

# European Security & Defence

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*International Security and Defence Journal*



## DIRCM - Countering IR Missiles

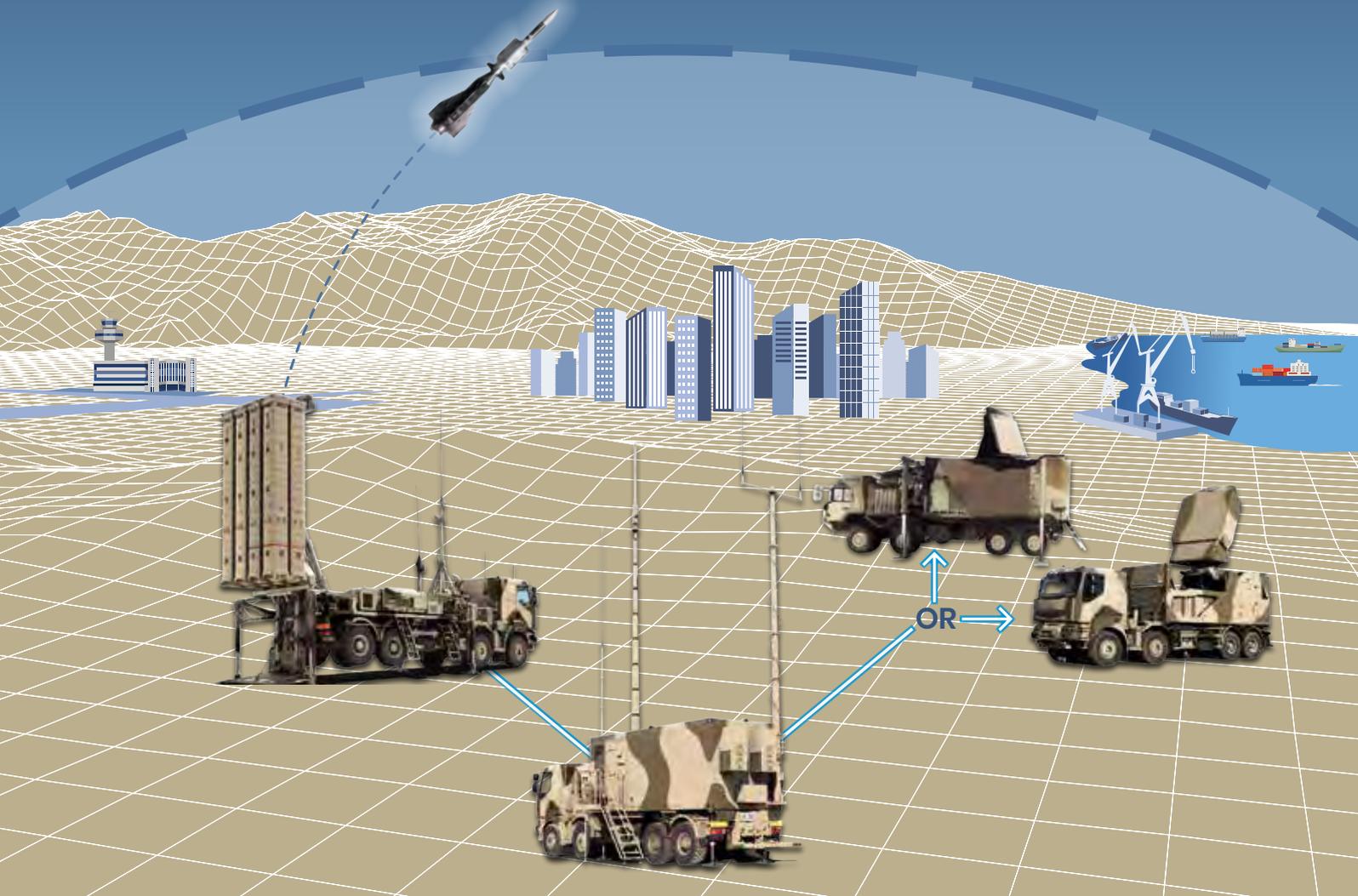
- US Army Howitzer Competition
- NATO Pods – New Airborne Capabilities
- International Corvette and Frigate Programmes
- Military Missions at the Edge of Space
- Small Arms Sights
- Military Bridging and Gap-Crossing

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With this issue of European Security & Defence (ESD), the last one in 2021, I would like to thank all of our readers and advertisers for their continued trust and confidence in our work. My thanks also go to all colleagues, associates and authors who have contributed their valuable share to the excellent results achieved by the magazine in 2021.

Even in times of the COVID-19 pandemic, ESD has reached an unprecedented number of readers compared to the entire period since 2015 when the magazine was launched in its current format.

The overall result clearly shows that an independent trade journal like ESD is of vital importance to provide a print and online platform for the exchange of information among and between all players in the global defence arena. For next year and the years to come, we will continue in our efforts to consolidate and increase the magazine's global distribution and readership, as well as meet the high quality standards that we have set for ourselves and that our readers expect from us regarding the magazine and its website's content.

You may also expect further growth in the 'Tamm Media family' including continued efforts to firmly establish ESD's naval sister magazine under a new name as an internationally recognised trade journal, both print and online. I wish everybody a relaxing holiday season and the best possible success for the years to come.

Sincerely Yours,

A handwritten signature in blue ink that reads "Peter Tamm".

**Peter Tamm**  
**Owner, President & CEO**  
**Tamm Media**



Photo: Rama / CC 2.0

While gasoline and kerosene have been the main fuels for aircraft for decades, contemporary concepts favour hybrid and all-electric power units.

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Image: Rheinmetall

The agility of a tank is its ability to speed up, turn, jink, and stop. To move heavier MBTs, powerful engines that generate tremendous horsepower are required.

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## ■ Naval Vessels Lürssen Launched

(lh) Bremen-based Lürssen shipyard group is operating its naval shipbuilding activities under the new brand Naval Vessels Lürssen (NVL) with immediate effect. As independent companies, all defence locations, and thus all shipbuilding capabilities of the Defence division, will be united in the new NVL Group, Lürssen announced at the end of September.

As the future umbrella company of the NVL Group, the independent company NVL was spun off from Fr. Lürssen Werft GmbH & Co. KG. According to the information provided, the NVL Group is now responsible for the entire newbuilding spectrum as well as all repair activities of naval and coast guard vessels. New construction and refits of yachts will continue unchanged under the Lürssen brand with Fr. Lürssen Werft as the holding company.

“With the Yacht and Defence divisions, we serve very different and increasingly het-

Photo: Lürssen/Neue Jadewerft



erogeneous markets and target groups. In addition, the complexity in both civil and military shipbuilding is growing,” explains Friedrich Lürßen, shareholder of the Lürssen Group. The management and owners decided on the separation of the two divisions in order to optimally exploit the competencies as a shipbuilder and the infrastructure at the shipyard locations, Lürßen states.

According to his cousin and co-partner Peter Lürßen, the split into two divisions is intended to strengthen national and international competitiveness and position the group of companies for the challenges of the future. The umbrella company of the NVL Group, based in Bremen-Vegesack, is managed jointly by Klaus Borgschulze and Tim Wagner as spokespersons alongside Dirk Malgowski and Lena Ströbele as managing directors. The NVL Group includes the newbuilding sites at Peene-Werft in Wolgast and Blohm+Voss in Hamburg, the service activities of Lürssen Logistics, the two repair yards Neue Jadewerft in Wilhelmshaven and Norderwerft in Hamburg as well as sites in Australia, Bulgaria and Brunei.

“All current projects for the German Navy and for our international customers will continue unchanged under the new umbrella brand,” explains Tim Wagner. “As a privately managed shipyard group, we are and will

remain independent and thus very flexible.” Under the Lürssen brand, the entire newbuilding portfolio of the Yacht division will be continued unchanged by the Bremen-based Fr. Lürssen Werft together with the Lürssen-Kröger Werft in Schacht-Audorf. Likewise, all activities in the field of yacht refits and services at the Bremen and Hamburg locations will be managed from the Yacht division. Fr. Lürssen Werft as the umbrella company of the yacht division is managed by Peter Lürßen as Chairman, Justus Reinke, Lena Ströbele, Sebastian Rheineck and York Ilgner. According to the press release, both divisions with all their associated companies will remain part of the Lürssen Group, which will continue to be family-run. On the other hand, Lürssen apparently intends to withdraw from the unprofitable business of ship maintenance and repair at its Blohm + Voss shipyard in Hamburg, which it acquired a few years ago. According to media reports, Peter Lürßen intends to discontinue this business. At the same time, the number of employees is to be reduced. There is speculation in the media that this could affect up to a fifth of the approximately 600 jobs at Blohm + Voss.

## ■ Daimler to be Divided

(gwh) Daimler AG announced the split-up of the company in two independent business units, effective from 01 October 2021. Mercedes-Benz AG will be in charge for the development, production and distribution of passenger cars and vans, while Daimler Truck AG will concentrate on the lorry business. Daimler Mobility AG will be merged into the other two companies. Chairman of the Board of Management of the higher-revenue Mercedes-Benz AG will be Ola Källenius. Daimler Truck AG will continue to be led by Martin Daum.

Since 2019, three subsidiaries had operated under the umbrella of Daimler AG: Mercedes-Benz AG, Daimler Truck AG and Daimler Mobility AG for financing and mobility solutions. There were numerous interdependencies and joint activities between the three subsidiaries, e.g. in sales, research and human resources. Daimler Trucks will continue to include Mercedes-Benz Special Trucks (MBS), which is responsible for manufacturing the UNIMOG, ZETROS and ECONIC trucks, configuring them according to customer requirements and selling them. This also includes the variants that

Picture: Daimler



are equipped according to military requirements and are grouped under Mercedes-Benz Military Vehicles. Whether and how the military versions of the G-Class can be assigned here has not yet been conclusively clarified.

The division of the group into two independent companies is intended to increase customer proximity and efficiency. The customer base for Mercedes-Benz is primarily made up of private customers, while Daimler Trucks is primarily geared towards customers from companies, organisations and authorities. At present, joint undertakings and property (documents, real estate and e.g. the Mercedes-Benz Museum) are being split up and assigned to the new owners.

For customers, changes result from the fact that the sales organisations are being reorganised and in some cases rebuilt. Contracts have to be concluded for contacts between the companies, as between two completely foreign companies. (Informal) agreements are also no longer permissible for antitrust reasons.

Mercedes-Benz AG and Daimler AG are to be listed in the DAX 40 on 01 December 2021.

## ■ Anne Quillon Appointed Procurement Director at Naval Group

Photo: Naval Group



(jh) Naval Group has announced the appointment of Anne Quillon as Director of Procurement, Sourcing and Supplier Management within the Operations and Performance De-

partment of company. She will manage all of Naval Group’s resources in the area of purchasing and will define the group’s “responsible purchasing” policy and manage its performance. She will also support the group’s subsidiaries.

Anne Quillon is 45 years old and joined Naval Group on 8 October 2021. She holds a degree in political science and a master’s degree in purchasing and supply chain management. She began her career as a consultant in sourcing and supply chain and then held several purchasing and supply chain positions at Safran, which she joined in 2002 and left in 2010. Anne Quillon then joined Alstom Power as France Sourcing Director before she was appointed Sourcing and Procurement Director for the Europe, Middle East and Africa region until 2015. She then became Head of Global Sourcing at GE Renewable Energy.

## ■ Nexter & STV Sign Ammunition Agreement

(jh) Nexter Group has signed an agreement with Czech manufacturer STV Group for the local supply and certification of shells and modular charges.



Photo: Nexter

Nexter undertakes to support the certification of artillery ammunition manufactured locally by STV Group for use on the CAESAR artillery system. The agreement also provides for the acquisition from Nexter of specific 155mm ammunition such as flare (LU 215), smoke (LU 217) and anti-tank (BONUS) rounds.

## ■ New CH-53K Series Production Facility

(gwh) Sikorsky has announced the delivery of the first CH-53K to the US Marine Corps (USMC) from its newly built series production facility.

The hallmark of the modernised plant is said to be its comprehensive digitisation. From the first design to the last screw, all processes, the corresponding documentation and the technical procedures are bundled in a digital system, the "digital thread", the company writes. This supports manufacturing according to the corresponding quality and safety standards, as well as to precisely monitor the installation of the individual components.

At the production plant, CH-53K series production takes place at six stations. 36 helicopters are currently in various preliminary stages of series production. Lockheed Martin pointed out that all critical components are manufactured or finally assembled at the plant. The T408 engines, which are the result of a direct collaboration between engine manufacturer General Electric (GE) and MTU Aero Engines of Germany, are also assembled at the facility. The entire facility offers potential to expand



Photo: Lockheed Martin

the production rate if needed. Plans for production extend well beyond 2032.

According to the company, the CH-53K is currently undergoing the final stages of operational testing with the USMC. Crews and technicians from the force are now operating the aircraft completely autonomously with the objective to complete the flight programme for the transfer of the aircraft into operational service.

The USMC is procuring a total of 200 transport helicopters at a unit cost of about €105M. Israel decided earlier this year to procure 18 CH-53Ks. In the – currently interrupted – competition for the heavy transport helicopter of the German Armed Forces, the CH-53K is one of the two competitors. The demand in Germany is for approximately 50 aircraft.

## ■ Thales & Weibel Sign Cooperation Agreement

(jh) Thales and Weibel Scientific have signed a cooperation agreement with the objective to create shared international export opportunities, according to a press release from Weibel. The agreement covers the integration of Weibel's short-range ground mission radars with the Thales radar portfolio to address Ground Based Air Defence (GBAD) or C-UAV missions. The agreement was signed at the Danish Embassy in Paris during the Danish Industrial Days in the presence of the French Minister of Armed Forces, Florence Parly, and Danish Minister of Defence Trine Bramsen.



Photo: Weibel

The agreement is expected to leverage Thales' international radar position. In particular, Thales will offer a common solution for the Danish Army's Ground Based Air Defence incorporating the Weibel XENTA-M5 radar integrated with the Thales GBAD solution.

## ■ Calian Acquires SimFront

(jh) Calian Group Ltd. has announced the acquisition of Canadian-based SimFront, effective immediately, in an agreement valued at up to CDN\$15M. Calian and SimFront have a 15-year collaborative relationship with the

Canadian Department of National Defence. During this period, the SimFront Virtual Command and Control Interface (VCCI) tool suite has served in support of simulation-to-Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR) integration/interoperability and After-Action Review (AAR). The VCCI tool suite, combined with Calian MaestroEDET<sup>™</sup>, will now enable Calian to provide end-to-end military training and simulation capabilities and pursue new opportunities with customers seeking integration and immersive training support.



Image: Calian

SimFront integration and augmented/virtual/mixed reality solutions elevate Calian capabilities in this area. SimFront customers include the Canadian Navy and Army, the UK Ministry of Defence and customers in the Asia Pacific region. Their simulation-to-C4ISR integration expertise and solutions support, and strengthen, decision-making, performance and readiness of tactical commanders and staff in operational environments.

In addition, SimFront is also involved in immersive training simulations for the healthcare and oil & gas industries having been developing simulation software since 2013. These simulations are expected to improve employee safety and performance against identified tasks.

## ■ Milrem Robotics Launches Cooperation with Lumina

(jh) Milrem Robotics has announced a cooperation agreement with Lumina Technology Partners (Lumina) in Canada. Under the agreement, Lumina will offer the full portfolio of Milrem Robotics products, including the THeMIS and MULTISCOPE UGVs to both public-sector and commercial customers, taking advantage of the available payloads to address a variety of applications including firefighting, transport and logistics, emergency response and monitoring.



Photo: Milrem Robotics

**Rheinmetall Submits BAFO to Australia**

(jh) Rheinmetall has submitted the company's LYNX Infantry Fighting Vehicle (IFV) Best And Final Offer (BAFO) for the Australian Department of Defence LAND 400 Phase 3 Mounted Close Combat Capability tender. Rheinmetall is one of two contenders for this procurement project, the other being Hanwha Defense Australia, offering the REDBACK IFV.



Photo: euro-sd.com

Rheinmetall Defence Australia Managing Director, Gary Stewart said the LYNX is a next generation tracked, digitised and highly protected IFV offering a step-change in Army's capabilities. The company has developed the LYNX with a growth path to meet continually evolving military needs throughout its anticipated 40 year life, the company writes. Submitting the BAFO represents the final deliverable of the two year Risk Management Activity (RMA) undertaken by the Department of Defence.

**KATALYST – New Electronic Architecture for Combat Vehicles**

(gwh) At the AUSA Annual Meeting, General Dynamics Landsystems (GDLS) unveiled its Next Generation Electronic Architecture (NGEA) designated KATALYST. The NGEA was presented integrated with a heavy unmanned combat vehicle serving as a demonstrator.



Image: GDLS

The increasing number of electronic and electrical devices for reconnaissance, communication, fire control, weapon systems and electronic warfare is constantly placing new and higher demands on the management of data and energy flows in combat vehicles. NATO has set a standard for this

with the NATO Generic Vehicle Architecture (NGVA). The KATALYST Next Generation Electronic Architecture is based on the same Modular Open Systems Approach (MOSA) and is designed to meet NATO standards, GDLS said, pointing out that the KATALYST architecture offers scalable and modular hardware and software for next generation capabilities on all future platforms and can serve as a basis for continuous modernisation to optimise performance, size, weight, power and cost (SWaP-C).

GDLS explained the concept of KATALYST by analogy with a mobile phone. KATALYST provides the electronic components and the operating system on the basis of which new applications for future capabilities can be implemented at any time with almost unlimited capacity. The hardware includes sensors, computer processors, standard I/O interfaces, Ethernet and CAN bus data exchange, and crew display. KATALYST is also capable of integrating other vehicle subsystems, such as active protection or defence from UAS, according to the company.

For the AUSA Annual Meeting, GDLS had presented a technology demonstrator with KATALYST architecture showing capability gains in all categories. The company stressed that mobility (obstacle avoidance, path planning), lethality (object detection, object identification/recognition, automatic target prioritisation) and survivability/reconnaissance (360-degree situational awareness, see-through armour, terrain analysis) were significantly improved.

KATALYST was developed with the OMFV programme in mind, with which the US Army intends to replace the BRADLEY infantry fighting vehicle. General Dynamics Land Systems has been selected for Phase II of the OMFV programme and is working with the US Army to develop the overall system requirements. In the next phase of the programme, from 2022, the company plans to build a prototype for the OMFV programme. Elements of the KATALYST NGEA are already integrated with several US Army and US Marine Corps prototype vehicles, GDLS said.

**Product 305E – New Russian Airborne Missile**

(yl) Recently procured Mil and Kamov combat helicopters are to be equipped with the new 305E multipurpose missile developed by the Kolomna-based KBM Design Bureau. The missile has been earmarked positioned as a main armament element for the Mi-28NM and Ka-52M aircraft. During the ARMY-2021 exhibition, the Russian MoD signed a contract with the Russian Helicopters (RH) holding for the delivery of 30



Photo: Laguk

modernised Ka-52M helicopters between 2022 and 2023. Simultaneously, Rostvertol was awarded a contract for 98 Mi-28NM helicopters by 2027.

The missile was advertised as combat proven and approved for export, which explains the letter «E» in the designation. It is designed according to the aerodynamic "duck" scheme, the rudders are located at the warhead, and the foldable wings at the tail part of the body.

According to data published by the manufacturer, the 305E missile has a weight of 105 kg, a length of 1945 mm, and a body diameter of 200 mm. The weight of the blast-fragmentation warhead is 25 kg. The solid-propellant engine provides a top speed of 250 m/s, the flight range is said to be in excess of 14,500 m. During flight, the missile operates at altitudes between 100 and 600 m. According to the company, the modular configuration allows for the use of different warheads.

For guidance, inertial guidance is combined with satellite navigation autonomous guidance controlled by the seeker with the option to involve a man-in-the-loop for the terminal phase of the trajectory. The missile is fired from the APU-305 launchers, designed for one or two missiles.

**MANTIS Weapon Station Wins GOLDEN IDET 2021**

(jh) Czech electro-optical systems developer EVPU Defence a.s. has announced that the company was awarded the GOLDEN IDET 2021 for the MANTIS RCWS, its new remote controlled weapon station for up to 12.7 mm calibre machine guns. The GOLDEN IDET is awarded by BVV Trade Fairs Brno, the organiser of the bi-annual IDET defence exhibition in Brno, Czech Republic, for the best



Photo: EVPU

exhibits presented at the trade fair. Competition categories cover military and security equipment, military and security communication and information technologies, military and security logistics and services, and training and preparation of military and police professionals.

MANTIS is a compact RCWS designed for machine guns up to 12.7 mm calibre. It is primarily intended for installation on armoured vehicles but, according to the company, its light weight and robust stabilisation allow installation on a variety of platforms including naval vessels. MANTIS enables 24/7 target detection, high precision firing and perimeter protection through the use of its electro-optical container with a full HD day camera, HD thermal imager, laser rangefinder and an optional aiming camera, the company says emphasising the system's stabilised design with four (2+2) axes in azimuth and elevation as the probably most significant element of innovation.

### ■ New Member of the LYNX Vehicle Family

(gwh) At Rheinmetall's Australian Military Vehicle Centre of Excellence (MILVEHCOE), the company has unveiled a new variant of the LYNX KF41 tracked vehicle. The LYNX Combat Support Vehicle (CSV) has been developed in Australia with the support of more than 100 industry partners.

The LYNX CSV is based on the LYNX IFV infantry fighting vehicle. The modular design of the basic vehicle was exploited to allow for the integration of components from a wide range of suppliers, as well as reconfiguration of the vehicle hull.

The CSV has been designed for combat vehicle recovery and repair tasks as well as mobility and logistics support. A five-tonne crane is mounted on the rear cover, which can be used for the recovery of vehicles or to move heavy loads. An aux-



Image: Rheinmetall

iliary tank enables the supply of fuel to external consumers (field filling station). A clearing blade is mounted on the front that can be equipped with ripper teeth. For self-defence, the vehicle features a remote-controlled weapon station for machine guns up to 12.5 mm and a 40 mm grenade machine launcher.

With the LYNX IFV, Rheinmetall is a contender in the Australian LAND 400 Phase 3 programme. A procurement decision for some 450 IFVs is expected in 2022. The Australian Army aims to achieve Initial Operating Capability (IOC) in 2024/25 and Full Operating Capability (FOC) by 2030/31.

### ■ Plasan Unveils ATeMM

(jh) At this year's AUSA Annual Meeting in Washington DC, Plasan unveiled the All-Terrain electric Mission Module (ATeMM) as



Photo: Plasan

a modular electric vehicle that can link to a legacy 4x4, providing 2,500 lbs of additional payload. Alternatively, two ATeMMs can be coupled forming a standalone 4x4 electric vehicle with 5,000lbs of mission payload capacity powered by a 74kWh battery pack

and operated via remote control. Besides, the ATeMM-T is ready for autonomous control integration, the company says.

### ■ Telerob to Supply Latvia with UGVs

(gwh) Telerob, which recently became a wholly owned subsidiary of AeroVironment, has been contracted by the Latvian Ministry of Defence to supply TELEMATX EVO HYBRID and tEODo EVO UGVs as well as technical support for the Latvian Armed Forces, AeroVironment announced at the end of September 2021. The multi-million euro order was placed in July 2021, and the agreed deliveries are to be completed this year.



Image: Telerob

AeroVironment describes the key features of the two UGVs as follows. The tEODo EVO is purpose-built for explosive ordnance disposal and disarming improvised explosive devices. The UGV features a 6-axis manipulator with telescopic reach, is heavy-lift capable (220 pounds/100 kilograms) and can precisely handle hazardous materials with a 12-inch (300 millimeter) gripper that features an integrated laser rangefinder, video input and data interface.

TELEMATX EVO HYBRID is a versatile UGV featuring compact dimensions and a strong lift capacity up to 82 pounds (37 kgs). It comes with a six axis precision manipulator with Tool Center Point Control to give operators humanlike control and a four track drive system with auto-levelling to easily handle multiple gradients, gaps and terrains.

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**Safran Maritime PATROLLER in OCEAN2020**

(jh) The maritime patrol version of Safran's PATROLLER drone has shown its ability to meet the maritime surveillance needs of navies or European maritime surveillance agencies as part of the European project OCEAN2020, Safran writes in a press release.



Image: Safran

The project is funded by the European Commission within the scope of the European Defence Agency's preparatory defence research action contract. The project entailed naval exercises in the Baltic Sea at the end of August, bringing together 18 partners, including five navies, for the final OCEAN2020 demonstration. It was designed to show that the combined use of drones operating in different maritime environments (air, surface, underwater) would give command centres a better grasp of the tactical situation. The PATROLLER drone showed its interoperability during the demonstration, including the real-time transmission of data from its sensors (radar tactical situation, multispectral videos) to the tactical operations centre (at a Swedish army test centre in Ravlunda) and to the Maritime Operations Control Centre (MOC) at the European Defence Agency premises.

**New Variants of the Infantry Squad Vehicle**

(gwh) At the AUSA Annual Meeting in Washington D-C., General Motors Defense (GMD) presented new variants of the Infantry Squad Vehicle (ISV). According to GMD, the ideas are based on experience gained during testing of the ISV, as well as feedback from the troops. The ISV 5 Heavy Weapon Gun Carrier has been equipped with a heavy machine gun (12.7 mm) on a ring mount. In addition, the crew can use light machine guns via pintle



Photo: GMD

mounts on both sides. The vehicle is suitable for fire support, e.g. of airborne troops. Four of the nine seats are assigned as operator station and ammunition storage. The ISV 5 has not yet been ordered by the US Army, Steve duMont, President of GM Defence, said at the presentation of the vehicle.

An all-electric version of the ISV was also presented at the event. In this vehicle, GM's eCrate electric powertrain replaces the internal combustion engine. The electric motor under the bonnet has an output of 149 kW and is powered by a 60 kWh battery, providing a range of between 110 and 240 km, according to the company. The drive is on the rear axle. Reportedly, all-wheel drive is also possible. Armament consists of a remote-controlled R150 weapon station from EOS, which weighs less than 80 kg and can be equipped with machine guns up to 12.7 mm. The electric drive enables almost silent driving and observation (silent watch). The all-electric version also loses four seats to make room for the battery under a load floor.

In 2020, GMD was contracted by the US Army Contracting Command to deliver 649 ISVs by 2024 for US\$214 million (about €185 million). To date, 70 vehicles have been delivered. The production rate is eight ISVs per month. The US Army has a total requirement of 2,065 ISV, to be covered in the next ten years.

The ISV is based on a Chevrolet COLORADO ZR2 and is powered by a 136 kW diesel engine. The curb weight amounts to 2.3 tonnes offering a payload capacity of 1.5 tonne. The nine-person crew is accommodated in four rows of seats with a view to all directions. The vehicle can be airlifted by helicopters such as the UH-60 BLACKHAWK and in the CH-47 CHINOOK.

**Palm-Sized BNET NANO to Debut**

(gwh) Israeli manufacturer Rafael has announced the addition of the ultra-small BNET Nano handheld radio to the BNET family. The new palm-sized radio has the technological features of the wider family, including scalability, multi-channel reception and spectrum superiority, Rafael writes. The BNET family features include multi-channel reception technology, high network capacity in terms of data rates and number of network subscribers in addition to minimal delays. The company describes BNET as a lightweight radio unit that enables point-to-point and point-to-multipoint topology as well as ad-hoc mesh network, with SDR Full IP design



Picture: Rafael

that supports connectivity of the entire brigade deployment area. BNET Nano works in areas where GPS is not available, an increasingly typical scenario on today's battlefield.

Rafael plans to unveil the new handheld radio to the trade public at the upcoming SIT-DEF (Peru), Expodefensa (Colombia), FEIN-DEF (Spain) and ADEX (Korea) exhibitions.

**NCI Agency to Procure Education & Training Services**

(jh) According to a press release, the NATO Communications and Information Agency (NCI Agency) plans to release a formal Invitation for Bids (IFB) to procure commercially available education and training services for NATO. The NCI Agency may award multiple contracts, based on nine training lots specifically set up in the IFB, which will be released in the coming



Logo: NCI Agency

weeks. The awards could be worth up to an estimated €10M in total depending on the services offered. The agreements will include a base period of three years, followed by two optional years.

These services will be managed by the Agency's NCI Academy, which delivers C4ISR and cyber training for NATO systems and services. Operators trained in the Academy will go on to operate and maintain NATO's information technology and communications systems, as well as its ballistic missile and cyber defence.

The NCI Academy is particularly interested in acquiring commercial-off-the-shelf training and consultancy services to meet growing requirements for skills and knowledge. The commercial training services covered under this IFB include:

- Instructor-led training complemented by virtual training delivery capabilities
- Official examination and certification
- Online training subscriptions and
- Training consultancy services

This contract is supposed to help the NCI Agency ensure NATO remains up-to-date with the latest commercial education and training solutions. Working with industry, the NCI Academy will support NATO in attracting and maintaining a tech-savvy professional workforce that is prepared for the future. The Agency plans to award a contract by the end of 2021.

### ■ Naval Group Awarded Design Contract for French OPV

(jh) The French Defence Procurement Agency (DGA) has awarded Naval Group the contract for the preliminary and detailed design of the ocean patrol vessel programme, the company has informed in a press release.

This award follows on from the signature of the framework agreement on 23 October 2020 for the study, development, production and initial operational maintenance of ten ocean patrol vessels for the French Navy.

A first contract had been awarded to Naval Group by DGA for the design and value analysis on 23 June 2021. The contract for a ship construction monitoring service is expected later.



Photo: Naval Group

The ocean patrol vessels programme aims at the renewal of the six high seas patrol vessels (ex-AVISOS A69) based in Brest and Toulon, and the public service patrol vessels based in Cherbourg. The mission spectrum of the new units will include support to deterrence, autonomous situation assessment in areas of sovereignty or interest, escort, evacuation of nationals, and protection of national interests in the maritime approaches.

This programme is part of an industrial scheme involving collaboration between civil and military entities. Naval Group, as overall project architect, is in charge of the design of these ships. DGA will entrust the construction to all or part of the

production shipyards that were awarded the framework agreement for deliveries between 2025 and 2029.

### ■ GA-ASI Completes Maritime Demonstrations in Europe

(jh) General Atomics Aeronautical Systems Inc. has reported the completion of a series of flight demonstrations that featured a company-owned MQ-9B SeaGuardian® Remotely Piloted Aircraft (RPA) in partnership with the Royal Air Force (RAF). The demonstration series began on 25 August and ended with the completion of the UK's Exercise JOINT WARRIOR on 30 September 2021.



Photo: GA-ASI

The objective of the flights was to showcase the operational capabilities of the MQ-9B, including the platform's maritime Intelligence, Surveillance and Reconnaissance, Detect and Avoid System, endurance and interoperability with NATO partners. During JOINT WARRIOR, a demonstration of Manned-Unmanned Teaming took place using the SeaGuardian and an RAF P-8. This demonstrated the RPA's ability to complement and support Anti-Submarine Warfare tasking, which included tracking, monitoring and reporting of sonobuoys.

The demonstrations were initially based out of RAF Waddington before moving to RAF Lossiemouth to support Joint Warrior. While based at RAF Waddington, one flight saw SeaGuardian fly to Leeuwarden Air Base, taking the RPA into Netherlands airspace, while testing airspace operational procedures. This demonstration, which

took place on 1 and 2 September, displayed SeaGuardian's maritime surveillance capabilities in support of international allies, the company writes. The Royal Netherlands Air Force has ordered four MQ-9A RPA and the first is expected to be delivered to Leeuwarden later this year. SeaGuardian returned to RAF Waddington at the conclusion of the event.

Next came the UK's first Civil Aviation Authority approved point-to-point domestic flight of a UAV using the UK's airways structure, when SeaGuardian flew from Lincolnshire, England to Moray, Scotland on 12 September. The flight was controlled by NATS, the UK's civilian Air Navigation Service Provider. A large set of airworthiness artifacts have been reviewed by the UK Civil Airworthiness Authority, who have approved MQ-9B for operations in unsegregated, uncontrolled airspace for the first time based on the suite of airspace deconfliction technologies and extensive documentation provided in the safety case.

SeaGuardian is the maritime version of the MQ-9B SkyGuardian®. As the launch customer, RAF has ordered 16 aircraft in their configuration, which they have named the PROTECTOR RG Mk1 RPA systems. The PROTECTOR is a derivative of the SkyGuardian, featuring an array of customer modifications.



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 **EVPÜ DEFENCE**

**G3 Systems Delivers Modular Hospital to Belgium**

(jh) G3 Systems Limited, in partnership with French shelter manufacturer Utilis S.A.S, has reported the completion of a contract to supply the Belgium Ministry of Defence with a modular, deployable field hospital and its associated medical equipment.

The initial procurement, valued at some US\$13.2M, provides a Role 2 Enhanced Field Hospital, comprising some 54 tents, a medical incinerator and medical equipment ranging from stethoscopes to x-ray machines and a telemedicine system. An additional 19 tents were procured to form the basis for a Role 2 Basic Hospital.

G3 Systems has provided the medical equipment and incinerator while Utilis manufactured the tents and provided the supporting infrastructure. Production commenced in June 2020 with delivery to the customer completed in March 2021. All hospital infrastructure and medical equipment was consolidated and packaged at Utilis' facility at Ennery, near Metz. The technical documentation and a training package was compiled by G3 Systems and provided to the Belgian Armed Forces as the end user.

Photo: G3 Systems



Following the completion of the initial equipment procurement phase, a ten-year support service has now commenced. G3 Systems will deploy a team of Field Service Engineers to provide maintenance support for the Belgian MoD on training and operational deployments, coupled with routine maintenance, spares provisioning and options for further equipment procurement. The anticipated additional value to G3 Systems is US\$4M, while operational and training deployments may also see this increase.

**M3 Bridge System for Latvia**

(jh) General Dynamics European Land Systems (GDELS) has announced a contract to provide the M3 amphibious bridge and ferry system to Latvia. The contract was awarded to GDELS by the US Army Contracting Command, Detroit Arsenal, which is managing the support to Latvia as it addresses needs

for additional NATO wet-gap crossing solutions. Deliveries will also include an integrated logistics support package consisting of training, tools and manuals.

Latvia will become the latest country to use the M3 bridge system, following South Korea, Indonesia, Singapore, Taiwan, the UK and Germany.

Image: GDELS



The M3 bridge system is used in different roles, from combat operations to civil defence. It can carry all NATO vehicles and can build a 100m (330 ft) floating bridge in less than ten minutes, the company writes. The vehicles will also be equipped with 'Arctic Kits' that will allow to operate them in very cold climate conditions.

**Estonia Procures Ammunition**

(gwh) The Estonian State Centre for Defence Investment (Riigi Kaitseinvesteeringute Keskus, RKIK) has announced its intention to procure ammunition from suppliers in Europe and Israel in the scope of framework contracts amounting to almost €80M. According to the RKIK, the supply of medium- and large-calibre ammunition (over 23 mm) worth €30M has been agreed with eight framework contract partners. For the supply of small calibre ammunition (below 23 mm), framework agreements worth €50M have been awarded to 10 contractors.

The framework contracts are concluded for terms of four years and can optionally be extended to eight.

In an announcement on the European procurement platform TED, the RKIK has published the names of the contractors for large-calibre ammunition, including:

- Arsenal JSC & VIPFISH (Estonia)
- BAE Systems GCSM (UK)
- Elbit Systems Land (Israel)
- EXPAL Systems (Spain)
- Hirtenberger Defence Europe (Austria)
- Nammo Lapua (Finland)
- NEXTER Munitions (France)
- Rheinmetall Waffe Munition (Germany)

**ZIRCON Missile Launched from Russian Submarine**

(yl) The Russian Navy has continued ZIRCON hypersonic missile testing with a launch from the nuclear submarine SEVERODVINSK to accompany previous firing from surface combatants.

The MoD's official statement quoted by the national information agencies claimed that the missile flight had met the expected characteristics to hit a simulating target. The military assessed the firing "as successful", according to the same source. A video released by the MoD shows that the launch was carried out at night with the submarine surfaced. Prior to this, the military had reported a number of successful ZIRCON test launches from the frigate ADMIRAL GORSHKOV (Project 22350) in July this year. Other tests were carried out in December, November and October 2020.

Photo: Malachite Design Bureau



SEVERODVINSK is a fourth-generation multi-role nuclear submarine of the YAS-EN 08850 class which entered service in 2014. The submarine is said to be capable of fighting against all types of surface and underwater threats. Retired Admiral Viktor Kravchenko, former Chief of the Russian Navy's main headquarters, said of the new tests: "This is a serious event for the Russian Navy. The speed characteristics of the missile are beyond question. Nobody can protect oneself against ZIRCON."

The start of serial deliveries of ZIRCON missiles to the Russian Armed Forces is scheduled for 2022. During the Army-2021 Forum in August, the MoD inked a respective contract with the manufacturer, the Tactical Missile Corporation. Russia claims to be far ahead with the development of hypersonic weapons, according to Russian Deputy Prime Minister Yury Borisov

Photo: RKIK



on 17 September. He claims Russia is also ahead of the West in “developing weapons based on new physical principles”.

### ■ Boeing Signs CHINOOK Block II Contract

(jh) According to a press release by Boeing, the US Army has exercised options for four contracted CH-47F Block II CHINOOKs with the aircraft scheduled for delivery beginning in 2023. Separately, the US Army has awarded Boeing a US\$29M



Photo: Boeing

advanced procurement contract for the second production lot of CH-47F Block II aircraft. The Block II CHINOOK features multiple upgrades aimed at providing additional lift capability and increasing commonality between US and allied fleets, thus reducing maintenance costs.

### ■ M3 Amphibious Bridging Vehicle for South Korea

(gwh) The armed forces of South Korea have chosen an amphibious bridging solution based on GDELS' M3 amphibious bridging and ferry system as part of the Korean Amphibious Bridging Vehicle (KABV) programme. According to the company, the bridge system will be adapted to the specific Korean requirements together with Korean partner Hanwha Defense and then designated M3K. The M3 is the world's fastest and most capable amphibious bridge and ferry system in terms of loading capacity, assembly time and manoeuvrability, both at sea and on land, writes GDELS.

In Europe, the M3 has been used by the German Army's Army Engineers and the British Army since 1996. In Asia, users include Taiwan, Singapore and Indonesia. With 110 vehicles planned, South Korea is reported to be the largest M3 user. Thomas Kauffmann, Vice President, International Business and Services at GDELS, sees the order as a confirmation of the importance of tactical bridges for modern armies in terms of interoperability and military mobility.



Photo: GDELS

The Amphibious M3 is a 4x4 floating vehicle with an integrated bridge that can be deployed to a width of 6.57m. By coupling the vehicles, either floating ferries for transporting heavy combat vehicles (up to MLC 85) or fixed bridges can be formed. The longest M3 floating bridge with a length of 350 m has been operated by German and British sappers to cross the Vistula River during the NATO exercise ANAKONDA in 2016. Docking systems enable joint operation with other bridge systems such as the Standard Ribbon Bridge, the Floating Support Bridge and the Improved Ribbon Bridge.



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# An Ongoing Catastrophe

## Re-designing Climate Security

**Dr. Andreea Stoian Karadeli**

As the COVID-19 crisis continues to unfold and affect every sphere of our lives, the threat resulting from climate change is heavily emphasised in every political discourse on the international scene. While the atmosphere, oceans and lands get warmer each year, ice melts and ocean levels rise; deadly disasters like wildfires, heat waves, and flooding are becoming increasingly destructive.

The effects of climate change are now visible in every corner of the world, with more and more countries suffering from severe weather events. Most recently, the World Meteorological Organization underlined that "2021 is a make-or-break year for climate action, with the window to prevent the worst impacts of climate change—which include ever more frequent more intense droughts, floods and storms—closing rapidly". Still, human nature has developed a habit of responding to threats, rather than trying to prevent them, while a lack of common perspective and action leaves all of us more vulnerable.

We are at the most dangerous crossroads of our human existence. We no longer face singular threats that we can counter individually, using one-size-fits-all strategies. Today, most of the threats we are facing are so-called "wicked" transboundary threats that no longer require just one approach, but rather force us to learn new ways to cooperate beyond the borders of our lands, political convictions, organisations, and scientific disciplines. Now, more than ever, we need to come up with solutions that are adaptable, fast, context-oriented and, more than everything – transboundary. And today, I challenge you to think of "climate change" using a different set of lenses.

### 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: Pixabay



*Climate change is a "wicked transboundary threat" that can only be understood and tackled in the framework of "comprehensive security".*

### "Comprehensive Security" vs. "Transboundary Threats"

During my first months at the US border with Mexico, as part of the academic team in the Department of Public Administration and Security Studies at the University of Texas Rio Grande Valley, I understood once more that, although the defence industry is one of the biggest investments world-wide, "security" is no longer just about a state, its military power, and the threat level. Danger no longer comes in one simple form, but rather in complex "wicked" covers – as our academic department tries to map it nowadays. Moreover, teaching security becomes a challenging task that does not lend itself to international relations and "security paradigms". Moreover, discussing "security" at the time of global crisis is nothing other than trying to find a path in a minefield: pandemic, climate change, environmental disasters, migration, economic reset, cyclic conflicts and unrest, extremism reloaded and a deepening lack of trust in our societies. Therefore, I dare you to look at climate change beyond the ongoing debate and see it as a "wicked transboundary threat" that

can only be understood and tackled in the framework of "comprehensive security". Used officially for the first time by former Japanese Prime Minister Ohira, the term 'comprehensive security' breaks the limited requirements of military defence against a particular 'enemy' and stresses the need to consider other aspects vital to national security, such as food, energy, environment, communication, and social security. While not denying the importance of military security, "comprehensive security" explicitly encompasses a wide range of other aspects, like the search for environmental security, for instance, which requires cooperation with other countries. The concept stresses the need for confidence building methods as a requirement for its attainment and pertains to issues such as preventive diplomacy, energy security, second order cybernetics, and greater transparency of international financial markets as a means to enhance overall stability. Moreover, "comprehensive security" provides the right platform to overcome the limited simplifications such as 'us' and 'them'. In the same way, "transboundary wicked issues" represent major challenges for evalua-

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***On the outskirts of Dadaab, Somalia, where many refugees are sheltering as the main camps are overcrowded, a family gathers firewood and builds a shelter to protect themselves from the elements and wild animals. The carcasses of animals, which have perished in the drought are strewn across the desert.***

tion as they cross not only the geographical/physical boundaries, but also to the academic/field specific and political/governmental limitations. In this regard, a “wicked transboundary threat” becomes a “cube-faced” issue that is no longer specific to just one certain country and government, political group or organisation, neither to just one certain discipline, requiring cooperation beyond the identified limitations.

### Climate Change and Security

Scholars and scientists have analysed the “tragic governance” of climate change and defined it as a “super wicked” problem that comprises “four key features: time is running out; those who cause the problem also seek to provide a solution; the central authority needed to address it, is weak or non-existent; and, partly as a result, policy responses discount the future irrationally”. Although the four reasons provided are undisputedly true, they do not describe the whole picture of climate change. The security threat represented by climate change fits into the category of complex wicked problems that truly transcend boundaries and distinctions between cause and effect, local and global problems, facts, and impressions. As a “complex wicked transboundary” threat, climate change is no longer part of the realm of local challenges and uncertainty, but rather globally connected events and ambiguity. Climate change is not only intractable in terms of contested knowledge and expertise, contested values and

unpredictability, but also in terms of its potential as a threat multiplier that can exacerbate existing trends, tension, instability, territorial and geopolitical struggles. In addition, climate change is interwoven with other wicked issues (such as climate refugees) and is characterised by potential consequences for peace and security, including border disputes, instability surrounding migration, impacts on energy supplies, food and water shortages, social stresses in weak states, and humanitarian crises from drought and flooding. Due to its complexity, transboundary wickedness requires a different evaluation perspective that acknowledges the following: (1) any type of boundaries are unclear, shifting and constantly redrawn, based on context and the continuous evolution of events; (2) collaboration and cooperation, trust and learning prove various flaws, and the realm of distrust, coalitions and imagination are repetitively activated; (3) the traditional paradigm of “us” versus “them” becomes an impediment in tackling these kinds of threats; (4) strategic communication and comprehensive understanding of the issue are key elements in developing a common perspective of the threat, beyond our previous limitations. Bearing in mind these elements that are vital for both the management, as well as the evaluation of transboundary issues, here comes the hardest question: What is an appropriate evaluation and management approach for the international governance of a complex wicked transboundary problem such as climate change?

