denmark, France, Germany, Italy, Norway, the Netherlands, Spain, UK and the US. Moreover, the dedicated IAMD At-Sea Demonstration/Formidable Shield exercises, alongside the EU Defence technological and operational developments, are supporting NATO and EU efforts to develop integrated and layered BMD networks to which every nation is contributing as part of a unified architecture with transnational and national industries.

Photo: US Navy

The AEGIS weapon system increases capabilities against longer range and more capable sophisticated threats through software and hardware updates exploiting the new Raytheon S-band AN/SPY-6(V)1 Air and Missile Defense Radar (AMDR) performances, as well as the enhancements to the in-service Lockheed Martin S-band SPY-1 family.

Photo: US Navy

Raytheon SM-6 guided missiles are used by the AEGIS (BMD) Sea-Based Terminal (SBT) (Increment 1 and 2) for endo-atmospheric engagements. The SM-6 is a dual role weapon system capable of engaging both surface and air targets over the horizon.

US Platforms and Effectors

The US AEGIS BMD capabilities capitalises on and evolves from the existing US Navy's Lockheed Martin AEGIS Weapon System (AWS) and Raytheon Standard Missile (SM) infrastructures. The AEGIS BMD provides a forward-deployable capability to detect and track missiles of all ranges. It also has the ability to destroy short-range ballistic missiles (SRBM) and medium-range ballistic missiles (MRBM) in both the mid-course and terminal phases of flight, alongside the intermediate-range ballistic missiles (IRBMs) in the mid-course phase of flight, according to US Missiles Defense Agency (MDA). By the end of FY 2022, there will be 48 BMD capable ship available, including TICONDEROGA class CG-47 cruiser and ARLEIGH BURKE class DDG-51 guided destroyers. Lockheed Martin is the lead contractor for the DDG-51 AEGIS combat system and provider of S-band SPY-1B/D radar and AEGIS combat system, while Raytheon is the lead contractor for the combat system of the three DDG-1000 ZUMWALT class destroyers and its core provider together with the SPY-3 radar. Exploiting the improved radar range, discrimination and engagement capabilities offered by the new Raytheon S-band AN/SPY-6 Advanced Air and Missile Defence Radar (AMDR), as well as the enhancements to in-service Lockheed Martin S-band SPY-1B/D families with the installation of antenna low noise amplifiers, AEGIS will increase capability against longer range and more capable sophisticated threats. It does so across the main weapon system spirals/production lines and associated baselines (BL): BMD 5.1 (BL 9.C2), BMD 4.2 (BL 5.4.1) and BMD 6.0 (BL 10). The AEGIS BMD uses

the Raytheon SM-3 family of guided missiles against exo-atmospheric ballistic missile threats alongside Raytheon SM-6 guided missiles that are used by the AEGIS Sea-Based Terminal (SBT) (Increment 1 and 2) for endo-atmospheric engagements. Having achieved initial operational capability (IOC) in 2014, the SM-3 Block IB contributes to expanding the BMD battlespace. It also engages longer range and ballistic missiles that are more sophisticated that may deploy countermeasures and launch in larger raid sizes. It is also equipped with a more flexible Throttleable Divert and Attitude Control System divert engine (vs Block IA). The SM-3 Block IB features a Kinetic Warhead's (KW) two colour infrared (IR) seeker and advanced signal processor and provides a real-time discrimination and characterisation capability while improving sensitivity for longer range targets and performance against more sophisticated threats. Developed co-operatively by the US and Japan, the SM-3 Block IIA provides greater capability over SM-3 Block IB. This includes increased velocity and range provided by a 53.34 cm (21-inch) diameter rocket motor propulsion stack, more than doubled seeker sensitivity, and more than tripled divert capability incorporated in an advanced KW. As the primary extended

Photo: US Navy - Petty Officer 2nd Class Nathan Beard

The AEGIS BMD uses the Raytheon SM-3 family of guided missiles for exo-atmospheric ballistic missile threat engagements. The US and Japan are cooperating in the development of the new SM-3 Block IIA providing enhanced capabilities over SM-3 Block 1B depicted here.

range air defence weapon for AEGIS cruisers and destroyers and potential future combatants, the SM-6 combines the airframe and propulsion system from the SM-2ER Block IV interceptor with the active radar seeker of the AIM-120C AMRAAM missile, while retaining the legacy SM semi-active radar homing capability for the terminal guidance phase. In service in both the Block I and Block IA, the latter provides improved performance against advanced threats. The SM-6 Dual I variant is fielded and provides sea-based terminal BMD capability against short-range ballistic, as well as cruise missiles. The under development and more capable Dual II missile is designed for use in the

Photo: Italian Navy

Under a French-Italian cooperation programme launched in 2016 and managed today by the OCCAR procurement agency, the two MoDs are working to put into service the MBDA ASTER 30 Block 1NT (New Technology) to deal with ballistic and latest missile threats. Depicted here is the current ASTER 30 version.

Photo: MBDA

The ASTER 30 Block 1 NT features a new active RF Ka-band seeker, together with a new weapon controller bringing increased target acquisition range and localisation accuracy, thus significantly improving direct impact probability.

terminal phase of a short- to-medium range ballistic missile trajectory.

ASTER Family and Block 1 NT Version

Under a French-Italian cooperation programme launched in 2016 and managed today by OCCAR procurement agency, the two MoDs are working to put into service the ASTER 30 Block 1NT (New Technology). This is the latest member of the MBDA ASTER missile family, capable of dealing with both ABT and the latest missile threats, including supersonic and ballistic systems for both land and naval applications. Last February, the UK MoD announced the plan to provide a BMD capability to the Royal Navy and 'the wider Defence'. This will initially upgrade its inventory of ASTER 30 missiles, and the procurement of the ASTER 30 B1 NT later on. Developed under the French-Italian FSAF (Future Surface-to-Air Family) programme, the MBDA ASTER missile family was conceived as a dual stage vertically-launched missile concept featuring a common terminal stage. This is also known as 'dart', with an active Ku-band seeker and a booster stage which comes in two different versions, thereby ensuring a range in excess of 30 km for the ASTER 15 and 120 km for the ASTER 30. Both systems are currently used by SAAM (Surface Anti-Air Missile) and PAAMS naval air defence systems by the Eurosam consortium. This includes Thales and MBDA (France and Italia) and MBDA UK (PAAMS S), the SAAM ESD (SAAM Extended Self Defence) family by MBDA Italia, alongside the MBDA France for the French Frégate de Défense et d'Intervention (FDI) in addition to international customers. The ASTER 30 also equips the land-based Eurosam SAMP/T system in the Block 1 version, which incorporates a proximity fuse and a blast fragmentation warhead effective against both ABT and Tactical Ballistic Missiles (TBMs) threats. According to MBDA, and as demonstrated in operational firings by SAMP/T system, the current ASTER 30 Block 1 is capable of dealing with TBMs in the SCUD class with a 600 km range.

The new ASTER 30 B1 NT is being developed in the latest iteration under a contract assigned in March 2021 by OCCAR to the Eurosam consortium. This version features a new enhanced weapon controller and a new active RF seeker operating in the Ka band, while the munition retains the same size, mass, and booster, allowing it to be used by all current launchers for both land and naval applications. Developed by the Thales seeker division with the support and components from the MBDA seeker division in Italy, the B1 NT seeker, together with the new weapon controller by MBDA, brings an increased target acquisition range. It also has the capacity to acquire targets with a lower radar cross section and thinner angular resolution for increased target localisation accuracy, thus significantly improving direct impact probability. According to released information, the B1 NT will be able to cover the entire SRBM (Short Range Ballistic Missile) threat domain, as well as the MRBM (Medium Range) domain up to 1,500 km range. The new version will also be capable of coping with TBMs with multiple warheads, as well as those with terminal guidance used in anti-ship ballistic missiles (ASBM). The latest EC (Enhanced Capability) under-development iteration, which is to provide longer range and higher altitude engagements to cope with new missile threats, is part of the ASTER 30 B1 NT baseline capabilities. The ASTER 30 B1 NT has an interception range of over 150 km against ABTs and can reach over 20,000 m altitude as part of the SAMP/T NG system. Based on latest French defence budget documentation, first series-production deliveries are planned for 2027.

BARAK MX Naval

In April 2021, the IAI (Israel Aerospace Industries) group announced the successful completion of a series of trials, including the interception of a ballistic missile surrogate threat that concluded the qualification phase of the BARAK ER (Extended Range) missile, the latest iteration of the BARAK interceptor family, and the launch of its de-

livery process to an undisclosed customer. With the availability of the BARAK ER for both land and naval applications, the combat proven BARAK MX family of Air & Missile Defence missile systems expands the capability to intercept ABTs at the extended range of 150 km alongside ballistic and other missile threats. The BARAK MX family of Air & Missile Defence missile systems already includes two interceptors sharing the same 22.7 cm airframe diameter. These are the MRAD (Medium Range Air Defence) with a single solid fuel pulse rocket motor and the LRAD with a dual/solid fuel pulse rocket motor with a 35 km and 70 km maximum range, plus a 10 km and 20 km maximum intercept altitude. The addition of the BARAK ER, with its 150 km range and 25 km altitude of intercept, provides enhanced flexibility to the overall system, the booster, plus the dual-impulse rocket motor allowing the missile to reach a significantly higher speed and manoeuvrability in the vicinity of the target thanks to the second impulse. The new interceptor is the result of the combination of a standard BARAK LRAD missile with a solid rocket propellant booster. This adds 1.3 m to the 4.5 m of the LRAD munition and increases the diameter to 0.35 m, while the weight at launch is 400 kg (versus 280 kg of the LRAD). The warhead is also different, as it is of a blast fragmentation type, which provides higher lethality while the active RF seeker introduced new algorithms for dealing with ballistic missile threats and the munition is expected to maintain the LRAD two-way data link concept. As the booster diameter falls within the current BARAK missile canister size, the difference lies in its length due to the longer 5.8 m munition plus booster.

TWISTER

In November 2019, the EU Council implemented the TWISTER (Timely Warning and Interception with Space-based TheatER surveillance) capability project within the Permanent Structured Cooperation (PESCO) framework. Coordinated by France and including Finland, Germany, Italy, the Netherlands and Spain, the project seeks to develop a multi-role endo-atmospheric interceptor and a space-based early warning to address emerging threats and is expected to be brought into service in 2030, with support from the European Defence Fund (EDF). Last December, an industrial consortium led by MBDA group responded to the EU call for a concept exploration study regarding an endo-atmospheric interceptor capable. The main requirements are to be able to operate with both naval and ground systems and allow engagements in a multi-system and multi-platform architecture. The design should primarily be optimised to deal with ballistic missiles up to 3,500 km range, Anti-Ship Ballistic Missiles up to 2,500 km range, hypersonic glide vehicles released by TBM similar carriers with up to 3,500 km range and high altitude hypersonic and supersonic cruise missiles. Furthermore, secondary targets such as subsonic and supersonic cruise missiles and ABT threats can also be dealt with. The follow-on developments of these studies could led to the successor of European SAMP/T and PAAMS systems in the long-term.

Early Warning and Long-range Surveillance Radars

The naval BMD early warning sensors have attracted greater interest in recent years although there are still scarce resources within the current national and alliance territorial and expeditionary defence concepts. In addition to US solutions already discussed, the European and Israeli industries are offering new products.

Photo: © IAI

As part of the BARAK MX air & missile defence system family, the Israel Aerospace Industries (IAI) group announced in April 2021 the successful completion of a series of trials, including the interception of a ballistic missile surrogate threat that concluded the qualification phase of the BARAK ER (Extended Range) missile.

Photo: Mourad-Cherfi – MBDA

Coordinated by France and including Finland, Germany, Italy, the Netherlands and Spain, the TWISTER (Timely Warning and Interception with Space-based TheatER surveillance) capability project within the EU Permanent Structured Cooperation (PESCO) framework, seeks to develop a multi-role endo-atmospheric interceptor and a space-based early warning to address emerging threats.

Thales SMART-L MM/N

During the US-led NATO At-Sea Demonstration/Formidable Shield 21 (ASD/FS 21) exercise in May 2021, the Royal Netherlands Navy (RNLN) DE ZEVEN PROVINCIËN air defence and command frigate, equipped with the Thales' long range surveillance D-band SMART-L MM/N radar, was able to autonomously detect a ballistic missile surrogate and provide tracking data through the NATO Communication network to the US Navy PAUL IGNATIUS guided-missile destroyer. These data enabled the latter platform's combat system to launch an SM-3 Block IA exo-atmospheric interceptor against a ballistic missile target outside the range envelope of its own radar – known as 'Launch on Remote' (LoR). It was able to guide it to intercept the non-separating ballistic missile surrogate well outside the earth's atmosphere. During the same exercise in another live event, thanks to Thales radar suite information, the RNLN frigate was able to conduct engagements on air threats, while simultaneously tracking a ballistic missile threat. In addition to the new radar, the frigate received modifications to the combat management system (CMS) and the new LINPRO link processor. Developed by Thales Nederland, the MM/N version is the latest and fully digital iteration of the SMART-L long-range D-band radar, which introduces a series of hardware, software and operating mode improvements, including a new high-power active EASA (Active Electronically Scanned Array) antenna based on GaN TRMs (Transmitter Receiver Modules). Together with the dual-axis multibeam receiver technology, these enhancements enable the radar to detect a very wide variety of objects including stealth, short and up to long range ballistic missiles and also space objects up to a 2,000 km instrumented range (480 km instrumented range versus air targets) with a 1,000 objects tracking capacity. Installed on all four DE ZEVEN PROVINCIËN frigates, the SMART-L MM/N is being considered by current and other potential customers.

Leonardo KRONOS POWER SHIELD

Basec on the RAT-31/FADR L-band long-range radar developments, the ATBMD NATO activities participation and new technologies insertion, Leonardo developed the fully digital D-band KRONOS POWER SHIELD early warning radar for tactical ballistic missile surveillance and defence. Conceived for both naval and land applications, the KRONOS POWER SHIELD is Leonardo's first fully digital radar using state-of-the-art digital beam forming (DBF) technology and latest high power GaN technology. The new AESA software defined radar features a digital antenna architecture based on 1000+ radiating elements grouped in DATs (Digital Active Tiles). This system implements a full radar chain for each single radiating element, providing excellent tracking accuracy thanks to bi-dimensional digital mono-pulse capability, high range resolution (wide band) to discriminate TBM boosters from TBM re-entry vehicles, advanced ECCM capabilities and clutter/multipath suppression by means of adaptive digital beamforming and stared antenna operation for radar performance extension.

With a 15 rotation-per-minute and a 4 second (rotating) and 1 second (staring) update time, an elevation coverage of 70° and 90° in search and tracking modes, the new radar is capable of > 1,000 simultaneous targets tracking and has an instrumented range of 400 and 1,500 km respectively against ABT and TBM targets. Procured by the Italian Navy and the Qatar Emiri Naval Forces (QENF), according to Leonardo, the KRONOS POWER SHIELD, together with the C-band KRONOS GRAND NAVAL rotating multifunction radar, can deal with up to 600 km TBM threats. The new system, together with the C-band 4FF KRONOS QUAD radar, can manage up to 1,300 km TBM's re-entry vehicles threats.

Hensoldt/IAI

On August 2021, the German BAAINBw procurement agency awarded the German Hensoldt group and Israeli IAI subsidiary ELTA Systems a contract for the delivery and installation of four long-range radars to modernise the sensor suite of the German Navy's SACHSEN class air defence frigates, as part of the "F124 ObsWuF" programme. The new radars, which received the designation TRS-4D/LR ROT, together with latest generation IFF systems, will replace the currently used SMART-L radars and IFF on board the frigates. A fourth system suite will be installed ashore at the German Navy's test reference and training facilities. According to a BAAINBw statement, thanks to AESA technology, the new radars will be able to detect and track particularly small and manoeuvrable targets, with a range of more than 400 km for air targets and up to 2,000 km for objects in the earth's orbit. The first platform will receive the new long-range radar during its scheduled maintenance period in 2024 and overall activities on the three ships will be completed in 2028. The new radars will allow the German Navy frigates to contribute to the NATO BMD in addition to enhanced air surveillance capabilities.

US, European and Neighbouring Countries BMD Capable Naval Platforms

As part of the US contribution to NATO missile defence through the European Phased Adaptive Approach (EPAA), in addition to the land-based version of the AEGIS BMD at the two sites in Romania and Poland, four BMD-capable US Navy AEGIS destroyers are forward-homeported at Rota, Spain. Two more are planned to be added at a later date. The US Navy's ARLEIGH BURKE class DDG-51 destroyers will all be equipped with the Lockheed Martin AEGIS combat system and SPY-1D(V) until the entry into service of the Flight III DDG-51 design. The first platform, namely the JACK H. LUCAS (DDG 125) destroyer is planned to be delivered in April 2023. This platform incorporates the new and more capable SPY-6(V)1 radar (AMDR, Air and Missile Defense Radar). Moreover, it includes associated changes to the ship's electrical power and cooling systems, alongside the latest AEGIS Baseline 10 (BMD 6.0), in addition to a new platform, weapon systems, electronic warfare and combat capabilities. Nine under-delivery 'Flight IIA Technology Insertion' destroyers are fitted with elements of the new DDG-51 Flight III, except the SPY-6 radar. A contender, together with a Northrop Grumman solution of the

Photo: US Navy

In May 2021, during the US-led NATO ASD/FS 21 IAMD exercise, the Royal Netherlands Navy DE ZEVEN PROVINCIËN frigate, equipped with the Thales' long-range surveillance D-band SMART-L MM/N radar provided early warning and target track data to the US Navy PAUL IGNATIUS guided-missile destroyer for successful exo-atmospheric ballistic missile surrogate engagement.

Photo: Leonardo

Procured by both the Italian Navy and the Qatar Emiri Naval Forces (QENF), the Leonardo D-band KRONOS POWER SHIELD early warning radar for tactical ballistic missile surveillance and defence, is Leonardo's first fully digital radar using state-of-the-art digital beam forming (DBF) technology and latest high power GaN technology.

Photo: Hensoldt

On August 2021, the German BAAINBw procurement agency awarded the German Hensoldt group and Israeli IAI subsidiary ELTA Systems a contract for the delivery and installation of four latest generation long-range radars to modernise the sensor suite of the Navy's SACHSEN class air defence frigates and land-based development installation.

Doppler Radar Technology from Weibel Scientific

According to Weibel Scientific, only Doppler radars can provide 3D tracking and are designed for precise measurement and pursuit ballistic missiles and other free-flying projectiles. Doppler radar systems uniquely handle a range of identification, measurement and tracking tasks for naval BMD with increased detail - despite atmospheric disturbances prevalent at sea that can cause anomalies and false readings for other types of radar.

To achieve the required level of accuracy, such solutions are based on X-band CW, MFCW and FMCW radar systems. As in the Weibel example, these could consist of mono-pulse Doppler radar antennae supported with real-time multi-object tracking processors and waveform generators that are controlled from an operator console. Depending on the specific radar requirements, 3D Doppler radar offers deployment flexibility for naval BMD, from a small two-man portable system to a shore-based trailer or housed system, as well as being ship-borne. This allows more comprehensive situational awareness for BMD as the 3D Doppler radar allows naval forces to accurately identify, track, assess, decide and respond appropriately to BMD and other airborne threats at sea.

Photo: Weibel Scientific

new DDG-51 radar programme won by the Raytheon AMDR, the Lockheed Martin new SPY-7 has been so far acquired by Japan, Spain and Canada.

In July 2020, the OCCAR procurement agency, on behalf of France and Italy, awarded NAVIRIS, the 50/50 joint venture between Fincantieri and Naval Group, the feasibility study contract for the French and Italian Navies' HORIZON-type guided-missile destroyer mid-life upgrade (MLU). The feasibility study was aimed at evaluating platform and combat system modification/enhancements in order to maintain, and possibly increase their capabilities and performances until their end of service. Other companies such as Leonardo, Thales, MBDA, Eurosam and SIGEN (joint venture between Elettronica and Thales) were involved. The study was recently completed and different solutions - including slightly different national variants should the two MoDs and Navies not want to maintain high commonality - were submitted. As the main Anti-Air Warfare (AAW) platforms for both navies, the HORIZON MLU would include enhancements or new equipment for the PAAM system - including new multifunction and long-range radars and munitions - the Combat Management System (CMS), communications and EW suites. Although no details were released, the Italian MoD's funding documentation presented to Parliament specifies the capability to use both ASTER 15/30 MLU and new ASTER 30 B1 NT, which are the same weapon programmes contracted by France. After configuration selection and MLU contract award, the first ship to begin upgrading activities will be an Italian platform from the beginning of 2026 and will last 18 months. All ships are to be upgraded by 2030-2031.

Late last February, the UK MoD announced that it was committed to upgrading the Type 45 DARING class destroyers' PAAMS air defence system by the late 2020s to provide a BMD capability for the Royal Navy and wider defence. The SEA VIPER (UK PAAMS variant) features a UK-specific C2 system, 48-cell SYLVER A50 VLS for ASTER 15/30 missiles and the BAE Systems SAMPSON E/F-band multifunction radar with two back-to-back antenna arrays providing DBF and hemispherical coverage. The Integrated Review funded the SEA VIPER Evolution (SVE) programme's Capability 1, upgrading the RN's missiles to the ASTER 30 Block 1 standard. The RN will also conduct an 'Assessment Phase' of 'SVE Capability 2' to further enhance this capability and cover a greater range of

threats, utilising the ASTER 30 B1 NT. Although no further details were provided, it is expected the in-service upgrading to Block 1 standard will be conducted in parallel with the already awarded ASTER 30 munitions life-extension contract by OCCAR. Both Italy and France are also part of the same contract, but have chosen to conduct joint activities on both the ASTER 15 and 30. Further UK missile defence developments are connected to the Future Air Defence System planned to equip the replacement of the Type 45 destroyers.

In late 2021, Italy launched the risk reduction study for the new class of guided destroyers under the so-called DDX programme to initially replace the two ADMIRAL class platforms, which entered service in the early 90s. The new DDXs are expected to be equipped for both AAW and BMD operations, as well as anti-surface and deep land-strike missions. With a new combat system derived from the PATTUGLIATORI POLIVALENTI D'ALTURA (PPA) platforms in the 'Full capable' configuration with Leonardo DUAL-BAND (C and X) Radar, Elettronica EW and MBDA Italia SAAM ESD air defence system, the DDXs are expected to be initially equipped with the ASTER 30 B1 NT. However, it is also foreseen to be fitted with new effectors to cope with future threats, such as the resulting next-generation interceptor component of the TWISTER programme. In the meantime, at least the PPA Full platforms equipped with the DBR radar suite capable of simultaneous ABT and BMD operations are the logical candidates for the ASTER 30 B1 NT deployment.

While conducting the AAW capabilities upgrade of its DE ZEVEN PROVINCIËN frigates, the RNLN became the first European navy to acquire a BMD long-range surveillance and tracking capability. It also demonstrated its ability to perform a co-operative engagement with a USN AEGIS 'shooter'. The RNLN and Netherlands MoD will also launch the programme for the Raytheon SM-2 Block IIIA replacement with a new long-range air defence missile in 2023. In the meantime, in December 2020, the Dutch and the German Ministries of Defence signed a cooperation agreement to work jointly on a next generation frigate to replace both the German Navy's SACHSEN class (F-124) and the RNLN De ZEVEN PROVINCIËN class frigates. The German Navy has acknowledged that the next generation frigate, also known as the F-127 programme, will be equipped with an integrated air and missile defence sys-

Photo: US Navy

In July 2020, the OCCAR procurement agency, on behalf of France and Italy, awarded NAVIRIS, the 50/50 joint venture between Fincantieri and Naval Group, the feasibility study contract for the French and Italian Navies' HORIZON-type guided-missile destroyer mid-life upgrade (MLU).

Photo: UK Crowncopyright

In February 2022, the UK MoD announced its commitment to upgrade the Type 45 DARING class destroyers' SEA VIPER (UK PAAMS variant) air defence system by late 2020s to provide a BMD capability for the Royal Navy with initially the integration of the ASTER 30 Block 1 and later, the ASTER 30 Block 1NT.

Photo: Luca Peruzzi

With a new combat system derived from the PATTUGLIATORI POLIVALENTI D'ALTURA (PPA) platforms in the 'Full capable' configuration (here depicted) with Leonardo DUAL-BAND (C and X) Radar, Elettronica EW and MBDA Italia SAAM ESD air defence systems, future Italian Navy destroyers are expected to be initially equipped with the ASTER 30 B1 NT missile system.

Photo: Navantia

Spain is contributing to the naval Alliance and European BMD efforts with the ÁLVARO DE BAZÁN class F-100 frigates' AEGIS combat system and AN/SPY-1D radar, which will be further enlarged with the new class of F-110 frigates entering service from 2027.

Photo: Royal Danish Navy

In 2018, Denmark decided to upgrade at least one of the IVER HUITFELD class frigates to a BMD sensor role. The Danish procurement agency awarded Terma a study and advisory support contract to provide an IAMD/BMD capability through the Terma-provided C-Flex CMS-based combat system of the frigates.

Photo: Rafael

The Israeli MoD and Navy are putting into service the new SA'AR 6 corvettes equipped with the IAI MF-STAR 4FF AESA radar and the same company's Naval MX BARAK air defence missile system using the BARAK LRAD munition. . Depicted here is a qualification firing of the Rafael CDOME missile system.

tem including interceptors against ballistic missiles and new threats. It will be the first platform to provide this capability as the upgraded F-124 frigates won't be equipped with such interceptors.

