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... But the EU Cannot Defend Europe

While the appearance of NATO Secretary General Jens Stoltenberg at the Berlaymont, the headquarters of the EU Commission, in December 2020 was still considered 'historic', such personal meetings between the Head of the Alliance and the EU institutions are now becoming routine. On 26 February, Stoltenberg met with the President of the European Commission, Ursula von der Leyen, and the President of the European Council, Charles Michel, at the Justus Lipsius building, the seat of the European Council, to attend the video conference of the EU heads of state and government. His participation was more than opportune, as the regular review of the security and defence policy agenda since 2012 was being discussed. Charles Michel began by emphasising that the EU wanted to "act more strategically" and increase its "capacity to act autonomously". At the same time, he said that it wanted to further deepen partnerships, precisely by reviving the dialogue with the Biden administration in Washington on security and defence issues. The EU and NATO discussed a joint response to Biden's advances, as most participants at the EU summit also sit around the table when NATO invites them to the summit.

On 15 March, the NATO Secretary General answered questions from two bodies in the European Parliament: the Subcommittee on Security and Defence and the Committee on Foreign Affairs. They discussed the possibilities for closer cooperation between the EU and NATO in the field of military mobility, combating hybrid threats and the use of emerging and disruptive technologies. In addition, MEPs discussed with him how the Alliance can better respond to security challenges that may result from the COVID 19 pandemic. The parliamentarians were also interested in ways to work more closely with each other to avoid unilateral initiatives that jeopardise the security of all Allied partners.

To the Brussels observer, the impression is that the NATO Secretary General is becoming tired of following up on statements from the EU on the state of its defence efforts. Much is repeated. For example, the minutes of the European Council contain phrases such as: The Council also recognised "that significant steps have already been taken", and the Council "called for further deepening not least in the area of crisis management where improved force generation is needed". The European Council called for a "rapid operationalisation" of the European Peace Facility and a "full use" of PESCO. In a speech to EU leaders, the President of the European Parliament, David Sassoli, welcomed "the transition from a common defence policy to a fully-fledged defence system".

That the defence of Europe depends on close transatlantic ties and not on seeking the continent's strategic autonomy was made clear by Jens Stoltenberg in an interview and speech to the European College in Bruges on 4 March. He does not see increasing European integration as contradictory to transatlantic cooperation. In his eyes, a strong transatlantic bond is the foundation of European security. He doubts that the continent should develop a "strategic autonomy" as advocated by French President Emmanuel Macron. For him, it is more about strategic solidarity than strategic autonomy. He supports the EU's defence efforts because more defence spending, new military capabilities and a reduction of fragmentation in the European defence industry would strengthen European security. That, in turn, is good for transatlantic security, he says. "All these efforts - as long as they are complementary to NATO - we welcome, but the EU cannot defend Europe," he stressed at the event at the College of Europe, chaired by the former EU High Representative for Foreign Affairs and Security Policy, Federica Mogherini.

Hardly noticed by the public is a remarkable initiative by the Director of the EU Military Staff, Vice Admiral Hervé Bléjean. He spoke with the Deputy Supreme Commander of Myanmar's Armed Forces, General Soe Win on 9 March. He appealed to his interlocutor to immediately stop the violence by the military authorities against the protesters in Myanmar. Admiral Bléjean will certainly also have called for the legitimate government to be reinstated. Those who know him know that he has also made clear comments on the role of armed forces in democracies. So far, this approach has proven unsuccessful, but nevertheless is worth noting and emulating.

Hans Uwe Mergener

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Four aircraft manufacturers have submitted final offers in response to Switzerland's requirement for 36 to 40 new multirole jets. **Page 26**

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After many years of neglect, the field artillery arms of many European countries are being upgraded with new platforms. **Page 34**

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Elisabeth Preston Joins KWESST Board of Directors

(jr) Elisabeth Preston has joined KWESST Micro Systems, Inc. as a member of the board of directors and will also serve as the Company's

Logo: KWESST

Corporate Secretary. She is an international business and trade lawyer, with significant transactional experience in many jurisdictions. Her experience spans more than 30 years advising companies as an executive in areas relating to:

- Governance
- Cross-border marketing
- Strategic relationships
- Major commercial transactions
- Financings to fund growth.

GA-ASI and GKN Expand Partnership

(jr) General Atomics Aeronautical Systems, Inc. (GA-ASI) and GKN Aerospace have signed a contract for the latter to manufacture the advanced composite V-tails for GA-ASI's new MQ-9B SkyGuardian®Remotely Piloted Aircraft System (RPAS) from their Cowes facility in the United Kingdom. SkyGuardian is the baseline system of the UK Royal Air Force's (RAF) PROTECTOR RG Mk1 and has also been selected by Belgium and Australia. This represents another milestone in the ten year strategic relationship between GA-ASI and GKN Aerospace, and adds to the strong investment GA-ASI is making in UK industries.

GA-ASI and GKN Aerospace had previously entered into a pre-production contract, under which GA-ASI provided the required engineering technical data and tooling, and GKN

Photo: GA-ASI

Aerospace developed their manufacturing processes and produced demonstrator parts. Under this latest agreement, GKN Aerospace will begin full rate production of the V-tails from the Cowes facility to support MQ-9B aircraft production.

GKN Aerospace has been a global supplier to GA-ASI's MQ-9 programme for a decade, with the strategic partnership on GA-ASI's RPAS starting in 2010. Activities began with the design and build of the "fit and forget" fuel bladder system in Portsmouth, UK, followed by the production of fuel bladders in the USA. Today, GKN Aerospace manufactures a range of products including the lightweight landing gear system, which it produces in the Netherlands.

New GM Defense Executive Chief Engineer

Photo: GM Defense

(jr) GM Defense LLC, a subsidiary of General Motors, has appointed Rick Kewley as executive chief engineer. Kewley will lead all aspects of engineering and programme execution, leveraging the company's core capabilities in integrated vehicles, power, propulsion, mobility and autonomy to meet customer requirements for existing and future opportunities.

Kewley is a US Military Academy graduate and former US Army officer, bringing 27 years of GM engineering and product development experience to GM Defense. He most recently served as executive director of GM Global Product Development Quality, where he championed engineering and product development quality strategies, strengthening customer satisfaction and reliability results across GM's global vehicle portfolio.

HENSOLDT to Purchase MAHYTEC

(jr) HENSOLDT has entered into an agreement to purchase MAHYTEC, a manufacturer of hydrogen storage tanks and renewable energy storage systems. Once the transaction is complete, with all the necessary approvals obtained, HENSOLDT will add technologies for compressed hydrogen storage in composite tanks as well as solid storage with metal hydrides, further com-

Photo: Hensoldt

plementing its portfolio of solutions to produce, store, and transport hydrogen-based regenerative energy.

Founded in Dole, France, in 2007, MAHYTEC offers specialised hydrogen storage solutions for mobile, nomadic and stationary applications. The company is able to offer compressed storage in composite tanks and solid storage with metal hydrides. Moreover, MAHYTEC provides solutions that integrate the entire hydrogen value chain – from production over storage to electrical conversion. MAHYTEC is therefore positioned as the only company able to provide its clients with a complete low-pressure storage solution. HENSOLDT and MAHYTEC have partnered in the field of intelligent hydrogen to energy solutions since 2015.

HENSOLDT also uses its capabilities to store and provide hydrogen-based green energy to reduce its own carbon footprint. One of its sites in France already runs entirely on hydrogen-based energy. The completion of the transaction is expected before summer 2021, depending on the necessary approvals by the relevant authorities.

Nicolas Chamussy Appointed CEO of Nexter

Photo: Airbus

(jr) Franco-German defence company KNDS announced the appointment of Nicolas Chamussy as CEO of Nexter, effective 1 April 2021. In accordance with the changes of governance reported in December 2020, he will be a member of the KNDS Executive Committee (ExCom).

A graduate of the École Polytechnique (1987), of the École Nationale Supérieure de Techniques Avancées (ENSTA) (1992) and of the Institut d'Études Politiques de Paris (1992), Nicolas Chamussy started his career at the DGA before joining the office of the French Minister of Defence as manager for industrial affairs and armament programmes. In 1996, he was entrusted with responsibility for the energy sector at the Budget Department of the Ministry of the Economy and Finance. He then joined the industry, where he held various senior management positions at EADS, in the space (Astrium) and defence (Cassidian) business units. He was Chief of Staff to the CEO of Airbus from 2012 to 2016, before becoming Director of Space Systems within the Airbus Defence & Space division and member of the Executive Committee of Airbus Defence and Space. Since June 2019, he has been the space advisor of Airbus.

Chaired by Frank Haun, the KNDS ExCom is in charge of the management of the company at holding level. The committee's operational positions are held by top executives from its two subsidiaries Nexter and KMW in

a balanced way, while the functions of Chief Integration Officer and Group Secretary have been taken over by Dutch executives.
The KNDS Executive Committee had its kick-off meeting on 1 March 2021. On the same day, the newly appointed Chairman of the KNDS Board of Directors, Philippe Petitcolin, took up his duty. The reorganisation of the KNDS management structure is now complete.

EDGE and IAI in C-UAS Agreement

Logo: EDGE

(jr) EDGE, the UAE's technology group, has agreed a Memorandum of Understanding (MoU) with Israel Aerospace Industries (IAI) to develop an advanced Counter-Unmanned Aircraft System (C-UAS) tailoured to the UAE market, with wider ranging benefits for the MENA region and beyond. EDGE will leverage SIGN4L, one of its subsidiaries, to collaborate with IAI.
Comprising advanced 3D radar, communications intelligence and electro-optic technologies that are integrated into a unified command and control system, the C-UAS is fully autonomous, requiring no human intervention. A series of countermeasures, ranging from soft-kill solutions such as spoofing and jamming, to hard-kill capabilities such as lasers and electromagnetic pulses, are offered based on the level of threat and targeted operating environment.
Both SIGN4L and IAI will leverage their technical capabilities to develop the system in response to specific customer needs. Further support will be available via IAI's partnership with Belgium Advanced Technology Systems which has a technical and marketing presence in the region.

Ultra Invests in Sonar Centre of Excellence

(jr) Ultra Group has confirmed a significant additional strategic commitment to Canada in the form of new investment to transform its Dartmouth, Nova Scotia site into a global sonar centre of excellence. This comes after recent announcements by Ultra of contract awards for the Hull Mounted Sonar (HMS) and Variable Depth Sonar (VDS) subsystems on the Canadian Surface Combatant (CSC) programme.

Photo: Ultra

The Dartmouth facility will be significantly modernised, reconfigured for expanded capacity and networked to Ultra's other sonar sites in the UK and Australia. These enhancements will provide the world-class sonar capability being delivered for the CSC, as well as sonar systems on other Canadian naval programmes. They will also provide the necessary infrastructure for further growth of sonar exports to Ultra's core five-eyes markets, leveraging Ultra's already significant successes in providing sonar capabilities to major international navies.
As part of this investment, Ultra will also be upgrading areas of its facility involved in sonobuoy production – an activity which commenced in Nova Scotia in 1947. Ultra is Canada's sovereign sonobuoy supplier, and also exports them to a number of allied nations, with demand and staffing levels expected to increase in this area.
Most importantly, Ultra's investment in its Canadian sonar infrastructure will provide the modern, high-performing workplace that underpins the company's dedication to Canadian high-tech job creation. In the two years since having been originally awarded programme definition studies for CSC, working in close partnership with Lockheed Martin Canada and Irving Shipbuilding Inc, Ultra's Canadian team has grown by over 150 employees, with another 80 high-tech roles expected to be made available in 2021 alone. Ultra is immensely proud that new employees – often graduates of Canada's universities and technical colleges – will enjoy high-value roles conducted in a world-class facility based in Atlantic Canada.

Rheinmetall Expects CHALLENGER Modernisation Contract Award

(lh) Düsseldorf-based Rheinmetall AG expects to be awarded a contract for the modernisation of the British Army's CHALLENGER main battle tanks. As Rheinmetall CEO Armin Papperger explained at the company's annual press conference in March, the British Ministry of Defence is expected to announce that the German defence company has been commissioned to digitise the CHALLENGER turret and integrate a smoothbore gun. He put the likely value of the project at €750 million as a first step. In addition, a second contract for ammunition deliveries will probably be concluded this year, Papperger said. This is a deal between the British and German governments.
According to the Rheinmetall boss, the supercycle in the defence sector will continue in the coming years. He sees great interest in the LYNX infantry fighting vehicle developed in-house. After signing a contract last autumn in Hungary for the production of more than 200 combat vehicles, he says, talks are underway

Photo: ESD archives

in Europe in the Czech Republic, Slovenia, Slovakia and, more recently, Italy. Papperger put the long-term business potential for the Lynx at €15 to 40 billion - although a contract in the USA would be needed to reach the latter figure. The Rheinmetall CEO expects a decision before the end of the year in Australia, where Rheinmetall is competing in the Land 400 programme with the LYNX.
Should the company win the contract in the USA to supply an infantry fighting vehicle as a replacement of the US Army's BRADLEY fleet, the vehicles would be manufactured entirely in the USA together with local partners. According to its own information, Rheinmetall has already established a US company last year that is also allowed to participate in classified programmes.
Overall, the Düsseldorf-based group closed the 2020 financial year with the third-best operating result in the company's recent history, namely €426 million. According to Papperger, Rheinmetall won many important contracts and increased its order backlog to a record value of over €13 billion. In addition, there are framework contracts for military trucks and ammunition in the order of more than €3.5 billion.

IAI Records Historically High Results

(jh) For 2020, Israel Aerospace Industries (IAI) reported annual sales of approx. US$4.2 billion – the highest since the company's founding, and supporting a 48% growth in net income to US$133 million – the highest net income ever recorded by the company. In parallel, the company's R&D activity crossed the US$ 1 billion threshold
Compared to 2019 and US$4,108 million, the sales volume grew to US$ 4,184 in 2020,,whereas the gross profit saw a 15% increase in 2020 to approx. US$665 million (approx. 16% of sales) compared with approx. U$577 million in 2019 (approx. 14% of sales) – an increase of some US$88 million
At the same time R&D activities increased by 13% (in-house and contracted) in 2020 to approx. US$1,036 million compared to approx. US$909 million in 2019.
The company's current order backlog amounts to approximates US$12.6 billion, representing 3.13 years of operation. IAIO has free cash flows totalling approx. US$1.3 billion.

First Pictures of TROPHY APS on LEOPARD 2

(gwh) The contracts for the integration of the TROPHY Active Protection System (APS) on Germany's LEOPARD 2 MBT have been concluded. The Federal Office of Bundeswehr Equipment, Information Technology and In-Service Support (BAAINBw) and the companies involved, Rafael (for the delivery of the protection systems) and Krauss-Maffei Wegmann (for the construction of new hulls and the integration of the systems into the MBTs), have announced that the corresponding contracts were concluded on 22 February 2021. Newly built LEOPARD 2 A7 chassis and LEOPARD 2 A6 A3 turrets provided by the German Government will be used for the integration of the systems. In its press release, KMW refers to the new name LEOPARD 2 A7A1. This suggests that the turret will receive A7 components as part of the work. These include, among other things, a crew compartment cooling system and an extension of the fire control system for programmable ammunition.

Photo: KMW

Diehl Continues Support for Swedish Air Defence System

(jr) Diehl Defence has received a three year service contract from the Swedish Defence Materiel Administration (FMV) to ensure high availability and readiness of the country's ELDENHET 98 air defence system. The contract award followed delivery and handover of the IRIS-T SLS weapon systems in 2020. The Swedish IRIS-T SHORAD configuration, installed on a Hägglunds BV 410 carrier and a Diehl ML-98 launcher, was introduced into service in the Air Defence Regiment after passing several firing campaigns on the Vidsel test and firing range. With the new contract Diehl Defence will continue a long record of cooperation with the Swedish armed forces.

Photo: Diehl Defence

VL MICA NG for Egyptian Navy

(jr) MBDA has received a contract from the Egyptian Navy for the VL MICA New Generation (NG) air defence system to equip its GOWIND class corvettes. Officially launched in October 2020, the system is based on the integration of the MICA NG missile into the existing VL MICA point and close area air defence system.

The VL MICA NG system offers improved capabilities to handle atypical targets (UAVs, small aircraft), as well as future threats characterised by increasingly low observable infrared and radio frequency signatures. Additionally, VL MICA NG will be able to intercept 'conventional' targets (aircraft, helicopters, cruise missiles and anti-ship missiles) at longer distances.

Photo: MBDA

The Egyptian Navy already equips its four GOWIND class corvettes, recently procured from the French Naval Group shipyards, with systems from the VL MICA family.

RAFALE F3-R to Enter Operational Service

(jh) On 08 March Admiral Pierre Vandier, Chief of Staff of the French Navy, and Air Force General Philippe Lavigne, Chief of Staff of the French Air and Space Force, jointly approved the RAFALE F3-R fighter jet's entry into operational service. The upgrade of the combat aircraft's capabilities ranks high on the list of priorities of the French military expenditure plan (LPM) which provides for a €2.7 billion investment in the development of the new RAFALE versions between 2019 and 2025.

Both service branches are now authorised to use all new capabilities developed for the F3-R standard, which has already been integrated with approximately 5ß0% of the fleet and will eventually be installed on all RAFALE aircraft in service. The decision also applies to the RAFALE aircraft of the GAE (carrier air wing) operated from the CHARLES-DE-GAULLE aircraft carrier, or those deployed from the forward air base in Jordan within the framework of operation CHAMMAL.

Photo: Dassault Aviation

The service introduction completes a process, which included the integration of the METEOR long-range air-to-air missile and the TALIOS land-based target designator.

The combination of the AESA RBE2 radar and the long-range METEOR missile gives the RAFALE the air superiority it needs for beyond visual range engagements in all weather. The new version of the RAFALE will continue to carry the enhanced medium-range, air-to-ground missile (ASMPA) as part of airborne nuclear deterrence missions.

AERALIS and Thales in Teaming Agreement

(jr) AERALIS has entered into a Teaming Agreement with Thales in the UK to develop philosophies, processes, devices & systems to operate the transformational AERALIS platforms. The development from Thales will take place alongside AERALIS' contract with the RAF's Rapid Capabilities Office to deliver research & development of an Advanced Modular Aircraft system.

AERALIS is redefining the possibilities for light military jet aircraft across various roles in the defence market including training, aggressor and light combat. The effort focuses on a UK-based development and production programme of an agile, modular, and commercially driven aircraft system aimed at increasing capability whilst significantly reducing through-life costs for customers. As they move to develop and certify a broad range of future aircraft systems to support the RAF's ambition to rationalise its future fleet, they will be working in parallel with Thales in the UK to ensure that the training systems required to teach pilots to fly AERALIS will be ready in conjunction with the modular aircraft system.

Photo: Aeralis

The plan is for the aircraft system to be offered as part of training solutions to customers across all aspects of both flying and operational training. Next-generation synthetic training devices and simulators will be a vital part of this process. With a well-established Training and Simulation division that designs and operates synthetic flight training simulators, such as those used at the RAF's VOYAGER and ATLAS training facilities at RAF Brize Norton, Thales will bring to bear many of its latest training solutions to complement the AERALIS system to ensure ground-breaking solutions for customers.