### Current Threats and Opportunities

Currently, global temperatures have risen about 1.8°F (1°C) from 1901 to 2020, sea level rise has accelerated from 1.7 mm/year throughout most of the twentieth century to 3.2 mm/year since 1993, glaciers are shrinking and the average thickness of 30 well-studied glaciers has decreased by about 20 metres since 1980. Furthermore, the area covered by sea ice in the Arctic at the end of summer has shrunk by about 40 per cent since 1979, plus the amount of carbon dioxide in the atmosphere has risen by 25 per cent since 1958, and by about 40 per cent since the Industrial Revolution (Global Climate Dashboard). Beyond these facts, the most dangerous side of global warming stays in its threat multiplier potential: increased conflict and state fragility, mass migration, tense competition and struggles for scarce resources, a trend toward nervous self-preservation, introspection, and even militarisation on the part of major powers, disruption to the international trading system, and more complex risk management in strategic planning. Due to its impact on existing local, regional, national, and international vulnerabilities, many argue that climate change can become a more serious security challenge than any other issue. Still, while climate change is “officially” prioritised in political discourse and policy documents both by national governments and international organisations, concrete steps fail to follow the over-emphasised declarations. Worldwide, governments have had to tackle more pressing issues and short-term crises, leaving “climate security” on standby. Although the need for international cooperation is acknowledged as a foundation to the complex wicked transboundary issue of climate change, there are still states that show signs of being tempted by a logic of isolationist self-reliance. Moreover, important branches of security such as conflict, migration, military and defence industry, economic security, and food security, have failed in fully integrating the implications of climate change towards their own fields. We are still far from understanding the direct and indirect relations between the real facts of the “complex wicked transboundary climate change threat” and the effects in the larger sphere of “comprehensive security”. Instead of drawing and trying to comprehend the bigger picture, we still limit ourselves to a fragmented approach that affects our long-term potential to tackle the current catastrophe, not to consider the next disaster. In addition, the longer it takes us to take the next steps from acknowledgment to practice, the fewer chances we have

to survive the next disaster. And despite the threat it represents, climate change can also be an extraordinary opportunity for us to develop better ways to communicate and cooperate beyond physical, political, psychological, and scientific borders.

## Recommendations

Bearing in mind the complex nature of the issue, at the international level, an integrated approach to climate change should be part of developing strategies related to conflict, migration, military, defence, and economics. Therefore, climate-related factors should be considered in the prediction and prevention of conflicts, including by improving governance in already resource-stressed states. Moreover, bearing in mind the current events, the world needs an international climate-induced migration prevention and management strategy that anticipates migratory flows and potential security risks, while tackling all the issues based on transboundary cooperation. Further on, as the defence industry and military have proved during the extraordinary developments in recent times, there is an increased need to draw the line between militaries' engagement with climate security. In this regard,

a broader understanding of the connection between defence requirements and the effects of climate change is necessary to develop defence equipment and military strategies to engage effectively with a broader range of climate-related challenges. Nevertheless, there is another side of the relationship between the security sector and climate change, as empirical evidence also shows that all over the world security sectors are often part of the problem themselves, contributing to, or aggravating climate-related security crises through poor governance practices and sometimes also through direct or indirect involvement in illicit activities that are harmful to the climate and the environment. The security sector also contributes directly to global warming, with military forces being among the largest emitters of greenhouse gases and consumers of fossil fuels in the world. Therefore, an assessment of these factors should be considered in the future management of security vs. climate change challenge. Last, but not least, the geo-economics of climate change forces governments to balance commitment to free trade and their desire to access resources and renewables while avoiding mercantilist policies. Currently, climate change is affecting the security of food in the most vulnerable

regions across the globe and the key element to tackle it is cooperation. As communities in every corner of the world are being affected independently in different manners, and at different levels, the domino effect of this threat is enormous and moves faster than we can adapt. This, once again, is another characteristic of its wicked transboundary nature that requires a different set of solutions, based on mostly on transnational, transgovernmental, transorganisational and transdisciplinary cooperation.

## Conclusion

So far, the assessment of the threat posed by climate change towards international security has failed to reflect its complexity. As a wicked transboundary issue, climate change needs a new approach that acknowledges all its characteristics together with its threat multiplier potential. Therefore, the issue of climate security should go from being a topic of political discourse, to a key aim of international action that forces closer cooperation between states, governments, organisations, and scientific disciplines. With our own future at stake, we have no other option than to cooperate and go beyond our borders to create a common, better, and safer tomorrow. ■

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# China's Missile Proliferation and Legal Regimes

**Debalina Ghoshal**

Ever since China developed missile capabilities, it has been accused of the proliferation of its missile technology to the Middle East, North Africa, North East Asia and South Asia regions. This article studies China's missile proliferation trends, encompassing both ballistic and cruise missiles, and also addresses future trends.

China's behaviour has led to serious proliferation concerns in Africa, the Middle East and South Asia (namely Pakistan). Pakistan has been a safe haven for asymmetric organisations, while North Korea is suffering from regime instabil-

ity and harbours revisionist tendencies. States such as Iran and Syria also indulge in supplying missile technology, but to asymmetric organisations like Hamas and Hezbollah. According to reports, China does not currently transfer complete mis-

Missile proliferation can be either vertical or horizontal and can include both ballistic and cruise missile technologies. China's Open Door Policy under its then leader Deng Xiaoping in the 1970s resulted in China building ties with West Asian

Screenshot: CC4.0



**A North Korean Hwasong 16 missile on display on North Korean TV**

## Author

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sile systems, though Chinese individuals are presently involved in the export of technology that can be used in the development of missile systems.

## Missile Proliferation Trends

Missile proliferation is the spread of either complete missile systems, or equipment and systems required to pursue missile development programmes to those states conducting research and development on issues pertaining to missile development.

states such as Syria, Jordan and other oil-rich countries for economic benefits. In exchange, China sold ballistic missile technologies to some of these states - Syria, Iraq and Libya to name a few. Saudi Arabia was Beijing's No.1 exporter of crude oil and in return, China sold long-range ballistic missiles to Riyadh. At the height of the Iran-Iraq War, when Saudi Arabia was denied the possibility of buying short-range ballistic missiles (SRBMs) by the United States, it turned to China for help.

**Libya**

China was reported to have been involved in the missile technology programme of the Libyan missile - the AL-FATEH 1,000km-range ballistic missiles - with help from the China Precision Machinery Import-Export Co. This report was confirmed in 2001 by the CIA. Hypersonic wind tunnel for modelling and simulation was also developed in the 1990s by Libya with the help of China. Furthermore, and according to reports, China was also helping Algeria in the 1990s to design a nuclear warhead for a SCUD-B missile system.

**North Korea**

With assistance from China, North Korea has also developed missile technology. In fact, not only has North Korea developed missile technology but this technology has also further been proliferated to states like Iran, Syria and Pakistan too. It is suspected that Chinese missile technology has been applied to North Korean TAEPO DONG and NO DONG Scud missiles. China's assistance to North Korea began in the 1960s when the Soviet Union refused to assist North Korea with its missile development programme. How-



Photo: CC3.0

**A FATEH-110 missile on the new TEL truck displayed at the Iranian Armed Forces parade in 2012**

ever, it was only by 1977 that substantial cooperation began between North Korea and China.

In 2012, reports also suggested that the North Korean KN-08 missile was paraded on a Chinese origin Transporter Erector Launcher. The United States reacted strongly since the UNSC Resolutions, which were designed to prohibit the scope of North Korea to continue with its ballistic missile development programme, were being breached by the Chinese even though they had pledged to respect the said resolutions.

**Iran**

In 2013, it was reported that the United States had sanctioned certain Chinese businessmen like Li Fangwei, for supplying parts, including high grade aluminium alloy, ultra-high strength steel and graphite cylinders, to Iran's Shahid Bakeri Industrial Group (SBIG) that could be used to develop missiles. He had apparently also agreed to supply gyroscopes and accelerometers to the SBIG which could be used for missile guidance purposes and which strictly fell under the purview of the Missile Technology Control Regime (MTCR).



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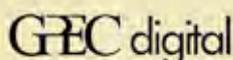


Photo: Dawn News / CC3.0



**In January 2020, Pakistan successfully conducted a surface-to-surface test launch of a GHAZNAVI missile.**

**Saudi Arabia**

China is also reported to have sold the DF category ballistic missiles to Saudi Arabia, which not only included the liquid fuelled DF-3s but also the sophisticated solid propelled DF-21s. While in 1998, the DF-3A category of ballistic missiles was sold to Saudi Arabia, in 2007, the DF-21 category ballistic missiles were sold to Riyadh. When Saudi Arabia acquired the DF-3s, they were already outdated because of their liquid propulsion and inaccuracy and hence, there was no doubt that eventually Riyadh would seek a more advanced missile system.

**Syria**

Beijing was also reported to have sold ballistic missiles to Syria. Syria's M-600 missiles are the Iranian version of the FATEH-110-A, which is again the Chinese version of the M-11. Syria is also reported to possess the M-9 missiles. All these missiles are solid propelled and hence, they have greater chances of survivability. Their range also adds to their prowess since they can be fired from deep within Syrian territory into Israel and Turkey, thereby, reducing their chances of being destroyed. Moreover, the missile production facilities at Aleppo and Hama were developed with Chinese, North Korean and Iranian assistance.

**Turkey**

China has also assisted Turkey in its missile technology development, including – reportedly - in the development of T-300 KASIRGA artillery rockets and also the J-series of ballistic missiles. In fact, according to reports, the J-600 T YILDRIM was developed from the Chinese WS-1 rocket system.

**Pakistan**

According to the US Under Secretary of State for International Security Affairs, China's Ministry of Aerospace Industry and Pakistan's Ministry of Defence were also involved in the proliferation of missile technology. US officials confirmed that Pakistan's HATF-3 is the M-11 version of short-range ballistic missiles. China on the other hand, justified its stance of exporting the M-11 to Pakistan since the missile did not have a payload of 500 kg (restricted by MTCR) and was restricted by range up to 280 km. Many in Washington, however, believed that the Chinese missile proliferation was an act of displaying Beijing's grievance over the US sale of F-16 fighter aircraft to Taiwan, which according to Beijing, was a breach of the US-China communiqué in which the US had pledged to "gradually reduce its sale of arms to Taiwan."

In June 2000, it was reported that Beijing was developing a "nuclear missile production facility" inside Pakistan for manufacturing the M-11 missiles. China's missile proliferation to Pakistan was of course initiated for one main reason - that Pakistan's missile capability would be a perfect deterrent against India's growing missile capabilities. This means that any missile development on Pakistan's part would leave no option for India but to concentrate on matching the capabilities. It was believed that this could reduce India's focus on China's missile capabilities. In 2001, there were also reports that China had transferred missile components to Pakistan for the SHAHEEN missiles. In fact, Pakistan received considerable assistance from Beijing on solid propulsion technology for their missile systems.

**Cruise Missile Proliferation**

China is also reported to be developing cruise missiles which analysts fear could be proliferated. Andrew Ericson, Dennis Gormley and Jingdong Yuan stated that "if China's past record of proliferating ballistic missiles and technology is an indication of its intentions vis-à-vis cruise missile transfers, the consequences could be highly disruptive for the non-proliferation regime." There were reports that China might have proliferated anti-ship cruise missiles to Bangladesh, Indonesia, Myanmar, Iran and Pakistan.

From the 1980s onwards, China has proliferated missile technology to Iran, with Teheran receiving Chinese anti-ship SEERSUCKER missiles. According to a 2011 report, China was Iran's largest arms supplier selling US\$312M in weapons since 2006, which have mostly included short-range anti-ship cruise missiles. In fact, China Precision Machinery Import-Export Corp. and Iran's Aerospace Industries Organisation have worked together to develop the "radar-guided variant of the C-701 cruise missiles" which Iran designated as the KO-SAR. China has also worked together on an air-launched cruise missile which Iran designated the NOOR which is the Iranian version of the Chinese C-802 cruise missiles. As late as 2013, reports were confirmed that China was selling missile parts to Iran. During the 1991 Gulf War, China sold approximately 60 C-802 missiles to Iran before being forced by the US to cease with such actions. However, reports confirm that Beijing continued to sell C-802 missiles to Iran which were later also used by Hezbollah against Israel. Reports also suggest that Pakistan's BABUR cruise missile bears "considerable similarity to the baseline Kh-55" and is a "license variant of the Chinese clone of the Kh-55." In 2020, there were reports that China had transferred sensitive technology to Iran pertaining to its missile programme.

**Future Trends**

We see that in the near future, China may not indulge in the proliferation of entire missile systems to its clients, but it surely would transfer equipment and parts, which could be used for dual purposes, both for civilian purposes or for developing missile systems. Chinese entities have been accused of transferring goods pertaining to missile technology that are MTCR controlled and this will likely continue. ■

# Russia's Belt of (In)Security

**Dr. Gayane Novikova**

New agendas were outlined in Russia's National Security Strategy, adopted on 2 July 2021. According to this document, Russia's external security concerns are multiplying. The West in general has been viewed as a major source of security threats. To prevent and fight them, Russia must build up its military might and improve cooperation with its partners.

Russia's National Security Strategy also noted an increased concentration on domestic issues and possible internal security threats.

Two major developments in the Mediterranean and Black Sea basins triggered Russia's intensified (reasonably aggressive) posture in these regions. Russia has viewed both the Arab Spring and the aspirations of Ukraine and Georgia for NATO membership as serious security threats. The third dimension – the US withdrawal from Afghanistan – has forced Russia to take several proactive measures.

## Return to the Mediterranean

The Arab Spring, especially its Syrian theatre, has allowed Russia to return to the Mediterranean as an actor. Providing its full political-military and diplomatic support to the Bashar al-Assad regime in the course of the civil war in Syria, Russia has aimed first of all to secure and strengthen its multi-layered presence and economic interests in the Middle East in general and in the eastern Mediterranean in particular. On the eve of its direct military intervention, on 26 August 2015, a new Russian-Syrian agreement was signed: Russia received full access to the newly-built Khmeimim air base in Latakia province free of charge and for an unlimited time. Three months later, a Russian S-400 air defence missile system was deployed to this base (also to the Tartus naval base) after Turkey had shot down a Russian military jet.

## Author

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Photo: Kremlin.ru

*On 18 March 2014, Russian President Putin signed a "Treaty on the adoption of the Republic of Crimea and Sevastopol to Russia".*

In 2017, Russia signed another agreement with the Syrian Government regarding the Tartus naval base which, after losing bases in Egypt and Libya, remained the only Russian foothold in the Mediterranean. In accordance with the new agreement, Russia leased the Tartus seaport for its Mediterranean Task Force free of charge for 49 years with the possibility of renewal for another 25 years. Moscow obtained full jurisdiction over the base and expanded its use for civilian business purposes. In May 2021, the two governments agreed that Russia would invest US\$500M to enlarge the naval base and to construct a floating dock. Simultaneously, the runway of the Khmeimim air base was extended; three TU-22M3 nuclear-capable long-range bombers were deployed for a series of training missions over the Mediterranean.

The second aspect of Russia's direct involvement in Syrian affairs aimed to prevent penetration of ISIS fighters into Russia's North Caucasus (a significant num-

ber were from Chechnya and Dagestan). Since the summer of 2015, Russia has continuously been using the Khmeimim air base to launch air strikes against "ISIS and other terrorist groups."

Russia's strong military presence in Syria has provided an opportunity for the restoration of its naval and air bases in Egypt and Libya. The joint manoeuvres conducted by Russian and Egyptian units, as well as a port visit by Russia's frigate ADMIRAL KASATONOV in Alexandria within the framework of its Mediterranean January-April 2021 voyage, can be viewed as first steps in this direction. The case with the Libyan bases is more complicated owing to the situation on the ground; however, according to satellite images, on 26 May 2020, six Russian MiG-29 FULCRUM and five Su-24 FENCERS were spotted in Libya at the al-Jufrah air base controlled by the Haftar Armed Forces. Besides, the "Wagner" Russian private military company has been used as a proxy for Russian interests in Libya.

## “Red Lines” in the Black Sea

For Russia, control over the Black Sea is crucial. The attempts by Georgia and Ukraine to shift closer to NATO have been viewed as a serious security challenge, concern, and threat. To prevent such a scenario, Russia has violated the territorial integrity of both states.

As a result of the August 2008, war in Georgia, and its recognition of the independence of Abkhazia and South Ossetia, Russia was able to strengthen and secure its military presence in these areas. In accordance with an agreement signed in February 2009, Russia and the Abkhazian authorities agreed that the Russian 7th military base could be stationed in Abkhazia for 49 years and that an automatic renewal for a subsequent 15 years would be possible. A similar agreement regarding the newly-established 4th Russian military base was signed with the South Ossetian authorities in April 2010. Hence, both semi-recognised state entities were gradually turned into completely militarised zones. Even in the long-term perspective, Georgia’s territorial integrity will not be restored.

Russia’s control over the north-eastern part of the Black Sea would not be sufficient without a naval base in Sevastopol, Ukraine. The annexation of Crimea in 2014 secured Russia’s broad strategic interests in the Black Sea basin and its direct access to the Mediterranean. Russia made it clear that membership in NATO of Ukraine (and Georgia) constitutes that very red line that can provoke open military confrontation. Simultaneously, the level of confronta-

tion between Russia and the Euro-Atlantic structures has sharply increased.

At the Brussels Summit in June 2021, NATO emphasised: “The conflict in and around Ukraine is, in current circumstances, the first topic on our agenda.” In particular, it reaffirmed its commitment to support the territorial integrity and sovereignty of Ukraine (as well as of Georgia and Moldova) within its internationally recognised borders: “We strongly condemn and will not recognise Russia’s illegal and illegitimate annexation of Crimea, and denounce its temporary occupation. Russia’s recent massive military build-up and destabilising activities in and around Ukraine have further escalated tensions and undermined security. We call on Russia to reverse its military build-up and stop restricting navigation in parts of the Black Sea.”

The NATO Summit was followed by the Sea Breeze-2021 manoeuvres launched on 28 June by the US and Ukraine with the participation and support of 32 NATO members and allied states. The announced goals involved bringing Ukraine up to NATO standards, and an improvement of interoperability and multinational cooperation in regional peacekeeping activities. Although these exercises at sea, on land, and in the air have been an annual event led by Ukraine (Russia participated in 1998), Russia viewed them as an aggressive act and direct threat to – and violation of – its national security by Ukraine and its partners. At the end of June, Russia tested its S-400 air defence system in Crimea and on 1 July, in parallel with the NATO drills, carried out its own military exercises fo-

cused on air strikes against simulated enemy ships. According to President Putin’s spokesman Dmitry Peskov, the desire of the current Government of Ukraine to solve its problems with Russia by joining NATO – “an anti-Russian military alliance” – constitutes a “red line.” The Russian leadership is “prepared to take measures to secure our borders and maintain the balance [parity] in Europe.” For this reason, Russia will take all necessary security measures “to deal with Ukrainian provocations.” It viewed the establishment of the “Crimea Platform” in August, 2021 as another “provocation.” The next round of military exercises in the Black Sea took place in September. Together with Belarus, Russia conducted a large multi-dimensional drill “Zapad-21” (10-16 September) that featured a scenario echoing the 2020 elections processes in Belarus: a coalition of NATO states intervened in Belarus to conduct a regime change. Ukraine, the US, and NATO responded with “Rapid Trident -2021” drills (23 September – 1 October) aimed “to prepare for joint actions as part of a multinational force during coalition operations.” On 23 September, Russia’s navy practised firing at targets in the Black Sea off the coast of Crimea using its BASTION coastal missile defence system.

## Afghanistan ... Once Again?

The chaotic US withdrawal from Afghanistan actually left the Central Asian republics facing all the problems emanating from this war-torn country. To some extent the developments in and around Afghanistan can become problematic for Russia and its interests in the broader Central Asian region. Sources of its main security concerns are the threat of terrorism generated mainly by ISIS and al-Qaeda, and drug trafficking. Nonetheless, Russia will not interfere in Afghanistan’s internal affairs. However, it will provide all necessary support to the Central Asian states in order to prevent a spill-over of Afghan problems into these countries, and their possible involvement in proxy wars. Three mechanisms – with different effectiveness – can be utilised to maintain relative stability: a building of capacity of Russian military bases in Tajikistan and Kyrgyzstan; a strengthening of the Russia-led political-military alliance – the Collective Security Treaty Organization (CSTO); and a stimulation of cooperation and operability among the Shanghai Cooperation Organization (SCO) member states.

In light of external security, Tajikistan is the most vulnerable among the Central Asian states. In autumn 2019, Russia deployed its S-300 anti-aircraft missile system to its 201st military base in Tajikistan; in 2021, it

Photo: Ministry of Defence of the Russian Federation



**Russia has been strengthening the Tajikistan Army in the wake of the Taliban taking control over Afghanistan. Depicted is a joint command post exercise with units of the Armed Forces of Russia and Tajikistan at Kharbmaidon training ground in Tajikistan on 14 March 2018.**

was reinforced with the “KORNET” anti-tank missile systems (ATGM), 17 BMP-2, and a batch of 12.7 mm heavy machine guns NSV UTYOS. In addition, Russia decided to provide US\$1.1M to build a new outpost on the Tajik-Afghan border.

Russia’s Kant air base in Kyrgyzstan has also come into focus. In June 2020, the Russian-Kyrgyz agreement was amended: Russia will deploy an air defence system and develop infrastructure for UAVs. The base hosts Su-25 attack aircraft and Mi-8 helicopters. In July 2021, Russia and Kyrgyzstan discussed the possibility of establishing a new Russian military base to formally serve as the base for the Collective Operational Response Forces (designed to react to crises short of interstate conflicts) under CSTO auspices.

Besides increasing the defence capacities of its military bases in the region, Russia holds drills with its partners. On 30 July 2021, a Russian-Uzbek military exercise was held along Uzbekistan’s border with Afghanistan. On 5 August, Tajikistan joined this drill. A trilateral exercise aimed at the elimination of “illegal armed groups invading the territory of an allied state” continued through 10 August. It took place in close proximity to the Tajik-Afghan border.

Another drill, “Zapad/Interaction-2021,” organised by the Chinese side under joint Russian-Chinese command was carried out on 9-13 August in the north-western part of China. This was the first time the Russian military on a large scale has been invited to China to participate in a military exercise. Both sides indicated as the main theme a coordinated defence of peace and security in Central Asia. The goal was to boost “China-Russia strategic mutual trust, strengthening exchanges and cooperation between the two countries, and unleashing their combat capabilities.” Russian-Chinese military cooperation indicates the willingness to act together in the areas of their common strategic interests and to share responsibility.

It is obvious that the prevention of any negative developments in Central Asia is in Russia’s strategic interest. To avoid any direct involvement in Afghan problems, Russia strongly supports the activities of two international organisations, the CSTO and the SCO, aiming to stimulate their involvement in a stabilisation of the region.

On 16 September, at the CSTO Dushanbe Summit, the member states decided to deploy troops on the Tajik-Afghan border, emphasising in the Declaration the effectiveness of military exercises and the intention to continue this practice. On 17 September, the SCO held its head of state summit in Dushanbe. The member states



Photo: MoD China / Liu Fang

**The joint Russian-Chinese Exercise ZAPAD/INTERACTION-2021 began on 9 August at a PLA training base in Qingtongxia City in western China’s Ningxia Hui autonomous region. The picture shows troops from China and Russia parading and two air squadrons at the opening ceremony.**

of CSTO and SCO confirmed their intention to take collective action neutralising – or minimising – threats streaming from Afghanistan. The latter possesses Observer status in both organisations.

### Instead of the Conclusion

Developments along Russia’s external borders require the precise attention of its political and military circles. In addition to complicated relations with the US, the EU, and China, Russia feels insecure to a certain degree as a result of: a) being surrounded by non-friendly Baltic States, Poland, Ukraine, and Georgia; b) trying to maintain balanced relations with Armenia and Azerbaijan; and c) attempting to avoid any problems in Central Asia in the aftermath of the Afghan crisis. Russia builds its security belt by either keeping or installing military bases, or involving – sometimes forcibly – vulnerable neighbouring states into its political, military, and economic spheres of influence. In the meantime, a more “egocentric” Russia conducts a selective foreign policy that focuses on those areas where it can gain maximum strategic advantage.

Furthermore, serious limitations are apparent in Russia’s multilateral security policy:

1) Moscow has used military intervention to prevent unwanted developments in the Mediterranean (Syria) and the Black Sea (Georgia and Ukraine) basins. However, viewed through the prism of its military capacity, in the Mediterranean region, Russia cannot compete with the US Sixth Fleet. Russia limits itself to demonstrations of its presence there.

In the Black Sea region, Russia’s strategic interests confront and compete with the interests of NATO, Turkey, Ukraine, and Georgia. Its modus operandi along all these axes varies: to some degree it accepts NATO’s activity in the Black Sea, manages a “mutual understanding” with Turkey despite Ankara’s position on Crimea, implements a hostile policy towards Ukraine, and ignores Georgia.

2) Although Russia has widened its military presence in the South Caucasus, it has lost its dominant position. In the aftermath of the 2020 Karabakh war, it was forced to accept Turkey’s growing political-military presence and activity in this region.

3) Russia possesses two mechanisms to control the situation in Central Asia: the CSTO, where it is a dominant power, and the SCO, where its interests compete first of all with China. To prevent negative developments emanating from Afghanistan, it needs to combine and coordinate the efforts of both organisations. However, the main obstacle is the serious rivalries that exist between their members and a lack of a joint strategic vision.

In general, Russia has shifted towards a more pragmatic approach to foreign affairs, concentrating on strengthening the weak links in its security belt, and applying multilateralism and regionalism. Confrontational tactics will be implemented only if Russia perceives a real threat to its security interests, such as the case of Ukraine. In all other cases, it will take preemptive low-cost measures, or will simply ignore selected developments. ■

# Current Dynamics of the Black Sea Region

**Dr. Andreea Stoian Karadeli**

Central to European security and NATO's agenda, the Black Sea region witnessed decades of conflict and unrest, marked by persisting historical rivalries, unrecognised territorial entities, and complex security threats. As the power game is still unfolding, both NATO and the European Union are developing new strategies to counter Russia's military and non-military offensive instruments.

The Black Sea is surrounded by six countries (Ukraine to the north, Russia and Georgia to the east, Turkey to the south, and Bulgaria and Romania to the west), out of which only three are NATO members and only two are EU member states. A crossroads for Europe, Asia and the Middle East, the Black Sea has emerged as a vital route for the movement of energy to Europe. With democracy backing up from the west edge, the Chinese financial offensive active from the east, Russian military struggle threatening from the north and instability coming from the south, the Black Sea Region is indeed a potential hot spot. The region only gained its place in the first lines of the global strategic agenda in the first decade of the twenty-first century after several key events: Bulgaria and Romania joined NATO and the EU in 2007, the Russia-Georgia War of 2008, the coloured revolution in Ukraine in 2013, and Russia's invasion of Crimea in 2014, the recent uprising in Belarus and finally Nagorno-Karabakh conflict of 2020. While the region hides as many opportunities as possible for further cooperation and development, the Black Sea continues to dive in the same dangerous power game of global and regional actors. Bearing in mind the global challenges of our

Photo: US Navy / Damon Grosvenor



**Sailors aboard the ARLEIGH BURKE class destroyer USS PORTER watch as the ship transits the Bosphorus, on 28 January 2021. PORTER is on patrol in the Black Sea in support of US national security interests in Europe.**

current times, this article aims to provide an assessment of the ongoing dynamics around the Black Sea and prospects for the region.

## Sochi, September 2021

At the end of September, the Russian and Turkish presidents met for the first time in-person after the break-out of the Covid-19 era. The meeting took place in the Russian Black Sea city of Sochi, the "de facto capital" and President Putin's favourite location for bilateral summits – a symbol of Russia's preservation of Prince Gregory Potemkin's 250-year-old legacy. In front of the press the two leaders discussed cordially the Covid-19 vaccine booster, and the superiority of the Russian Sputnik-V. Behind the close doors, President Erdogan and President

Putin debated the developing bilateral cooperation, touching on important topics such as trade and collaboration for defence industry, regional issues, and future common projects for the two countries. Among all the details released to the public, the most vital information for the Black Sea security comes from the common announcement that Russia and Turkey will collaborate in developing submarine and jet-engine technologies. While this can be seen as a balance to the similar military cooperation between Turkey and Russia, the underlying reasons and strategies behind the official projects is yet to be discussed. Still, Turkey's dangerous game with Russia threatens the security and stability of the Black Sea Region, while all the other actors either observe from distance or take precaution in every action.

## 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.

## Neighbours in a Disguised Hot Spot

The dynamics of the Black Sea have always been tense, with neighbours calculating each action while determining the risk for every handshake. Russia has remained the “bully of the class”, trying to impose its position through calculated military and non-military offensive acts threatening the security and stability of the region. At a large scale, Russia sees the Black Sea region as a key element to its geoeconomics strategy, aiming to project Russian power and influence in the Mediterranean, protect its economic and trade links with key European markets, and make southern Europe more dependent on Russian oil and gas. The Black Sea also provides the security buffer zone for Moscow to protect its boundaries from any kind of southern vulnerability. With a well-developed strategy and a bit of luck, by using the Black Sea as a springboard, Russia can further project power into the Middle East, the Balkans, and the Mediterranean — and strengthen its re-emergence as a great power. Although hard to believe, the Moscow is determined to use the Black Sea to gain further access in regions that are so-called NATO-dominated. The developing relation to Turkey resulting in Ankara’s estrangement from the West fits perfectly Putin’s plans for the future of the region, pointing out at both NATO and EU’s current vulnerabilities.

### Turkey

On the other side, Turkey’s relations with Russia, have always been far from ideal, resulting into many direct and indirect confrontations and hostile competition, throughout time. While Ankara does not fully trust Moscow’s commitment to their common initiatives, Turkey aims to become a regional power. In this regard, the role of the “balance holder” in the Black Sea Region, and not only, is just one of the strategies developed by Ankara to create an equilibrium between US assertiveness and Russian resurgence in its near abroad. However, its struggle can easily turn into an increasing vulnerability to both sides and risk further volatility on several terrains.

While strongly opposing a large NATO presence in the region and claiming its potential to maintain maritime security in the Black Sea in cooperation with other NATO member and partner countries, as well as Russia, Turkey unintentionally contributed to Moscow’s strengthening its military build-up in the region after



Photo: US Navy / Patrick W. Mullen

**Romanian Special Forces board a vessel during exercise TROJAN FOOT-PRINT 21 off the coast of Mangalia, Romania on 7 May 2021. The exercise aims to improve interoperability with allies and partners on the Black Sea.**

the annexation of Crimea. Moreover, for the sake of regional balance and trying to avoid further confrontation with Russia, Ankara refused the opportunity to regain its dominating naval presence in the Black Sea and did not join the anti-Russian EU sanctions. Meanwhile, Turkey and Russia managed to come to common agreements in several frozen conflicts such as Nagorno-Karabakh. In this case, Turkey has always supported its brother country – Azerbaijan - against Armenia and has provided military training and weapons to Baku. On the other hand, Armenia, has benefited from Russian support due to its defence pact with Moscow and the presence of a Russian military base and Russian border guards. While the main fighting took place at a critical sport for Europe and Turkey’s energy security, Russia and Turkey proved their capacity to come up with an interim arrangement between them, temporarily ending the war, though not yet the conflict. Russian and Turkish management of the crises showed their awareness of the threat for escalation represented by these frozen conflicts and the potential to put at risk other regions of common interests for both sides.

In short, although Turkey does not always comply with EU and NATO policies in the Black Sea, and it plays a very dangerous game walking on a very thin line over an alligators’ trap, Ankara emerged as one of the balancers of Russia. What is debatable is for how long the Turkish government will be able to resist the pressure that comes from different sides, making it harder to sustain the balance.

### Ukraine

Another neighbour on the Black Sea, Ukraine used to be known for its “maritime maturity”, in the past, and as a diversified maritime economic landscape made up of river transportation, shipbuilding, and a gas and oil industry. However, the past 25 years have marked a continuous decline for almost all of Ukraine’s maritime power and the country’s access to the Black Sea has already been severely restricted by the ongoing occupation of Crimea and Russia’s systematic disruption of Ukraine-bound shipping in the Azov Sea since 2018. Currently the commercial ports of Odesa, Mykolaiv, and Kherson serve as Ukraine’s economic lifeline to global markets. Moreover, Russia continues to threaten the maritime traffic and hit severely the country’s economy. While, Kiev has the support of the West and Turkey, the threatening actions coming from Russia’s side are not to be underestimated and the situation should be treated with caution.

### Georgia

Alike Ukraine, Georgia has also witnessed the Russian aggressive policies and Moscow’s use of both military power and hybrid warfare instruments to further challenge any allies of the West in the Black Sea. In October 2019, the Russian Military Intelligence service (GRU) executed a disruptive cyber-attack on Georgia’s government servers, as one example of the Russian offensive that includes various malign actions such as disinformation, cyber-attacks, energy

Photo: USMC / Sgt. Alexandria Blanche



**US Marines conduct combat training during Black Sea Rotational Force on Mihail Kogalniceanu Air Base, Romania.**

blockade, covert intelligence, and military activities. The final aim of these actions is to pressure Tbilisi against the West. While the NATO-Georgia cooperation is at target, strengthening Georgia’s “hybrid defence” capabilities is more important than ever. Since its occupation of Georgian territories, Russia has illegally deployed troops to Abkhazia, which lies on the eastern coast of the Black Sea. Further on, Moscow’s developing military build-up of forces on the Crimean Peninsula and the improved air and naval capabilities reflect Russian’s clear intentions to create an A2/AD zone in the Black Sea. Its actions are far from the traditional strategies of the past, as Kremlin pushes in offensive through every viable channel.

**Romania and Bulgaria**

The two EU member states on the ground, Romania and Bulgaria, are both post-communist democracies, who joined NATO in 2004 with the sec-

ond wave of eastern enlargement after the Cold War. Due partly to its historical grievances towards Russia, Romania has been very vocal, calling for a stronger NATO response and it also became the first country to host a Patriot surface-to-air missile system in the Black Sea region. It also carries out regular rotational deployments of NATO forces. From 19 to 29 March 2021, Romania organised Sea Shield 21, a multinational NATO exercise. Romania’s commitment to fully support NATO against Russia’s offensive strategy has been proved since the country joined the Alliance. On the other hand, Bulgaria proved to be more cautious regarding Russia. For a long time, Moscow has taken advantage of Bulgarian dependence on old Russian military technology and routinely penetrated Sofia’s defence sector, proving not only national vulnerabilities but also reflecting a weakness for the Alliance. In March 2021, five former and

current senior Bulgarian defence officials were charged with selling classified NATO information to Russia. Moreover, as part of Moscow’s asymmetric war strategy, Bulgaria is also a prime target of the Kremlin’s hybrid activity due to energy dependence and a strong Russian influence in its political realm. So far, Bulgaria have made significant steps against Russia’s offensive strategies, by updating its national security and defence strategies and inaugurating the Maritime Coordination Centre in Varna. Still, there is a long way ahead in building up Bulgaria’s resilience and the other members and partners support to reduce NATO’s vulnerabilities in the region.

**Policy Recommendations for the EU and NATO**

Just like in the context of the Baltic Sea, the Black Sea has no joint commander for peace and war to actively engage in the countering Russian challenges in the region. Nor are there suitably placed and focused regional joint headquarters for either the EU or NATO. NATO must create a supreme allied commander (SAC) for both regions — a SACBaltic and SACBlack Sea. In the same way, new steps to empower NATO’s presence on the ground can also benefit the EU’s position to increase the security and stability of the eastern neighbourhood. While being a strong advocate of NATO military and naval presence in the region, the EU should be more active in the region and cooperate with NATO on initiatives to increase intelligence- and surveillance-sharing, defence interoperability, operational cooperation and military mobility projects that can provide a multi-layered strategy to counter Russia’s continuous aggressions. Last, but not least, the EU has the potential if it is given the opportunity to engage on an active role in the economic cooperation in the region that can further enhance stability and security. Today, more than ever before, NATO’s south-eastern flank needs to grow stronger and show no vulnerability on any side. Such a target can only be achieved through enhance collaboration between its members – Romania, Bulgaria, and Turkey – and its strongest partners in the region: Ukraine and Georgia. While understanding Russia’s “asymmetric bullying strategy”, the Alliance should be aware of its own strengths and enormous potential to create a better, more stable, and secure Black Sea Region. ■



**Announcement and Call for Papers**  
**Brussels, 25/26 January 2022**  
**17<sup>th</sup> NATO Life Cycle Management Conference**

**MITTLER**  
**REPORT**

**LCM in a Changing World -  
Developing Partnerships and Modes of Collaboration**

Chaired by: Thomas E. Pedersen and J. Bo Leimand (ret), Danish Defence Acquisition and Logistics Organisation (DALO)

After COVID and Brexit, as we witness a realignment of US priorities, collapsing supply chains, a rising China and a belligerent Russia, the annual NATO LCM Conference will continue to assess the lessons learned and achievements made in areas such as Quality Assurance, Life Cycle Costing, Configuration Management, Acquisition Practices, Material Maintainability et al. as a basis for new and innovative approaches. The event will again be organised in cooperation with the NATO Life Cycle Management Group (AC/327) and with the support of the NATO Industrial Advisory Group's (NIAG) Industrial Interface Group (NIIG) supporting NATO AC/327, and the German CALS Forum. The conference will be combined with a small exhibition, where interested parties are invited to showcase respective capabilities and will take place at the Park Inn by Radisson Brussels Airport on **25/26 January 2022**.

**Scope of the Conference**

According to NATO's Systems Life Cycle Management (SLCM) policy the main goal of systems life cycle management is to efficiently and effectively deliver, use and maintain NATO capabilities. The primary objectives include:

- To have a common understanding of all aspects of SLCM;
- To create integrated and seamless business management practices, from initial concept to retirement;
- To establish effective collaboration between all stakeholders, with clearly defined responsibilities;
- To facilitate technology insertion, mid-life updates and address obsolescence based on life cycle considerations;
- To define and apply an integrated systems approach to the development, use and support of systems;
- To acquire systems that fulfil operational and logistic requirements, optimise internal and external interfaces, address integrated logistics and in-service support, and minimise production, in-service and disposal impacts on the environment.

Against this background, the 17<sup>th</sup> NATO LCM Conference will provide a platform for the presentation of innovative approaches and concepts in support of effective materiel management. In addition to specialist presentations and papers the conference will provide ample opportunity for the exchange of information between and among experts, programme managers and decision makers from the nations' armed forces, defence administration and industry.



**Briefing Abstracts**

The papers/briefings are to present status reports and results as well as expert analyses of current and future LCM, LCC and ILS implementation projects. Today, the military environment is increasingly influenced and characterised by cooperative models, innovative economical schemes and the need for environmentally friendly solutions. In response to that, presenters are encouraged to also consider related aspects of their subject.

- Those interested in giving one or more presentation(s) in accordance with the theme of the conference are requested to submit their abstract(s) preferably in an electronic format (email);
- The time slots for the presentations are limited to 20 - 30 min. incl. 5-10 min. discussion time;
- Abstracts should not exceed 10 - 15 lines and should briefly address the subject and objective of the presentation;
- Your abstract submission should include the title(s) of the presentation(s), name and position of the speaker, organisation and full address with phone and fax numbers and email address.
- Deadline for the submission of abstracts: **12 November 2021**.

following which information on the selected papers and further information will be circulated.

**Points of Contact**

Please send abstracts to the PoCs below. AC/327 will be pleased to advise you on the content of your paper, whereas Mittler Report Publishing is in charge of all organisational aspects.

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# US Army Howitzer Shoot-Off

## Which System Will Win the US Army Competition?

**John Antal**

Methods of warfare are changing rapidly, and the US Army faces a problem. The Second Nagorno Karabakh War, in late 2020, vividly demonstrated the power of precision fires in the modern battlespace. In that war, Armenian towed artillery became easy prey to the Azerbaijani top-attack kamikaze drones. Unable to “shoot and scoot” rapidly, and not adequately protected with Counter Unmanned Aerial Systems (CUAS) defence, the Russian-made towed D-30 122mm howitzers and D-20 152mm of the Armenian army were quickly discovered and devastated by Azerbaijani drones. The recent war in the Caucasus was the first war in history won primarily by unmanned systems – something of which anyone interested in military affairs should take note -- and the lessons of this war have far-reaching consequences that few in the west seem to recognise.

Witnessing the war in the Caucasus and having focussed on counterinsurgency warfare for the past twenty years, the US Army has seen that it is outgunned and outranged by the artillery of peer competitors such as China and Russia. As a result, the number one modernisation priority is long-range precision fires. The Chief of Staff of the US Army, Gen. James McConville, explained in an interview by the Center for Strategic and International Studies in March 2021, that the Army needs “long-range precision fires, the ability to penetrate an anti-access/area-denial capability, [and] the ability to provide an anti-ship capability from land.” To meet these challenges, the US Army established a shoot-off

Photo: Serbian Ministry of Defence.



**The NORA-B52 155mm Wheeled Howitzer depicted in this photo is one of the competitors in the US Army's 2021 “shoot-off” competition completed in the fall of 2021. The NORA is considered one of the most successful products of the Serbian defence industry.**

### 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.



**For the US Artillery Fires competition the ARCHER system is presented integrated on an RMMV 8x8 truck.**

for production-ready artillery systems from developers from several countries. To field quickly and deploy long-range-precision-fires (LRPF) for its STRYKER and light units, the Army cannot wait for the usual ten-year programmatic development cycle to design and produce a new howitzer. Being behind the curve, it wants to pick from a group of existing wheeled howitzer systems that, if purchased, could be deployed rapidly to combat units to replace the shorter range, less survivable legacy towed artillery systems in its fleet.

The US Army shoot-off between the ARCHER, ATMOS, BRUTUS, CAESAR, and NORA systems involved 90 days at Yuma Proving Ground, Arizona, and was completed before November 2021. Prior to the competition, each system was rigorously evaluated. The firing tests included evaluation in the areas of mobility, fire control integration, compatibility with firing US Army projectiles. Here are the five systems that were invited to prove their capabilities to the US Army Field Artillery in 2021:

### ARCHER Mobile Howitzer

BAE Systems Bofors offered its ARCHER FH77BW L52 truck-mounted howitzer. BAE reports that ARCHER is based on the successful Bofors FH77 field howitzer, consisting of an automated 155 mm 52-calibre gun mounted on an RMMV 8x8 truck. The system is a fully automated, self-propelled 155 mm howitzer where loading, laying and firing are handled from inside the armoured cabin, offering full protection for the gun crew at all times. As with the other systems in the shoot-off, the maximum range for ARCHER with rocket-assisted EXCALIBUR ammunition is around 50 km. ARCHER also offers an optional Advanced Multispectral Camouflage System and in-



Photos: Nexter



***Nexter's CAESAR truck-mounted artillery system has both extensive combat record and an impressive sales record around the world, and is currently under consideration by the British Army, among others.***

cludes an ammunition resupply system with a support vehicle for a complete artillery solution.

### ATMOS (Autonomous Truck-Mounted Ordnance System) IRON SABRE

Elbit Systems of America entered their battle-proven ATMOS IRON SABRE 155mm truck-mounted howitzer to the US Army shoot-off. Accord to Elbit, ATMOS offers

the advantages of superior fire power, enhanced mobility and rapid response time. Highly adaptable, the modular ATMOS system is compatible with any 6x6 or 8x8 high-mobility tactical truck, although current models do not have an armoured cabin. According to Elbit, ATMOS supplies fire support for all types of missions and can be easily interfaced with customers' existing C4I systems. IRON SABRE incorporates an embedded electronic suite, automatic laying system and automatic loading system. This



Photo: Wikimedia, Ibaril, Stridsvagn12

***The ARCHER system, presented by BAE Systems Bofors, shown here on its customary Volvo chassis***

Photo: AM General



**The BRUTUS System, offered by AM General and Mandus Group, is the only wholly-American team in the competition.**

advanced electronic suite is claimed to enable accurate navigation and autonomous operation, reduced crew size, increased fire power and high precision accuracy. The shoot and scoot capability of the IRON SABRE is provided by a first round ability within 30 seconds of vehicle halt, and the system can fire 6 rounds in less than 110 seconds.