The Spanish MoD and Navy is contributing to the naval Alliance and European BMD efforts by equipping the ÁLVARO DE BAZÁN class F-100 frigates with the surveillance, detection, tracking and dissemination capabilities of the AEGIS combat system and AN/SPY-1D 3D radar. Spain will further enlarge its contribution with the entry-into-service of the new class of F-110 frigates from 2027. The F-110 frigates are equipped with a new generation combat system centered on a radar suite with the new Lockheed Martin/Indra S-band SPY-7(V)2 and Indra X-band PRISMA-25X system, alongside the standard Mk 41 Vertical Launching System (VLS). The new Canadian Surface Combatant's frigates will also feature the SPY-7 radar, potentially contributing to BMD activities.

In 2018, Denmark decided to upgrade at least one of the IVER HUITFELD class frigates to a BMD sensor role and the Danish procurement agency awarded a study and advisory support contract to Terma to provide an IAMD/BMD capability through the Terma-provided C-Flex CMS-based combat system of the frigates. The Danish Navy is implementing the SM-2 Block IIIA missile area air defence capability and launched a study for the combat system modification to implement the SM-6 missile. The new Frégate de Défense et d'Intervention (FDI) platforms being built by Naval Group for the French Navy are set to be delivered from 2024 onwards. They will be equipped with the new generation Thales S-band 4FF AESA SEA FIRE and could also play an unspecified BMD role with combat system updates and ASTER family capable missiles, together with external tracking data support, although this is not part of the current released requirements. The Greek MoD is in the final stages of procuring the same platforms equipped with ASTER 30 Block 1 missiles. The Turkish MoD meanwhile is working on the TF-2000 Air Defence Destroyer, which is expected to include BMD capabilities, provided as for the effector, by the SIPER family of long-range air defence missiles, which includes the participation of the Aselsan, Roketsan and Tübitak Sage companies. In the Mediterranean basin, the Israeli MoD and Navy are also putting into service the new SA'AR 6 corvettes equipped with the IAI MF-STAR 4FF AESA radar and the same company's Naval MX BARAK air defence missile system using the BARAK LRAD munition. With the implementation of a longer canister, the BARAK ER munition can be embarked. ■

Unmanned Systems in the UAE

Melanie Rovery

The United Arab Emirates (UAE) is developing its unmanned capabilities and is fast becoming established as being one of the most advanced in the Gulf region. The UAE is indeed evolving in the development of unmanned systems by offering approximately 60 systems to the export market in just over two years.

Its capacity and capability in unmanned systems is increasing with the technology and development to build the UAE's industrial base progressing fast. The country is keen to limit its dependency on joint production with foreign partners with regard to unmanned systems and technology and instead replace it with an indigenous capability.

Military Professionalism

The UAE is ready to protect and define itself as a country with influence and military professionalism. By developing its unmanned military capabilities within as well as using offset strategies with foreign partnerships, it has started to gain momentum in its goal of self-reliance. Joint development brings a wealth of technology sharing as well as insights and expertise. Testing and evaluation is well underway and moving at great speed with plenty of autonomous system prototypes being developed.

Military unrest within the region coupled with its modest size and lack of human resource, make the UAE a perfectly suited candidate for the proliferation of unmanned technology.

The UAE doesn't just have a demographic issue, it also has a demographic limitation in terms of the amount of Emirati nationals it has. Military and terrorist activities in countries such as Iran, Bahrain, Iraq, Lebanon, Syria, and Yemen reinforce the UAE's concerns of protection. Unmanned and autonomous systems provide an effective way to level up their capabilities and protect military installations, airports and oil facilities from volatility in the region.

Photo: Melanie Rovery

The GARMOUSHA was designed and developed to fulfil specific requirements of the UAE's Armed Forces. Seen on display for the first time at UMEX 2020.

EDGE Group

In December 2019, the UAE conglomerate 'EDGE Group' was formed and consisted of 25 UAE defence manufacturers to become one entity. Subsidiaries of EDGE include Emirates Defence Industries Company (EDIC), Abu Dhabi Autonomous Systems Investments Co LLC (ADASI), Emirates Advanced Investments Group (EAIG), Tawazun Holding, NIMR and many others.

The CEO of EDGE, Faisal Al Bannai, has been executing a vision of being a technology company that does defence rather than a defence company that does technology. EDGE has been aggressive in its product development and has brought various unmanned products to market in just over two years (despite a global pandemic). The amalgamation of defence manufacturers is predominately focused on autonomous capabilities with the CEO setting a clear future vision of creating and exporting its own products.

he Unmanned Systems Exhibition & Conference (UMEX) held in Abu Dhabi National Exhibition Centre (ADNEC) Abu Dhabi in February 2020 saw the unveiling of the UAE's first domestically produced 'Garmousha' vertical take-off and landing (VTOL) drone. The unmanned aerial system (UAS), produced by ADASI, is a light unmanned aircraft designed to carry 100 kg over a six-hour period up to 150 km.

Automation

Automation is a strategic priority for EDGE with ADASI revealing its unmanned ground vehicle (UGV) products at IDEX, held from 21-25 February 2021. The AJBAN 440A armed robotic vehicle (ARV), developed in collaboration with NIMR, is a multipurpose, ballistic and blast protected light tactical patrol vehicle that can accommodate a crew of five. The 4x4 platform can be equipped with a roof-mounted weapon station and has a communication range of up to 12 km. Miles Chambers, Director of Business De-

Author

Melanie Rovery is an independent researcher of unmanned systems and is based in London. Her research includes 25 years' experience of the defence sector within Janes. Melanie's specific expertise lies in military robotics, autonomy, AI and uncrewed systems. She has delivered studies and research regarding the future of unmanned platforms to military forces and has authored publications such as Janes Land Warfare Platforms: Logistics and Unmanned.

Photo: ADASI

The AJBAN 440A armed robotic vehicle (ARV) is a joint development between NIMR and ADASI.

velopment – Platforms & Systems, EDGE explained how EDGE have been making significant advancements to boost the UAE's autonomous capabilities, "As part of the UAE's Industry 4.0 agenda, EDGE is playing a major role in leveraging advanced technologies to develop superior autonomous solutions, both to bolster national and regional defence, and further afield to key markets for export."

Chambers noted that there will be an increasing reliance on unmanned systems across land, air, and maritime domains in the future with EDGE investing extensively to fast-track R&D investments in these areas to bring related products such as autonomous systems and smart munitions to market with speed. Chambers added, "As our customers evolve their unmanned missions, we are advancing our capabilities, providing longer endurance, offering increased payload, and focusing on tactical flexibility in dynamic environments."

ADASI also displayed its SCORPIO-M (mini - weighing 15 kg) and SCORPIO-S (small - weighing 195 kg) UGVs. Both platforms are designed to be deployed with Special Forces teams to carry out intelligence, surveillance, target acquisition, and reconnaissance (ISTAR) operations. The SCORPIO-S can mount a manipulator arm that fully extends to 1.35 m.

Counter Drone Technology

In March 2021 Israel's Israel Aerospace Industries (IAI) and UAE's EDGE agreed to partner to develop counter drone technology to detect a range of UAV threats. The memorandum of understanding (MoU) demonstrated the first time that an Israeli defence company has collaborated with an Emriati counterpart.

In a written statement in September 2021, the US Secretary of State Antony Blinken noted that since the beginning of 2021, Saudi Arabia has undergone approximately 240 drone attacks throughout 2021. Many of these attacks were likely to have been carried out by Houthis rebels who have severely ramped up their attacks over the past year. With these threats noticeably increasing, it comes as no surprise that counter-drone tech is high on the agenda.

The Dubai Airshow held from 14-18 November 2021 revealed several offerings of counter-unmanned aerial systems (C-UAS) technology which signals that the UAE are interested in this specific area. The UAE is highly likely to experience the same threats as other countries in the region such as those from unmanned drone attacks.

Two C-UAS systems were displayed at the Dubai Airshow. US-based Fortem Technologies showed its upgraded SkyDome system, which has been operational in the UAE since receiving investment from UAE's Mubadala Investment Company in 2019. The SkyDome system consists of an AI-enabled DroneHunter UAS equipped with onboard TrueView Radar for low SWAP-C active electronically scanned array (AESA). It features a combination of multi-channel beam form on receive, 16 digital channels with multi-dimensional deep learning. The radar can neutralise Group 2 and Group 3 UAV threats and can discern patterns of life and anomalies to accurately identify

Photo: Fortem Technologies

The SkyDome C-UAS system is designed to protect high-risk infrastructure from drone attacks.

targets. UAVs are autonomously identified as a threat and neutralised with a net and then towed away.

Emirati company International Golden Group (IGG) displayed SKYLOCK which is owned by Israel's Avnon. The system has undergone testing in the UAE with armed forces. However, a contract is yet to be signed.

Halcon (subsidiary of EDGE) unveiled a full-scale model of its 'Reach-S' fixed-wing medium-altitude long-endurance (MALE) unmanned combat aerial vehicle (UCAV) at the Dubai Airshow held in 2021. The UCAV was displayed armed with four Desert Sting-16 (DS-16) precision-guided weapons and is anticipated to provide a take-off weight of 600 kg (with payload of 120 kg). Currently in its initial design phase, it is likely to achieve its first flight within a year.

Photo: Milanion

AGEMA is a modular, multi-mission UGV designed to operate in rough terrain.

Unmanned Combat Aerial Vehicles

Despite previous purchases from China and the US. The United Arab Emirates (UAE) export Unmanned Combat Aerial Vehicles (UCAVs) to foreign countries. Abu Dhabi aim to strengthen their domestic UAV industrial base and have invested in indigenous models such as the Emirati Yabhon series, produced by ADCOM Systems and destined for export.

Due to their geographical position with Iran just across the water, the UAE has a significant maritime counter-terrorism threat. A suspected drone attack in July 2021 from Iran on an oil tanker in the Gulf of Oman coupled with an alleged high jacking of a vessel in August 2021, has led to the UAE procuring three unmanned mine hunting capabilities over the past 18 months.

Future indigenous unmanned companies such as Abu Dhabi Ship Building Company (ADSB) are highly likely to produce autono-

Photo: General Atomics Aeronautical Inc

GA-ASI's MQ-9B SkyGuardian/SeaGuardian multi-mission remotely piloted aircraft

mous surface vessels. At the Dubai Airshow in November 2021, EDGE, ADSB and Israel Aerospace Industries (IAI) announced they will jointly develop advanced unmanned surface vessels (USV) for the military. The series of `170 M' USVs will be designed by ADSB with IAI developing the autonomous control system. The unmanned vessels will be designed to carry out submarine detection and anti-submarine warfare in both semi and full autonomous modes.

Al Seer Marine, based in Abu Dhabi, partnered with L3Harris to demonstrate an Unmanned Surface Vessel (USV) at IDEX in February 2021. The rapid interceptor vessel demonstrated its ability to be fitted with various payloads integrating L3Harris' ASView autonomous control system, FalconIII RF-7800 W radio and Wescam MX-10MS EO/IR imaging system. The USV is 11 m in length and weighs 7,200 kg. The vessel can reach speeds of up to 45 kts.

Another Emirati-based company with a visible presence in the unmanned space in the UAE is Milanion. Based in Dubai, Milanion specialises in Unmanned Ground Vehicles (UGVs) and first displayed its AGEMA platform at UMEX in February 2020. AGEMA is a modular, multi-mission platform that is mounted on either a 6×6 or 8×8 drivetrain. The UAE Armed Forces expressed an interest in the AGEMA at IDEX in February 2021 and, just a year later, saw Milanion move their development and manufacturing capability of the platform to Tawazun Industrial Park (TIP), the Centre for Strategic Defence Manufacturing in Abu Dhabi. The company is now focusing its efforts on AI and autonomous technology.

A Future Requirement

The UAE is most definitely prioritising unmanned and autonomous systems as a future requirement. In 2020, a Foreign Military Sale (FMS) was approved for the US to supply the UAE Government with General Atomics, MQ-9B SkyGuardian UAV and related equipment for an estimated cost, when combined with their order of F-35s, of US$2.97Bn. The sale is a welcome boost to ensure that the UAE has the capability to counter future threats and is likely to modify the military balance in the Gulf region. The MQ-9B as an intelligence collection asset that will be able to provide the country with relevant Intelligence, Surveillance, and Reconnaissance (ISR) as well as offering target acquisition for self-defence. The operational advantage of a weaponised remotely piloted aircraft will be a boon to the UAE.

However, the UAE cancelled a deal with the US in mid-December 2021 which included 18 advanced drone systems. The cancellation was likely due to tensions rising and trust issues between Washington and Abu Dhabi regarding the UAE's ties with China and Russia.

Research, development and innovation is notably high on the agenda for the UAE. The benefits of such defence partnerships are felt across the country. In February 2021 it was revealed that the UAE's Tawazun is to take control of the UAE's Armed Forces and Abu Dhabi Police procurement process. Tawazun Economic Council (TEC) in the UAE are now managing the development of indigenous high-value sectors such as unmanned and autonomous technology and are the defence and security acquisitions authority.

The Tawazun Economic Program (TEP) ensures that an offset policy can create the long-term partnership of defence manufactures. Any major procurement over approximately US$10M has an offset liability placed upon it for approximately 60% of the value. The TEC are responsible for holding any foreign company to account to put forward proposals to discharge their obligation and how it links to UAS objectives industrially. Training from foreign defence entities provides offset credits to help discharge the obligation.

The conglomeration of EDGE was effectively to bring in all of those disparate companies that were established with these offsets, and put them under one house. Now the UAE have this industrial capability, they can quite aggressively pivot from that industrial base and actually create and export products. There is not just a need to manufacture platforms in the UAE but also for foreign enterprises to demonstrate that they are either transferring technology or training Emiratis. The UAE has also created a partnership that leads to a third country export and drives their own export.

There are three nations in the Gulf which are really working hard at local industrialisation, those being the UAE, Saudi Arabia and Qatar. The UAE certainly has been the lead for IP within the Gulf region. The UAE has made great progress in unmanned technologies and autonomous capabilities however there is still room for improvement. Efforts are still work in progress and much remains to be done however the UAE is further ahead in its industrial developments in comparison to Saudi and Qatar and are not a country to be underestimated. ■

Photo: Fortem Technologies

Fortem Technologies' DroneHunter is part of the SkyDome C-UAS system.

Medium Helicopters – A Centrepiece of Military Success

Jack Richardson

In the global defence and security arena today, few pieces of equipment are more important than Medium Support Helicopters.

Ever since rotary wing aircraft first began supporting military operations in the aftermath of World War 2, in theatres as diverse as Korea and Algeria, Medium Support Helicopters have only grown in importance. Definitions of different helicopter categories vary, but medium (as opposed to light and heavy) support helicopters generally sit between 14,000 and 45,000 lbs. As a result of their importance, companies all over the world are continually marketing solutions in the category.

A Major American Programme

Perhaps one of the most recognisable Medium Support Helicopters is the Sikorsky UH-60 BLACK HAWK family. Making its first flight in 1974 and entering service with the US Army five years later, this iconic aircraft has been deployed in a wide range of theatres from the Caribbean to the Gulf and the Balkans, alongside operations in Iraq and Afghanistan. It has won a large number of export orders and has been developed in specialist variants for the US Navy, Air Force and Coast Guard. However, the US is now looking to future technologies in order to replace this famous type.

The Future Long Range Assault Aircraft (FLRAA) programme has the purpose of delivering a next generation rotorcraft to replace the BLACK HAWK, with the first units becoming operational in 2030. FLRAA is being conducted under the aegis of the Future Vertical Lift (FVL) programme, alongside the Future Armed Reconnaissance Aircraft (FARA) requirement. The key specifications for FLRAA are to supply an aircraft able to carry 12 assault troops with a maximum speed of 230 knots (twice that of the BLACK HAWK). The winning aircraft must have a combat range of 230 Nautical Miles (also double the UH-60's limit) and an overall unrefuelled range of 460nm. These range requirements are to cater for the increased distances inherent in the Asia-Pacific theatre, where the US Army is likely to be conducting a large number of its future operations. The winning aircraft must also have open architecture systems to enable software upgrades over its service life. To achieve these exacting specifications, the US's main rotorcraft producing companies are banking on innovative new technologies.

Photo: Leonardo

Leonardo UK is offering a military derivative of the AW149 medium support helicopter.

Of the two shortlisted competitors, the first is from Bell, offering the V-280 VALOR tilt rotor design. Drawing on the experience accrued during the design and production of the V-22 OSPREY for the US Marine Corps, Air Force and Navy, this proposal will take tilt rotor technology a step further. The key distinguishing feature of this design is that only the blades of the engine will rotate when transitioning from horizontal to vertical flight (and vice versa). By contrast on the V-22 OSPREY, the entire engine Nasal rotates. The prototype made its maiden flight in December 2017 with the company continuing to refine it as part of the development process.

Author

Jack Richardson is a professional UK based author and a regular contributor to ESD specialising in defence and security.

Photo: Leonardo

The AW149 is available in several configurations.

Also competing for the FLRAA contract is a partnership between Boeing and Sikorsky, also offering a distinctive design with several innovative features. This marks a culmination of many decades work for Sikorsky (which is now owned by Lockheed Martin) in its development of X2 technology. This involves a coaxial, counter rotating, main rotor and, instead of a conventional tail rotor, a set of coaxial 'pusher' blades. The company reports that this enables the aircraft to fly faster, over greater distances and performer tighter turns. The proposed aircraft, which has yet to fly, has been named the DEFIANT X by Sikorsky. From what has been revealed publicly, it has next generation features including radar cross-sections reduction, fly-by-wire technology (also offered on the V-280) and a helmet mounted display similar to that deployed on the F-35 LIGHTNING II fifth-generation fighter. Following the rigorous selection process, the winning design will be selected later this year.

Away from the US, NATO member states the UK, France, Germany, Italy and Greece have signed an MoU to further the Next-Generation Rotorcraft Capability (NGRC) to replace their existing types such as the AW101 MERLIN, another Medium Support Helicopter used by several countries around the world, in addition to the NH-90. A further agreement was signed by the partners (with the Netherlands as an observer) in February 2022 to take this possible solution to the next stage. However, little details of this exist as yet so several of these countries are pursuing more immediate programmes.

New Medium Helicopter

Perhaps one of the most significant Medium Support Helicopter requirements extant today is the UK's New Medium Helicopter (NMH) programme. This was announced in the 2021 Command Paper entitled Defence in a Competitive Age. The aim of the NMH programme is to rationalise the UK's Medium Support Helicopter fleet with a single type replacing several legacy models. The most prominent aircraft in need of replacement is the PUMA HC2 which has been in service with the RAF since the early 1970s, providing utility support across a wide variety of theatres. NMH also aims to replace GRIFFON HAR2 helicopters operated by the RAF's 84 Squadron out of the Cyprus Sovereign Base Areas in roles including utility, firefighting and Search & Rescue (SAR). This is in addition to Bell 212s deployed to support the British Army presence in Brunei and the Eurocopter AS365 DAUPHINs used to support the UK's special forces. The Command Paper placed a great emphasis on the UK having forces forward deployed around the world in order to react to situations as they emerge. Therefore, having a Medium Support Helicopter forward based in locations such as these marks a manifestation of this doctrine. The project has attracted a wide amount of interest from across industry with several major manufacturers expressing an interest.

One of the earliest to present a solution was Leonardo UK which is offering a military derivative of the AW149 medium support helicopter. If successful, Leonardo has said the aircraft, which is already in service with the Italian Armed Forces in addition to those of Egypt and Thailand, would be built at the company's facility in Yeovil, Somerset. This factory has a long history of supplying the UK Armed Forces with helicopters dating back to the Westland Helicopter Crisis of the 1980s. Another notable contract was the manufacture of AH-64D LONGBOW APACHEs under license from Boeing, where they were designated the WAH-64. The plant has also supplied the UK, and limited export customers, with the AW101 MERLIN and AW159 WILDCAT helicopters. In promoting their bid, Leonardo's promotional material has demonstrated the AW149 in several configurations including:

- Troop transport
- Casualty Evacuation
- Airborne Command Post
- Close Air Support
- Special Forces
- Cargo Resupply

A model of the AW149 featured prominently at Leonardo's pavilion during the DSEI 2021 exhibition in London last year. The company argues that the UK selecting this aircraft for NMH could lead to significant new exports. This claim has also been made by rival manufacturer Airbus. A

Photo: Sikorsky

The most recognisable medium support helicopter is the Sikorsky UH-60 BLACK HAWK.

model of their solution was also displayed at DSEI 2021. This would be a military version of the H175 helicopter which as been deployed since 2014 in a wide variety of civilian roles including SAR, VIP transport and Offshore Oil & Gas support. In a bid to market its proposal, Airbus has proposed to build the helicopter at a new facility within its site in Broughton, North Wales, where the company currently manufacturers wings and landing gears for its portfolio of civilian airliners. These are the two most detailed proposals at time of writing but others are likely to enter the mix. Another likely frontrunner is a variant of the ubiquitous BLACK HAWK, potentially built at Lockheed Martin/Sikorsky's facility in Poland. Also touted as an option is the Bell 525 RELENTLESS, an advanced civilian type with features including composite construction, fly-by-wire and side stick controls that is currently undergoing certification, with the company saying it will bid.

The contract is valued at £1Bn for between 36 and 44 helicopters (alongside simulators and support services). A contract is expected to be published in the middle of 2022 with the aircraft entering service from the mid 2020s. The UK has also signed an agreement with the US to exchange information on the latter's FVL programme, opening the door to cooperation by the two countries on vertical lift solutions going forward.

NH-90 Proliferation

Another country seeking to modernise its legacy fleet with a common solution is France. Over the last two decades, France has been replacing a larger number of helicopter types with single fleets. The most prominent example of this is the NH-90 family. Produced by the NHIndustries consortium consisting of Airbus Helicopters, Leonardo and Fokker, the French Army has deployed the Tactical Transport Helicopter (TTH) variant and the French Navy the NATO Frigate Helicopter (NFH) model. The former has largely replaced early versions of the PUMA family in the tactical transport role and has already been deployed to support French operations in Mali. With a composite fuselage, the NH-90 TTH features a glass cockpit, fly-by-wire controls, helmet symbology by virtue of the Thales TopOwl helmet mounted display for the pilots and capacity for 20 fully equipped troops. It also has a ramp at the rear for loading and offloading cargo. This aircraft has also been deployed from France's MISTRAL class Landing Platform Helicopter (LPH) ships. Going forward, France plans to induct 10 improved NH-90 TTHs from 2025 which are optimised for special forces operations. This will be done through improvements to the cockpit avionics to allow operations in challenging conditions and greater options to deploy guns from the cabin.

In addition to France, several countries across Europe utilise the NH-90. The German, Spanish, Greek and Finnish Armies currently field the type in the medium support role. Norway and Sweden also use it for maritime applications This is in addition to the Italian Army, which deployed it to Afghanistan during the latter stages of the International Security and Assistance Force deployment in both the medium support and aeromedical evacuation roles. In March 2016, Italy announced that four NH-90s, alongside four AW-129 MANGUSTA attack helicopters, would be deployed to Northern Iraq under the Aegis of the international operation countering so-called Islamic State. The primary mission of these aircraft was providing Combat Search and Rescue (CSAR) for allied combat aircraft operations in the area. The force also protected Italian personnel working to protect the Mosul Dam, located near Erbil were the force was based.

In addition to the TTH variant operated by the Italian Army, the Italian Navy operates the NFH variant from its fleet of surface combatants. The service has also taken delivery of 10 Maritime - Italian Navy Tactical Transport examples. This sub-variant has key features such as the rear-ramp of the TTH but also has modifications including the maritime optimised landing gear found on the NFH. Since taking delivery of the final aircraft in September 2021, the Italian Navy announced that it will used for amphibious and special operations.

Although it has enjoyed several successes, the NH-90, which like many large collaborative defence programmes suffered significant delays, continues to suffer setbacks. Earlier this year, the Australian Department of Defence announced that the aircraft, which has the local designation MRH-90 TAIPAN, would be withdrawn from service early. The reasons given for this were not meeting requirements due to problems which include, amongst others, difficulties for personnel when entering and exiting the aircraft. As a result, Australia has announced plans to purchase a more modern version of the BLACK HAWK as a replacement.

Photo: Boeing-Sikorsky contractor

SB>1 DEFIANT is the technology demonstrator proving out transformational capabilities for the DEFIANT X weapon system, the Sikorsky-Boeing team offering for the US Army's Future Long-Range Assault Aircraft (FLRAA) competition as part of the Army's Future Vertical Lift programme. DEFIANT X will enable crews to fly low and fast through complex terrain, where army aviators spend most of their time. It will extend capabilities of army aviation on the modern battlefield – and is designed to fit in the same footprint as a BLACK HAWK. With DEFIANT X, the US Army will deliver troops and cargo in future combat at twice the range of the current fleet.