U212CD Submarine Agreement Reached

(hum) The German-Norwegian U212CD (Common Design) submarine project is entering the home straight, although the signs of the past months suggested failure. The Norwegian Ministry of Defence announced on 23 March that an agreement had been reached with thyssenkrupp Marine Systems (tkMS) on the development and building contract. In addition, there was agreement on the joint acquisition of missiles and on the development of the 'Future Strike Missile'.

Image: esut.de

To replace its six ULA class boats, Norway decided on a joint design with Germany, designated the U212CD. In October 2018, TKMS submitted the first offer which was updated in July 2019 and in spring 2020, it was said that by the end of the year, the contract should have been signed and sealed.

The Norwegian Government's press release correctly states that the contract cannot be finalised until it has been approved by the German Bundestag. In view of the German federal elections in autumn of this year, parliamentary approval is hoped for before the summer break. The last session week for the Bundestag, also the last of the 19th legislative period, is 21-25 June. In the defence budget, €5.5Bn has been allocated for the two boats destined for Germany.

Forsvarsmateriell, the Norwegian procurement agency, projects more than 45 billion Norwegian kroner (approx. €4.43Bn) for the four Norwegian submarines, including VAT, a risk margin and implementation costs. Norway expects the first submarine to be delivered in 2029, with the procurement to be spread over ten years. According to earlier announcements, Germany will take over submarine numbers three and six of the series.

Naturally, there is no information about technical details. According to reports, U212CD will be larger than the class U212A operated by the German Navy.

Nexter Introduces SHARD 120

(gwh) Nexter has introduced the SHARD 120 advanced Armour-Piercing, Fin Stabilised, Discarding Sabot (APFSDS) kinetic ammunition (KE) for 120 mm smoothbore MBT guns. The ammunition complies with STANAG 4385 and can be used in MBTs with the corresponding gun widely used in NATO.

The APFSDS features an extended penetrator made of a new tungsten alloy from Plansee Tungsten Alloys, which is driven by an optimised sabot. The projectile is propelled from a combustible cartridge case by a new high-performance, low-erosion propellant from Eurenco. According to Nexter, this achieves a very high level of terminal ballistic performance.

The new SHARD ammunition is the result of R&T work on innovative materials and external ballistics, based on historical work for the French DGA and the implementation of an agile development process, Nexter said.

Firing campaigns – most recently under extreme temperature conditions and at long ranges – have confirmed the performance expected in the simulation in terms of penetration and accuracy.

Nexter expects to complete the architectural optimisations this year and then move into the industrial qualification phase in 2022. The validation and qualification of innovative technology building blocks in the SHARD programme is also one of the milestones in the development of very high performance ammunition for future land combat systems, in particular the Main Ground Combat System.

Photo: Nexter

Collins Aerospace MS-110 Market Perspective

(jr) Following the announcement of an Indefinite Delivery/Indefinite Quantity (IDIQ) contract modification by the US Air Force for its newest airborne reconnaissance pod, the MS-110 Multispectral Airborne Reconnaissance System, Collins Aerospace sees a very strong demand for the system throughout Europe and NATO partners.

The MS-110 is the follow-on to the widely deployed DB-110 system. It offers a multiband, true-colour capability that significantly increases the intelligence value of the collected imagery with features that

Photo: Collins Aerospace

include features to identify camouflage and increased spatial resolution. The system provides a stand-off range capability approaching 100NM and the ability to image over 40,000 Square Miles per hour during both day and night time.

The legacy DB-110 system has the largest worldwide installed base of any long range reconnaissance pod with 18 customers who have purchased 89 pods examples.

Current operational platform installations of Collins' DB and MS-110 systems are primarily on F-16 as well as business jet class multi-intelligence aircraft such as Bombardier's GLOBAL EXPRESS and the P-3 Maritime Patrol Aircraft. Collins has demonstrated a lightweight pod version of the system on the General Atomics MQ-9 where the stand-off range capability of the sensor would help reduce the threat presented by advanced, longer range surface to air weapons.

The MS-110 in the fast jet pod is also compatible with the F-18 SUPER HORNET which is under consideration in several European fighter competitions. As a full 'end-to-end' system, an MS-110 programme includes sophisticated mission planning computers as well the company's SCI-Toolset suite of ground station exploitation software. A new 'on-demand' data link has also been added which greatly increases the system's utility for indications and warning missions during periods of escalating tensions or actual combat operations.

STH Award Procedure Discontinued

(gwh) The 1st Public Procurement Tribunal of the Federal German Cartel Authorities (Bundeskarttelamt) has decided that the annulment of the award procedure for the procurement of a Heavy Transport Helicopter (STH) by the Bundeswehr is effective. Accordingly, the award procedure with the two bidders Lockheed Martin and Boeing does not have to be continued, although the annulment decision is unlawful. The unlawfulness was justified by the Procurement Tribunal on the basis of the estimate of the procurement costs, which could not be explained comprehensibly.

The award procedure started in February 2019 and was cancelled by the German Armed Forces in September 2020 because the bid prices were significantly higher than the budget allocated as part of the federal budget. Lockheed Martin had objected to this decision and subsequently applied for

Photo: Boeing/Sikorsky

a review before the Procurement Tribunal.

If Lockheed Martin appeals against the decision of the tribunal, the Düsseldorf Higher Regional Court would be the next instance. In the meantime, the Bundeswehr is preparing an alternative procurement route. Price enquiries will be used to determine the costs for direct procurement from a manufacturer and then possibly the purchase will be carried out according to an FMS procedure.

In the case of complex defence material such as the STH, the life cycle costs are assessed to be about the same as the mere procurement costs. In the previous award procedure, life cycle costs were covered for 30 years.

New Russian UAV Developments

(yl) The Russian MoD has released a video of the ORION UAV conducting several strikes in Syria, including a blow against an ammunition depot during a night flight.

This is a tough environment with lower clouds where the UAV has used a thermal imager and a night vision camera for aiming. The UAV featuring in the report was marked with 38 stars on its airframe, denoting the number of missions concluded. This included 17 combat and 20 reconnaissance flights, as well as one mission not being specified.

ORION is the first Russian UAV locally designed and produced by the Moscow-based Kronshtadt company. According to open sources, the UAV is able to fly for up to 24 hours and has a maximum take-off weight is 1000 kg including a 200 kg payload. ORION is intended for aerial reconnaissance of the terrain, determining the coordinates of ground and surface objects, as well as for topographic survey of the area. In the strike version, the UAV can carry up to four air-to-ground missiles. The ORION's operational sealing is up to 5 km with a flight range of

Photo: Igor Laskin

120 km. It can be controlled from a mobile operator station which is capable to run up to 4 UAVs simultaneously.

The UAV has an export version termed ORION-E, which has been included in the product catalogue of Rosoboronexport. The vehicle mock-up has been displayed at the Army 2020 International Forum and Rosoboronexport exposition at IDEX 2021 in Abu Dhabi.

Russian Air Force to employ THUNDER and LIGHTNING

(yl) During the ARMY 2020 International Forum Kronshtadt presented its new UAV of heavy class being titled GROM (THUNDER). According to official data, GROM will have a take-off weight of 7 tons and be capable of delivering a 1.3 ton payload at a distance up to 800 km. It can reportedly employ a variety of weapons including guided missiles as well as the KAB-250 and KAB-500 guided aerial bombs. The weaponry can be allocated at four suspension points – two under the wing consoles and two inside the UAV's airframe.

During ARMY 2020, Nikolai Dolzhenkov, Kronstadt general designer, claimed GROM would be employed to support the Su-35 and Su-57 fighters to preserve the manned aircraft and their pilots. The drones would be used to neutralise enemy air defence during joint missions teamed with conventional aircraft.

According to the recent company spokesman statement, which was quoted by the national information agencies, GROM will be able to control a swarm of 10 light strike

Photo: Igor Laskin

drones being launched from another aircraft, presumably a non-UAV. Those small drones are being designed by Kronshtadt as well and are called MOLNIYA (LIGHTNING). The UAV is reported to have a length of 1.5 m and a wingspan of up to 1.2m while the speed of the device is declared to be around of 600 – 700 km/h. The UAV payload is said to range from five to seven kg. It is also planned to use the MOLNIYA UAVs as high-precision guided munitions or reconnaissance target designators, according to the company spokesman. The exact timing of the system employment within the Russian Air Force has not been specified.

Barco UniSee 500 to Enter New Markets

(jr) Barco has unveiled the next generation of its Barco UniSee 500, optimising applications in environments such as control rooms, corporate lobbies, meeting rooms and television studios. Furthermore, the enhanced ease of deployment and servicing makes sure the product benefits the sales channel even more and effectively addresses the sustainability charter in line with Barco's strategy.

Photo: Barco

According to the company, the UniSee LCD video wall platform offers the world's smallest optical seam and almost eliminates the 'grids' that traditionally interrupt content shown on LCD video walls. Furthermore, because the platform was completely redesigned, it also takes a huge step forward in terms of image quality, installation precision, ease-of-servicing and reliability in critical environments. A follow-up version, Barco UniSee 500, answers the market demand for an LCD video wall that excels in image quality, reliability, and ease of servicing at a reduced brightness level and cost. Several innovations, including optimised Sense X algorithms to further improve both intra-tile and overall inter-tile uniformity, ensure an unequalled viewing experience.

C-390 MILLENNIUM

SUCCESSFULLY ACCOMPLISHING MISSIONS

The C-390 Millennium multi-mission aircraft is in-service with Brazilian Air Force delivering exceptional performance and fulfilling all expectations, most notably with support during the Covid-19 pandemic. The C-390 is also the aircraft of choice for Portugal and now Hungary too. Both these air forces have selected the C-390 to meet their own unique and demanding operational requirements. By combining state-of-the-art systems and proven technologies with a worldwide network of reputable suppliers, the C-390 Millennium is a versatile addition to any air force. The C-390 is the most reliable, easy to operate and efficient aircraft in its class.

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Photographic record made by the Brazilian Air Force on one of the missions to combat COVID-19 in Brazil.

Elbit Unveils AMPS NG

(jr) Elbit Systems has unveiled the next generation of its Advanced Multi-Sensor Payload System (AMPS™ NG), adding Shortwave Infrared (SWIR) technology to the existing day Charge-Coupled Device (CCD) TV sensors and a unique, highly capable, dual FLIR sensor design.

Packed in the widely fielded two Line-Replacement Unit (LRU) AMPS pod, the AMPS NG offers extended capabilities in all conditions, dramatically extending observation performance in limited visibility conditions, using its SWIR channel to effectively overcome high humidity, smoke or dust. In recent flight tests that were conducted in Israel, the new system was able to produce high resolution imagery of a football game in MWIR channel from a distance of 25km and aerial target tracking of the HERMES 900 in SWIR channel from dozens of kilometres.

Photo: Elbit

AMPS NG is fully qualified for extreme operational conditions and is in final integration stages and flight tests onboard a UAV for a European air force.

Similar to the legacy AMPS, the new system is optimised to enhance and increase the throughput of target intelligence production which is facilitated by autonomous navigation with an inertial system and GPS, as well as highly accurate geo-pointing and geo-location capabilities. AMPS NG is also suitable for a range of airborne intelligence Stand-off and Stand-in mission profiles and is ideal for use with both manned, and unmanned, aircraft.

Honeywell Wins CHINOOK IDIQ Contract

(jr) Honeywell has won a four year Indefinite Delivery, Indefinite Quantity (IDIQ) contract for new production and spare T55-GA-714A engines that power the US Army's CH-47 CHINOOK helicopters. This US$476M contract will ensure that the fleet has spare engines to support future missions and available engines for Boeing's Philadelphia Production Line through 2024 to serve the US Army and foreign partner nations' new aircraft requirements. The engines will be assembled and tested at Honeywell's production facility at the company's Aerospace global headquarters in Phoenix.

Securing this engine production contract follows a milestone year for the T55 engine after Honeywell won a competitive repair and overhaul contract for it in 2020. The company also completed a new engine repair and overhaul facility in Phoenix. That move allows the repair and overhaul work on the T55-GA-714A engine to be fulfilled in the same location as new engine production. The T55 centre of excellence provides for a shared workforce, facilities, and engineering resources between both engine lines and delivers up to 20 engines per month to the US Army, foreign military and commercial customers.

Photo: Honeywell

Also in 2020, Honeywell entered into a Cooperative Research and Development Agreement (CRADA) with the US Army to demonstrate and fly its upgraded T55-GA-714C engine on the heavy-lift, twin-engine CH-47F CHINOOK helicopter. The new 6,000-horsepower engine is 23 per cent more powerful and consumes 9 per cent less fuel than the current T55. New modifications also make the next-generation T55 easier to maintain with lower operating costs and increased readiness. Work is ongoing now in Phase 1 of the programme while ground and flight demonstrations are expected to begin in 2022. The new 714C variant of the T55 is designed to be affordably incorporated into the 714A as an upgrade kit during overhaul at Honeywell's R&O Center of Excellence or at the Army's Corpus Christi Army Depot.

Russian Su-30Ms Invited to Belarus

(yl) Belarusian President Alexander Lukashenko has proposed locating Russian Su-30SMs at military bases in his country. Mr. Lukashenko claims this practice used to happen in 2014 during the World Ice Hockey Championship. The Belarusian leader said that the aircraft should be operated by both Russian and Belarusian pilots as there are sufficient military bases to avoid the need for the construction of new infrastructure. The money being saved should be used for the new aircraft production.

Alexander Lukashenko also said that these aircraft should be equipped with the most modern weaponry. "We are not talking about the nuclear warheads. We are talking about conventional weapons", he said. According to the existing contract, Belarus will receive a new batch of four Sukhoi Su-30SM multirole combat aircraft by October 2022. The Su-30SM has become a key version of the Su-27/35 family which Russia delivers to its allies from ex-Soviet Union republics such as Armenia and Kazakhstan as well.

Military-technical cooperation between Belarus and Russia covers different spheres. Earlier this week, the Armed Forces of Belarus officially confirmed receipt of the first batch of 9M120 ATAKA anti-tank guided missiles developed by the Kolomna-based Engineering design bureau of the High Precision Weapons holding. The missile can be fired from both armoured vehicles/tanks and helicopters. It is equipped with a cumulative action warhead and is designed to destroy tanks of all types, including those with dynamic protection screens at a range of up to 6000 m.

Photo: MoD Belarus

IRON STING Mortar Unveiled

(jr) The Directorate of Defense R&D in Israel's MoD, alongside the IDF's Ground Forces and Elbit Systems have revealed the IRON STING guided mortar munition. This is a 'networked precision fire system' that employs laser and GPS to engage targets accurately and prevent collateral damage. Trials have been conducted successfully, concluding the system's development.

The 120 mm mortar has recently undergone final trials at a testing site in southern Israel. The completion of testing enables the start of serial production ahead of the system's supply to the IDF. The series of tests was carried out using two networked cardom mortar sys-

Photo: Elbit

tems that were developed by Elbit Systems. IRON STING is designed to engage targets precisely, in both open terrains and urban environments, while reducing the possibility of collateral damage and preventing injury to non-combatants. Its operational use will revolutionise ground warfare and equip battalions with organic, accurate and effective firepower.

Bundeswehr Orders More MELLS Missiles

(jr) Diehl Defence has received an order for more than 600 additional MELLS (lightweight, multi-role guided missile system) guided missiles. The anti-armour missiles for precise engagement of armoured ground and infrastructure targets are scheduled to be delivered to EuroSpike GmbH in 2024. This is a joint venture between Diehl, Rheinmetall and Rafael, which is in charge of programme management and marketing in Europe.

Photo: Diehl Defence

Diehl Defence produces the MELLS guidance and control assemblies in Germany, including the high-resolution dual-mode seeker head as well as the warhead while carrying out final integration. The missiles are delivered from Diehl's integration centre in the German State of Saarland. They are not only used with a portable command and launch unit in dismounted operation but also from the MARDER and PUMA armoured infantry combat vehicles as well as the WIESEL gun carrier.

During operation, soldiers benefit from a sophisticated seeker technology and the special warhead architecture of the light, compact, effector. The free choice between daylight and night vision mode offers a reliable and stable target tracking even in case of changing visibility conditions. Until 2024, the total volume of the missile procured by the purchasing authority will increase to more than 4,600 items, thanks to the latest order. It is part of a basic agreement on the procurement of missiles over the next ten years. Thus, the supply to the German Army with one of the most modern anti-tank missiles is also safeguarded in the future.

Australian IFV Candidates Presented

(jr) The two contenders for the largest acquisition project in the history of the Australian Army have been officially unveiled in Canberra. The new IFV prototypes are currently under evaluation, and once delivered, the project will provide the Army with an advanced, cutting-edge, mounted close combat capability.

Photo: euro-sd.com

The two shortlisted contenders for the project are Rheinmetall Defence Australia, offering its KF-41 LYNX, and Hanwha Defense Australia, with its REDBACK. Both companies have proposed to build the vehicles in Australia, with substantial investment in Australian industry capability, supporting Australian jobs, talent and technology.

A decision on the preferred solution will be presented to Government for consideration in 2022. The IFVs will replace the current M113 APCs that have been in service since the mid-1960s.

Denmark to Field SPIKE LR2

(gwh) The Danish Defence Acquisition and Logistics Organisation (DALO) will purchase the SPIKE LR2 Anti-Tank Guided Missiles (ATGM) from EuroSpike in order to equip the reconnaissance and infantry units of the country's two combat brigades. The purchase will be carried out through the NATO Support and Procurement Organisation (NSPA).

Starting this year, the battalions will be equipped with launchers and missiles as well as training and simulation means over a period of five years. Some of the systems will be integrated into remote-controlled PROTECTOR weapon stations from Kongsberg on the EAGLE V and PIRANHA V protected wheeled vehicles currently being delivered from General Dynamics European Land Systems.

The 5th generation SPIKE LR 2 ATGM is designed for use from vehicles and by dismounted forces with a target spectrum including medium and heavily armoured vehicles as well as fortified positions in a range band up to 5,500 metres. The infrared seeker with a CCD camera transmits the image from the target to the shooter via glass fibre. This allows the missile to be used in both fire-and-forget and fire-and-observe modes. In the latter case, the shooter can change the target or abort the engagement after firing. Additionally, the engagement can be started without the shooter seeing the target when firing. In the final phase, the shooter can choose the angle of attack: direct or top attack.

Photo: DALO

By procuring through the NSPA, Denmark has secured a fast delivery, a good price and a good supply availability. The country has joined a group of 14 NATO countries that use interoperable SPIKE LR or LR 2 systems, including:

- The Baltic countries
- The Netherlands
- Germany
- Poland
- Spain
- Italy

Thus, the Danish Armed Forces will be able to cooperate with allies using the same system and draw on common stocks / logistics in future operations in and outside Europe.

TESEO Mk2/E for Italy

(jr) MBDA will provide the Italian Navy with the new TESEO Mk2/E missile. This new generation system builds on the legacy TESEO family, known worldwide as OTOMAT, and will bring a substantial improvement in anti-ship capabilities. TESEO Mk2/E will efficiently engage both sea and land targets at very long range, with full mission control throughout the missile flight. It will have an innovative integrated mission planning and a new RF seeker, with options for additional features and capabilities in the future.

Photo: MBDA

TESEO Mk2/E is the answer to evolving threats that generate the need to evolve operational requirements. This solution is the result of joint MBDA and Italian Navy technical and programme activities over the past three years that matured the concept of this advanced system. The TESEO Mk2/E missile system will equip the next generation destroyer (DDX) and could replace the previous Mk2/A version onboard FREMM

and HORIZON class frigates. The new multi-purpose Offshore Patrol Vessels currently in production are already fitted for TESEO Mk2/E installation in future. In the anti-ship weapon market, TESEO Mk2/E will represent a new standard with its very high performance and will be ready to be tailored for international requirements.