**BRUTUS**

The only fully US team in the competition, AM General and Mandus Group offered the BRUTUS. This is a 155mm truck-borne howitzer employing a "hybrid soft recoil" system to enable the weapon to be fired from a relatively lightweight truck chassis.

BRUTUS is based on the proven HAWKEYE 105mm mobile weapon system produced by AM General. The Brutus self-propelled howitzer is 7.6m long, 2.44m wide, and 3.5m high and the total weight of the 6x6 truck-mounted system is 14.8 tons. BRUTUS does not have an armoured cabin. According to AM General, BRUTUS has an "advanced digital fire control system featuring enhanced navigation, integrated muzzle velocity radar and improved sighting/targeting capabilities greatly enhances lethality."

**CAESAR System**

The 155m CAESAR is a wheeled self-propelled howitzer produced by Nexter

Systems from France. The name "CAESAR" is an acronym created from the French "CAmion Équipé d'un Système d'Artillerie" (translating to English as "Truck Equipped with Artillery System"). CAESAR is the main howitzer for French army artillery regiments and is also under consideration by the British Army for its Mobile Fires Platform (MFP) programme. The system can be fitted on a variety of 6x6 wheeled trucks and has been demonstrated integrated on a modified Tatra T-815 8x8 chassis. The French Army use the Renault (now Arquus) SHERPA 10 chassis. The French Army version of CAESAR does not have an armoured cabin for the crew, but Nexter is developing one. CAESAR was successfully deployed to Afghanistan, Iraq, and Syria to support French operations.

**NORA B-52 M21**

Florida-based Global Ordnance has teamed with Yugoimport of Serbia to enter the NORA B-52 155mm wheeled howitzer in the US Army "shoot-off." Developed by the Serbian Military Technical Institute in Belgrade, NORA is one of Serbia's most successful weapons exports. According to Global Ordnance, the system features a fully automatic auto loader and a shoot and scoot under armour capability to protect the entire crew. The gun system has a maximum sustained rate of fire of 4 rounds/min. The system provides enhanced mobility and automatic loading. Marc Morales, President of Global Ordnance, LLC, expressed his interest in being invited to the competition: "This is an excellent opportunity to bring a fantastic piece of equipment at an unmatched value to the US Army soldier. Global Ordnance is proud to be the company to offer the NORA and is excited to show the US Army what it can do in the shoot-off."

The US Army wants a more mobile, lethal, survivable, wheeled 155mm howitzer system that is a production-ready system to replace its legacy towed howitzer fleet. In addition, the US Army's emerging doctrine, Multi-Domain Operations, requires a robust Long Range Precision Fires (LRPF) force to negate enemy fires and support cross-domain operations of air and naval forces. No shoot-off winner has yet been declared and the announcement of results from the contest are pending: the Army is keeping its cards close to its chest. Once the findings are announced, the winners may be asked to conduct further tests or to provide proposals for production, delivery, fielding, training and support to the US Army.

Photo: Elbit Systems of America



**The ATMOS IRON SABRE offered by Elbit Systems of America, shown here at the Yuma Proving Ground, is one of the last five contenders.**

# Sol-Air Moyenne Portée/Terrestre (SAMP/T) SAMP/T NG

## A New European Long Range Ground-Based Air Defence System

### A Game Changer

SAMP/T NG is the new generation of SAMP/T system that is in service with the French Air and Space Force and the Italian Army. SAMP/T NG has already been ordered by France and Italy, and will be delivered from 2025.

The SAMP/T NG is designed to protect armed forces and sensitive civil or military sites against new challenging threats -and also to be a strategic system. It is a game changer with its ability to guarantee air sovereignty, to counter all types of threats simultaneously including supersonic and ballistic missiles, and to support new operational concepts such as advanced A2/AD (Anti-Access / Area Denial).

### Strategic Capabilities

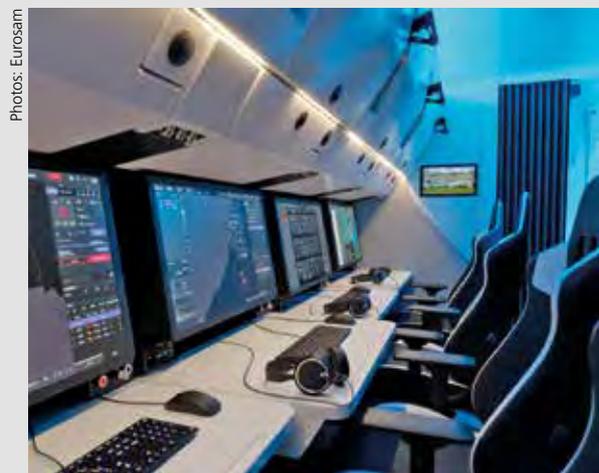
The SAMP/T NG has unique strategic capabilities, combining 360° protection; detection range in excess of 350 km and interception of air-breathing targets beyond 150 km; detection and interception of manoeuvring ballistic missiles at ranges beyond 600 km. The system can operate in a dense civilian air environment, cooperating with friendly

military aircraft. It can be fully integrated into national air defence networks and is fully interoperable with NATO / coalition systems. In addition, SAMP/T NG offers dual capability simultaneously to defeat all types of targets, in any combination; it counters emerging and future threats as diverse as manoeuvring ballistic missiles, re-entry vehicle ballistic missiles, hypersonic missiles, UAVs and highly manoeuvrable aircraft, in a saturation attack scenario and a challenging cyber environment. It can be quickly deployed by a small crew, is easily integrated in an air defence network, and can be intensively operated with limited support.

### State of the Art Systems

The European SAMP/T NG has four main components and will benefit from state of the art technologies:

- An enlarged ASTER family including enhanced missile: the ASTER Block 1 New Technology missile addresses new and emerging threats, from short to long-range missions including self-defence. After launch, the ASTER missile is inertially guided using target data transmitted by the SAMP/T system. The final homing phase is achieved by an active seeker, providing a highly accurate capability in all weathers. The unique combination of aerodynamic and directed thrust vector control (PIF-PAF), means the missile is capable of high G manoeuvres, giving an unmatched hit-to-kill capability.
- A new 360° multifunction radar with a rotating Active Electronically Scanned Array Antenna based on GaN technology with “on the edge” signal processing management - Ground Fire 300 or Kronos Grand Mobile High Power. This guarantees high probability of detection and tracking precision, even in heavy clutter & counter-measure environments. It can simultaneously track more than 1000 air-breathing or ballistic missile targets, yet can deploy in less than 15 minutes with only 2 operators. It complies with high mobility requirements by civilian road or rail infrastructure, and by ship or aircraft as a standard 20' ISO container.
- A command and control module based on upgraded open command and control software architecture and enhanced



Photos: Eurosam  
Command centre of the SAMP/T NG system

connectivity. A team up to four people manages the sensors and networks in order to create an integrated air and space tactical picture and to benefit from the latest technologies for decision-making and weapon assignment. The system is also fully compliant with the latest regulations in term of Information security and access control.

- An upgraded vertical launcher with new electronics to enhance the key SAMP/T NG advantages: 360° launch; automatic deployment; remote control; a highly effective missile; and high rates of fire.

### European Industry

**eurosam** was established in June 1989. A joint venture of MBDA France, MBDA Italy and Thales, European leaders in air defence, **eurosam** is the industrial prime contractor and system design authority for the development, production, marketing, sales and in-service support of a range of medium and long range naval and ground-launched air-defence missile systems. These systems were developed to meet converging operational requirements of the French and Italian Governments. The cooperation, including the UK from 1996, has achieved export successes, in both naval and land configurations. On 19 March 2021, the SAMP/T NG contract was awarded by OCCAR to the **eurosam** consortium.



ASTER missile firing at the DGA test range at Landes

# Identification Friend or Foe

**Thomas Withington**

**"Mode-5" sounds like a devious plan hatched by a James Bond super villain. It is in fact something more prosaic; an Identification Friend or Foe protocol.**

The need to discern the goodies from the baddies is as old as war itself. So-called 'blue-on-blue' incidents are tragic both for victim and perpetrator. They are horribly likely to occur and history is replete with examples: The War of the Roses (1455 to 1487) saw the Houses of Lancaster and Tudor pitted against the House of York as

the Lancastrians after his own side mistook the emblems on his banner with those of the Yorkists. The debacle plunged Lancastrian morale and help the Yorkists win this decisive battle. 20 days later, the Lancastrians were finally defeated during the Battle of Tewkesbury fought in Gloucestershire, central England. The Lancastrians lost and

Both TORNADO crewmembers were killed. The tragic incident was partially blamed on the jet's faulty IFF system. IFF has been intrinsic to air power since the Second World War. Germany, the UK and the US all deployed IFF equipment to help keep their aircraft safe from their own side's itchy triggers. The RAF fielded one of the first IFF systems. Employing elegant simplicity, the apparatus equipped an aircraft with a radio receiver. By the eve of the war, the RAF had built a chain of radars along much of England's southern and eastern coasts. These could look circa 86 nautical miles/nm (160 kilometres) outwards over much of continental Europe's Atlantic coast. If the Luftwaffe was assembling formations of bombers en route to targets in the UK, these Chain Home radars would detect them. This early warning gave RAF fighters enough time to scramble and reach the best place in the sky to intercept the bandits. There was just one problem: Chain Home radars could not distinguish RAF and Luftwaffe planes.

## SSR

IFF was the solution. When the RAF aircraft's IFF transponder detected a Chain Home radar pulse it sent a coded reply. This would tell the radar operator that the target they had detected was friendly. This beautifully simple, yet effective approach formed the template for future IFF systems. Today, these systems retain those basic principles.

For understandable reasons, IFF interrogators equip an array of platforms, typically any tasked with engaging hostile military aircraft. This includes fighters, SAMs, radars, Airborne Early Warning (AEW) aircraft and vessels performing anti-air warfare. IFF transponders equip military aircraft and warships to indicate that they are friendly.

## Air Traffic Control

One IFF spin-off was Secondary Surveillance Radar (SSR). The development of IFF technology and SSR are entwined. Sec-



Photo: NATO

**NATO's E-3A Sentry AEW aircraft have been upgraded with Mode-5 compatible IFF interrogators. Other NATO nations are making similar efforts with their military aircraft.**

both camps fought for the English throne. The war witness the Battle of Barnet near north London on 14 April 1471. The Houses of York and Lancaster were locked in mortal combat. The Earl of Oxford was leading Lancastrian forces. He was fired upon by

King Henry VI, the reigning Lancastrian was disposed. Victorious, the House of Tudor would rule England for the next 118 years.

The passage of time has not dulled the blue-on-blue spectre when swords cross. The postmodern era is not shorn of this menace. Fast forward five centuries to when a Royal Air Force (RAF) TORNADO GR4A ground attack jet was downed by a US Army Raytheon MIM-104 PATRIOT Surface-to-Air Missile (SAM). The plane was hit during the opening stages of Operation Iraqi Freedom on 22 March 2003.

## Author

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

Secondary surveillance radar plays a key part in Air Traffic Control (ATC). Civilian aircraft are equipped with a radio transponder. The SSR will send out a request for the aircraft's identity, known as an interrogation, on a frequency of 1.030 Gigahertz/GHz. The aircraft will receive the interrogation and send a reply, known in the trade as a 'squawk'. The squawk is transmitted back to the SSR on a frequency of 1.090GHz. It contains details of the aircraft's identity and altitude. SSR works with a Primary Surveillance Radar (PSR). The PSR sweeps the sky and detects aircraft. These show up on the air traffic controller's screen tracks. Without SSR, these tracks would be nothing more than lines moving across a radar screen. Information obtained by the SSR is superimposed on these tracks. By fusing together the PSR and SSR information, a controller sees not only an aircraft's location and heading but also its identity and altitude. Mounting the SSR antenna atop the PSR antenna aids this fusion, as the former will see in exactly the same direction as the latter.

### The ATC Advisory Committee

The fact that IFF and SSR are cousins has influenced the trajectory of recent identification friend or foe developments. Mode-5 and Mode-S are new closely related IFF and SSR protocols. Back in 1968, the US Department of Transportation was concerned over increases in air traffic and corresponding increases in the dangers of mid-air collisions. Like many big organisations confronted with a serious problem, they formed a committee. The resulting Air Traffic Control Advisory Committee (ATCAC for short) was tasked with examining future ATC technologies. To aid their quest, they reached out to the Massachusetts Institute of Technology's Lincoln Labs. A crucial requirement of the Department of Transportation was that any new technology had to be compatible with the US' existing ATC infrastructure. Another consideration was that future technologies had to take into account expected growths in air travel in the 1980s and 1990s. One major issue was that squawks could become 'garbled': Two aircraft in close proximity squawking at the same time to the same interrogation risked the SSR receiving an unclear reply. This could fox controllers on the identity and altitude of these aircraft, risking potentially disastrous misunderstandings. A way had to be found to ensure that aircraft close together did not give garbled squawks to an SSR interrogation.

In 1971, the US Federal Aviation Administration signed a contract with Lincoln Labs to help develop the new ATC infrastructure. Lincoln was to develop a radio frequency beacon system satisfying these needs compatible with existing ATC infrastructure. A solution to the garbled squawks was found. Each aircraft would have a unique identification code, much like a telephone number.

Each interrogation from the SSR would be addressed to a specific aircraft based on its ID code. A reply would only be sent by the transponder the interrogation was addressed to. The approach stopped every aircraft in the vicinity of the SSR replying to every interrogation request. This greatly reduced congestion on the squawk frequencies of 1.090GHz. Crucially, the new transponder protocol could still reply to legacy SSR interrogations.



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Photo: Thomas Withington



**The antenna for a secondary surveillance radar can be seen here atop the antenna for the primary surveillance radar. The development of SSR and IFF are closely intertwined.**

### Mode-S

Design work for this proto Mode-S architecture finished in 1975. Work received additional impetus in 1993. The US Congress mandated Traffic Collision Avoidance Systems (TCAS) for all passenger aircraft carrying over ten passengers. TCAS used Mode-S RF transmissions to ascertain the position of one aircraft relative to another. As all aircraft flying in US airspace had to have TCAS, it began to spread around the world. Given TCAS' reliance on Mode-S, this correspondingly helped the proliferation of the latter. In the US, Mode-S formed the basis of the FAA's Automatic Dependent Surveillance-Broadcast (ADS-B) ATC scheme. Quite simply an aircraft periodically broadcasts its identification, altitude and position using its Mode-S transponder, irrespective of SSR interrogations. SSRs and other aircraft receive these transmis-

sions and their accompanying information. ADS-B makes good several of the TCAS' inaccuracies: Position information articulated by ADS-B is derived from the aircraft's Global Navigation Satellite Signal (GNSS) receiver. Although the brief for Mode-S emphasised the use of existing infrastructure, airports and ATC centres are equipped with ground stations to receive these transmissions. ADS-B is now proliferating around the world and with it Mode-S. Regarding the aircraft's unique address, blocks of codes are allocated to each International Civil Aviation Organisation member state. The country will then allocate specific codes to aircraft registered there. There is little chance of the world's air fleet running out. The 24-bit coding used ensures that over 16.7 million codes are available. If the aircraft changes the country where it is registered, its address will correspondingly change.

### Mode-5

In a nutshell, Mode-5 is a secure version of Mode-S. It is mandated throughout NATO (North Atlantic Treaty Organisation) via the alliance's Standardisation Agreement-4193 (STANAG-4193). Unlike Mode-S, Mode-5's interrogations and squawks are encrypted. As a written statement supplied by NATO notes "Mode-4 was limited to identifying friendly aircraft by receiving the right reply to the corresponding Mode-4 interrogation". Athanasios Chouliaras, an aerospace and defence consultant, says Mode-5 "replaces the legacy Mode-4 IFF, which uses Morse code-like signals for military identification". An article published on the Tel Instrument Electronics Corporation website gives a summary of Mode-5's development and adoption. Mode-4 was introduced in the 1960s. It was originally called IFF Mk.XII. As it used US Mode-4 cryptography it became known as Mode-4 IFF. This IFF standard was adopted throughout NATO and several allied nations. In 1995, the US Joint Chiefs of Staff ordered a new IFF protocol to replace Mode-4. Unsurprisingly, this became known as Mode-5. In 2002 NATO ratified STANAG-4193. This mandated Mode-5 throughout NATO. The development of Mode-5 was led by the US Navy. The navy was in turn assisted by an international working group of NATO nations. Several companies have since become involved in the design, development and manufacture of Mode-5 IFF systems. Alongside the Tel Instrument Electronics Corporation, these companies include BAE Systems, Hensoldt, Leonardo, Raytheon, Sagetech Avionics, Telephonics and Thales. Although the US Navy was midwife to Mode-4's birth, responsibility for the protocol passed to the US Air Force. Although Mode-4 is no longer certified for NATO use several allied nations like India and South Africa continue to use the protocol. Hence, it continues to be supported for those nations. The air force also ensures all Mode-5 hardware and software meets the requisite STANAGs. Mode-5 expands the information carried by the squawk vis-à-vis Mode-4: "The new Mode-5 system constitutes a limited datalink system. Not only is it able to identify friendly aircraft, but it also receives extra information" on an aircraft's identity and position, says NATO's statement. As Tom Furey, chief executive officer of Sagetech Avionics notes: "Mode-5 provides better perfor-

mance and security than Mode-4, and added two-way data transfer using secure waveforms, containing encrypted GNSS and other flight information about the interrogated aircraft." It also provides a step-change in terms of performance: "Mode 5 ... allows interrogators to identify friendly aircraft IFF systems at longer ranges (compared to Mode-4), using a secure, encrypted code." This range improvement eliminates another Mode-4 shortcoming, says Mr. Chouliaras. The previous system suffered limitations identifying friendly aircraft at long distances. This was especially acute when flying in close formation. Usefully, by virtue of its architecture, Mode-5 is interoperable with Mode-S. This ensures military aircraft can travel with ease through civilian controlled airspace. Encryption is at the heart of Mode-5. Sagetech is involved in the manufacture of Mode-5 IFF transponders. Mode-5 IFF systems need cryptographic computers to secure the interrogations and squawks: "The cryptographic computer is loaded with codes that change every few seconds ... and provides the parameters of encryption and decryption to the transponder," says Mr. Furey. Mode-4 used to change its code once a



Photo: MEADS International

**Alongside aircraft and warships, ground and surface platforms like SAM systems and warships also use Mode-5 interrogators to ascertain the identity of air targets.**

day. As the coding for Mode-5 changes every few seconds, this is much more secure, argues Mr. Chouliaras. This rapid change of coding is achieved through the use of Time of Day (TOD) authentication. Mode-5 cryptographic equipment is available from General Dynamics, Hensoldt and Raytheon.

### Additional Equipment

Other equipment required for Mode-5 transponders includes a link to the aircraft's GNSS receiver. Aircraft also need dorsal and ventral antennas to ensure full spherical Mode-5 coverage. This is important to guarantee that any interrogator can receive IFF squawks regardless of the aircraft's aspect relative to the interrogator. For example, an AEW aircraft at a higher altitude may be sending the interrogation. This would be received

by another aircraft's dorsal antenna and replied to using the same. Conversely, an interrogation may be received from a ground-based air surveillance radar. This would be received and replied to using the ventral antenna.

### Compatibility

The Mode-5 IFF protocol is not compatible with Mode-4. As such, all NATO platforms needing to carry an IFF transponder must be physically upgraded with new Mode-5 IFF equipment. Mode-4 was officially 'decertified' on 30 June 2020. This now makes Mode-5 the only standard IFF system in NATO service. NATO has upgraded its fleet of Boeing E-3A Sentry AEW planes with Mode-5 interrogators, said its statement. Beyond this, responsibility for rolling out Mode-5 equipment across platforms falls to individual NATO members. NATO thus shies away from predicting when the implementation of Mode-5 will be complete: "It would be premature to say when the process will be complete across the Alliance, but work is underway." Mode-5 is an unsung, yet vital, part of how NATO reduces the danger to its assets from blue-on-blue incidents. The alliance emphasised in its statement that "Mode-5 IFF is a fundamental component of how NATO provides security to its members. It is a significant demonstration of the allies' collective commitment to safeguarding NATO airspace." ■



Photo: Sagetech Avionics

**IFF transponders are now available for uninhabited aerial vehicle platforms where space and weight is at a premium. Sagetech Avionics' MX12B is one of the smallest and lightest systems on the market.**

# On Target – Advances in Small Arms Sights

**David Saw**

**At first sight, the small arms sector is one where mature technologies hold sway and technological innovation is rare. Recently, however, there has been much innovation in the sector.**

If you were to look at the military small arms sector in a rather superficial manner, you might conclude that real progress has been something of a rarity. For example, the standard NATO 7.62x51 mm round was standardised in 1954, with the US standardising the 5.56x45 mm round in 1963, while the NATO standard 5.56x45 mm SS109 round developed by FN Herstal was standardised in October 1980 - some 41 years ago. As such, there is not much evidence of visible change in the context of small arms ammunition.

Regarding small arms themselves, the evidence suggests very little change having taken place. The M16 rifle is arguably the dominant western assault rifle. It was first ordered in 1963 for the US Army, with production starting in 1964, and first deliveries in 1965. The M16 was developed from the AR-15, which had first seen combat in South Vietnam in 1961, so it would therefore seem fair to say that the dominant western assault rifle is a 60-year-old weapon. On the other hand, it could be pointed out that the current version of the M16 family used by the US military is comparatively less aged, as the M4 carbine was only selected in 1994.

## Modifications Only

All of this would seem to indicate that the small arms sector is one where mature technologies hold sway and technological innovation is rare. There was a point where you could make an argument that all of this was true, though fortunately this argument only covers part of the story. In fact, there has been much innovation in the small arms sector, as the M4 has had nearly 100 modifications since it entered service, resulting in increased performance and a vastly reduced failure rate. Ammunition performance has also improved markedly. The latest rounds fit the standardised

Photo: Corporal Dean Lynam, Canadian Forces Photo



**3<sup>rd</sup> Battalion, The Royal Canadian Regiment (RCR), on an airmobile exercise in Ontario in June 2021. Note the ELCAN SPECTER OS, otherwise designated as the C79, on the Colt Canada C7A1 assault rifle.**

calibre dimensions, but offer increased range and penetrative power.

The primary contributing factor in advances in the small arms sector has been 20 years of war in Afghanistan since the commencement of Operation Enduring Freedom in 2001. Afghanistan, followed by Iraq, and then the expansion of the fight against terrorism to a global conflict, has created an environment where evidence from combat operations leads to new requirements and the money is available to turn those requirements into reality. In this environment, there is innovation, not just in how systems are being built by taking advantage of improvements in materials, optical, electro-optical and electronics technology, but also in how we look to meet operational requirements.

## Fundamentals

To obtain an understanding of where we are now in terms of small arms sights and where we could go in the future, it is necessary to look at the evolution of small arms and the requirements that drive that evolution, and in turn the combat experience that drives the generation of requirements. The starting point for this analysis comes with the realisation that the bolt-action rifle and its full power round were not the optimum small arms solution for the infantry. Instead, the evidence pointed to the intermediate round, such as the German 7.92x33 mm Kurz and the Soviet 7.62x39 mm M43 rounds, as the optimum solution. In turn, these rounds prompted the arrival of the modern assault rifle.

In terms of sights, quality optics were expensive and therefore an optical sight was generally only issued to a sniper and attached to a selected highly accurate rifle. One of the first attempts at developing a night sight capability came from Germany, in the Zielgerät 1229 VAMPIR. The system entered service in limited numbers in 1944, issued to snipers and later integrated with the MG34 and MG42 machine guns. The sight was then integrated with the Sturmgewehr 44, arguably the first modern assault rifle, and used in combat from February 1945 onwards. The system consisted of an infrared light, an optical sight and a very heavy 15 kg battery pack carried by the operator. VAMPIR worked, but it was very cumbersome, and true night sights would only start to be a real possibility many years later.

The British Army looked to introduce a new rifle to replace its standard bolt-action rifle and submachine gun, which resulted in the EM2 rifle in the intermediate 7x43 mm calibre. What was significant about the EM2 was that it had an integrated optical sight. The EM2 was an excellent weapon, a true assault rifle, although expensive, but some senior officers criticised it because its cartridge was not powerful enough for long-range accurate target engagement. Such engagements were a rarity rather than the norm, and across the vast majority of engagements a properly set up rifle with an optic would be far more accurate than a conventional rifle. As is commonly known, US Army pressure resulted in NATO adopting the 7.62x51 mm round as standard in 1954, and consequently, Britain dropped the



**In January, the US Marine Corps began fielding the new Squad Common Optic (SCO), shown here integrated with the M27 Infantry Automatic Rifle (IAR). The SCO is the Trijicon Variable Combat Optic Gunsight (VCOG), a 1-8x28 optic, and will replace the Trijicon ACOG optic in service.**

EM2 and adopted the FN FAL in 7.62x51 mm. They did not fit the FAL with an optic, and Canada also adopted the FAL, though initially had an optic on the weapon, but this was subsequently discarded. NATO therefore had battle rifles with an over-powered cartridge that allowed for long-range engagements, but the vast majority of infantry have to make do with iron sights, which reduces the successful outcomes in such engagements.

### Into the Night

It was the 1960s and the Vietnam War that saw the integration of a relatively effective night-fighting capability with small arms. By 1967, the US Army had started to field the AN/PVS-2 STARLIGHT scope, an image intensification system, which was a first generation device offering adequate performance. By the end of the 1970s, GEN II devices such as AN/PVS-4 were available, with these remain-

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Photo: Elbit Systems



**The Elbit Systems Assault Rifle Combat Application System (ARCAS) offers an integrated solution consisting of a built-in computerised Artificial Intelligence (AI) powered system.**

ing in service post-2000. The arrival of GEN III tubes offered higher reliability and improved performance leading to such systems as the AN/PVS-17 Miniature Night Sight (MNS). Further development led to GEN III OMNI V–VII tubes and the resultant performance improvements. In terms of night-fighting capabilities from the 1960s onwards, there have

been important progress in technology and this has translated into major performance gains in night sights. Earlier generation systems were unreliable and tiring to use, unlike the current generation of systems. Perhaps the most important change in terms of night vision has been that of affordability. It was not that long ago that night vision devices, such

as goggles and sights, were so expensive as to preclude widespread issue. This is no longer the case and, as a result, western armed forces have gained significant operational advantages due to enhanced night-fighting capabilities.

Night vision technologies are more readily available than before, both in terms of military grade and commercial grade systems. Inevitably, this has seen the proliferation of such capabilities and predictably, that has started to erode some of the night-fighting advantages enjoyed by NATO and allied forces. On the other hand, as long as the pace of technological innovation continues, then the night-fighting advantage will still be a critical factor in combat.

### Optical Path

History repeated itself in the 1970s when Austria took into service the Steyr AUG (Armee Universal Gewehr) with its integrated Swarovski 1.5x optical sight. Elsewhere in the mid-1970s, the British introduced the L2A2 Sight Unit Infantry Trilux (SUIT); this was a 4x optical sight designed for daytime or low light conditions, and was adopted by the UK, Australia and New Zealand. In British service, it was used on the SLR (the British version of the FN FAL) and the GPMG (the British version of the FN MAG), but it was not widely deployed.

Things changed for the British when they adopted a new assault rifle in the mid-1980s in the form of the L85 in 5.56x45 mm calibre that came equipped with the L9A1 Sight Unit Small Arms Trilux (SUSAT), a 4x optic. Ironically, while the original L85 was a pretty horrendous weapon, the SUSAT was a fairly good optic. More than 30 years after they sought to provide their assault rifles with an optic, the British finally achieved that goal with the SUSAT.

The Canadian Armed Forces decided to replace their version of the FN FAL battle rifle, the C1 and the C1A1, in the mid-1980s with a 5.56x45 mm rifle that would be based on the Colt 715 and modified to meet Canadian needs. This resulted in the C7 assault rifle and later the C8 carbine. Like the British, the Canadians wanted to provide their new rifle with an optic and they selected the ELCAN SPECTER OS, a 3.4x optic that they classified as the C79. The C79 was attached to the weapon via a Weaver rail, but this was subsequently replaced by a MIL-STD-1913 Picatinny rail. US Special Forces have been the catalyst for much of the development of optics, night sights and rails. Evidence of what



Photo: Crown Copyright

**Rifles on exercise at the Sennybridge Training Area prior to deployment to Afghanistan in 2019. The British L85 assault rifle was originally equipped with the SUSAT optic, though a number of Trijicon ACOG optics were later acquired for Afghanistan, followed by a significant number of ELCAN SPECTER OS optics.**

can be achieved can be seen with the United States Special Operations Command (USSOCOM) Special Operations Peculiar Modification (SOPMOD). SOPMOD was an evolving series of kit designed to add sight, both day and night, and a host of other capabilities that could be integrated with the M4 carbine and the FN SCAR. As the SOPMOD programme evolved, other Special Forces' weapons, including different rifles, light and medium machine guns and crew-served weapons were included. Operators select the appropriate options for their mission from the range of systems in the SOPMOD package.

The Block 1 SOPMOD package used the Knight Armament Company (KAC) Rail Interface System (RIS). Also included were the Trijicon Advanced Combat Optical Gunsight (ACOG), the Aimpoint CompM2 mount for the AN/PVS-14 monocular night vision device, Insight Technology AN/PEQ-2 infrared target pointer, illuminator, aiming laser and the Visible Light Illuminator (VLI) and the Trijicon reflex sight. Other options included the Insight Technology AN/PEQ-5 visible laser sight and the AN/PVS-17A MNS.

Improvements to Block 1 included a new RIS, with Insight Technology supplying the SU-233/PVS and SU-238/PVS gun lights. Also included were the EOTECH SU-231/PVS holographic weapon sights, SU-237/PVS ACOG and the AN/PVS-17A product improvement kit. The Block 2 package had the SU-232/PAS CNVD-T thermal sight, SU-231/PEQ holographic weapon sight, XPS-3 weapon sight, G33 magnifier, SU-230/PVS ELCAN SPECTER DR 1-4x optic and the L3Harris AN/PVS-24 clip-on night vision device. Further SOPMOD enhancements were integrated as requirements and systems evolved.

The SOPMOD effort commenced in the mid-1990s and it helped to drive the technology of sights forward and created the environment where conventional forces saw the utility of many of these sights and associated systems and took them into service. Finally, it seemed that the age of small being equipped with nothing more than iron sights was coming to an end in the more sophisticated conventional forces around the world. All of a sudden, Picatinny rails were sprouting all over assault rifles and there seemed to be no end to what soldiers were prepared

to attach; optics, magnifiers, night sights, laser target pointers and tactical lights being the most common add-ons.

Once Western forces became embroiled in ground combat operations in Afghanistan and Iraq, the demand for improved sights grew rapidly. For the British Army, combat operations in Afghanistan saw the issue of an Urgent Operational Requirement (UOR) covering the acquisition of the Trijicon ACOG to replace the SUSAT. Later, a more conventional procurement effort saw the acquisition of the ELCAN SPECTER OS, the Shield Close Quarter Battlesight (CQB) and Qioptiq thermal and night sights.

The US Marine Corps had earlier adopted the Trijicon ACOG in 2004 as the Rifle Combat Optic (RCO), and more recently, the US Marine Corps looked for an RCO successor system in the Squad Common Optic (SCO) programme. In January this year, they started fielding the SCO system having selected the Trijicon Variable Combat Optic Gunsight (VCOG), a 1-8x28 optic, to fulfil this requirement.

Another user who solved its evolving optic requirements by turning to its existing supplier was Denmark. In the mid-1990s,

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Photo: Calvin Reimold, US Army

**An M249 5.56x45 mm Squad Automatic Weapon (SAW) on the range at Fort Devens, Massachusetts.**

the Danish Army selected the Colt Canada C7A1 as its new rifle (GEVÆR M/95) and then took the C8A1 carbine into service as the KARABIN M/96. In parallel, they adopted the ELCAN C79 as their optic. In 2010, Denmark ordered a new variant of the Colt Canada rifle with an integrated upper receiver, with the weapon classified as the GEVÆR M/10, which became the primary service rifle. Denmark has now taken delivery of the ELCAN SPECTER DR 1-4x optic for its rifles and M60E6 machine guns, with their M2HB heavy machine guns equipped with the 1.5-6x version of the SPECTER DR.

**Future Prospects**

Lessons from Afghanistan and other combat operations have led to a rethink on a number of issues regarding small arms. Previously, the assumption was that most engagements would take place at distances up to 300 metres, but that has since changed and we are now looking at distances up to 600 metres and perhaps beyond. This has created a need for higher performance ammunition and, of course, for more effective sights. Another issue was ammunition expenditure, which was far higher than anticipated, but the effects did not reflect the amount of ammunition expended. Obtaining more effects per round expended was another argument for improved sights

and for improved fire control devices. The infantry soldier was already overburdened with too much weight, so if that could be reduced by maximising the utility of the ammunition carried, it would make a positive contribution to reducing the overall weight burden. In a related move, ammunition weight could be further reduced, for example, by the use of plastic cases.

Later in the Afghanistan conflict, the capabilities of the Taliban started to improve; for example, some Taliban groups began wearing body armour. The solution to these hardened targets was higher performance ammunition and, of course, better sights. Night combat remained an advantage for western forces, but again the Taliban started to acquire some night capabilities, meaning the solution was to improve the dependability and performance of western night sights and other night vision equipment.

As we know, there are currently very few limits on what can be attached to small arms in terms of sights and other accessories. To that end, we must add suppressors that are applied to small arms to reduce signature, which can be regarded as a positive, but on the downside, this adds more weight and size to the weapon. It is advisable not to add too much weight to the weapon and avoid any impact on its fit and form. An obvious solution is to reduce the weight of each of the items that

can be added to the weapon, plus the requirement to reduce the weight of the batteries needed to power these items. Or we can look to have an integrated fire control system that includes all of the systems needed in terms of sights and related equipment in a single system.

The integrated fire control system appears to be the path to the future for small arms. A trend confirmed by the US Army Next Generation Squad Weapons (NGSW) programme to replace in-service US Army small arms, with its NGSW-FC fire control system element for which L3Harris and Vortex Optics are competing. ELCAN has developed their own fire control solution in the form of the SPECTER Digital Fire Control Sight (DFCS) and the system is already being evaluated by a number of NATO armies on different small arms platforms.

Another option in the integrated fire control system area comes from Elbit Systems with their Assault Rifle Combat Application System (ARCAS), which is described as “a built-in computerised Artificial Intelligence (AI) powered system that interfaces with the rifle’s Electro-Optical (EO) sight, with a helmet mounted eyepiece and with the rifle’s assemblies, providing soldiers with real-time intuitive actionable combat information.” The ARCAS computer is integrated with the forward grip of the rifle, and receives and integrates data from the user’s EO sight, tactical information from C2 systems, data from other ARCAS users and information on the status of the user’s weapon. The user can view this data as an overlay on the EO sight picture or via an eyepiece mounted on the helmet. ARCAS can include thermal or low light sights, or interface with existing EO sights. The system has built-in growth potential and can also run third-party applications according to Elbit.

Where ARCAS is interesting is that it offers the opportunity to increase the situational awareness of the user and maximise the weapon’s potential. Beyond that, it offers another way to integrate the infantry soldier into a digitised operational environment.

Clearly, we are entering a future where just integrating an optic with the standard assault rifle is no longer enough. If integrated fire control systems can deliver the ability to acquire and accurately engage targets at the desired battle ranges in both day and night conditions, then this is the way forward. However, these integrated fire control solutions must not impose a significant weight burden and must be fully reliable in terms of fit, form and function. ■

# Addressing Military Bridging and Gap-Crossing Requirements

**Tim Guest**

**Crossing wet and dry gaps for any military requires engineering know-how and sufficient suitable bridging equipment and systems to span the numerous gaps that will be encountered in a major conflict.**

**M**ilitary bridging is high on the agenda of many allied militaries across Europe, with programmes and projects underway and established processes and test protocols in place defining what is required if a bridging system is to be adopted and deployed. This article looks at design and test code aspects for military bridging systems, the status of a current gap-crossing competition underway in the UK, along with certain significant industry and military unit milestones and developments.

## Bridging Need Scene Setting

Across the European theatre of operations, dry and wet-gap obstacles, from streams and tributaries to major rivers such as the Danube, the Rhine and the Elbe, as well as dry gullies and gorges, present the armies of NATO and its allies with the challenge of being able to deploy sufficient tried and tested bridging capabilities, should the need arise, to move any and all equipment and vehicles needed over such obstacles and onwards to wherever the front line of any future conflict in Europe might be.

While there is a wide variety and some highly capable bridging systems currently in use within NATO, such as the M3 rig, improved ribbon bridging equipment, medium girder bridging, armoured vehicle launched bridge (AVLB), the Leguan bridge layer to name but a few, the quantity of such systems, according to certain engineer general staff within NATO, is below what would be needed to span all the obstacles an allied army will encounter moving back and forth across Europe in a conflict, were even a fraction of the bridges spanning rivers and gaps degraded or destroyed.

And even with bridges intact, many will be unable to support the tonnage of modern tanks whose military load classifications (MLC), often between MLC 80 and MLC 95, far exceed those of their ancestors whose tonnages were more than adequately handled by most of Europe's bridges built since WW2, which can mostly



Photo: KMW

**Military bridging is high on the agenda of many allied militaries across Europe. Pictured: Krauss-Maffei-Wegmann's LEGUAN AVLB is also offered on the LEOPARD 2 chassis, which can carry and deploy a single 26 m bridge, or two 14 m bridges with a load classification of MLC80.**

cope with vehicles up to MLC 70.

To meet this challenge NATO and its allies need urgently to increase the quantity of bridging systems available and, at the same time, make sure new systems conform to, and meet, stringent and established requirements to ensure they are up to the job.

## Ensuring Needs Are Met

First published in 1974, the latest update to the 'Trilateral Design and Test Code (TDTC) for Military Bridging and Gap-Crossing Equipment', prepared for the design and testing of mobile military bridges and launch mechanisms and agreed between Germany, the UK and the US, was issued in March 2019. It is intended to ensure all bridging and gap-crossing equipment coming into service with these nations' armed forces is designed and made in accordance with a standard set of loading,

design and test parameters, as well as accepted materials, so that any new bridging system will, ultimately, meet user needs and can be readily manufactured.

Prepared by the Design and Analysis Group for Military Bridging and Gap-Crossing Equipment, the TDTC covers a wide array of such subjects as clear-span and combination bridging, pier support requirements, floating bridges and rafts, as well as looking at typical vehicle data that needs to be taken into account for design purposes and topographical matters when it comes to a physical gap or crossing and how factors such as temperature, local environment, altitude and anchorage available to crossing equipment must be considered in design and testing regimes. Loads and load combinations have also to be factored into equipment design to cover as many eventualities as might be encountered in any sudden or spontaneous operational eventuality.

Photo: WFEL



**NATO and its allies need urgently to increase the quantity of bridging systems available across the Alliance. In July, WFEL delivered the first of 17 new MGB Medium Girder Bridge systems (pictured) to the British Army's Royal Engineers.**

**Bi-lateral British-German Footnote**

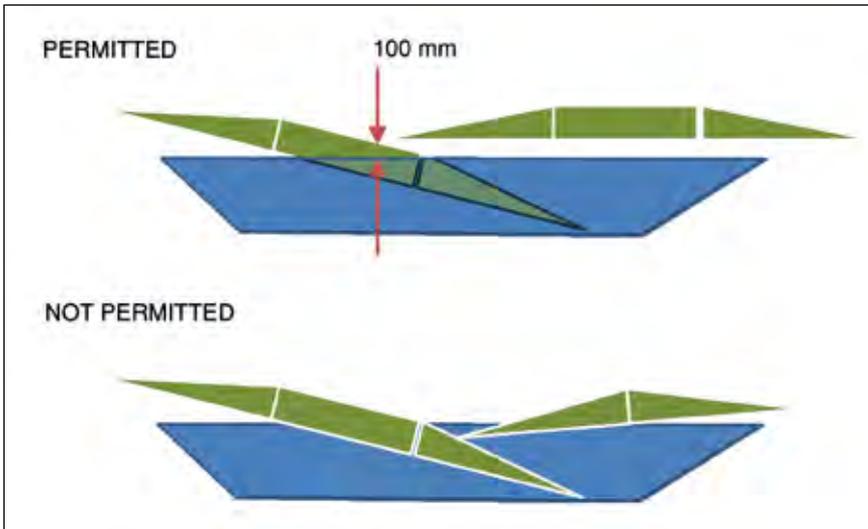
In October, the Chiefs of the British and German Armies attended a formal re-designation parade of specialist military engineers in Minden, Germany. General Sir Mark Carleton-Smith and Generalleutnant Alfons Mais, were the principal guests of honour at a joint German-British parade marking the formal establishment of the German-British Amphibious Engineer Battalion 130, setting a benchmark for integration and interoperability. Some 600 soldiers marched over two M3 Rig bridges and formed up to be officially re-designated, including troops from 23 Amphibious Engineer Squadron RE, formally based in Sennelager, but with equipment co-located at Minden. The new battalion is primarily focused on amphibious operation, though has other engineering capabilities. Both nations are currently the only ones in NATO to have the M3 rig, although Latvia has just signed a contract that will see it become the newest member in NATO to operate the M3.

Photo: Bundeswehr



On the safety side of things, the TDTC explores safety coefficients and fatigue factors relating to metals, composites and adhesives used in the manufacture of bridging equipment, as well as looking at operational safety issues such as floatation and stability, avoiding rotation and overturning and how anchorage points must be secure to avoid lifting. Systems' ability to be able to tolerate and withstand a degree of damage sustained during deployment or under enemy fire without becoming inoperable is also set out in the document with testing regimes to address all these areas and more.

The TDTC goes into great detail on a wide range of matters, from floating bridges and rafts, to specific sub-systems such as hydraulics that can be affected by altitude impacting launch and retrieve times, sometimes to such an extent that in extreme altitudes, bridge launch and retrieval may not be achievable. On the subject of combination bridging, for example, it states that this may be used across wet or dry gaps in situations where the clear span to be bridged exceeds the span capability of a single bridge system, thereby requiring two as a potential solution. That said, across wet gaps, the use of combination bridging on water is only permissible, according to the TDTC, under conditions where the maximum surface water speed at mid-stream does not exceed 1.5 m/s (2.9 knots). It can also only be used where, under its own weight (i.e. without any vehicles or other additional live weight crossing), the water level does not come within 100 mm (4 in) of any trafficable deck surface. The TDTC also stresses that combination bridges must not be launched without some form of non-metallic interface between the bridges in order to spread the anticipated live load and prevent slipping between metallic surfaces in wet conditions and under live vehicle trafficking where vibration along with vertical and sideways forces will be present. The TDTC for Military Bridging and Gap-Crossing Equipment includes extensive data sheets documenting metallurgical aspects and requirements of aluminium and steel for the manufacture of equipment, as well as detailed appendices with relevant force, weight, density, velocity, slope, pressure and other conversion tables tailored to the specific tasks of bridging and gap crossing. Its Appendix C, for example, sets out comprehensive and illustrated, tabulated details of the characteristics of hypothetical vehicles used for the rating of vehicle and bridge MLC in SI units. Latest data on composite and adhesive materials are also detailed in the TDTC's appendices.



Source: TDTC for Military Bridging and Gap-Crossing Equipment

also jeopardise the location's suitability as a crossing point if enemy forces pick up on the interest shown by the recon engineers. The project, run on behalf of the Defence and Science Technology Laboratory (Dstl), stated the wet gaps considered in the project to be as much as several hundred metres wide.

Enter project 'Map the Gap'; its aims include the removal of personnel from the recon task and, instead, envisage a semi-autonomous remote system that can conduct the required survey activities for either bank of a water gap and collect measurements of the potential crossing locale, but without deployment of personnel. This not only protects troops, but also provides the chance of more potential crossings being surveyed.