Descendants of the PUMA

Although European industry continues to promote the NH-90, there is still a role for

Photo: Bell

The V-280 VALOR tilt rotor design takes tilt rotor technology to a whole new level.

the ever evolving PUMA family. In addition to the COUGER (a militarised variant of the civilian SUPER PUMA) an evolution of the original with enhanced engines and avionics, France also operates the H225M CARACAL. This is another continuation of the PUMA family which has the added option of an air-to-air refuelling probe. This is something France uses in the CSAR and special forces support roles in conjunction with the new KC-130J SUPER HERCULES tanker variants jointly operated with Germany. This is a type France has successfully exported to states including Brazil and the Gulf nations of the UAE and Kuwait in addition to Singapore. Some of these customers have integrated the EXOCET anti-ship missile onto the H225M for maritime strike missions.

While France continues to successfully export defence equipment such as the RAFALE multi-role combat aircraft, the country continues to innovate in the rotary wing sector. Lighter helicopter types are deployed across the French Armed Forces in a wide variety of roles. These range from the GAZELLES flown by the army for armed reconnaissance missions to SAR DAUPHINS operated by the Navy and FENNECs deployed by the Air and Space Force to counter slow aircraft posing a threat in domestic airspace. In the spirit of commonality, France has chosen a medium support helicopter to replace these. The favoured solution is the H160M based on the H160 civil helicopter produced by Airbus helicopters. In December 2021, France placed an initial order for 30 of these aircraft, which will be called the Guépard in French service across the three military branches. The eventual plan is for 169 examples. Artist impressions show the Army and Air Force variants utilising forward firing gun pods and the Navy version with a VENOM anti-ship missile. All variants feature an EO/IR pod on the chin and the TopOwl helmet sight from Thales for situational awareness. The maritime one will be deployed from various surface ships in the French Navy. H160Ms will be delivered from 2027 but the French Navy has started operating civilian examples from land bases to cover the crucial SAR role in both the North and South of the country. This frees up higher end helicopters such as the NH-90 for combat deployments. It has also been reported that the H160M could be offered for the UK's NMH requirement.

A Russian Veteran

Away from the various Western aircraft on offer, Russia has significant pedigree in the production of Medium Support Helicopters. One of the most widely used in both the former Soviet Union and the wider world is the Mi Mi-8. Making its first flight in 1961, the type was shortly afterwards given the NATO reporting name HIP. The aircraft has also been refined into the Mi-17 which has given it improved performance in high altitude environments. This family of aircraft was used by the former Soviet Union in a wide variety of roles. This included the support of air assault operations during the invasion of Afghanistan down to the delivery of humanitarian aid during the 1980s famine in Ethiopia. Footage from Ukraine also shows what appear to be these aircraft taking part in the Russian offensive. On the export market, the HIP family has been sold to countries as diverse as India and Peru to name just two. Today, is it built by the Moscow Helicopter Plant, the Kazan Helicopter Plant and the Ulan-Ude Aviation Plant in a wide variety of variants including, gunship, electronic warfare, airborne command post and SAR.

New Market Entrants

One of the main customers for the HIP family is the Indian Armed Forces, but India is now seeking to diversify its supply of defence equipment under Prime Minister Narendra Modi's flagship "Make in India" initiative. The country has had an indigenous aircraft design and manufacturing industry since independence from the UK in 1947 but this has since expanded to include helicopters. Following on from the Hindustan Aeronautics Limited (HAL) DHRUV utility helicopter, which has been procured by the Indian Armed Forces in addition to both domestic and international civilian customers, the company is moving into the Medium Support Helicopter market. This takes the form of the proposed Indian Multirole Helicopter (IMH) which will have to be compatible with hot and high conditions encountered across large parts of the country.

Another state in the Asia-Pacific region facing significant security challenges for which it is modernising its Armed Forces is South Korea. After many decades relying on imported equipment from the US, among other states, this country boasts a thriving aerospace and defence industry. Alongside flagship combat aircraft recapitalisations such as the T-50 GOLDEN EAGLE trainer family and K-X BORAMAE stealth combat aircraft project, the country has made significant upgrades to its rotary wing capabilities. On the Medium Support Helicopter side, this has been best demonstrated by the Korean Aerospace Industries (KAI) SURION. This is a derivative of the SUPER PUMA and has been deployed by the Republic of Korea Army since 2021 in a variety of missions including utility support, Medical Evacuation and amphibious operations. This final variant is named the MARINEON and features key modifications such as folding rotor blades in order to facilitate operations from ships such as the Republic of Korea Navy's DOKO class LPHs. At the ADEX 2021 expo, KAI also unveiled an armed version of the MARINEON to fulfil the South Korean Marine Corps need for an attack helicopter.

Conclusion

The Wars in Iraq and Afghanistan saw Western forces turn to Medium Support Helicopters to improve speed, capacity and endurance for purposes including the resupply of troops, medical evacuation and rapid force movements to match the mobility of insurgent adversaries. As the world becomes more unpredictable, the capabilities supplied by these aircraft will only grow in importance. ■

Rotary Wing: Faster, Further and More Assertive

André Forkert

According to analysis from Janes Market Forecast, the global helicopter market is worth a total of almost €332Bn between 2022 and 2031. Transport helicopters account for almost half of this market share (around €161Bn), followed by multi-role electronic and government-furnished equipment (GFE). The latter two each have a share of about €43Bn. In terms of individual platforms, the Sikorsky H-60 BLACKHAWK leads the procurement ranking by far, ahead of the Sikorsky CH-53, Boeing AH-64 APACHE and Boeing H-47 CHINOOK. This is mainly due to the fact that many nations are currently modernising their ageing fleets and a new generation of light and medium transport helicopters is coming to customers. But Russia's attack on Ukraine is also likely to renew interest in true combat and anti-tank helicopters among many European countries.

Currently, the focus is on platform performance, i.e. higher payload, range and speed. In the US Marine Corps (USMC) and in Israel, for example, these demands are met by the supply of the Sikorsky CH-53K for the next 40 years. From a German airborne point of view, it looks like this in purely numerical terms: the WIESEL's successor, the LuWa (airmobile tracked weapon carrier) should be able to be transported as an internal load with two vehicles. The demonstrator weighs about 5 tonnes with ammunition and crew.

Next in the Medium Transport Helicopter (MTH) segment, the demand for higher speed for troop transports - and not heavier loads - will come into focus. The Bell/Boeing V-22 OSPREY was the first to implement the aspect of higher flight speeds with the tiltrotor. Just take a look at the Future Vertical Lift (FVL) programme in the USA and the further development of models like the OSPREY. Skyworks Aeronautics Corp. from Chicago/USA also intends to enter this segment with its VERTIJET. This is a vertical take-off and landing (VTOL) high speed and long-range gyrodyne. This aircraft is flown by one pilot and, according to the company, can carry six passengers, fly at 644 km/h and cover 1,609 km. Embraer and BAE are also working on militarising the EVTOL project, an all-electric counterpart.

Photo: MBDA

MBDA Germany plans to develop an entire ENFORCER family based on the ENFORCER ground precision rocket. This could be used as an effector on land, at sea and in the air. Shown here is a graphic of the ENFORCER Air for UAVs and helicopters.

Photo: Sikorsky

First flight of an unmanned Sikorsky BLACKHAWK. During these 30 minutes flight, the helicopter flew some tactical manoeuvres.

A German Army concept paper calls for Army aviators to have "Agility and flexibility to quickly shift focus in land operations." As a core capability, the Army aviators should be able to rapidly deploy their weapon systems in daytime, at night and in poor visibility, over long distances, independent of terrain and under threat, to provide effect and support throughout the entire Area of Responsibility. Within

Author

André Forkert a former infantry officer, is Co-Editor of the German website www.soldat-und-technik.de.

Photo: Boeing

This graphic shows only one of many capabilities of the Boeing CH-47 CHINOOK. With the STH Germany would also enlarge its fire rescue effects.

the framework of the performance triangle of speed, range and payload, flight speeds of more than 220 knots and mission times of at least three hours without additional tanks or air-to-air refuelling are required. Another core requirement is Manned-Unmanned Teaming (MUM-T).

In Europe, the question will arise as to how the successor to the NH90 and the existing combat helicopters will look. Put another way, will there be a European Future Vertical Lift programme? Initial approaches are already being considered at the European Defence Agency (EDA). The FVL programme of the US Army consists of four projects: the Future Long-Range Assault Aircraft (FLRAA) programme; the prototype competition of the Future Attack Reconnaissance Aircraft (FARA); Future UAS; and the Modular Open Systems Architecture. The FLRAA is intended to replace the US military's (Army and USMC) BLACKHAWK helicopter fleet, starting in 2030.FARA is intended to fill the critical gap of a light attack and reconnaissance capability previously filled by the Bell OH-58D KIOWA WARRIOR, which was retired in 2014. Of the original five contenders, a down-selection was conducted in the summer of 2020, and two designs, the Bell 360 INVICTUS and the Sikorsky RAIDER X, are now being further developed. Evaluation tests are to be carried out with both aircraft in autumn 2023, with a start of production from 2028 at the latest. For FLRAA, there are two applicant teams, Textron's Bell (with V-280 VALOR) and Sikorsky-Boeing with the DEFIANT X. A pre-selection is to be made at the end of 2022, with delivery of a prototype in mid or late 2025. Regarding the DEFIANT X, Lockheed Martin states: "To deter future conflicts, there must be a transformational improvement in rotorcraft systems capabilities. The speed, range, and manoeuvrability, that X2 technology provides increases the survivability of the aircraft in the future threat environment. The scalability of X2 technology is developed to fit multiple missions - focusing on Multi-Domain Operations connectivity, interoperability, multi-mission applicability and scalability and survivability."

Also interesting from a German perspective is the Medium Transport Helicopter programme of the German Federal Police. Here, 44 machines are due to be procured. Most recently, the availability of the H215 SUPER PUMA fleet was also a problem there. The project has been out to tender since 2021 and is currently in the bidding phase. Rheinmetall/Sikorsky will probably compete with the S92 and Airbus with the current version of the H225 SUPER PUMA.

Asked for the most important technologies and innovations for rotary wings, Michael Hostetter, Vice President, Boeing Defense, Space & Security in Germany, said: "Future rotorcraft will need to be intelligent, modular and adaptable to improve their capability, availability, affordability and interoperability across the extraordinary range of applications for which they are required, and the range of users. Intelligent rotorcraft, fully aware of the on-board configuration and condition, can partner with all operators to reduce workload to maximise safety and performance while improving availability and reducing the sustainment burden. Modularity and interoperability enable rapidly outfitting systems in real time for the intended use, optimising the configuration with preferred and available approved components. Modularity is broader than open mission systems and vehicle management, also applying to structure and systems and propulsion and powerplant. Modularity also reduces initial and ongoing acquisition costs, and facilitates upgrades and improvements and new configurations."

New Orders, Additions and Replacements

As mentioned above, many users are receiving a new generation of aircraft; here are just a few examples: the Philippines ordered 32 new BLACKHAWKs, Saudi Arabia has received its first UH-60M, the US Army has received its first UH-60V

Photo: Andrew White

The UAE Special Forces have developed, together with Sikorsky, a kit that can transport two electro-bikes at the sides of the BLACKHAWK.

(VICTOR) and the Polish Special Forces received more S-70i aircraft. Sweden is also considering replacing its NH90s with SEAHAWKs and expanding its BLACKHAWK fleet, according to Swedish media reports. Australia is also likely to replace its 47 NH90s (TAIPAN) with the BLACKHAWKs early. This underlines why the BLACKHAWK is the class leader worldwide. Norway is also looking at a leasing option to supplement its NH90 fleet with another model. These will be used by the Coast Guard and fill capability gaps of the NH90. Airbus took orders from France for the new H160 and from Spain for 36 H143s and delivered the first NH90 to Qatar. Austria ordered 18 Leonardo AW169Ms (from 2023) to replace the ALOUETTE 3, and the Colombian Navy has received AW139s. Bahrain has ordered 12 AH-1Z VIPERs, and Israel is the first export customer for the CH-53K after the USMC. India, on the other hand, is receiving its first CH-47 CHINOOK. As for Combat Search & Rescue operations, Italy has received the Leonardo HH-139B. In December 2021, Spain released €1.2Bn for the further development of the Airbus TIGER Mk III. The timeframe is 2029 to 2037. France has also already committed to the Mk III development. Germany's commitment is still open, and according to Boeing, there is a parallel request for the AH-64E APACHE GUARDIAN. Australia will also take the TIGER out of service early and replace it with the APACHE. The German Army in particular is still struggling with catastrophic clarity levels with the TIGER. Soon, the oldest machines will have to be phased out again. Key system improvements in the Mk III programme include enhancements to the mast-mounted electro-optical system, helmet-mounted visual system, enhanced visual system, radios, manned and unmanned cooperation data links (MUM-T), new air-to-ground and air-to-air weapons, improved protection and countermeasures, a new navigation system (including GPS and Galileo synchronisation), a new avionics suite, a new tactical data management and battlefield management system. In addition to the APACHE, it would also be conceivable for the Germans to join the Americans' FVL programme and then receive the first aircraft from 2030/35. Until then, however, the TIGER would have to be kept alive. Especially in view of the war in Ukraine, the demand for a quick marketable solution is likely to become greater. The UK has already concluded a cooperation agreement with the USA to obtain information from the FVL programme. This is intended to further develop its own technologies and ensure the interoperability of all platforms between the two states.

Photo: Sikorsky

The DEFIANT X should replace the UH-60 BLACKHAWK. In 2021 it reached a speed of 457 km/h.

Photo: Lockheed Martin

Sikorsky's MATRIX technology in action. The MATRIX technology will enable operators to fly more manned missions in adverse weather or restricted visibility, fly missions more effectively in complex and obstacle rich environments, eliminate sources of pilot and operator error, and reduce operating costs.

In the combat helicopter sector, the Netherlands and the UK are upgrading their AH-64D. Moreover, South Korea presented the KAI Marine Attack Helicopter (MAH) at ADEX 2021, a combat helicopter for maritime operations. Here, too, explicit reference is made to MUM-T capabilities. Australia is also demanding a maritime capability for the TIGER successor. Bell has completed the first of 12 AH-1Z Vipers for Bahrain. Turkey unveiled its own light combat and transport helicopter for the first time in 2018 with the TAI T625 GÖKBEY. Turkey also has a second combat helicopter, the Turkish Aerospace T129 ATAK - developed in cooperation with Leonardo and based on the AW129. Germany planned a Light Utility Helicopter Streitkräfte (LUH SK) project - for the Army, Navy and Air Force - a training helicopter that would also operate in the Army as a light, weaponised platform below the TIGER. The BMVg (German MoD) has now decided to discard this option. This means that the helicopter will remain a pure training platform. The Airbus H145M is being considered. As a result, the Army will now have to start a new project to fill the gap below the TIGER. Originally, it was planned to equip a portion of the H145Ms for the Army with H-Force in order to have the option for sensors and effectors later on.

Especially in the case of combat platforms, the demand for assertiveness is paramount. MUM-T and the wingman and Air Launched Effect (ALE) concepts will play a very important role in this.

Unmanned Platforms

Many armed forces suffer from recruitment problems, with the training of personnel being both expensive and lengthy. In order to reduce the number of personnel and to protect the soldiers, many missions in the future will probably rely more and more on unmanned systems. This will be no different for VTOL platforms. General David Berger, commander of the USMC, recently called for faster progress in unmanned aerial vehicles (UAV). In addition to UAVs, he had VTOLs for logistical tasks in mind. The USMC would have to have a balanced fleet of manned and unmanned aircraft in the future, he said. Since 1999, the capabilities have been tested with the Kaman Aerosystems K-MAX, which has been adapted by Lockheed Martin. The K-MAX offers a payload of 2,041 kg and is said to have a payload cost of US$ 1,200/flight hour. It has already been deployed in Afghanistan, as well as from ships. In December 2021, the US Navy deployed the Northrop Grumman MQ-8C FIRE SCOUT from a ship (LCS-5) for the first time.

Korea Aerospace Industries (KAI) presented the unmanned Light Armed Helicopter (LAH) at ADEX 2021. It is based on the Airbus H155 platform and has a 20 mm GATLING gun under its nose tip. It also has an Electro-Optical/Infrared (EO/IR) sensor and can carry missile pods on its stubby wings. The Korean Army has a programme of 214 LAHs, to be introduced from 2022/23, and Airbus also anticipates an international requirement of 300 to 400.

An unmanned 30-minute flight of a UH-60A BLACKHAWK was announced in February 2022. The aircraft can be piloted either manned or unmanned. At the core of the system is Sikorsky's MATRIX autonomy technology.

Igor Cherepinsky, Director of Sikorsky Innovations, said: "Advancements that support autonomous and optionally piloted operations, like Sikorsky's MATRIX Technology, will change the ways aviators and air crews execute their missions, assisting when flying with reduced crew or limited visibility. MATRIX is like a virtual second pilot that will help operators fly safely and confidently in dangerous and complex missions. It can leverage full authority flight control inputs for autonomous flight - including take-off, route planning, obstacle avoidance, site selection and landing."

Photo: Lockheed Martin

Sikorsky's CH-53K production site. The Marine Corps' CH-53K programme completed initial operational test and evaluation in March and is on track to be operational this year.

Photo: Boeing

Boeing's CH-47 CHINOOK (shown here) and Sikorsky's CH-53K are the two contenders for the German STH programme.

Graphic: Boeing

Within the German STH Project, the support of Special Forces is one of the main requirements, as is the air-to-air refuelling capability of the helicopter.

MUM-T

MUM-T offers a number of advantages to the manned aircraft and also increases range, endurance, flexibility, survivability and overall combat value. For example, the crew of the manned helicopter can control an Unmanned Aircraft System (UAS) and send it ahead of its flight path to recognise or suppress enemy sensors and effectors. In this way, when the helicopter changes the area of operation, the sensors of the UAS – which is already operating at the final destination - can already be used during the helicopter's approach in order to obtain a better picture of the situation. This enables the helicopter to immediately begin mission implementation upon arrival at the mission target. If the UAS have their own effectors, this also increases the penetration capability and range of an attack helicopter, or, thanks to the number of effectors, considerably improves its lethal effect on the target. In this way, the Army aviators will be better able in the future to develop their effect deep into enemy

space in support of land force operations, even under threat from enemy air defence systems.
The use of drones will be (partially) automated and supported by artificial intelligence (AI). This will also allow the use of swarms without increasing the workload of the crew. The riskier the mission, the more likely it will be taken over or supported by unmanned systems. In addition to the use of drones or wingman, so-called Air Launched Effect are also used, these are launched from the manned aircraft or carried by a wingman UAS.
Michael Hostetter of Boeing Defence Germany states: "[the] APACHE has teamed GRAY EAGLE and Shadow, as well as SCAN EAGLE, and is capable of teaming with others. However, we want to emphasise that the APACHE is the only attack or reconnaissance helicopter with MUM-T capabilities. MUM-T is fully integrated into the APACHE's display and controls, giving aircrew greater situational awareness and net-centric interoperability - increasing survivability by allowing for early detection and identification of threats on the battlefield."
Korea Aerospace Industries (KAI) is developing a MUM-T system to be used on helicopters in service with the Republic of Korea's military. Development should be ready by the end of 2022. Bell has just integrated the ESG's Mission Management System into a Bell 429 to support MUM-T. Furthermore, the Netherlands are using L3Harris ROVER (Remotely Operated Video Enhanced Receiver) 6i transceivers technology to support their AH-64E with its inherent level 4 MUMT capability. General Atomics Aeronautical Systems has integrated MUM-T capabilities in its new MOJAVE-UAS. In Germany, Quantum-Systems GmbH had a MUM-T demonstration using an Airbus H145M together with their VECTOR's UAS. This UAS offers a flight time of 120 minutes and can operate even under harsh conditions.

Armament and Sensors

A helicopter is actually no more than an airmobile platform, without added value. It is only through its cargo - e.g. Special Forces (SF) or combat vehicles - or its sensors and effectors that it gains real added value in reconnaissance or combat (air and ground support).
For example, the UAE Special Forces has developed a kit to carry (silent, electric) two-wheelers on the UH-60. This increases the SF's ground mobility without having to resort to a larger aircraft.

Photo: Bundeswehr

Maritime Special Forces (Kampfschwimmer) of the German Navy leave a CH-53GA via ramp to begin their tactical mission.

For some time now, the SPIKE NLOS guided missile has been used on the UH-60 and now the SPIKE ER2 has also been integrated on the H145M. The Brazilian Navy has equipped its H225M for anti-surface warfare (ASuW) with the MBDA EXOCET AM39 Block 2 Mod 2 anti-ship missile. The British Navy fired the Lightweight Multirole Missile (LMM) MARLET from the WILDCAT HMA2 for the first time in June 2021. The MBDA BRIMSTONE is also increasingly being considered as an armament for helicopters and UAVs. A new addition may be the MBDA ENFORCER Air. Due to strong demand for small, lightweight and affordable precision missile systems suitable for use on light helicopters or tactical UAVs, MBDA Germany GmbH is refining its ENFORCER to meet future requirements. The baseline ENFORCER is a 90 mm-calibre, lock-on before launch (LOBL), "fire & forget", disposable, day/night, lightweight precision-guided shoulder-launched weapon system. The modular design of the ENFORCER system enables a range of development options, including a pro-

Photo: Bell

Bell's V-280 VALOR is part of the US Army Future Vertical Lift (FVL) programme. Bell cooperates with Lockheed Martin.

spective "family" of ENFORCERs for land, air and sea applications. Like a smaller and more cost-effective brother of the BRIMSTONE.
New sensors mean increased range or better protection. Hensoldt equips the German NH90 TTH with a new AMPS self-protection system, and the US Air Force is seeking a new missile protection system for its HH-60W JOLLY GREEN II combat search-and-rescue (CSAR) helicopter as an improvement. Italy is using Leonardo's MAIR Missile Warning System on more and more helicopters.
When looking at the topic of sensors, a detection and protection system against small, non-military drones must also be considered in the future. These now pose an ever-growing threat. ■

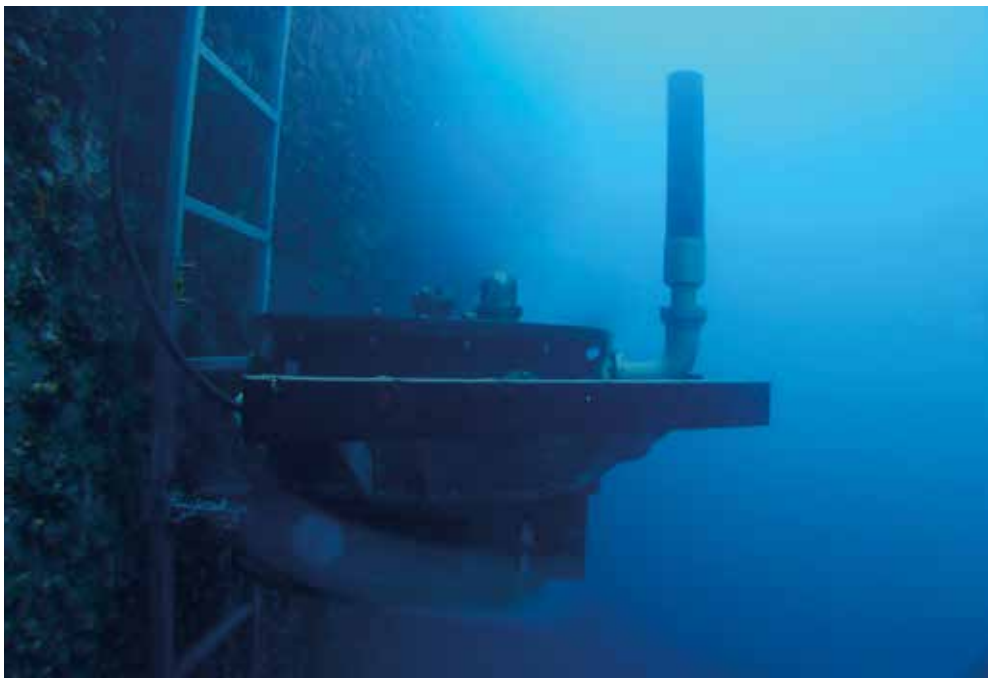
Protecting Coastal Infrastructures and Waters from Underwater Threats

Luca Peruzzi

The growing underwater threat has driving the development of defence systems quickly put into place and requiring a reduced manned and logistic footprint.

The increasing underwater threat represented by mines and waterborne improvised explosive devices (WBIED) together with unidentified intrusions into national waters, terroristic and adversary special forces attacks, together with the vulnerability not only of ports and approaching sea line of communications, but also of other coastal infrastructures as well as offshore facilities to these threats, have driving the development of layered and deployable alert and defence systems capable to be quickly put into place and requiring a reduced manned and logistic footprint. These include diver detection sonars (DDS) and wider underwater detection systems together with rapid environmental assessment systems carried by underwater and surface, unmanned and manned platforms in order to, as quickly as possible, detect and identify the threats in the difficult environmental conditions of ports and shallow coastal waters. High frequency active sonar have become the answer to diver detection, classification, identification and tracking, together with underwater loudhailer to inform the diver is being tracked and to surface. In parallel to the increasing number of micro, small and medium UAVs and ROVs, together with unmanned surface platforms being put into service for conducting rapid environmental assessment (REA), mine countermeasures (MCM), intelligence surveillance and reconnaissance (ISR) alongside hydro- and oceanographic operations, the industry has been developing payloads with increasing-capable but at the same time not-power hungry sensors able to be fitted to these small platforms.

Photo: DSIT Solutions



The Israeli DSIT Solutions' AQUASHIELD fix installation Diver Detection Sonar (DDS) system operating at 'a 60 KHz central frequency' offers a long range detection with up to 3,000 metres diameter coverage.