Continued IRON DOME Development

(jr) Rafael Advanced Defense Systems and the Israel Missile Defense Organization (IMDO) have successfully completed a test campaign of the IRON DOME weapon system. This campaign, along with two recent IRON DOME tests, demonstrated a significant upgrade of the system's technological capabilities. These involved a range of complex scenarios and successfully intercepted and destroyed targets. Specifically, this simulated existing and emerging threats, including the simultaneous interception of multiple UAVs in addition to a salvo of rockets and missiles.

Photo: Licenced to Rafael by Shaul Golan

The campaign took place in a testing site in Southern Israel, with the participation of IAF soldiers. The new version of the IRON DOME system will be delivered to the IAF and the Israeli Navy for operational use to strengthen Israel's multi-tier missile defence capabilities.

The prime contractor for its development is Rafael Advanced Defense Systems Ltd. under the IMDO. The system's MMR radar is developed by ELTA, a subsidiary of Israel Aerospace Industries (IAI). The Battle Management Centre is developed by Rafael and mPrest, a Rafael subsidiary.

With over 2,500 combat interceptions and a success rate of 90 per cent, IRON DOME's development began in December 2007. It is designed to defeat threats including rockets, artillery, mortars, aircraft and cruise missiles The system's development has continued throughout the years and its capabilities today include wider coverage, a broader spectrum of threat interception and the ability to handle very high volume salvos.

FLIR Systems Contracted for Next-Generation Chemical Detection Technology

(jh) FLIR Systems has won a contract worth up to $8.0 million from the United States Defense Threat Reduction Agency's Joint Science and Technology Office (DTRA JSTO) to rapidly develop next-generation chemical detection solutions based on ion mobility spectrometry (IMS) and mass spectrometry (MS) technology.

FLIR will team with Purdue University to advance their cutting-edge research in ion mobility design and two-dimensional mass spectrometry (2D MS/MS) into a modular, flexible platform system for chemical detection. The platform will be fielded as a lightweight, person-portable sensor for downrange chemical screening, as a sensor payload for unmanned platforms, and as an embedded real-time monitor for chemical releases. The programme's goal is to provide forces with smaller, faster, more interconnected chemical detection and identification tools for use in a wide range of scenarios.

Milrem Robotics and Marduk Technologies Launch C-UAS System

(jh) Milrem Robotics, a European robotics and autonomous systems developer and Marduk Technologies, a provider of Counter Unmanned Aerial System (C-UAS) solutions, jointly launched a mobile autonomous C-UAS platform that offers protection against loitering munition and surveillance drones.

The system features the electro-optical C-UAS platform Marduk SHARK and the THeMIS unmanned ground vehicle (UGV). This mobile solution provides frontline forces with an independent ability to detect, classify and target loitering munition and other flying objects. It uses advanced artificial intelligence and machine learning models.

Photo: Milrem

The mobile C-UAS platform can be integrated with kinetic and non-kinetic weapon systems and with different sensors and effectors such as radar, radio frequency detector, jammer, laser, etc.

Currently, most C-UAS solutions are used stationary, however, utilising mobile platforms with autonomous capabilities gives forces the flexibility to relocate them according to the threat assessment. Mobility also provides early warning for the forces in various positions.

MKU delivers Body Armour to Military Police, Sao Paulo, Brazil

(jh) Indian/German company MKU became the first company outside Brazil to provide ballistic vests to the elite Military Police Sao Paulo. Military Police Sao Paulo had initiated a tender for 14,500 ballistic vests based on the latest NIJ 0101.06 standard of the National Institute of Justice, USA. The specifications of the tender for the ballistic vests were highly focused on overall end-user experience with special emphasis on comfort, lighter weight & flexibility.

Photo: MKU

MKU has over 3 decades of experience coupled with state-of-the-art infrastructure and manufacturing processes. These high-performance vests, with Level IIIA protection were custom designed by MKU to ensure enhanced ballistic protection at lower weights, comfort, mobility, and ease of use. They are made using special antibacterial fabrics, which ensures comfort, even over prolonged use. MKU delivered the vests in over 21 different sizes as per the customer request.

The vests are NIJ certified and were thoroughly tested for performance, during the tender process and after they were delivered.

North Macedonia to Receive 54 STRYKER AFV

(gwh) Less than a year after North Macedonia's admission to NATO, the USA has responded positively to the country's request for the procurement of 8x8 STRYKER combat vehicles in the scope of an FMS programme. Accordingly, North Macedonia will receive 54 STRYKER AFVs, among them the M1126 Infantry Carrier Vehicle (ICV), M1130 Command Vehicle (CV) and M1129 Mortar Carrier Vehicle (MCV) variants, as well as peripheral equipment such as heavy machine guns,

Photo: US Army

smoke launchers, radios, remote-controlled weapon stations, GPS receivers and driver optics. In addition, there are spare parts, special tools and test equipment, documentation, and logistic support. The financial volume of the entire package is estimated at €176 million.

The 8x8 STRYKER is a protected combat vehicle derived from the PIRANHA III designed by General Dynamics European Land Systems-Mowag (GDELS). The vehicles will be supplied with reinforced protection, have a weight of up to 25 tonnes and are powered by a 260 kW Caterpillar diesel engine. Depending on the mission equipment, the vehicles offer space for up to eleven soldiers in addition to the regular crew (commander, driver, gunner). The vehicles for Northern Macedonia will be produced at GDLS-Canada in London, Ontario. Subcontractors include Harris (radios) and Kongsberg (weapon stations).

The Armed Forces of Northern Macedonia have 8,000 active soldiers and 5,000 reservists, structured into an infantry brigade with four infantry battalions amongst others, an army aviation brigade and support forces. The defence budget in 2020 was around €135 million.

German Army Declares "System Panzergrenadier" Fit to Fight

(jh) Supplied by Rheinmetall and its partner companies, the Bundeswehr's System Panzergrenadier (Armoured Infantry System) has reached an important milestone. On 18 March 2021, Lieutenant General Alfons Mais, the Chief of the German Army, declared the system fit to fight. He also recommended equipping NATO's spearhead formation, the Very High Readiness Joint Task Force (VJTF) 2023, which the Bundeswehr will be furnishing, with the new system. In essence, System Panzergrenadier consists of an upgraded version of the PUMA AIFV and the VJTF2023 version of the Future Soldier – Expanded System (IdZ-ES) developed by

Photo: Rheinmetall

Rheinmetall. Following extensive development and modification work, System Panzergrenadier underwent a three-week-long tactical evaluation at the Bergen training area in northern Germany in February 2021. It passed the test with flying colours.

System Panzergrenadier will substantially enhance the fighting strength and combat effectiveness of the VJTF 2023. Equipped with System Panzergrenadier, this formation will, for the first time in Germany, bring together a digitised vehicle platform – the enhanced VJTF version of the PUMA infantry fighting vehicle – and a soldier system equipped for digital radio communication.

System Panzergrenadier offers two key advantages: first, all soldiers, whether mounted or dismounted, can access the same information; and second, they are able to share this information with greater precision, more quickly and more robustly. The closely knit network of sensors and infantry weapons and the infantry fighting vehicle minimises the time between target detection and target engagement. This blending of capabilities into a single overarching system enables more effective tactical interaction of the soldiers and their IFV, enhancing in turn the overall combat effectiveness of mechanised infantry units.

A total of forty VJTF-grade PUMA vehicles will form part of the VJTF 2023 panoply of equipment. The most advanced version of the PUMA to date it integrates standoff anti-armour weapons like the MELLS multirole guided missile system; additional sensors such as a new driver vision system; and improved C4I architecture.

The new panoramic and driver vision system heralds the end of the periscope era. For the first time, the entire crew will be able to "see through" the armour, both day and night. The fusion mode combines daylight vision with high-performance thermal imaging, enabling swift detection of concealed targets around the clock. The PUMA is the first significant Western combat vehicle to include a system like this as a standard feature.

India Launches Next-Generation ARJUN Main Battle Tank

The Indian Government is surging ahead with its 'Atmanirbhar Bharat' (Self-Reliant India) policy, by ordering indigenous equipment with the latest being added to the kitty of Indian manufacturers is the approximately US$1.3Bn order for two regiments of the new, improvised, homemade ARJUN main battle tank (MBT) for the Indian Army.

The order for 118 tanks, developed by the Government-owned Defence Research and Development Organisation (DRDO), to be manufactured by the Ordnance Factory Board (OFB) for the Heavy Vehicles Factory (HVF) incorporates 71 improvements, including 14 major upgrades to the original version - the ARJUN Mk-1 - 124 of which are currently in service in the Indian Army.

Photo: Suman Sharma

The ARJUN Mk-1A main battle tank in 2014 at Defexpo in New Delhi. When the upgraded ARJUN prototype was first unveiled, DRDO decided to call it ARJUN Mk-2, but then renamed it ARJUN Mk-1A.

The original Mk-1 has been upgraded to the Mk-2 version with the requested upgrades consisting of 14 major and 83 minor improvements. Most upgrades have been carried out though some, which could not be done, were considered unnecessary, hence they settled somewhere in between for a mutual designation since all requirements on the erstwhile Mk-2 were not required. Therefore, officially the ARJUN Mk-2 was renamed the ARJUN Mk-1A. Both are similar and for now there is no Mk-2 version.

The 68.5tonne MBT is 10.19 metres long and promises to be a dependable, state-of-the-art war-fighting machine providing high mobility, superior firepower, and exemplary protection. The DRDO is also in the final stages of developing five indigenous anti-tank weapons which will be integrated on the ARJUN, making it a potent weapons platform. These weapons are: the NAG Anti-Tank Guided Missile; its standalone version, christened SANT; the HELINA – an airborne NAG, able to be fired from helicopters; an MPATGM man-portable version; and the ARJUN gun barrel, all of which will form the full complement of the weapons suite. This generation of the ARJUN, which will become one of the world's heaviest battle tanks, will mainly be deployed to the western theatre's desert region. The Indian Army's mainstay until now has been the Russian T-90, which has undergone a major overhaul.

Each of the two ARJUN Mk-1A regiments will be equipped with 59 tanks, against the authorised 45, since this is a new raising, hence the increase in number. After the limited series production, each of the two regiments will first receive five tanks by the middle of 2023, 30 tanks by mid-2024 and the remaining 24 by 2025-26.

Suman Sharma

Security Policy and Force Development in Bulgaria

Kasimir Karakachanov

In 1994, the states participating in the Organisation for Security and Co-operation in Europe (OSCE) adopted a Code of Conduct on Politico-Military aspects of security. The Code is a fundamental document setting forth the principles of good governance in the security sector management and playing the role of a monitoring mechanism as regards the observance of the said principles. It became effective as of 01 January 1995. The exchange of information carried out under the Code contributes to confidence and security building between the countries. As an additional transparency measure, the reports are published on OSCE's website.
By 15 April 2021, Bulgaria is to submit its national report on the Code of Conduct on Politico-Military Aspects of Security to the Organisation for Security and Co-operation in Europe (OSCE).

Photo: Bulgarian MOD

Krasimir Karakachanov is the Deputy Prime Minister for Public Order and Security and Minister of Defence of Bulgaria.

The information exchanged on an annual basis between our country and the other states participating in the OSCE is prepared jointly by the Ministry of Foreign Affairs, the Ministry of Defence, and the Ministry of Interior on the basis of answers to the questionnaire adopted by the OSCE members. The bigger part of the questions falls under the competence of the Ministry of Defence. Those relate to, among others, the legislative basis regulating defence planning, democratic control, roles and missions of the armed forces, the execution of the military service, education in international humanitarian law, the legal and the administrative procedures to protect the rights of the armed forces personnel.

Programme 2032 Outlines the Development of the Armed Forces of Bulgaria

The Programme for the Development of the Defence Capabilities of the Armed forces of the Republic of Bulgaria 2032 sets out the strategic framework and main parameters of the defence policy and the build-up and sustainment of defence capabilities adequate to the risks and threats up to the year 2032, and, in some aspects, beyond that year.
The draft Programme 2032 was adopted by virtue of Decision No. 86 of the Council of Ministers dated 1 February 2021 and has been submitted to the National Assembly for approval.
The document analyses the security environment and its impact on the development of defence capabilities. It sets out the strategic goal of defence policy: protection of the territorial integrity and of the national interests through build-up, sustainment and employment of defence capabilities adequate to the security environment and build-up of modern armed forces with a single command and control system in peacetime and in the event of crises.
Programme 2032 indicates that in order to carry out the assigned missions and tasks, the armed forces are to maintain a total strength of not less than 43,000 including 3,000-strong voluntary reserve. The parameters of the capabilities, structure, and command and control system of the armed forces are also defined.
The role of the armed forces is to guarantee the sovereignty, security and independence of the country, to defend its territorial integrity, and to participate in NATO collective defence and the EU Common Security and Defence Policy.
The three primary missions of the armed forces are defence, support of international peace and security, and contribution to national security in peacetime. The level of ambition for employment of the armed forces has been defined for each of the three missions accordingly.
Functionally, the armed forces will comprise Deterrence Forces and Defence Forces. In addition to that, Programme 2032 envisages the establishment of two new structures, the Communications and Information Support Command and the Logistics Support Command.
To strike the optimum balance between the defence capabilities needed, the fulfilment of missions and tasks assigned to the armed forces, and the resources available for defence, it is forecast that by 2024 defence spending reach 2% of the GDP. After 2024, defence spending is to be maintained at not less than 2% of the GDP and, if the economic situation so permits, at a higher level, while committing to invest at least 20% of defence spending in procuring new weapon systems and equipment.
Programme 2032 foresees that the investment projects on rearming, reequipping, and modernising the armed forces are to encompass the full life cycle of a defence product: acquisition, operation and maintenance, decommissioning, and, respectively, planning and timely provision of the funds required.
Programme 2032 envisages development to be achieved in all areas related to the armed forces: defence acquisition, defence infrastructure, military education, social policy (morale and welfare), and human resources management.
It is human potential that is the main driver and guarantee for the success of each and every activity pursued in the field of defence. Securing competitive salaries for those in defence, comparable with labour market pay, has been a continuous effort with projected sustained impact well beyond 2032. The focus will be on creating conditions conducive to motivating people in defence and recruiting and retaining in service high-quality adequately trained personnel.
Programme 2032 was elaborated on the basis of the outcomes of the Strategic Defence Review, which was carried out as an integral part of the interagency Strategic Review of the National Security and Defence Protection System and Strategic Defence Review implemented at national level. The programme will in turn provide the basis for the elaboration of a Plan for the Development of the armed forces of the Republic of Bulgaria 2026, a successor Plan for the Development of the Armed forces of the Republic of Bulgaria 2027-2032, and a long-term Investment Plan-Programme 2032. ■

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Bulgarian Defence Industrial Capabilities

Peter Cholakov

This article introduces the Bulgarian defence industry and highlights products and capabilities that Bulgarian companies can provide to the international market. After a brief historical review, the factors that play a crucial, role in industrial development are adressed, followed by short dedicated introduction to the individual elements of Bulgaria's defence industrial base.

History

The Third Bulgarian State was officially formed in 1878, nearly 500 years after its annexation by the Ottoman Empire. The young country found itself in a dynamic and dangerous environment and the first defence industries were established soon after. Multiple local conflicts and the First World War provided solid proof that a strong defence industry was a must for the country and this led to multiple investments and projects in this area.

After WWII, Bulgaria became a part of the Eastern (Soviet) Block and its industrialisation was strictly supervised and directed by the USSR. This led to a new wave if investments in the defence sector – some enterprises had their capacity increased and new ones were established. Technology transfer from the USSR was a major factor for increased competitiveness and growth of the sector.

After 1989, Bulgaria transitioned to democracy and a free market system and this led to many new opportunities in the form of potential markets and numerous challenges like increased competition and new codes of conduct. Local manufacturers of defence-related products used this opportunity and established partnerships with companies in Western Europe, Japan and other developed countries. Obtaining licences and technological transfer helped the sector and increased the competitiveness of the Bulgarian industry on the military export market.

Author

Peter Cholakov is the Co-chairman of the Bulgarian Defence Industry Association – acad. Stefan Vodenicharov (BDIA)

Photos: author

Opening ceremony of the HEMUS 2020 exhibition in Plovdiv

Recent Developments

It is easy to say that history, international politics, integration and geographical location play major role in the development of the local defence sector. Bulgaria joined the North Atlantic Treaty Organization (NATO) in 2004 and the European Union (EU) in 2007. As a result, Bulgarian troops participate in NATO missions and the country has an external border of the EU making it a partner of the European Border and Coast Guard Agency. These developments have been key factors for the modernisation of the Bulgarian Army and have spawned new opportunities to local manufacturers of defence-related products that can cooperate with renowned international companies and industrial market leaders.

Maintaining reliable distribution channels is also a key factor to the success of Bulgarian defence companies. Long-term relationships that were established decades ago still contribute to successful projects and

Entrance gate to the ARSENAL facilities at Kazanlak

Grenade launchers are part of ARCUS' core portfolio.

DUNARIT specialises in the production of a wide range of ammunition.

more than 90% of the local production is exported to several countries worldwide. The Bulgarian defence industry has a good reputation in many regions of the world and often participates in international tenders, projects, exhibitions and trade shows. Maintaining good balance between technically sound staff and sales personnel helps them to fulfil customer needs and requests.

Local governing bodies that observe the activities of the Bulgarian defence industry are the national ministries of defence, economy, internal and external affairs, as well as other structures related to security and defence. Local legislation is based on EU legislation as well as conventions and international agreements. All local manufacturers have licences necessary for production, import, export and technology transfer of and for defence-related products and every single programme is monitored by the Bulgarian authorities and customs officials.

In 2004, a number of Bulgarian defence companies established the Bulgarian Defence Industry Association – acad. Stefan Vodenicharov (BDIA). The association serves as a forum for the exchange of information and ideas between government bodies and the defence industry in order to address industrial challenges and to ensure continuous development of the industry. The association's main activities include industry analysis, event coordination and member representation at international trade fairs, cooperation with local government bodies in the areas of law, education,

Acoustic buoy from HIGH-TECH IMS

Headquarters of International Armored Group

Personal ballistic protection is among MARS ARMOR's core capabilities.

MTG DOLPHIN's facilities provide repair capacity for vessels of up to 18,00 tonnes displacement.

defence policy and export control, and co-operation with international organisations and other national associations.

BDIA is also a partner of the HEMUS International Defence Equipment and Services Exhibition in the city of Plovdiv, a renowned event that attracted a growing number of visitors even during the pandemic in 2020. Noticeable exhibitors during last year's exhibition were Elbit Systems, Lockheed Martin, Rafael, L3 Harris, John Cockerill, IAI and many more. The next HEMUS exhibition is planned for 2022, supported by the national ministries of defence and economy.

Companies, Products and Services

Depending on ownership, we distinguish two groups of companies in the Bulgarian defence industry – state-owned companies under the jurisdiction of the local Ministries of Defence, and private organisations. Private companies can be divided into two subgroups – former state-owned companies that were privatised after the transition to democracy, and newly formed companies that started from scratch.