Four Phase 1 challenges had to be addressed by any solution proposal. Chal-

**Across wet gaps, the use of combination bridging on water is only permissible, according to the TDTC, under conditions where the maximum surface water speed at mid-stream does not exceed 1.5 m/s (2.9 knots).**

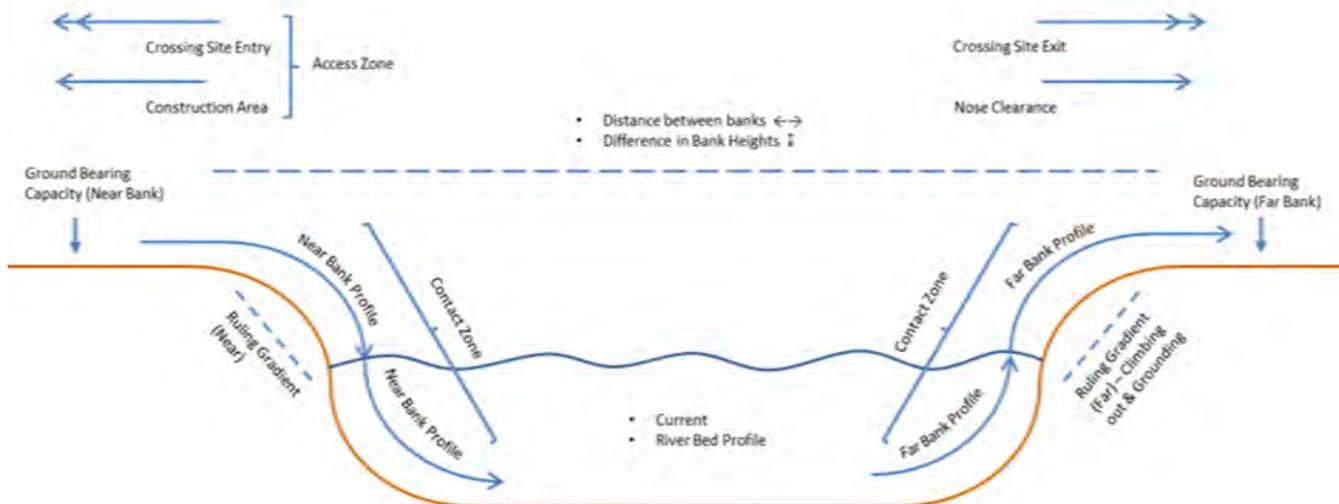
### UK Seeking an Autonomous Solution

While the TDTC addresses a plethora of traditional bridging and gap-crossing issues and equipment, a key operational challenge facing all engineers is that of recon for suitable crossing places. This is the subject of a current project in the UK, which has recently entered Phase 2. Launched in February last year when the UK MoD officially began Phase 1 of its Map the Gap project in which Defence and Security Accelerator, DASA, set out to find ideas for an 'autonomous' gap and water-crossing solution that addresses the dangers faced by engineers when conducting reconnaissance to find suitable crossing points. Such recon typically involves surveying both sides/banks of a wet gap or river, which not only exposes troops to potential enemy fire, but can



Photo: WFEL

**In June, it was announced that UK military bridge maker, WFEL, is to supply a number of its Dry Support Bridges (DSB – pictured) to the Philippine Army under the HORIZON 2 phase of the revised AFP Modernisation Programme.**



Source: UK MoD 'Map the Gap'

**Minimum gap crossing characteristics and measurements**

Photo: WFEL DSB



**WFEL is now the sole bidder for UK MoD's Military Bridging Project – Project TYRO. Project TYRO aims to provide UK Heavy Forces with Close Support Bridge (CSB) and General Support Bridge (GSB) capabilities for the Royal Engineers to cross wet and dry gaps.**

Challenge 1 was to measure the ground bearing capacity of the far bank of a wet gap obstacle, by taking an average of five readings with a tolerance of +/-50 kPa. Challenge 2 was to produce a bank height profile of the far bank contact zone, encompassing up to 2 m below the minimum waterline and 8 m inland of the bank edge. The profile to be produced

with a minimum horizontal resolution of 10 cm and vertical tolerance of +/-1 cm. Challenge 3 was to measure the gap width (between banks, with a tolerance of +/-5 cm) and the vertical difference in bank heights with a tolerance of +/-2cm and any proposals had to be able to cope with banks up to 300 m apart. And challenge 4 was to measure the local flow

rate of a river and produce a full riverbed profile for water depths of up to 3 m, and river widths up to 300 m.

Phase 1 contracts lasted about 10 months, with five SMEs funded to develop and test their solutions with the MoD, and culminated in a two-week demonstration of the systems – built to technology readiness level (TRL) 5 - Technology basic validation in a relevant environment - at a wet-gap site in the UK. The total funding for the Phase 1 bids was £1.2M. A drone-mounted system using electromagnetic scanning was put forward by Scytronix; Wight Ocean demonstrated a bottom-crawling amphibious system; unmanned aerial system sensors along with data analysis capabilities were demonstrated by Nordic Unmanned; Digital Concepts Engineering demonstrated a combined UGV/UAV platform comprising multiple sensors for data acquisition, processing and presentation; and Foundry Cube partnered with Ultrabeam Hydrographic demonstrated an autonomous, amphibious, hydrographic survey vehicle, using sonar, lidar and other technologies to deliver results.

Now, Map the Gap has entered Phase 2 and in July £2M in contracts were awarded by DASA to three SMEs to develop semi-autonomous reconnaissance and survey systems in line with Map the Gap requirements. The three small and medium-sized businesses awarded

Photo: Dominic King, Army Press Office Germany



**Beyond NATO, GDELS is partnering with Hanwha Defense in South Korea. Both having been selected by Korea's Defence Acquisition Program Administration (DAPA) to jointly produce 110 amphibious bridging vehicles for the Korean Army, Seen here, M3 Amphibious Rigs from the UK's 23 Amphibious Engineer Troop and Pionierbattalion 130 of the German Bundeswehr, which have now amalgamated, conducting NATO training exercises in 2016 across the River Vistula in Poland.**

the Phase 2 funding to fast-track their innovations for testing with the British Army are: Digital Concepts Engineering awarded £982,791 to develop a proposed low-signature, autonomous-unmanned air and ground system with a capability to deploy sensors to collect the desired gap measurements; Ultra-beam awarded £498,075 to develop its ARGONAUT 2 product, an autonomous and amphibious, kinematic survey vehicle that includes a modular survey sensor package with LiDAR, sonar, current profiler and electric cone penetrometer. Autonomy is also enhanced by implementing AI Machine Learning technology; the third SME is ISS Group awarded £514,727 to further its UAV rotorcraft equipped with 3-D photogram metric, EO/IR and downward viewing IR cameras, offering a simultaneous localisation and mapping sensor, ground penetrating radar and bathymetric / topographic LiDAR.

Assistant Head Manoeuvre Support and C-CBRN, Capability Directorate, Army Headquarters, Colonel Sam Stuthridge OBE, said that DASA had elected to take forward these three UK contenders into the next phase of the study and to accel-



Photo: GDELS

**GDELS will provide the M3 Amphibious Bridge and Ferry System to Latvia, which will become the newest NATO customer to receive the system. Deliveries will also include a logistics support package consisting of training, tools and manuals. With the M3, Latvia will be able to contribute to NATO enhanced forward presence by providing allied troops mobility and interoperability with other M3 users.**

erate the selected technologies through further trials and experimentation in order to achieve a world-class product, one with utility within manoeuvre support, but also across wider defence capabili-

ties. He added, "Map the Gap will directly support Project TRITON – a next-generation amphibious bridging system being jointly procured with the German Army." ■

# Over All Obstacles

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# The Optronic Maintenance Solution for the TIGER Aircraft

## The Test Instrumentation Gunner Sight System (TIGSS)

**Florian Lobitz**

“spy with my little eye...” not very much, because the TIGER aircraft is capable of operating from behind any cover provided by terrain. The mast-mounted sight, OSIRIS (Optical Stabilized InfraRed Integrated System) on top of the German TIGER helicopter’s main rotor head is the prime sensor and one of the most versatile features of the aircraft.

### History

Combining a laser range finder, thermal imaging and high definition camera, the mast-mounted sight offers multiple options for reconnaissance, target identification and tracking. With the TIGER aircraft entering service more than 15 years ago, maintenance concepts had already been developed for all kinds of components. The mast-mounted sight, however, required special attention due to its highly sophisticated architecture. The line of sight, for example, demands accuracy of the overall system of  $\pm 60\mu\text{rad}$ , meaning a maximum of 60 mm deviation each at 1,000 m distance. In a real attack scenario with a distance of 5,000 m, this implies a maximum failure of 30 cm. With potential intelligence and manoeuvrability of the chosen weapon or the type of ammunition, e.g. high explosive, taken into the equation, any threat can be engaged and destroyed.

This article focuses on activities taking place in the background in order to guarantee operational availability of such a vital asset. Highly sophisticated maintenance capabilities are required to ensure smooth operation. OCCAR, in particular the Tiger Programme Division, took over the leadership and the responsibility to provide the best equipment possible for the customer.

### Author

**Florian Lobitz** is the TIGER Ground Support Equipment Manager at the OCCAR-EA (Organisation Conjointe de Coopération en Matière d’Armement).



German TIGER attack helicopter equipped with an OSIRIS sight head



The deployable work room

At the beginning of sight head maintenance, two options were commonly used: shipment to and repair at the supplier facilities and using the UMMS (UHT Mast-Mounted sight Shelter). The UMMS was introduced into service as cleanroom environment based in a highly mobile shipping container for sight head maintenance. The idea and initial realisation of UMMS was simply brilliant. At some point in time, however, no series production of the solution was formalised or contracted, thus no redundant

operation could have been established and a kind of prototype status remained. Moreover, after years of service, ageing and obsolescence kicked in and decreased reliability. It was time for a new sustainable maintenance solution. This was the moment for the TIGSS idea.

### The TIGSS Idea

Founded on the experiences of UMMS, the TIGSS (Test Instrumentation Gunner

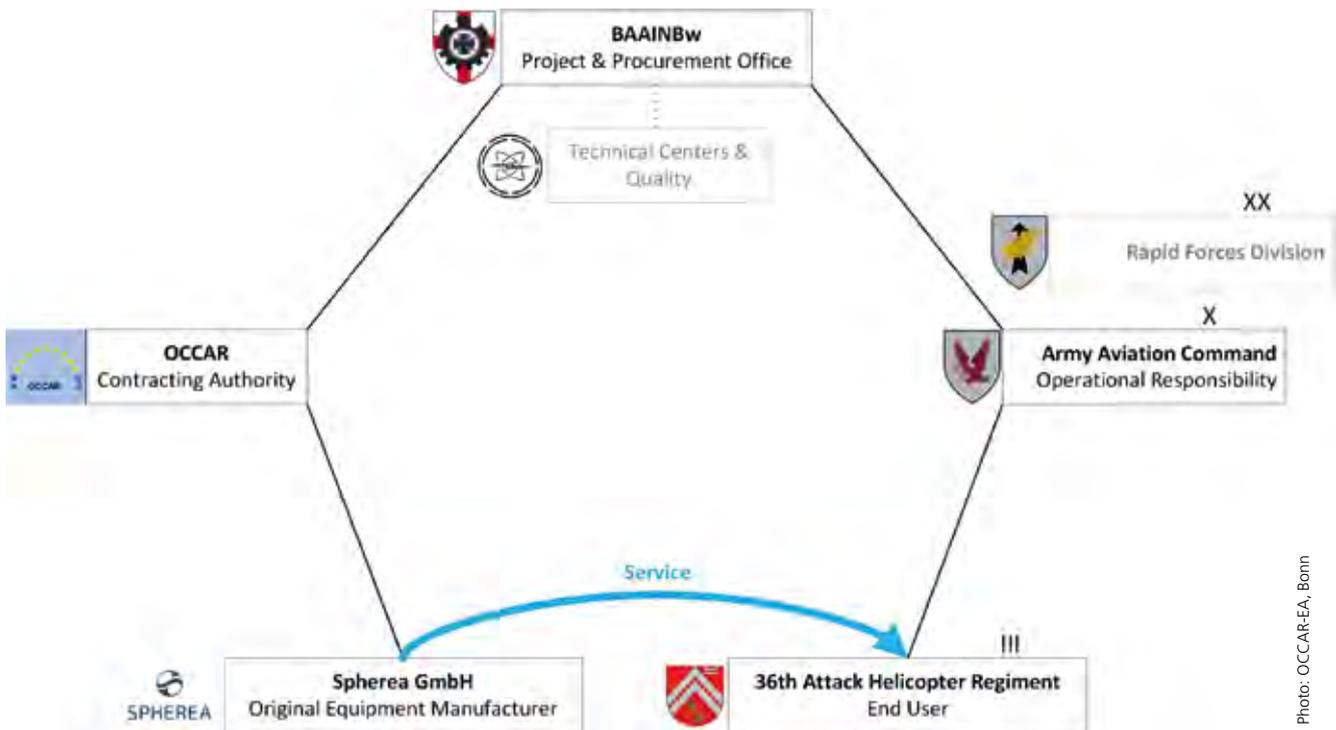


Photo: OCCAR-EA, Bonn

**Schematic Stakeholder Overview**

Sight System) should provide a reliable test environment with the characteristics of a series production equipment in terms of reliability and serviceability. Three test benches were manufactured with as many similarities as possible. In order to achieve maximum versatility, one deployable workroom was planned and engineered. This mobile tent solution, currently deployed at the German main operating base in Fritzlar, is capable of sheltering one entire TIGSS and is equipped with conditioning generators to create the required cleanroom environment within a separate compartment of the tent, where the service on the sight head is performed. The deployable workroom offers the opportunity to rapidly relocate maintenance activities and

to operate under all climatic condition imaginable. A second TIGSS bench is also installed at the Fritzlar Base, separated mainly into two fixed installations: The optronic deployable test solution (ODTS) is located in-side a 15 square metre cleanroom with the electronic deployable test solution (EDTS) next to the cleanroom wall inside a standard aircraft hangar workshop. In order to be operational, a TIGSS requires one ODTS and one EDTS. Both test benches should then serve the German Armed Forces as a redundant test environment reducing down times of test bench availability to the absolute minimum. In addition, a third EDTS (electronic components only) remains at the industry site for modification, upgrade

and other integration purposes, as most of these activities are only performed on the electronic parts of the entire system. Modifications of the optronic system are rare. The kick-off for this project took place in the late 2000s and was forged into a development contract in 2012. During the following years, intense research and development was performed by EADS Test & Services, which later on transitioned into Spherea.

**Entering Service**

In December 2018, the first TIGSS installed inside the deployable workroom tent entered into service at the Fritzlar Base. The second bench followed about

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Photo: Sphera GmbH



**Optronic and Electronic Deployable Test Solution (in the background)**

half a year later in July 2019 with a final acceptance test at the manufacturer site. After-wards, some unpredictable technical discrepancies needed to be taken care of. In a nutshell, the stimulating infrared source within the ODTS was misinterpreted by the sight head's optronics and was then processed back to the EDTS. Later, the EDTS displayed an error message stating a defective sight head sensor.

In order to isolate the error and to tackle the problem, experts from all branches gathered in a think tank: this included manufacturer expertise from Sphera chief engineering and service technicians, users' expertise from the regiment in Fritzlär, as well as supporting engineering knowledge from the official services' side. Start-ing with hose

and cable lengths, bending radiuses, potential interferences and so on, all deviations between the properly working first bench and the faulty second bench were precisely assessed. The complete troubleshooting process took about one year before the second TIGSS test bench could finally enter service at a customer site in July 2020. In the end, the problem could be solved with software-based corrections, founded on empirical trials without major modifications of the just introduced equipment.

### Dependable and Reliable

The prime objective of TIGSS was always to provide the most reliable and dependable test solution for the OSIRIS mast-mounted sight. Throughout the whole

TIGSS project, different stakeholders interacted - as shown in the graphic - in order to guarantee the best service to the end user at the regiment in Fritzlär. With a number of entities involved, one major project management element is to allow direct communication and to promote a can-do spirit on a daily basis. OCCAR, as the main project management organisation in this polygon of stakeholders, shoulders financial liability, guarantees technical project controlling and promotes a multi-disciplinary exchange between all stakeholders.

With a number of ups and downs occurring during the TIGSS development and an in-service ramp-up phase, the project was not always unquestioned, but since mid-2021, the initial objective has now been achieved. With a remarkable spirit and co-operative attitude of everybody involved, TIGSS has become a redundant and dependable addition to the German Armed Forces' maintenance capabilities. Moreover, the lean structures and processes within the overall organisation allow quick and precise decisions to boost operational availability of OSIRIS sight heads and in the end, the availability of combat ready aircraft.

Since TIGSS has reached a stable in-service phase, several individual modifications and upgrades have already been initiated. The integration of an uninterruptible power supply (UPS) system, a safety relevant improvement by introducing a light curtain safety fence instead of a mechanical metal mesh barrier, as well as pro-active obsolescence management have been triggered to maintain maximum operability. Needless to say, the annual maintenance and calibration activities are coordinated in such a way as to avoid parallel down time of the two test benches at Armed Forces' facilities.

### Future

Being a well-established weapon system within the German Bundeswehr, the TIGER aircraft will continue to serve as a close air support provider for most of the 2020s and 2030s. Moreover, the future of TIGSS is directly linked to the TIGER operation. In any case – whichever decision is taken by German Bundeswehr officials in Bonn and Koblenz – OCCAR is standing by to support with all its knowledge, project management expertise and dedication, to enhance capabilities of the system, to guarantee robust in-service support and to offer a maximum number of available sight heads and combat ready aircraft. ■

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# Price Tag for the SUPER ALLIGATOR Disclosed

**Yury Laskin**

According to Russian media, the Ministry of Defence (MoD) has approved the price for the Kamov Ka-52M helicopters. This comes after 30 of the latest Ka-50/52 version were contracted by the MoD during the Army Forum 2021. Local journalists obtained the rotorcraft insurance documents to count the Ka-52M unit price as 1.75Bn roubles, equating to around US\$15M, according to the current exchange rate. This figure does not include smart weaponry, ammunition, ground equipment, spare parts or other accessories.

The decision on the Ka-52 upgrade was based on the helicopter's combat experience in Syria. The performance in that theatre was considered successful, but the aircraft's weak points were also identified. The MoD signed a R&D contract with Russian Helicopters in April 2019. The Ka-52M was dubbed SUPER ALLIGATOR as a follow-up to the previous version known as ALLIGATOR. The prototype made its maiden flight on 10 August 2020 with the test campaign expected to be completed by 2022.

## Changes Implemented

The gunship design has been significantly updated. The helicopter received an improved optoelectronic system to extend the target detection distance, especially at night. The new radar employs an active phased array for more confident flying at low altitudes in adverse weather conditions.

In addition, the new radar supports the new smart weaponry employment, such as long-range missiles. The Ka-52M, as well as the Mi-28NM, will be armed with a new light multi-purpose guided missile known as the PRODUCT 305 with an effective firing range of 15 km. The weapon made its public debut at the Army-2021 Forum. The fire-and-forget missile was developed by the Kolomna-based KBM Design Bureau, High Precision Weapons (HPW) Holding subsidiary.

There was also information about plans to use even longer-range HERMES-A missiles from the Tula-based Shipunov KBP Design Bureau, another HPW subsidiary. The helicopter is able to interact with the STRELETS (SHOOTER) reconnaissance,



Photo: Olga Korobkova, Laguk Media

**46 Ka-52K helicopters, the naval version of the original Ka-52 helicopter, are subject to procurement by Egypt to equip the MISTRAL class amphibious assault vessels.**

control and communications system of the Radioavionica company. This will help the scouts and gunners from the ground to transmit the coordinates of targets directly to the crews. The new digital drive of the 30 mm cannon facilitates targeting and improves stabilisation during firing while the heated blades facilitate Ka-52M operations in cold weather. The SUPER ALLIGATOR is set to enter service with the Russian Army Aviation in 2022-2023.

## Export Potential

Earlier this year, Deputy Defence Minister Alexei Krivoruchko announced plans to acquire more than a hundred Ka-52M aircraft. The helicopters will also be offered on the export market with a dedicated price tag. It is well known that the transport helicopters of the Mi-8/17 family were sold abroad for more than US\$30M per unit. Against this background, the Ka-52M export version price should be even higher. In May 2021, Rosoboronexport CEO Alexander Mikheev announced plans to bring the upgraded Ka-52M to the international market after completion of the test campaign. The naval version of the original Ka-52 is already in service in Egypt. The version

was designated Ka-52K, (with K meaning 'shipborne', or 'korabelny' in Russian). In 2015, Cairo signed a contract for 46 of these helicopters, becoming their first export customer. They are used both on land and at sea, based on the Egyptian amphibious assault vessels of the MISTRAL class. The ships were initially built in France for the Russian Navy, but the contract was cancelled by the French after Russia took control of Crimea. The ships' design was adjusted to operate the Ka-52K, while the manufacturer also took care of anti-corrosion treatment for operations at sea. In addition, the helicopters received folding blades and wings for them to be placed in internal hangars, and able to be raised and lowered on special elevators.

Deliveries to Egypt began in 2017. Russian rotorcraft have been used there in parallel with the previously purchased American AH-64D APACHE. In recent years, they have been observed interacting in major exercises. It is not clear though who may become the first export customer for the SUPER ALLIGATOR. However, there were recent reports that China was considering the possibility of acquiring 36 Ka-52K helicopters for its LPDs. ■

# High Technology in Support of Connected Forces

**Korhan Özkilinc**

The Turkish Armed Forces are in for a "Digital Transformation" and have adapted to the concepts of Artificial Intelligence (AI), Unmanned Technologies and C5I. The 'soldier-machine interaction' interface will serve as the basis for advancing the "Digital Troops" concept.

The latest areas of interaction within the Turkish Armed Forces are between the Air Force and the Army, the Army and the Navy, the Navy and the Air Force, thereby forming a kind of strategic triad. The "Digital Troops" concept should encompass three important characteristics: the speed of the units; the effectiveness of the attacks; and the breadth of the intervention, especially supported by the use of AI and cognitive machines. The first steps in the direction of the "transformation process into digitalisation" began 20 years ago with the project "Air Force Command Information Management System - AFCIMS" which was not common in NATO at that time. From that time onwards, the Turkish General Staff understood how to introduce digitalisation on a step-by-step basis and to adopt a new military doctrine. Today's successes of Turkish UAVs in different trouble spots are due to the AFCIMS project. In this regard, the Turkish Army Fund is the catalyst for progress in this domain.

Photo: ASELSAN



*The ATOK is a set of portable integrated technologies designed to support military sub-units up to 15 soldiers.*

## Command Control and Battle Management

According to Havelsan, the Battle Management Effectiveness & Decision Support System is currently defined by seven parameters within the area of "Operational Components": these are C2; Intelligence; Fire Support; Survival; Air Defence; Manoeuvring; and Combat Service Support (Combat Logistics). The generated data space is transferred to the area of situational awareness, where the Cynefin Decision-Making Framework plays an important role in shaping the Combat Skills and Mission Requirements, which is an important contribution to building Adaptive and Cognitive Systems (A&CS). "Digital Troop Technologies" are basically A&CS and currently consist of Advanced Training and Combat Readiness Systems, Mobile Agile and Network-Enabled Command Control, Conventional Combat Elements, Smart

Photo: ASELSAN



*ATOK includes a messaging software enables the sharing of all kinds of information. The system is currently designed for close quarter combat.*

Information Systems, Integrated Autonomous, Robotic Systems, and last but not least, Digital Soldier (CENKER). The main goal is the absolute functionality of the system-of-systems and thus the optimal use of the sensor-to-shooter system. This means that the task-oriented or dedicated systems are collected here, which combine their resources and capabilities into a new, more

complex system, thereby creating more functionality and performance in total than with individual combat systems. The challenge in Future Warfare Environment in all domains (Air/Land/Sea) is the balanced and effective use of C2 systems; here both companies - Aselsan and Havelsan - have developed C2s for the Turkish Armed Forces, mentioning Agile Command & Control

Systems, Network-Centric Command & Control Systems, Mobile Command & Control Systems, Genesis ADVENT (Navy) and HAKIM (Air Force) where AI is applied. To bring the effectiveness of the C2 systems to the highest level, extremely complex communication systems must be equipped, and in this regard Aselsan has developed new radio and satellite communication systems that reach from headquarter(s) to the front. Of course, C2 systems are constantly evolving and have begun to take over some of the human decision-making, but it remains to be seen whether the incoming data from battlefield information systems will finally be taken over by virtual AI. MilSOFT has developed a combination of sophisticated system platforms for UAVs and drones, which, in combination with the different domains, generate a special role for frequency management and data management in the operational area or for the battlefield. This is basically a data fusion platform where data from different sources is collected by special intelligence solutions and bundled, analysed and processed by innovative algorithms to create a dynamic situation picture. Functionality, starting from Link-M(military) is a Tactical Data Link System that enables tactical data exchange between land, sea and air platforms using existing or new HF and V/UHF radios. This is supported by the Multi Data Link Processor, with this meeting the main requirements for network-centric capability to NATO standards. However, at the heart of this is the MilSOFT Intelligence System (Mil-INTEL), which is designed for efficient and effective analysis of various types of intelligence data, allowing intelligence officers to search through all data at high speed and extract meaningful information from it, thereby performing multi-dimensional analysis using different views and sharing analysis with other officers as needed. These platforms can show an overall picture of the area of operation with different map views (2D/3D), provide video/sensor data in real time and enrich it with additional analysis tools. We are talking about a sensor-to-shooter that creates the tactical picture and provides the operator with support functions to enable effective decision-making.

## Future Soldier Systems

Regarding the archives of the SSB, formerly SSM, the first official event regarding the future Turkish soldier system started at the SSM (Ministry of Defence) and Training and Doctrine Command under the name "1st Single Private Modernisation Of the Future" on 23 December 2008. The current

version of CENKER consists of two main system landscapes: "Situational Awareness Based on Wearable Sensors" and "Augmented Reality in Operational Environment". In Situational Awareness Based on Wearable Sensors, the future infantry troops are enabled to permanently connect to "Operation Centre" and "Tactical Command & Control" via the various communication channels in the digital environment, thus supporting their situational awareness in real time. While at the same time, the "Wearable Sensors" collect information about the soldier's physical condition based on "Body Motion Analysis", which is transmitted to the centre. The infantryman interfaces with drones and Unmanned Ground Vehicles (UGV) via the EO/Thermal Camera and protected gateway to carry out the mission, and of course, the weapon is interactively connected to the corresponding network. In Augmented Reality in Operational Environment, the infantryman has a connection to the "Combat Cloud" through various interfaces and "Edge Unit". Through the "Deep Neural Networks" and the "Data Processing" with the support of the 3D Visualisation Engine, a digital twin of the battlefield will be generated. Of course, CENKER will maintain its proximity to the allied standards "Soldier System Engineering Architecture (USA)", "Generic Soldier Architecture (NATO)" and "Generic Open Soldier Systems Reference Architecture (EU)". If required, CENKER can be equipped with an exoskeleton, whereby the weight can be reduced to 1/8 of the total weight. Additionally, BITES, a software company that Aselsan is involved with, has developed with another 12 companies the ATOK, which stands for Military Tactical Operations Kit. This kit consists of portable integrated technologies designed to maximise the security of troops. An armoured mobile platform 4x4 equipped with 5G mobile network from the company ULAK and portable technologies such as a geo-information system and VR glasses will support military sub-units up to 15 soldiers. In addition, a specially developed messaging software enables the sharing of all kinds of information. The system is currently designed for close quarter combat and attempts are being made to harmonise the interface between soldiers and mobile platforms in cellular networks. The second phase of the project, i.e. the off-road capability, started in October this year.

## Swarming Technologies

Havelsan is developing swarm technologies for the next generation of unmanned vehicles including swarm algorithms that



Photo: Korhan Özkilinc

**Turkey's CENKER soldier system is designed to be compatible with NATO's Generic Soldier Architecture. It can also be equipped with an exoskeleton.**

allow one unmanned vehicle to know the location, mission and distance of another unmanned vehicle. In this way, unmanned vehicles are not only coordinated with each other, but are able to perform different tasks together. Therefore, the interaction of the swarm's capabilities on all platforms - air, land, underwater and surface - is known as 'herd intelligence'. MilSOFT's swarm system, which was presented in November 2020, consisted of five drones and this also worked in the simulation environment with 25 drones. MilSOFT should be able to carry out reconnaissance, detection and surveillance of areas and objects so that the engagement of targets becomes feasible. Here, a communication system within the swarm has been developed. The drones can communicate up to 500 metres apart, but there is also another solution that allows them to communicate at a distance of 10 km. The information obtained in the swarm will be able to be transferred between units with a relay function, and the type of armament of the unmanned vehicles will allow attack options to be enabled. Tests are being conducted on how to transmit commands from helicopters to the swarms, i.e. manned-unmanned teaming. In the future, the swarm system will be

## ■ ARMAMENT & TECHNOLOGY

able to carry out sub-tasks completely on its own – though a complete autonomy of the systems is not planned. Furthermore, the company STM is developing a swarm technology framework for rotorcraft (multi-rotor) and fixed-wing drones in non-GPS environments.

### Domain Air

In the Turkish small-rotor drone development environment, many companies have been established and all of them have set up R&D departments, thanks to state subsidies. In contrast to the UAV industry, the industrial landscape here is diverse. Especially in the conflicts in Nagorno-Karabakh between Armenia and Azerbaijan, in Libya and in Syria, Turkish drone swarms have attacked enemy tanks, missile systems, radars and command centres to affect the course of the war which has attracted public attention. In the beginning, battles are undoubtedly controlled by soldiers, but as the combat process becomes more intense, the drones will take action without human intervention. All these systems will go through the OODA (Observe, Orient, Decide, Act) military command and control process and may make decisions in a few seconds; the motto being, whoever is faster than their enemy will dominate the battle and win the war. A recent UN report claims that the Turkish drone KARGU-2 eliminated its target in Libya without a "man in the loop", i.e. in a fully autonomous procedure as a killer robot. This was denied by the Turkish SSB President Ismail Demir, who said that in this case a soldier was at the end of the decision-making process and stopped the attacker shortly before the act. Several dozen companies operate in the Turkish



Photo: Korhan Özkilinc

**DASAL, a Joint Venture between Aselsan and Altinay, offers multi-rotor drones in four sizes: mini, small, medium and large, with a wide range of variants.**

industrial landscape and STM is the only example selected here. STM has developed disposable drones or 'kamikaze drones' called ALPAGU, which are armed with explosives and weigh about 4 kg. They are programmed to pursue their target in solo or in formations and engage targets i.e. concentration of enemy fighters or armoured vehicles. These disposable drones are released from launchers and can fly for about 20 minutes in the air with an effective range of up to 5 km and an altitude of 100 m. The speed of these drones is said to be about 120 km/h. From the same company, KARGU, is an ISR drone equipped with thermal sensors and technically advanced reconnaissance and combat optics and has man-in-the-loop capability. It has a range of about 5 km with a mission duration of 15 minutes and 72 km/h speed, a maximum mission altitude of 2,500 m and a combat weight of about 6.3 kg. A final example is TOGAN, a reconnaissance drone with almost the same dimensions as the KARGU, but which can remain in action for 50 minutes at an altitude of

3,300 m. The Turkish small drones have the capability to operate in swarms but in the near future, huge swarms of AI-controlled processors will complete missions that will far exceed the capability of human commanders. A special role in the drone market will be played by DASAL, a Joint Venture between Aselsan and Altinay, which offers multi-rotor drones in four sizes: mini, small, medium and large, with a wide range of variants. A hand-sized mini drone weighing a few hundred grammes and the large ALBATROS drone weighing about 700 kg, offering a payload of up to 150 kg, will not only play an important role at the operational level for troops, but also generate new markets.

### Domain Land

In the last decade, the development of UGVs has really benefited from new technologies, although they currently operate as remote-controlled robots, but will soon be involved in missions independently. The SSB developed a plan for UGVs a few years ago and they are supposed to have the following capabilities: maintenance, autonomy, mobility, and combat capability. These UGVs are divided into three categories, light, medium and heavy. The light category includes three types of tactical robots weighing between 1 - 6 kg. They are equipped with drop-cams (360 real-time recording), loudspeakers and are used in urban environments for tasks ranging from reconnaissance, surveillance and observation to bomb disposal; many Special Forces units have been equipped with them. In the case of medium-heavy UGVs, SSB tendered two sizes, one at 500 kg and the other at 2.5 tonnes. In the former category, four UGVs have recently made it to the final selection for the Turkish Land Forces - Aselsan, with its ASLAN UGV, while Havel-san's BARKAN, Best Group's FEDAI and Elektroland Defence's HANCER, are com-



Screenshot: via author

**The MilSOFT Intelligence System (Mil-INTEL) is designed for analysis of intelligence data, allowing intelligence officers to search through all data at high speed and extract meaningful information from it.**

peting against each other. All four UGVs are equipped with Aselsan's SARP remotely operated weapon system, plus electro-optical sensors, data link systems. The finalists conducted firing tests with their 7.62 mm guns, and the competition will be completed later this year and this is expected to go into series production. All vehicles meet the requirement of digitisation interface for the Turkish Future Soldier System. In the category of 2.5 tonne UGVs, the tender will be announced by SSB this year, and some companies have also submitted bids. Here, the company Katmercilik will stand out. In this class, the UGVs should have the following characteristics: reconnaissance, surveillance and target marking. With their dimensions, they are able to carry heavy weapon systems such as anti-tank missiles, especially as load carriers and, if necessary, the ability to transport injured persons out of difficult terrain. The heavy UGVs are 14 to 25 tonne 4x4 vehicles, namely EJDER YALÇIN from Nurool Makina, KIRPI II and AMAZON from BMC. These platforms will primarily be used for logistical tasks and reconnaissance in risky terrain. They will be especially equipped with high firepower and integrated with powerful machines for mobility. The UGVs will interface with the land vehicles of the Turkish Army and will have intensive manned-unmanned teaming with the latest generation 6x6 and 8x8 armoured vehicles. At the IDEF'21, FNSS presented the SHADOW WARRIOR, a tracked tank that can move autonomously on the terrain and perform autonomous missions in the compound. The company BMC has introduced the AMAZON model, a 4x4 armoured vehicle equipped with a drone that also operates autonomously. Both vehicles have multiple sensors and a LIDAR (light imaging, detection and ranging) system, a technology that scans the environment in three dimensions using laser technology.

## Domain Sea

The Turkish Navy has received a USV (Unmanned Surface Vehicle) ULAQ, a cooperative project between Ares Shipyard and Meteksan. This USV is capable of operating alone, as well as in conjunction with innovative communication systems. Primarily, it is used to maintain coastal security, carry out coastal landings and port controls, but by attaching sensors and existing missile armaments, it increases situational awareness in real time. The USVs are linked to GENESIS ADVENT (Network Supported Data Integrated Combat Management System), a Next Generation Command Control System developed specifically for the Turk-

ish Navy. Recently, Aselsan and Sefine Shipyard launched a project that will enable Unmanned Naval Vehicles to hunt submarines through its modular design and trimaran concept with the ability to pick up torpedoes and missiles, and even sonobuoys. The defence industry is in the process of manufacturing Unmanned Underwater Vehicles (UUVs). Armelsan has developed remotely operated underwater vehicles; it is also certain to develop UUVs to track enemy submarines and divers if needed. From defence circles, it has been heard that the Navy is in the process of developing a wireless underwater communication network. Because of the difficult underwater environment due to numerous reflections, sonar signals and noise, the challenges for underwater operations are very high, but in the future, UUVs will become an impor-

reception complex with a size of 4,625 m<sup>2</sup>. The new headquarters of the Turkish Armed Forces and Ministry of Defence will include one of the largest military operations centres in the world and will also include several bunker complexes. At the beginning of last year, 6 January 2020, the new headquarters of the Turkish intelligence service, Milli İstihbarat Teşkilatı (MIT) was ceremonially opened, which is located exactly in the neighbourhood of this Turkish Pentagon.

## Conclusion

The focus of the concept, future "Digital Troop" will be that they will have one or more command and control centres that will enable coordinated action in real time between unmanned systems and manned



Screenshot: via author

**The Mil-INTEL platform can show an overall picture of the area of operation with different map views (2D/3D), provide videosensor data in real time and enrich it with additional analysis tools.**

tant component for manned submarines. Moreover, the LPD ANADOLU will be converted into an aircraft carrier of unmanned systems, i.e. different drones and combat drones for water, air and land. A second carrier called LPD TRAKYA is in the waiting. The "New Security Doctrine in 2023" On Turkish Armed Forces Day, the groundbreaking ceremony for the new Turkish Pentagon, a crescent with a star based on the Turkish flag, was held by Turkish President Recep Tayyip Erdoğan on 30 August 2021. The first phase of the Turkish Pentagon, which consists of several building complexes, will be opened on 19 May 2023 (the Commemoration of Atatürk, Youth and Sports Day). After completion, the National Defence Ministry, the General Staff, and the headquarters of the Air Force, Navy and Army will be located there. More than 15,000 people will work in an area of 890,000 m<sup>2</sup>; only the

units, so that, among other things, decisions can be made as to which countermeasures can be deployed when and where. It is obvious that human decision-making in the battle process will steadily decrease and be automated by machines, because in "Digital Battlefield" time, direction and resources will have absolute priority. The Turkish General Staff, as well as the defence industry, are fully aware that the Networked Unmanned Technologies will determine the fate of wars in the near future. But the unmanned systems also have an Achilles heel, because the range and the deployment time is currently a major limitation for these modern warfare assets. In this regard, Aspilsan, a company of the Turkish Army Fund with several technology companies, is working on innovative energy storage technologies. Succinctly, the Turkish Armed Forces' digitalisation strategy is based on three main pillars, "Transformation", "Holistic" and "Intelligence". ■

## Best Rotorcraft Engines from Ukraine

Photos: MOTOR SICH JSC



**Vyatcheslav A. Boguslaev,**  
**President of Motor Sich JSC**

MOTOR SICH JSC is the Company specializing in designing, manufacturing and after-sales service of the aircraft gas-turbine engines, industrial gas-turbine drives as well as gas-turbine power-generating units powered by these drives. Recently we also actively work to build the helicopter-building industry in Ukraine.

Quality and reliability of the aircraft engines manufactured by our Company are proved by many years of their operation in airplanes and helicopters in more than 100 countries around the world.

The Company is one of the world leaders specializing in manufacturing the helicopter turboshaft engines and a wide range of helicopter engines, including the TV3-117 family engines, used to power a major part of produced medium-class helicopters of "Mi" and "Ka" types, as well as the world's most powerful engine D-136 used to power the world's most load lifting helicopter – Mi-26. In addition to the helicopter engines, we supply the turboprop and turboprop engines for airplanes and UAVs, as well as the engines for auxiliary power units.

Every year MOTOR SICH JSC is the participant of various exhibitions. This year is not an exception. Our Company is going to exhibit such full-scale products as TV3-117VMA-SBM1V, Series 1, MS-400, MS-450, MS-500V, AI-450C, AI-322F at SAHA Expo-2021 Aerospace and Defense Exhibition in Turkey.

Since 2018, MOTOR SICH JSC actively strengthens its presence in the Turkish market. At present our Company and Turkish Aerospace Industries work to use the engines manufactured by MOTOR SICH JSC in the aircraft manufactured in Turkey. In addition, the negotiations are underway with other Turkish companies not only on application of products manufactured by the Zaporozhye Company in the Turkish aircraft, but also on other forms of cooperation. The Turkish companies show a considerable interest in our latest developments.

Now our Company works to build the family of turboshaft engines of new generation – MS-500V featuring the takeoff power of 600 to 1100 hp used to power the helicopters of various purposes with the takeoff weight of 3.5 to 6 tons. The purpose of development of the MS-500V family is to build reliable, low-cost and efficient engines. The selected level of thermodynamic parameters is ensured by application of the simplest engine design in this power category. The MS-500V-01 engine and its versions are designed on the basis of double-rotor diagram, including the gas generator rotor and the free turbine rotor. The free turbine transmits power to the reduction gearbox mounted in the front part of the engine.

The materials and special coatings of the parts make it possible to operate the engine in all climatic conditions. The engine operation is checked and the appropriate diagnostics are performed using onboard and ground monitoring facilities by the parameters received from transducers and switches installed on the engine. The engine features an electrical starting system. The MS-500V versions with the takeoff power of 630 hp and the MS-500V-01 with the takeoff power of 810 hp obtained the Type Certificates.

The works are underway to build the MS-500V-02 and MS-500V-03 engines featuring the takeoff power of 1100 hp (with the power takeoff shaft looking forward and aft respectively). Among our developments are the MS-500V-04S/SE turboprop engine versions featuring the takeoff power of 750 of 950 hp and the MS-500V-05S/SE featuring the takeoff power of 950 to 1050 hp used for UAVs; the MS-500V-02S version was certified in 2020.

One of the activities of our Company is building the MS-700 engine of new generation in the takeoff power range of 1400 to 1600 hp. The engine incorporates the

perspective two-stage one-shaft centrifugal compressor and single-stage turbine for its drive. The MS-700 engine is of modular design; it is equipped with electronic digital ACS and ensures a low level of noise and exhaust emissions.

The MS-700 family engines built for a new generation of helicopters and airplanes will also make it possible to remotorize the existing aircraft. It is possible to build the helicopter version (MS-700V) and the aircraft version (MS-700S) in cooperation with the foreign customer with further localization of its production facilities in the country of the customer.

Nowadays, MOTOR SICH JSC carries out works to build the MS-340 family engines (for UAVs) featuring the maximum thrust of 340 to 350 kgf, as well as the new-generation engine – MS-450 with thrust of 398 kgf and significantly improved weight and overall dimensions. In several countries the work is underway to power UAVs by special versions of turboprop and bypass turboprop engines manufactured by MOTOR SICH JSC, which make it possible to build UAVs of MALE, HALE and UCAV categories. In order to further improve the flight performance of helicopters and their efficiency during operation in high-mountainous regions of warm countries, the TV3-117VMA-SBM1V engine was designed at MOTOR SICH JSC. To use in new helicopter programs, the TV3 117VMA-SBM1V, Series 1, engine version with electronic digital ACS was designed; in 2020, it obtained the Type Certificate issued by the Aviation Register of IAC. The use of new ACS will significantly improve the flight performance of helicopters and the efficiency of engines.

Today, small aircrafts are highly demanded all over the world, therefore MOTOR SICH JSC actively participates in the work carried out by SE "Ivchenko-Progress" to design small-sized turboshaft and turboprop engines of the AI-450 family.

The AI-450M engine version with the takeoff power of 400 hp, 430 hp or 465 hp (depending on the ACS adjustment), obtained the Type Certificate.

Moreover, the work is underway on the AI-450C and AI-450C-2 turboprop engine versions with the takeoff power of 495 and 750 hp respectively, used for general aviation and training aircraft, including the aerobatic category (versions AI-450CP and AI-450CP-2).

Nowadays, MOTOR SICH JSC actively develops its own helicopter-building program. The certified helicopter production facilities of MOTOR SICH JSC include machine and assembly shops furnished with advanced equipment, a section for stripping and application of paint coatings, a flight test complex, a simulation center for training crews of all types of produced helicopters. MOTOR SICH JSC established its own scientific and technical base for designing, manufacturing, testing and certification of helicopters. The results of the above fruitful work of the Company are dozens of military and civil helicopters solving real problems.

The first implemented project of helicopter-building program of MOTOR SICH JSC was the 8MSB – medium multipurpose helicopter featuring the maximum takeoff weight of 12000 kg. The helicopter is powered by the powerplant consisting of two gas-turbine engines TV3-117VMA-SBM1V, Series 4E, with electrical starting. The 8MSB helicopter powered by the TV3-117VMA-SBM1V, Series 4E, set a number of the world records, among which is the absolute altitude record in horizontal flight in the E1 class – 9155 m, which is 300 m higher than the height of Mount Everest – the highest mountain peak in the world.

The 8MSB helicopter can be manufactured in a number of versions: transport, passenger (VIP version), search and rescue, medical, fire-fighting and military (8MSB-V).