Photo: DSIT Solutions

The POINTSHIELD is the smaller and portable system of the DSIT Diver Detection Sonar family for protection of vessels as well as for the fixed installations where limited area needs to be covered.

Intruder Detection Systems

The Israeli DSIT Solutions company offers a complete range of around the clock, critical coastal sites and naval assets protection solutions, in service with a range of mostly undisclosed military, homeland security, oil and gas and other civilian customers. AQUASHIELD DDS offers a unique modular, open architecture and windows-based design with intuitive human-machine interface (HMI), operating at 'a 60 KHz central frequency' and offering a long range detection with up to 3,000 meters diameter coverage. Capable to handle more than 1,000 targets simultaneously, AQUASHIELD is indicated to have a detection range of 1,000, 700 and 1,500 metres respectively against

open and closed circuit breathing apparatus-equipped divers and SDVs, alongside UUVs. The POINTSHIELD is the smaller and portable system of the same DSIT DDS family for protection of vessels at anchor and ships at berth, as well as being suitable for the fixed installations where limited area needs to be covered. Being easy to be deployed and retrieved manually or with mechanical systems, capable of fully automatic operations, it incorporates advanced signal processing allowing the detection of respectively open and closed circuit breathing apparatus-equipped at 500 and 700 m, alongside UUVs. DSIT also offers the SEASHIELD coastal surveillance system combining bottom-based active and passive sonar systems for long-range real-time underwater surveillance under a shore-based station.

Introduced in 2007 and sold to a wide range of customers including the US Navy and the US Coast Guard, Sonardyne has kept pace with users' needs of the SENTINEL DDS, enhancing the system capabilities. Different variants are available, with the baseline version including Scylla underwater loudhailer, configured for most commercial and infrastructure protection, including support for networked sonar arrays and integration with third party C2 systems. The Sonardyne SENTINEL comes with two different sensor heads respectively suitable for expeditionary use with a lightweight aluminium housing (35 kg in the air/6 kg in the water) and for permanent installations with a super-duplex housing (45.5 kg in the air/18 kg in the water). With a 70kHz centre frequency, the SENTINEL emits a 360° linear-period-modulated (LPM) pulse and uses 256 receive beams equally spaced along its perimeter to discriminate targets in up to 1500 m range even at high velocity. The results means SENTINEL can detect scuba divers up to 1,000 m range and divers with closed circuit breathing equipment up to 700 m, alongside UUVs and SDVs. The SENTINEL baseline suite includes one sensor head which can be mounter either way up or cable suspended, the sonar processor unit and the command workstation with intuitive HMI.

In Europe, Atlas Elektronik UK (AEUK) is offering the CERBERUS Mod2 DDS which found service with reportedly a dozen of customers, including German Navy, which was the first NATO customer to fit with a DDS one of its class of vessels (F125 frigates). The system, which is powered with ships cabling, can operate as a stand-alone system, without integration into the combat system. In the case of the German Navy, the components were required to meet

Photo: Sonardyne

Introduced in 2007 and sold to a wide range of customers, the Sonardyne SENTINEL DDS comes in different variants, configured for most commercial and infrastructure protection, including support for networked sonar arrays and integration with third party C2 systems, alongside a military-only SENTINEL XF variant.

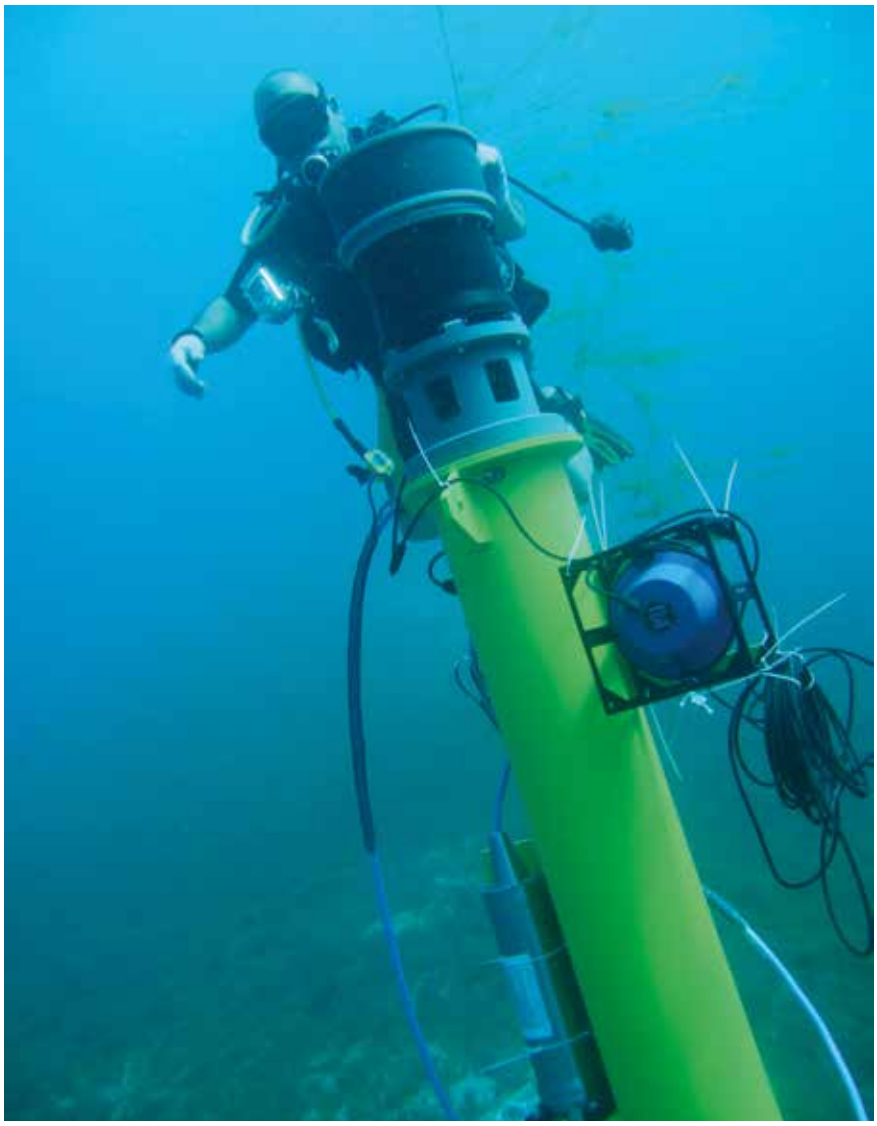


Photo: Sonardyne

In September 2021, Sonardyne announced multiple deals to protect a string of naval facilities and critical national infrastructure in the Middle East, using its SENTINEL DDSs as part of a NiDAR 360 degree surface and sub-surface waterline surveillance system, developed and supplied by MARSS Group.

additional requirements and standards, including a completely new design and build of a bespoke power supply and processing unit (PSPU) qualified to customer rigorous standard. Designed to meet the demands of both portable and shipborne applications, the CERBERUS Mod2 features a sonar head of compact design (400x300 mm and 23kg in air), while the complete system including the deployment cable, power supply and processing unit (PSPU) and remote laptop, weights around 72 kg. Operating with a frequency range of 70 to 130 kHz, and equipped with an automatic detection, classification, identification and tracking system, providing reliable alerting of multiple underwater targets with minimal false alarms, the CERBERUS Mod2 has a detection and tracking range for open and closed circuit divers of respectively 900+/850+ and 700+/675+ meters.

Last January, the Norwegian Norbit group, announced that Norbit Subsea was awarded an order from an undisclosed international customer for delivery of several GUARDPOINT surveillance sonar systems. Managed by proprietary GUARDPOINT Tracking Software, the portable system with a sensor head of

Equipped with the Atlas Elektronik UK (AEUK) CERBERUS Mod2 DDS, the German Navy was the first NATO customer to fit one of its class of vessels, the F125 frigates, with a DDS.

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<50 kg weight (in addition to <10 kg as topside unit), operating at 70 kHz frequency, has a maximum detection range against open circuit diver, closed circuit diver, SDV and midgets of respectively 800, 400 and 1,000 meters. Norbit Subsea also offers the Wide Band Multibeam System (WBMS) Forward Looking Sonar (FLS) for swallow water conditions and easy deployment.

In addition to other systems on the market, including the Spanish SAES' DDS-03 portable high-frequency system characterized by high-performance even in difficult scenarios with unfavourable propagation conditions such as warm waters, and the Armelsan ARAS-2023, which is indicated as the first Turkish-made DDS, operating at 70 kHz frequency, with a 40 kg sensor head capable of detecting open circuit and close circuit divers, together with SDV respectively at 800, 400 and 1,000 m maximum range, to be embarked on the new Turkish Navy LHD, the Norwegian Kongsberg group, with its long experience with its DDS 9000 and vessels sonar families, is marketing the SD9500 system. The Kongsberg over-the-side dipping sonar offers diver detection, ASW and volumetric survey capabilities in shallow, reverberation-limited waters with a compact and lightweight design capable to be deployed by any vessel, including smaller vessels (10+ m)

or unmanned surface vessels (USVs). Finnish DA-Group is however proposing a lightweight modular and deployable underwater surveillance system with bottom-based sensors centred on the TURSO TDS (Target Detection System) developed by the same company for new sea mines applications.

Imaging Underwater Sensors

Among the latest technologies and solutions in the sensors segment which could make the difference, according to their developers and claimed capabilities to be operationally proven, the US company Klein Marine Systems (as part of MIND Technology company) has introduced its new generation AUV-MAKO integrated sonar payload for micro, small and medium AUVs and ROVs, alongside the MA-X View 600 for surface platforms, while the Canadian Kraken Robotics company is proposing its AquaPix MINSAS commercial-off-the-shelf (COTS) Synthetic Aperture Sonar (SAS) for integration into AUVs as well as surface towed solutions, such as the company's KATFISH system.
The new Klein AUV-MAKO is a multiple sensors' dry low-power payload, consisting of a shared processing engine and a set of focused 600 kHz side scan arrays and a µMA-X nadir imaging nose array in the first iteration of a pre-planned additional capabilities roadmap. The AUV-MAKO side scan delivers focused 600 kHz imagery at an optimum range of 50 meters per side with capability of reaching 120 meters per side. It produces 900 kHz-type resolution imagery without the range and motion limitations typical of an higher frequency system. The AUV-MAKO µMA-X system is based on Klein's latest MA-X technology which provides imaging of the nadir gap directly under the path of the vehicle, with the same interpretive characteristics of the side scan sonars. The AUV-MAKO provides a true full-swath coverage with a >40% increase in survey efficient (extended mission duration or shorter time to cover the same area vs not-equipped with nadir AUVs), high contrast across the entire swath and in-stride multi-aspect view, alongside real-time integration with ATR systems thanks to on-board processing. In 2020, the µMA-X solution was delivered in support of US Navy Next Generation Small-Class UUV evaluation sponsored by the US Defense Innovation Unit (DIU) organization. The same technology is applied to the Klein's MA-X VIEW 600 towed body of 1.42m length and 24.7kg weight, incorporating com-

Photo: SAES

The Spanish SAES' DDS-03 portable high-frequency system is available for both infrastructures and ship protection, characterised by high-performance even in difficult scenarios with unfavourable propagation conditions such as warm waters.

Photo: Armelsan

The Armelsan ARAS 2023 is indicated as the first Turkish-made DDS, operating at 70 kHz frequency, with a 40 kg sensor head capable of detecting open circuit and close circuit divers, together with SDV.

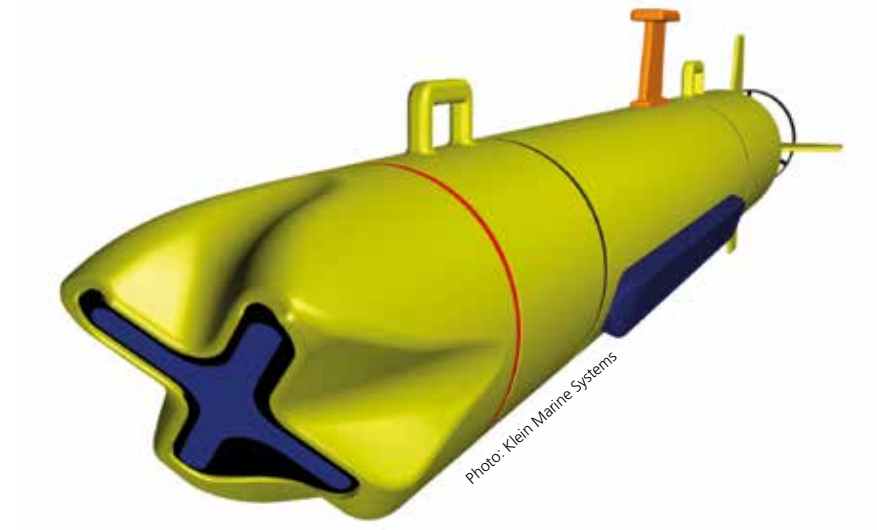
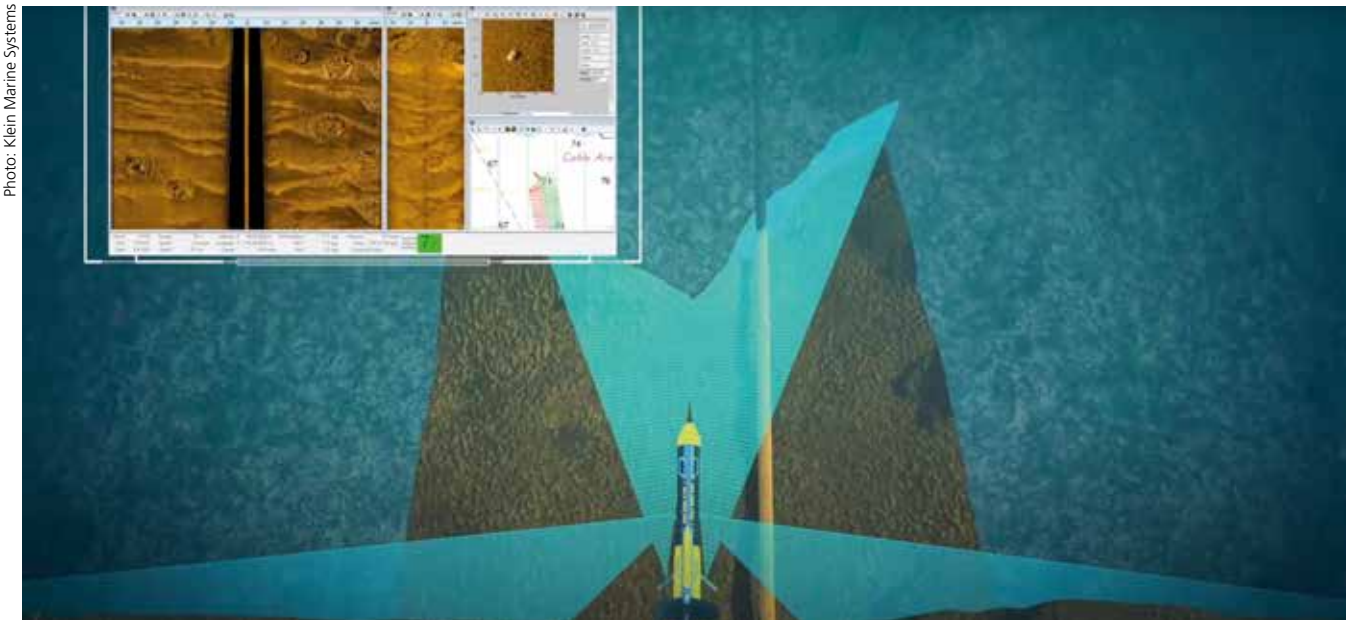


Photo: Klein Marine Systems

Klein Marine Systems (as part of MIND Technology company) is offering its new generation AUV-MAKO integrated sonar suite, which represents a breakthrough in payload developments for micro, small and medium AUVs and ROVs.

Photo: Klein Marine Systems



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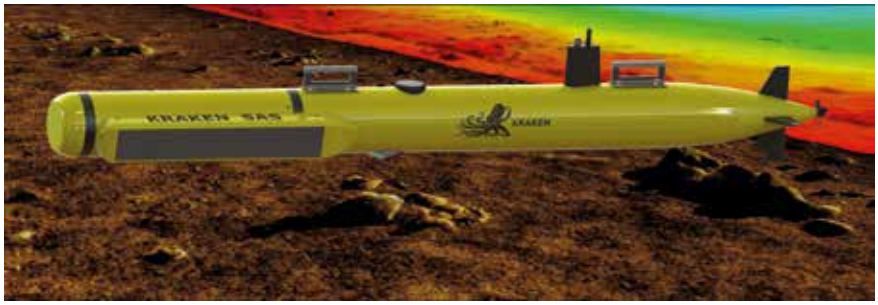
pany's broadband CHIRP sides scan sonar and MA-X gap-filler, which already saw international success. The system allows 40% less survey time at sea, 40% less fuel consumption and higher probability to complete the survey in a window of good weather, according to Klein.

After being contracted in 2020 by the Danish and Polish MoDs to provide the KATFISH towed Synthetic Aperture Sonar (SAS) vehicle and the SEASCOUT Autonomous Launch and Recovery System (ALARS) and intelligent Tentacle winch, together with SeeByte's embedded ATR capability for MCM operations, the Canadian Kraken Robotics company announced in October 2021 to have been contracted by Canadian government for testing of Kraken's KATFISH towed SAS system by the Royal Canadian Navy (RCN) on board a vessel of opportunity and the untethered Light Weight SAS system, deployed on an RCN's REMUS 100 AUV. The contract scope is to evaluate the new systems in supporting the RCN in the passage lanes survey along the coasts and into designated ports, alongside hydrographic duties. Both mentioned systems are based on the company's AquaPix MINSAS, which is an off-the-shelf configurable SAS capable of 2x2 cm ultra-high definition imaging, which according to the Canadian company, can replace high-end side-scan systems at an affordable price, while delivering significantly higher resolution, range, and area coverage rates (ACR). The increased range and resolution and associated higher ACR of SAS over traditional SAS systems can significantly expand, according to Kraken Robotics, the capabilities of the customer's AUV systems for a variety of tasks for naval, scientific, and commercial applications. Last February an undisclosed South Korean customer has ordered the 1000-meter rated AquaPix MINSAS 60 sonar for use in a military application. ■

Photo: Kraken Robotics



The Canadian Kraken Robotics company is proposing its AquaPix MINSAS commercial-off-the-shelf (COTS) Synthetic Aperture Sonar (SAS) for integration into AUVs, as well as surface towed solutions, such as the company's KATFISH system.

Photo: Kraken Robotics

An wreck image collected by the configurable Miniature INterferometric Synthetic Aperture Sonar (MINSAS), which maintains an industry-leading 1.9 x 2.1 cm constant Ultra HD resolution across the entire swath out to ranges of 200 meters per side, along with simultaneous 6 cm x 6 cm bathymetry.

Viewpoint from New Delhi

Photo: Suman Sharma

When India Went Nuclear

Suman Sharma

India's need to have a robust nuclear deterrence programme looks to be justified by the current Russian invasion of Ukraine. Nature may give us eyesight, but very few develop a vision! Former Indian prime ministers, the late Indira Gandhi and AB Vajpayee, both from two ideologically opposite parties, but both extraordinary visionaries, catapulted India into the exclusive club of nuclear nations by conducting the first and second nuclear tests under super-secret conditions in 1974 and 1998, thereby inviting heavy sanctions from the West.

The ongoing Russian invasion of Ukraine highlights the importance of India possessing a robust nuclear deterrence programme, thereby vindicating New Delhi's stance to bolster its nuclear defence in the wake of the ever-increasing China-Pakistan axis in its immediate neighbourhood. With the recent nuclear trigger threat made by Russian President Vladimir Putin, the eternal debate about the need for nuclear weapons has once again been brought to the fore. As experts debate no-first use and restraint, Russia, with the most nuclear warheads in the world, recently had the IAEA scrambling for discussions, as the danger caused by a nuclear accident appeared almost imminent. India, which is not a signatory to the Non-Proliferation Treaty (NPT) of nuclear weapons, is said to be in possession of around 160 nuclear warheads.

As the world's second largest weapons importer after Saudi Arabia, India, which has a strong military-industrial complex, needs a planned, collaborative drive towards disruptive technologies such as special operations, cyber, artificial intelligence and space, in addition to its nuclear capability. Former Prime Minister AB Vajpayee, who faced western sanctions following the 1998 nuclear tests - codenamed 'Smiling Buddha' - reiterated the need for going nuclear, "Atomic weapons are being collected in our neighbourhood, how can we forget this, especially when our neighbour is claiming with conviction that they have developed atomic weapons. America is sitting in Diego Garcia with atomic weapons. We do not wish to use atomic weapons on anyone, but we want to augment our capability so that in future no one can think of attacking India."

India Goes Nuclear

India conducted its first nuclear test in 1974 because of the prevailing adverse security environment, and the second nuclear test in 1998. China has been nuclear since 1964. Beijing helped Pakistan acquire nuclear weapons by 1987. The Comprehensive Test Ban Treaty (CTBT), which prohibits any nuclear weapons testing anywhere in the world, was being forced upon India from 1996, so the decision had to be taken to conduct the second test in 1998. The Indian leadership has shown strategic vision since independence in moving towards the exploitation of nuclear energy in the service of the nation. Support of all political parties in India towards this effort over the years enabled the decision to go nuclear in 1998.

India was declared a nuclear weapons state in 1998, after which the Nuclear Doctrine was launched in 2003, which mainly comprises no-first use policy, maintenance of minimum credible deterrence and no use of nuclear weapons on non-nuclear weapons states. Nuclear expert and Distinguished Fellow at the Centre for Air Power Studies in New Delhi, Manpreet Sethi says, "India's nuclear weapons provide security through nuclear deterrence. It helps to safeguard India against nuclear coercion or blackmail by adversaries both of whom lay territorial claim on India."

The nuclear triad capability was achieved after the Indian Navy launched its first ever indigenously constructed nuclear-powered ballistic missile submarine, better known as a ship submersible ballistic nuclear (SSBN), INS ARIHANT, and India entered the elite club of nuclear nations which includes the US, Russia, China, UK and France.

INS ARIHANT, the first in the line of six such SSBNs, is nuclear powered and also capable of carrying and firing nuclear tipped missiles. A nuclear triad is a three-dimensional military-force structure comprising nuclear warhead armed submarines, land-launched nuclear missiles, and strategic aircraft carrying nuclear missiles and bombs.

Russia derives its strength from its military-industrial complex and energy reserves, despite the fact that it has a lower GDP than India. India's defence set-up yearns for technology transfer in its imported platforms, resulting in New Delhi signing multiple friendship and cooperation treaties with most nations who do not support India at the UN during procedural voting, politically and militarily. Left to fend for herself, India, which is bogged down by border conflicts on both sides, radical Islamic terrorism, an economic downturn due to the pandemic, urban Naxalism and Maoism, reinforces the inescapable need to maintain a potent nuclear deterrence programme.

FLRAA: The US Army's Future Long Range Assault Aircraft Programme Progresses

Sidney E. Dean

The FLRAA programme seeks to provide a UH-60 replacement for the US Army. While FLRAA is intended to be multimission-capable (mirroring the operational spectrum of the BLACKHAWK), the armed forces are focused on the air assault mission as the primary "raison d'etre."

The United States Army currently operates more than 1,700 UH-60 BLACKHAWK helicopters. These utility helicopters constitute the primary air assault platform for light infantry. They also perform logistics, casualty evacuation (CASEVAC) and search & rescue (SAR) missions.
The UH-60 family was introduced in 1979. There have been repeated upgrade programs to enhance performance and extend service life, but introduction of a successor aircraft has become pressing. Obsolescence and materiel fatigue are not the only reasons replacing the UH-60 is vital. The spectre of war with a peer power, or with a regional power utilizing modern air-defence weapons, requires the United States to field an assault/utility helicopter equipped with the most advanced avionics, sensors, and performance parameters.

Foto: Bundeswehr

Sikorsky DEFIANT helicopters conducting low-level flight operations through mountainous terrain

FLRAA Programme

The Future Long Range Assault Aircraft (FLRAA) program seeks to provide a UH-60 replacement for the US Army, the US Marine Corps (USMC), and the joint service US Special Operations Command (SOCOM). Program management lies with the Army. While FLRAA is intended to be multimission-capable (mirroring the operational spectrum of the BLACKHAWK), the armed forces are focussed on the air assault mission as the primary "raison d'etre."
The new medium-lift aircraft will display significant performance enhancements compared to the UH-60. This includes dramatic increases in speed, range and endurance. The minimum acceptable or threshold cruising speed is 230 knots. The Army's objective targets include a maximum continuos cruise speed of 280 knots, and an unrefueled mission radius of at least 300 nautical miles. The US Marine Corps, which is expected to acquire the second-largest FLRAA fleet, has set even higher performance standards (295 knots cruise speed and 450 nm range). These physical performance parameters largely reflect the unprecedented mobility challenges which would arise from a major war in the East Asia. Over and above the longer distances anticipated in future wars, the enhanced speed and agility will also increase survivability in contested environments, and facilitate immediate exploitation of newly created openings in enemy defences.
Troop-carrying capacity in the air assault configuration is considered a vital factor in determining the ultimate selection of one contender over another. Here, again, the Pentagon has set a minimum capacity – 12 combat-ready soldiers – which exceeds the capacity of the UH-60.
Other fundamental requirements include full networking and interoperability with other aircraft and ground forces operating in a multi-domain battlefield. Modularity and open-systems architecture will also be essential for maximizing the FLRAA's flexibility, keeping on-board systems up-to-date, and reducing operating cost.