Based on products and services, the following capabilities are provided by the national defence companies:

- Production of small arms and light weapons;
- Production of ammunition;
- Production, repair works and overhaul of aviation equipment, armoured vehicles, tanks and ships;
- Production of radars and communication equipment, radio and phone jammers, command posts and control stations, sea and river navigation systems;
- Production of protective equipment;
- Production of day sights, thermal imaging and nigh vision devices, laser range finders, laser target designators, video observation and surveillance systems;
- Services like engineering, maintenance, disposal and demilitarisation of weapons , specialised software development.

The Bulgarian Defence Industry

The following Bulgarian companies are some of the country's most renowned defence enterprises:

Located in Lyaskovets, **ARCUS Co.** is an internationally recognised engineering centre of competence, specialising in the design and production of grenades, mortar rounds, fuzes, pistols, revolvers, grenade launchers and mortars. The company was

Command post vehicles are among SAMEL 90 PLC's portfolio.

in 1965 and employs nearly 2,900 staff, 120 of which are engineers tasked with R&D projects.

ARSENAL J.S.Co. was founded in 1878 in Rousse as the first production plant to serve the newly created Bulgarian Army. Due to some strategic considerations the facility was relocated to Kazanlak by law of the National Assembly in 1924. Today, the activities of ARSENAL J.S.Co. cover the design, production and trade of small arms and artillery systems, ammunition, primers, propellants, charges, pyrotechnics, hunting and sport weapons and ammunition, cemented carbide tools, tips and inserts.

DUNARIT Corp., established in 1903 in the city of Ruse, is a private producer of gun powder. Since its foundation the company has gone through various development stages and a variety of defence products have been developed since thanks to the company's qualified and experienced personnel. DUNARIT's core portfolio includes air-to-ground ammunition, artillery ammunition, engineering skills, industrial and civil products, as well as logistic services.

HIGH-TECH IMS LTD. is one of the leading industrial organisations in the field of national security and defence. A team of scientists and engineers has a long experience in developing, designing and manufacturing high-end security and defence systems and products for the protection of the country against threats from land, air and sea, the combat to terrorist operations and the modernisation and upgrade of materiel in service. The company offers specific solutions like radio hydroacoustic buoys, countermeasure devices, underground pressure and seismic sensors, communication systems and different types of cameras.

International Armored Group is an industry leader in the manufacturing of specialised armoured vehicles with over 20 years of experience and a global footprint with field offices in the USA, Canada, the UK, the UAE, Turkey, Pakistan and Iraq. The company offers vehicle armour solutions based on customer specifications, customised according to individual requirements.

MARS ARMOR LTD. is an innovative company specialising in the development and production of bullet-resistant and stab protective equipment for law enforcement and military forces. The company is an exclusive manufacturer of items for personal ballistic protection – bullet-proof vests, hard armour plates, ballistic shields and combat helmets, all of which are sold on the global market.

MTG – DOLPHIN PLC. was established in January 1991. For the last 30 years the company has gained a strong position and reputation on the international market as a reliable partner in the shipbuilding and ship repair arena. The production capacity and resources of the company's yard allow building special-

Clip-On Thermal Scope by OPTICOELECTRON GROUP J.S.Co.

OPTICS J.S. implements thermal imaging technology for night vision applications.

ised vessels of up to 8,500 tonnes and repair of vessels with a displacement of up to 18,000 tonnes. Core designs of MTG – DOLPHIN PLC. include inland water and offshore patrol vessels, corvettes, training sailing ships, dredgers and auxiliaries.

Celebrating its 50th anniversary in 2021, **OPTICOELECTRON GROUP J.S.Co.** is one of the most advanced Bulgarian companies, specialising in opto-mechanical, opto-electronic and laser devices and systems for applications in defence and security, medicine, and machine-building. The product portfolio includes anti-aircraft and field artillery sights for deployment around the clock, day and night optical sights, laser range finders, laser target designators, optical systems for armoured vehicles, video observation and surveillance systems.

Located in the town of Panagyurishte, **OPTIX J.S.Co.** was established in 1998 as a 100% private company and specialises in the design and manufacturing of optical, opto-mechanical and opto-electronic assemblies and devices for military and law enforcement applications. The portfolio of OPTIX J.S.Co. includes thermal imaging and night vision devices, day sights and integrated solutions, built according to international standards or according to customer specifications.

SAMEL-90 PLC was established in 1964 as a supplier of military electronic communication equipment for the Bulgarian Army. Today, the company is committed

TCHERNO MORE specialises in sensor sytems for a variety of applications.

to manufacturing a wide variety of products such as jammers, command post vehicles, surveillance equipment, radars, tools and mechanics. Ter staff always strives to introduce innovative products and develop new high-performance solutions.

Quality Optical Components

After 50 years, Opticoelectron is still the largest producer of quality optical components and OEM products in the Balkans. The company has a total of 600 employees of which 150 are highly qualified engineers and PhDs specialised in optical and mechanical design, working on developing own products or customer requests.

Opticoelectron is one of the most advanced companies specialised in optomechanical, optoelectronic and laser devices / systems for the defence and medical industries. In recent years, we have invested significant funds to improve, renovate and upgrade our production base. We have machines and technological solutions that many of our competitors would envy. We constantly invest in our human resources - we train, retrain and increase our employees' creative thinking.

Photo: Optoelectron

Opticoelectron has a closed production cycle, starting from research and development going through the production process up to marketing and sales of finished products. The company's head office and premises are in Panagyurishte, which is 90 km south-east of Sofia, the capital city, and 80 km north-west of Plovdiv, the second-largest city in Bulgaria. It is located in an Industrial Park of 260 000 sqm; 108 000 sqm. of the total area are production plots.

Over 97% of total production is exported to EU countries, North and South America, and the Middle East. Opticoelectron has four ISO quality certificates: NATO Commercial and Governmental Entity Code (NCAGE), NATO-Secret, AQAP 2110, and DUNS Number.

Essential defence products in our portfolio are as follows: anti-aircraft and ground artillery sights for firing by day and night; day, night and thermal optical sights, SWIR lenses, laser range finders, laser target designators, optical systems for armoured vehicles, observation and surveillance systems for mobile, semi-stationary and stationary systems.

TEREM is in control of the Bulgarian MoD's repair facilities.

RPG-7 rounds from TRANSMOBILE

TEREM S.H.C. is structured as an organisation comprising the military repair facilities of the Ministry of Defence and providing repair and overhaul of military equipment for the Bulgarian Armed Forces. As of now, the company has six subsidiaries for repair, overhaul, modernisation and logistic support of aviation equipment, ships, armoured vehicles, small arms, light weapons, artillery systems, missiles, ammunition, radar and communication equipment.

TCHERNO MORE Co. is a joint stock company located in the city of Varna, with 100% of the shares owned by private shareholders. The company specialises in the design, production and sale of radars systems for large and small surface ships, tracking and identification systems, coastal radar systems, airport traffic surveillance radars, etc.

TRANSMOBILE Ltd. was founded in 1994 in Sofia and focuses on the implementation, production and supply of products and technologies for military engineering and infantry applications. The company is well known for its universal silent launch system for mines and grenades, innovative, highly effective RPG-7 rounds, anti-tank mines, diversion mines and shell-bodies in calibres ranging from 60 to 155 mm and length up to 700 mm, and mortar shells in calibres from 60 to 120 mm. ■

The Brazilian Navy: An Evolving Navy in Consolidation

J. F. Auran

The Brazilian Navy has launched multiple projects over the past decades, most of which have failed. The publication on 10 September 2020 of the Plano Estratégico da Marinha 2040 provides an opportunity to assess and identify the following objectives. Today, a Marinha do Brasil (MB) appears to be well on its way to its submarine and frigate programme's success.

Brazil operates the largest Navy in South America to protect its 7,491 km of coastline and the underwater wealth, such as its vast oil reserves. The "Esquadra" consists, among others, of the ATLANTIC class multipurpose helicopter carrier PHM ATLANTICO, five NITEROI class frigates, two of the GREENHALGH class, several corvettes and five submarines. During the last decade, the country launched an ambitious construction programme to replace its ageing units. Even if the programme to acquire an aircraft carrier has been abandoned, the submarine programme (PROSUB), the TAMANDARÉ class frigate programme (PCT), and the polar and hydrographic programme vessels are on track.

Photo: Marinha do Brasil

Launch of the HUMAITÁ submarine - S41

2040 Navy Strategic Plan

The document issued recently by the Navy Headquarters paves the way for the next 20 years. The Navy is directed to focus more heavily on the South Atlantic Ocean and tightly control Brazil's maritime approaches. The Navy must cope with threats such as piracy, illegal fishing, organised crime, natural resources disputes, cyber warfare, terrorism, illegal access to knowledge, pandemics, natural disasters, and environmental issues. The PEM 2040 aims to achieve a minimum of 65% of ships and aircraft operational availability. It also mentions a wide range of modernisation projects without details or schedule development. One objective is to boost the country's Defence Technological and Industrial Base (DTIB). Except for vessels, the Míssil Antinavio de Superfície (MANSUP) and Míssil Antinavio Aéreo (MANAER) anti-ship missiles are strategic for the maritime force.

Author

Jean François Auran is a retired French Armed Forces officer and a Defence and Security Analyst.

The Submarine Development Programme (PROSUB)

Four TUPI class submersibles and a TIKUNA (a modified TUPI) are currently serving in the Brazilian Navy. The submarines, built in the 1990s, need to be modernised. Furthermore, the fleet is experiencing repeated periscope and engine issues. The Programa de Desenvolvimento de Submarinos (PROSUB) aims to produce four conventional submarines and build Brazil's first nuclear-powered submarine. The contract signed in 2009 between Brazil and France includes a significant transfer of technology by Naval Group. The two countries created a joint venture ICN (Itaguaí Construções Navais), 41% owned by the French group and 59% by its Brazilian partner, the Odebrecht conglomerate. The contract also includes the erection of a shipyard and a naval base (EBN). The construction of four submarines is progressing at the Itaguai site despite the health crisis. The RIACHUELO, the first of the SCORPÈNE Brazil (SBR), was launched in December 2018 and delivered in 2021. The HUMAITÁ, TONELERO and ANGOSTURA will be delivered in 2022, 2023 and 2024 respectively. Even if not fitted with AIP, these sophisticated units will carry the new-generation F21 heavy torpedo from Naval Group and the EXOCET SM39 anti-ship missile. Two submarines currently in service could be put up for sale.

The Fleet Renewal Programme

The MB operates a limited number of surface combat vessels after the withdrawal of most INHAUMÁ class corvettes, and the corvette class BARROSO is limited to just one unit. The five NITEROI frigates form the backbone of the naval escort force. Designed and partially built by British

Thornycroft, they entered service between 1976 and 1980. After several tentative efforts to restore a significant capability, the Navy launched the TAMANDARÉ class PCT programme. The Águas Azuis consortium formed by TKMS, Embraer Defense & Security and Atech won the competition.
Classified as a corvette until 2017, the Brazilian frigate is an evolution of the 2000-tonne model TKMS Meko A100 design already sold to Malaysia and Poland. The ship is modified to face the harsh conditions of the South Atlantic. Oceana shipyard, appropriately acquired by TKMS, will produce the four units with German technical assistance. Embraer's subsidiary Atech will receive a technology transfer from Atlas Electronik to provide the combat system. The Brazilian Navy has already ordered the 76/62 mm guns in Italy. Their delivery is scheduled between 2024 and 2028 for a US$1.6Bn estimated cost.
The Brazilian Navy owns a fleet of high seas patrol vessels and coastal patrol ships, even if most of them are ancient. The MB made a good deal by buying three AMAZONAS class oceanic patrol boats destined for Trinidad and Tobago from BAE Systems. Despite a contract with the Constructions Mécaniques de Normandie (CMN), Brazil faces great difficulty building the MACAÉ class patrol boats by the INACE shipyard. This class should eventually include six units, whereas the initial projection was 27 units. The coastal patrol vessel fleet is not up to the needs of the Brazilian Navy.
Maintaining a significant amphibious capacity is crucial for the country to extend its influence in the region. Brazil modernised its fleet with the acquisition in 2015 of the former French TCD SIROCCO. With the PHM ATLÂNTICO, this makes a coherent projection tool for a moderate cost.
In 2019, the Brazilian Navy launched a programme to build a new Antarctic support ship for the Brazilian Antarctic Programme

Photo: US Marine Corps photo / Sgt. Daniel Barriospirela

PHM ATLÂNTICO (A-140) entered service in the Brazilian Navy on 10 July 2018.

Image: thyssenkrupp Marine Systems

The four TAMANDARÉ class frigates are scheduled to enter service between 2024 and 2028.

Photo: Marinha do Brasil

PHM ATLÂNTICO during Aspirantex 21

(PROANTAR). The Brazilian Navy owns the ALMIRANTE MAXIMIANO, launched in 1974, dedicated to this mission. ICN (Itaguaí), which does not have the technical competence, relied on the company Kership (Naval Group) and offered a ship whose design is close to the French L'ASTROLABE. The Navy Programme Management Directorate made the "short list" public in February 2021. Damen shipyards, Itaguaí Construções Navais S.A./ Kership S.A.S and the Brazilian shipyard Estaleiro Wilson Sons were selected. An order is expected from June 2021.

The Brazilian Navy is also reportedly looking for two new hydro-oceanographic vessels. The project is currently at the RFI (request for information) stage, but things could go quickly, with an order expected by the end of next year. The acquisition of logistics support vessels is still included in the PAM 2040. It is now termed the Navio de Apoio Logístico Móvel. The purchase of the WAVE class unit of the Royal Fleet Auxiliary should be an advantageous option for Brasilia.

Naval Aviation Situation

Since Sao Paulo's aircraft carrier withdrawal, the Naval Aviation no longer has a dedicated platform. The Navy has only a few AF-1B/C SKYHAWK aircraft, currently being modernised by Embraer. The helicopter fleet has been reinforced in recent years by sixteen EC725 COUGAR helicopters. The SUPER LYNX are also being modernised, with the first unit delivered in February 2019, the second in May 2020. The four others will be gradually delivered by the end of 2022.

Photo: Marinha do Brasil

The Brazilian Navy participates in the fight against Covid-19

Operational Activities

In the fight against the Covid-19 pandemic, the Navy contributed to the transport of large quantities of oxygen to Manaus. The struggle against drug traffickers, especially active in the area, is ongoing. On 15 February, the patrol boat ARAGUARI intercepted a sailboat 270 km from Recife in cooperation with MAOC Lisbon with a large quantity of cocaine. The US Coast Guard regularly sends vessels to work jointly with the Brazilian Navy.

The Navy participated for ten years in the United Nations Interim Force's maritime component in Lebanon (UNIFIL). The mission was to secure the country's territorial waters and to help develop the Lebanese Navy. On 2 December 2020, the frigate INDEPENDENCIA left Lebanon after ten months of presence in the eastern Mediterranean.

Training is imperative for the Navy, which invests heavily in this area. Exercise ASPIRANTEX 2021 took place in February. The 152 Navy Academy's second-year midshipmen on board the ATLÂNTICO held various posts and conducted numerous exercises of all types. Six ships made up the Task Force which included several air assets. Other students embarked aboard the BRASIL training ship from September to February on the XXXIV Guardas-Marinha training trip.

International Cooperation

The Navy is present along the African coasts and regularly participates in multinational maritime exercises in the Gulf of Guinea, where piracy is rife. The Patroller APA took part in the last edition (October 2020) of the exercise GRAND AFRICAN NEMO (Navy Exercise for Maritime Operations), a French initiative. Brazil is also participating in the US exercise OBANGAME EXPRESS. It maintains cooperative links with Angola and Namibia with regular stopovers for its ships. Furthermore, the Brazilian Navy formed Namibia's Marine Corps.

To conclude, the Brazilian Navy is slowly improving despite financial limitations. It can be considered a coherent tool with qualified personnel even if the modernisation process is taking longer than expected. ■

Key Features for VoIP Services in Tactical Networks

As IP technology is being widely adopted in tactical communication networks, also tactical voice networks are moving towards the use of Voice over IP (VoIP).
When considering the right VoIP solution for tactical environments, the question usually comes up whether a commercial off-the-shelf solution could work. Based on long-term experience from working with tactical VoIP solutions, tactical communication experts at the Finnish company Bittium have discovered that typical commercial VoIP server solutions have several handicaps.
"One of the challenges is how the VoIP service works for the benefit of mobile troops. Typically, VoIP servers require preparing a dial plan in advance, which defines the trunk connections between servers. Similarly, the users have a fixed location in the network. As tactical networks are mobile by definition and routes between servers may change and some may become temporarily unavailable, this type of centralised VoIP solution does not work," says Jussi-Pekka Pudas, Product Manager at Bittium. "In addition, quality of service and priority of calls are not supported in commercial solutions, and integration of VoIP and legacy audio in the same network is challenging.

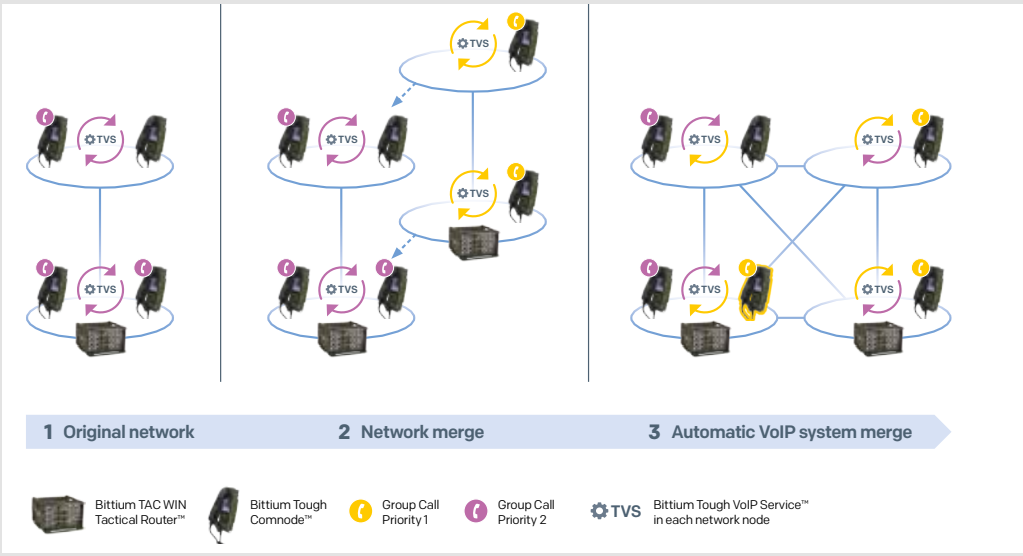

Image: Bittium

With Bittium's VoIP Service users benefit from features such as mobility and priority.

Distributed, Self-Healing System with High Mobility

So, what is the best way to offer VoIP services in tactical networks? Bittium has developed a solution called Bittium Tough VoIP Service, that has been specifically designed for mobile tactical environments. According to Jussi-Pekka Pudas, one of the key features is that it is a truly distributed solution: "This means that a loss of a single element in a central role in the network will not cripple the service. Instead, any node in the system can claim that role. The server entity is typically installed on each network router node, from our products that could be Bittium TAC WIN Tactical Router, Bittium Tough SDR radios, or Bittium Tough Comnode. Each of the servers can work independently to provide local VoIP service to local users. Full set of tactical features can be provided without being dependent on any centralised service beyond the local router."
Bittium's VoIP Service is also self-healing. When the network expands and connection to other tactical nodes is established, it automatically forms connections also between the VoIP servers. If the network connections break and reconnect, or the network topology changes, the VoIP network will also recover without any user interaction.