The 8MSB-V helicopter was adopted by the Ministry of Defense of Ukraine. Today, the 8MSB-V helicopters are operated by units of the National Guard of Ukraine, Army Air Forces, Air Force, State Border Service, Aviation of Naval Forces of Ukraine. In order to improve the flight performance range for operation of the Mi-8MTV helicopter (versions Mi-8MT, Mi-8MTV-1, Mi-17) under high temperatures and altitudes to be capable to make flights as per category A and B, the specialists of MOTOR SICH JSC carried out a complex of certification works resulting in obtaining the Supplementary Type Certificates. The

Mi-8MTV helicopter (versions Mi-8MT, Mi-8MTV-1, Mi-17, etc.) powered by the TV3-117VMA-SBM1V-03 engines can perform rescue operations using a winch with one engine inoperative. It should be noted that for the Mi-8MTV helicopters powered by previous engines TV3-117VM it was prohibited to perform rescue operations using a winch with one engine inoperative.

The Mi-8MTV/Mi-17 helicopters (versions Mi-8MT, Mi-8MTV-1, Mi-171, etc.) powered by the TV3-117VMA-SBM1V-03 engines and equipped with the VR-14 reduction gearbox version can be operated in category A and in category B simultaneously, with appropriate restrictions for each category. The Mi-8MTV helicopter powered by the TV3-117VMA-SBM1V-03 engines is capable to safely perform the flight mission above the water and residential areas even in case of failure of one of the engines.

Our Company carries out operations to develop, manufacture and overhaul the helicopter reduction gearboxes. At present, we organized overhaul of the VR-8A, VR-14 and VR-24 main reduction gearboxes for the Mi-8, Mi-17 and Mi-24 family helicopters. The work is underway to design, jointly with SE "Ivchenko-Progress", the VR-17MS main reduction gearbox for the Mi-17 helicopters with the takeoff power increased up to 14 tons. The VR-14MS reduction gearbox is also under development to be installed in the Mi-8MT (MTV) helicopters as well as for upgrading the Mi-8T helicopters. The modified tail transmission units of the Mi-8MTV (AMT) helicopters and their versions are manufactured to increase transfer of transmitted peak power. This all makes it possible to overhaul the Mi-8, Mi-17 and Mi-24 helicopters at MOTOR SICH JSC with their simultaneous reauthorization and upgrading.

Another direction of the helicopter-building program of MOTOR SICH JSC is development and production of light helicopters. The MSB-1 helicopter is the first certified

helicopter designed by MOTOR SICH JSC in the light category. The MSB-1 multipurpose helicopter differs from other helicopters of light category by its spacious cargo-and-passenger cabin and twin-engine powerplant. As compared with the Mi-2 helicopter, the power of each engine was increased from 400 to 430 hp.

Despite the fact that the MSB-1 belongs to the light class helicopters, its transport capabilities are quite high. Thus, the helicopter cabin is designed to carry 8 passengers (excluding the pilot), which significantly exceeds the capacity of more expensive foreign analogues.

A new system of cargo transportation on the external sling was developed and certified.



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**8MSB helicopter**

# Defence Export - Israel's Strategic Investments in the Arabian Gulf

**Tamir Eshel**

The peace accord signed in 2020 between Israel, UAE, and Bahrain brought to the limelight the strategic dialogue between these countries that have been going under the radar for almost 20 years. This dialogue focused on strategic defence issues and provided some of the Gulf nations access to Israel's advanced technologies in return to national interests that could benefit the Jewish state. Leaving anti-Israeli sentiments of the past, at a time of an accelerating danger from Iran, and the everlasting rift with Sunni Arabs, and growing radicalism among Sunnis, alliance with Israel, even in secrecy, was the right move.

Practically speaking, leaving the Palestinian problem aside, Israel and the moderate Sunnis of the Middle East have many interests in common and only a few disagreements. For decades, the Palestinian issue was placed in the front line, preventing any dialogue and progress. The peace agreements with Egypt in 1979 and Jordan in 1994 changed this deadlock, and the determined and pragmatic attitude of the Trump administration has brought the Gulf states to join the Abraham Accord in 2020.

Indeed, Israel and its neighbours in the Arabian Gulf have much to benefit from the agreements. Alarmed by the recent US withdrawal from Afghanistan, Arab nations are worried about the further drawdown from the region, seeking alternative means of deterrence against Iran and its proxies.

Such concern is not related only to direct attacks, as Kuwait suffered in 1990.

Freedom of navigation is of strategic interest to all Gulf states, securing oil transport from the region. Recent repeated drone attacks on ships reflect this clear and imminent threat. Other types of threats include mining, explosive suicide boats, and anti-ship missiles, which are also of great concern. This makes the issue of maritime domain awareness a top priority for countries in the region.

Other concerns address cruise missiles and drone attacks suffered by the UAE and Saudi Arabia in recent years. While Houthis in Yemen took responsibility for all those events, forensic studies have indicated Iran had direct involvement in those attacks. Striking across the Arabian Gulf would be much easier than circumventing thousands of kilometres from Yemen, across or around the Arabian

Photo: Rafale Defense Systems



***This year, Israeli air defence systems such as the IRON DOME from Rafale, will undoubtedly grab the attention at the Dubai Air Show.***

Peninsula. That's why air and missile defences are among the most urgent issues, particularly in UAE, Bahrain, the closest neighbour to Iran, and Saudi Arabia, which face repeated attacks from Yemen in the south and potentially from Iran.

Cyber attacks are also of great concern. Although attacks are not directly attributed to a specific country, it is largely accepted the cyber attacks on Saudi oil companies were directed from Iran.

Other aspects that benefit warming relations with Israel are the establishment of regional alliances, such as the one between Greece, Cyprus, UAE, and Israel. Israel has advocated for the UAE integration in the Eastern Mediterranean arena, using Israeli infrastructure to establish direct links to the emirates.

Israel is appreciated by neighbours and foes for its military might, technological prowess, economic stability, and close alliance with the USA. Unlike past notions that the Jewish state was alien to the region, Israel is now regarded as a bastion of democracy and progress, rooted in the Middle East. A nation that would not leave its allies as strategic interests drift elsewhere.

## Providing Solutions

Trade and defence business were done through mediating companies under cover of secrecy until formal relations were established. Nevertheless, big business in significant volume was struck between the Gulf states and Israel, related to homeland security, cyber, unmanned systems, mainte-

## IAI's Mission to Transfer State of the Art Technology, Knowledge and Skills

IAI is the largest defence and aerospace company in Israel. With 15,000 employees, the company is the leader in new technology development and patent registration in Israel. Living in a tough neighborhood means that IAI must provide cutting-edge technologies and solutions for air, land, sea, cyber, and space.

Some of these key products and technologies include Unmanned Aerial Vehicles (UAVs) based on the proven Heron family of products, radars and electronic intelligence, satellite and space systems, as well as missiles and loitering munitions. Other products include IAI's BARAK-MX air defense system. Employing Area Defense to intercept aircraft, missiles, or drones at a range up to 150 km, the BARAK MX family extends the defensive coverage across the entire task force by combining multiple systems carrying BARAK-MX into an integrated defense network. Users can also network their offensive weapons across a task force to achieve scalable and optimised effects. These capabilities could include a range of IAI-made weapons, including long-range missiles, loitering weapons, and precision-guided munitions and missiles.

In addition, IAI is a leading provider of Air Defense and Surveillance, Airborne Multi-Mode, and target acquisition radars and electronic warfare systems for defense and HLS markets worldwide. These include spaceborne, airborne, maritime and ground sensors in all major disciplines: radars,



Photos: IAI

***The Remote Platoon Vehicles (RPVs), designed and manufactured by IAI's ELTA Systems group, are robust, versatile multi-purpose/multi-mission platforms that support and complement troops on the ground and enhance their force protection in battlefield conditions.***

SIGINT, IMINT, full-motion video (FMV), early warning systems and even WAMI (Wide Area Motion Imagery). IAI is constantly innovating and has expanded its expertise into the latest technologies such as advanced radar and signal processing, autonomous platforms, AI and machine learning. Beyond IAI's state-of-the-art solutions is the understanding that transfer and sharing of knowledge is key to a successful defense solution. They say you can give a man a fish and feed him for a day, or teach one how to fish and feed them for a lifetime. IAI practices this understanding. An IAI solution does not end with the

product, but includes deep collaboration with local economies and industries.

Take, for example, IAI's recent cooperation with Hensoldt in Germany to provide new Radars to the German armed forces. In cooperation with IAI, the German customer will receive a combination of a national partner in system integration, certification and long-term support, as well as concept proven, market perfected systems.

IAI also partnered with MCL this past year to provide Remote Patrol Vehicles to the U.K. Land Forces. Through the cooperation IAI will transfer knowledge and know how in land robotics expertise. This is based on the understanding that transfer of skills is both better for the customer who gains knowledge from the transaction, and the system, that will benefit from lifetime maintenance and repair on behalf of the user.

Israel Aerospace Industries (IAI) is a world-leading aerospace and defense company innovating and delivering state-of-the-art technologies in space, air, land, naval, cyber & homeland security for defense and commercial markets. Combining the "Start-up Nation" spirit of innovation with decades of combat-proven experience, IAI provides customers with tailor-made, cutting-edge solutions to the unique challenges they face including satellites, UAVs, missiles, intelligence solutions, weapon systems, air defense systems, robotic systems, radars, business jets, aerostructures, and more.

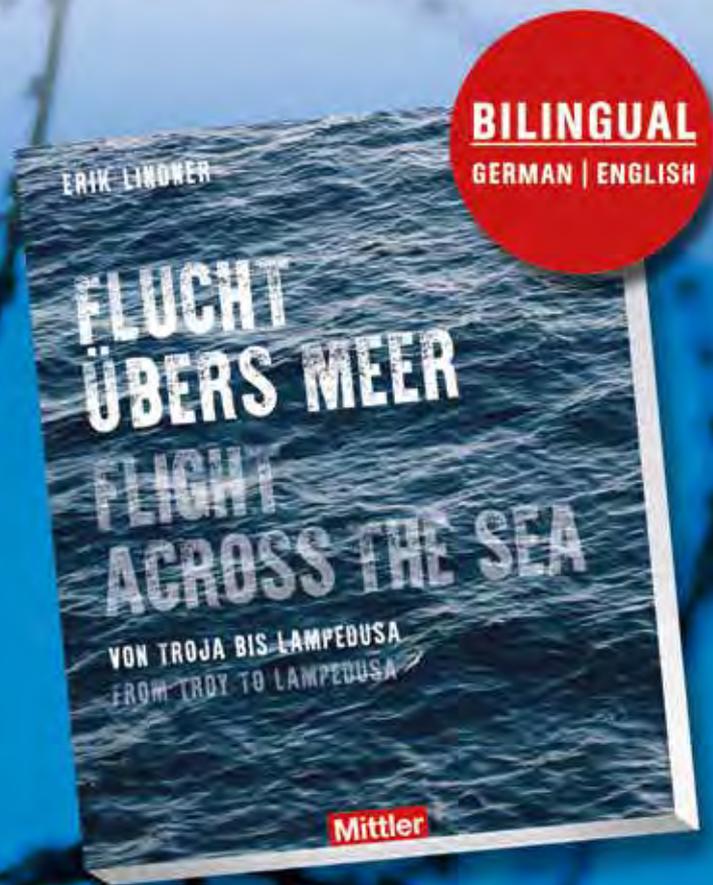


***Launched on 6 July 2020, OFEK-16 is an electro-optical reconnaissance satellite designed and built by IAI for the Israeli Ministry of Defence.***

ERIK LINDNER

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nance, and support. Some of those projects were related to large government programmes those Israeli contractors helped design, integrate, and manage 'mega projects'

While the mediator companies are no longer required, the solution-based concept is still lucrative for Israelis doing business in the Gulf. It is pursued by most of the major Israeli defence companies, for example, IAI, presented at the Dubai Air Show.

This is part of the strength IAI offers, integrating its products and systems provided by the customer or other manufacturers into comprehensive solutions tailored to fit the customer's needs. The company has successfully implemented this strategy in many overseas markets, cooperating with local vendors and adding value to a local ecosystem. IAI's leaders have said they see the UAE as a leader among the Gulf states and are ready to partner with the UAE and other partners to create new solutions to the ever-changing environment.

## Air Defence

Facing the proliferation of ballistic missiles, drones, and cruise missiles, countries in the region strive to obtain the best air defences they can buy. Until now, the US PATRIOT and THAAD and the Russian PANTSIR, with several European air defence systems selected for naval vessels, were the only choices. While Russians are presenting their latest technologies, access to the S400 has been blocked by US sanctions. This year, Israeli air defence systems, namely BARAK MX, SPYDER and IRON DOME from Rafael, will undoubtedly grab the attention in Dubai, along with their European competitors; however, this time, the Israelis will be able to compete. Equally important are radars and command and control systems that provide the battle management of air defence assets. Israeli Counter-UAS solutions will also stage at these displays, addressing the desperate need to defend critical infrastructures from drone attacks.

## Rocket and Missiles

An attractive new appearance expected at the Dubai Air Show is the debut of the new Israeli Government-owned company Tomer. Responsible for developing and manufacturing rocket propulsion systems for missiles and launchers, Tomer was separated from Israel Military Industries (IMI) during its privatisation and sale to Elbit Systems. Due to the sensitivity of having such activity under private ownership, the Government established Tomer as an independent company supplying propulsion systems for all Israeli weapon manufacturers. As part of its new business strategy, the company now markets its capabilities in export markets. Among these weapon systems are the rocket motors of the ARROW missiles, SHAVIT satellite launchers, IAI's BARAK 8 air defence systems, and artillery rockets produced by Elbit Systems. The Dubai Air Show is Tomer's first appearance in an international event, having a special significance as it is presented so close to Iran's backyard.

## Special Mission Aircraft and Drones

Special mission aircraft and unmanned aerial systems are other areas of interest for their advantage in creating a real-time situational picture necessary for good deterrence and rapid response to emerging threats. Such aircraft were developed by IAI Elta and operate with several air forces worldwide.

As Israel has proven since the 1973 war, maintaining a credible airborne early warning and situational awareness is as critical as having lookouts in the high ground. The Gulf states require such capabilities now, more than ever.

Unmanned Aerial Systems (UAS) provide part of this high ground, with aerial vehicles carrying sensors operating at high, medium, or low altitudes, collecting intelligence, performing search and rescue, and monitoring targets before, during, and after an attack. Many Israeli companies are producing UAVs, but only some are bringing them to Dubai. These include Israel's top three UAS companies - IAI, Elbit Systems, and Aeronautics. With drone wars becoming part of the reality in the Middle East, loitering weapons are becoming an effective means enabling the military to engage targets quickly after they are detected. This short 'sensor to shooter' is critical in combatting terror or repelling suicide attacks. Such weapons have been exported by Aeronautics, Uvision, IAI, and Elbit Systems.

IAI's strong presence at the Dubai Air Show emphasises its commitment for the long term. As part of its business strategy in other markets, IAI seeks to establish joint ventures with companies and organisations that could contribute to developing market opportunities, marketing, and support ongoing programmes. IAI will showcase a wide variety of strategic defence systems, including a multi-mission aircraft system, VTOL UAS, various satellites, electro-optics payloads, and missiles.

Cyber security is another area where Israel and Gulf states have much in com-



Photo: Aeronautics

**Aeronautics is expected to showcase the ORBITER 4 UAS at this year's Dubai Air Show.**

mon. Regarded as one of the world's first 'Cyber Nation,' Israel has been exporting cyber security solutions to the Gulf states for over a decade. In April this year, a consortium of companies established under the helm of government-owned Rafael Advanced Defense Systems pursued cyber protection of infrastructures such as oil, gas, water systems, and other utilities. In Israel, Rafael is the prime contractor of the National Cyber Emergency Response Team (CERT). On the same note, Rafael has teamed with UAE's Group 42 company to form the JV company Presight.AI, intending to commercialise artificial intelligence and big data technologies.

Other JVs seek different areas for cooperation. As part of its strategy, IAI has recently

established two joined ventures – one with the UAE's leading defence company Edge and another with its largest air carrier Etihad. The JV with Etihad will convert Boeing 777 into freight carriers. The memorandum of understanding signed with UAE's Esge group paves the way for developing advanced Counter-Unmanned Aircraft Systems (C-UAS) tailored to the UAE market, with wide-ranging benefits for the region. The scope of these activities sees the UAE becoming a hub to the Arabian Gulf and beyond.

The upcoming Dubai Air Show provides a unique opportunity in paving the open way for Israel's aerospace and defence companies to reap the fruits of the seeds planted in past years when the cooperation was shrouded cover and secrecy. ■



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# Viewpoint from Istanbul



Photo: Korhan Özkilinc

## The Turkish Melodrama

Korhan Özkilinc

I am a Christian, I am a Jew, I am a Muslim because I am Turkey with its multi-faceted rich cultural landscape and higher values that unite its people living between the continents of Asia and Europe'. Unfortunately, this beautiful image has suffered over the last ten years, having witnessed multiple human tragedies caused by the "Arab Spring". Ultimately, the uprisings in the Arab region cost the lives of several million people. Moreover, many of those who were forced to leave their homeland by repressive Arab dictators were also exploited and murdered as refugees on their way to a safe Europe by human trafficking rings, all of which happened in the so-called civilised 21st century.

Turkey lies exactly at the crossroads of many of these tragic conflicts. The country's budget is not only burdened by six million refugees living in Turkey, but also by its military intervention in the north of Syria. This makes Ankara's interest policy with its long-time ally, the USA, rather shaky because the Janus-faced relationship with Moscow does not make it easy for Turkish diplomats who also have to fulfil important obligations as a NATO member.

This political tightrope act has also led to Turkey's exclusion from the F-35 JSF programme by the USA, with Ankara basically not included in the contractual agreement. Turkey and the US are currently in discussions to supply 40 units of the latest version of the F-16 fighter and 80 upgraded systems for the already in-service F-16s to the Turkish Air Force for US\$1.5Bn, already paid for of course, with an additional payment. The Turkish defence industry is insisting on the continuation of the F-35 JSF project because it is not included in the contractual agreement. But a further US blockade of F-16 negotiations would give Turkish President Recep Tayyip Erdoğan the option of negotiating with Russia and China, which could lead to discrepancies with NATO to the detriment of US foreign policy. However, one thing is certain: if there is a change of government in Ankara, the S-400 missiles will be back in Russia, as this cannot be used optimally with the country's own system, which is why ROKETSAN is working at full steam on its own development, which will already be in use in a few years.

### Gezi Park Protests

The "Arab Spring" dilemma has also found its imitation in Turkey. The protests against Erdoğan's government started at the end of May 2013 in the centre of Istanbul's Taksim Square and lasted until the end of August that year. One police officer and seven demonstrators died in the violent clashes. Nearly 10,000 people were injured on both sides and a considerable number of buses, cars and buildings were destroyed. This incident went down in history as the "Gezi Park protests".

The actual reason for the protests was a park area of about 200m x 200m, i.e. 4 hectares, where the Taksim Kışlası (Taksim Military Barracks) used to stand before it was demolished to create a green area. Unfortunately, this green space is now used by many people of African descent as a social meeting place at night. The Turkish president wanted to rebuild the historical barracks as a business district or shopping centre with traditional architecture. The protests against this building project were then manipulated by certain violent groups. We can interpret here the beginning of the "Turkish Spring", taking place exactly at the climax of the "Arab Spring". The consequences would have been too explosive, with not only many deaths, but also a huge migration of Turks would have taken place in the direction of Western Europe. Importantly, the Turkish population in Germany is a key factor here as 1-2 million Turks (with an additional 4-5 million with a Turkish background) live in Germany which would have created a socially explosive situation. Europe is already overburdened with a few hundred thousand migrants from Syria, and we can already say "Thank God, it didn't come to that".

Why have I brought up the Gezi Park protests of eight years ago? About one week ago, the ambassadors of Germany, France, Canada, the Netherlands, Denmark, New Zealand, Norway, Sweden and Finland, led by the US embassy, issued a statement calling for the release of the imprisoned cultural patron Osman Kavala, who has been in prison in Turkey for four years without conviction. Kavala is linked to the Gezi protests, among other things. In response, Turkish President Erdoğan spoke of declar-



Photo: Burak Su / CC BY-SA 2.0

*With the "Gezi Park Protests", the "Arab Spring" has been imitated in Turkey.*

ing the ten ambassadors "Persona Non Grata". In the Turkish political landscape, this was all taken too far. Former President Abdullah Gül, who was a companion to the incumbent President, said that when Recep Tayyip Erdoğan was jailed for writing a poem, "we raised his case with the support of the social democrats in the EU. We should not overdo it, he said, because the Turkish Foreign Ministry had already given the appropriate answer."

### Osman Kavala

The question is though, who is Osman Kavala? He is a colourful and very interesting personality who is known as the entrepreneur, the biggest publisher in Turkey, patron of the arts and human rights activist. But he is also labelled the Turkish George Soros because of his closeness to Soros. The Kavala family, i.e. the Kavala group, was already very active in the times of the Özal Government - one could even say they were one of the pioneers of the Turkish arms industry. The family company, MIKES, which

was established as a JV in 1987 with the US company LORAL, is currently trading as SPACE SYSTEM LORAL; it was involved in electronic warfare and microwave technology and was the most important part of the Turkish Air Force's F-16 fighter modernisation project, which was later transferred to Aselsan. Through its strategic market position, MIKES basically acted as the interface of the Turkish Army's fund corporations. Its dealings were also known beyond the country's borders and they also maintained strong relations with Israel in medical technology. In the politics of the defence industry, MIKES lost its market position in the course of time and went bankrupt, whereby a large part of the several hundred employees transferred to today's defence company STM which serves as a catalyst for the further development of the Turkish defence industry even today.

Osman Kavala has gone from being a playmaker to an important chess piece on the politicians' board game. But the players should be aware of one thing: there can only be a win-win effect, otherwise they will be the losers in the eyes of the Russians and the Chinese.

# Military Missions at the Edge of Space

**Doug Richardson**

At altitudes above 60,000 feet, meteorological conditions favour a new type of platform – the so-called High-Altitude Platform Systems (HAPS) which are typically unmanned aerial vehicles (UAVs) with various sensor payloads.

As cruise altitudes approach 60,000 ft. (18,000 m), the sky becomes a very lonely place. The days when Concorde passengers sipped champagne while flying at these heights are over, and current airliners have flight ceilings of less than 45,000 ft. (14,000 m). Fighter pilots may fly the occasional mission at the upper limits of their aircraft's performance envelope, but the only aircrew with many flight hours at these extreme altitudes are those tasked with flying the Lockheed U-2 or the few surviving examples of its little-known Russian equivalent, the Myasishchev M-55 ('MYSTIC-B'). In this strange world where the sky is the deepest shade of azure blue and the earth's curvature becomes visible, there are no clouds, winds rarely exceed 5 kn, and turbulence is minimal, meteorological conditions that favour a relatively new type of airborne platform – the high-altitude unmanned air vehicle. Often referred to as a high-altitude platform systems (HAPS), these normally take the form of an unmanned air vehicles (UAVs) with long-span wings, but airships or even balloons are also being used. Originally known as PREDATOR-C, the General Atomics Aeronautical Systems AVENGER started life as a developed version of the PREDATOR series of turboprop-powered medium-altitude UAVs, but evolved to become a larger and extensively redesigned vehicle powered by a Pratt & Whitney Canada PW545B turbofan. Weighing 8,250 kg and fitted with a wing of 20 m span, it can carry a payload of around 3,000 kg to a cruise height estimated to be 60,000 ft. An AVENGER-ER version announced in 2016 has a wingspan of 23 m, and can carry a radar, electro-optical (EO) or munitions payload on sorties of up to 20 hours duration. The existence of the Lockheed Martin RQ-



Photo: USAF

*Taken from the cockpit of a Lockheed U-2 cruising at close to maximum altitude, this photo shows the dark sky and curved horizon that are typical of extreme flight altitudes.*



Photo: (US DoD)

*The General Atomics Aeronautical Systems Avenger has been credited with a maximum operating altitude of 60,000 ft (18,000 m).*

170 SENTINEL was revealed in 2007 by unofficial photographs that showed what was then an unknown type of UAV at Kandahar in Afghanistan. A tailless 'flying wing' with a span estimated at around 27 m, it has a configuration likely to offer a reduced radar cross section (RCS). A cruise altitude of around 50,000 ft has been estimated. In December 2011, Iran displayed what it claimed was an RQ-170 that had been 'hijacked' by an Iranian cyberwarfare unit and commanded to land near the city of

Kashmar in northeastern Iran. The US confirmed that the vehicle was one of its UAVs (it is reported to have been an asset operated by the US Central Intelligence Agency rather than the USAF), but its request that the drone be returned was dismissed by Iran, which subsequently claimed that it was reverse-engineering the vehicle. The best-known HAPS is probably the Northrop Grumman RQ-4 GLOBAL HAWK. Originally known as the Ryan

**Author**

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

Aeronautical TIER II+, it is a UAV with a wingspan of 39.9 m, and a gross weight of 14,628 kg. A single turbofan engine gives the vehicle a cruise speed of 570 km/h, and an operating height of up to 60,000 ft. A maximum payload of 3,000 kg can be carried.

## Payloads

An initial production batch of RQ-4A version for the USAF was followed by the definitive RQ-4B, and the current variant of this is the Block 40. The sensor payload of GLOBAL HAWK has evolved over time. The original installation included a radar based on the Raytheon HISAR reconnaissance system (a derivative of the ASARS-2 carried by the U-2), and a combined EO/IR sensor, but later versions of the RQ-4B introduced an ENHANCED INTEGRATED SENSOR SYSTEM (EISS). Operations over Iraq and Afghanistan have involved a BAE Systems COMINT system and an automatic target recognition 'blue force' tracker.

Other known payloads have included an AIRBORNE SIGNALS INTELLIGENCE PAYLOAD (ASIP) and an MP-RTIP (Multi-Platform Radar Technology Insertion Programme) radar offering synthetic-aperture radar SAR and ground moving target indicator (GMTI) radar. In 2016, Northrop Grumman revealed that it had funded a test flight to demonstrate that GLOBAL HAWK could carry the SENIOR YEAR ELECTRO-OPTIC RECONNAISSANCE SYSTEM (SYERS 2) multi-spectral suite used by the U-2S. Two improved sensors delivered in 2020 were the MS-177 multi-spectral camera system to provide multiple channels in the visible and infrared bands, and an increment 1 upgraded AN/ASQ-230 intended to handle expanded electronic threats.

Under its Alliance Ground Surveillance (AGS) programme, NATO ordered five



Photo: USAF

**The USAF plans to procure more than 50 examples of the Northrop Grumman RQ-4 GLOBAL HAWK.**

GLOBAL HAWK RQ-4D Block 40, and the final example was delivered in November 2020. GLOBAL HAWK was also ordered by South Korea and Japan, while several countries including Canada and India have expressed potential requirements. Japan's first RQ-4B GLOBAL HAWK made its maiden flight on 15 April 2021.

Under its Broad Area Maritime Surveillance (BAMS) programme, the US Navy evaluated then selected the GLOBAL HAWK to meet its needs for a real-time intelligence, surveillance and reconnaissance (ISR) system to supplement its fleet of Boeing P-8 POSEIDON maritime patrol aircraft. The USN wanted its new UAV to have the ability to descend in order to get a closer view of targets of interest. This required that the airframe and wing be strengthened, and that the vehicle be fitted with a de-icing system. Designated as the MQ-4C TRITON,

this variant entered USN service in 2018. Its primary surveillance tool is the Northrop Grumman AN/ZPY-3 Multi-Function Active Sensor (MFAS) AESA radar. Australia announced an order for six, and plans for a possible seventh.

In 2007, Germany had placed an order for five EURO HAWKs, a version of the RQ-4B that would carry an ELINT/COMINT suite, but this programme was cancelled in 2015 due to the rising cost of certifying the GLOBAL HAWK to fly in controlled airspace. Three years later, Germany announced that it planned to procure the MQ-4C version, but this decision was short-lived. In 2020, the scheme was dropped in favour of procuring three Bombardier GLOBAL 6000 manned aircraft equipped with a Hensoldt ISIS-ZB SIGINT suite. Once again, the problem had been that of operating the UAV alongside civil air traffic.



Photo: Northrop Grumman

**NATO operates a fleet of five GLOBAL HAWK UAVs.**

## Threats

In the age of surface-to-air missiles, a high cruise altitude does not provide platform invulnerability. On 20 June 2019, Iran's Islamic Revolutionary Guard Corps shot down a high-altitude UAV that was flying over the Strait of Hormuz. According to the US, the UAV was flying in international airspace, but Iran claimed that it had entered Iranian airspace. Initial US reports of the incident claimed that the UAV was an MQ-4C TRITON drone, but US Central Command later confirmed that it was a Broad Area Maritime Surveillance – Demonstrator (BAMS-D), a GLOBAL HAWK variant procured by the USN and used to refine tactics, techniques and procedures for use in a maritime environment.

Fighters able to operate effectively at such extreme altitudes can also pose a threat to HAPS. In August 2020, three Russian MiG-31 FOXHOUND fighters intercepted a USAF RQ-4B that was flying over the Chukchi Sea (the waters north of the Bering Strait). Intercepting the GLOBAL HAWK was a mission well within the capability of the MiG-31, which has a ceiling of more than 80,000 ft. (25,000 m). It is not clear whether the GLOBAL HAWK and TRITON carry a self-protection EW suite. Some reports suggest that GLOBAL HAWK is fitted with an AN/AVR-3 laser-warning receiver, AN/APR-49 radar warning receiver, an unidentified jamming system, and an ALE-50 towed decoy.

## Russian Developments

In the late 1960s, the Soviet Union fielded the Tupolev Tu-123 YASTREB, a 35,600 kg supersonic reconnaissance



Photo: Russian Defence Ministry

**The Sukhoi S-70 OKHOTNIK-B is a low-RCS UAV being developed to serve both an independent system but also as an unmanned companion for the Sukhoi Su-57 FELON stealth fighter. Its reported top speed of 1,000 km/h is well below that of the Su-57, while the reported presence of two internal weapons bays suggests that OKHOTNIK-B is intended for low or medium-altitude use. Its altitude ceiling is unlikely to match the 66,000 ft (20,000 m) of the fighter.**

UAV with a maximum speed of 2,700 km/h, a range of 3,200 km, and a maximum cruise height of almost 75,000 ft. When NATO radars tracked early YASTREB flights, these were initially assumed to be sorties by MiG-25 FOXBAT fighters, and led to a Western over-estimation of that fighter's performance. Retired in the late 1970s, the Tu-123 was followed by the transonic Tu-141, but the latter was a medium-altitude system with a cruise height of just under 20,000 ft.

Growing economic difficulties and the collapse of the Soviet Union resulted in UAV development being near-abandoned. When in 2008 Russia became involved in military campaigns in Abkhazia and South Ossetia, the technical

weakness and modest performance of its then-current UAVs became apparent, so the resulting catch-up efforts have been focussed on low and medium altitude systems. If Russia does have a high-altitude UAV programme, it has yet to reveal it.

According to a 2019 report in the Russian daily Izvestia, the Sokol ALTIUS is to play a major role in the country's future UAV operations. First flown in its definitive form in 2019, the vehicle has been cited in some press reports as being Russia's equivalent to GLOBAL HAWK, but this is incorrect. ALTIUS has a take-off weight of only 8,000 kg, and is powered by not by a turbojet or turbofan engine, but by two turboprop powerplants. Its maximum cruise height is only 39,000 ft. (12,000 m).

One of the most interesting Russian UAV projects is the OBZOR-1 being developed by TsAGI and Myasishchev EMZ. This seems to be shaped to minimise RCS, but although being promoted as a high-altitude system, is expected to have a cruise height of around 35,000 ft.

Guizhou Aviation Group's XIANGLONG (SOARING DRAGON) is the first Chinese UAV in this performance class. Thought to have flown for the first time in 2008, it has a wingspan of 23 m, weighs 7,500 kg, and can carry a payload of 650 kg. Powered by an unheated turbofan engine, it has a maximum operating altitude of 59,000 ft. (16,000 m) and a range of 7,000 km.

Development of the SHENDIAO (DIVINE EAGLE) by the Shenyang Aircraft Design Institute started about a decade ago,

Photo: Thales



**A joint venture between Thales and Leonardo Thales Alenia Space, the STRATOBUS autonomous stratospheric airship is intended to operate at an altitude of 65,000 ft (20,000 m).**

and the system may have entered service around 2018. An estimated wingspan of 40-50 m would make it the world's largest operational UAV. Its novel configuration combines twin fuselages joined near their front by a canard wing surface, a rear-mounted high-aspect wing, and two large vertical stabilisers. SHENDIAO is powered by a single high-bypass turbofan, but a reported maximum operating altitude of 82,000 ft. (25,000 m) seems over-optimistic.

Developed by the Aerospace Division of Korean Airlines, the KUS-FS is a turbo-prop-powered UAV intended to be in the same performance class as PREDATOR, and has been credited with a cruise altitude of 50,000 ft (15,000 m). First flown in 2012, it is probably not yet in operational service. Potential roles include reconnaissance, radar-surveillance, sigint, and strike missions.

The Airbus ZEPHYR started life as the QinetiQ ZEPHYR 6, which flew for the first time in 2003. Powered by electric motors fed by rechargeable batteries and solar cells, this version demonstrated an 82-hour mission at an altitude of 61,000 ft. (18,600 m). Sold to what is now Airbus Defence and Space in 2013, it was ordered in its definitive ZEPHYR S form by the UK in 2016 to serve as a long-endurance reconnaissance asset. Built largely from carbon fibre composite materials, ZEPHYR S has a 25 m wingspan, but weighs only 62 kg, but can carry a 5 kg payload. Its maiden flight in 2018 lasted for only a few minutes short of 26 days. Two of the UK's ZEPHYR S crashed in 2019 and 2020. A follow-on ZEPHYR-T version has a twin-boom configuration, a 33 m wingspan, and a payload of up to 20 kg.

An airship-type solution has the advantage of being able to linger over an area for a long period of time. Conceived by Thales Alenia Space, a joint venture between Thales and Leonardo, STRATOBUS is an autonomous stratospheric airship intended to operate at an altitude of 20,000 m. STRATOBUS is expected to be 115 m long, 34 m in diameter at its widest point, and be almost seven metric tons in weight. In its basic form, it is expected to carry a 250 kg payload, and provide this with 5 kW of electrical power, but missions in the equatorial region could raise these figures to 450 kg and 8 km. According to Thales Alenia Space, the vehicle should be able to fly five-year missions briefly interrupted by annual servicing.

In January 2020, Thales Alenia Space signed a contract with the French de-



Photo: Lockheed Martin

**Current versions of the DRAGON LADY have been in service since the 1980s, but plans for their retirement are regularly postponed.**



Photo: Boeing

**This Boeing concept for a hypersonic strike and reconnaissance aircraft faces competition from a rival Lockheed Martin TR-X design.**

fence procurement agency DGA (Direction Générale de l'Armement) to carry out a concept study to determine whether a STRATOBUS-type platform could meet French Army operational needs in areas such as intelligence, surveillance and reconnaissance (ISR). This will allow long-term work to begin on the control aspects of such platforms, and the high-reliability autonomous avionics that these will require, and is expected to lead to a flight demonstration by the end of 2023.

Despite the number of unmanned platforms under development, the manned high-altitude aircraft is not obsolete. Often referred to as the DRAGON LADY, the U-2 is still used by the USAF. There

have been proposals to retire these aircraft, but several proposed dates have slipped, and it now seems likely that further updates to the aircraft are planned, allowing it to remain in service alongside the RQ-4.

At least two US teams are studying potential replacements for the U-2. In 2015, Lockheed Martin released artist's impressions of a proposed TR-X unmanned stealth aircraft, while Boeing showed a concept model of a potential hypersonic strike and reconnaissance aircraft in 2018. But at a time of low defence budgets, it is questionable whether such an aircraft will be built in the near future. U-2s and HAPS are likely to continue their near-monopoly of those lonely skies above 50,000 ft. ■

# Countering Infra-Red Guided Missile Threats

Luca Peruzzi

With the changing of crisis scenarios, from high altitude operations as flown in the past decades in conflict theatres such as Afghanistan, to lower airspace to counter sophisticated networked air defence systems, the threats to airborne platforms are multiplying.

The sophistication of MANPADS (Man-portable air defence system) or vehicle-mounted IR-guided missiles, has required European, Israeli and US manufacturers of Directed Infra-Red Countermeasures (DIRCM) to further evolve their solutions in order to cope with latest generation

air-based supply-chain, Elettronica group is today proposing the new generation ITAR-free fully-European technological sovereignty QCL-based ELT/577 DIRCM. The Italian group entered the market providing its fibre-laser based ELT/572 DIRCM solution in a twin-turret configuration and

(radio frequency) jammers from the same company. Moreover, Elettronica's patented DIRCM/flares combination and tailored algorithms have demonstrated effectiveness against fourth-generation imaging infra-red seeker-guided missiles. Called QUIRIS (from the Latin, Roman citizen), the new generation ELT/577 QCL-based DIRCM has been conceived as an "all-in-one" piece of equipment for multi-platform applications, able to provide self-protection capabilities against latest IR-guided weapon systems, from helicopters to tactical and strategic transport/tankers, large-body special missions and VIP aircraft. Based on internal funding, Elettronica developed and qualified on test ranges against simulated threats, a new generation DIRCM centred on advanced solid-state laser emitters exploiting proprietary SWIR and MWIR QCL technology. As a result, the ELT/577 can effectively protect up to high IR-signature platforms, while still preserving a compact form factor, which allows installation even onto small helicopters, according to Elettronica. The QUIRIS jamming turret features a fast-responding gimbaled mirrors system, capable of guaranteeing hyper-hemispherical coverage, a tracking thermal camera, a solid-state emitters high-power multispectral laser module and a processing unit, weighing <22 kg and 200 mm wide, 340 mm high (including turret) and 294 mm depth single-unit. Supporting multi-turret configuration and multi-threat engagement scenarios, the output laser beam features three different wavelengths, in SWIR and MWIR bands, in order to maximise the protection against first, second, third and thanks to the patented and demonstrated DIRCM/flare combination, also fourth-generation IR missile seekers. As a candidate for new and retrofit national and international airborne self-protection programmes, such as on the Leonardo AW-249 combat helicopter integrated with Leonardo's new generation MAIR



Photo: UK Crown copyright 2021

**A Royal Air Force Airbus A-400M ATLAS C.1 equipped with a self-protection suite centred on Northrop Grumman LAIRCM DIRCM. The A-400M customers chose different DIRCMs for their fleets.**

IR-guided seekers (such as 4th generation image seekers). This has benefited the digital transformation of formerly hardware-based functions and emerging Quantum Cascade Laser (QCL) technology to provide high power generation with a reduced footprint and high efficiency, therefore enlarging the range of protected platforms towards smaller ones.

## Elettronica's ELT/577

Exploiting the expertise achieved in the development of the in-service fibre-laser based ELT/572 DIRCM and the internally funded research & development (R&D) activities, alongside investments in a Europe-

open architecture designed to operate with any IR or UV (Ultra Violet) missile warning system (MWS). The ELT/572 has been successfully integrated in different platforms, both fixed and rotary wings, including the AW-101, C-27J, C-130J and Bombardier GLOBAL EXPRESS, and has been integrated, or is in-service with Airbus MILDS AN/AAR-60, Saab MAW-300 and more recently, the Leonardo MAIR MWS. The Italian Air Force has successfully integrated and qualified the ELT/572 in a twin-turret configuration on board the C-130J tactical transport aircraft and Leonardo HH-101A combat SAR (Search & Rescue) helicopter, in the latter case within a full self-protection suite, also including Radar ESM and RF



Photo: Elettronica

**The Elettronica group is today proposing the new generation ITAR-free fully European Quantum Cascade Laser-based ELTI577 QUIRIS DIRCM.**



Photo: Elettronica



**The Elettronica ELTI572 DIRCM is already in service with the Italian Air Force and other international customers on tactical and special missions platforms.**

MWS for the Italian Army, but also fixed and rotary-wing platforms of the Italian Air Force, the ELTI/577 is promoted in a suite with new generation fully digital receiver and expandable active decoy, also from Elettronica. These are all managed together with other self-protection equipment by the company's ELT/950 EW-manager.

### Indra's INSHIELD

To cope with present and future IR-guided weapon threats, Spanish electronic house Indra, with the support of the Spanish Ministry of Defence (MoD), developed and qualified the INSHIELD DIRCM. Developed as a demonstrator with Spanish MoD support as part of the SYP 21501 R&D national programme, the INSHIELD was also suc-

cessfully tested during the NATO Trial EMBOW XVI exercise on board a CHINOOK helicopter, preceded by evaluation tests, including a campaign with missile live firing. Based on a modern modular and open architecture, the INSHIELD DIRCM suite is based on a number of jamming turrets and one central processor. In a single box, the jamming turrets incorporate both the pointer/tracker and the high-power solid-state multispectral laser offering a full hemispherical coverage for each turret, while the suite is capable of detecting and managing multiple simultaneous threats, being effective against missiles of Western or Eastern origin, according to Indra. In December 2020, the company and the Spanish Ministry of Defence's Directorate-General of Armaments and Materiel signed a €111M contract to equip 23 NH90 helicopters with a new generation defence aid suite (DAS). The helicopters belong to both Army and Navy versions for the Army, Navy and Air Force. Indra will provide an Enhanced Suite Controller (EW manager), a next generation full digital Radar Warning Receiver (RWR ALR-400H FD) and the INSHIELD DIRCM suite, while integrating and supplying all other equipment, including a MWS, Laser Warning System (LWS) and the countermeasures dispensing suite (CMDS). No information on the DIRCM suite was provided, but according to contract documentation, a dual turret configuration was selected. The new IDAS will be part of other enhancements of the Standard 3 configured helicopters to be delivered from 2024/2025 onwards. According to the contract documentation, not all helicopters will be equipped with the full suite. In 2018, Indra was awarded a contract by OCCAR (Organisation Conjointe

de Coopération en matière d'Armement/Organisation for Joint Armament Co-operation) to provide an INSHIELD DIRCM suite to equip up to nine platforms out of a total of 27 A-400M transport aircraft under procurement on behalf of the Spanish Ministry of Defence. The contract also features ILS products and services, alongside tolls to programme the system libraries, including jamming sequences, allowing the Spanish Air Force to operate without external dependencies and based on its own intelligence. More recently, the Spanish Council of Ministers funded and approved the launching of contractual negotiations to equip the future fleet of Boeing CH-47F with a new DAS based on the INSHIELD DIRCM system. In the meantime, a number of US-provided DAS have been procured with the new helicopter for immediate deployment in the operational areas.