The Contenders

In March 2020 the Army awarded contracts to two industry competitors – Bell-Textron and a Boeing-Sikorsky team – to participate in the FLRAA Competitive Demonstration and Risk Reduction (CD&RR) phase 1. That phase encompassed requirements derivation, tradeoff analysis and preliminary conceptual design. In March 2021 both competitors advanced to CD&RR phase 2, with a focus on integrating major subsystems and mission systems on the candidate airframes. Work under phase 2 will be performed through

May 30, 2022. "Through CD&RR efforts, Army leaders have had the ability to make early, informed decisions ensuring FLRAA capabilities are not only affordable, but that they meet Multi-Domain Operations requirements while delivering on an aggressive schedule that does not sacrifice rigor for speed," said Brigadier General Rob Barrie, program executive officer for Army aviation, upon award of the phase 2 contracts.

The two contenders have been flying technology demonstrator aircraft representative of the general design characteristics of the production aircraft they would construct. Military pilots and maintenance personnel have had access to the demonstrators, both to gain direct insight and to provide feedback to industry. In addition to hundreds of hours of flight testing, both aircraft have been intensely studied in mission integration laboratories and on propulsion test beds. Observations made and insights gained during the CD&RR phases will guide the contractors through the process of refining and/or adjusting their design and technology concepts. These insights also guide the military through the process of developing concepts of operation based on what performance characteristics can reasonably be expected.

Bell-Textron V-280 VALOR

The twin-motor Bell Textron V-280 Valor technology demonstrator utilizes tiltrotor propulsion, and bears some resemblance to the larger V-22 Osprey made by the same firm. The V-280 features integrated cabin armor, and has a v-shaped tail which enhances maneuverability, especially at high speed. Top flight speed achieved during testing was 305 knots. Bell completed flight testing of the V-280 in June 2021, but continues to evaluate data gleaned since the first flight of the aircraft in December 2017.

Bell's ultimate design proposal is expected to closely resemble the V-280, although it is likely that lessons learned during the demonstration phase will mandate some changes. Bell has the advantage – both with regard to performance and to optimized maintenance procedures – of more than 600,000 flight hours experience with the tiltrotor V-22. This propulsion technology is operationally proven. The propulsion system on the V-280 features a simplified drive system design, with pylon versus nacelle rotation. According to Bell, this eliminates ground heating and simplifies maintenance, especially in the field.

Photo: Boeing-Sikorsky

Artist Concept of the SB-1 DEFIANT technology demonstrator, as presented in 2015

Photo: Sikorsky

The Sikorsky-Boeing technology demonstrator SB-1 DEFIANT first took flight in March 2019 and leverages Sikorsky's X2 technology with a rigid compound rotor and pusher propeller.

Photo: Sikorsky

Then Army Chief of Staff, Gen. James C. McConville sits in the cockpit of the SB-1 DEFIANT after a flight demonstration in October 2020.

Photo: US Army

A soldier examines the passenger compartment of the SB-1 DEFIANT.

Photo: Bell

Soldiers egress through two 1.8 metre wide sliding doors in this artist concept of the V-280 VALOR technology demonstrator, as presented in 2015.

Photo: US Army

The Bell V-280s depicted in this concept image have more than twice the speed and range of current helicopter platforms. The image shows the FLRAA in the background, escorted by a notional tiltrotor configured Future Attack and Reconnaisance Aircraft.

Other proven performance parameters include a 280 knot airspeed, and excellent mobility during low-speed flight operations including slalom flight manoeuvres. The fly-by-wire digital control system includes the option for unmanned flight control, freeing up the cockpit crew for additional functions. The V-280 is self deployable at ranges up to 1,700 nautical miles, with a combat radius – depending on configuration – of 500-800 nautical miles, significantly exceeding the Army's requirements for long-range assault missions.

Bell also sets great store in force protection capability inherent in the Piloted Distributed Aperture Sensor (PDAS). Developed by Texron's parent company Lockheed Martin, PDAS provides the aircrew with 360 degree situational awareness. It consists of a network of integrated sensors – including six infrared-capable cameras distributed around the hull of the V-280 – which are linked to cockpit and helmet displays via an open-architecture processor. The display can also be made available to personnel in the rear of the aircraft, including door gunners, hoist operators, or infantry preparing to debark.

Boeing-Sikorsky SB-1 DEFIANT

The Boeing-Sikorsky demonstrator platform for the CD&RR phase is designated the SB>1 Defiant. The twin-engine aircraft, which first flew in March 2019, is classified as a compound helicopter. Its propulsion system differs from conventional helicopters. It has two counter-rotating coaxial rotors and a rear-mounted pusher propellor. The former provide enhanced lift and stability compared to conventional rotor designs; the latter provides considerable forward thrust without tilting the axis of the main rotors.

On 18 January 2022 the team announced that the SB>1 had successfully completed its first complete mission profile flight. As described by Sikorsky's chief Defiant test pilot, Bill Fell, the test "fully demonstrated Defiant's ability to execute the FLRAA mission profile by flying 236 knots in level flight, then reducing thrust on the propulsor to rapidly decelerate as we approached the confined, and unimproved, landing zone. This type of level body deceleration allowed us to maintain situational awareness and view the landing zone throughout the approach and landing without the typical nose-up helicopter deceleration." The demonstrator had previously performed low-level flight operations in forested terrain, 60-degree

banked turns, and sling-loaded a 2,400 kg Multiple Launch Rocket System.

The team announced in January 2021 that it will submit the Defiant X coaxial helicopter, which is based on the Defiant SB>1, as the formal entry for the production aircraft. Compared with the technology demonstrator, the proposed production design features reduced thermal signature, improved aerodynamic handling, and a tricycle landing gear to improve performance in austere environments. Additionally, autonomy capabilities have been integrated into the flight controls to enhance agility and responsiveness.

On February 10, 2022 the team announced that the Honeywell HTS7500 turboshaft engine had been selected to power the Defiant X. Honeywell has stated that the engine provides the most favorable power-to-weight ratio in its class of military helicopter turboshaft engines. The newly introduced HTS7500 will provide enhanced payload capacity and greater fuel efficiency, according to the accompanying Honeywell press release.

Air Launched Effects

Parallel to the airframe CC&DR phase 2 contracts awarded in early 2021, the Army also initiated contract solicitations to other firms to submit bids for vital subsystems, particularly open architecture avionics and mission-management systems. "Crucial to the success of FLRAA's objectives is the deliberate integration of a Modular Open Systems Approach (MOSA) into its requirements, acquisition and sustainment strategy," an Army statement said. "MOSA is a critical enabler for improving lifecycle affordability, directly aligning with Army Aviation objectives to achieve sustained affordability and deliver continuous capability upgrades against future threats."

Open architecture will also facilitate integration of exchangable mission systems, including so-called "Air-Launched Effects" or ALEs. As defined by the US Army, ALEs refers to a family of systems consisting of an air vehicle, payload(s), mission system applications, and associated support equipment designed to autonomously or semi-autonomously deliver effects as a single agent or as a member of a team. Depending on the carrier aircraft and the ALE configuration, effects can range from kinetic or electronic attack, to reconnaissance and surveillance. The technology is intended for use on legacy aircraft as well as on several classes of helicopter currently under development. When deployed on the FLRAA, ACE systems could enhance force protection by detecting and potentially neutralizing enemy

Photo: US Army

A wing is lowered onto the fuselage of a Bell V-280 VALOR at the Bell facility in Amarillo, Texas.

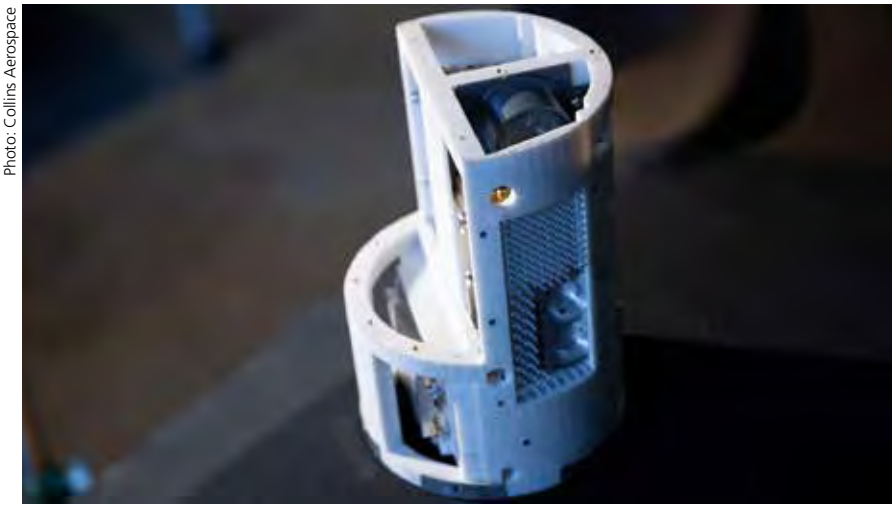
Photo: US Army

Army and Bell-Textron test pilots jointly approach the V-280.

Photo: US Army

Then Army Chief of Staff, Gen. James C. McConville flies the V-280 simulator before a VALOR flight demonstration in Arlington, Texas, in October 2020.

Photo: Collins Aerospace



The RapidEdge mission system module is designed to control Air Launched Effects (ALE) systems.

air defences and other threats along the helicopter's flight path.

Several firms are competing for ALE-related contracts. Collins Aerospace announced on 31 January 2022 that it had successfully demonstrated the RapidEdge™ Mission System designed to support ALE operations. In addition to laboratory based tests, the demonstration series also included integration of the mission system on the tube-launched Altius-700 UAS, which can provide helicopters with an on-board reconnaissance, counter-UAS, and ground attack capabilities.

As described by Collins Aerospace, the RapidEdge™ technology acts as the "brain" of the ALE system and includes radios for communication, solutions for handling multiple levels of classified data, mission computing, and autonomous behaviours of the air launched vehicles. "We designed our RapidEdge™ Mission System solution for this market with a robust and resilient open systems approach at a high technological and manufacturing readiness level," said Heather Robertson, vice president and general manager, Integrated Solutions for Collins Aerospace. "The offering is primed to meet the Army's aggressive program schedule while delivering a critical capability to the warfighter."

The FLRAA will also be capable of operating jointly with larger unmanned aerial vehicles (Manned-UnManned Teaming), which could provide future aerial assault missions with even stronger reconnaissance and force protection assets. Regardless of which vendor wins the final contract, the FLRAA's open architecture approach facilitates integration of multiple payloads and datalinks for collaborative cross-domain operations between airborne and ground forces.

Photo: US Army

Launch of an ALTIUS 600 tube-launched UAV from a US Army UH-60 BLACKHAWK helicopter. Similar air-launched effectors are likely to be deployed on the FLRAA.

Timeline Going Forward

The final Request for Proposals was issued to both firms in July 2021. Bids were due by the end of September of that year. Assessment of the firms' bids is slated to be completed by the end of March, 2022, with subsequent selection of a single firm to continue into the prototype development and testing phase.

Award of the prototype development contract to the winning firm is expected to be announced by the end of June, 2022. The virtual prototype development phase will begin upon contract award, and run through December 2023, culminating in a preliminary design review. The virtual prototype phase will overlap with the physical prototype construction phase, which will begin during the third quarter of Fiscal Year (FY) 2023, and run through the second quarter of FY 2026; this phase will require delivery of six aircraft for the engineering and manufacturing development stage. The first of several prototypes could be delivered as early as the third quarter of FY 2025, with flight testing and evaluation – conducted jointly by the government and the vendor – to run through the end of FY 2029.

The production and deployment phase is expected to begin in 2028 with a Low-Rate Initial Production order of eight aircraft. The Army plans to equip the first operational unit in 2030. As the new aircraft is procured, the armed forces will begin retiring legacy UH-60 aircraft. However, acquiring a full fleet of FLRAA will take years. Modernized UH-60M and UH-60V helicopters will continue to operate alongside the new type, with the last units presumably not retiring until circa 2060. This will enable aviation brigades to deploy aircraft according to mission requirements and the operational environment, preserving the new aircraft for the more challenging scenarios. ■

Rocket Artillery Trends

David Saw

This article discusses the origins of rocket artillery, describes its introduction to the modern battlefield, and explains why some were excited by the possibilities it offered while others rejected it. The article describes how many of the doubters of the utility of Multiple Rocket Launcher systems in the West changed their minds and suddenly became believers once they understood what was possible with these systems.

Rocket artillery, also known as Multiple Rocket Launcher (MRL) systems, has had mixed fortunes in Western militaries over the years, where the preference was for the accuracy of tube artillery to provide precision fires. In contrast, MRL systems were seen as a less discriminating and less accurate area weapon, hence the majority view being a preference for tube artillery rather than MRL artillery. Today, MRL systems have transformed the artillery picture, offering high levels of accuracy, vastly extended ranges and the ability to neutralise the complete spectrum of target types.

Elsewhere, the attitude towards rocket artillery was much more positive. The Soviet Union was the pioneer in the operational use of MRL systems in the modern era. Subsequently, it invested heavily in further developing the operational capabilities of such systems. Inevitably, Soviet satellite states followed suit and also acquired MRL systems in numbers, both Soviet or local variations of prevailing MRL technology. States such as China and India also acquired Soviet MRL systems and this provided the basis for their own indigenous rocket artillery developments, more comprehensive in China than in India. Chinese MRL technology has also provided the basis for others to develop their own MRL systems

Other nations that have developed their own sophisticated MRL capabilities include Brazil, which is an excellent example of having exported their own MRL solutions. In terms of sophistication one should not ignore Israel, which having captured Soviet-origin MRL systems on the battlefield, went on to utilise them as a part of its own artillery arsenal, and then developed performance improvements, providing the basis for indigenous MRL programmes. Other nations have also developed and fielded MRL solutions, including Iran, Japan, South Korea, South Africa and Turkey amongst others.

Photo: British Army

British Army MLRS during a live fire exercise. Britain will upgrade 44 MLRS launchers to the M270B1 standard, extending the service life of the system to 2050. The upgraded system will use the Guided MLRS Extended Range (GMLRS-ER) missile and the Precision Strike Missile (PrSM).

The fact of the matter is that a functional basic MRL system is not that difficult to develop. At that level, the technology required is not state-of-the-art. A 122 mm rocket with a High Explosive (HE) payload and reasonable performance is not going to pose that much of a technical challenge: Add in the launcher and place it on a truck chassis and you are good to go. In contrast, developing a viable tube artillery system is a very different level of difficulty, to the extent of being unachievable for many countries.

Single-Tube and Expedient Solutions

To complete the spectrum of rocket artillery utilisation, it is necessary to mention the use of artillery rockets by insurgents and non-state actors. A typical option in this regard is the single-tube GRAD-P launcher. This was developed in the mid-1960s, and initially had a 122 mm 9M-22M HEF rocket with a range of 11 km based on a tripod mount.

Another single-tube rocket system was developed in China, using the 107 mm rocket of their Type 63 MRL system. This was a 12-barrel system on a towed carriage. Subsequently, vehicle-mounted versions were developed. Initially, the 107 mm rocket had a range of some 8 km, with HE and HE-I ammunition natures available. Later on, new rockets were developed with a range out to 11 km, and these included an HE-F nature, a cargo round, even a rocket containing an electronic jammer and allegedly a rocket with a white phosphorous payload. It should be noted that these days, many other countries manufacture 107 mm rockets as well. The 107 mm rocket is particularly suitable for insurgents and other non-state actors as it can be successfully launched from virtually any apparatus. The Type 85 single-tube launcher is not a necessity in this regard, although using it makes the rocket more accurate.

Photo: Ukrainian Land Forces

A Russian BM-21 GRAD convoy caught on a road in Ukraine by the Ukrainian Land Forces. Both Russia and Ukraine utilise the BM-21 system. The BM-21 entered service in 1963/1964 and is still a viable weapon system nearly 60 years later.

Vietnam, Afghanistan and Iraq

The single-tube rocket system first became noticed during the Vietnam War, when the Viet Cong typically used 107 mm and 122 mm rockets to attack both military and civilian targets in South Vietnam. The Afghan Mujahideen were enthusiastic users of rocket systems with a wide variety of targets being attacked. In one case in 1986, a major Afghan Army ammunition dump outside Kabul was hit with a salvo of 107 mm rockets, triggering numerous secondary explosions and causing massive damage.

The use of artillery rockets in asymmetric conflicts would become a fact of life in Afghanistan post-2001 and Iraq post-2003. One very common rocket system encountered was originally intended for rocket pods used by aircraft and helicopters. This was the S-5 57 mm rocket. The rockets were then re-purposed to become expedient artillery rockets on a range of locally manufactured mounts, ranging from single-round to multiple launcher. The range of the rockets was short and in combination with all sorts of strange local mounts were as likely to injure the user as much as the target.

In Iraq, there were a whole array of rocket threats that were faced by Coalition Forces and the threats continue to evolve to this day challenging Iraqi security forces. Once the Iraqi Army collapsed after the fall of Baghdad in April 2003, there were vast stocks of unsecured munitions available that were acquired by insurgent groups, some loyal to the Saddam Hussein regime and some Islamist, Shia groups, tribal groupings and others who simply saw profit to be gained selling weapons and munitions.

There were examples of 240 mm calibre rockets used by insurgents. These were normally used with the truck-mounted BM-24 system. In Iraq, insurgents manufactured launchers for these 240 mm rockets; accuracy would not be great but the destructive effect would be significant. Mention should also be made of Improvised Rocket Assisted Munitions (IRAM). Here, a propane gas cylinder filled with C4 or another military grade explosive is attached to an artillery rocket, often 107 mm. In Iraq, a truck would be converted to carry rail launchers for the IRAM. The launchers and the IRAM would be hidden from view until the launch site was reached; the truck driver would then leave the vehicle and the rockets would be launched by a second person activating the system via cell phone. Once the rockets were launched, they would ignite flammable materials located on the truck bed; the truck would then catch fire and no evidence would be left to track down the perpetrators. The IRAM downside was limited range and poor accuracy, but get close enough to the target and these system have real destructive effect.

Countermeasures

In the main in Iraq and Afghanistan, the rocket threat was mainly centred on 107 mm and 122 mm systems, with variations coming into play depending on where the rockets were sourced from. As previously noted, initially most of the rockets were already in-country, then external suppliers came to the fore, for example with Iran supplying favoured groups in Iraq. The threat of rockets, with those of mortars and other artillery in Iraq and Afghanistan led to the development of Counter Rocket Artillery and Mortar (C-RAM) systems as a defensive measure to protect high value targets. Early C-RAM proposals flirted with laser technology, but the majority of C-RAM systems fielded thus far are based on naval CIWS technology, with one major exception of the form of the missile-based Israeli IRON DOME system.

Palestine

There was an obvious requirement for Israel to have a credible C-RAM solution as it faces a massive rocket threat from Hezbollah in the Lebanon and now also in Syria, plus Hamas and the Palestinian Islamic Jihad (PIJ) in Gaza. The Hezbollah rocket inventory ranges from Chinese 107 mm systems, Russian BM-21 122 mm and probably the BM-27 URAGAN 220 mm MRL system (likely via Iran or Syria). On top of these capabilities, it also has a vast number of different Iranian artillery rocket types, including large calibre systems with ranges between 200 and 400 km. It is expected that Hezbollah could launch between 1,500 and 2,500 rockets a day against Israel in the event of a conflict, according to Israeli officials talking to Agence France-Presse (AFP) in October 2021, with large areas of Israel coming under threat. Back in 2006, when Hezbollah clashed with Israel, it would have taken a month for Hezbollah to launch the number of missiles that the Israelis now expect to be hit with in a single day.

In Gaza, both Hamas and the PIJ have access to rockets with Iranian types predominant, but both groups also manufacture their own rockets. As previously stated, building a basic rocket is not that much of a technological challenge. However, these 'home-built' rockets have their problems; range is short and performance is questionable. This explains incidences of rockets dropping short within Gaza or going off course. In May 2021, when Hamas and PIJ were firing rockets into Israel, some 400 were fired every day and of these more than 90 per cent were intercepted and destroyed by the IRON DOME system, according to a report by AFP.

The intensity of the rocket threat in the Middle East is unlikely to reduce. For insurgents and non-state actors, the fact that there is now so much emphasis on C-RAM demonstrates what a powerful tool rockets can be. As reported by AFP in May 2021,

Photo: US Space Force

A Lockheed Martin Precision Strike Missile (PrSM) launches from a HIMARS at Vandenberg Space Force Base, California, in October 2021. PrSM will give MLRS users a deep fires weapon to replace ATACMS; it will have a range in excess of 499 km.

the cities of Tel Aviv and Ashdod received the largest amount of incoming ordnance since the foundation of the state of Israel. Now consider what might happen in the event of Hezbollah unleashing its rocket arsenal. On the other hand, Israel has the IRON DOME system and shelters for its citizens, plus the means to rapidly target rocket launch sites and their supporting infrastructure.

The asymmetric wars of the post-2000 period have seen a major change in how the artillery rocket is viewed. Its significance has expanded from a weapon for use on the conventional battlefield to playing a role in a far more complex military environment. In the context of the Israeli situation, the artillery rocket has become the basis for a strategic threat. Furthermore, threat intensity continues to increase and this requires further investment in defensive countermeasures and defences – all of which goes to show that a relatively unsophisticated weapon system can have an effect far out of proportion to the investment needed to make it a threat. Even so, no matter how much Hamas and PIJ boost their rocket capabilities they will never have enough rockets to make them a weapon of decision. For Hezbollah, their rocket arsenal is truly significant. The fact that they could launch 2,500 rockets in a day constitutes a massive threat. It is still not a weapon that could force a decision though, and it could not stop the inevitable and quite possibly decisive Israeli retaliation.

On the Battlefield

The roots of the modern MRL can be traced back to the 1930s and the Soviet Union where research into solid fuel rockets led to practical solutions in particular a 132 mm design. A 16-rail MRL launcher was then designed and mounted on a ZIS truck and this became the BM-13 KATYUSHA. It is estimated that only 40 BM-13 systems were completed before the Soviet Union was invaded on 22 June 1941. The first combat use of the system was on 14 July 1941 near Orsha, in what is today Belarus, when a battery of BM-13 commanded by a Captain Flërov engaged the enemy reporting highly satisfactory results. Depending on the rocket type used, the range for the BM-13 was between 7,900 metres and 11,800 metres. Unsurprisingly, there were negatives with these early MRL systems, including range limitations and rocket dispersion. Of course, if you had enough MRL systems, the weight of the salvo more than made up for dispersion and as larger calibre rockets were fielded, salvo density rose dramatically increasing on-target effects. Outside of the Soviet Union, others were impressed with the potential of the MRL system and most of the major combatants fielded artillery rocket systems of various natures.

Post 1945, the Soviet Union introduced a new MRL generation with higher performance, but it was in the early 1960s that they introduced an MRL system that was arguably one of the most influential systems of its type in the modern era; that system was the BM-21 GRAD. During the current Russian invasion of the Ukraine, nearly 60 years after it entered service, the BM-21 is being used in combat by both Russian and Ukrainian forces.

The standard BM-21 is a truck-mounted system, initially a Ural 375D, with the launcher having 40 rocket tubes for 122 mm rockets. The capability evolution of MRL systems is demonstrated by the fact that, according to Soviet data, in comparison to the BM-13 of the 1940s, the BM-21 had four times the salvo weight and eight times the total destructive capacity! Initially, the BM-21 rocket had a range of 20 km, though more recent rockets have ranges in excess of 40 km. Rocket natures include HE-F, anti-tank mine, smoke, sub-munition and RF jammer. Apart from countries in the former Soviet space, countries that have manufactured the BM-21 include China, Egypt, Ethiopia, Iran, North Korea and Pakistan.

Photo: US Marine Corps

An M142 High Mobility Artillery Rocket System (HIMARS) conducts pre-shoot standard operating procedure checks at Marine Corps Air Station Cherry Point, North Carolina in March 2021. HIMARS is mounted on the FMTV tactical truck and can use a six-rocket MLRS pod or a single ATACMS rocket.

Western Responses

Western responses to Soviet MRL systems were limited, though there were exceptions. Germany introduced the Light Artillery Rocket System (LARS) into service at the end of the 1960s; this was a 36-tube 110 mm calibre MRL. An upgraded version of LARS-2 on a new MAN truck chassis was introduced in the early 1980s. However, there was an attempt at a more ambitious project known as RS-80, which involved Germany, Italy and the UK. This was a six-tube 280 mm calibre MRL mounted on a LEOPARD 1 chassis, with the rockets having a range of between 40 and 60 km. The British withdrew from the project in 1975 after they could not convince the other two partners of their preference for rocket accuracy and the programme then ground to a halt.

The NATO Solution

In the mid-1970s, the US Army changed its mind about MRL systems and generated a requirement known as the General Support Rocket System (GRS), which later became the M270 Multiple Launch Rocket System (MLRS) which entered service in 1983. In Europe, the MLRS was acquired by Denmark, France, Germany, Greece, Italy, the Netherlands, Norway, Turkey and the UK. Later, both Denmark and the Netherlands sold their MLRS to Finland, while Norway retired its systems.