Prioritisation and Call Admission Control

In addition, Bittium provides a solution for prioritising VoIP calls in tactical networks. "VoIP calls not only have a configurable priority within the voice service, but Bittium TAC WIN network also implements a Call Admission Control system which can manage calls in the network. This means that the user will receive feedback if the network capacity is not sufficient for the call. Also, ongoing low priority calls can be released in case it is required to release network capacity for higher priority calls. As a result, the reliability of the voice service is remarkably improved, and the behaviour of the service is more consistent," says Jussi-Pekka Pudas.

Interoperability Made Easy

When introducing new solutions to existing tactical networks, interoperability becomes a critical aspect. Bittium's VoIP service has been designed to support easy integration with other VoIP and mobile networks. It supports standard SIP (Session Initiation Protocol) interfaces towards VoIP clients and other VoIP systems. This enables the use of any terminal devices and trunk connections to third party VoIP systems; building a connection between a tactical and a commercial network is also feasible without additional equipment or software. This allows communication between tactical networks and mobile networks, for example LTE.
It is often also necessary to be able to form a direct voice connection to legacy voice radio systems. Bittium provides an integrated solution that can connect a VoIP network to an analogue one through a RoIP (Radio over IP) gateway.
"Bittium Tough VoIP Service together with our VoIP terminals and applications form a complete solution for voice communications in tactical networks. In addition to our own applications, it is possible to integrate third party applications and solutions, for example by using an SDK for the integration. Together with Bittium TAC WIN, Tough SDR, and Comnode networks and nodes, the system provides mobile connectivity from command posts to dismounted soldiers," says Jussi-Pekka Pudas.

For more information on Bittium's tactical communication solutions, please visit **www.bittium.com**

The Future of Swiss Air Force – Standing at the Crossroads

An Update on the Swiss Air Force

Georg Mader

With the programme delayed bv the pandemic, 18 November 2020 marked the deadline for a quartet of hopeful vendors to deliver their vision and prices for one of the largest procurement programmes in Europe.

Four aircraft manufacturers have submitted final offers for Switzerland's acquisition of 36 to 40 new multirole jets worth CHF6Bn. In parallel, a system of long-range ground-based surface-to-air missiles (called BodLuv) has been requested, adding another CHF2Bn to the total cost. Following a referendum on 27 September 2020 that – very narrowly by 50.1% or 8,670 votes – provided the green light for the project called "Air-2030", the Swiss Air Force's NKF-board (Neues Kampfflugzeug) under Peter Winter and national armament agency armasuisse are expected to forward both decisions to parliament in early summer 2021.

Swiss colleagues and friends described to ESD the true nature of the shock to the government and the country's military leadership that 49.9% of Swiss voters – especially in the western and southern parts of the country – did not "behave" in a traditionally supportive manner on Army matters and also that they had not "bought" their arguments. These were that for control, protection and defence of neutral Swiss airspace, a combination of modern jets and GBAD would be essential. Today's aircraft types such as the F/A-18C/Ds and short-range SAMs are, or will soon – meaning by 2030 - become obsolete, while a long-range SAM does not exist at all since the once mighty BLOODHOUND was retired in 1999. Visibly sobered by the razor thin outcome was Defence Minister Viola Amherd, who linked the issue with the fate of the whole Swiss Army.

Author

Georg Mader is a defence correspondent and freelance aerospace journalist based in Vienna, Austria, and a regular contributor to ESD.

Photo: Luftwaffe

A lineup of Swiss AF HORNETs

Photo: armasuisse

A US Navy F-18F at Payerne in April 2019

With Europe or with the US?

Up until the end of the final risk assessment, the quotation for the best-and-final offers and the previous in-country evaluations, the list of competitors includes the EUROFIGHTERTranche-4 (Airbus D&S, Germany), F/A-18 SUPER HORNET Advanced (Boeing, USA), RAFÁLE F4 (Dassault, France), F-35A (Lockheed Martin, USA) and GBAD-Systems by SAMP/T (Eurosam, France) and PATRIOT (Raytheon, USA). This range illustrates that the upcoming decision is not only a technical, but also a highly political issue. The security orientation of this formally neutral and wealthy nation - embedded and interconnected, but strictly not part of the EU – for the next 30 years is standing at the crossroads between deeper European defence cooperation or to remain a "wing" of the USAF or USN (as it has

been and will still be if the SUPER HORNET is chosen).
Another factor is the level of participation of Swiss industry, whose share, however, has been limited to 60% of the total value. Switzerland has an active and capable aerospace and defence industry, thus it comes as no surprise that Airbus and – to a lesser degree - Lockheed Martin are touting different approaches to assembling their planes locally. Airbus has been assisted by four EUROFIGHTER operators - (Germany, Spain, Italy and the UK) - who sent their ambassadors in Switzerland to a news conference to talk up the prospect of a wider industrial and political partnership that would follow if the EUROFIGHTER were to be chosen. With Austria's 15 downgraded Tranche-1s, three Swiss neighbours with common languages are operating this aircraft type. Michael Flügger, Germany's ambassador in Switzerland, mentioned the possibility of EUROFIGHTER-based airspace patrol cooperation along the Italy-Switzerland-Germany axis and Franz Posch, who heads the Airbus campaign in Switzerland, told reporters that "the company's commitment to locally assemble all of the notional aircraft would more than fulfil the offset requirements established by the Swiss Government." His "boss", CEO Dirk Hoke added that "Switzerland will gain full autonomy in the use, maintenance and application of the data from its aircraft. By providing construction data and other important information, Switzerland will be given complete and independent control of the EUROFIGHTER."

Photo: SRF

For many years now, Swiss Defence Minister Viola Amherd has tried to rejuvenate the Swiss AF fleet.

Controversial Discussions, Heated Debates

Lockheed Martin, with its F-35, also has high hopes to broaden the plane's user base in Europe with Switzerland firmly in its sights. The company's offer includes a basic programme of 36 jets, with options for an additional four aircraft. According to the company, LM is offering one "extra" industrial participation opportunity to Switzerland. For an unspecified additional cost, Switzerland will be able to conduct the final assembly of four F-35 aircraft at the RUAG facilities in Emmen by 2028, allowing the Swiss technicians that currently work on the country's aging HORNET fleet to gain deeper knowledge of the aircraft's design. Switzerland would further have the opportunity to domestically produce about 400 canopies and transparencies for any F-35 aircraft and LM would establish a European hub for the maintenance, repair and overhaul of F 35 canopies and transparencies in Switzerland. Also, the Swiss would be able to purchase parts through the pool shared by all F-35 operators while their offer also contains a six-month deployed spares package, a separate ,"pot" of parts that would al-

Photo: armasuisse

A French Airforce RAFALE at Payerne in 2019

Photo: armasuisse

A USAF F-35A being tested by armasuisse officers in Payerne

ways be managed locally to meet Swiss autonomy operational requirements. The same applies for "certain" engine and airframe refurbishment projects. It has to be added that the selection of F-35s triggers the most controversial discussions, since in heated debates, many in politics and in media circles refer to the aircraft as a striker. On the other hand, it would be fully logical if, in an acquisition foreseen for 30+ years, with the latest technology, and with an impact on the entire military sector would not be pursued or assessed by the Air Force evaluators. An important point here could be last year's recognition by the F-35 Joint Programme Office (JPO) that – after years of painful patches, LM's ALIS maintenance platform no longer offers a stable basis for the long-term operation of the F-35 and a new cloud-based and government owned Operational Data Integrated Network (ODIN) is announced for December 2022.

Boeing has meanwhile positioned its offer of an F-18E/F SUPER HORNET (Advanced) fleet as a logical extension of Switzerland's existing F-18 infrastructure. As an F/A-18 operator, Switzerland would have the option to reuse up to 60% of existing physical and intellectual infrastructure, making the transition easier and more cost effective over the service life of the aircraft. As regards costs, the company adds that their offer would "easily fit within Switzerland's current F-18 operating budget." Regarding offsets, one has ""reached out to 100 current and new partners across Switzerland." One aspect seen as a true surprise in several media outlets and other forums, was the fact that after US notifications, the same number of F-18E/Fs would be US$870M more expensive than the F-35s. But that may – partly - be explained by the variety and amount of ordnance involved.

France's Dassault, with its offer of the RAFALE-F4 - mentioned by many Swiss interlocutors to ESD as the "secret champion - is the only vendor keeping tight-lipped. Citing only a commitment to confidentiality, a spokesperson told reporters after the final bids were delivered, that "the company had no plans to characterise its offer nor the nature of the relationship between the Swiss and French governments to that end." Since then – no public message has been heard.

The latest developments were clarification visits to authorities and industrial partners in Paris, Berlin and Washington up to the end of January by armasuisse head, Martin Sonderegger, Peter Winter and BodLuv project leader Markus Graf. Currently, the evaluators are supporting the political process regarding the two decisions, which are to be implemented in the so-called "Army message 2022' by the end of 2021. This means that contract negotiations need to be finalised by then. Deliveries are expected between 2025 and 2030.

Indirectly connected to the fighters is another Swiss Air Force project called "Silenzio", which looks to support national airspace radar coverage with sensors and software of a truly passive system. It is not known, however, if "usual" providers like the Czech ERA, Saab or Hensoldt have already been consulted.

Round the Clock Service

By the very end of 2020, the Swiss Air Force established a 24h QRA-readiness capability with two armed F/A-18C/Ds operating at a maximum of 15 minutes notice to get airborne at any time in Swiss airspace. This has been subject to a parliamentary motion since 2009 and for that reason, 100 extra functions and an additional EUR28M per year has been provided. Neighbouring Austria is now - as far as ESD is aware - the last country in Europe with no 24h QRA capability.

Rotory Renewal

Until mid-2022, RUAG, for a total of CHF168M, is extending the service life of eight Swiss Air Force COUGAR helicopters by modernising their flight-management computers, precision navigation and communication systems, new radios, helmet displays and IDAS-3 self-defence kits. Fifteen older SUPER PUMA platforms already underwent a similar upgrade before 2014. Following that contract, RUAG seems to be withdrawing completely from any defence business in order to focus on the space sector. Subsequently, it has recently given away all MROs on military helicopters at Oberpfaffenhofen to General Atomics Europe (HQ in Dresden). This step incidentally also creates some doubts about LM's proposal to implement the final assembly of F-35s at any of RUAG's facilities. ■

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ARQUUS

HAMMERHEAD, QUICKSTRIKE and More

US Navy Offensive Mine Warfare Programmes

Sidney E. Dean

With the end of the Cold War, the US Navy (USN) considered offensive mine warfare a low-priority capability. The resurgence of great power rivalry and the strengthening of Russian and Chinese naval forces have required a reassessment.

The USN is currently upgrading its offensive capabilities by developing and introducing new mine systems and enhancing current systems. Like legacy mine technology, the new and future ordnance will be designed to attack both surface ships and submarines. The most promising concept of operations remains targeted deployment of mines in coastal and maritime straits and near egress routes from naval bases. Such deployment would constitute an anti-access/area denial strategy and either bottle up enemy naval forces or channel hostile warships into specific waters. Ideally, this would force enemy ships into kill zones within range of US and allied missile and air forces, but prevent enemy ships from targeting US task groups.

Slide: USN

This briefing slide presenting current and future offensive mine systems was published in January 2020.

Current Offensive Mine Warfare Capabilities

The current US sea mine arsenal consists of the QUICKSTRIKE family of air-launched mines and the Mk 67 SLMM system (Submarine Launched Mobile Mine). All of these mines are suitable only for deployment in shallow waters (12 to 60 metres depth). Once deployed into the target zone, all come to rest on the sea floor to lie in wait – if need be, for prolonged periods. As influence mines, they react to the acoustic or magnetic signature of enemy vessels or to changes in water pressure caused by the passage of a vessel. The integral Mk 71 Targeting Detecting Device (TDD) of these mine systems utilises different sets of algorithms for different vessel classes in order to optimise targeting; it is also capable of differentiating between actual vessels and decoys or countermeasures.

The QUICKSTRIKE family of mines consists of three variants, the Mk 62 (500 pound/227 kg class), the Mk 63 (1,000 pound/455 kg class) and the Mk 65 (2,000 pound/907 kg class). The two smaller types are based on converted general-purpose gravity bombs outfitted with batteries, sensors and control systems to identify and classify targets and initiate attack. The Mk 65 is a clean-sheet design, and utilises a thin-walled mine case rather than a bomb body. Introduced in the 1980s, the QUICKSTRIKE family was upgraded with new target detecting and arming devices and new batteries a decade ago. All three variants are deployed by US Navy maritime patrol aircraft, by carrier-based tactical aircraft, and by US Air Force bombers (depending on the weapons' weight class, a B-52 bomber can carry 20-24 QUICKSTRIKE mines per mission). After release, a drag chute decelerates the mine's descent to prevent damage when impacting the water. Chute-decelerated mines are difficult to deploy accurately, with a sizable percentage drifting off target. This requires the releasing aircraft to fly at low altitudes (approximately 150 metres above the sea surface) and at slow speeds (a maximum of 320 knots), frequently making multiple passes over predictable routes in order to seed a complete minefield. These factors make the deploying aircraft vulnerable to hostile fire.

In contrast, the Mk 67 SLMM system is deployed covertly by attack submarines. It consists of a Mk 37 torpedo outfitted with a 2,000 pound mine warhead, a mine-target detection device, and a long-endurance battery. The weapon is released at sufficient distance to target to avoid detec-

tion of the carrier submarine. The torpedo travels under its own power to the final deployment zone (which could be a port entry or some other narrows), and comes to rest on the ocean floor until activated by the passage of an enemy ship. The SLMM system was introduced in 1987, and is approaching technological obsolescence.

HAMMERHEAD

The SLMM is to be replaced by the HAMMERHEAD mine system. The new ordnance will be deployed by Extra Large Unmanned Underwater Vehicles (XLUUVs) rather than by manned submarines. The Navy cites two reasons for this change. On the one hand, the 16 metre long ORCA XLUUV is still considerably smaller than manned attack submarines, which reduces the risk of detection while delivering mines in contested waters. Secondly, when utilising only machines, the Navy will be able to take greater risks, such as closing in on enemy formations and bases before deploying the mines in order to place the ordnance more precisely and refine its potential impact on enemy movements. In contrast to SLMM, HAMMERHEAD is designed to be deployed in medium to deep waters, making it suitable for operations in strategically significant sections of the North Atlantic and Arctic.

Upon deployment, HAMMERHEAD will anchor on the ocean floor and rest in a vertical posture until activated. As described by the USN, the HAMMERHEAD system will be composed of a minimum of six modules enclosed in a containment tube. At the bottom is the mooring module which anchors the mine to the ocean floor. It is followed by the energy module which contains the long-endurance battery. Next in line is the Command, Control, Signal Processing, and Decision module, which constitutes the "brain" of the weapon system. This brain is followed by the capsule module which constitutes HAMMERHEAD's "heart" or core. It takes up approximately two-thirds of the entire containment vessel, and holds the weapon system's actual effector, a Mk 54 lightweight torpedo around which the entire HAMMERHEAD architecture is designed. Side-by-side atop the capsule module rest the antenna-like communications module and sensor module. The modular design of the weapon system ensures that individual components can be upgraded at any time with newest technology.

Photo: USN

The 2,000-pound QUICKSTRIKE Mk 65 mine was introduced in 1983.

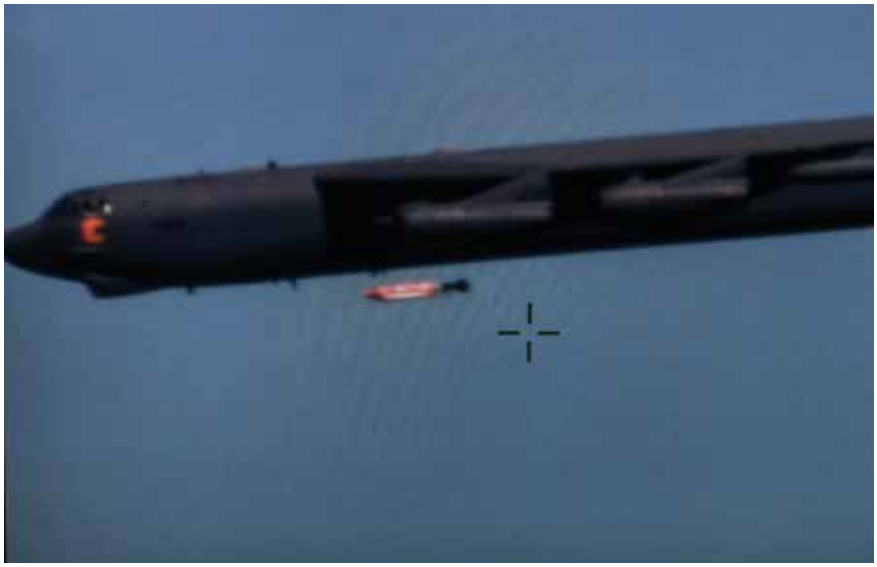
Once anchored in place, the weapon enters a passive state to preserve energy. This enables it to remain functional for several months. HAMMERHEAD can be programmed to remain passive until remotely activated, which would allow the Navy to proactively station mines in expectation of a conflict. Alternately, the weapon can be set to activate automatically when sensors detect and autonomously identify the signature of enemy ships, boats or submarines. Once a legitimate target has been positively identified, an intercept course is calculated and the torpedo is launched when the target is in the optimal position.

The control system can be programmed in advance to only react to a certain class of vessel, permitting other warships to pass by. According to the USN, the weapon system will primarily target enemy anti-submarine warfare (ASW) forces including attack submarines and advanced unmanned underwater vehicles. One potential tactic would be for an ORCA to deploy several mines, then deliberately transmit acoustic or electronic signals mimicking those of a manned submarine or surface ship in order to lure enemy submarines into the mines' path. The fact that HAMMERHEAD launches a fully functional torpedo as the effector enables the mine to be deployed at a greater distance and in a greater variety of locations near the kill zone, reducing the likelihood that enemy sweeps will detect the mine. A January 2021 report by the Pentagon's Director, Operational Test and Evaluation, described the Mk 54 lightweight torpedo as the US Navy's most capable ASW weapon. The Mk 54 Mod 1 currently in service has a cruising speed of 40 knots and a range

Photo: USN

A QUICKSTRIKE-ER Mine in underwing carriage by a B-52 bomber. To prevent damage to the JDAM-Er tail assembly the mine is carried upside down. The folded wings of the JDAM-ER kit are clearly visible.