### Leonardo's MIYSIS

In June 2020, Leonardo announced that it was under contract to provide its MIYSIS DIRCM for a Middle Eastern government customer's new VVIP transport aircraft. MIYSIS will be installed on a Bombardier GLOBAL 7500 aircraft, the first of its type to be selected by a government customer. This adds to the range of MIYSIS customers, which so far include, according to Leonardo, the UK Ministry of Defence and the Canadian Department of Defence, together with other three undisclosed NATO member countries, and alongside a number of non-NATO undisclosed customers. To offer a readily-exportable single solution to protect the full range of rotary, turbo-prop, fixed-wing and jet transport, small-to-large platforms, with



Photo: Indra

**The Indra INSHIELD DIRCM was successfully in-flight tested during the NATO Trial EMBOW XVI exercise on board a CHINOOK helicopter in 2017.**

a two-head configuration for spherical protection, characterised by a light, small and least power-hungry DIRCM system, Leonardo integrated a new light-weight, low-cost pointer/tracker design. It did so together with an ad hoc version of its Type 160 multi-watt, multi-band fibre-pumped laser. The result is a system centred on a baseline integrated turret solution with all moving parts sealed behind a 14 cm dome with tracking capabilities through nadir and superior sightline performances, characterised by reduced dimensions (183 mm wide, 270 mm long and 341 mm high, weight 16 kg) and power consumption, which pre-

Photo: Leonardo



**In addition to the UK and Canadian Armed Forces, the Leonardo MIYSIS DIRCM also has three undisclosed NATO customers, alongside a number of countries globally.**

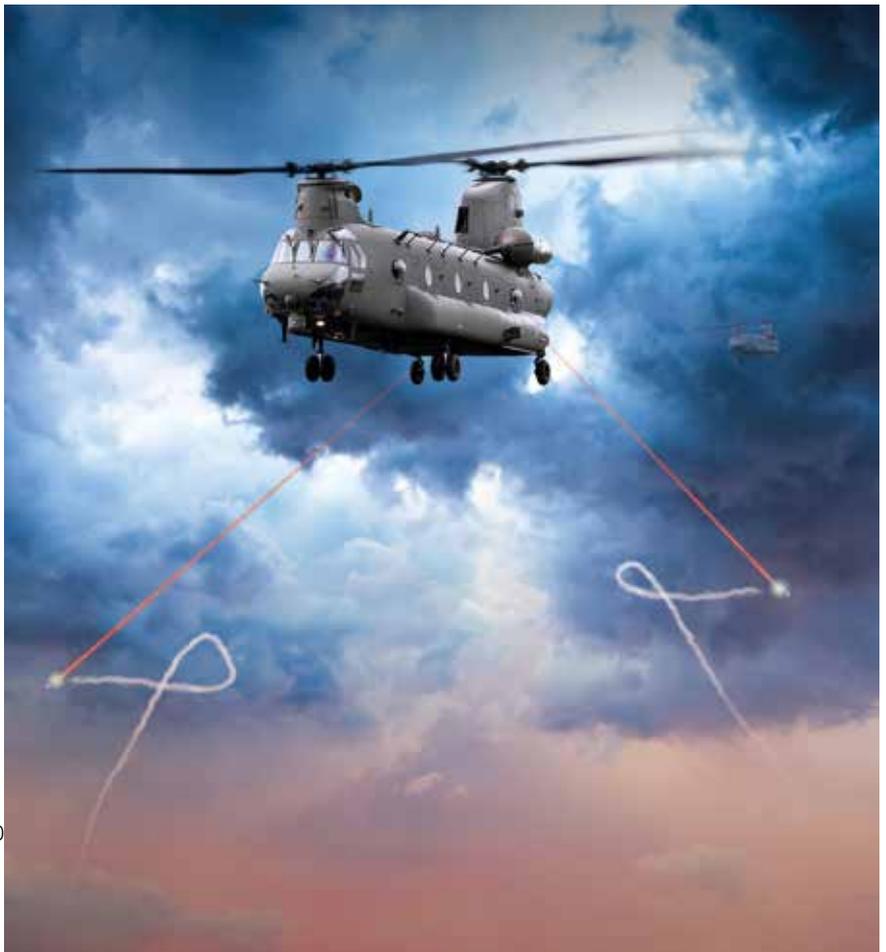


Photo: Indra

**The Indra group has been contracted by the Spanish MoD to install the INSHIELD DIRCM on board the Airbus A-400M, the NHIndustries NH90, and was selected for the CH-47F CHINOOK.**

sents external airframe reduced drag. In addition to a modular design and open architecture, allowing the integration of different types of MWSs, the baseline configuration includes two laser point trackers. These are managed by a single electronic unit, which handles the whole threats engagement including the simultaneous engagement of multiple targets and the target hand-over between the two turrets, for a total weight of 37.6 kilograms (excluding MWS). The MIYSIS DIRCM has been independently verified to have a 100 per cent success rate, with UK and international customers conducting extensive analysis and live fire trials. With the signature of Leonardo's UK arm of a Strategic Partnering Arrangement with the UK's Ministry of Defence pro-

Photo: Leonardo



curement and R&D agencies alongside the Royal Air Force in September 2020, the MIYSIS DIRCM is expected to equip a wider range of UK aircraft to further develop platform-level integrated protection systems. In addition to the current fleet of SHADOW R2 surveillance aircraft and managed by Leonardo's Modular Advanced Platform Protection System (MAPPs) controller, which exploits the NATO DAS standard, the MIYSIS is foreseen to be the standard for the E-7 WEDGETAIL AEW platform, as well as the majority of the UK's helicopter fleets. Leonardo is

also in discussions to provide the MIYSIS to the UAE and other countries in the Middle East, among other potential worldwide customers. The group is also working with Abu Dhabi-based Platoon Advanced Technologies and other local and international partners to propose MIYSIS for some of the UAE's key platforms.

### Elbit Systems' MUSIC family

Elbit Systems is the first non-US company to offer a compact DIRCM solution based on advanced fibre laser technology. The Elbit

**Leonardo is in discussions to provide the MIYSIS to the UAE and other countries in the Middle East, after being contracted for the system in the region.**

Systems' family of Multi Spectral Infrared Countermeasures (MUSIC) DIRCM solutions utilises an open-architecture design allowing its seamless integration on any aircraft type. The MUSIC DIRCM family is centred on a hyper-hemispherical dome for maximum coverage, a sealed mirror gimbal for high reliability and a thermal camera for accurate acquisition and tracking, alongside a powerful dual-band laser; each band is independently programmable and capable to accept user-defined jamming codes. Proven in operational scenarios with over 300,000 operational flight hours, the Elbit Systems' MUSIC family comes in three different versions including the Mini-MUSIC, J-MUSIC and C-MUSIC. Featuring a highly reliable and compact DIRCM turret, the Mini-MUSIC was designed to meet the protection requirement of rotary and turbo prop fixed-wing platforms. The Mini-MUSIC features plug-and-play and easy installation with a single, multiple or podded 19 kg LRU DIRCM turret. Accord-



Photo: Elbit Systems

**Featuring a compact single-LRU DIRCM turret, the Mini-MUSIC was designed to meet the protection requirements of rotary and turbo prop fixed-wing platforms, in single, dual or podded turret configuration.**

ing to Elbit Systems, the Mini-MUSIC was chosen by militaries and governments around the world to protect various platforms. These different platforms include the UH-60 in a single turret fuselage design, Sikorsky's CH-53 and the Boeing CH-47 with a dual Mini-MUSIC pods configuration, Leonardo's AW-139, also with dual MINI-MUSIC pods, the VIP Airbus H-225 with dual Mini-MUSIC pods and the Airbus C-295 single turret fuselage,



Photo: NSPA

**The J-MUSIC has enjoyed different important selection and contracts, including the NATO Airbus A330 Multinational Multi-Role Tanker Transport Fleet (MMF) in a self-protection suite with dual-turret fuselage-mounted installation with the company's PAWS IR MWS.**

among others. The J-MUSIC, as the distributed version of the C-MUSIC, provides installation flexibility and is optimised to protect large aircraft, including transports, tankers, special mission and VIP platforms. It is offered in a single, multi-turret fuselage or podded solution with a baseline compact package, including the jamming turret, electronic unit, laser generator unit and the aircraft interface unit. The J-MUSIC has enjoyed important selection and contracts, including with the NATO Airbus A330 Multinational Multi-Role Tanker Transport Fleet (MMF) in a self-protection suite with dual-turret fuselage-mounted installation with the company's Infra-Red-based Passive Airborne Warning (PAWS IR) MWS for a number of European air forces (Belgium, Luxembourg, the Netherlands, Norway and Czech Republic), with the German Air Force's Airbus A-400M fleet, provided and integrated by Diehl Defence with Elbit Systems into the platform EW suite, in addition to the Brazilian and Portuguese Air Forces' Embraer KC-390 transport aircraft. The C-MUSIC is contained in a single, fuselage-mounted conformal pod, which was initially certified and installed on more than ten different aircraft models of Israeli commercial airliners alongside a specially configured Israeli Government B767 VIP aircraft. The system gained rapid and growing international interest, resulting in multiple VIP and commercial C-MUSIC installations, including Boeing B747-8i, 747-400, 777-200, 737-800, Airbus A330-200 and A340-500, with operators in the US, Asia, Europe and Africa.

### Bird Aerosystems' SPREOS

In October 2020, Bird Aerosystems announced it had successfully conducted a

live firing demonstration of the effectiveness of its SPREOS (Self Protection Radar Electro-Optic System) DIRCM against different types of MANPADS, including the most advanced ones available today, the company said. Based on a specific customer request, the company stressed that the demonstration proved the system was able to defeat 100 per cent of the missiles. As part of its field-proven Airborne Missile Protection System (AMPS) family of solutions which is to provide complete protection against all known Surface-to-Air Missiles (SAM), including MANPADS, laser beam rider and radar-guided threats, Bird Aerosystems is offering the SPREOS single-turret system, which combines a semi-active dual band radar and a QCL technology-based DIRCM system. Alerted by the missile warn-



Photo: BIRD Aerosystems

**Last October, Bird Aerosystems announced it had successfully conducted a live firing demonstration of its SPREOS (Self Protection Radar Electro-Optic System) DIRCM against different types of MANPADS.**

Photo: BIRD Aerosystems



**Bird Aerosystems was contracted to deliver its SPREOS DIRCM as part of an AMPS-MD solution to be installed on an Airbus 320 type aircraft in its AEROSHIELD POD configuration.**

Photo: Northrop Grumman



**In April 2020, Northrop Grumman was awarded by the US Army a US\$959.1M, five-year, full-rate production contract for the Common Infrared Countermeasures (CIRCM) DIRCM system.**

ing sensors, SPREOS slews to the direction of the threat, activates its dual-band (L- & Ka-band) radar function for confirmation and tracking, which are performed simultaneously on both frequencies. Following the confirmation and tracking, the SPREOS deploys the dual-band countermeasure laser, causing the missile to miss the aircraft. Weighing <15 kg with a compact size (single LRU) without fuselage penetration, the SPREOS is an ideal solution for a range of airborne platforms with the same company's AMPS MD solution. Featuring a proprietary dual-band laser based on QCL technology directly coupled with the radar for minimal errors, the SPREOS eliminates

all of the false alarms and ensures that only actual threats receive an effective jamming response. Since its unveiling in 2018, Bird Aerosystems registered an expansion of its customers and platforms applications for the AMPS and SPREOS. In August 2020, the company announced that it had signed a new contract for the delivery of the SPREOS DIRCM solution and for the certification of the AMPS-MD on Airbus 320 type aircraft. The complete AMPS-MD system, including the SPREOS, will be installed into BIRD'S all-in-one AEROSHIELD POD and the latter certified for the platform, in collaboration with Airbus France. Bird Aerosystems' solutions are in wide-scale, long-term use

by some of the world's largest commercial, governmental, military, and transnational organisations – including NATO forces, UN Air Operations, the US Government, Airbus and other major aircraft manufacturers.

### Northrop Grumman's CIRCM and LAIRCM

Northrop Grumman's Common Infrared Countermeasures (CIRCM) system reached a major programme milestone in April 2020. After a successful six-month initial operational test and evaluation (IOT&E) and declaration of the system being operationally suitable and effective, the US Army awarded the US company a US\$959.1M, five-year, first full-rate production contract. This provides justification and approval for the procurement of up to 596 CIRCM B-kit units over the contract period. The CIRCM has been developed to expand the number of US Army platforms, which could be protected against the latest IR threats. It represents the next generation lightweight, laser-based IRCM component that will interface with the Army's Common Missile Warning Systems (CMWS), Limited Interim Missile Warning System (LIMWS) and future MWSs, alongside the CMDS in order to defeat current and emerging missile threats that use multispectral technology. To initially equip APACHE, BLACK HAWK and CHINOOK platforms, the Army's present and new MWSs will combine with the dual-head CIRCM system comprising dual compact pointer-tracker units, dual lasers, and a system processing unit. Based on the cooperation on the Northrop Grumman AN/AAQ-24(V) DIRCM programme, also known as the Large Aircraft Infrared Countermeasures (LAIRCM), Leonardo provides the pointer/trackers from UK and the QCL technology by Leonardo DRS's Daylight Solutions for the CIRCM programme. In August 2020, a long-term pricing agreement was signed between Northrop Grumman and Leonardo to provide the pointer/trackers for the full-rate production contract period of this programme. As an interim solution, dictated by the latest operations in Syria and Iraq, the US Army integrated the Department of the Navy's LAIRCM onto the APACHE, BLACK HAWK and CHINOOK platforms. The LAIRCM is the well-known Northrop Grumman DIRCM system provided to the US Department of Defense, as well as international customers. In 2021, Northrop Grumman announced that it will install more LAIRCMs on both US and international fixed-wing and rotary-wing platforms as part of an existing indefinite delivery, and undefined quantity contract for the system upgrades, modifications and installation on



Photo: USAF / Joshua Seybert

**The Large Aircraft Infrared Countermeasures Large Aircraft Countermeasures (LAIRCM) is the well-known Northrop Grumman DAIRCM system provided to the US DoD, as well as international customers.**



Photo: US DoD/NAVAIR

**The Leonardo DRS AN/AAQ-45 DAIRCM system's low size, weight and power design will support a range of rotary and tilt-wing aircraft throughout the US armed services, including application to the emerging future vertical lift programme.**

a wide range of platforms, including the C-17, C-5, C-130J, P-8, CH-53K, KC-46 and international customers.

## Leonardo DRS DAIRCM

In March 2020, Leonardo DRS announced that the US Air Force had for the first time operationally used an HH-60G PAVE HAWK CSAR helicopter equipped with the AN/AAQ-45 Distributed Aperture Infrared Countermeasure (DAIRCM) fitted under a Joint Urgent Operational Needs Statement (JUONS). According to US Air Force documentation, the DAIRCM has a suite of missile warning, laser warning, hostile fire indicator (HFI), and infrared countermeasure (IRCM) components designed to defend the aircraft from various threats, including infrared guided missiles, either shoulder-fired, vehicle-launched or otherwise. Aircrews will be able to return precise and immediate defensive fire and automatically provide IRCM



Photo: USMC - Sgt. Jennessa Devey

**In addition to the USAF HH-60G, the AN/AAQ-45 DAIRCM is being installed on US Navy and Marine Corps rotary-wing platforms, including the Bell UH-1Y VENOM.**

to effectively deter, suppress, or destroy the enemy threat, or manoeuvre to avoid the threat. Developed from technology originally developed by the US Naval Research Laboratory, the DAIRCM is an aircraft survivability system approach, according to Leonardo, that utilises a single sensor for both two-colour IR missile warning and a wide angle field of view gimbal for threat countermeasures, alongside HFI, laser warning, and future application for Degraded Visual Environment. Leonardo DRS employs its 2 Colour IR detector and Quantum Cascade Laser technology. The system's low size, weight and power design supports a range of rotary and tilt-wing aircraft throughout the services, including application to the emerging future vertical lift programme. The entire system only weighs about 32 kg and includes 4-to-6 sensors, a central laser unit, a control processor and fibre optic cable assembly. The system uses a single, centrally installed laser that provides laser energy to a selected sensor where an integrated laser pointer module directs it towards the declared threat. The threat-warning sensor sends raw video and digital data information to the processor, which analyses the data for an incoming missile, laser, or hostile fire threat. If the processor detects a threat, it notifies the aircrew through the control interface unit and provides the proper countermeasure against the incoming missile. In addition to the USAF HH-60G and in the future the HH-60W among others, following operational testing and evaluation, the US Navy and Marine Corp made fielding decisions for the DAIRCM initially on the Sikorsky MH-60 SEAHAWK, Bell UH-1Y VENOM and AH-1Z VIPER. ■

# Modern Aero Engines: Multifuel vs. Hybrid vs. Electric

**Alex Horobets**

With the rapid development of aviation in the 20th century, gasoline and kerosene have remained the main fuels for aircraft engines for decades. The most likely direction for further research development is toward hybrid and all-electric power units.

The basic requirements for engines have not changed dramatically – it is long service life and reliability, efficiency, low weight, as well as certain dimensions and shape. This, however, did not stop designers from searching for alternative principles of aircraft engines and energy sources. Some even arrived at the concept of nuclear aircraft engines.

Electric engines have been researched for several decades in the automotive industry, with a constant increase in their power capacity and range, which has made it possible to start replacing the internal combustion engine. For obvious reasons related to more complex requirements, aviation is much slower in this regard, although it is also moving in this direction. Electric actuators are also being increasingly used to replace mechanical or hydraulic ones in aircraft. Nevertheless, it is aviation that remains the most difficult area to enjoy any breakthrough in electrification.

## Progress in the Industry

The reciprocating engine is the same age as modern aviation. This type of engine has long been the primary one, until turbojet engines were first introduced in the middle of the 20th century. Modern realities are forcing the aviation industry to adapt towards curbing fuel costs. The demands on the performance of modern aircraft engines are also growing steadily. Fuel costs are one of the major expense items for air carriers so significant new aircraft engines are naturally expected to save them fuel. Besides, aviation standards for noise and gas emissions are also being tightened.

The advantages of electric airplanes are undeniable: they are quieter, more reliable, and cheaper to operate. Besides, they resolve the issue of harmful emissions. On the one hand, such engines provide great opportunities for optimising the internal volume of the aircraft and on the other hand, the problem of imperfect batteries remains significant, signifi-

Photo: Rama / CC 2.0



**The SOLAR IMPULSE2 prototype aircraft was able to fly non-stop for 26 hours. Its batteries were charged during daytime to release energy at night.**

cantly limiting the flight range. Furthermore, the required battery pack is still too heavy, while their charge is insufficient for long flights in the framework of standard aircraft operation.

To date, the most common engine in modern aviation remains the internal combustion engine. To replace such engines with those operating on solar or other renewables, as well as to put them into mass operation, remains critical to address the issue of solar panels' excessive weight. For example, the SOLAR IMPULSE2 prototype aircraft was able to fly non-stop for 26 hours. Its batteries can be charged during daytime to release energy at night. If such types of aircraft are to be applied by the military domain, the first thing that comes to mind is UAVs able to carry out long flights without the need for recharging.

## New Technology Developing Across the Atlantic

In advanced economies, new projects in the field of aviation technology are being

developed at full speed. Often enjoying government support, the programmes explore new areas, including in the production of aircraft engines. It is worth noting that military and civilian engine projects often cross paths and complement each other since they use common technology to develop new engines.

The United States has gained experience in developing technology for power units used in both military and civil aircraft, which brings American companies to the leading positions in the global market. The main R&D driver for such technologies is offered by federal agencies, such as the Department of Defence and NASA, which are focused on longer-term prospects, that is, a period of 25 to 50 years. In the US, it is the Federal Aviation Administration (FAA) and NASA that deal with the design of new engines. The FAA develops technologies with a 5 to 10-year perspective, while NASA looks at an even longer term.

According to NASA's research, achieving the 2030-2035 goals to reduce fuel costs

and the noise of power units, including in subsonic passenger aircraft, is viewed as a challenging endeavour requiring new technical solutions.

More significant results, including zero emissions, can be achieved by switching to hybrid engines or all-electric power units, but more new equipment and technology has yet to be developed to this end. Boeing, Northrop Grumman, Cessna, General Electric, Rolls-Royce, and Pratt & Whitney partook in researching the concepts of future engine making.

In Europe, there are programmes underway to find new solutions in the field of aviation. The work is being carried out under the auspices of the European Commission, through framework programmes. The Sixth and Seventh Framework Programmes developed critical technologies for 2020-2025 passenger aircraft engines. Safran, MTU Aero Engines, and Rolls-Royce acted as project coordinators.

In 2019, the first-ever contract for the supply of electric aircraft was signed at the Le Bourget Air Show in Paris and concerned the nine-seat ALICE aircraft developed by Israel's Eviat. Aircraft certification was expected to have been completed by late 2021. According to the declared features, the aircraft will be able to cover a distance of up to 1,000 km at a speed of 440 km/h. This is a fairly clear example of how aircraft design can be altered without using traditional engines. With the ALICE, two electric motors are located at the wing tips, plus another at the tail. However, in 2021, the aircraft was re-designed with only two electric motors at the tail. The company opted for electric motors produced by the US-based magniX.

## Hybrid Technologies

In May 2015, the CAFE Foundation's Electric Aircraft Symposium (EAS) IX was held in California, where the findings of a report were voiced on the current progress in electric aircraft technology. The weakest link in the electric motor mechanism was its batteries. It was noted that lithium batteries had to be improved while their safe operation on board the aircraft has yet to be properly ensured.

In such conditions, one promising area on which the main manufacturers of aircraft engines are focused is hybrid power units, where a piston or gas turbine engine is combined with an electric motor. An electric power unit is simpler and lighter than a mechanical one, which allows for the creation of aircraft of various designs. Such an approach also allows for the increased efficiency of the engine's operation, reduc-



Photo: United Technologies Corporation

**United Technologies Corporation's PROJECT 804 demonstrator based on Bombardier's DASH 8 light turboprop aircraft, where a hybrid power unit is installed to replace one of the engines.**

ing harmful emissions, and achieving lower fuel consumption.

The combination of a traditional engine and an electric motor partially solves the issues typical for modern aviation. Therefore, almost all major aircraft engine manufacturers have been working towards this end.

For example, in July 2021, Pratt & Whitney received support from the Government of Canada for the first flight involving a turboprop hybrid aircraft engine. United Technologies Corporation is developing hybrid engines to be installed in various aircraft. The corporation presented its PROJECT 804, a demonstrator of Bombardier's DASH 8 light turboprop aircraft, where a hybrid power unit is installed to replace one of the engines. It is estimated that such an aircraft will consume less fuel and be able to carry up to 50 passengers over distances of up to 463 km within an hour.

In June this year, Rolls-Royce, as part of its plans to reduce emissions by 2030, began

testing the first components of its own hybrid power unit based on the AE2100 unit, previously developed in cooperation with Airbus. It is likely that the development of a hybrid power unit will be completed by 2030. France's Safran is developing a hybrid propulsion system for helicopters and commercial aircraft. It is assumed that by 2040-2050, such power units will boast a significant share of orders.

General Electric, in partnership with XTI, is developing a TRIFAN hybrid power unit for light passenger and transport aircraft. Powered by a hybrid power system, the DENALI light aircraft by Cessna Catalyst will be able to transport up to four people at a distance of up to 3,000 km at a speed of about 500 km/h. The finished product is expected to make its maiden flight by 2030.

Accordingly, the hybrid power unit can also be applied to military aviation as an additional electrical power source and will increase the aircraft's thrust and manoeuvrability.



Photo: GE / Textron Aviation

**Powered by a hybrid power system, the DENALI light aircraft designed by Cessna Catalyst will be able to transport up to four people at a distance of up to 3,000 km at a speed of about 500 km/h.**

## Promising Power Units for the Military

The list of requirements the Army sets for features and capabilities of electric-powered aircraft is even more stringent than for civilian airplanes. NATO's areas of operations range from the High North to its southern borders. This means that future missions will be carried out both in cold and wet conditions, or hot, dry climates. Besides, there are missions where rapid manoeuvring is required in transporting cargo. This will all affect existing and future tactical platforms. Also, new military electric-powered aircraft will have to be able to operate in conditions of limited logistical support and infrastructure, while carrying massive ammunition loads.

Assessing the progress in the development of the new warplanes' architecture, the US-based GE Aviation should be mentioned. It has successfully completed prototype tests of a promising adaptive aircraft jet engine, the XA100, which has been under development since 2007, contracted by the US Air Force. Due to the peculiar features of the engine shape design, it will consume less fuel. In particular, the adaptive engine is planned to be used on the F-35 LIGHTNING II fighter. Replacing the standard power unit with the XA100 will increase the F-35's flight time by 50 per cent and the range by 35 per cent. Fuel consumption will also be significantly reduced by 25 per cent. Pratt & Whitney is also developing an adaptive engine.



Photo: Cummins

**Cummins' Advanced Combat Engine (ACE) technology delivers 50 per cent more power and 13 per cent more fuel efficiency.**

In 2020, during the National Defence Seminar organised by the Brazilian Ministry of Defence, Embraer and the Brazilian Air Force presented a new military aircraft with a hybrid propulsion system. The STOUT (Short Take-Off Utility Transport) project will boast two turboprop engines located closer to the fuselage and two electric en-

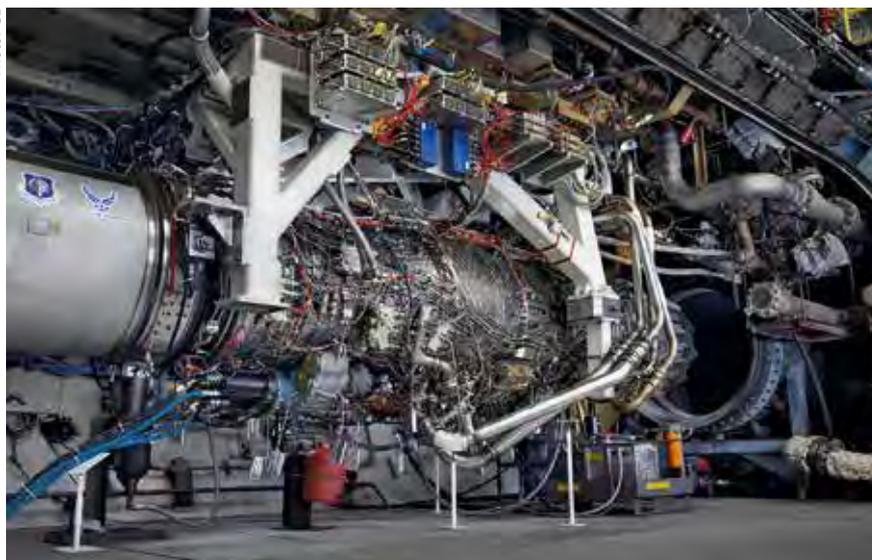
gines at the wing tips. It is expected that the aircraft will have a range of 2,452 km with a 3-tonne load. The warplane will also be able to operate on short unpaved runways and in jungle areas.

In August 2021, the US Army signed a US\$87M contract with Cummins to deliver the opposed-piston (OP) Advanced Combat Engine. The company specialises in the production of diesel engines and engines running on alternative fuels. The

footprint by 2030 and to improve energy efficiency of its propulsion systems.

BAE Systems are also actively working towards making civil and military aviation go electric. The company has spent decades developing hybrid and all-electric propulsion systems for commercial and military platforms, both on land and at sea. US-based start-up Wright Electric has begun developing an electric engine for the 186-seat WRIGHT 1 aircraft. The project

Photo: GE



**The GE XA100 engine in a testing facility. GE initiated testing at its Evendale, Ohio, altitude test facility on 22 December 2020.**

development of the Advanced Combat Engine (ACE) implies a modular diesel engine that can be hybrid in nature and use the innovative opposed-piston technology to provide leap-ahead capabilities in power density and heat rejection not available in the current marketplace. This Advanced Combat Engine technology delivers 50 per cent more power and 13 per cent more fuel efficiency. The ACE can be integrated into hybrid architectures to unify and ease the logistics burden of multiple powertrains and facilitate the adoption of electrified technology.

Also in 2021, Rolls-Royce launched a new investment project with Purdue University to develop new test platforms for high-altitude and hybrid-electric engines to be installed in future generations of military aircraft.

The new Rolls-Royce high-altitude test cell at West Lafayette will expand opportunities for testing new engine designs, including for the V-22 OSPREY, C-130J SUPER HERCULES aircraft, and the Bell V-280 VALOR aircraft competing in the US Army's Future Long-Range Assault Aircraft programme. As part of this programme, the new test facility will enable Rolls-Royce to move towards its goal of achieving a zero carbon

will consist of several inverter engines, which will form the core of the power unit. The WRIGHT 1 will have three electric engines – two located under the wings and another one in the tail section. Wright Electric is collaborating on the project with BAE Systems on flight control and energy management systems and plans to start ground tests as early as this year, scheduling their first test flights for 2023.

Also in 2020, reports emerged about the TEMPEST project, a sixth-generation fighter manufactured by BAE Systems, whose fully electric model could be developed and powered by on-board batteries. The new aircraft is expected to be ready by 2030. No details have leaked so far as to the aircraft's operation principle. However, it can be assumed that advantages of the electric version would be low noise and the lack of a heat trace from the exhaust gases, which will seriously complicate detection by enemy radars.

## Electricity and UAVs

At the current level of technology development, it is most realistic to apply hybrid and electric motors without losing tactical and technical characteristics to UAVs, primarily

due to the significantly lower weight and size compared to full-sized aircraft. It is in this direction that leading companies for the production of UAVs are heading, so it is only a matter of time. At the 2019 Le Bourget Air Show, Airbus and Boeing showcased prototypes of electric UAVs, one of which was on display within the event's flight programme.

In March 2021, there were reports about the adaptation of X-Engine technology for drones manned by the US Air Force. In particular, that power supply for unmanned aircraft systems can be provided by a hybrid-electric propulsion system. The Small Business Technology Transfer (STTR) contract worth US\$150,000 was awarded through AFWERX to support AGILITY PRIME, a project set to develop electric vertical take-off and landing (eVTOL) aircraft for commercial and military use.

A rotary diesel engine with a hybrid-electric unit is considered a promising model for UAVs. Since batteries today have insufficient battery life, they can only be fully utilised in a limited number of devices. At the same time, the military require a longer life for UAV flights. Moreover, the X-Engine, in conjunction with the generator, can charge batteries during flight, which will increase the operating range. The X-Engine can also be configured in parallel lines with an electric drive, where the engine is used for traction or lift.

LiquidPiston CEO and Co-Founder Alec Shkolnik concluded that the X-Engine has the advantages of a hybrid-electric configuration in drones against inefficient gasoline and diesel engines, as well as amid the lack of technological breakthroughs in all-electric engines.

## Outlook

Transitioning to electric engines in the military aviation domain opens up a range of prospects. While it is only a matter of time, it is unlikely to happen overnight given the slow pace of the electrification process due to the need to develop multiple related technologies. Therefore, we should definitely expect to see a certain transition period when hybrid options will be used. As a result, hydrogen gas turbine engines, hybrid and battery-powered all-electric aircraft will gain prominence. In the short term, by 2025, the demands on aircraft engines will increase significantly, but for the most part, they will still imply traditional operation principles. Various versions of aircraft with hybrid and electric propulsion are expected to have been produced by 2030-2040. Despite the high demand for technology development, it is the electrical system that looks most tempting in terms of the benefits it carries. This type of propulsion system will reduce the likelihood of aircraft detection and eliminate emissions. Engine maintenance costs will be significantly curbed, while the risks of mechanical faults will be reduced as well.

The main questions so far, however, concern the batteries to be used in all-electric aircraft, in particular their ability to store significant amounts of energy. Today, the dynamics of battery development is too slow to talk about meeting power needs of modern combat aircraft. The pace of charging or battery replacement, especially in combat conditions, as well as logistics and storage in varying climatic conditions, also raises questions.

Therefore, so far, the use of a hybrid propulsion system, which combines the best features of both traditional and electric engines, remains closest to implementation and practical application in combat aircraft. The main issue for designers is to make sure that the current stage does not drag on for too long. ■

## Masthead

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Cover: In altitudes where earth's curvature becomes visible, High-Altitude Platform Systems (HAPS) are increasingly used for observation and reconnaissance.  
Photo: CNIM Air Space

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# Engines of Destruction

## An Update on Main Battle Tank Power Packs

**John Antal**

The tempo and lethality of war is accelerating. Smarter, more precise weapons, which are linked to ubiquitous sensors, have created a very deadly battlespace. The recent Azerbaijan-Armenian war, where Armenian tank forces were decimated by Azerbaijani drones, sensors, long-range artillery and precision missile strikes, demonstrated this point and exposed the weakness of traditional thinking concerning how to fight modern wars.

With the dramatic success of precision unmanned aerial weapons against armoured vehicles in this war, many question the role of the Main Battle Tank (MBT). Tanks still play a critical role in war, but they must become more agile to survive and win in this new, more lethal battlespace. Nearly every MBT in the world today was developed during the Cold War and as they are upgraded with additional armour,

larger calibre cannons, and active and passive protection systems, they are getting heavier and agility is suffering. The agility of a tank is its ability to speed up, turn, jink, and stop. To move heavier MBTs, powerful engines that generate tremendous horsepower are required. You also need a reliable transmission that can reduce and vary the higher engine speed to the slower speed of the tank

### The T-90M

The T-90M PRORYV-3 (BREAKTHROUGH) tank is a state-of-the-art, third generation MBT and provides the Russian Army with a powerful and survivable tank with better protection, firepower and increased mobility than other tanks in the Russian inventory. The T-90M is the most important tank in the Russian arsenal, as it merges

Photo: ROK MIND



*The Republic of Korea K2 BLACK PANTHER represents the latest in Main Battle Tank (MBT) design for the modern battlefield.*

### 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.

track. Thus, the engine and the transmission are the critical components of agility. In his book "Tank Warfare", the great tank expert Richard Simpkin stated that the most important factor in tank agility is the tank's power-weight ratio, the horsepower (hp) available per ton of tank weight. This article reviews the engines of the Russian T-90M and the Republic of Korea's K2 BLACK PANTHER to describe the current state of the technology and briefly assess the emerging Franco-German Main Ground Combat System (MGCS) concept.

the best design aspects of its predecessor T-72 and T-80 tanks. The T90M was developed by the Russian defence company UralVagonZavod (UVZ), the largest main battle tank manufacturer in the world. It is an upgrade of the PRORYV-2, also known as T-90MS. The tank incorporates a new turret, the cannon developed for the T-14 ARMATA, and a new engine. The T90M costs approximately US\$4.5M each. These upgrades increase the tank's weight from 46 to 50 tons, requiring a more powerful engine to maintain agility. The T-90M's



Photo: MoD Russia

**The T-90M is the most important tank in the Russian arsenal, as it merges the best design aspects of its predecessor T-72 and T-80 tanks.**

new powerplant is the V-96, 12-cylinder diesel engine which produces 1,250-1,300 hp, generating 26 hp per ton when mated with a new, Russian-developed automatic transmission. This is the most powerful engine and transmission of any Russian tank, and UVZ developed this combination based on previously proven designs.

## The K2 BLACK PANTHER

The Republic of Korea (ROK) fielded a new tank, the K2 BLACK PANTHER MBT. It is rated as the most advanced and expensive tank in the world. Developed by Hyundai Rotem, an affiliate of the Hyundai Motor Group, each K2 tank costs US\$8.5M and has cutting-edge features including the ability to fire the KSTAM (Korea Smart Top Attack Munition) from its 120 mm cannon. Introduced in 2009, the K2 started with the dependable German-designed MTU MT-883 Ka-501 4-cycle, 12-cylinder water-cooled diesel engine from Germany's Tognum Group, one of the largest global suppliers of diesel engines, coupled with a German designed RENK transmission. Hyundai Rotem subsequently developed its own tank engine and transmission for the K2. The latest version uses a South Korean-made Doosan DV27K 4-cycle, 12-cylinder water-cooled diesel engine and a South Korean-made S&T Dynamics automatic transmission. The DV27K engine generates 1,500 hp and provides a power to weight ratio of 27.3 hp per ton. The fully automatic transmission of the vehicle includes five forward and three reverse gears. Problems with the S&T Dynamics transmission in late 2020 caused the South Koreans to replace it with the reliable RENK transmission. In addition, the ROK has negotiated a deal with Turkey to export the K2's technologies, but the problems with the S&T Dynamics transmission have delayed Turkey's new Altay MBT development plans. The problem with the S&T Dynamics transmis-

sion illustrates how difficult it is to design an effective and reliable engine and transmission combination to move heavy MBTs.

## The Main Ground Combat System

In 2019, Germany and France agreed to work together on a future ground combat system called the Main Ground Combat System (MGCS). Rheinmetall, one of Europe's leading suppliers of armoured vehicles such as the Leopard MBT, MBT Advanced Technology Demonstrator, Lynx Infantry Fighting Vehicle, Kodiak Armoured Engineer Vehicle, and the Wiesel

Light Reconnaissance Vehicle, has developed a forward-thinking tank design for the MGCS. The French-German Research Institute of Saint-Louis (ISL) is coordinating the design and development of the MGCS. This process involves the design of a family of vehicles that will have different capabilities, both manned and unmanned, to complement each other and operate together as a team. Development plans call for five phases: operational requirements analysis, concept studies, technology development and demonstration, system integration and demonstration and system production. Initial reports describe one design as a two-man tank with an unmanned turret. The two human operators are seated in the hull in a specially armoured, protected "survival-cell" capsule. By reducing the number of crewmembers, and protecting them in a smaller area, the MGCS needs less armour. Since the common factor for tank design is roughly 10 tons of armoured weight per crewmember, the Rheinmetall design could significantly reduce the tank's weight. The design has the engine in the hull's front and the chassis will borrow its configuration from the KF41 Lynx. The main armament could be a conventional cannon or possibly an electro-thermal-chemical gun (ETC). The tank's controls will be digital. This new design will require an abundance



Artist's impression: Nexter

**Nexter's concept of the multi-platform system MGCS**



Artist's impression: Rheinmetall

**Rheinmetall's vision of MGCS**

	T-90M	K2 Black Panther	MGCS
<b>Engine Type</b>	V-96 12-cylinder diesel engine	DV27K 4-cycle, 12-cylinder water-cooled diesel engine	Hybrid or All Electric?
<b>Engine Horsepower</b>	930 kW/1,300 hp	1118.5 kW/1,500 hp	TBD
<b>Tank Weight</b>	50 tons	55 tons	30 tons or less?
<b>Power to Weight Ratio</b>	26 hp per ton / 19.38 kW per ton	27.3 hp per ton / 20.35 kW per ton	TBD
<b>Road Speed</b>	65 km/h	70 km/h	TBD

of electrical power, so the engine could be a hybrid or all-electric with an electric cross drive transmission. The ISL has completed both the operational requirements analysis and the concept study and is currently in the technology development phase. The MGCS is an ambitious programme scheduled for production in 2035.

Military procurement is a ponderous and difficult process in the best of situations and hinders the design and fielding of totally new systems to replace legacy platforms. Sticking with what works, and incrementally improving current

equipment is usually a safer bet, until it no longer is. Today, the 1500 hp power-rating has become the standard for modern MBT with even the Russians moving to upgrade their latest engines from 1300 hp. The current generation of MBT engines and transmissions have improved as much current technology will allow. It requires new thinking to change this equation. New hybrid and electric designs are on the horizon and promise significant advantages over conventional turbine and diesel engines. Hybrid Electric Drives (HED) are smaller

than conventional diesel engines, require a simpler drive train, have 40% fewer moving parts compared to diesel engines and promise to provide 20% better fuel efficiency. They also produce ample electricity for modern tank computer and onboard C4ISR systems. Today, no hybrid or electric engines are used on MBTs. As new engine technologies improve, future MBTs must move in this direction. Until combat vehicle designers start thinking differently, however, the diesel engine, with about 1,500 hp and a reliable transmission, will rule. ■

### RENK America looks to wider market

Following the acquisition of L3 Harris Technologies Combat Propulsion Systems (CPS) in mid-2021 for US\$400M in cash, RENK America was formally launched at AUSA 2021 held in Washington DC in mid-October 2021.



Photo: RENK America

**Ted Trzesniowski is the CEO of RENK America who can supply home and export customers with a complete range of powerpacks for tracked military vehicles.**

M88 armoured recovery vehicle (ARV) with the latest M88A2 ARV being powered by the AVDS-1790-8CR developing 1,050 hp. Development of the AVDS-1790 family of V-12 diesel engines continues with the addition of electronic fuel injection (EFI), increased reliability to reduce the time between overhaul to 2,500 hours and power increase to 1,500 hp. According to Ted Trzesniowski, "we are a one stop shop for complete power pack and mobility solutions for tracked armoured fighting vehicles."

Under the leadership of Chief Executive Officer Ted Trzesniowski, RENK America seeks a wider market for its products and can pull in expertise from the expanding portfolio of the parent RENK Group in Germany who are the largest manufacturer of automatic transmissions for tracked vehicles in Europe.

RENK America is probably best known for its AVDS-1790 series of air cooled V-12 diesel engines of which over 35,000 have been manufactured with production still underway. These are fitted to upgraded M48A3 and M48A5 main battle tanks (MBT), all of the M60 series MBTs as well as the

To meet future military requirements, RENK America is also investing in a fully integrated hybrid electric drive (HED) solution and hopes to unveil a complete compact and scaleable solution to potential customers in 2022.

The company has also supplied re-powering and upgrade kits to a number of export customers including Israel for the MERKAVA Mk 1 and 2 MBT (AVDS-1790-6A developing 900 hp) and the MERKAVA Mk 3 MBT (AVDS-1790-9AR developing 1,200 hp). In addition, RENK America is currently in the process of re-powering a foreign self-propelled howitzer (SPH) by supplying complete powerpacks consisting of the AVDS engine and Allison transmission.

In addition to the AVDS-1790 family of diesel engines, the company also manufactures the HMPT series of tracked vehicle steering transmissions. The HMPT has evolved through several power upgrades and continues to be the smallest, lightest and lowest cost 800 hp transmission on the market. The HMPT transmission is installed in the BRADLEY Fighting Vehicle, M270 series Multiple Launch Rocket System (MLRS), M109A7 PALADIN Integrated Management (PIM), Armoured Multi-Purpose Vehicle (AMPV), Korean K21 infantry fighting vehicle and several other applications worldwide.

In addition to the CPS business, the acquisition also includes Magnet-Motors business based in Germany which is a world leader in high performance electric power supplies and hybrid drive systems for military applications.

RENK Group (Germany) has previously acquired the Horstman Group of the UK who have extensive experience in suspension solutions for a wide range of military applications including the M777 155 mm lightweight towed howitzer and upgrades for the M109 155 mm SP howitzer.

RENK France is active in the home and export markets and for the latter has developed and qualified a complete power pack for the widely deployed Russian T-72 MBT.

# Networked Future Weapon Systems for Turkish Forces

## Directed-Energy Weapons and Railguns

**Korhan Özkilinc**

In the last five years, Turkey's arms industry has not only gained momentum in the export of weapons systems, but at the same time has been able to reduce imports only to the essential.

The Arab Spring has changed the regional dynamics due to ongoing ethnic and political conflicts in such a way that Turkey has been forced to redefine the geopolitical instruments in its foreign and security policy. In particular, Turkey's defence industry as an instrument of power has to provide its innovative capabilities as a contribution to the country's foreign policy strategy. However, arms exports not only deepen diplomatic relations with the respective countries in terms of foreign policy, it also makes it easier for the Turkish Armed Forces to carry out their security missions geographically.

Photo: ASELSAN



Testing ASELSAN's TUFAN railgun

Photo: ASELSAN



ASELSAN's TUFAN railgun on public display

Of course, it is in the nature of any country eager to maintain its military superiority in crisis regions and at the same time gain qualitative advantages over foreign policy rivals that Ankara has been investing for at least a decade and very seriously in innovative weapons systems, including weapons based on new technical principles. There is considerable discussion in the media about Turkish UAVs acting as 'game-changers' in crisis regions, innovative missile systems, new frigates and fighter planes, but what has been pushed into the background are directed-energy weapons (DEW) and railguns. DEWs are weapon systems that can disable or destroy military targets with focused energy. Tübitak announced in 2015 at the IDEF fair that they have successfully hit targets with lasers. Six years later, Tübitak has presented an even larger laser gun that is being considered for permanent installation on Turkish warships in the near future.

### Laser Guns

The laser guns can already be seen on BMC armoured cars, and on the OTOKAR COBRA also. Such a gun could definitely bring down an unarmoured helicopter, and without any problems with stronger laser power, it would also be possible to bring down armoured helicopters. Aselsan has already reported in 2018 that it has destroyed drones with a laser weapon, and explosive devices from several hundred metres distance, even kilometres. In August 2019, a Chinese-made UCAV Male Wing LOONG II belonging to the UAE, was reportedly destroyed by a Turkish armoured fighting vehicle equipped with a laser gun near Misrata in Libya.

The state research institute Tübitak Bilgem has also developed the ARMOL laser weapon system which has also successfully passed the acceptance tests, as announced by the Minister of Industry

Photo: ASELSAN



Munition for the TUFAN railgun

Photo: Korhan Özkilinc



Tübitak's SAPAN railgun

and Technology Mustafa Varank. The system will be a vehicle-mounted fibre laser system (ARMOL) and qualified to be included in the inventory of the Turkish Armed Forces. The 400-kg laser system consists of target acquisition equipment and a control terminal mounted on a COBRA armoured vehicle. The 1.25-kW laser weapon is capable of damaging 3-mm steel plates at a range of at least 500 m and is also intended to be integrated into aircraft as a weapon system.