MLRS continues to be the NATO rocket artillery system of choice and it will be in service for many years to come, as evidenced by an ongoing British Army MLRS upgrade programme. At the end of March 2021, it was announced that an agreement had been reached with the US Department of Defense (DoD) covering a five year programme to upgrade 44 British MLRS launchers. Work will commence in March 2022 and will be carried out at the Red River Army depot and at the Lockheed Martin Camden, Arkansas, facility, the work is included in existing production contracts between the UK and Lockheed Martin.

The upgrade will take five years to complete and the resulting M270B1 will provide the British Army Land Deep Fires capability until 2050. The upgrade will include a new armoured cab and upgraded automotive and launch mechanism components, Composite Rubber Tracks (CRT), and a vehicle camera and radar system will be added. A new Fire Control System (FCS) will be developed collaboratively with the US, UK, Italy, and Finland.

The upgraded MLRS will utilise the Guided MLRS Extended Range (GMLRS-ER) missile which should be in service from 2025 and will increase engagement ranges from the current 84 km out to 150 km. The other new weapon system that can be employed is Lockheed Martin's Precision Strike Missile (PrSM) that is expected to be in service from 2024 and this offers a range from 60 km out to more than 499 km. The PrSM was developed to meet a US Army requirement for a 499 km range weapon to replace non-insensitive and cluster munition versions of the Army MGM-140 Army Tactical Missile System (ATACMS), a 300 km range system. It should be noted that the 499 km range was the result of the 1987 Intermediate-Range Nuclear Forces (INF) Treaty that limited land-based ballistic missiles, cruise missiles, and missile launchers with ranges above 500 km. However, the US withdrew from the INF Treaty in February 2019.

The future of the MRL system is quite clear from the upgrade to the British M270B1 MLRS force, as the objective is long-range high precision deep fires. The HIMARS truck-based MRL system will also be capable of using the PrSM rocket system, further expanding its utility. Elsewhere, others are looking at their own deep fires solutions, for example Iran is said to have fielded a rocket with a range in excess of 600 km! The only drawback with these extended range systems is being able to achieve accurate targeting for these deep fires systems.

Elsewhere, the artillery rocket will continue to be an attractive means of firepower for insurgents/non-state actors. Ideally these groups would look to be supplied with rockets from external sources, but if that is not possible the ease of building rockets from locally available materials as demonstrated by Hamas and PIJ in Gaza makes them ideal weapons. All of which sees the artillery rocket having a long-term future in both conventional and asymmetric conflicts. ■

Photo: Roketstan

Roketsan of Turkey has developed a complete range of rocket solutions from 107 mm calibre upwards, 122 mm solutions include guided rockets, with 230 mm, 300 mm and even 610 mm rockets developed for long-range engagements.

Talk and Squawk – Military Vehicle Onboard Communications

Tim Guest

This article discusses the origins of rocket artillery, describes its introduction to the modern battlefield, and explains why some were excited by the possibilities it offered while others rejected it. The article describes how many of the doubters of the utility of Multiple Rocket Launcher systems in the West changed their minds and suddenly became believers once they understood what was possible with these systems.

Just as reliable military communication systems and equipment are essential for uninterrupted communication among the wider military assets spread out across a battlefield communications network, the immediate environment inside a military vehicle, whether tracked or wheeled, armoured or otherwise, also needs to support an effective means of communicating in what can also be a harsh and challenging setting. Noise, vibration and even smoke, can all combine to make the task of communicating between crew members an extremely difficult one, unless supported by an effective onboard means of communications, one that interoperates and integrates with the tactical comms, as well as any battle management systems in use onboard, thereby enabling commanders to switch between the two, as necessary, without impacting operational capabilities. This is where an effective vehicle intercom system plays its part.

An effective vehicle intercom system (VIS) provides onboard voice intercommunication between vehicle occupants that must be clear and reliable under harsh operational conditions. Latest systems deliver traditional intercom capabilities while incorporating advanced software-defined features, including an open architecture, technology-agnostic approach with units or modules easily integrated and connected to other onboard communications, vehicle C4 systems, networked communications gateways, vehicle-borne tactical radios and

Photo: Savox

The immediate environment inside a military vehicle, whether tracked or wheeled, needs to support an effective means of communicating in what can also be a challenging setting.

Photo: via author

Noise, severe vibration from cross-country driving, and even smoke can all combine to make the task of communicating between crew members an extremely difficult one. Pictured here is the Vitavox OUTACOM tactical public address system (speakers in view) installed aboard a British Army AJAX armoured fighting vehicle.

Author

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

ancillary/peripherals, such as headsets, speakers, neck microphones, handsets, field telephones and PA systems, from a wide number of makers.
This article takes a brief look at some of the latest and deployed military vehicle intercoms solutions available from a variety of industry players.

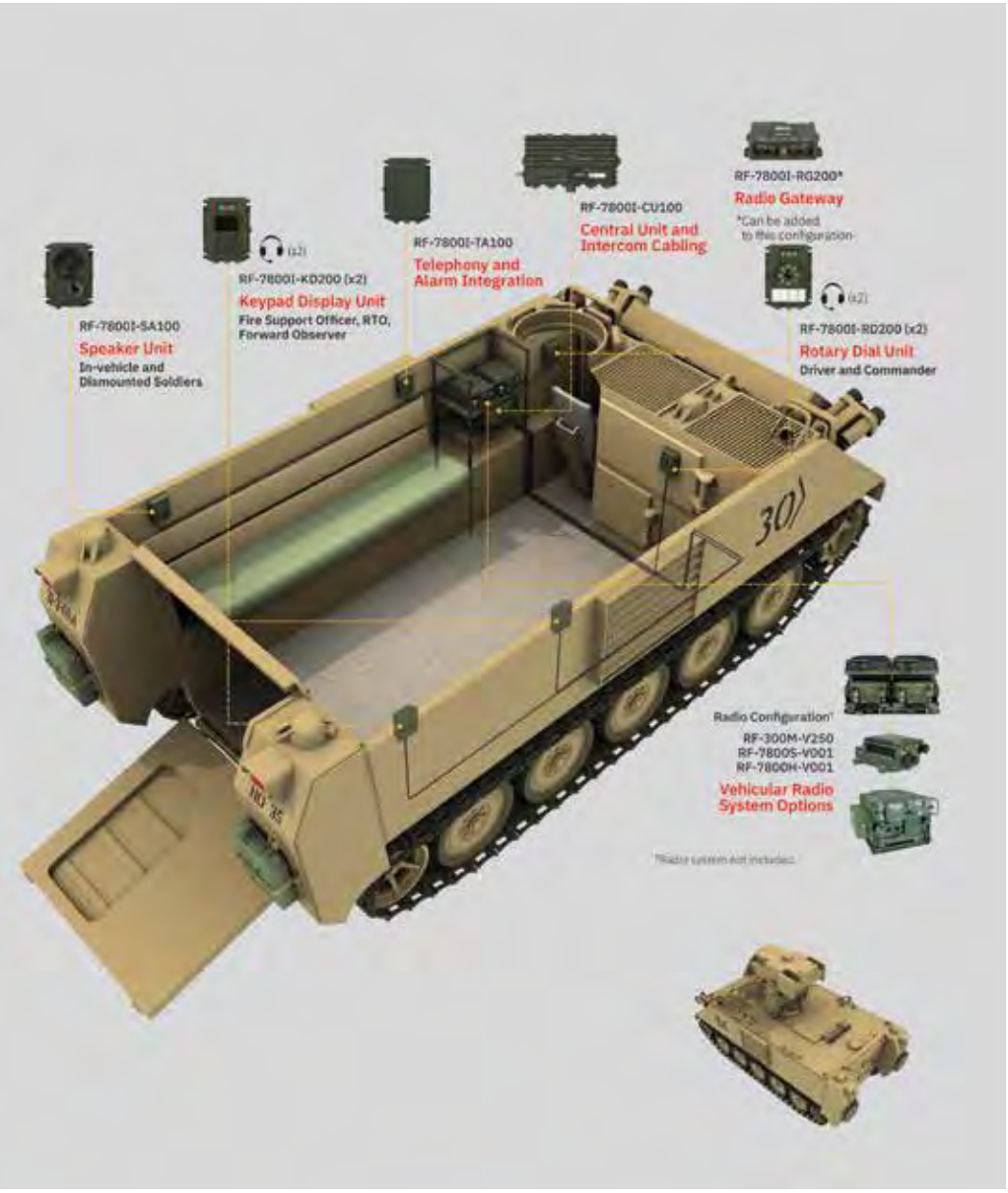
Systems on the Move

In service with a number of western military users aboard several vehicle platforms is the IMP intercom system from Savox; this onboard C2 system has a digital 10MB Ethernet backbone at its core, and provides clear communication both

Photo: Savox

The IMP intercom comprises a series of rugged modules connected to each other throughout a vehicle, not only allowing the system to be easily accessed by the crew, but also providing redundancy should any one module fail or be destroyed.

Photo: L3Harris



In addition to communications for mounted crews, the intercom system for mechanised fire support vehicles connects dismounted observers beyond-line-of-sight. The L3Harris RF-7800I provides a data relay link to the remote forces, and distributes GPS information to and from a spoof-resistant receiver to the targeting laser for the fire support computer system.

inside and outside a vehicle, allowing users to converse internally using the intercom feature, or dismounting troops to communicate over the system's radio link with crew remaining inside. The intercom comprises a series of rugged modules connected to each other throughout a vehicle platform, not only allowing the system to be easily accessed by the team inside the vehicle, but also providing a degree of system redundancy should any one module fail or be destroyed. Software defined and programmable, IMP provides intercom, radio control and a common core system architecture for high-speed data distribution.
The company's Tactical Radio and Intercom Controller, TRICS, interoperates with IMP, as necessary, and is a software-controlled device with push-to-talk functionality, (both wired and wireless), that allows customer configurations to fit specific user requirements. It offers remote control of up to four different channels and devices and can interconnect radios, smartphones/LTE devices and the VIS. Towards the end of last year, the company introduced its TRICS Lite, a more compact version of the TRICS unit.

Modular and Dynamic

From L3Harris, the RF-7800I Tactical Networking Intercom System is a small, lightweight, power-efficient intercom system that is VICTORY (Vehicle Integration for C4ISR/EW Interoperability) and GVA-compliant, suited and customisable for a variety of vehicle platforms. The RF-7800I is a ruggedised intercom system that enables the delivery of clear voice and data communications between crew members within the limited, noisy confines of military vehicles. It is interoperable with the company's Falcon family of tactical radios, as well as a wide range

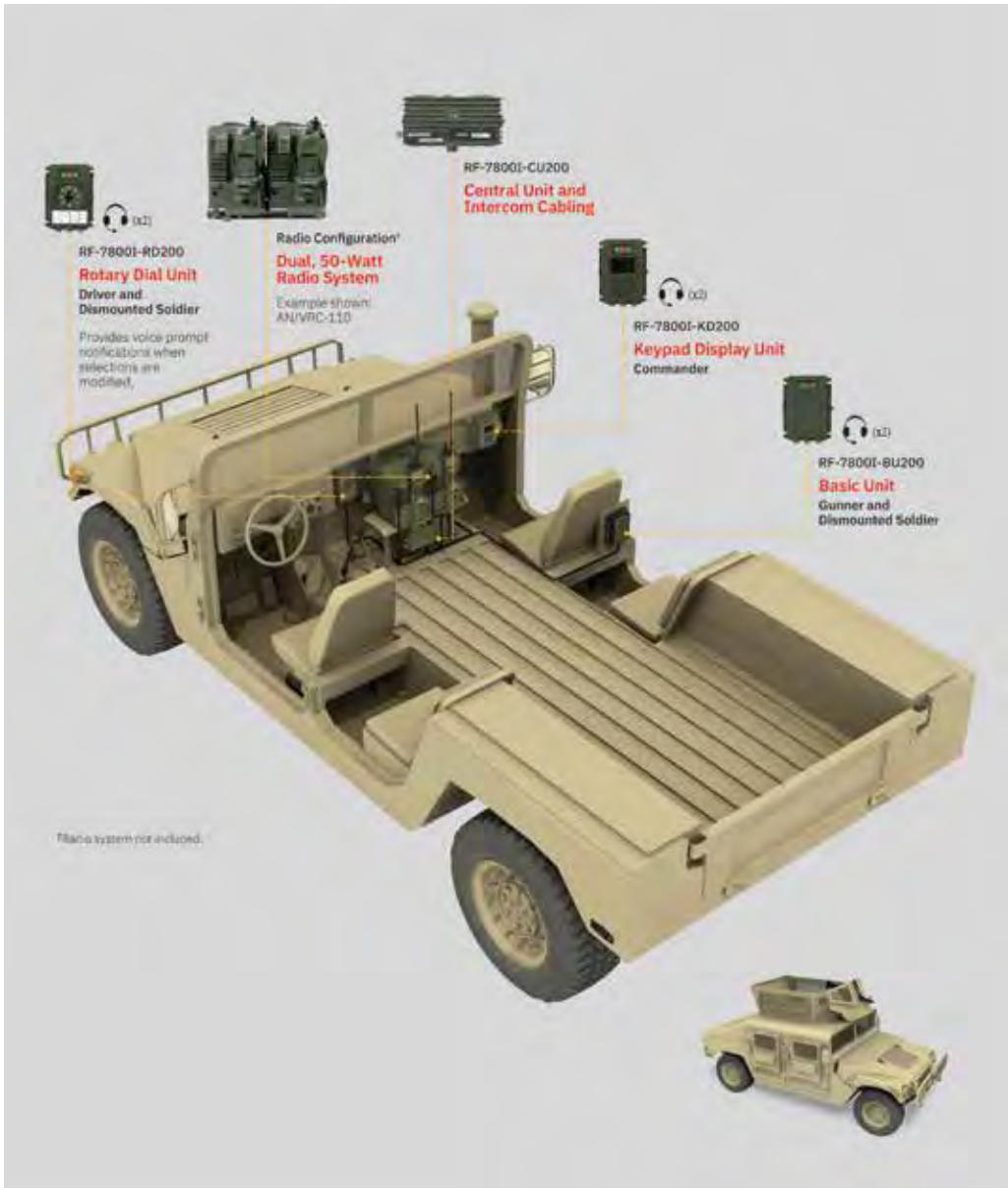
of other military, government and commercial devices. The system's modular design makes it easy to configure and install to meet the specifics of any operational scenario or mission. The VIS provides simultaneous data and voice through a single connection for up to 10 radios and has PTT app functionality for shared voice, text, video and graphics on radios, smartphones, tablets and laptops. The RF-7800I provides remote control of L3Harris Falcon tactical radios up to 2km away from their mother vehicle and supports other HF, VHF, UHF, SPR, LMR and BGAN satellite communications technology, connecting dismounted personnel, tactical operations centres and vehicular units. The system's keypad display unit provides real-time command and control of the intercom system and any connected radios.

The L3Harris RF-7800I-CU Central Unit forms the core of the intercom system and employs headsets with advanced dynamic noise reduction technology to eliminate background noise, delivering clear voice communications and data-sharing capabilities for up to eight crew stations and 10 combat net radios. The vehicle's system status, crew station controls and indicators are also monitored by the unit for greater control of the system. A 'light' version is available to support voice-only communication between crew stations and radio transceivers and a four-wire highway cable connects the central unit and crew stations, reducing unnecessary cabin clutter. The system is software-configurable and upgradeable through a simple, PC-based user interface and provides efficient, simultaneous data and voice capabilities via a single connection for up to 10 radios.

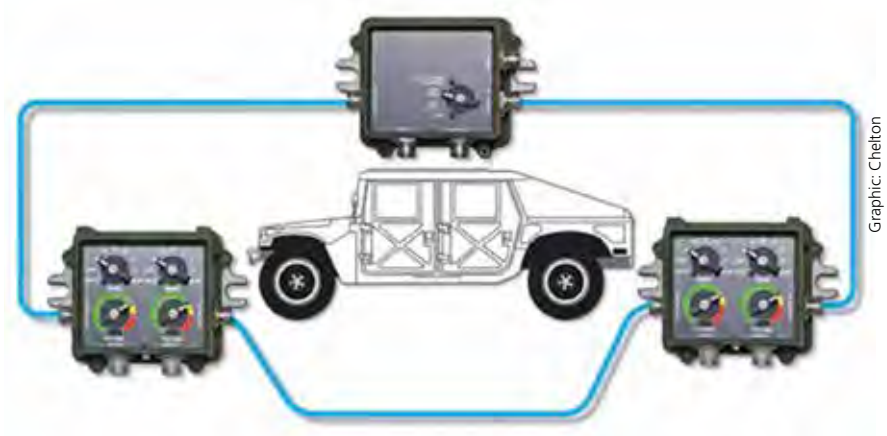
In addition to communications for mounted crews, the intercom system for mechanised fire support vehicles connects dismounted observers beyond-line-of-sight. The L3Harris RF-7800I provides a data relay link to the remote forces, and distributes GPS information to and from a spoof-resistant receiver to the targeting laser for the fire support computer system. Local dismount units can also communicate to support vehicle crews via radio or tank phone, and to mobile troops through the system's integrated speaker.

With over 150,000 of its systems in service around the world, Chelton's VISs, as with other systems on the market, use a modular approach to provides users with effective, scalable solutions across a wide range of vehicle types, ranging from light

Photo: L3Harris



A 'light' version of the RF-7800I is available to support voice-only communication between crew stations and radio transceivers and a four-wire highway cable connects the central unit and crew stations, reducing unnecessary cabin clutter.



Graphic: Chelton

Chelton's recently-launched Tactical Gateway Interface Voice-Over IP communications terminal is compatible with the company's range of VIS including the TacG2 (AN/VIC-5), ROVIS (AN/VIC-3) and the Light Vehicle Variant (LV2).

Photo: Vitavox

While OUTACOM is in service on traditional vehicle platforms, Vitavox has also been conducting trials and experiments with the system on UGVs and light vehicles, specifically around deception & decoy applications.

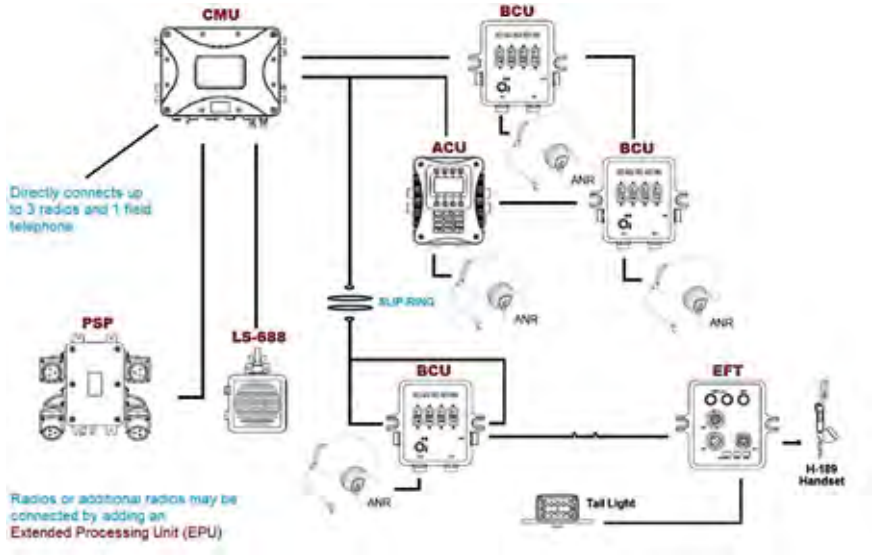


Photo: AT Communication International

DVIS has a modular design that allows a high level of flexibility and cost-saving when increasing the number of users, or when integrating additional equipment. Pictured: Four-person DVIS configuration.

vehicles to heavy armour and command centres, to enable all crew safe, secure, fast and reliable onboard voice and data communications. The company's MIL-SPEC VIS solutions have high levels of battle damage resilience – such as the bullet proof ROVIS and LV2 systems – and are backward compatible and easy to use, even with gloves on. The TacG2, for example, is said to be a next-generation digital vehicle intercom system providing fast, safe, secure and reliable communications that enable vehicle-mounted troops to communicate in the most demanding of environments. The system is made up of a number of standard operator units, which can be mixed-and-matched to satisfy specific functional and technical configuration requirements. The system has IP connectivity, VoIP calling, selective calling, and interconnects with vehicle displays; increased functionality can be achieved by connecting additional modules. TacG2 is compatible with Chelton's recently-launched Tactical Gateway Interface (TGI) Voice-Over IP communications terminal, which is compatible with the company's range of VIS including the TacG2 (AN/VIC-5), ROVIS (AN/VIC-3) and the Light Vehicle Variant (LV2). The TGI extends connectivity outside a vehicle allowing communication through terminal, switch and routing, and interfaces directly with Chelton's intercom systems via the radio port, opening up a variety of potential connectivity solutions using IP connectivity, field wire or Ethernet operation.

The company's LV2 has a small footprint using minimal real estate inside a vehicle making it suited to light and small vehicle applications. The system provides high quality external communications over

Photo: Vitavox

The latest intercom product from Vitavox and already in service with NATO forces is the software-defined VITAVIC 400C (compact), which has been specifically designed for small/light tactical vehicles.

Photo: Vitavox

The VITAVIC 400 VIS is a software-defined, fully digital, mil-spec intercom in service with NATO forces.

Combat Net Radio and is fitted aboard US Army HMMWVs, as well as a range of other light vehicles. The LV2 is the most widely used of Chelton's VIS and offers crews the ability to monitor all onboard radios, central control over the intercom's operating mode, whether VOX, live mic/PTT, has individual volume controls, as well as a second, though optional, intercom channel. It also provides a full wireless intercom capability for crew and dismounted troops and supports up to 10 users.

Loud, for AJAX, but with a UGV Twist

Currently being installed aboard the British Army's AJAX armoured fighting vehicles is the Outacom tactical public address (PA) system from Vitavox Tactical Communications Systems. The system enables direct, command and control of the immediate locale from within the vehicle. The system suits safe crowd control and dispersal operations and enables direct audio communication to distances of up to 300m, where, previously, communicating with a civilian population from inside an AFV would have meant opening the hatch and exposing personnel to danger. The system is made up from two rugged loudspeakers, a programmable integrated control unit and noise-cancelling military microphone. Additional functionality in AJAX includes listening capability, which allows two-way conversations whilst remaining safe inside the vehicle. The PA system seamlessly interconnects with the VIS as required using the Outacom Control Unit, or PASAM. Whilst Outacom is in service (e.g. with AJAX, other NATO units), Vitavox has also been conducting trials and experiments with the system on UGVs and light vehicles, specifically around deception & decoy applications. All Vitavox systems are rugged Mil-Std tested, with the Outacom also tested to Def-Stan. The company's Vitavic 400 VIS is a software-defined (SD), fully digital, mil-spec intercom in service with NATO forces. It's a modular system and connected with a single Central Communication Unit (CCU) can support up to 21 crew and six combat net radios in one vehicle – rebroadcast from two to an expanded capability of six different combat radios -- and operates with any encrypted peripherals and signals with no manufacturer input required. The system is fully upgradeable and easily programmable via a standard laptop or fill gun, with no down time required and dismounted personnel can remain connected via short range soldier radio or field telephone interface. The company's most recent addition to its product range and already in service with NATO forces is the software-defined Vitavic 400C (compact), which incorporates Digital Signal Processing (DSP) as standard and has been specifically designed for small/light tactical vehicles that require no direct interface with the control unit(s). It offers all the same functionality of the Vitavic 400 and is seamlessly controlled via an inline PTT with up to two radios directly controlled. Vitavox offers slim-line, dynamic noise reduction headsets to accompany the 400C, as required.
Another modern digital intercom system for a wide variety of platforms ranging from light transport to heavy armoured vehicles is the DVIS - Digital Vehicle Intercom System, from Switzerland's AT Communication International. This digital system is designed as a Local Area Network (LAN) and employs VOIP technology offering not only high-quality voice communication, but also reliable

Masthead

European Security & Defence
Issue 04/2022, April 2022
ISSN 1617-7983 · www.euro-sd.com

Published by

Mittler Report Verlag GmbH
A company of the TAMM Media Group

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Layout:
AnKo MedienDesign GmbH, Germany

Production:
Lehmann Offsetdruck GmbH
22848 Norderstedt, Germany

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

Managing Directors: Peter Tamm, Thomas Bantle

Advertising, Marketing and Business Development
Stephen Barnard
Phone: +49 228 35 00 886, Mobile: +44 7984 033154
stephen.barnard@mittler-report.de

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

Waldemar Geiger
Phone: +49 228 35 00 887
waldemar.geiger@mittler-report.de

Dr. Andreas Himmelsbach
Phone: +49 228 35 00 877
andreas.himmelsbach@mittler-report.de

Advertising Representative, Russia & CIS:
Laguk Co., Yury Laskin, General Director
Krasnokholmskaya Nab., 11/15, 132, RF-109172 Moscow, Russian Federation
Phone: +7-495-911-1340, Fax: +7-495-912-1260, Email: yury.laskin@mittler-report.de

Exhibition Management and Advertising Administration: Renate Herrmanns

Advertising Accounting: Sabine Rump

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

Cover: Today's market for medium helicopters is extremely competitive with companies all over the world offering solutions in the category.
Photo: Leonardo

Annual subscription rate: €82.50 incl. postage

Reduced annual subscription rate for distribution in Germany:
€64.90 incl. postage

Photo: Savox

The TRICS interoperates with the onboard IMP VIS and is a software-controlled device with push-to-talk functionality, (both wired and wireless), that allows onboard and disembarked functionality to fit specific user requirements. It offers remote control of up to four different channels and devices and can interconnect radios, smartphones/LTE devices and the VIS.