Photo: USN

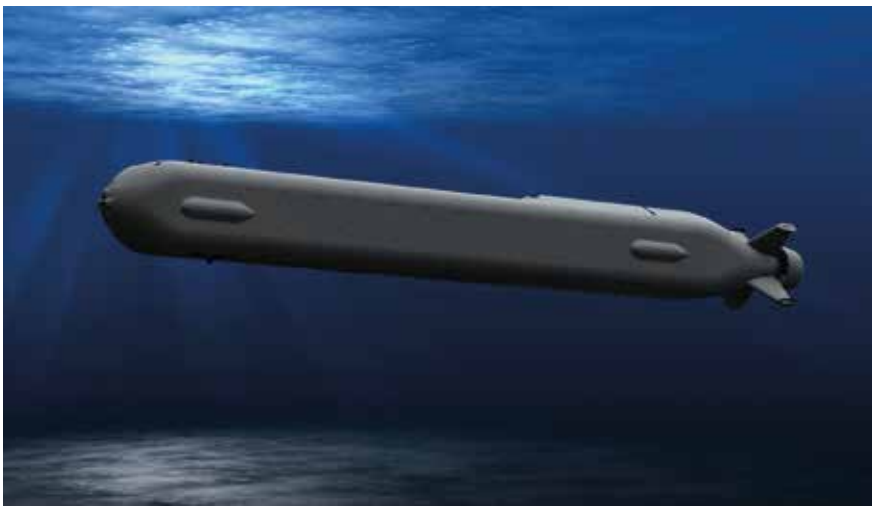


A B-52 bomber launches a QUICKSTRIKE-ER mine.

Photo: USN

A QUICKSTRIKE-ER Mine in flight over the Pacific.

Photo: Boeing



The future HAMMERHEAD mine system will be deployed by the ORCA extra-large unmanned underwater vessel (XLUUV) depicted here in a concept image.

of 9,000 metres. A performance-enhanced variant designated Mk 54 Mod 2 is expected to be fielded in 2026.

Development and procurement of HAMMERHEAD is a high-priority project. It was initiated in 2018, and was designated as both a Maritime Accelerated Acquisition Programme and an Acquisition Rapid Prototyping Programme in 2019. In April 2020, the USN conducted a virtual Industry Day with representatives of 16 defence and technology firms to discuss the capabilities profile and concept of operations. The results of this discussion flowed into the competitive Request for Proposals (RfP) which was released on 5 January 2021, with a response due date of 22 March 2021. The RfP was released by the Naval Sea Systems Command (NAVSEA) Programme Executive Office Unmanned and Small Combatants (PEO USC), Mine Warfare Programme Office (PMS 495), which is responsible for all mine development and procurement programmes. Contracts for the prototype design and testing phases are to be awarded by the end of fiscal year 2021 (31 September 2021), potentially to multiple firms. The RfP calls for five prototype units per contractor to be delivered for evaluation 24 months after contract award.

QUICKSTRIKE-ER

For the time being, the Navy wants to retain the QUICKSTRIKE air-launched family of mines, but is applying new technology to enhance operator safety and weapon performance. This includes awarding a contract in 2018 to Pennsylvania-based Sechan Electronics for upgraded Mk 71 Mod 1 target detection devices and adaptors.

The most significant development, however, is the decision to equip QUICKSTRIKE mines with the Joint Direct Attack Munitions (JDAM) kit. Produced by Boeing, the standard JDAM kit introduced in 1997 consists of an add-on empennage or tail assembly which incorporates an INS/GPS navigation system; it serves to convert gravity bombs into precision guided (but still unpowered) munitions. In 2012, Boeing introduced the JDAM-ER (Extended Range) variant, which includes two folding body strakes to provide extra lift and stability.

QUICKSTRIKE mines equipped with the standard JDAM system are designated as QUICKSTRIKE-J. Benefits include a flattened glide path which provides for a gentler splashdown, enabling aircraft to release mines from a higher altitude. Glide range is increased to a maximum of 15 nautical miles. Accuracy is also significantly improved over the standard QUICKSTRIKE configura-

Photo: USAF.

The basic concept of the HAMMERHEAD mine is similar to the CAPTOR mine used by the US Navy 1979-2001. The CAPTOR mine was designed to target soviet submarines. It consisted of a Mk 46 torpedo inside a container tube which was anchored to the ocean floor.

Photo: USN

The Mk 54 light torpedo is the planned effector of the HAMMERHEAD mine.

Boeing is developing a JDAM variant incorporating a small jet turbine engine.

tion. The Circular Error Probability (CEP) is reduced to ten metres. These improved parameters enable a large aircraft to seed an entire minefield with one pass, saving time and reducing exposure. The JDAM guidance kit permits mines to be laid in specific but unpredictable patterns, further complicating the adversary's minesweeping operations.
Mines equipped with the extended range kit are designated as QUICKSTRIKE-ER. The body strakes mounted at the mine's midsection significantly increase deployment range to 40 nautical miles when released from 10,770 metres altitude. Depending on the state of enemy air defences, US aircraft might even be able to seed an opposing force's harbour entrance or the mouth of a river or bay from standoff distances using the ER variant.

Future Air-Deployed Mine System

While the JDAM-ER kit will significantly enhance the QUICKSTRIKE family's versatility, this may not be enough for the Pentagon. Future conflicts against sophisticated adversaries, whether major powers or smaller but well-equipped foes, are likely to require greater standoff ranges for deploying mines. For this reason, NAVSEA issued a Request for Information (RfI) regarding the potential for long-range aerial delivery of maritime mines. The RfI was issued in August 2020 "to determine whether industry possesses the requisite capabilities to successfully design, manufacture, assemble, test and deliver a long-range air delivered maritime mine."
The RfI cites minimum performance parameters which include delivery of a 500 pound explosive payload over a distance of 100 nautical miles; objective performance would entail delivery of a 2,000 pound explosive payload over a distance of 100 nm. The Navy agreed that any proposed design concepts may utilise the target detecting, safety, and arming devices currently utilised on the QUICKSTRIKE family of mines.
Some potential techniques for enabling these enhanced performance parameters might include carrying the mine inside a cruise missile or strapping wings and a jet engine onto an existing mine. Boeing has already conducted wind tunnel tests of a JDAM-ER augmented by a compact turbojet engine; such a configuration is widely expected to provide the weapon with a 200 nm range.

Reactive Mining

The more flexible mine delivery technology and tactics become, the more options theatre commanders will have at their disposal. This will be especially vital when operating in theatres close to enemy territory, such as the Black Sea or Baltic region or in the South China Sea. One potential innovation has been termed "reactive mining". The term describes the short-notice aerial deployment of minefields upon sighting of hostile naval forces in suitable waters, such as littoral zones, straits, or archipelagos. Forward deployed bomber detachments could conceivably cut off entire enemy task groups, or significantly delay their progress. At some future point, unmanned aerial vehicles could be an alternate to delivery by manned aircraft. The combination of new delivery methods, greater delivery range, and innovative operational concepts places US armed forces at the door to a renaissance of offensive mine warfare which could have a tactical or strategic impact not seen since the mine warfare of the Second World War. ■

European Field Artillery Technologies

Christopher F. Foss

After many years of neglect, the field artillery arms of many European countries are being upgraded with new platforms that are capable of firing enhanced natures of ammunition with greater range and effect.

While 105 mm towed artillery systems are still used by some European countries, 155 mm artillery systems, towed and self-propelled (SP) are the most widely used in Europe and 155 mm is the main area of investment. Some countries still deploy 155 mm towed artillery systems but there is a clear trend to the deployment of SP artillery systems as these can come into and be taken out of action much more quickly and are therefore more survivable against counter battery fire.

While the traditional role of artillery has been that of suppression of threat forces, operational experience in the Ukraine has shown that artillery caused more losses of armoured fighting vehicles (AFV) and other platforms than any other weapon deployed on the battlefield, including anti-tank guided weapons (ATGW).

Photo: KMW

Krauss-Maffei Wegmann PzH 2000 155 mm/52 calibre is the only conventional tube artillery system deployed by the German Army and is now back in production for the third time.

Tracked Platforms

The German Krauss-Maffei Wegmann 155 mm/52 calibre PzH 2000 is the only conventional tube artillery system deployed by the German Army with export sales having been made to Croatia (ex German Army stocks), Greece, Italy (with most manufactured under licence by the now Leonardo), Kuwait, Lithuania (ex German Army stocks, Netherlands and Qatar. Production has started again to supply 24 PzH 2000 to Hungary as part of a major package that also includes LEOPARD 2A7 series main battle tanks (MBT). PzH 2000 was developed over 30 years ago, with first production systems completed in 1998 for the Germany Army. To extend the operational life of German Army PzH 2000 a mid-life upgrade is planned that will replace obsolete subsystems as well as greater automation so the crew can be reduced. Today, the 155 mm fuzed projectile is loaded automatically with the Rheinmetall Modular Charge System (MCS) loaded manually. While it was expected that the PzH 2000 would become the standard NATO 155 mm/52 calibre tracked SP artillery system, this has not occurred and the South Korean Hanwha K9 THUNDER 155 mm/52 calibre SP system has been sold to Estonia, Finland, India, Norway, and Poland (chassis), with Turkey manufacturing its own version under the name of the FIRTINA.

For many years, the US-designed 155 mm M109 was the mainstay of NATO field artillery units with the upgraded version being fitted with a 155 mm/39 calibre barrel. It is still used by some countries in Europe and Switzerland who upgraded theirs with a 155 mm/47 calibre barrel. Rheinmetall and Leonardo have developed upgrade packages for the M109 which included a new 155 mm/52 calibre barrel, but none of these have entered service.

The British Army still deploys the now RBSL AS90 with a 155 mm/39 calibre barrel and this was tested with a 155 mm/52 calibre barrel and MCS but in the end this never entered service. The British Army has a programme to replace its AS90 under the Mobile Fires Platform (MFP) programme which is expected to be a 155 mm/52 cal SP weapon, tracked or wheeled. The 155 mm ammunition, charges, limber and fire control system (FCS) are separate projects within the Close Support Fires Programme. If all goes to plan, 135 MFP are expected to be procured for four regiments for deployment with the two armoured infantry brigades and the future strike brigades. The UK will retain is 105 mm LIGHT GUNS used by air assault and commando regiments.

Author

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

Nexter, land defense architect and system integrator in France, is a major reference in armored combat systems, artillery, and in the ammunition field. Nexter designs innovative solutions for land, air, sea and security forces, in order to bring French and foreign armed forces a decisive operational advantage.

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Photo: Christopher F Foss

The Turkish FIRTINA 155 mm/52 calibre SP howitzer is based on the South Korean K9 THUNDER and shown here with ammunition resupply vehicle to rear.

Photo: Nexter

The French Nexter CAESAR (8x8) 155 mm/52 calibre artillery system is based on a Tatra 8x8 chassis with a protected forward control cab, with Denmark being the launch customer.

Photo: Christopher F Foss

The French Army CAESAR 6x6 155 mm/52 calibre SP artillery system with protected cab can be loaded aboard A400M transport aircraft.

Wheeled Platforms

There is a trend towards the fielding of wheeled SP in Europe, with the French Army being the first with the Nexter CAESAR 155 mm/52 cal system which was originally developed as a private venture. This is based on an Arquus (6x6) platform and 72 production systems have been delivered to the French Army plus five prototypes with additional orders expected. CAESAR is deployed by Indonesia, Saudi Arabia (on Mercedes-Benz 6x6 platform) and Thailand. More recent customers include Czech Republic and Denmark. The latter are on a Tatra (8x8) platform and fitted with a fully protected cab and an ammunition loading system. The baseline CAESAR only carries 18 x 155 mm projectiles and charges while the 8x8 can carry at least 30.

The Krauss-Maffei Wegmann ARTILLERY GUN MODULE (AGM) was originally shown installed on a GDELS Santa Barbara Sistemas tracked chassis with the complete system being called the DONAR, but so far this has not been adopted. AGM is now being offered on other platforms including the BOXER (8x8) Multi-Role Armoured Vehicle (MRAV) with this combination called the REMOTE CONTROLLED HOWITZER 155 (RCH-155). This has been developed as a private venture but is expected to be procured by the German Army in the future. The 155 mm/52 calibre weapon is laid onto the target by the crew by remote control and carries 30 rounds of 155 mm ammunition plus associate charges which compares to 60 rounds of 155 mm ammunition and MCS carried by the larger and heavier PzH 2000.

The Swedish BAE Systems Bofors FH-77 BL52 ARCHER 155 mm/52 calibre (6x6) SP artillery system was originally developed to meet the requirements of Norway and Sweden but in the end Norway pulled out and ordered the South Korean tracked K9 THUNDER 155 mm/52 cal system. ARCHER is based on a Volvo 6x6 A30 articulated loader which has a high level of cross-country mobility with the fully enclosed protected cab at the front and the 155 mm/52 calibre ordnance at the rear which is fed by an automatic loader with which holds 21 x 155 mm projectiles 126 charge modules. A total of 48 ARCHER were ordered, 24 for Norway and 24 for Sweden but as of early 2021 Sweden will take 36 with the remaining 12 for sale. To meet potential export requirements, late in 2019 ARCHER was shown integrated onto the rear of the German Rheinmetall MAN Military Vehicles HX52 (8x8) plat-

form with first firing trials taking place early in 2020.

Having taken over Soltam, Elbit is also a manufacturer of artillery systems. In addition to providing the complete artillery weapon and its ammunition, it can also provide the key command and control and target acquisition systems. The company has developed the ATMOS (Autonomous Truck Mounted Howitzer System) which has been integrated onto a variety of 6x6 and 8x8 platforms and with sales already made to a number of countries including Azerbaijan, Botswana, Cameroon, Rwanda, Thailand and Uganda. This is normally fitted with a 155 mm/52 calibre ordnance but there are also other alternatives including 155 mm/39 and 155 mm/45 calibre barrels or even the 130 mm barrel from the Russian M-46 towed artillery system. A 155 mm/52 cal system has been developed to meet requirements of the Israel Defense Force.

Serbia has been self-sufficient in artillery systems for many years and sold its NORA B52 155 mm 8x8 series to Cyprus, Bangladesh, Kenya and Myanmar. This is based on an 8x8 cross-country chassis with a fully protected forward controlled cab and the turret installed at the rear with 36 155 mm projectiles and associated charges and a computerised FCS. The latest version is called the ALEXANDAR 155 mm MGS-25 and is also based on a 8x8 platform but with the remote controlled module (RCM) turret at the rear armed with a 155 mm/52 calibre ordnance and 12 projectiles and associated charges. Once these have been fired, the RCM is traversed and reloaded again from the magazine located to the rear of the protected cab with a similar number of projectiles and charges.

Foto: Bundeswehr

The Remote Controlled Howitzer (RCH-155) is essentially the Artillery Gun Module integrated onto the rear of the BOXER (8x8) MRAV platform.

Photo: Christopher F Foss

The latest Serbian Yugoimport ALEKSANDAR 155 mm/52 calibre MGS-25 SP artillery system with ordnance elevated and stabilisers deployed

While there is a trend to wheeled SP artillery systems, it is worth mentioning that the former Czechoslovakia developed the 152 mm DANA SP artillery system based on a Tatra 8x8 platform with the protected cab at the front, turret in the middle and protected power pack at the rear and this was built in large numbers for the home and export markets. Following the end of the Cold War, Slovakia continued development which resulted with the fielding of the 155 mm/45 calibre ZUZANA and this is now deployed by Cyprus and Slovakia. This was followed by ZUZANA A2 and has a similar layout but based on the latest Tatra 8x8 chassis armed with a 155 mm/52 calibre weapon with a total of 40 projectiles and associated charges.

Early in 2021, Excalibur of the Czech Republic revealed the DITA 155 mm/52 cal functional demonstrator which has a similar layout but the turret is armed with a 155 mm ordnance with an automatic ammunition handing system operated by the crew in the protected front cab.

Photo: NAMMO

The Norwegian company of NAMMO has developed a new family of 155 mm ammunition with a more streamlined design which can be fired from 155 mm/52 cal systems with systems like ARCHER.

Ammunition

Main natures of 155 mm have typically been high-explosive (HE), smoke and illumination and these are still widely used.

An increasing number of countries are insisting that their ammunition is insensitive munition (IM) compliant. To achieve longer range, hollow base (HB) or rocket-assisted projectiles (RAP) can be used, although as range increases so does dispersion. Another longer range projectile is the Extended Range Full Bore Base Bleed (ERFB BB) first fielded by South Africa.

NAMMO Norway has developed and placed in production a family of more streamlined 155 mm projectiles with the IM HE-ER designated the NM 269 which also features an interchangeable BB or hollow base (HB) unit.

In Spain, EXPAL is now in production of their ER02A1 155 mm extended range projectile with a maximum range of up to 40 km and is also working on precision guidance kit for 120 mm mortars which will be followed by one for 155 mm artillery projectiles.

Nexter has been working on their 155 mm KATANA precision guided projectile with the Mk1 featuring a Inertial Measurement Unit/Global Navigation Satellite Guidance (INS/GPS) which will have a range of up to 60 km with a CEP of under 10 m. Late in 2020, first test firings were carried out to demonstrate its flight control capability.

Under development are Ramjet 155 mm artillery projectiles which will have much longer range but carry less explosives, with NAMMO being the first in Europe to announce their projectile.

Artillery projectiles are used for suppressive fire. To increase accuracy and reduce collateral damage, they can be fitted with a nose-mounted guidance kit. Market leader is the US Northrop Grumman M1156 Precision Guidance Kit (PGK) of which over 65,000 have now been manufactured. This was first deployed by the US Army and Marine Corps with first export customers being Australia and Canada for use with their BAE Systems 155 mm M777 series lightweight howitzers. It can be fitted to 155 mm artillery projectiles with a standard NATO fuse well. According to Northrop Grumman, their PGK has been tested in a number of European SP artillery systems including PzH 2000, ARCHER and AS-90.

Nexter Munitions has completed development and trials of their SPACIDO course correction system for 105 mm and 155 mm artillery projectiles.

IAI has developed and placed in production the TOPGUN precision strike artillery fuse which is claimed to provide an ac-

Tactical Muzzle Velocity Radar

Weibel's Muzzle Velocity Radar Systems (MVRS) were introduced in 1992, and has since then been in service with some 30 countries and on more than 4.500 howitzers and other gun systems. The MVRS-700 series radars are small and ruggedized radars meant for installation on the weapon itself. The system measures velocities from 30 to 3.000 m/s and is designed to be mounted on tanks, howitzers, mortars and naval gun systems, interfacing directly to the fire control system (FCS).

Many parameters, such as temperature, humidity and barrel conditions influence muzzle velocity. It is pivotal to compensate for these parameters and improve accuracy and reduce dispersion by adjusting individual gun settings according to precisely measured muzzle velocity.

The radar system consists of an antenna with an integrated processor and an optional display unit placed near the gun commander. The antenna unit contains all necessary electronics and the acoustic trigger. The measured Doppler signals are digitized by the processor and analyzed immediately after recording. The result is available less than two seconds after fire, and the result can be sent simultaneously to an FCS in order to adjust fire automatically.

The MVRS-700 series comes with a number of unique optional features for enhanced performance:

- No need for calibration in entire system life cycle since the system is self-calibrating.
- Motion compensation for optimal precision in velocity measurement.
- Variable frequency to avoid interference from other guns.

Whether mounted on legacy systems or modern state of the art systems, the MVRS will reduce the number of rounds spent on non-effective firing due to normal dispersion – and it reduces the risk of collateral damage and blue on blue fires. This means that it takes lesser rounds to achieve the desired terminal effect and the crew can leave their vulnerable firing position faster. The MVRS will have an improving effect on legacy ammunition even when used on modern weapon systems.