In October 2021, the Turkish police received a small drone with a laser weapon, ordered by the Ministry of Interior. This drone, the Asisguard EREN, is able to drill carbon steel 3-mm thick with its 500 W laser from a distance of 500 m in 90 seconds and from 300 m in 30 seconds and from the closest proximity of 100 m in just 10 seconds. Therefore, Turkish specialists in optoelectronic systems managed to heat the laser power to a single point over a long period of time and continuously, i.e. the laser gun could focus on a specific point of the target and heat

it until it was completely destroyed even while the target was moving.

### The NAZAR Project

The competence of Turkish engineers is particularly evident in the NAZAR project. This project was officially presented by Meteksan at IDEF'21. The project was signed between Meteksan and SSB in 2015 and the company had already invested in the development of optoelectronic technologies for several years. The NAZAR system provides a state-of-the-art broadband laser soft-kill capability against EO/IR-guided missiles to protect key bases and facilities. The system has the capability to detect EO and IR-guided missiles and neutralise them with laser-blinding and soft-kill techniques to the approaching missiles from a long range.. Currently, the mobile land version exists and is also planned to be fitted to the I class frigates in the future. The system will also be able to work with other sensors and systems to increase overall efficiency.

### ALKA

Another system has been introduced in 2019 by Roketsan with its ALKA. The system consists of two components and uses electromagnetic and laser technology against asymmetric threats as a very close hybrid air defence system. The system is particularly effective against UAVs and drones occurring in swarms and the core of the system architecture consists of AI models. Threats are interfered with by an Electromagnetic Jamming System and are destroyed by a Laser Destruction System with two-layered defence architecture. It can also be used to counter bomb (booby) traps in residential areas and roadside Improvised Explosive Devices. The ALKA system is used operationally with 4x4 vehicles. An additional advantage of these laser weapons is that they are powered by their own generator and therefore do not depend on an external power source, which means that the cost of firing the laser gun is equal to the price of the fuel consumed during firing. In addition, compared to conventional projectile weapons, missiles are much cheaper as they have to be built, transported, stored and maintained in order to be used. When fired, DEWs have no muzzle flash or smoke plume, meaning it is possible to fire from concealed positions so friendly troops are not in danger; therefore, DEWs are a very effective combat system.

Photo: Roketsan



The ALKA by Roketsan

### Railguns

In contrast to laser weapons, railguns, which work with enormous amounts of energy, are also very popular. The weapon system accelerates steel projectiles by means of a current-carrying carriage along two parallel rails. The acceleration of the metal projectiles is caused by the magnetic field generated by the current



**The NAZAR laser gun**

flow. The closed system is dependent on the length of the rails and the strength of the current, and reaches speeds of several kilometres per second. Turkey has developed three prototypes, although not simultaneously with the superpowers. The Turkish research institute Tübitak Sage was the first to start testing the SAPAN in 2014 and officially announced in 2016 for the first time that it had reached a range of 30 km during tests. Aselsan presented the TUFAN at IDEF'17 and the railgun system "SAHI209" of the company Yeteknology in 2019. Aselsan's TUFAN is one of the most promising sys-

tems for the Turkish security forces and will be produced in three different models, i.e. for the future frigates of the Navy and as a mobile system for the Army. During testing, the TUFAN reached a speed of 6 Mach or over 7,400 km/h and produced a muzzle energy of 2 megajoules. The company's goal is to accelerate the projectile to a long range of several hundred kilometres. The introduction of railguns in the Turkish Armed Forces will take some time because the development and research of railguns is difficult as it depends on many parameters. This means that a system for the Navy

will have big differences to land systems. Depending on the design, railguns differ greatly from conventional naval guns. In comparison, a conventional ship's gun, depending on its design, has a range of about 25-40 km, but a railgun has a range of 200 km, and compared to a missile, it is a tenth of the cost. This means that in the future, we will see railguns in different designs that will retire many of today's weapons and significantly change the nature of combat, i.e. railguns, and DEWs also, will contribute enormously to the sensor-to-shooter domain.

## Outlook

Turkey has set ambitious goals designed to make the Turkish defence industry 100 per cent independent of the outside world by 2053, while increasing its export capacity to US\$50Bn. In order to achieve these goals globally, at least ten Turkish defence companies should be among the 100 largest companies in the world. In the Turkish defence industry in particular, more than 1,600 companies are active, and the trend is continuing upwards. Of course, many of these companies will consolidate in the next few years and reform themselves in foreign markets; this development, in combination with Turkey's proactive foreign policy, will serve as a catalyst. Whether Turkey's defence industry will become 100 per cent independent is questionable, but the attitude of the US to exclude Turkey from the F-35 JSF programme has not only posed a new challenge to the Turkish defence industry, but also caused it to acquire important competencies it did not have before, and made its attitude more self-confident. ■

Photo: BMC / via author



**A laser gun on a BMC armoured vehicle**

# NATO Pods: New Airborne Capabilities

**Doug Richardson**

The words "underwing pod" cover reconnaissance pods, jamming pods, targeting pods, as well as simpler hardware such as gun pods, multi-round rocket pods, or even the prosaic cargo pods that can carry such unglamorous items such as aircrew luggage during long-range deployments. But it is those pods which exploit advances in modern electronics and electro-optics that provide the greatest increase in capability to a combat aircraft.

The days when nations could afford to develop or even procure dedicated reconnaissance variants of front-line fighters are long over. A pod-mounted sensor system is the only viable method of equipping a fighter for reconnaissance tasks. Until the mid to late 1980s, imaging pods contained traditional film-based cameras, but the digital revolution was so swift that by the mid-1990s, film-based pods were mostly used by smaller countries that could not afford electro-optical technology.

## Reconnaissance Pods

In 2018, the USAF placed an order with an initial ceiling price of US\$22.9M for UTC Aerospace Systems DB-110 airborne reconnaissance systems that would be sold to end users under the Foreign Military Sales (FMS) programme. This was the largest single acquisition of DB-110 pods procured through FMS, and was intended to meet the growing need for advanced intelligence, surveillance and reconnaissance (ISR) capabilities among US allies worldwide. At that time, the system was already in service with 14 countries on platforms such as fighters, patrol aircraft, unmanned air vehicles (UAVs), and business jets. A derivative of the Senior Year Electro-optical Reconnaissance System (SYERS) sensor carried by the Lockheed U-2, the DB-110 is a dual-band 110 inch focal length reconnaissance system table to produce high-resolution imagery by day or night at standoff ranges of more than 150 km.

Photo: UTC Aerospace Systems



*The DB-110 pod seen here on an F-16 can gather imagery from standoff ranges of up to 150 km, enough to keep the aircraft safe from many SAM systems, but not from long-range threats such as the Russian S-400 TRIUMF.*

Photo: USAF



*Lockheed Martin's AAQ-33 SNIPER advanced targeting pod is in service with more than 20 air forces.*

## Author

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



Photo: Northrop Grumman

**OpenPod is Northrop Grumman's concept for a rapidly-reconfigurable pod system based on line-replaceable units such as interchangeable sensor.**

Several recent conflicts have seen the Rafael RECCELITE II reconnaissance pod used in action. Designed to provide real-time imagery collection by day or night, and from all altitudes, this can transmit live video imagery to suitably equipped ground stations. It is often used in an automatic mode that involves capturing images as the aircraft overflies pre-defined locations.

The SCAR-POD (Self Contained Aerial Reconnaissance Pod) originally designed by Airborne Technologies for use on the Pilatus PC-9 single-engine turbo-prop training aircraft represents the opposite end of the capability spectrum. This lightweight carbon-fibre pod does not need any airframe modifications, but uses lug suspensions that allow it to be fitted to any aircraft with hard points. Communication between the pod and its operator is done via WIFI, eliminating the need for external cabling. Possible payloads include a gimbal-mounted EO/IR system, downlink and uplink hardware, and COMINT/SIGINT equipment. These payloads can be powered for up to three hours by an internally-mounted battery pack.

## Targeting Pods

Targeting pods range in complexity from single-function units such as laser spot tracker pods and laser designator pods, to multifunction pods that combine forward-looking infrared (FLIR), TV, laser spot tracking and laser designation capabilities. Fixed-wing aircraft are the most common platform to receive such systems, but helicopters and UAVs can also be fitted with pods.

Under the Passive Attack Sensor System (PASS) programme, USAF F-15C/D fighters have been fitted with the Lockheed

Martin AAQ-33 SNIPER advanced targeting pod and a large multi-function cockpit display. The pod contains a mid-band FLIR, high-definition TV camera, laser spot tracker, laser designator, and a digital video recorder. Although the pod has an aerial search function, it is usually steered towards aerial targets by the aircraft's radar. However it can also be manually steered, or cued by the pilot's Joint Helmet Mounted Cueing System (JHMCS). On 8 July 2020, an F-15C from the USAF's 85th Test and Evaluation Squadron (TES) was the first to use targeting data from the pod to conduct an AIM-9X SIDEWINDER engagement of an air target.

In July 2020, the USAF placed an initial order for Northrop Grumman LITENING targeting pods with full-colour digital video, and two-colour laser spot search and track capabilities, and in May 2021

these pods entered service with the US Air Force Reserve and Air National Guard. Any existing LITENING pod can be upgraded to add colour capability, and this new configuration also provides an ability to record simultaneous video feeds from all sensors for post-mission analysis, plus an automatic laser code display and eye-safe mode. The colour output has a resolution of better than 1,000 x 1,000 pixels, and is intended to give the user a more detailed understanding of their environment, and shorten the time required for complete situational understanding. Northrop Grumman saw infrared search and track (IRST) and targeting pods as potential early applications for its OpenPod concept in which the use of line-replaceable units, interchangeable sensors, and an open architecture would allow a pod to be reconfigured in minutes. These sensor changes would not require modi-



Photo: Raytheon

**Mid-Band pods for the Next Generation Jammer (NGJ) being assembled by Raytheon.**

Photo: Northrop Grumman



**Under the USAF's Electronic Attack Pod Upgrade Program (EAPUP), Northrop Grumman is modernising the USAF's ALQ-131 EW pod, seen here under test in an anechoic chamber.**

fications to the aircraft, so the pod could be modified or updated without affecting the aircraft's configuration.

### Reconfigurable Pods

A similar concept for a reconfigurable pod is the AgilePod being developed by the US Air Force Research Laboratory (AFRL) to serve as a low cost, reconfigurable, multi-intelligence, open-architecture system that uses centre modules of differing lengths, optional side modules, a nose cone, and tail cone. AgilePod hardware delivered in December 2016 led to flight trials conducted in June 2017. These showed the potential usefulness of an open-architecture pod that would allow RF systems such as multi-mode radar, EW systems, and communications systems payloads to be rapidly tailored in a flight-line environment in order to meet evolving mission needs.

Evolving threat systems require the deployment of new or updated jamming pods. To replace the legacy ALQ-99 jammer used by the EA-18 GROWLER, the USN plans to develop three types of Next Generation Jammer (NGJ) pod – the ALQ-249 Mid-Band (Increment (Inc 1), Low-Band (Inc 2), and High-Band (Inc 3). Frequency coverage of these variants is reported to be 2-6 GHz, 100 MHz-2 GHz, and 6-18 GHz respectively. The three are intended to counter a variety of threat systems used by potential adversaries. Raytheon's NGJ Mid-Band pod is undergoing flight-testing, while L3Harris has

been tasked with developing the NGL Low-Band pod. Funded by the USN and the Royal Australian Air Force, the Low-Band pod is intended to counter threat systems such as VHF-band radars that could track stealth aircraft. Early development of the NGJ High-band pod is expected to begin in the near future.

Lockheed Martin's ALQ-248 Advanced Off-Board Electronic Warfare (AOEW) Active Mission Payload (AMP) is a pod designed for use on USN MH-60R or MH-60S helicopters. It will operate independently or in conjunction with the ship-board SEWIP Block 2 EW suite to detect and counter incoming anti-ship missiles (ASMs).

In March 2021, the USN announced that its Air Test and Evaluation Squadron had flight-tested a pod-based towed decoy system. Flown on a P-8A maritime-patrol aircraft, this was based on a pod made from the fuselage of an AGM-84 HARPOON antiship missile. It housed a fibre-optic towed decoy (FTOD) dispenser used to deploy the ALE-55 decoy. Now undergoing system-level testing at the Naval Air Weapons Station at China Lake, the new pod is expected to form the basis of an operational system.

### Jammer Pods

Flight-testing of Saab's Electronic Attack Jammer Pod (EAJP) started in 2019. The unit is part of the company's AREXIS family of EW systems. Although designed to complement the on-board electronic

warfare system of the company's GRIP-EN E/F fighter, it will be compatible with other types of fighter. The jammer uses active electronically scanning array (AESA) technology, and its coverage includes the lower frequency bands used by some anti-stealth air defence systems.

Hensoldt has exploited AESA hardware, 3D printing technologies, and artificial intelligence techniques to create its new KALAEATRON ATTACK multi-function jamming system. Due to begin flight trials intended to confirm the results from ground tests, the system could be integrated into a relatively small pod that would be easy to integrate with combat aircraft, and UAVs, then used for stand-in, stand-off, and escort jamming tasks.

### EW Pods

To remain combat-effective, an EW pod must be upgraded to match evolving threats. The widely-used Northrop Grumman ALQ-131 was first fielded in the 1970s, and development of a follow-on Block II version began in 1983. This variant introduced a power-management system that allowed the system to automatically detect specific threats, and respond with the most effective jamming technique and power level. It used a combination of noise, repeater or transponder electronic jamming techniques, and saw extensive combat service during the 1990s.

Latest version of the ALQ-131 is that being fielded under the USAF's Electronic Attack Pod Upgrade Program (EAPUP). Intended to replace the service's current electronic attack pods, it has successfully undergone tests designed to verify the system's capabilities and readiness for operations in modern combat scenarios involving multiple, simultaneous threats. For the international market, Northrop Grumman has developed the ALQ-131C, which is designed to have pulse-to-pulse interoperability with the APG-83 AESA radar carried by the F-16. Its high-sensitivity digital receiver, high speed processors and digital radio frequency memory (DRFM) are intended to allow high-fidelity digital signal generation, giving the ability to defeat known, emerging and envisioned future threats in even dense, complex threat environments.

Similar upgrade programmes have been applied to other pod-mounted EW systems. Developed by what was then Marconi Space and Defence Systems (now part of Leonardo) and delivered from 1981 onwards, the SKYSHADOW pod was designed to defend UK strike aircraft

from Soviet surface-to-air missile systems by delaying radar acquisition or, in concert with chaff, by breaking radar lock. By the late 1980s, improvements in potential threat systems required what was then Marconi Defence Systems to upgrade SKY-SHADOW. The resulting Project THOR kept the system effective throughout the 1990s. Operations over Libya showed the need for yet another upgrade, so what was then Selex ES (now part of Leonardo) began work a project that resulted in what is now termed the Common Jamming Pod. This retained the basic pod structure, but replaced the entire receiver chain, updated the travelling wave tube (TWT) transmitters, introduced a digital control unit and a digital techniques generator, and installed two towed radar decoys into the rear of the pod.

Jopana Technologies developed its ALQ-231(V) INTREPID TIGER II EW pod to provide Marine Corps fixed-wing aircraft, helicopters, UAVs, ground-based systems, and laboratories with an airborne electronic warfare and electronic attack communications jamming capability. The system incorporates company's S902R GOLDEN-EYE III and S905R RAIDER III rugged processor, and data storage systems provided by General Micro Systems. During an exercise in mid-2020, the US Army demonstrated the Lockheed Martin Multifunctional Electronic Warfare (MFEW) Air Large jamming pod on a General Atomics GRAY EAGLE extended range UAV. Conceived as the Army's first brigade-level airborne electronic warfare jamming pod, the MFEW is expected to enter service some time in 2022. The Army also hopes to eventually field the system on smaller types of UAV.



Photo: USAF

**USAF technicians inspect a Raytheon ALQ-184 jamming pod. This updated version of the earlier ALQ-119 saw action during the 1990-1991 Gulf War, and during combat operations over Iraq and the former Yugoslavia.**

### Pods for UAVs

As the complexity and cost of sophisticated UAVs continues to rise, they too become candidates for self-protection. In October 2020, General Atomics Aeronautical Systems demonstrated a newly developed Self-Protection Pod (SPP) on an MQ-9 flying at the Yuma Proving Grounds. The pod contained an RI&S ALR-69A(V) radar warning receiver, and a Leonardo DRS AAQ-45 Distributed Aperture Infrared Countermeasure (DAIRCM) system that uses a single sensor for both two-colour IR missile warning and wide field-of-view gimbal for threat countermeasures. It also carries a BAE Systems ALE-47 countermeasures dispenser system for flares, chaff, and other airborne decoys. These subsystems were controlled by a Terma ALQ-213 Electronic Warfare Management System installed in

the pod. The UAV was able to track radio-frequency (RF) and infrared (IR) missile threats, and deploy countermeasures, including Leonardo's BriteCloud Expendable Active Decoy (EAD).

Several programmes illustrate new capabilities for aircraft-mounted pods. On 3 August 2020, General Atomics conducted the first test flight of an MQ-9 UAV fitted with a ROSETTA Echo Advanced Payloads (REAP) pod designed to create a communications relay network able to provide seamless connectivity between air and ground participants located in the demonstration area using protocols such as Link 16 and UHF/VHF radio. Operational assessment of the pod by the US Air National Guard (ANG), Air Force Reserve Command Test Center (AATC), and Ultra Electronics was completed in less than two months. It included the successful transfer of video received from a COYOTE small UAV to a ground node located around 180 km away. A follow-on REAP-2 configuration will be integrated into a version of the AgilePod.

### Laser Pods

Assembly of a pod-based directed energy laser system under the US Air Force Research Laboratory Self-Protect High Energy Laser Demonstrator (SHIELD) advanced technology demonstration programme is now under way, following delivery of the pod structure early in 2021. Two remaining subsystems are due to be delivered later this year, allowing work to start on integrating the complete system, including the beam control hardware and laser. An F-15 has already flown with a laser test pod, and air-launched missiles have successfully been shot down using a ground-based system configured to represent the pod-mounted hardware. ■



Photo: US Air Force

**This artist's impression shows the US Air Force Research Laboratory's Self-Protect High Energy Laser Demonstrator (SHIELD) pod-based directed energy laser system in action. Assembly of the first of three examples began in early 2021.**

# Special Mission Aircraft

Lengthy product certification procedures are hampering the growth of the market.

**J. C. Menon**

The demand for special mission aircraft is increasing, with militaries across the world looking to acquire armed over-watch to provide special operations forces with deployable, affordable and sustainable manned aircraft systems capable of executing close-air support, help in precision strikes and with armed intelligence.

The growth of the military aviation segment of the special mission aircraft market can be attributed to the growing demand for usage in various special missions carried out by the military forces such as reconnaissance and surveillance operations. Air forces and federal law enforcement agencies around the world are using special mission aircraft for intelligence, surveillance, and reconnaissance (ISR) and border protection activities. Israel is one of the countries building and acquiring some of the most sophisticated special mission intelligence gathering aircraft globally.

Business jet manufacturers have been producing special mission aircraft for over three decades with more than 1,000 aircraft delivered to governments and militaries worldwide.

## GULFSTREAM for Israel

Early this year, the Israeli Air Force (IAF) took delivery of a special mission GULFSTREAM G550 from Gulfstream Aerospace to support and enhance their mission-critical surveillance operations. "Israel has been a Gulfstream special mission customer for many years... With unparalleled performance capabilities, our modified aircraft can fly the demanding missions governments and militaries conduct around the world. Combined with the exceptional reliability our platforms provide and the expertise of our dedicated teams, Gulfstream's special mission service is second to none," said Mark Burns, President of Gulfstream. Israel's IAI also has delivered special mission aircraft to the Israeli Defense Forces (IDF) and numerous countries worldwide, with the IAI considered to be one of a select few companies that possess these technology capabilities in-house. IAI's ELTA Systems is in charge of the conversion process and

Photo: Bombardier



**The Bombardier GLOBAL 6000/6500 series is one of the most popular platforms for Intelligence, Surveillance and Reconnaissance (ISR) missions.**

offers a host of aircraft for air-to-air, air-to-ground and air-to-sea coverage providing multi-mission Intelligence, Surveillance, Target Acquisition, and Reconnaissance (ISTAR) capabilities. Benefiting from IAI's aircraft expertise, ELTA has acquired vast experience in converting business or military aircraft into dedicated sophisticated multi-mission ISTAR. IAI currently works with several airplane manufacturers to upgrade aircraft for these operations, including Dassault, Bombardier, Gulfstream, and Embraer.

## Bombardier for USAF

Bombardier was chosen once again by the US Air Force to provide a high-performance aircraft. The Bombardier GLOBAL aircraft, known in the business aviation industry for its range, spaciousness and a smooth ride, is a proven, go-to platform for special government missions thanks to its speed, payload capacity, built-in power redundancy, reliability and endurance. US Representative Ron Estes said, "These Bombardier GLOBAL 6000 aircraft modified and tested in Wichita give our airmen a competitive advantage in flight and communication." All of Bombardier's portfolios— from the LEARJET 75 to the GLOBAL 7500, are candidates for conversion into special mission aircraft.

To date, the 6000/6500 series has proven to be the most popular for Intelligence, Surveillance and Reconnaissance (ISR) mis-

sions, with "hundreds of thousands of hours flown," according to Steve Patrick, Vice President of specialised aircraft at Bombardier.

In 2018, Bombardier teamed with Lockheed Martin to offer the GLOBAL 6000 to the US Air Force to replace its ageing Boeing 707 JSTARS radar imaging and battlefield management aircraft.

## French Order

France recently ordered 12 Dassault FALCON 2000 ALBATROS aircraft equipped for maritime surveillance duties.

"It is a high-performance aircraft equipped with a mission system and sensors of the latest generation," said Dassault Chairman and CEO, Eric Trappier.

The ALBATROS is the latest in a line of maritime surveillance aircraft based on various FALCON platforms.

The ALBATROS is based on the FALCON 2000LXS business jet and will be equipped with a range of instruments to suit it for a variety of maritime patrol roles, including search and rescue, fighting pollution and trafficking, surveillance of borders and exclusion zones, and fisheries policing. Large observation windows will be installed in the forward part of the cabin for visual searches and a Thales SEARCHMASTER multi-mode radar will be mounted in a belly fairing. A retractable Safran EUROFLIR optonics turret will be fitted under the rear

fuselage, and the aircraft will be capable of air-dropping search and rescue kits. The aircraft will also be equipped with a communications suite tailored to its military and public service tasks.

## India not Far Behind

In India, the state-owned Defence Research & Development Organisation (DRDO) is working on several projects to give the Indian Air Force (IAF) dedicated special mission aircraft such as ISTAR and AEW platforms.

According to a DRDO official, the multi-intelligence ISTAR aircraft will be based on a high-altitude, high-endurance business-type jet, with the ability to operate over both ground and water. Its purpose is to collect high-resolution imagery using its on-board SAR and EO/IR sensors.

India has also formalised the acquisition of 56 Airbus C295 aircraft at an estimated cost of US\$2.7Bn to replace the IAF's legacy AVRO fleet.

"The C295 has proven again as the segment leader, and with the addition of India as a new operator, the type will enlarge its footprint even more, not only on the operational aspects but on its own industrial and technological development," Michael Schoellhorn, CEO of Airbus Defence and Space.

Under the contractual agreement, Airbus will deliver the first 16 aircraft in 'fly-away' condition from its final assembly line in Seville, Spain. The subsequent 40 aircraft will be manufactured and assembled by Tata Advanced Systems (TASL) in India as part of an industrial partnership between the two companies.

The first 16 aircraft will be delivered over a period of four years after the contract implementation. All the IAF C295s will be handed over in transport configuration and equipped with an indigenous Electronic Warfare Suite.

Sukaran Singh, Managing Director and



Photo: Gulfstream / IAI

**The Israeli Air Force is relying on a special missions GULFSTREAM G550 to enhance their surveillance operations.**

Chief Executive Officer of Tata Advanced Systems Limited, described the sealing of the deal as a moment of pride for Tata and a "milestone" for the Indian military manufacturing ecosystem.

"For the first time, an Indian private company will be wholly manufacturing an aircraft in India. This endeavour demonstrates the Tata Advanced Systems' capabilities as a defence manufacturer to build globally competitive complex platforms in India," he said.

## New Design from Bell Textron

Bell Textron recently unveiled design concepts for new aircraft systems for military use. The concepts will use Bell's "High-Speed Vertical Take-Off and Landing" (HSVTOL) technology.

"Bell's HSVTOL technology is a step-change improvement in rotorcraft capabilities," said Jason Hurst, Vice President of Innovation. "Our technology investments have reduced risk and prepared us for rapid development of HSVTOL in a digital engineering environment, leveraging experience from a robust past of technology exploration and close partnerships with the Department of Defense and Research Laboratories."

"Bell's HSVTOL capability is critical to future

mission needs offering a range of aircraft systems with enhanced runway independence, aircraft survivability, mission flexibility and enhanced performance over legacy platforms," said the company.

Bell also claims that the combinations of new aircraft technology and digital flight control advancements may help evolve HSVTOL technology for modern military missions.

## Leonardo, Diamond Tie Up

Meanwhile, Leonardo and Diamond Aircraft Industries have teamed up to offer a version of Diamond's popular twin-engine DA62 aircraft customised for maritime surveillance missions. The new variant, designated DA62-MSA (Maritime Surveillance Aircraft) will be equipped with a full ISR suite based on Leonardo's ATOS (Airborne Tactical Observation and Surveillance) mission system. The collaboration is a response to the need for cost-effective, short/medium-range land and maritime surveillance platforms in regions such as South America, Africa and Asia Pacific.

More than 110 twin-engine special mission aircraft have been sold by Diamond and more than 60 ATOS systems are already installed by Leonardo on ten different platforms, including for Italy's Air Force, Guardia di Finanza (customs police) and Coast Guard and for Australian Customs. With the DA62-MSA, Leonardo and Diamond are able to offer an extremely cost-effective and user-friendly light ISR solution for maritime security needs, with a Take-off Weight (MTOW) of 2,300 kg, endurance of up to eight hours and up to four crew able to operate with land and maritime radar.

While factors such as increasing defence expenditure of countries and growing terrorism activities are driving the growth of the market, lengthy product certification procedures are hampering the growth of the market. ■



Photo and text: IAI

**The P600 AEW (Airborne Early Warning) is based on the Embraer PRAETOR 600 business jet. It can provide an extended Air Situational Picture by monitoring aerial activity in areas outside ground radar coverage.**

# New Approaches to Demilitarisation, Dismantling and Disposal (D3)

**Marcus Kluge, Selma Fernandes, Ines Alves**

The processing of every military system at the end of its life cycle – the retirement phase - remains a largely unnoticed event. Disposing of legacy equipment is not an overly entertaining story and usually makes the headlines only for the wrong reasons.

The growing technological complexity of systems and underlying legal regulations create a considerable challenge for those in the business of demilitarisation, dismantling and disposal (D3) of military assets. Add to that the growing importance of environmental protection. NATO has accepted this challenge.

Photos: NSPA



**Demilitarisation by cutting the barrel of a main battle tank**

## NATO's Agenda

Although largely unknown to the wider public, NATO has been working in the field of environmental protection for many years. While the focus in the past has been put on military missions in operational theatres, the NATO Secretary General raised it to the next level in 2021 by introducing the NATO 2030 initiative. It recognises environmental factors such as strategic security risks and NATO's responsibility to respond meaningfully.

The new focus has subsequently been incorporated into business strategies of literally all NATO bodies. The NATO Support and Procurement Agency (NSPA), for example, has a matching ambition and seeks to "introduce green initiatives aimed at reducing energy usage, increasing recycling, as well as tackling Demilitarisation, Dismantling and Disposal (D3)". The latter will be achieved by "contributing to the development of the environmentally friendly disposal of customer surplus equipment through the offer of attractive and economic services in the D3 domain". The role of D3 as a key contributor is recognised therefore and the moment has come to

look at ways how D3 projects can meet expectations and deliver quantifiable results.

## The D3 Challenge

At first sight, the phasing out of military equipment may not look like a major challenge. After deciding to retire a military system, the first question Ministries of Defence need to answer is the disposal strategy. The traditional options are sale, gift, donation, conversion to another use (e.g. training), or destruction. Selecting an option will depend on a number of considerations, as well as the nature and condition of the item. Take the example of a legacy main battle tank: counting the tanks and pooling them at a single site is the easy part. Still, in order to determine the best D3 approach, the designated system manager or surplus office will have to answer a set of questions that have an impact:

- Arms transfer obligations – do the original acquisition contracts/agreements include provisions for advance authorisations and specific demilitarisation procedures, i.e. from the country of origin (USA Foreign Military Sales and similar)?

- International treaties – does the disposal have to follow specific demilitarisation procedures and require specific accounting in accordance with international treaties, i.e. the Conventional Forces in Europe (CFE) treaty?
- Legal obligations – which international and national laws and regulations apply to labour, health and safety, environmental protection, and management of waste and hazardous substances, such as asbestos?
- Classified or controlled components – which items have a security classification that demand special treatment and tracking? Which items have to follow special processes and authorisation schemes for their destruction, i.e. cryptographic and military GPS elements?
- Sourcing – do I have organic or industrial sources in-country with the necessary permissions and capabilities? If not, can third-country sources be used? Can the material be exported safely at all? Which regulations apply locally at the source's site?
- Certification – how does the disposal have to be certified to satisfy national and international requirements? What types of evidence are recognised? Which authorities can issue such a certification?

## Authors

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As if these questions are not already tough enough to answer and demand a certain degree of knowledge and experience, there are additional factors that make matters even more complicated:

(1) D3 should be carried out with minimum costs or, in an ideal world, pay for itself, or even generate profits;

(2) D3 has to comply with stringent environmental regulations. Not a single country can afford to have its reputation damaged in the global media on top of legal and financial sanctioning;

(3) D3 has to contribute to a green agenda. Many countries are committed to achieving sustainable economies by 2050, often referred to as “decarbonisation”. Fostering a circular economy is another goal.

D3 can be a rather complex and time-consuming undertaking, requiring a broad knowledge of several key areas and a profound understanding of the costs, benefits, and risks associated with each disposal option and the military system itself.

While cost and compliance requirements have been applied literally to every project in the defence domain for a long time, the focus on environmental aspects is a relatively new development. It has quite a significant impact on D3 projects and requires that a strategic perspective be adopted early on to ensure the highest level of environmental protection.

### Providing D3 Solutions

It is good news for everyone that security and environmental aspects have become the dominant drivers for developing viable D3 solutions. They all contribute to making D3 safer and cleaner. Unfortunately, it does not make things easier or cheaper.

The NSPA has been supporting NATO and Partner nations under the auspices of a dedicated D3 Support Partnership (SP) for almost a decade. Today, NSPA’s D3 portfolio spans from ammunition disposal via site remediation to entire military systems’ demilitarisation and hazardous material treatment and disposal. Recent efforts



**The guiding requirements for Demilitarisation, Dismantling and Disposal of defence material**

have focused on establishing a framework of readily useable contracts with specialised and globally operating industry partners. These contracts shall not just enable a rapid response to emerging D3 enquiries, but also support a maximum scope of military systems and D3 related activities.

### D3 Development Phase

The Development Phase is the starting point of each D3 project and assesses the peculiar challenges in a structured way. While most of the legal and security aspects are evaluated by NSPA experts and in close co-operation with the requesting customer nation, the identification and assessment of the hazardous material usually requires the involvement of a specialised company. The NSPA has several laboratories under contract that can provide on-site

sample taking and subsequent chemical analysis in laboratories.

As so often is the case, the devil is in the detail: there are countless regulations for the proper accounting and treatment of hazardous materials to protect the environment and human life. Fifty years ago, many of the substances eventually found to have an adverse impact on the health and/or the environment, were considered harmless and applied in large volumes. Asbestos fittings, lead paints, cadmium and hexavalent chrome coatings, polychlorinated biphenyl containing electric/electronic components, mercury switches and radioactive illuminations are only some of the substances you will likely find in legacy military equipment. These are rarely documented and necessitate that a new mapping of all hazardous materials is carried out with a clear identification of each substance, particular quantities and conditions.



**Materials gained from MBT Leopard 1**



The D3 strategy is then tailored to address the project-specific hazards. It describes the recommended approach for the removal of hazardous items, their handling, interim storage, protective measures and disposal processes.

### D3 Execution Phase

The Execution Phase starts by selecting the best-qualified and most cost-effective company for the selected D3 strategy. Compliance with applicable standards and previous relevant experience are checkpoints during this selection process. Due to the

large variety of D3 tasks, NSPA contracts address a large range of military, non-military and dual-use systems, to include the air, land and sea domains, as well as their sub-components, support equipment or infrastructure.

Contracted D3 activities include the recovery of material, transportation, on-site dismantling, demilitarisation, material segregation, storing, tracking and tracing of controlled items. The actual recycling and disposal of recovered materials is equally included in NSPA contracts and provides several options, i.e. for the specialised waste processing, re-use or sale. At the end of

the process, a Certificate of Disposal and any additionally requested evidence will be issued by the NSPA to document the successful execution.

### Turning a Liability into an Asset

Compliant D3 comes at a cost. Consequently, warehouses and storage areas are full of old military equipment and have been left untouched for decades - "out of sight, out of mind". Every nation faces issues with leftovers from the Cold War, albeit of different magnitude.

The NSPA has proven that a perceived liability can be turned into a profitable business. Global market prices for scrap steel, aluminium and copper have been continuously at a level where the sale of recovered material exceeded the actual D3 and recovery costs.

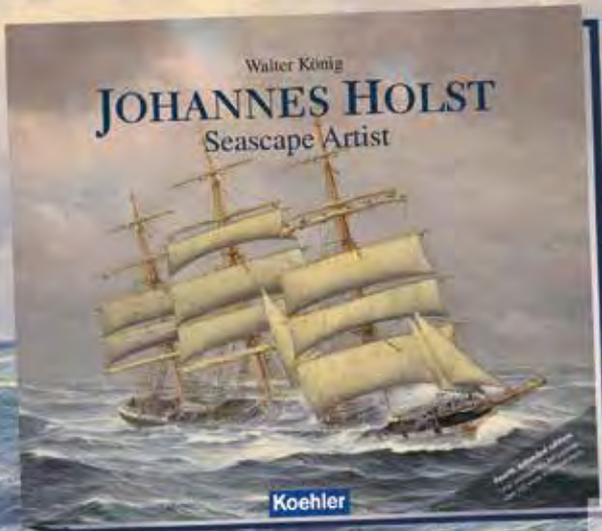
The pie chart shows the different shares of metals gained during the D3 of LEOPARD I tanks. About 24 tonnes of metal were recovered from each tank. At 2020 prices, the scrap metal revenues were around €5,000 to €6,000 per vehicle, while actual D3 costs were between €3,000 and €4,000 per vehicle.

Another profitable example is the D3 of M113 Armoured Personnel Carriers with a weight of around 12 tonnes, largely built from aluminium. At 2021 prices, the scrap metal value achieved was around €4,000 to €5,000 per vehicle and the D3 costs were between €1,000 to €2,000 per vehicle. Both examples show that a net profit between €2,000 and €3,000 per vehicle can be a realistic planning figure. Taking into account that as of today there are still hundreds, if not thousands of these vehicles waiting for D3, some nations may well be sitting on hidden treasure.

### Reducing the Military Carbon Footprint

Societies have become increasingly sensitive about the conservation of resources, energy efficiency, fighting climate change and risks associated with the globalised traffic of hazardous goods. Recycling is critical for the protection of our environment, contributes to the preservation of natural re-

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sources, is essential for new manufacturing and creates jobs. Metals can be recycled without loss of quality and qualify ideally for a circular economy. Every tonne of recycled scrap steel (and contained alloying elements) prevents the extraction of new metal from ores. The savings are quite impressive: recycling one tonne of scrap steel saves 1.4 tonnes of iron ore, 0.8 tonnes of coal, 0.3 tonnes of limestone and 1.67 tonnes of carbon dioxide (even 4.3 tonnes for high quality steel used i.e. in military vehicles). On average, in terms of environmental savings, 72 per cent energy consumption can be saved, water use is reduced by 40 per cent, water pollution by 76 per cent and carbon dioxide emissions by 58 per cent.

In 2018, almost 94 million tonnes of steel scrap were recycled in the European Union, representing 56 per cent of the total European steel production. The total savings in carbon dioxide emissions are a staggering 157 million tonnes. This is the equivalent of the annual emissions from all cars driving in France, the United Kingdom and Belgium combined.

Steel is certainly the most prominent metal to look at due to its ubiquity in many legacy systems. Nevertheless, aluminium and copper are even more attractive metals for recycling – the benefits for the environment are a multiple of those for steel due to the higher amount of energy required for their extraction from ores. For example, one tonne of recycled aluminium conserves more than 4 tonnes of bauxite ore, and manufacturing new products from recycled aluminium can save up to 95 per cent of the energy needed compared to virgin materials.

The two above-mentioned NSPA D3 projects for the LEOPARD I and M113 alone have resulted in environmental savings of approximately 88,000 tonnes of carbon dioxide and 110 million kWh of energy, a value that can be compared to the energy which a 1,000 MW coal power plant can generate in five days. This energy would require the burning of 45,000 tonnes of coal. These numbers provide an initial idea of the potential savings still out there and the positive impact of D3 activities to protect our planet.

## D3 Outlook

Predicting the future is always uncertain. However, some clear trends cannot be ignored and will play a central role for the D3 of military systems:

1) Demand: there are still large inventories of phased out and surplus equipment in most nations that are stored in a more or

Recovered materials from 100 Leopard I MBTs		Recovered materials from 100 M113 APCs	
Material (*hazardous material)	[Kg]	Material (*hazardous material)	[Kg]
Iron & steel (tires, tracks, cannon)	2,052,282	Iron & steel	670,332
Ferrous metal (engine)	440,578	Ferrous metal (engine)	77,090
Aluminium	133,799	Aluminium	335,266
Other non-ferrous metals	137,509	Other non-ferrous metals	121,834
Mixed metals	9,551	Tracks rubber	13,024
Tracks	22,099	Electric wires	1,624
Tracks rubber	8,091	Electric components	2,060
Electrical wires	4,433	Plastic	15,128
Electric components	17,945	Asbestos*	100
Plastic	4,962	Lead batteries*	1,220
Asbestos*	2,893	Lubricant oil*	2,996
Lead batteries*	26,624	Fuel oil*	1,622
Lubricant oil*	13,480	Antifreeze liquid*	292
Fuel oil*	8,199		
Antifreeze liquid*	4,033		

Recovered materials from 100 LEOPARD 1 MBTs (left) and 100 M113 APCs (right)

less orderly way. The perception of them being a potential safety and security threat is likely to increase;

2) Technical Complexity and Diversity: we will see the advent of more composite elements (glass, carbon, aramid fibres with epoxy materials), sometimes layered with steel, honeycomb structures and other fused materials. Additive manufacturing (3D printing) will introduce a large variety of different plastic materials. Computer and other electronics will be omnipresent and further miniaturised, sometimes deeply embedded in structural parts. The trend for more electrification will go along with the addition of batteries, wiring and electric motors. The recovery, segregation and re-cycling of these materials will be considerably more difficult;

3) Compliance and Environment: environmental aspects will gain more importance for future D3 projects. This is a direct consequence of tighter regulations being implemented and a public desire for more transparency of potentially “dirty and dangerous” projects, even many years after project completion;

4) Management of Hazardous Materials: Nations must adopt a proactive approach to ensure that all hazardous materials are properly mapped upfront, with a clear intention to address and update associated disposal risks throughout the entire life-cycle;

5) Costs: it is quite obvious that the growth of technical complexity, diversity of equipment and materials, dangerous substances, removal and disposal of hazardous material, strict compliance, and increasingly stringent legal and environmental requirements will make D3 more expensive in the future;

6) Generating Revenues: the desire to make money from surplus equipment by selling rather than destroying will increase. Firstly, due to budget constraints, to ensure that taxpayer’s money is not wasted after

high-value defence systems are phased out. Secondly, to promote a circular economy and avoid waste. Transfers of systems to other eligible users are therefore likely to become the primary objective of most future D3 projects. Specialised market knowledge and access will be crucial, as the potential customer base is often very limited and rather discreet. A broad spectrum of tools will be needed to reach out to these customers on a global scale, exploiting the advantages of e-sales platforms.

## Conclusion

D3 is an often overlooked aspect of a military system’s life-cycle. Its manifold challenges in terms of technical and legal requirements demand a comprehensive and professional project management that builds on D3 specific expertise. The NSPA has proven that the separation of a development and execution phase ensures an early understanding of compliance requirements, a broader understanding of costs, benefits and risks, and identification of sales options. Access to global customer markets and the rapid activation of a specialised and multi-skilled contractor framework will be essential for a successful implementation.

Every D3 project can also become a tangible contribution to a nation’s “green agenda” by reducing carbon dioxide emissions, saving the world’s finite resources and contributing to significant energy savings. This is quite a turnaround when looking back more than fifty years when dumping into the sea was a widely accepted approach. The future of D3 will face more challenges, but there is no way back and no viable alternative, as we see the demand on the rise. There are many reasons for every system manager to plan for the system’s retirement phase already today, no matter when it will happen eventually. ■

# AWACS Succession: SLEP and AFSC

**Giulia Tilenni**

During the 2016 Warsaw Summit, NATO members officially launched the Alliance Future Surveillance and Control (AFSC), a project aimed at defining the next generation AWACS capability. In the meantime, the Alliance has launched the final phase of the Final Lifetime Extension Programme, to extend the operational life of the current fleet to 2035.

NATO acquired its own Airborne Early Warning capabilities (AEW) in the 1970s, in response to the need to better detect small, high-speed aircraft at long ranges. According to the operational requirement, the Alliance sought a flexible and mobile system to provide command and control (C2) capabilities to air, land and maritime commanders, with an emphasis on the detection of maritime surface targets. The NATO Defence Planning Committee approved the purchase of 18 Boeing E-3A, or NATO Airborne Warning and Control Systems (AWACS), in December 1978. In the following decade, the Alliance established a main operating base in Geilenkirchen, Germany, and upgraded the 40 NATO Air Defence Ground Environment (NADGE). Since then, the NATO Airborne Early Warning and Control Force (NAEW&C force), the Alliance's largest collaborative venture, has been taking advantage of AWACS, which is among the rare assets owned and operated by the Alliance, for a wide range of missions. In peacetime, the aircraft can be used for air policing, non-combatant evacuation operations, embargo, and initial entry, in addition to crisis response and airspace security during important international events. They have been involved in assurance measures for Turkey since 2015 and for the Central and Eastern European Allies since 2014, with a redeployment on and around the territory of NATO Allies in response to Russia's aggressive actions in Ukraine. AWACS operated by NATO have provided relevant situational awareness during numerous operations, such as in Libya and Afghanistan, and, more recently, have supported the work of the Global Coalition to Defeat ISIS and the counter-terrorism Operation Active Endeavour in the Mediterranean Sea.

Photo: NATO



**E-3As are modified versions of the Boeing 707 equipped with long-range radars and passive sensors.**

Photo: US Air National Guard



**A NATO E-3A aircraft leaves formation after receiving fuel from a KC-135 aircraft after performing mid-air refuelling training over Central Europe with the Pennsylvania Air National Guard's 171st Air Refuelling Wing.**

## NAPMO

Sixteen countries participate in the NAEW&C Programme Management Organisation (NAPMO): Belgium, the Czech Republic, Denmark, Germany, Greece, Hungary, Italy, Luxembourg, the Netherlands, Norway, Poland, Portugal, Romania, Spain, Turkey and the United States. The United Kingdom has a limited participation, but its E-3D aircraft are part of the NAEW&C's Force. France, which has an

observer role, often assists in coordinated operations, and ensures the interoperability between its E-3F aircraft and the other E-3 fleets.

## The E-3A

The E-3A is a modified version of the Boeing 707 equipped with long-range radars and passive sensors, able to detect, track, identify and report potentially hostile aircraft operating at low altitudes, and pro-

## Author

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vide fighter control of Allied aircraft. Each aircraft can fly for about eight and a half hours within a maximum range of 9,250 km at a 30,000-foot service ceiling. It is thus able to cover a surveillance area larger than 120,000 square miles, but air-to-air refuelling capabilities allow for extending the in-theatre endurance. Active surveillance sensors are placed into the distinctive “rotodome” mounted on the fuselage. This structure, which has a 9.1-metre diameter, provides 360° radar coverage out to more than 400 km thanks to its rotation cycle every ten seconds. A flight crew of three and mission crew of 12 operate the aircraft.