Tactical Radio and Intercom Controller, TRICS, which interoperates with the onboard IMP VIS.

data capabilities. It has a modular design that allows a high level of flexibility and cost-saving when increasing the number of users, or when integrating additional equipment. The main control unit is the Central Multimedia Unit (CMU), and this can be connected to a WAN, thereby bolstering the functionality of the system's communications through a gateway. DVIS incorporates an LCD display and intuitive controls, built-in noise cancellation, is scalable for different platforms and has in-built redundancy through its ring-type architecture. Active/dynamic noise reduction headsets are used with the system. Optional Equipment for DVIS includes: Data Modem Unit, Voice Recording Unit (VRU), LAN Gateway Controller (GWC), Tactical C4I (TCC), Low-band VHF Radios (HT-78). The CMU controls the connections to other modules and equipment. The CMU' can be programmed according to the vehicle type and the functional requirements of each platform. Power for the entire intercom system emanates from the CMU and is distributed to each of the devices within the intercom system.

Leonardo's Tactical and TETRA Footnote

Off the shelf from Leonardo DRS is the company's VIS product that offers a flexible, future-proof solution to platform-based audio aboard military and emergency responder vehicles where high-quality, intra-crew and intra-fleet voice communications are required – the system supports both tactical combat net radio technologies as well as TETRA. This software-defined VIS is fully interoperable with most existing tactical and emergency services radio and radio networks and supports VoIP. The Ethernet-based capability of the Leonardo DRS VIS network enables system integrators to construct audio networks using modular building blocks. Built to open standards, the VIS supports up to six combat net radios and can interconnect up to 16 crew, with each person having independent volume control and active/dynamic noise reduction headsets. The ruggedized system is suitable for use with rotary junction box, slip-ring type vehicles and uses advanced codecs to ensure high quality audio even across low-bandwidth slip-rings. All the VIS components use FLASH-based micro-processors, which are field re-programmable and by supporting multiple CODECs and upgradeable software modules, compatibility with future communication requirements is ensured. ■

Chilean Air Force Update

Robert Czulda

The Chilean Air Force is a mix of relatively new and old aircraft, which are expected to be replaced. Several modernisation programmmes have been initiated, but the most costly ones – such as an upgrade of the F-16 multirole jets – have suffered from economic problems, which are a result of the COVID-19 pandemic.

Directions of technical modernisation depend mainly on challenges, which a particular state faces, and tasks, which its military has to carry out. The Chilean Air Force (FACh, Fuerza Aérea de Chile), which was established in 1930, is mainly responsible for protecting national sovereignty and airspace. Chile is a safe country and thus the risk of a conventional aggression is very low. Therefore the FACh is mainly engaged in non-military operations, such as patrolling, SAR (Search and Rescue), transport and humanitarian relief (including medical evacuation from remote areas). For instance, in August 2021 the FACh sent supplies to Haiti, while in February 2022, the FACh deployed its Bell 412 helicopters to fight forest fires in the Araucanía Region.

Aerial assets are vital in a highly mountainous country with one of the longest coastlines in the world (6,435 km). The main challenge for the FACh is a large area of operation. Chile considers itself a so-called tri-continental country with a unique position in Antarctica, South America and south-eastern part of the Pacific Ocean. An airspace under national responsibility covers an area of approximately 31.9M km². This also includes Antarctica, where SAR duties are shared with Argentina.

According to FACh Commander, Air General Arturo Merino Núñez, there are currently four main challenges facing the Chilean Air Force. Apart from maintaining operational capabilities, the list includes: a delayed modernisation of the F-16 multirole jets; implementation of a civilian-military space programme; and incorporation of the PILLÁN II new primary training aircraft.

Author

Dr Robert Czulda specialises in International Affairs and Polish Defence matters and is based in Poland at the prestigious University of Łodz.

Photos: Chilean Air Force

Currently, Chile operates the CASA C-101 AVIOJET (A-36 HALCÓN) combat/trainer jets.

In the future, the A-29Bs might replace the outdated A-36s (depicted).

Combat Aircraft

The backbone of the FACh is a relatively large combat fleet, which is composed of F-16 multirole jets. Currently, Chile has 44 F-16s in total, mostly of an older A/B MLU variant (Block 20) – 36 used jets were procured from the Netherlands. The MLU variant was equipped with a new F-16 Modular Mission Computer (MMC), new Honeywell liquid crystal displays, HUD, NVG night vision goggle compatible instruments, an INS (Inertial Navigation System), GPS, AIFF, FCR and the ability to carry the BVR AIM-120C5/7 AMRAAM missile. Only ten are relatively new (Block 50/52 variant) and they were bought from Lockheed Martin in 2006. In 2017, Chile asked the United States for a modernisation programme, which would extend the service life of Chilean F-16s through to the 2030s. It also requested new equipment, including 19 Joint

In 2021, Chile received two used C-130H HERCULES from the United States.

A CASA 212

Currently, Chile has 44 mostly older F-16s.

Helmet-Mounted Cueing Systems, Multifunctional Information Distribution System Joint Tactical Radios (MIDS JTRS), six inert MK-82 general purpose bomb bodies; two MXU-650KB Air Foil Groups and 44 LN-260 Embedded GPS/INS units. No offset agreement related to the update package was announced. The project does not include the purchase of weapons.

It was initially planned to launch modernisation works on all 46 jets before 2021. Additionally, Santiago reportedly also wanted to procure between six and eight new F-16 Block 50 jets. Later, however, this initiative – considered one of Chile's air priorities – suffered a serious setback. First, in July 2020 the US Defense Security Cooperation Agency (DSCA) notified the Congress of a possible sale to Chile of "equipment and related services for F-16 Modernization" for roughly US$ 634M. Then Chile announced that this project had been halted due to financial problems and the necessity to combat the COVID-19 pandemic. It was officially explained that "although the upgrade project has been technically validated and was awaiting an allocation of resources, a decision was made to postpone it due to health emergency and a need to prioritise state resources in other more urgent areas".

Initially, Chile planned to phase out all legacy aircraft, including the F-5E TIGER II, MIRAGE 5 (5BA/5BD ELKAN) and MIRAGE 50CN (50C/FC PANTERA), and rely only on the F-16s. This plan was only partially accomplished. Chile still has ageing Northrop F-5E TIGER II light supersonic fighters, which do not meet the operational requirements of modern warfare, but are very useful in Chile's harsh climate (which includes strong winds). Moreover, airframes are fatigued – Chile purchased 18 TIGER IIs in the 1970s. In 1993, they were modernised to a more advanced standard, now known as TIGER III. They were integrated with ELTA EL/M-2032B multi-mode radar, INS/GPS together and various new navigation/ communication sets, in addition to the PYTHON IV and DERBY missiles, as well as GRIFFIN LGB laser-guided bombs. It is believed that 12 TIGER IIIs are still in service and no deadline for their retirement has been set. A life extension programme is under consideration. It is worth noting that in August 2018, representatives of South Korean KAI visited Santiago, where they promoted the KF-X programme (4.5 fighter aircraft).

Trainers

The FACh has already initiated a long-term process of replacing its old train-

ers. Currently, Chile has the T-35 PILLÁN twin-seaters, which are used for basic training, and the CASA C-101 AVIOJET (A-36 HALCÓN) combat/trainer jets. Both were delivered in the 1980s. The latest upgrade occurred in December 2018, when Embraer handed over four A-29B SUPER TUCANO combat trainers (the first two from a total of six were delivered in March 2018). Chile's first order was made in 2008, when Embraer was requested to manufacture 12 SUPER TUCANOs for the FACh (selected over PILATUS PC-21, Raytheon T-6A TEXAN II, Aermacchi M346, KAI T-50 and LMAASA AT-63 PAMPA). The A-29Bs might replace the A-36s in the future and an acquisition of additional aircraft has not been ruled out. Regarding the T-35s, Chile started looking for a replacement in May 2019. At least 40 aircraft, codenamed PILLÁN II, are to be manufactured by ENAER (Empresa Nacional de Aeronáutica de Chile) and join the FACh between 2024-2025. A prototype is expected in the near future.

Transport Fleet

It is necessary for such a mountainous country to maintain an effective and robust transport fleet. The FACh has several types of aircraft, including the Gulfstream G-IV, Boeing 767 and 737, Learjet 35, C-130H/KC-130R HERCULES, as well as C-212 and DHC-6 TWIN OTTER (in service with all three Chilean military branches). Over the last decade, the FACh was strengthened by three KC-135 STRATOTANKER aircraft with long-range transport and tanker capabilities. Another significant upgrade occurred in 2015, when Chile received the first of two in total KC-130R (previously used by the US Marines and offered by the US Defense Security Cooperation Agency).

In 2015, Chile bought two KC-130R previously used by the US Marines.

Initially, Chile planned to phase out all legacy aircraft, including the F-5E TIGER II.

In 2021, Chile received two used C-130H HERCULES from the United States. They joined two C-130Hs previously acquired by Santiago and three KC-130R. At the same time, the FACh has been working on a procurement of medium turbo-prop transport aircraft. The FACh suffered a great loss in December 2019, when the KC-130R, which was en route from Base Aérea Chabunco) in Punta Arenas in southern Chile to the Antarctic station of La Base Presidente Eduardo Frei Montalva, when it crashed with 17 crew and 21 passengers on board.

Over the last decade, the FACh was strengthened by three KC-135 STRATOTANKER aircraft with long-range transport and tanker capabilities.

Chile uses T-35 PILLÁN twin-seaters for basic training.

Chile`s transport fleet is also composed of UH-1 helicopters.

The transport fleet, also composed of Bell 412 and UH-1 helicopters, was recently enhanced with a procurement of the S-70i (MH-60M) utility helicopters, which were produced in Poland by PZL Mielec (subsidy of Sikorsky Aircraft Corporation). An order was made in December 2016 and the last batch of three helicopters (six ordered in total) was delivered ahead of schedule in October 2018. The S-70i helicopters were handed over to the II Brigada Aérea's Grupo de Aviación N° 9 (2nd Air Brigade's 9th Aviation Group), where they are tasked with transport duties (including humanitarian relief). They were recently used extensively during the COVID-19 pandemic, when they made numerous short distance flights of 300-400 km to transport patients from Santiago to hospitals in other Chilean cities. Due to the latest procurement, the FACh has now seven BLACK HAWK helicopters, including an S-70A-39 received years ago. More procurements of utility helicopters are expected.

Early Warning

One of FACh's recent initiatives was a decision to upgrade its AEW (Airborne Early Warning) capabilities, which are very modest, but will soon receive a significant boost. Chile has just one Boeing B-707-385C aircraft, which was built in 1965 and was previously used by LATAM Airlines Chile (later, in 1990, it was transferred to the FACh). Due to fatigue, this aircraft, codenamed CÓNDOR, is expected to be retired in mid-2022. CÓNDOR is equipped with Israeli-made EL/M-2075 PHALCON L-band active phased-array radar with six separate antenna arrays.

Looking for an opportunity to establish a foothold in South America, China presented its C4ISR (Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance) proposal in 2018, which included the Shaanxi ZDK-03 (AWACS) aircraft. However, Chile decided to look for something else. In early February 2022, it was announced by the British Ministry of Defence that London would sell (for an undisclosed amount) two used E-3D SENTRY Mk 1 to the FACh, "following a period of crew training in the UK". It was also reported that a third aircraft was also acquired, but it will serve as a source of spare parts. The ex-British E-3Ds, which are equipped with a single AN/APY-2 passive electronically scanned array radar in a radome on top of the rear of the fuselage, served in the RAF for 30 years. Despite their age, when delivered, the FACh will significantly boost its airborne warning and control capabilities, also including in terms of weather surveillance, communication and command-and-control. E-3Ds will be very useful also in other duties, such as search-and-rescue operations and protecting territorial waters from smugglers (this also includes drug dealers, which have grown in strength in Chile in recent years).

Space Assets

The FACh is involved in the National Satellite System (SNS, Sistema Nacional

Satelital), which was presented in 2020 as a joint initiative among the Ministry of National Defense, Transport and Telecommunication and Ministry of Science, Technology, Knowledge and Innovation. As was mentioned officially, SNS is a "fundamental pillar to materialise Chile's ambitious Space Programme". It is expected that between 2022-2025, Chile will launch up to ten satellites (in cooperation with SpaceX and Israeli ISI Imagesat International). Three orbital control ground stations will be enabled in Santiago, Punta Arenas and Antofagasta. In December 2021, the FACh created the Space Directorate. Its role is to promote implementation of Chile's SNS. The first space images were acquired by the FACh from ISI Imagesat in September 2021.

According to Chile-based BNamericas analitycs company, the FACh has established a cooperation with the Chilean Ministry of Mining's National Geology and Mining Service (SERNAGEOMIN, Servicio Nacional de Geología y Minería) in the field of satellites. SNS was visited in September 2021 by Mining Undersecretary Edgar Blanco and SERNAGEOMIN head, Alfonso Domeyko. According to an agreement, which reportedly has already been signed, satellites are expected – apart from purely military duties – to provide information for the Chilean mining industry (including identification of areas with renewable energy potential), to detect volcanic eruptions (105 in total, 90 active) and of potential areas of natural disasters.

In 2017, Chile asked the United States for a modernisation programme, which would extend the service life of Chilean F-16s through to the 2030s.

India's Presidential Fleet Review

Suman Sharma

With the recent Presidential Fleet Review showcasing the latest indigenous platforms, has India's seaborne self-reliance finally becoming a reality?

Aimed at showcasing India's naval might, the 12th edition of the President's Fleet Review (PFR), held at the end of February in the southern city Vishakhapatnam - home to the Indian Navy's Eastern Fleet, coincided with the 75th anniversary of India's Independence celebrations, locally known as 'Azadi Ka Amrit Mahotsav'.

A tradition which began in 1953 under India's first President, Rajendra Prasad, to enable the President of India, also the Supreme Commander of the Indian Armed Forces, to review naval preparedness once in his five-year term in office, this year emphasis was on showcasing indigenous platforms. President Ram Nath Kovind reviewed the fleet with the theme '75 years in Service of the Nation.' where the latest state-of-art indigenously built combat platforms were exhibited, before he embarked on INS SUMITRA, an indigenously constructed Naval Offshore Patrol Vessel. INS SUMITRA was designated as the Presidential yacht, distinguishable by a large Ashok Chakra at the front.

As the Indian Ocean region (IOR) attracts intense scrutiny and interest from the world's navies, India is viewed as being the centre of activity in this region as 50 per cent of the global container traffic, 66 per cent of global oil and 33 per cent of the world's cargo traffic passes by here.

Strategically, India's importance is unchallenged in the region. With a long coastline extending into the IOR, the Indian Navy's muscular presence and possible power projection deep into the Indian Ocean makes New Delhi a formidable maritime partner for other coastal nations in the region like Australia, Japan, Vietnam and Indonesia.

Indian Prime Minister Narendra Modi in his 2016 International Fleet Review (IFR) address declared the IOR as one of his foremost foreign policy priorities, after which India has seen a consolidation of bilateral relations with primary IOR states like the Seychelles, Mauritius, Sri Lanka, and the Maldives. Groupings like the Quad bolster India's position further geopolitically, owing to her strategic location.

Photo: Press Information Bureau, Ministry of Information & Broadcasting, Government of India

The President of India, Ram Nath Kovind, inspecting the Guard of Honour, during the Presidential Fleet Review 2022 at Visakhapatnam, Andhra Pradesh.

Operational Preparedness

Besides the show of strength and maritime capability, the PFR also endorses operational preparedness. According to the Indian Navy's statement, "In terms of significance, the Navy's Presidential Review is second only to the Republic Day Parade." During the review, President Kovind said, "[the] Indian Navy's constant vigil, prompt response to incidents and untiring efforts have been highly successful in ensuring safety of the seas and of the maritime commons which are critical to our trade and energy needs." Former Indian Navy Chief Admiral (retd.) Sureesh Mehta said, "Since target practice at sea is carried out, the PFR gives an opportunity to all platforms to be tested operationally once in five years as live firing cannot be done every day. The purpose of the PFR is professionalism, with other benefits like integration of the civilian populace of the area who get a sense of the service during public display events. Passage exercises are also held with other navies sometimes, which is an added advantage."

Participating Platforms

The participating vessels in this year's PFR included newly inducted combat platforms, notable among them being the latest homemade products. These included the brand new stealth destroyer INS VISAKHAPATNAM, the recently commissioned KALVARI class submarine - INS VELA, two KOLKATA class guided missile stealth destroyers - INS CHENNAI and INS DELHI, three SHIVALIK class stealth frigates and three KAMORTA class anti-submarine warfare (ASW) corvettes. Ships from the Coast Guard, Shipping Corporation of India (SCI) and Ministry of Earth Sciences were also among the participants. An impressive fly-past by the Indian Naval Air Arm with a spectacular display by 55 helicopters and fixed-wing aircraft like CHETAKs, indigenous Advanced Light Helicopters (ALH), SEA KINGs, KAMOVs, DORNIERs, IL-38SD, P8I, HAWKs and the MiG 29K captivated the audience.

It is worth mentioning that 47 out of the 60 ships and submarines which participated have been constructed in Indian shipyards,

thus showcasing indigenous capabilities and progress towards 'Atmanirbhar Bharat' (Self-Reliant India).
Ships from all the Commands of the Indian Navy - two operational Commands, one training Command and the tri-services Andaman and Nicobar Command were anchored in four columns. The Presidential yacht sailed past 60 ships anchored in four lanes.

"Make in India"

Expressing his satisfaction on the Indian Navy becoming increasingly self-reliant and being at the forefront of the 'Make in India' initiative, President Kovind noted in his address that about 70 per cent of the contents of several warships and submarines under construction in various public and private shipyards across the country were now indigenous. He said, "It is a matter of great pride that India has built nuclear submarines and soon we would have our indigenously built aircraft carrier, VIKRANT, joining the service", adding that the development of indigenous naval shipbuilding capabilities is an impressive contribution to the making of an 'Aatmanirbhar Bharat'.
During the final stage of the review, a mobile column of warships and submarines carried out a high-speed steam past alongside the Presidential yacht. Several enthralling waterfront activities like the Parade of Sails, a search and rescue demonstration at sea, aerobatic display by HAWK aircraft and water Para jumps by the elite Marine Commandos (MARCOS), made the review awe-inspiring.

IFR & PFR

India has conducted 12 Fleet Reviews, out of which ten were PFRs and two were International Fleet Reviews (IFR), in which warships from other countries are also invited for participation.
The first IFR in 2001 in Mumbai had ships from 29 navies, while the second IFR in 2016 was held in Vishakhapatnam in which a total of 95 warships from 50 navies, participated. The Pakistan Navy was invited, but declined the Indian offer to participate in the 2016 IFR. The 2016 IFR was significant on many counts as it brought together a total of 50 maritime countries including 22 naval chiefs, 4,000 sailors and 90 ships. The sheer magnitude endorsed the growth of the event compared to the 2001 IFR, which was almost half in numbers. The 2016 IFR had two of India's aircraft carriers participating – INS VIRAAT (decommissioned in 2017) and INS VIKRAMADITYA

Photo: GODL India

INS VIKRAMADITYA with a SEA HARRIER

– which made its fleet review debut, after she was commissioned into the Indian Navy in 2013.
Along with the two carriers, other new acquisitions debuting in 2016 IFR were the carrier-borne MIG 29K strike fighters, the KM-31 AEW helicopters and the P8I long-range maritime reconnaissance aircraft.
Indian Navy Vice Admiral (retd.) Shekhar Sinha explained, "[the] PFR is primarily for the Supreme Commander of the Armed Forces, where the Navy pledges its loyalty and commitment to the Constitution of which the President is the keeper. Presenting the operational status before the President, along with firepower is the objective. IFR on the other hand speaks about the Navy's growing prowess in the region; it's a cooperation mechanism with friendly navies in the domain."

Other Nations

Among the naval fleet review hosting nations, notable are the UK, Australia, New Zealand, Canada, Japan, the US and China. Australia, the UK and China have hosted International Fleet Reviews also, in which Indian naval ships have participated.

MILAN 2022

Close on the heels of the PFR was the biennial multi-nation maritime exercise MILAN 2022, with the largest ever participation. Delegations from more than 40 countries and warships from 30 navies participated with the exercise held towards the end of February 2022.
Aimed at fostering bonds across oceans, MILAN, a multilateral naval exercise begun by the Indian Navy in 1995 at the Andaman and Nicobar Command has been held biennially except for 2001, 2005, 2016 and 2020. While the 2001 and 2016 editions were not held due to International Fleet Reviews, the 2005 edition was rescheduled to 2006 due to the 2004 Tsunami, while the 2020 edition was postponed to 2022 due to COVID-19.
MILAN began with just four nations - Indonesia, Singapore, Sri Lanka and Thailand, besides India, but has grown in scope and participation over the years. Originally conceived in accordance with India's 'Look East Policy', MILAN has since expanded in keeping with the Indian Government's 'Act East policy' and Security And Growth for All in the Region (SAGAR) initiative. Participation has increased from six regional countries to 18 in 2014, which also included IOR littorals. With the Indian Navy's engagement with Friendly Foreign Countries (FFCs) expanding over the decades, a need was felt to further consolidate naval cooperation by enhancing the scale and complexity of the MILAN exercise and engaging both regional and extra regional navies of the world.
MILAN-2022 was larger in 'scope and complexity' with a focus on war-gaming at sea, including exercises on surface, sub-surface and air domains, along with weapons firing.
The Indian Navy not only serves as an instrument of power projection, but also for diplomatic outreach. To this end, the conduct of joint multi-lateral exercises represents an important activity bringing together different navies. While navies may operate in different regions, there is always a need to cooperate on issues of common interest such as anti-piracy, maritime security and humanitarian assistance and disaster relief (HADR) missions. Moreover, Navy-to-Navy interactions enhance mutual understanding, cooperation and inter-operability between maritime forces. ■

Modernisation Plans of the Baltic States

Robert Czulda

The threat from Russia, which has existed for a number of years, has forced Lithuania, Latvia and Estonia to increase their defence spending. Now, as a result of the full Russian aggression on Ukraine, military modernisation is even more vital.

These three small Baltic States have no other option than to arm themselves, as they are the most vulnerable NATO member countries. Despite financial challenges, only increased by the COVID pandemic, they have all recently committed not to reduce their defence spending below 2 per cent of GDP. "The spread of the virus has not changed our geopolitical location nor the conventional threats we face, meaning that defence spending, which has only recently begun to rise in Europe, cannot be undermined and must be maintained in absolute terms", explained Estonian Defence Minister Jüri Luik in May 2020. Russia's aggression on Ukraine only makes their commitment stronger.

Lithuania, Latvia and Estonia have each increased their modernisation efforts since 2014, when Russia invaded Ukraine for the first time. Each State has its own problems and vulnerabilities, which affects modernisation priorities. For instance, Estonia – with a defence budget worth €748M this year (2.31 per cent of GDP) – is the most northern, which means that NATO support would be the greatest challenge. Latvia – with a defence budget of €669M (2.27 per cent of GDP) this year – is located between Lithuania and Estonia and has the shortest border with Russia, but is also a neighbour of Kremlin's puppet, Belarus. A major defence issue for Lithuania – whose defence budget this year is worth €1.2Bn (2.05 per cent of GDP and projected at 2.5 per cent by 2030) – is that it is sandwiched between Russia (Kaliningrad Oblast) and Belarus. Moreover, in case of war, Lithuania would be an obvious target since it connects the Baltic States with other NATO members (sharing a land border with Poland).

Author

Dr Robert Czulda specialises in International Affairs and Polish Defence matters and is based in Poland at the prestigious University of Łodz.

Photo: MoD Lithuania

In mid-March 2022, Lithuania's parliament unanimously voted to increase the defence budget by almost €300M to a total of €1.2Bn. €258M will be devoted to arms and ammo acquisition as well as to cyber security.

Photo: MoD Lithuania

Lithuanian elite Iron Wolf Brigade was recently equipped with the BOXER armoured vehicles, locally known as VILKAS

All three Baltic States have relatively modest naval forces, which are mainly responsible for securing territorial waters and exclusive economic zones (EEZ). Fleets are based mostly on used ships, either donated by partner states or procured for a symbolic amount. The longest seashore is in Estonia (1,241 km or 3,800 km if islets are included), while Latvia has less than 500 km and Lithuania just 100 km. Their air forces are

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Photo: MoD Lithuania

In March 2022 Lithuania announced a procurement of additional JAVELIN anti-tank missiles, launchers and other equipment for EUR 36M

also small – none of the Baltic States have any combat aircraft and there are no plans to procure them, both due to financial and operational reasons. Their skies are protected under the NATO Baltic Air Policing mission (with bases in Estonia and Lithuania). The air forces of all three Baltic States are responsible mainly for airspace surveillance, control duties, air support, transportation, and SAR assistance.

Lithuania

The Lithuanian military has a very special role, because during an armed conflict it would have to protect the narrow strip of the so-called Suwalki Gap, which is arguably NATO's most fragile hotspot, connecting the Baltic States with Poland and the rest of NATO territory. In order to defend it efficiently, the Geležinis Vilkas (Iron Wolf) Mechanised Brigade – which is Lithuania's elite unit – was assigned to NATO's Multinational Division North East headquarters. This unit has been closely cooperating with the Polish 15th Mechanised Brigade.