Danish Army M109A3 with MVRS-700C

Photo: Morten Barker

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curacy "better than 20 m Circular Error of Probability at any range. "
To enable armoured targets to be engaged, 155 mm artillery projectiles carrying sub-munitions fitted with a small high-explosive anti-tank (HEAT) warhead to neutralise the vulnerable upper surfaces of armoured vehicles were manufactured in large numbers. These are no longer deployed by many countries following the signing of the Ottawa convention.
There two major European 155 mm top attack projectiles, BONUS and SMArt 155. BONUS was originally developed to meet the requirements of France and Sweden with two production lines, one in France by Nexter Munitions and one in Sweden by BAE Systems Bofors and carries two sub-munitions. BONUS has since been adopted by other countries in Finland, Norway, and Saudi Arabia and more recently by the US Army who placed its contract for BONUS Mk 2 through the NATO Support and Procurement Agency (NSPA) with deliveries underway.
The SMArt 155 mm was developed to meet the requirements of Germany by GIWS, a joint venture company between Diehl and Rheinmetall. In addition to the German Army, sales have also been made to other countries including Australia, Greece and Switzerland. The production line is now being re-established and new projectiles will have some improvements as well as replacement of obsolete sub-systems. They are expected to be qualified from 2022 onwards.

Photo: via author

Italian 155 mm VULCANO Ballistic Extended Range projectile as it would appear in part of its flight without sabots

Photo: Rheinmetall

Production of the German SMArt 155 mm top attack artillery projectile will start in the future to replenish German Army stocks. This carries two sub-munitions.

To engage high value targets at longer range, Leonardo have completed development and industrialisation of the VULCANO 155 mm ballistic Extended Range (BER) unguided artillery projectile which has been type classified by the Italian Army. Leonardo is working with the German company of Diehl for a semi-active laser (SAL) version of the VULCANO which would have a maximum range of 80 km when fired from a 155 mm/52 cal weapon. As of late February 2021, both of these are at Technology Readiness Level 8 (TRL 8).
The US Army and Marine Corps have fielded the Raytheon EXCALIBUR M982 series 155 mm precision guided munition (PGM) for many years. In early March 2021, Raytheon confirmed that international users include Australia, Canada, India, Jordan, Netherlands and Sweden. Raytheon also confirmed EXCALIBUR compatible 155 mm artillery systems include ARCHER, AS90, CAESAR, G6 K9 THUNDER, M777, M198, M109 series and PzH 2000. By March 2021, more than 14,000 EXCALIBUR had been manufactured, with the latest EXCALIBUR Ib being the current production model. Since it was first fielded, Excalibur has been continuously developed, with recent developments including Excalibur Shaped Trajectory (EST) and Excalibur S which is laser guided. According to Raytheon, over 1,400 Excalibur have been fired in combat.
Conventional bag-type charges have given way to MCS which reduce waste and can be used with automatic loading systems to reduce crew numbers and increase rates of fire.

The Future

While there are a number of different tube artillery systems in Europe, the only significant one for the future is the Future Indirect Fire System (FIFS) which is a potential follow-on by France and German to replace currently deployed PzH 2000 and CAESAR.
Liquid propellant artillery weapons did have much potential but in the end these fell by the wayside.
Today, 155 mm/52 calibre systems with a chamber volume of 23 litres are standard and meet the Joint Ballistic Memorandum of Understanding (JBMoU).
The US is developing the 155 Extended Range Cannon Artillery (ERCA) which will be back-fitted to the M109A7 as well as a new suite of ammunition.
Rheinmetall has also stated that it its developing new longer-range 155 mm artillery systems for the future and the joint venture of Rheinmetall Denel Munitions (RDM) has a track record in 155 mm artillery projectiles and MCs. Late in 2019, a PzH 2000 firing a RDM 155 mm Assegai M2005 Velocity-enhanced Long-range Artillery Projectile (V-LAP) and a new top charge achieved a range of 66.943 km.
While there emphasis placed on achieving longer range, target acquisition is still the key whether this is achieved by forward observers (shorter range), acoustic detection systems, locating radars, unmanned aerial vehicles, fixed or rotary wing aircraft. ■

The Need for Power

Batteries versus Fuel Cells for Unmanned Aerial Vehicles

John Antal

The modern weapons of war are thirsty for electrical power. Hybrid engines and all-electric motors promise to be the future of commercial and military systems, but due to cost of replacing entire fleets of vehicles, and the reliability of petrol and diesel engines, most military forces will be tied to internal combustion technology for many years.

Small Unmanned Aerial Vehicles (UAVs), however, offer an exception. These weapons are playing an increasingly critical role in combat operations and are mostly powered by batteries. For these systems, staying in the air and operating for hours, rather than minutes, can be the difference between mission success or failure. Extending the flight time of small UAVs, therefore, is becoming a priority. There are two primary means of providing electrical power for small UAVs: batteries that store electrical energy or fuel cells that generate electrical power.

Batteries

Today, Lithium ion (Li-ion) batteries power nearly every rechargeable device you own, and they are also the most common battery used by small UAVs. According to the Clean Energy Institute at the University of Washington, a Li-ion battery "is an advanced battery technology that uses lithium ions as a key component of its electrochemistry. During a discharge cycle, lithium atoms in the anode are ionized and separated from their electrons. The lithium ions move from the anode and pass through the electrolyte until they reach the cathode, where they recombine with their electrons and electrically neutralize. The lithium ions are small enough to be able to move through a micro-permeable separator between the anode and cathode." The advantage of Li-ion batteries is that they have the highest energy density per weight of any other battery. In addition, Li-ion batteries are commercially available and are the key power source for electric automobiles.

Elon Musk, the CEO of Tesla, has pledged to develop improved Li-ion batteries for his electric cars. In September 2020, Musk promised to automate production of his newly designed "tab-less" 4680 Li-ion Battery Cells. Batter "tabs" are metallic components welded onto battery electrodes. With the new tab-less design, the electrons inside the battery experience less heat and resistance. According to Tesla's 4680 patent: "Current cells use a jelly-roll design in which the cathode, anode, and separators are rolled together and have a cathode tab and an anode tab to connect to the positive and negative terminals of the cell can. The path of the current necessarily travels through these tabs to connectors on the outside of the battery cell. However, ohmic resistance is increased with distance when current must travel all the way along the cathode or anode to the tab and out of the cell. Furthermore, because the tabs are additional components, they increase costs and present manufacturing challenges." The new 4680 tab-less battery will provide five times the energy, six times the power, and 16% greater range than the battery currently used in Tesla cars. This new high-density 4680 Battery Cell is projected to

Photo: US Air Force, Staff Sgt. Rachel Simones

Three small unmanned aerial vehicles (UAVs) fly at Edwards Air Force Base. Most small UAVs are battery powered. To extend range and endurance, UAVs are now using hydrogen fuel cell technologies.

Author

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Photo: Tesla

Tesla's future 4680 battery cell with 6X more power, 5X more energy, and 16% more range.

cost less than current batteries because of Musk's plans for streamline manufacturing and large-scale production. This is good news for Tesla automobile customers, as it will reduce the price of electric cars, and it is also good news for the military. As Li-ion batteries improve in the commercial sector, they will become more available and less expensive to power military systems. The 4680 battery, or similar designs, could increase range and capability for small UAVs. This new battery technology, however, is still years away. There are thousands of small UAVs that military forces need to upgrade right now, not in 2023 or 2024. To keep small UAVs flying and operating longer, we need an alternative power source.

Fuel Cells

To extend small UAV endurance, hydrogen fuel cells provide an immediate solution. Fuel cell technology can be two to three times more efficient than internal combustion engines and generate three times more energy density than Li-ion batteries. Hydrogen fuel cells convert hydrogen and oxygen into water and, in the process, produce electricity and heat as long as fuel is supplied. A fuel cell consists of a negative electrode (or anode) and a positive electrode (or cathode) that is sandwiched around an electrolyte. A small hydrogen fuel tank attached to the UAV provides the hydrogen while and oxygen is pulled from the atmosphere. The problem with fuel cells is the availability of pure hydrogen gas. You cannot just pull it from the surrounding air. Although hydrogen may be the most common element found on earth, it is difficult and expensive to capture and store. To be useful, hydrogen is pressurised in steel tanks.

Several companies have made hydrogen fuel cells for small UAVs that significantly extend range and outperform battery systems. One company, Ballard Unmanned Systems Inc., a Southborough, Massachusetts-based company that was recently purchased by Honeywell, launched a turnkey hydrogen fuel cell UAV configuration that can be applied to most existing small UAVs. This system enables small UAVs to fly approximately three-times longer than with the leading battery systems. Another company, Intelligent Energy, produces a hydrogen fuel cell for small UAVs that extends UAV flight time from minutes to hours and allows the UAV to carry a heavier payload. In 2019, Intelligent Energy partnered with South Korean liquid hydrogen specialist MetaVista to create a hydrogen fuel cell that powered a UAV to break the world record for the longest flight time at 12 hours, 7 minutes, and 22 seconds. The MetaVista team used a 6-litre liquid hydrogen cylinder and Intelligent Energy's 800W Fuel Cell Power Module to power the UAV.

Small UAVs will increasingly play an important role in future conflicts by providing both offensive and defensive capabilities. They will be used to gather intelligence, surveillance, and reconnaissance (ISR) information; or could operate in autonomous, networked swarms to attack targets BVLOS; or might be used to defend critical systems to defeat enemy UAVs. To do this, new sources of power to keep small UAVs flying and operating longer are needed. Current battery power systems limit UAV operations, and improved batteries such as the new "tab-less" 4680, are years from production. As Ballard and Intelligent Systems have proven, hydrogen fuel cells provide a viable, and affordable solution to extend the capabilities of small UAVs. For small UAVs that need increased endurance, especially those that need to operate for extended periods or conduct BVLOS operations, fuel cells are the answer. ■

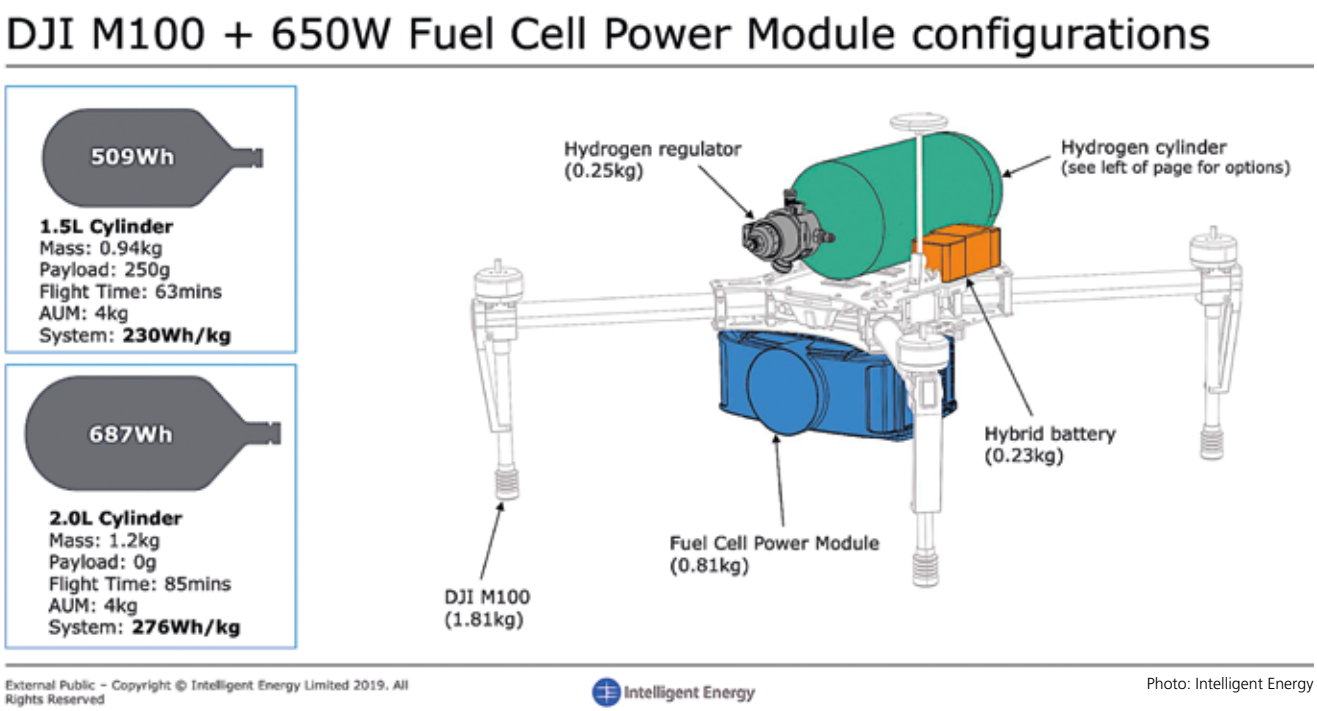

Photo: Intelligent Energy

Intelligent Energy is a world leader in hydrogen fuel cell power for small UAVs. The diagramme above shows the fuel cell configuration for one of their UAVs.

Portable Power Supply for Every Mission

Tom Stuelpnagel

Unbelievable power in a small package: The portable "P2M2" brings all the advantages of fuel cell technology into the field. The modular power management system supplies Special Forces troops with all their power requirements when deployed on missions. It is fully autonomous thanks to a stand-alone power supply and safe as a result of its low-emission power generation.

The major advantages of the fuel cell, which have been well-known for about a decade – especially through their use in German 212A class submarines – have now been implemented on a smaller scale by fuel cell specialist SFC Energy, together with Vincorion.

Whether a long-range reconnaissance patrol (LRRP) team with inflatable boats landing on a foreign coast or a squad of the 2nd Platoon of the German Special Forces Command (KSK) being airdropped into a crisis or conflict area, each unit has to fend for itself. Once in the theatre of operations, the technical equipment is usually activated first – while the LRRP team use their high-end optoelectronics to reconnoitre the situation and explore potential high-value targets, the KSK requires, among other things, a secure radio link: secure means, above all else, remaining undetected and self-sufficient.

Avoiding unwanted contact with the enemy is a top priority for both units as they have to disappear from sight, just like the German Navy's 212A class submarines. Submerged and without the ability to refuel, a polymer electrolyte membrane fuel cell (PEMFC) supplies the vessel with power even while under water.

In addition to their size, the difference between submarines and special operations forces operating on land lies in the amount of power required and the range of equipment demanding electricity. In the submarine, the propeller shaft consumes almost all of the power (306,000 watts of three-phase alternating current). In contrast, the KSK, LRRP, and other mobile ground units require vastly different mission-specific equipment and therefore have varying power requirements. Furthermore, all of them often require direct current (DC), in addition to alternating current (AC).

The P2M2 Portable Power Management Module from Vincorion, known for providing tailored power solutions for military systems on land, sea, and air, solves this problem. The P2M2 is flexible, delivering both direct current (5 to 24 volts) and alternating current (120 to 400 volts) with a peak load of over 10,000 watts.

The fuel cell used in the P2M2 is based on direct methanol technology (DMFC). This means it continuously generates power from methanol with an output of 500 watts, supplying smaller devices directly or charging the P2M2 storage modules for the next peak loads.

Due to its high energy density, 10 litres of methanol are enough to provide 11.1 kilowatt hours of energy. As such, four 10-litre fuel cartridges are enough to operate a device with a continuous energy consumption of 50 watts for more than one month without interruption.

In doing so, it generates virtually zero emissions – just water vapour, some carbon dioxide, and a barely detectable amount of waste heat. Furthermore, the noise level is also negligible and the vibrations emitted by the P2M2 are less than those of a parked truck. The fuel cell as a decentralised power supply also results in other decisive advantages, said Karandeep Singh, Managing Director of FC TecNrgy Pvt Ltd: "Border guards at remote outposts benefit from the significant reduction in weight, reliable operation, and crucial cost and logistics savings compared to the heavy generators previously used."

Photo: Yuri Arcurs

Easy-to-handle: The portable P2M2 Power Management Module moves with the unit each time it changes position.

Photo: Vincorion

The P2M2 system can be configured with a combination of input, output, and storage modules. The fuel cell module generates a constant 500 watts.

In addition to the optional EFOY fuel cell module, a P2M2 system consists of other modules that can be combined flexibly in a 19-inch rack design, including a storage module with over four kilowatt hours, as well as input and output modules – *see Figure 2*.

In addition to its light weight – each module can be carried by a single individual – the P2M2 stands out for its tremendous flexibility and can tap into almost any AC/DC power source like vehicles, unstable local grids, old diesel generators, or mobile solar power systems – the corresponding input module can accept power from any source. In the process, the fuel cell reliably ensures that units are never without power and keeps the modules constantly charged.

In addition, the Portable Power Management Module is absolutely environmentally friendly, meaning that the civilian versions can also be used in disaster relief or in remote nature reserves. This is why Vincorion, as a specialist for propulsion and power systems, has partnered with SFC Energy AG, the world's leading manufacturer of mobile methanol fuel cells, which has already sold over 50,000 fuel cells and received the European Innovation Award this year.

"We are convinced that fuel cells are a worthwhile addition to the electricity supply range for our power solutions," stated Dr. Stefan Stenzel, Managing Director of Vincorion, at the presentation of the one-of-a-kind P2M2 at a symposium held by the German Association for Defence Technology (DWT) last fall.

Fuse and Propellant Developments

Tim Guest

Makers and users of the latest artillery, mortar and naval weapon systems want the very best in ammunition to ensure their platforms deliver the desired on-target effects as effectively and precisely as possible. Fuses and propellants are key parts of this essential equation.

A round of high explosive or any other kind of projectile designed to achieve a certain on-target effect will only be able to do its job if propelled to the target using the correct amount of the right kind of propellant to achieve the desired range, followed, once at the target, by detonation in any number of different, programmable/settable ways, e.g. point detonation or proximity, using the right kind of fuse.
This article looks at a handful of recent developments involving an innovative fusing solution for a naval scenario and the manufacture and delivery of modular propelling charge systems to meet certain artillery requirements.

Photo: Rheinmetall

Rheinmetall's ASSEGAI Series of tactical modular charges will propel artillery shells from any 155mm gun system, with the charge system fine-tuned for specific customer requirements to function optimally with the specific weapon systems and artillery shells involved, for maximum effectiveness.

A Fuse on the Ocean Waves

The last five months have seen the navies of Belgium, the Netherlands, and the UK all announce orders for BAE Systems Bofors 40 Mk4 and/or Bofors 57 Mk3 naval guns. In the most recent of these, BAE Systems has been selected to supply 12 Bofors 40 Mk4 naval guns, six to each of the Belgian and Dutch navies as part of the Mine Counter Measures Vessels (MCMV) programme. Shipbuilders Kership will install the guns on the 12 mine hunting vessels, with the first ship scheduled for delivery to the Belgian Navy in 2024. Lightweight and compact, this naval gun system combines long range and a high rate of fire, giving the mine-hunting vessels a greater level of defence against surface, air, and shore-based threats and expands the number of European nations using the Bofors 40 Mk4, with Finland and Sweden also recent adopters. For the UK Royal Navy's Type 31 frigates, five Bofors 57 Mk3 and 10 Bofors 40 Mk4 guns will be delivered.