## The Future

In the last 30 years of operations, NATO’s AWACS have evolved according to the changing geopolitical environment. To maintain its key role in air battle management, the fleet required expenditures or commitment of approximately US\$13Bn. The Follow-on Upgrade Programme (FUP) enhanced the situational awareness’ support for cooperating units and replaced analogue cockpits with digital technology. An update completed in 2018 adapted the communication system to current and expected air traffic management requirements, including the ongoing development of communication systems using Internet Protocol (IP).

The fleet is currently undergoing its final modernisation programme worth US\$1Bn, intended to extend the system’s operational life until 2035. The programme, awarded to Boeing as prime contractor, concerns upgrades to the NE-3A’s data link and voice communications capabilities, and enhanced Wide-Band Beyond Line-of-Sight airborne networking capability.

## The AFSC Initiative

With the E-3 fleet expected to retire soon after 2035, NATO members have had to rethink their AWACS capabilities, which have become an indispensable tool in a wide range of peace and wartime operations. The Final Lifetime Extension and the Alliance Future Surveillance and Control (AFSC) initiative, launched in 2016 with the participation of the 30 NATO members is aimed at defining the best options for the post-2035 period according to high-level military requirements. In 2017, the North Atlantic Council (NAC) gave the Luxembourg-based NATO Support and Procurement Agency (NSPA) the responsibility for the relevant R&D. The AFSC project office, created within the NSPA, was provided with a €118.2M

budget to manage the development phases and to liaise with the relevant stakeholders within the Alliance. Studies are aimed at supporting the Alliance and member countries, either individually or in groups, in their procurement choices concerning next generation systems. The first phase of the “Concept Stage” was launched in the same year to evaluate the new technologies, and declared as completed, on schedule and on budget, in 2018. It resulted in four “Small Case Studies” (SCS) that helped to define the basic architecture and requirements. Following



Photo : DVDS / Andrea Hohenforst

**E-3A tail-number 455 takes off from NATO Air Base Geilenkirchen, Germany.**

the swift launch of a second phase, six high-level concept proposals developed by as many consortia were presented in 2020:

- Airbus Defence and Space
- Boeing, with Indra, Inmarsat, Leonardo, and Thales (also known as ABILITI).
- General Atomics
- L3Harris with 3SDL, Deloitte Consulting, Hensoldt Sensors, IBM, Musketeer Solutions, Synergeticon and Videns
- Lockheed Martin
- MDA Systems, with General Dynamics Mission System

While NATO is evaluating and refining the concepts presented, three high-level conceptual approaches have been identified for further analysis through separate Risk Reduction and Feasibility Studies (RRFS), launched in mid-2021. The evaluations for the shortlisted concepts are expected to start in 2023, to identify the new developments eventually needed according to the capabilities already available. This will result in a technical concept, to be translated into the Programme Establishment, which will mark the final phase of the Concept Stage.

## SCAF and TEMPEST

The Alliance has not expressed any detailed operational requirement yet, but it is already possible to identify some likely features. The next generation platform will likely be a completely different effector compared to the existing E-3A SENTRY for at least two reasons. Firstly, the number of assets will be reduced from the existing fourteen. Secondly, the new platforms intended to assure AWACS missions will have to be interoperable with legacy systems, but also with fu-

ture ones, intended to operate in high intensity missions, mainly against peer/near-peer enemies. As per these considerations, the adoption of a system-of-systems approach is likely. In line with the requirements for the next generation fighter programmes SCAF and TEMPEST, the AFSC will probably consist of a main vehicle able to coordinate a range of assets (aerial, digital, naval, space- and land-based) devoted to intelligence gathering. Its main missions will be: the gathering, analysis, and distribution of relevant information on potential threats to allow for their identification, localisation and tracking; the creation of a battlespace situational awareness of a common, accurate, integrated and constantly up-to-date operational picture; the control, coordination, monitoring and evaluation of its own assets and resources to eventually tackle the enemy’s activities in the relevant area of action. To reach these objectives, the aircraft must be able to carry out multi-domain surveillance and control missions in all operational scenarios (authorised, contested, denied).

Photo: NATO



**The cockpit of an E-3A**

State-of-the-art wide-band communications (e.g. satellites, VHF, datalink, etc.) and data storage systems will have to provide the most adequate tactical situational awareness to allied command and control (C2) centres. To be more effective, the platform needs high survivability (partially granted by the distributed system's architecture) and auto protection features, in addition to a high level of modularity.

The NSPA is extensively researching in numerous domains, such as systems architectures, sensors, IA and automation, information sharing, and cybersecurity, and exploring possible structures and combinations for the system-of-systems.

### Future Perspectives for AWACS

With the final decision on its features expected in two years, it is unlikely that a future NATO AWACS based on brand new technology will be ready in time for the phase-out of the E-3A SENTRY. Some options are available that will avoid a capability gap that would have a significant impact on NATO. The Alliance might finally decide to award Boeing a new, expensive contract, to further extend the operational life of the existing fleet, or purchase Boeing E-7A WEDGETAILS as the UK and Turkey have already done. Should NATO decide to go ahead with the current approach and acquire disrupting technologies on schedule, the best solution would be to purchase an open architecture allowing for plugging in new technologies. Such an option will

allow NATO to wait for a more mature technology while looking at the progress of the TEMPEST and FCAS programmes, crucial for interoperability. The two are still under development, and the lack of full political agreement among partners on some features might still put their original schedule at risk. Using existing UAVs as platform might be a possibility. However, here again, the reticence of some members, this time on the spectrum of their missions, might complicate a deal. The German decision to scrap the purchase of Northrop Grumman RQ-4 GLOBAL HAWK over possible security risks and disruptions to its civilian air traffic is an interesting example.

### Modernising the AWACS Fleet

The modernisation of the AWACS fleet after 2035 will be crucial not only for NATO, but also for the broader defence of Europe. France and the UK are also struggling with the renovation of their ageing fleets. Paris will have to replace its four E3-F AWACS by 2035. However, the Loi de programmation militaire (military programming law) for 2019-2025 mentions launching studies for their replacement by that time, suggesting that the country will likely face a capability gap. London has recently announced that it expects a two-year-long capability gap between the phase-out of its E-3D SENTRY, expected this year, and the entering into service of the three Boeing E-7A WEDGETAILS due to be received in 2023. In the past, the UK used to pledge its assets to

NATO AEW&C Force's assets in case of need. For the next two years though, the Royal Air Force will have to rely on NATO aircraft if needed.

### Outlook

Maintaining a high-paced political schedule will therefore be crucial for completing the programme on time, but recent events such as the rushed withdrawal of troops from Afghanistan are exacerbating political tensions among allies and relaunching (again) the calls for more European strategic autonomy. NATO's European members expected the Biden Administration to mark a radical change compared to the Trump presidency concerning US engagement abroad. However, the cancellation of Australia's deal to purchase French submarines to finally buy American, and the creation of AUKUS, the new alliance between Canberra, Washington, and London to deal with the rising threat posed by Beijing's policies in the South China Sea and wider region, have renewed tensions with Paris, and more generally raised concern among European allies. Moreover, President Biden has recently reaffirmed that the US' future military engagements abroad will be limited to what is strictly necessary. Already in 2019, when he defined NATO as "brain dead", French President Macron tried to convince the Allies that establishing a real European strategic autonomy was the best way to protect and promote EU interests abroad. Three years later, an autonomous European defence is far from being realised and EU investments in the defence sector have not worked as a bottom-up driver for a more integrated EU defence policy. The political uncertainty following the recent German elections and the upcoming elections in France might disrupt the EU's political agenda as well and may even disrupt common European defence efforts. The French EU rotating presidency in the first semester of 2022 might represent the last chance to accelerate defence collaboration. Returning to AWACS, these capabilities are neither included in the programmes already approved under the PESCO framework, nor financed under the European Defence Fund (EDF). The lack of proprietary solutions in Europe makes the launch of a European-led project in this domain unlikely. Regarding these considerations, the outcome of the ongoing political tension among some NATO members will be a crucial element vis-à-vis the completion of the future AFCS initiative. ■

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# International Corvette and Frigate Programmes

**Bob Nugent**

The world’s fleets of corvettes and frigates attract significant operational and market interest — an interest that exceeds their relative importance as naval ships types when measured by hull numbers or weights in today’s global fleets. This article provides a short review of international frigate and corvette programmes—future and present.

Corvettes and frigates remain a focus of effort and investment for several reasons. First, the two types are the most numerous types of multi-mission surface combatants. That is, in contrast to patrol vessels, attack craft or other ship types optimised for a single primary mission, corvettes and frigates are typically designed to carry out missions in several naval domains – notably, surface warfare, anti-air and anti-missile warfare and antisubmarine warfare. Secondly, corvettes and more so frigates represent the largest and most capable surface platform – the “capital ships” – in many navies around the world. Lastly, as ships designed to operate either singly or in naval formations of many ship types, corvettes and frigates offer naval leaders wide options for employment, and in doing so challenge their commanders and crews to master the many facets of the naval art like almost no other type of naval ship.

This article provides a short review of international frigate and corvette programmes, drawing on naval market forecasts and other data from AMI International, a naval market consultancy that has served the industry globally for over

Photo: Mark König / CC BY-SA 4.0



**The air defence frigate NIELS JUEL (F363) in June 2018 close to Harstad, Norway**

30 years. The article begins with overviews of new construction corvettes and frigates projected to enter service over the next 20 years, highlighting some trends and regional developments for each type. The article concludes with a brief look at the numbers of corvettes and frigates now in service, with some observations about regional patterns, ship design specifics (displacement) and average ages of the types.

## Corvettes-Future and Present

The corvette fills an interesting space in the surface combatant market, as these

AMI defines the corvette as fast (25 knots or better), well-armed ships that displace between 700 and 2000 tons. A corvette is generally not intended for extended ocean-going operations but have higher speed and therefore less endurance and range than OPV.

AMI forecasts the corvette market over the next 20 years as comprising 57 new hulls with a total acquisition value of US\$12.9Bn billion. This makes the corvette one of the smaller subsegments of the global naval market, representing about 1% of the 20-year future market for naval ships by value, and about 2% of the 20-year market by number of hulls.

## Author

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Total Number of Projects	In Progress	Planned	Total Value	Total Build 2021 to 2024
16	9	6	12,877.70	57

types of ships share characteristics of both their smaller fast attack and patrol craft counterparts (size and hull features) and larger frigates (weapons and sensors). Corvettes and Offshore Patrol Vessels also have many design features in common.

The average value of new corvettes forecast to be acquired is about US\$225M, with an average displacement of just over 1,500 tons full-load displacement (FLD). Countries acquiring new corvettes are generally mid-tier or smaller navies, where the affordability of the corvette compared to the frigate is an at-

tractive aspect of the vessel type. Of the 15 countries projected to add new construction corvettes to their fleet by 2040, three are countries that were part of the former Soviet Union (Ukraine, Turkmenistan, Azerbaijan), while two others (Poland and Bulgaria) operate in seas on the flanks of the former USSR. Russia and Germany are the most prominent among "Tier I" navies with corvette programmes. Of note, AMI does not identify any new corvette programmes in China's naval future, although as detailed below, the PRC is forecast to acquire 50 new frigates over two programmes in the next two decades.

Turkey stands out as country that has enjoyed some corvette export success with its indigenous MILGEM corvette design. AMI classifies Turkey's 3000 ton modified MILGEM G design as a frigate, but MILGEM exports to Ukraine and Pakistan are based on the smaller (2,000 ton) original MILGEM corvette.

Corvettes historically have been primarily intended for anti-submarine warfare, tracing operational and design lineage back to convoy escort ships of World War II. However, in the post-Cold War era, corvettes have become more multi-mission platforms – "junior partners" to frigates in combined fleet operations, and capable of at least limited independent operations across the mission spectrum of ASW, AAW and ASUW. Of the 57 new corvettes in AMI's market forecast, almost all are equipped with anti-surface missiles and guns as well as gun or missile based anti-air capabilities. Corvettes generally retain some ASW capability with sonars and ASW rockets or torpedoes.

### The Global Inventory

AMI tracks a total of 332 operational corvettes in its inventory of serving naval ships – the Existing Ships Data Base. With only 57 new corvettes forecasted to be built in the coming 20 years, the existing corvette inventory can only get smaller between now and 2040. This will increase the incentives for navies to invest in modernisation to keep their corvettes in service and capable of meeting mission requirements, since they will not be replaced on a one-for-one basis by new build programmes now in place or projected. Among the 332 corvettes, in service, the age distribution breaks out as follows:

Commissioned Year	Number	Percent
Older than 2005	179	54%
2005-2015	77	23%
2016-2021	76	23%
Total	332	100%

Photo: Ahmed IV / CC BY-SA 3.0



**The GOWIND class corvette EL FATEH takes part in an exercise between Egypt, Greece and Cyprus.**

Notably, over half the world's fleet of corvettes are 15 years or older, further signalling that the corvette segment will get smaller through 2040, when most of those older hulls will have been retired.

### Frigates: Future and Present

AMI defines the frigate as a medium-sized surface combatant (between 2,000 and 5,000 tons) that is either optimised for one specific role (anti-submarine warfare or anti-air warfare) or is a general purpose multimission combatant that has fewer systems and capabilities than a destroyer. A frigate is generally the smallest surface combatant that can conduct extended blue-water missions in a high-threat environment.

Total Number of Projects	In Progress	Planned	Total Value	Total Build 2021 to 2040
57	32	23	183,192.50	368

AMI forecasts the frigate market over the next 20 years as made up of 368 new hulls with a total acquisition value of US\$183.2Bn. While larger than the corvette market by a factor of 15, the frigate segments still represents only 15% of the world's future naval ships by aggregate market value, and roughly the same percentage by hull numbers. By comparison, the future submarine market of fewer hulls (300) makes up about one third of the total naval market (about US\$400Bn) over 20 years by aggregate value. Looking at future frigate procurements by region, the Asia-Pacific leads, with 15

countries accounting for 20 of 57 programmes (35%) and 167 of 368 new hulls (45%). Next is the NATO (excluding the US) and Non NATO Europe (Finland and Sweden) region with 11 countries and 15 programmes projected to build 73 new frigates (20%).

AMI global forecasts for future frigate acquisitions are US\$495M per ship in average cost, and just over 3,800 tons FLD in average displacement. Regional averages for the Asia-Pacific and Euro regions are shown here, reflecting slightly larger frigates in the AP region (4,100 tons compared to the Euro zone (3,900) and a lower average acquisition cost in the Asia-Pacific region (about US\$400M per hull compared to just over US\$500M per hull in Europe). The later difference reflects the heavy weight of Chinese ships in the A-P region

(50 of the 167), for which actual acquisition costs, while unknown, are estimated to be lower than for frigates built in Europe.

	Total Tons	Total Ships	Average
AP	692040	167	4143.95
NATO	303175	77	3937.34

	Total Tons	Total Ships	Average
AP	68402.5	167	409.5958
NATO	39704	77	515.6364

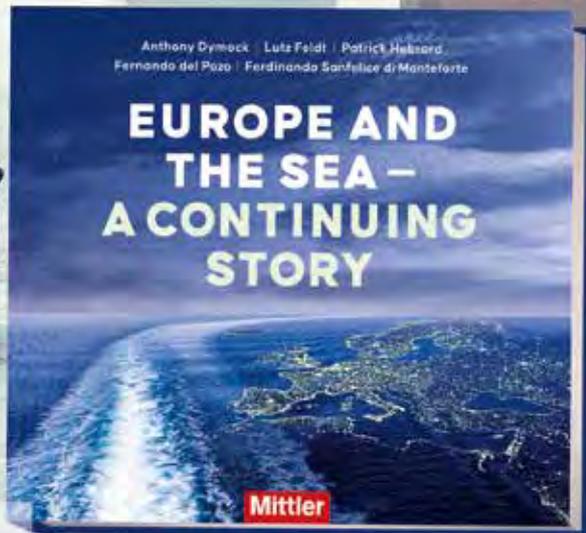
Photo: Fincantieri



A PESCO project aims at developing a new class of military ship named "European Patrol Corvette" (EPC).

# EUROPE AND THE SEA

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As for frigates currently operating around the world, AMI tracks 575 hulls now in service. Of those, 298 (just over 50%). Using an estimated average service life of 30 years, about 200 frigate hulls are expected to be retired by 2040. With 368 new hulls under construction, this indicated many nations are growing their frigate fleets and are building at above replacement rate. This trend is especially true in the Asia Pacific region, where China is projected to build 50 new 4,500 ton frigates over the coming two decades. Japan's frigate program will see 22 new hulls of the Mogami class join the JMSDF over the same period, while three different Indian frigate programs account for 17 new ships of the type.

### Conclusion

The corvette and frigate as types in the naval market appear to be on different courses. Corvettes in service are aging at a rate far beyond what new programmes will replace, indicating that the type, while still present, will shrink further in importance as a component on most fleet structures over the coming two decades. In contrast, frigate construction is robust and growing, both among navies that have long relied on the type as the most numerous surface combatant in their fleets (in Europe and some navies in the Asia-Pacific region such as Japan and Australia), and among navies whose force structures overall are growing in number and capability. China is the foremost example of the later type of "frigate growth" market, but others in the region include India, Indonesia and Malaysia. ■

# Gaming for Urban Military Operations

**Suman Sharma**

Urban military operations, which range from besieged cities and towns, hostage situations, street patrols and gunfights, guerrilla attacks, and gang warfare, appear to represent new-age warfare, and are here to stay.

No conventional battlefield can possibly prepare you for the nightmare that is a city besieged. Urban combat is the most difficult for a variety of reasons. For starters, it takes the longest amount of time because every building, every room, every subway tunnel, every car, every sewer pipe, every nook, and cranny of this massive maze must be searched," according to Max Brooks in his book "The Zombie Survival Guide".

Modern day warfare in the urban theatre involves risks ranging from collateral damage of civilian casualties to paralysing everyday life, and to destruction of government structures. Urban warfare has come a long way from the American-Mexican Battle of Monterrey in the mid-19th century right up to present-day Taliban insurgents in Afghanistan which fought the Afghan Government forces in densely populated towns and cities, bombing hospitals and schools, and taking over provincial capitals. The Taliban achieved a world record according to United Nations figures for civilian casualties.

Recent examples of limited urban conflict can be seen in the Israeli-Hamas conflict in Gaza where high-rise buildings were brought down, craters made on busy main roads by Israeli attacks, while close to 4,000 rockets were launched by Hamas on Israeli cities, resulting in the deaths of hundreds on both sides. India experienced its first major urban combat operation during the 2008 Mumbai terror attacks, better known as the '26/11' attacks, where close to 200 innocent people were killed amidst coordinated shooting and bombing assaults in a four-day operation at the Taj Palace hotel. Referred to differently by militaries worldwide, such as Operations in Built-Up Areas (OBUA), Fighting in Built-Up Areas (FIBUA),



Photo: USMC

*US Marines undergoing an urban warfare training course*

Fighting in Someone's House (FISH), Causing Havoc in People's Streets (CHIPS), Military Operations on Urban Terrain (MOUT), Operations in a Volatile Uncertain Complex Ambiguous (VUCA) environment, urban combat poses numerous challenges including demographic implications, collateral damage, destruction of public property, hostage situations, and attackers using populated areas to hide. Equally challenging is the gaming or training in limited and controlled environments for these operations.

The complexity of urban warfare lies in an undefined battle theatre compared to a conventional one, with the need to gauge the actual enemy, and launch assaults with the protection of civilians in mind. Other challenges include restricted fields of view and fire, limited battlefield mobility, near zero manoeuvrability of armoured fighting vehicles (AFVs) and infantry combat vehicles (ICVs), in addition to the need to clear, secure and hold areas.

## Gaming in Urban Terrain

Former Indian Army Director General of Military Operations (DGMO) Lt. General (ret'd.) Vinod Bhatia says, "MOUT requires a different doctrine, flexibility in organisation, special military hardware, training and leadership. The simulation models for

MOUT have been developed at the tactical level and are effective in training the leaders. The models are generic in nature as the modus operandi will change depending on the terrain and task. Fortunately, the Indian Army's experience in counter terrorism (CT) ops comes in handy in urban areas." Besides actual training exercises, military war gaming largely employs tools like 3D and 2D models, micro models, sub models, computer programmes with standard simulations and technical inputs pertaining to geography and chronology. Achievement-aligned performance has given rise to research-based gaming which measures efficacy under a certain environment. Gaming which ranges from space to guerrilla warfare is still followed on the patterns of WWII offensives. The urban terrain is far from the regular topography owing to its compound and multifaceted nature, in terms of roads, infrastructure, routes and streets, residences and the overall plan of a city enmeshed with urban architecture which makes warfighting a particularly difficult exercise.

Urban areas present an extraordinary fusion of exterior, interior, horizontal, vertical, and subterranean forms superimposed on natural vegetation and drainage. The surrounding countryside may even appear as superimposed on an urban area on a map. The purview and actual size of urban

## Author

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Photo: US Navy

**US Navy sailors participate in urban warfare training in Barrigada, Guam, 31 January 2018.**

military operations are many times that of a similarly-sized undeveloped piece of agricultural land. For example, a high-rise building occupies the same land area as a small agricultural field, but each floor on the building incorporates approximately an equal area as the ground floor. Therefore, a 10-storey building, with its multiple floors and roof effectively has more area to defend compared to a ground area of the same size. It is this density and complex geography what makes urban military warfare more demanding in terms of resources, manpower and time management. Cities and towns often get transformed after experiencing volatile operations, in the areas of power, electricity, sewage and drainage, with essential services shutting down. The sheer volume and density created by this urban geometry makes urban operations so resource intensive in terms of time, manpower and material. Sometimes, huge piles of rubble can accumulate thereby incapacitating transportation, coupled

with the destruction of urban structures which also alter geography through the demolition of reference points. Intelligence, Surveillance and Reconnaissance (ISR) capabilities need specialised equipment such as corner shot weapons, artillery in direct fire role, Directed Energy Weapons (DEW), helicopter gunships and drones for surveillance and targeting. A virtual environment (VE) MOUT simulated training module includes creating a virtual urban habitat, with near perfect specifications of interiors and exteriors of the concrete structures, conveniently allowing entry and movement within them. Though VE can be used effectively for MOUT training, some tasks are not meant for VE, for instance climbing a virtual rope. Numerous militaries worldwide are using workarounds by successfully amalgamating virtual and real scenarios, like using representations of actual rifles of the same weight and specifications, and pulleys used for counter-balancing rope climbing. More intimidating tasks include movement over windowsills, wire meshes, climbing walls and spatial walks. It has been discovered that creating a workaround integrated system of ledges, windowsills, and walls in modelling MOUT situations may prove to be less cost-effective compared to real structures.

A research study sponsored by America's Marine Corps Systems Command in the late 1990s listed the following MOUT tasks suited for VE training, for movement in urban areas outside buildings:

- Fundamental motor skills
- Avoiding open areas
- Conducting movement under cover
- Selecting routes that reduce or negate possibilities of friendly fire
- Crossing open areas such as streets, fields, open areas between buildings, rapidly under cover of fire
- Moving on rooftops not covered by direct enemy fire
- Moving in and along streets

## Limitations

Urban operations can best be described as an irregular threat which makes it difficult to distinguish friend from foe, and frequently involve landing troops in the realm of endangering one's own soldiers or inflicting civilian casualties. Dealing with civilian populations who might be inimical to the military, the success of missions depends on having the locals on one's side, which means that connecting with them culturally is mandatory.

3D models create limitations of situational awareness. Urban structures differ both in construction materials and design which might affect the functionality of weapons, thereby making troops vulnerable. For example, it is important to be able to calculate the outcome whether a stone wall would have the same effect as a wooden fence; in the same way a realistic simulation of the volume of debris caused by demolitions or collapse of weak structures with helicopter landings, is equally important.

A Dutch research study for NATO concluded that 3D models do not present an accurate picture for tactical training, options for cover, durability of structures, and ammunition type to be used. Feature reality of ammunition, weapons and vehicles are limited and require thinking and decision-making in 3D.

Artificial Intelligence (AI) used in simulated war games of simulated soldiers is generally different and considered unsuitable for urban environments, as inadequacies can be witnessed in human reactions such as collision prevention, audio-visual means of detection of enemy fire, shooting, fleeing etc., as can be seen in a real scenario.

Live training sessions have the advantage of eliciting real time responses in the way soldiers run, walk, kneel, handle weapons, and offer the opportunity of being able to observe their hand and eye movements.

In one of its research studies, American think tank, the Rand Corporation, found that, "Traditionally limited to war, gaming is now applied to business, urban, social, and other areas. Since all deal with confrontation between protagonists, "confrontation analysis" may be the appropriate term, with military gaming a branch concerned with military problems."

As world powers transition from the post-Cold War era and enter new theatres of warfare involving combat in a terrain altered by human activity like urbanisation, exemplified by the building of villages, towns and cities, it is imperative that there is better planning and training in order to execute this role. ■



Photo: US Army / Spc. Craig Jensen

**Iraqi soldiers clear a room during urban warfare training at Camp Taji, Iraq, 13 December 2016.**

# “A Story Made of Future”



Photo: Elettronica

**As a leader in cyber and electronic warfare with 2,700 systems supplied to over 28 nations, the Italian company Elettronica's systems are deployed for a variety of missions. This includes strategic surveillance, self-protection, Sigint, electronic defence and operational support for airborne, naval and ground applications. Elettronica Group boasts a strong record of collaboration on all key modern platforms such as the Italian PPA, the EUROFIGHTER TYPHOON, the NFH-90 helicopter, the Italian and French ship class HORIZON and FREMM, and a wide range of projects in the Middle East and Asia. ESD had the opportunity to talk to Domitilla Benigni, CEO and COO of Elettronica Group.**

**ESD:** This year, Elettronica celebrates its 70<sup>th</sup> anniversary. Can you provide a brief historical review on how the company has developed during that period?

**Benigni:** Our company was founded in 1951 to bring Italy into the field of Electronic Warfare (EW); a field that did not exist at that time in our country. Now, 70 years later, we are the only Italian company dealing exclusively with EW and we are one of the few companies globally to have made it their core business.

Since our foundation, we have grown from 25 to over 1,000 employees worldwide. We have opened five representative offices stretching from the Middle East to Asia, including an office in Brussels. We have established a company in Germany (Elt GmbH) which has specialised in homeland security for the past 40 years. We have also founded Cy4Gate, our cyber security and cyber intelligence company. This has allowed us to become a robust group with integrated defence and security expertise.

More than 30 governments around the world trust our systems. However, participation in major European defence programmes has been crucial to grow our engineering and industrial acumen. To this end, we have played a major role in pan-European defence projects like the TORNADO and EUROFIGHTER TYPHOON combat aircraft, the FREMM and PPA class frigates and patrol vessels and the NH-90 helicopter.

In recent years, we have focused heavily on research and development. This helps us retain our position as a centre of excellence, focusing on sovereign technologies that support national and European strategic autonomy. For example, we are a design

authority for the TYPHOON programme and we invested early researching solutions for hybrid threats like malicious drone use and cyber attacks.

It is our inclination to anticipate future events that led us to choose the motto "A story made of future" which epitomises our anniversary.

**ESD:** What are Elettronica's core capabilities today? And what does the distribution of these capabilities across your international subsidiaries look like? Are there individual competence centres? What percentage of your staff works in R&D?

**Benigni:** Our core business still focuses on electronic defence in the radar band, implemented through solutions like ESM (Elec-

tronic Support Measures), ELINT (Electronic Intelligence), RWR (Radar Warning Receivers) and ECM (Electronic Countermeasures). It is this historical competence that underscores our recognition as a centre of excellence in our niche.

Since the 2000s, solutions in the electromagnetic domains of infrared and communications have been added to these core capabilities.

In addition, by sharing expertise with our Cy4Gate affiliate, Elettronica has developed competencies and operational capabilities in the cyber domain, particularly where the electromagnetic spectrum is used as a vector. Cy4Gate has enriched our security solutions, but our subsidiary Elt GmbH had already paved the way, particularly with homeland



Photo: Eurofighter

**Elettronica is the design authority of the electronic attack component of the Eurofighter TYPHOON's PRAETORIAN EW self-protection suite.**



**The senior management team of Elettronica, consisting of Enzo Benigni (Chairman and CEO), Domitilla Benigni (CEO and COO), and Lorenzo Benigni (Senior Vice President Governmental & Institutional Relations)**

security solutions such as MUROS, the Multirole Operation Support Vehicle, which can be used to assist in the security protection and management of large events and public spaces.

More recently, in addition to demands for logistical support for our products, we have added training activities through our EV Academy. This allows us to transfer the skills necessary for the optimal use of our products to the end user.

**ESD:** Artificial Intelligence is one of the buzzwords in today's industrial arenas. Can you elaborate on the subject?

**Benigni:** Artificial Intelligence (AI), as well as Machine Learning, are enabling technologies for our products and processes. High-tech applications have undergone great diffusion and growth, especially in the military domain. However, I think it is right to open a debate at the European level on the limits of AI, because in operational scenarios we cannot ignore the "human in the loop". Humans remain indispensable not only in software applications but also in engineering, because an ingenious solution is always the product of the human brain.

**ESD:** What are your most important programmes at present, both in Italy and internationally?

**Benigni:** Elettronica will plant more towards non-EU markets in the coming years. At the same time, I must admit that we imagine a future marked above all by the great European defence programmes that we see as the only way for European affirmation on the international stage. We are currently talking about the TEMPEST, a pan-European advanced undertaking that revolutionises the very idea of military aircraft as we know them. This sixth generation combat aircraft will trigger a significant leap forward in terms of technology and mind-set regarding the concept of European integrated defence.

**ESD:** With the Defence Multi-Year Planning Document 2021 - 2023, the Italian Government recently released a new budgetary plan for funding its military. Which programmes contained in the document constitute challenges and perspectives for Elettronica?

**Benigni:** The most recent defence plan has several funding chapters. The one we are specifically interested in relates to the TEMPEST. Moreover, I can mention the C-27 PRAETORIAN fixed-wing gunship, NH-90 tactical transport helicopter, AMV DORIA (a warship for the Italian Navy), EH-101 medium-lift utility and naval support helicopter upgrade, the Defence Cloud, and new off-shore patrol vessels for the Italian Navy.

**ESD:** What are the most important challenges and perspectives on the global defence market?

**Benigni:** The challenges that lie ahead were the subject of the conference held on our 70th anniversary, dedicated to the future of the world of defence.

Defence, more than any other sector, depends both on geopolitics and technology. In this interaction, it is technology that dictates the timing and logic of geopolitics.

The effects of digitisation have been disruptive on defence. Traditional operational scenarios have been replaced by the Internet of Battlefield Things (IOBT). The IOBT is a system of connections between devices, sensors and weapon systems, platforms and soldiers that will shape tomorrow's conflicts and which will see cyber playing a central role.

The market will be occupied by companies that have very early on looked into this evolution, where the boundaries of security are increasingly blurred and where cyber resilience has become essential.

**ESD:** What do you expect the company and its capability portfolio to look like ten years from now? Are there things on the drawing board that current and possible future clients should be interested in?

**Benigni:** Our future roadmap starts from the awareness of the growing role of the electromagnetic spectrum and the dominance it will assume in light of the digitalisation affecting the defence domain.

For the same reason, we have been radically transforming our value proposition. We design our systems in an integrated and netcentric way to be ready for the platforms of the future like TEMPEST and its successors.

Our systems and operations are increasingly focused on the software layer. We are constantly researching in order to anticipate threats so as to launch new product ranges. The latest includes our ADRIAN mini- and micro-drone defence system, our Tactical EW Suite (TEWS) for border surveillance and protection and the new systems for unmanned and conventional submarines.

In terms of our technology roadmap, we have moved from Gallium Arsenide to Gallium Nitride. This provides greater efficiency and higher performance to our systems and we are working with the Quantum Cascade laser. Obviously, all our products are secure by design. Security is built in from the outset to guarantee cyber resilience.

**The interview was conducted by Jürgen Hensel.**

# Turkish Tactical Utility Helicopter Programmes

**Ian Frain**

Located between the Mediterranean and Black Seas, Turkey felt the need to embark on an indigenous helicopter programme. The result was the TAI T625 GÖKBEY first introduced in the summer of 2018, a twin-engined light transport/utility helicopter. Turkey's Under Secretariat for Defence Industries plans to offer the new platform to the Turkish Armed Forces and cooperating nations.

Turkey has had its share of conflict over the years, from before the days of the Ottoman Empire to the Cold War, when Turkey held a vitally strategic position between the East and West, through the first Gulf War right up to the present day. It has been three decades since the end of the Gulf War / Operation Desert Storm when the allies also conducted operations from Incirlik and Bataan Air Bases against Saddam Hussein's forces and later when protecting the Kurds during Operation Safe Haven, primarily using NATO rotary wing assets. Tension has always been present along Turkey's borders, and currently these have been exacerbated by the political struggles within Syria, the influx of refugees, and the threat from internal terrorist groups. Turkey has also unfortunately experienced its share of natural adversity as well, such as earthquakes, wildfires, and flash floods.

## A Multitude of Platforms

The Turkish military and paramilitary helicopter fleet has a unique mix of American, European, and even Russian airframes across several military and paramilitary / airborne public service arms. The mix covers everything from the single-engine Bell 206B3 JET RANGER (for training), the Bell AH-1P COBRA, and the twin-engine Bell AH-1W SUPERCOBRA attack helicopter. In the battlefield and maritime role there are the single-engine Bell UH-1H, AgustaBell AB-205, to the twin-engine AgustaBell AB-212,



Photo: TUSAS

**A T625 GÖKBEY experimental version**

AB-412EP, Sikorsky S-70 (both land BLACKHAWK and naval SEAHAWK). The Airbus Helicopters AS532UL/AS532UT COUGARs are used for the Combat Search And Rescue (CSAR) role. Finally, Russian Helicopters MI17lv is in service with the Jandarma (Gendarmerie) Aviation Directorate in the airborne public service role, alongside the Sikorsky S-70 and Bell 429 GLOBALRANGER. During the IDEF 2021 defence show in the summer of 2021, there was an agreement for support of the Jandarma MI17 fleet between the Turkish Aeronautical Association and Ukrspecexport as part of a larger deal which involves potential maintenance of other MI17 aircraft in neighbouring countries. Recently, the Jandarma have added a dedicated attack helicopter role to their public state security role with the Turkish Aerospace T129 ATAK twin-engine dedicated attack helicopter.

In August 2021, as fires raged across the southern Mediterranean area, Oregon-based Erickson Airplane provided one

of their orange-red heavy lift S-6AE Air-crane to assist the Turkish authorities' rotary wing assets in combatting the fires alongside the para-public and military helicopters. The Turkish General Directorate of Forestry themselves operate the Sikorsky S-70i BLACKHAWK and Bell 429 GLOBALRANGER.

## Global Co-operation

Turkish Aerospace is involved in some of the major rotorcraft manufacturing programmes globally. Turkish Aerospace Aerostructures Division manufactures the body and canopy for the AgustaWestland AW139. For the Airbus Helicopters AS532, Turkey is the largest operator with 28 helicopters assembled by then EUROTAL - a TUSAS Aerospace Industries/Eurocopter joint venture divided between the Air Force and Land Command around two decades ago. Turkish Aerospace makes the fuselage, tail cone canopy, engine cowlings and rear doors for the

## Author

**Ian Frain** is the founder and owner of Helian, an aviation research consultancy specialising in the rotary wing industry based in the UK.

COUGAR. On the Sikorsky S-70 series, the empennage, tail cone, rotor pylon, stabiliser and centrebox are all manufactured in Turkey. The company is also distinguished as a Centre of Excellence for the S-70.

The Helicopter Group of Turkish Aerospace is involved in two major co-operative projects and has been involved in various helicopter programmes over the years. These include manufacturing under licence or co-operating in the production of helicopters. The prime example is the T129 ATAK attack helicopter, which was developed in conjunction with Leonardo Helicopter Division, based on their AW129 MANGUSTA (MONGOOSE) attack helicopter. The T129 ATAK is currently entering service with the Turkish Land Forces (Turk Kara Kuvvetleri) Aviation Command, complementing the attack helicopter fleet already featuring the Bell AH-1W SUPERCOBRA and AH-1S COBRA.

The classic icon from the Vietnam War was the single- and twin-turbine engine Bell UH-1 IROQUOIS, more affectionately known as the 'HUEY' across the armed services of the United States during the conflict. Many variants were exported and built under licence throughout the world. Turkey was a major customer of both the single-engine Bell 204/205/UH-1H and the Italian AgustaBell variants, such as the AB-204/5 and the twin-engine AB-212 and four-blade AB-412EP.

### The Turkish Indigenous Helicopter Programme

In 2013, the Under Secretariat for Defence Industries (SSB) and Turkish Aerospace

Photo: TUSAS



**The T129 ATAK manufactured for Brazil**

signed a contract which saw the Helicopter Group begin work on the Turkish Indigenous Helicopter Programme.

This six-tonne airframe was mainly aimed at replacing the fleet of the above legacy helicopters across the Turkish Air Force, Land Forces Aviation Command, and the Gendarmerie General Aviation Command. There is also scope for the T625 to replace the Agusta Bell AB-212 and AB-412 in both the Navy and Coast Guard Command.

One major requirement of the new helicopter is the ability to operate in hot and high altitude conditions while providing high levels of comfort and safety to the operator/customer.

At the outset, the Turkish Indigenous Helicopter Programme was known as the Ozgun, but in the beginning of 2017, the Turkish Aerospace Industries Helicopter

Group officially designated the helicopter as the T625. This five-bladed, fourteen seat (two pilots and twelve passengers), multi-role helicopter has a large cabin. The very size and capacity will easily be able to accommodate the variety of missions and roles intended. These include airborne law enforcement, transportation, cargo, VIP/corporate, offshore, EMS (Emergency Medical Services) and SAR (Search and Rescue).

Production of the T625 airframe began in the summer of 2016 with the first metal cut designed. The airframe was produced with the goal of providing better fuel consumption, subsequently leading to longer endurance and range. One example in the airframe design and production of this is the use of a retractable landing gear.

### The Heart of the T625

The T625 will be expected to operate in hot and high altitude conditions so the aircraft has a Max Take Off Weight (MTOW) of 6,050 kg (13,337 lbs) while being able to operate up to a maximum ceiling of 20,000 ft or 6,096 m.

The T625 is powered by a pair of Light Helicopter Turbine Engine Company (LHTEC) CTS800-4A and is capable of performing at single-engine operation at Category A standards, adding the safety element during One-Engine Inoperability (OEI).

This engine is a joint venture between Honeywell and Rolls-Royce and runs at 1,373 hp each, thus marking the first time a civil helicopter is powered by this engine. The CTS800-4A powers the T129 ATAK as well.

Photo: TUSAS



**The standard version of the T129 ATAK**

## Touch Screen Technology

The trend for today's modern aircraft cockpit is predominantly an all-glass cockpit, and Turkish avionics company, Aselsan, provides the avionics suite for the T625. This includes the glass cockpit which has two wide touch screen (8x20 inches) Integrated Mission Displays, plus two touch screen (8x10 inches) data entry Touch Command Control Units. There is also a four-axis dual redundant automatic flight control system which has been developed to provide superior performance and handling quality.

Photo: TUSAS



**A T129 showing off its weapons arsenal**

## The GÖKBAY General Purpose Helicopter

The signing of the Indigenous Helicopter Programme Contract also led to the creation of the Rotary Wing Technology Centre (DKTM), which was established at the Middle East Technology University (METU) Technopark Facility. The DKTM facilitates Research & Development efforts, and technological acquisition amongst other activities. Both the SSB and Turkish Aerospace identified several areas of interest that align with their Rotary Wing Technology Roadmap.

The T625 started to take shape in 2016 with the cutting of the metal for the airframe and the development of the gearbox and transmission. The first flight took place on 6 September 2018 at 06:00 hours. On the

12 December 2018, the T625 was named GÖKBAY (meaning Sky Lord) by Turkish President Recep Tayyip Erdoğan. The T625 is waiting to be certified by both the Turkish Civil Aviation General

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**Graphic illustration of proposed 10-ton helicopter**



Directorate (SHGM) and the European Aviation Safety Agency.

## Wings of the HAWK

Like the famous Bell UH-1 HUEY, its development and replacement post-Vietnam is the Sikorsky S-70 BLACKHAWK. For almost three decades, the Turkish Armed Forces have operated the S-70/UH-60 variant in their Land Forces, Jandarma, and National Police, and the naval variant S-70B SEAHAWK in their Navy.

Turkish Aerospace are involved in modernisation programmes for the rotary wing platforms across the Turkish Armed Forces. These capabilities are mainly avionics-based such as Modular Integrated Avionics Architecture, Growth Capability, Multiple Operating System and Hardware Support, Integrated Mission Planning Systems, and more.

## The 10-Tonne Project

The Turkish Land Forces aviation element has entered the heavy lift role in the last couple of years, operating the new Boeing CH-47F CHINOOK to provide heavy lift across the armed forces. However, one of the current major projects for Turkish Aerospace is the development of a 10-tonne

heavy lift helicopter. This is intended to be a general-purpose airframe, primarily for troops, and will also be easily adapted for Search and Rescue in both short and long range (offshore/coastal) roles. The design will feature a retractable undercarriage, rear loading ramp, and enough headroom for personnel to stand up. It is intended to fly at a speed of 315 km/h (170 knots) carrying 20 fully-equipped troops and will subsequently have a range of up to 1,000 km (621 miles).

## The HAWK and Heavy Future

There are still many exciting projects ahead of the Turkish Aerospace Rotary Wing Division. The TUHP – Turkish Utility Helicopter Programme, designated T70, is a development based on the Sikorsky S70i. Over the next decade more than 100 aircraft are expected to be manufactured and delivered across the Turkish Air Force, Land Force, and Special Forces, the National Police and Gendarmerie, and also to the Turkish General Directorate of Forestry. In 2014, the Turkish authorities signed a contract with Turkish Aerospace and their sub-contractors to manufacture the TUHP; two years later, Sikorsky themselves accepted a S-70i airframe from their Polish subsidiary for the TUP

programme. It is expected that a total of 190 T70 aircraft will be built, from which 109 will be delivered over a decade to both the Turkish military and para-public operators. In November 2019, Turkish Aerospace unveiled the first locally assembled T-70.

Though initially the Turkish Utility Helicopter Programme tender started in 2007 with then AgustaWestland AW149 and the Sikorsky S-70 BLACKHAWK as candidates, the winner was to provide an initial batch of 109 aircraft under a US\$4Bn contract. During the bi-annual Farnborough Airshow in 2010, AgustaWestland exhibited a mock-up of the proposed TUHP-149 in the Finmeccanica pavilion. However, in April 2011, the Turkish Defence Ministry announced that the winner was the Sikorsky S-70 BLACKHAWK.

TUSAS Industries Inc. is the prime contractor for this programme, but there are other subcontractors involved, including Sikorsky Aircraft, Aselsan, TEI and Alp Aviation. TUSAS, as the main manufacturer, is responsible for final assembly, tests and logistic support overall. TEI will build the engines under a licence from GE – General Electric. Aselsan, an avionics and navigation specialist, will co-develop the enhanced digital cockpit, known as IMAS, or the Integrated Modular Avionics System, with Sikorsky. The production of dynamic components, such as the landing gear and gearbox, will be the purview of Alp Aviation.

Innovation has always been at the heart of the Turkish aerospace industry and its academia. Istanbul Technical University and Turkish Aerospace participated in a little-known project called Arikopter nearly two decades ago, with the backing of Turkey's State Planning Organisation. International partners were rumoured to be Safran Helicopter Engines. The project was supposed to focus on the two-tonne class, with a crew of two pilots and six passengers. There was a projected first flight date for 2011, but it is now understood that the project has been halted. ■

Photo: TAI



**The BLACKHAWK for Turkey's Jandarma police units**

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