A top priority for the Lithuanian Land Forces is the full integration of the 88 BOXER (8x8) vehicles (codenamed VILKAS), armed with Rafael SAMSON Mk II RCWS, an Orbital ATK MK44 30 mm gun and Rafael SPIKE LR ATGMs. The final batch is due to be delivered this year, which means a one-year delay due to technical defects and the COVID-19 pandemic. This represents the largest procurement contract in Lithuanian history. Vehicles were officially handed over in 2019 and are now being integrated by the Geležinis Vilkas Brigade in Rukla and Alytus. No decisions have yet been made, but Lithuania has been considering a replacement of its tracked M113s earlier than previously planned (in 2030).

In early 2016, Vilnius ordered 340 Daimler AG's Unimog U5000S 5-tonne capacity trucks for EUR 70M. The last batch was handed over in late 2020 with deliveries allowing Lithuania to phase out their older Unimog trucks. The Lithuanian Army's experience with new vehicles was positive enough to make another request – all 42 U5000s from the second batch were delivered in late 2021. They were all procured through the NATO Support and Procurement Agency (NSPA). The U5000s increase the Lithuanian Army's mobility, which use them for various logistical tasks. More procurements are planned in the near future – of the heavier (5-10 tonne) trucks.

Photo: MoD Lithuania

In recent years Lithuania procured three Eurocopter AS365N3+ DAUPHIN helicopters for various tasks, including SAR.

As part of the deep modernisation of its transport fleet, in late 2020, for roughly EUR 10M, Lithuania ordered 25 special purpose AROCS trucks (16-tonnes) for the transportation of PzH 2000 ammunition, containers, vehicles, equipment and other military supplies. Another acquisition underway is for used vehicles of different purposes – Mercedes-Benz all-terrain vehicles, DAF trailers and trucks, trawls, spare trailers, etc. – on a bilateral basis from the Netherlands Armed Forces. Modernisation efforts also include eight Daimler AG's ZETROS 3643 off-road capacity heavy duty trucks, which can transport heavy (up to 70 tonnes) vehicles, such as PZ2000 SPHs, or Bergepanzer-2 armoured recovery vehicles. The 3643s will be deployed to the General Romualdas Giedraitis Artillery Battalion and the Logistics Battalion of the Geležinis Vilkas Brigade.

Another priority of the Lithuanian Army is to enhance the high-mobility capability of its mechanised infantry, which need bigger vehicles than the HMMWV multirole light trucks already in service. In order to achieve this goal, Vilnius decided to procure 200 joint light tactical vehicles (JLTV) for €142M between 2020-2024. The first batch of 50 vehicles was handed over to the Geležinis Vilkas Brigade in Rukla in January 2021. Vehicles will be deployed to the Žemaitija Brigade, which was formed in 2016 in western Lithuania.

Efficient fire support is another key priority. In 2015, Vilnius ordered 21 ex-German PzH 2000 155 mm SPHs. The first batch was handed over in December 2018 and are now used by the General Romualdas Giedraitis Artillery Battalion of the Geležinis Vilkas Brigade. It is important to underscore that 16 operational howitzers were slightly upgraded by Germany's KMW before their transfer to Lithuania (for €10.5M, with the remaining five used for training and spare parts). Vehicles were equipped with more advanced fire control software and an improved battle management system.

This is a major boost for Lithuania, which previously had to rely on towed M101A1 105 mm guns. The PzH 2000s offer more

Photo: MoD Estonia

In late 2020 Estonia presented the K9 THUNDER self-propelled howitzers purchased from South Korea. They will serve for at least 30 years

Photo: MoD Estonia

Estonia heavily invested in various types of shoulder fired missiles, recoilless rifles and anti-tank guided missiles. Purchases include AT4 and JAVELIN systems

Photo: MoD Latvia

In December 2021 Patria was awarded a contract for providing support to Estonia's XA-180 and XA-188 fleet. It is valid for another seven years

mobility, fire precision and much longer range (40 km compared to 11 km of the towed howitzers). More modernisation efforts are planned. In January 2022, it was officially confirmed that Vilnius wants to boost its capabilities with another procurement – this time with a ground-based multiple launch rocket system. The supplier has not yet been announced, but it was revealed that this initiative will be carried out in coordination with Latvia and Estonia – in December 2021, the Baltic States agreed to buy similar systems. Most likely, they will select the High Mobility Artillery Rocket System (HIMARS) from the United States (such a preference was announced by Chief of Defence Lieutenant General Valdemaras Rupsys in 2022). Due to increased tensions with Russia, Vilnius decided to speed up the procurement process – while previously it was expected to purchase the MLRS by 2028, the date is now 2026. The contract is expected to be signed this year.

Air defence is also among Lithuanian modernisation priorities. In June 2020, Vilnius received the NASAMS medium-range system. In total, Vilnius is procuring two NASAMS batteries (four launchers) for its air force. Just like other Baltic States, Lithuania is also enhancing its anti-tank capabilities. In January 2022, Vilnius signed an agreement with Saab for a delivery of the Carl Gustaf M4 (84 mm) recoilless rifles (man-portable and reusable). This deal is worth roughly EUR 14M and will allow Lithuania to phase out the previous generation of the Carl-Gustaf launchers, which has been in service since the 1990s. At the same time, the US State Department gave the green light to a potential sale of the FGM-148F JAVELIN ATGMs. Lithuania has been using JAVELINs since 2001 and recently requested an additional 341 missiles with 30 launchers.

Lithuania has also identified some naval priorities. Apart from a recent acquisition of navigation radars with air target detection and tracking capability for four patrol boats (P11 ŽEMAITIS, P12 DZŪKAS, P14 AUKŠTAITIS and P15 SĖLIS), Vilnius is also procuring a third ex-British HUNT class mine countermeasures vessel (former HMS QURON). There is still one naval programme to be completed: Lithuania wants to acquire a new Safety and Rescue Exercise (SAREX) ship. Four UH-60M aircraft, ordered in 2020 for EUR181M, will replace the currently used and obsolete Russian-made Mi-8 helicopters and bring Lithuania closer to NATO standards.

Estonia

Estonia's modernisation priorities were adopted in the 2031 development plan

national defence, which was approved by the Government in December 2021. It is planned to increase wartime manpower levels from 24,200 to 26,700 soldiers with an additional 4,000 in reserve. Among the technical priorities included are, among others, mobile naval radars with a joint (among Baltic States) radar picture. Territorial defence, anti-tank capabilities (for all infantry brigades) and general situational awareness, and battle command are to be enhanced. Between 2024-2025 Estonia will establish two radar sites. As a result of the Russian aggression against Ukraine, Estonia urgently ordered 5,942 Spanish C90-CR-RB grenade launchers. In January, 500 Spike-SR ATGMs, as a replacement of the Pv-1110 towed 90 mm recoilless guns, were purchased.

The most important modernisation effort of the Estonian Land Forces during a previous budget period was a procurement of 44 CV9035 AIFVs for its reconnaissance (scout) battalions, along with six LEOPARD 1-based support vehicles. Last year, two local companies - Scania Eesti AS and AS Ühenenud Depood – were awarded a contract worth EUR 30M to reconfigure 37 CV90s. They will be adapted for combat engineer and anti-tank roles. Vehicles will have improved night-driving capabilities and increased turret protection. This is the biggest order placed in the Estonian defence industry to date.

Additionally, the 2nd Infantry Brigade is expected to be equipped with new armoured vehicles. Estonia, which has 70 XA-188 and 56 older XA-180 APCs, planned to procure them earlier, but this was postponed until 2025-2030. Thanks to a planned modernisation effort, the XA-188 will remain in service until 2048, and the XA-180 until 2028. Estonia also wants to replace the machine guns and Carl Gustaf anti-tank weapons.

Regarding artillery, Estonia also decided to upgrade its equipment, which is now composed of legacy 155 mm FH-70 towed howitzers (24 supplied by Germany) and 18 ex-German/Finnish D-30 122 mm guns (the latter howitzers Estonia wanted to donate to Ukraine). A total of 18 ex-South Korean K9 THUNDER SPHs will serve for approximately 30 years. The first trials of now operational K9s were carried out by the Estonian Army in early 2021. As explained by Estonian Eesti Rahvusringhääling news agency, "the procurement and acquisition ties in with Ministry of Defence doctrine for the next few years, which will include a focus on developing EDF artillery capabilities, in addition to fully mechanising both the EDF's infantry brigades, and setting up coastal defence systems which will include missile systems and sea mines".

As mentioned earlier, Estonia joined Lithuania and Latvia in a regional effort to procure MRLS artillery. It was explained by Tallinn that "an MLRS system makes it possible to attack high-value targets that are very far away. The system is used in fire and move-type tactical situations to avoid counter-fire. The weapons system can use long-range high-precision munitions". As noted by a Poland-based OSW (Centre for Eastern Studies), "Estonia is moving to the next stage in the development of its armed forces. After a period of investment in the basic systems for the land forces, whose task is to delay enemy forces until allied reinforcements arrive, Estonia wants to develop longer-range capabilities".

On top of Estonia's defence budget, projected through 2026, is a coastal defence system with anti-ship missiles and naval mines. Tallinn plans to carry this out jointly with Latvia. Estonia has already completed identify-

Photo: MoD Latvia

Since 2004 Latvia has been a user of the RBS-70 man-portable air defence system. In 2015 a contract for deliveries of RBS 70 missiles was signed

ing needs and conducted a market survey. It is expected that an Estonian-Latvian system (or only Estonian) will have an operational range of at least 300 km, and could – as explained by head of the Estonian Defence Forces Lt. Gen. Martin Herem – "support combat operations on each other's territories, as well as to influence military capabilities which could prevent the arrival of allies". The project cost is estimated at EUR 46M. So far, in October 2021, Estonia signed a contract with Singaporean-Israeli company Proteus Advanced Systems for the purchase of BLUE SPEAR 5G anti-ship missiles. Regarding mines, they were ordered last year from an unnamed Finnish company. When accomplished, both projects will significantly bolster Estonia's coastal defence.

Latvia

Latvian modernisation efforts are very small, even when compared with other Baltic States. No wonder – its defence budget is the lowest and its military is lightly armed. For 2022, Riga allocated €758M for defence, while 32 per cent of this amount is to be devoted to investments (not only technical modernisation). Already in January, Defence Minister Artis Pabriks underlined a need to spend 2.5 per cent of GDP in the next three years. However, before an increase, Latvia expects a reduction to EUR 748M in 2023 (2.07 per cent of GDP). Modernisation has been carried out within principles set in the National Defence Concept 2020-2024. One of the most important goals is to increase Latvian interoperability with its NATO allies and to encourage greater voluntary participation in the National Guard, which is expected to grow to at least 10,000 troops by 2024. Investment priorities include the following: indirect fire support, air defence, mechanisation, tactical air transportation, command management, combat engineers, special operations units, as well as the support capabilities of the receiving state (HNS).

While Lithuania has already boosted its mechanised infantry with new vehicles, Latvia is still in a middle of the whole process. Previously, Latvia wanted light and medium 4x4 tactical vehicles. A total of 12 companies submitted their proposals and finally the one made by Sisu Auto (with GTP 4x4) was selected. However, in June 2020 Latvia switched its interest to 6x6 armoured vehicles. The project was initially carried out with Estonia and Finland, but last year Tallinn opted out due to mounting costs. Finally, in late October 2021, Riga received the first four 6x6 Patria wheeled APCs. Deliveries are planned to finish in 2029. Latvia, which does not have any infantry fighting vehicles, ordered more than 200 PATRIA for roughly €200M. This is the largest modernisation effort in Latvian history. An interesting plan was announced in February 2022 by Latvia and Estonia, who want to find a partner able to supply both countries with vehicles of 16 different types over the next ten years (both vehicles of a load capacity up to 5 tonnes and above). A declared contract value is EUR 693M.

Latvia does not want to lag behind its Baltic allies in terms of artillery. The Latvian Army is now accepting the M109A5Ö SPHs (modernised A2/A3 variant with 155 mm/39-calibre M185 barrel), which were procured along driver training platforms and a mobile tactical control centre. In total, 47 used vehicles were ordered in Austria, which received them in 1994 from the United Kingdom. They were upgraded between 2003-2007 and kept in storage.

It is reported that Latvia is now looking to boost its small Air Force, composed of An-2 transport aircraft and Mi-17 helicopters, with tactical UAVs both for reconnaissance and even strike roles. No details have been made public, but Riga showed some interest in the Bayraktar TB2 drones from Turkey – an official Latvian delegation visited the Baykar National UAV R&D and Production Centre last year. Regarding confirmed modernisation efforts, Riga ordered four UH-60M BLACK HAWK helicopters for EUR 175M (deliveries are expected this year) and two locally manufactured ultralight PELEGRIN TARRAGON trainer aircraft.

Photo: MoD Latvia

A backbone of Latvian mechanized forces are the SCIMITAR armoured reconnaissance vehicles/light tanks - 123 were procured from the United Kingdom

Future Plans

Although all three Baltic States have their own, unique capabilities and needs, it is possible to identify some similarities. All are interested in future enhancing general mobility, anti-tank capabilities within mechanised infantry, as well as in improving air defence (with MANPADS and short-range systems). An important and symptomatic change among all three Baltic States is an attempt to acquire long-range strike capabilities (artillery), which can serve as a conventional deterrence. When finally procured and introduced, such systems will increase their capability to influence the enemy with indirect fire from a distance.

There is no doubt that Latvia, Lithuania and Estonia will closely analyse Russian doctrine and tactics used against Ukraine. Their conclusions will shape future modernisation efforts, which will then be revised. Some projects will be sped up (light arms, anti-tank systems, air defence, communications), while others will be added (various UAVs, surveillance and reconnaissance). Moreover, military stocks have to be re-supplied as soon as possible, since the Baltic States has assisted Ukraine by supplying arms. Lithuania donated STINGER MANDPADs, some light arms with ammunition, bulletproof vests. Latvia also delivered STINGERs, while Estonia sent JAVELIN ATGMs.

We might also expect more integration, including in terms of interoperability, among the Baltic States and with other NATO partners. Some attempts – for instance joint military procurements – have already been made, but so far, they have proved too successful. A potentially important milestone was reached last year. First, in May, they agreed to tighten their defence cooperation. Then, in December, the Governments in Vilnius, Riga and Tallinn agreed to create a joint Baltic operational area to coordinate defence. ■

Photo: MoD Latvia

Latvia is expected to procure more MANPADS - in early 2022 the Government in Riga supplied STINGER systems to Ukraine.

Team Orlando – Continued Dedication in Simulation and Training

Team of Authors, National Center for Simulation

The growth and diversification of Modelling, Simulation, and Training (MS&T) is a global development, and Team Orlando understands itself as a force multiplier supported by members of the US Department of Defense. The US Navy and Army were the first to collaborate on training programmes through a memorandum of agreement signed by the Secretaries of the Army and Navy. They were later joined by other military services, the University of Central Florida's Institute for Simulation and Training, and the National Center for Simulation to expand the partnership, grow the industry, and broaden the use of simulation and training.

Since the early 1990s, other government organisations and industry became involved to form a government, industry and academia triad, which became known as Team Orlando. Through these and other organisations and associations, the MS&T industry has consistently grown and opened doors for new technologies, applications, ideas, opportunities, and improved training.

Image: Lockheed Martin

The Joint All Domain Operations Staff Trainer covers the full spectrum of multi-domain operations.

Team Orlando Today

The four military service representatives, US Navy, NAWCTSD; US Army, PEO STRI; US Marine Corps, PM TRASYS; and the US Air Force, AFAMS are the core military members, and are joined by a number of other organisations: military, other government, industry, and academia.

The Team Orlando MS&T community is supported by more than 60 years of research and development, a high-tech workforce, billions of dollars in investment annually, and an ecosystem of connected infrastructure and specialised centres of excellence. From its early aviation roots as a training centre for military pilots, and later a community built to win the space race, Orlando's storyline is one that begins and remains as a community that welcomes and embraces simulation innovation.

On an annual basis, over US$11.2Bn in defence procurement is awarded across Florida's simulation industry. The MS&T nexus is located in Central Florida.

From aerospace and defence to education, healthcare, and gaming, Central Florida's simulation technology sector drives innovations that have a global impact.

Two of the Team Orlando's founding members are the University of Central Florida (UCF) through the Institute for Simulation and Training (IST), and the National Center for Simulation (NCS), representatives of academia and industry respectively.

ISTs involvement in MS&T predates the formal naming of Team Orlando and began in 1982. Over the years, UCF has advanced IST's foundation. The university led the US in establishing the first graduate degrees in modelling and simulation, and later created a School of Modelling, Simulation, & Training (SMST). Most recently, the focus of IST and SMST is around digital engineering from the perspectives of research, technologies, and instituting partnerships internally – across all the schools at UCF. Externally they engage with partners in industry, other academic bodies, and government organisations, to expand the use of simulation and begin to realise the full impact of MS&T across various industrial sectors and domains.

Along those same lines, the industry representative, the National Center for Simulation (NCS), has a fundamental and focused objective to extend modelling, simulation, and training-related technologies to new applications. This is carried out principally by leveraging the investments that have been made in defence-related programmes, and pursuing new and emerging commercial opportunities, such as digital media, education, entertainment, manufacturing, medical/health care, photonics, serious games, space, and transportation.

NCS is a member-based association, and its membership extends beyond the traditional defence-related organisations, providing opportunities to cross-pollinate the applications of MS&T into virtually every business and industry sector.

It is located in Orlando, in the middle of the state of Florida, and has become a strong voice of the MS&T industry. A not-

Authors

The Orlando-based, National Center for Simulation (NCS) is a not-for-profit trade association with government, academic and industry members operating as an open consortium.

for-profit trade association with government, academic, and industry members operating as an open consortium, the NCS mission is to lead the growth of the modelling and simulation industry.
Additionally, NCS supports advocacy/outreach for the MS&T community, runs numerous programmes for Science Technology Engineering & Mathematics (STEM) education, and workforce and business development opportunities for its government, industry, and academic partners.

The Business of MS&T

Today, Central Florida is home to a thriving US$6.5Bn MS&T community that was built to accomplish the important MS&T mission that saves time, money, and lives. For over 25 years, NCS has supported our member companies who have developed some of the greatest Training Aids, Devices, Simulators, and Simulations (TADSS). Those training devices have proven their value since the very early years, intended to give soldiers in combat a superior tactical advantage over their adversaries. In fact, our industrial base develops and produces some of the most innovative, advanced, and game-changing technologies to continue to meet the mission of our military at home and abroad, and now in other industry sectors!
Our history is rich. As a technology start-up community, Team Orlando has contributed to ubiquitous training systems globally. Some examples are the Multiple Integrated Laser Engagement System (MILES); the creation of Distributive Interactive Simulation (DIS) that led to blending live-virtual-constructive simulations, and gaming systems that can be seen on exhibition floors across the world.
Other technologies include mobile apps for training, immersive simulation systems, and multi-level Military Operations in Urban Terrain (MOUT) sites around the world. The first wireless medical manikin is another great example. Currently, our industry is developing higher and better virtual, augmented, and XR technologies. The physical, mental, and emotional aspects of training have come to fruition, and various technologies are being tapped to make these high-fidelity training systems. Moreover, Team Orlando players are already working on cyber, artificial intelligence, data mining, data prediction, and one-world terrain.
Our training and simulation technologies offer "six-degree-of-freedom" high fidelity simulators that are networked and linked around the world in live-virtual-constructive gaming that includes augmented reality training exercises that were unimaginable just ten years ago. It continues to evolve as government, academia, and industry invest in science and technology to produce low-cost, head-mounted displays; virtual reality; augmented reality; cyber; artificial intelligence; intelligent tutoring; data mining; data analytics; medical technology; theme park entertainment engagement; gamification; and of course, space to write the next chapter of MS&T.
Central Florida Research Park and the I-4 Corridor are home to some of the nation's most significant defence contractors. NCS plans to continue to be a strong advocate focused on expanding the industry's prominence and growth, helping current businesses expand, and attracting new businesses to be part of the MS&T industry. Team Orlando looks forward to being contacted by new interested parties. ■

Hospital Ship – Made in Germany

Editorial Team, Hansa Online

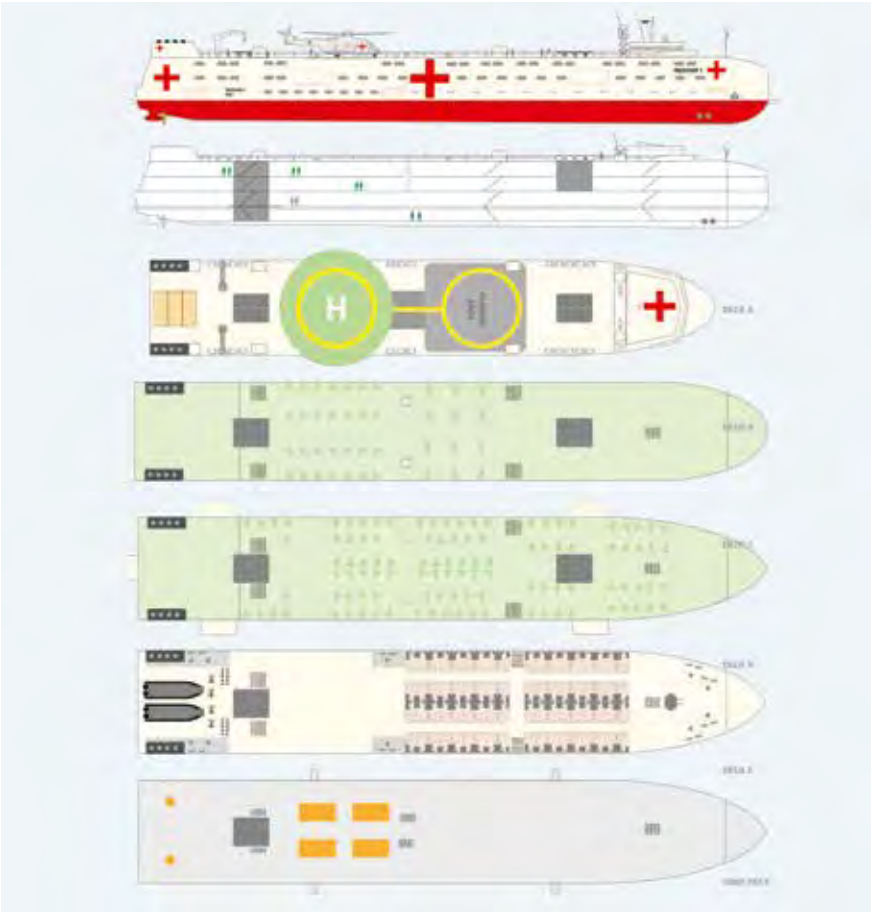
A German private initiative has presented the concept for an efficient MEDISHIP that could be used worldwide in crises, natural disasters and pandemics. A shipyard has already been found, and now the first client is being sought.

Images: Medship

The MEDISHIP is a fully equipped, seagoing hospital ship of 118 m length that can also call at small ports

After the major explosion disaster in Beirut in 2020 with more than 6,500 injured, the question arose: Why are there no hospital ships specifically designed to care for a sudden large number of seriously injured people? The answer is easy: they simply have not thought of it. A private Hamburg-based group of initiators had intensively studied this topic after the events in Lebanon and has now developed a perhaps pioneering design of a hospital ship under the name MEDISHIP.

At present, there are only very few ships of this kind in the world. Apart from the newbuilding GLOBAL MERCY (174 m, 200 beds) based on a Stena ferry design, delivered last year and in service for the organisation "Mercy Ships", most of the other available units are converted former ferries or tankers. Their size and draught often do not allow them to provide effective medical assistance where required. The specially designed MEDISHIP could therefore fill a gap, even in remote areas and under difficult nautical conditions.



The MEDISHIP's suggested deck configuration

The design is an approximately 118 m long ocean-going river ship (4,000 GT) with a steel hull and an aluminium upper deck. With a width of 18.0 m, the draught is only 3.5 m (4.0 m under ballast). It is thus relatively small, can pass under bridges and call at smaller ports, but with its diesel-electric propulsion (4 x 1500 kW) it can sail the oceans just as well at up to 17 knots. The ship can care for up to 150 sick or seriously injured people on board.

On two modular decks, state-of-the-art medical equipment could be made available, including a high-performance operating theatre (12 beds), a shock room (28 beds), a bed deck (100-150 patients), sterilisation rooms, radiology, pharmacy, clinical chemistry laboratories, dentistry, storage rooms and also a refrigerated mortuary including crematorium. A third deck accommodates the crew (30) and medical staff (46). On the upper deck are a helicopter landing pad, cranes, two landing craft, all-terrain quads and a drone platform.

In peacetime, the ship can be deployed off countries with shortages of medical supplies. In the event of natural disasters (tsunamis, earthquakes), pandemics or accidents like the one in Beirut, the ship can be deployed very quickly to crisis areas. The initiators have already found a German shipyard, FSG, that is willing to take on the technical design work and build the ship. A Hamburg shipping company would take over the technical management.

Now they are looking for interested parties for this concept. One addressee is the Federal Government in Berlin.

For more information, please email the Hansa team at redaktion@hansa-online.de

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