Author

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The guns provide optimised ammunition types, including the cost-efficient programmable 3P ammunition, offering user flexibility through the ability to automatically switch between different fusing modes for the ammunition in the face of different threats; engaging different targets traditionally requires switching between different types of ammunition, which takes time and can make the difference between mission failure and success. The 6-mode programmable fuse for the 40 and 57 mm Bofors 3P, pre-fragmented, programmable, proximity-fused ammunition, on the other hand, provides the guns with the highest possible combat flexibility as the fuse can be programmed in six different function modes to provide optimised effect against any aerial, surface or shore target. Each 3P fuse is automatically and individually programmed by a proximity fuse programmer, which continuously receives data from the fire control computer system and, immediately before firing, programmes each fuse to a final, selected mode. This gives naval forces an advanced capability to respond to traditional threats, such as anti-ship missiles, aircraft, ships and shore targets, including those with armour protection, as well as new threats, such as UAVs. The fuse's gated proximity mode suits air defence threats; its gated proximity mode with impact priority suits air defence for large targets where an actual direct impact is a higher probability. Its time mode is suited to small, fast-manoeuvring surface targets and concealed/dug-in, onshore targets. An impact mode suits surface targets, and its armour-piercing mode will be programmed against armoured

surface targets. The fuse's default setting is a standard proximity mode.

Modular Propellant Charges in Europe

Assegai Series propelling charges are part of a recent €25M award by a NATO customer to Rheinmetall for artillery ammunition, which will be fulfilled by the Group's South African subsidiary, Rheinmetall Denel Munition (RDM). Several thousand conventional and extended-range artillery shells of the Assegai Base Bleed and V-LAP family will be delivered, as well as M92 Assegai tactical modular charges. Delivery commenced in December 2020 and is due to be complete by May 2021. The Assegai Series tactical modular charges will propel artillery shells from 155mm gun systems for the customer, with the charge system fine-tuned to function optimally with the specific weapon systems and artillery shells involved for maximum effectiveness. According to the company, there are a number of advantages for users of the Assegai modular charge system; it simplifies logistics and makes handling in self-propelled artillery systems easier for the crew, but it also reduces barrel wear through the incorporation of RDM's Barrel Wear Reducer and produces lower muzzle flash using RDM's Muzzle Flash Reducer. The former results in longer barrel life, the latter makes the artillery system harder for the enemy to detect. Jan-Patrick Helmsen, RDM's CEO said the new uni-modular charges achieve better performance and simplify the logistics, especially in gun systems with automatic loading systems.

Modular charges are something that leading energetic materials specialist, Eurenco, has pioneered for many years with their current complete bi-modular charge systems designed to enhance the performances of modern tube artillery, in terms of improved range, firing rate, no residue and reduced logistics. The company's modular charges are compatible with any 155mm gun (52, 45 or 39 calibre), including the K9 and CAESAR. Its 'Charges Modulaires' TCM 155mm are bi-modular charges including single and multi-base propellants with combustible cases, with almost half a million made per year. In 2017, the company opened a second production line with fully robotized capabilities for the manufacture of its charges making it, according to the company, the largest and most modern production facility in Europe for modular charges. This second modular charge production line – Ligne 2 Charges Modulaires or LI2CM – is highly automated, with three times more robots than line 1 and has an annual capacity of 250,000 modules. LI2CM supports production of supplies for Eurenco's European customers like Nexter Munitions and will also support modular charge exports in wider

Photo: EXPAL

At IDEX 2021, EXPAL Systems highlighted developments in naval proximity fuse solutions, with new proximity fuses for 76mm and 5"/ 127mm munitions to enhance on-board anti-air warfare capabilities, specifically against sea skimming missiles.

Photo: Nexter

CAESAR on display at the Nexter stand at IDEX 21. 70,000 modular charges from Eurenco's Bergerac facility are slated for delivery between 2021 and 2022 to the French Army for use with the CAESAR system.

Photo: BAE Systems

Each 3P fuse is automatically and individually programmed immediately before firing to any one of six modes modes making the 3P round extremely versatile against a wide range of targets.

Europe, Asia, the Middle East and the Americas.

Indeed, Eurenco is halfway through delivering on a contract awarded by Nexter in 2018 for the supply, by 2023, of more than 100,000 REACH-compliant, combustible cartridges and more than 300 tons of high-performance propellant specifically designed for Nexter Munitions' 120mm HE and Armour Piercing Fin Stabilised Discarding Sabot (APFSDS) tank ammunition for the export market. The two companies were already both part of the French excellence team for medium and large-calibre ammunition and already had a longstanding partnership on strategic products, such as modular charges for the 155mm/52 cal CAESAR artillery system, and combustible cartridges and propellants for 120mm HE and APFSDS tank ammunition for the LECLERC MBT.

More recently, the Eurenco-Nexter relationship benefitted from the Bergerac site upgrade when, in 2020, Nexter placed a major order for modular artillery charges within the framework of a contract announced by the French Defence Procurement Agency (DGA) for a total of 70,000 modular charges to be made in Bergerac for delivery between 2021 and 2022 to the French Army for use with the CAESAR artillery system. The modular charges for CAESAR meet NATO JBMoU requirements, making them compatible with all 155mm artillery systems that comply with this standard. These latest modular artillery charges use from one to six modules, depending on the desired range and replace conventional charge bags. With only two types of modules, live and slow charges, this propellant system is much safer to use even when at increased rates of fire, which are aided by the increased convenience of the modular system.

Overall, LI2CM has strengthened the Bergerac site as Eurenco's excellence centre for all its combustible product ranges, from propelling charges, including the modular charges for artillery systems, to combustible cases for tank ammunition and nitrofilm for mortar increments. This most recent contract with Nexter, via the DGA, makes it possible to support and reinforce the production capacity of the French ammunition industry, on French soil, for the benefit of the French armed forces.

Photo: Nexter

Eurenco's 'Charges Modulaires' TCM 155mm are bi-modular charges including single and multi-base propellants with combustible cases and are compatible with any 155mm gun (52, 45 or 39 calibre), including the K9 and CAESAR.

An Energetic Future

Certainly, when it comes to artillery, future propellant and energetic solutions are many. Some will be high-performance, 3D-printed propellants and combustible items that will enhance or moderate their performance parameters, such as combustion rate, burn temperature, behaviour, as well as recycling aspects. These will determine the achievability of longer ranges by latest weapon system platforms, as well as greater on-target precision, and other aspects such as lower barrel erosion. New propellant chemistry and explosive behaviours are being researched and developed further that are very insensitive, without diminishing their performance, while others will suit smaller propellant charges for guided munitions. ■

RPAS Guarding the Seas

J. C. Menon

Early this year, the EU Maritime Safety Agency (EMSA) floated a tender to contract Remotely Piloted Aircraft Systems (RPAS) for €20M. With the latest order, the EU Commission has probably spent at least €500M on the use of drones since 2017 for maritime safety.

The EU has become increasingly active in ensuring a secure global maritime domain. This involves combating threats posed by illicit activities, such as piracy against ships, drug trafficking, smuggling and trafficking in human beings, or illegal fishing, as well as by natural disasters, climate change, or conflict in and around coastal regions.

A Maritime Surveillance Operation

Aiming to test the use of RPAS in enhancing the maritime awareness scenario in the French Mediterranean Sea, the Secrétariat Général de la Mer requested EMSA to establish a multipurpose maritime surveillance operation, having the Navy (Marine Nationale) and Customs Service (Douanes) as the operation's strategic and tactical leaders.

Operational missions which started in September 2020 for an initial period of three months consisted of general maritime surveillance over waters under French sovereignty and jurisdiction in the Mediterranean Sea, encompassing maritime monitoring and surveillance in support of coastguard functions. This included maritime safety and security, supporting further maritime domain situational awareness, fisheries control and law enforcement. The operation also focussed on maritime environmental protection, such as oil spill detection and characterisation, identification of targets possibly connected and offering support to oil spill response where needed.

Photo: Elbit

Elbit Systems recently launched the HERMES 900 Maritime Patrol configuration.

Maritime Awareness

Unmanned aircraft coupled with powerful satellite communications have taken maritime awareness to the next level. Unmanned systems are becoming an increasingly essential part of the world's fleets as modern navies seek new ways to carry out dangerous tasks.

To enable this, besides the US, the UK, Canada, France, Middle Eastern countries, and leading navies in the Asia-Pacific region, are investing heavily in unmanned solutions for maritime missions. The platforms chosen range from the Boeing Insitu-made SCANEAGLE, Northrop Grumman's MQ-4C TRITON, to the Israeli Elbit Systems' HERMES 900 MALE UAV and Israel Aerospace Industries (IAI)-made HAROP systems.

The HERMES System

Recently, the HERMES 900 Unmanned Aerial System (UAS) successfully completed a series of flight demonstrations for the UK Maritime and Coastguard Agency (MCA). The demonstrations were run by the MCA and were designed to test the capabilities of using a UAS to enhance Search and Rescue (SaR) capabilities. In the recent demonstrations, the HERMES 900, equipped with SaR specific radar, an Automatic Identification System (AIS), an EO/IR payload, an Emergency Position-Indicating Radio Beacon (EPIRB) and full satellite communications, was deployed on a range of missions that simulated shoreline rescues, water rescues in dangerous air space and long-distance ship rescues which crossed international air space lines. With a wingspan of 15m, the 1.2 tonne HERMES 900 is already deployed with more than a dozen advanced customers around the globe providing SaR and reconnaissance capabilities.

Elbit Systems offers extended life-saving capabilities with its recently launched HERMES 900 Maritime Patrol configuration with inflated life rafts for detection, identification and saving the lives of survivors at sea. It was revealed that this configuration was delivered to an undisclosed customer in South-East Asia. Interactively controlled from mobile land-based mission systems, fixed operation rooms or own force ships, the HERMES 900 provides multi-sensor data and live video feed in real-time to mission operators and ship crews at sea.

The HERMES 900 UAS can operate in stand-alone mode or can be integrated into an overall set-up of aircraft, ships, shore

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Photo: IAI

The HAROP is a standoff loitering attack weapon system designed to locate and precisely attack targets.

or offshore-based sensors, and maritime control centres and HQ. The HERMES 900 can perform versatile missions such as EEZ monitoring and control, coastal protection, surveillance and protection of vital assets (such as oil rigs), anti-piracy operations, environmental monitoring, SaR operations, as well as participation in Anti-surface warfare (ASuW), Sea-Shore operations, and more, a company official informed.

The HAROP System

Similarly, in February, IAI signed deals to provide loitering munitions systems to Asian countries worth over US$100M. The deals include the sale of the naval version of the HAROP system. The maritime HAROP system provides an operational solution for a range of vessels, from offshore vessels to fighting frigates in the naval theatre. In a complex naval theatre, the HAROP system provides mission commanders in a fleet of ships the capability to independently and organically collect intelligence, assess targets and strike.

The intelligence gathered by the HAROP is directly integrated in the vessel's control room and allows for quick, accurate and lethal decision-making. Use of the HAROP on naval platforms is an operational alternative and a complementary element to using sea-sea missiles, with a wide range of uses and with optimal cost-efficiency.

The maritime and land combat-proven HAROP provides an operational solution for a range of low and high-intensity conflict scenarios and also for anti-terrorism activity. The HAROP is equipped with day/night cameras and has the ability to search, find and attack both static and moving targets with maximum precision, on land or at sea and at a long range. A strike can take place from any direction and at any angle of attack.

Photo: Martin UAV

The V-BAT is a long-endurance aircraft capable of carrying multiple sensors.

The V-BAT UAV

The Defence Research and Development Canada (DRDC) entrusted Kongsberg Geospatial to conduct trials of a new long-endurance UAV surveillance system for the Canadian Coast Guard. The Martin UAV V-BAT aircraft was selected to provide the unique ability to combine take-off and landing from the small confines aboard ship with the long endurance of a fixed-wing aircraft while carrying multiple sensors. "UAVs are a useful tool, but they are only truly effective if they can collect sensor data that results in actionable intelligence," said Ranald McGillis, President and CEO of Kongsberg Geospatial.

The aircraft will communicate with the Kongsberg Geospatial sensor data management system, called MIDAS, which allows a range of sensor data, including full-motion video from unmanned systems to be processed and exploited in near real-time by analysts on board Canadian Coast Guard ships. MIDAS provides the capability to compare historical and live data from the mission area, and to examine sensor data with a variety of tools, including motion and object detection, in near real-time. This analytical capability can greatly enhance the effectiveness of UAVs for a variety of mission types.

The V-BAT UAS provided by Martin UAV is a fixed-wing vertical take-off and landing (VTOL) aircraft specifically designed to operate from very small spaces on ships, on land, and in nearly any environment. The V-BAT is a long-endurance aircraft capable of carrying multiple sensors, including land and maritime wide area surveillance. "Our Midas system allows users to fully exploit raw sensor data, and derive useful intelligence at the tactical edge where the UAV is being used. In a SaR context, that could mean using infrared sensors, or near real-time motion detection to locate a subject

when visibility or weather conditions are poor," McGillis added.

The Block 5 MQ-9A

Several companies are developing or upgrading their existing systems to meet customer demands. General Atomics Aeronautical Systems recently completed development and tests of what they claim is the world's first self-contained Anti-Submarine Warfare (ASW) capability for an Unmanned Aerial System.
GA-ASI said it had successfully demonstrated an 'A' size sonobuoy carriage, release, process and control from a company-owned MQ-9A Block 5 on a US Navy Pacific test range. Using a SATCOM link, GA-ASI remotely processed bathythermal and acoustic data from deployed 'A' size Directional Frequency Analysis and Recording (DIFAR-AN/SSQ-53G), Directional Command Activated Sonobuoy System (DICASS-AN/SSQ-62F) and Bathythermograph (BT-AN/SSQ-36B) sonobuoys and accurately generated a target track in real-time from the Laguna Flight Operations Facility located at Yuma Proving Grounds. The MQ-9A Block 5 successfully deployed one BT, seven DIFAR, and two DICASS buoys to initiate prosecution and continuously track a MK-39 EMATT (Expendable Mobile ASW Training Target) over a three-hour period. Target track was generated using General Dynamics Mission Systems-Canada's industry-leading UYS-505 Sonobuoy Processing Systems.

Photo: Armee de LAir

A French Army Block 5 MQ-9A

The MQ-9B SEAGUARDIAN

GA-ASI is developing this first-of-its-kind capability for its new MQ-9B SEAGUARDIAN UAS, in partnership with the US Navy under a Cooperative Research and Development Agreement with Naval Air Systems Command. "This demonstration is a first for airborne ASW. The successful completion of this testing paves the way for future development of more ASW capabilities from our MQ-9s," said GA-ASI President David R. Alexander. "We look forward to continuing collaboration with the US Navy as they explore innovative options for distributed maritime operations in the undersea domain."
GA-ASI first demonstrated a sonobuoy remote processing capability in 2017 from an MQ-9A. Since then, GA-ASI has added a Sonobuoy Management & Control System (SMCS) to monitor and control deployed sonobuoys, and developed a pneumatic sonobuoy dispenser system (SDS) capable of safely carrying and deploying 10 US Navy compliant 'A' size or 20 'G' size sonobuoys per pod.
The MQ-9B SEAGUARDIAN has four wing stations available to carry up to four SDS pods, allowing it to carry and dispense up to 40 'A' size or 80 'G' size sonobuoys, and remotely perform ASW anywhere in the world. In a standard maritime ISR and ASW configuration, SEAGUARDIAN's endurance exceeds 18 hours, encompassing a mission radius of 1,200 nautical miles with eight hours of on-station time for submarine prosecution, providing a low-cost complement to manned aircraft for manned-unmanned teaming (MUM-T) operations.
"We have already received orders for this capability from two separate foreign customers, and demand is anticipated to be extremely strong for the MQ-9B SEAGUARDIAN with its high-end maritime capabilities and low cost relative to legacy manned maritime platforms," Alexander said.
Last year, the former Trump administration approved the sale of four MQ-9B "weapons-ready" unmanned aircraft to Taiwan for an estimated value of US$600M. It is understood that Taipei will purchase the maritime version of the MQ-9B. ■

Photo: GA-ASI

The MQ-9B SEAGUARDIAN

Supporting FIM-92 STINGER Missiles

Piero Toffano

The NATO Support and Procurement Agency (NSPA) provides a well-functioning logistics support concept

The NATO Support and Procurement Agency, with its head office in Capellen, Luxembourg, brings together in a single organisation NATO's logistics and procurement, including armaments acquisition support activities, providing integrated multinational support solutions for NATO, its member countries and partner nations as its customers.
Within NSPA's Life Cycle Management Business Unit, embedded in the Air Combat Missiles Section of the Air and Land Combat Systems Programme Office, NSPA provides support to several user nations of the FIM-92 STINGER missile system. This support is performed under the legal framework of the multinational STINGER Support Partnership (SP), established in 1989 and currently supporting ten user nations. Through the SP, NSPA provides a highly effective and efficient platform for multinational cooperation, enabling partner nations not only to consolidate requirements, but also to share and exchange technical experience and lessons learned gained in utilising and supporting the system.

Range of Services Provided

The STINGER weapon system encompasses different types of equipment, including the missile round, a gripstock for man-portable air-defence systems (MANPADS) firings and a wide variety of training, test, and support equipment. All these, in addition to some missile launch vehicles such as the Advanced Short Range Air Defence System (ASRAD), are supported by NSPA. This support comprises of the following elements:

- Acquisition of end items (excluding missile and gripstock), spare parts and related accessories,

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Photos: NSPA

STINGER missile and gripstock

- Supply and maintenance support,
- Central stocks of critical items,
- Ammunition surveillance programme,
- In-service support through contractors,
- Onsite support by NSPA team,
- Project management and technical / engineering support,
- Documentation support, and
- Transportation services.

Besides fulfilling the customer requirements in scope, time and at the required quality level, a primary aim is the consolidation among the participating nations in order to obtain economies of scale when launching industry support contracts, ultimately leading to cost-effective solutions.
In addition, NSPA acts in full compliance with all national regulations, in particular those stemming from the US which is the Original Equipment Manufacturer (OEM), such as the US International Traffic in Arms Regulations (ITAR), but also other Support Partnership Membership nation's regulatory requirements.

Acquisition

With its thorough technical and logistics expertise, NSPA can assist nations in determining their technical requirements, develop Statements of Work (SoW) together with the National Subject Matter Experts (SME) and manage the entire acquisition process. NSPA's technical experts work in integrated project teams side by side with their procurement colleagues responsible for the commercial aspects. Acquisition projects can range from a major requirement-based competition for a defined capability, (NSPA has initiated the acquisition of portable IFF Mode 5 capable interrogators), to procuring authorised and certified spare parts.

In-service Support Network

In support of STINGER systems, NSPA has established a number of contracts with the US Government (FMS cases) and European industry, putting in place a well-structured support infrastructure.

STINGER fired at the NATO Missile Firing Installation, Crete

Through building on its continuous networking with the national authorities, Subject Matter Experts (SME), relevant US Government entities and industry representatives, NSPA is able to ensure timely and effective in-service support. For example, NSPA manages multi-year projects, such as the Service Life Extension Programme (SLEP) allowing the STINGER Partnership participating nations to use their STINGER missiles well into the next decades. NSPA has also developed a dedicated transportation service to ensure all system related security aspects are followed, allowing a seamless service from the confirmation of a requirement to the delivery of the parts to the nation's premises.

Extension of Missile Shelf Life

A dedicated surveillance programme ensures the reliability and safety of the STINGER missile throughout the lifetime of the system by four complementary surveillance methods:
(1) In-storage inspections are performed by the nations to visually check the state of the stored items in their depots.
(2) The SME of the NSPA Test Team periodically conducts missile function tests at national depots located in the SP countries using the dedicated tailor-made NSPA Surveillance Test Vehicle (STV), a unique vehicle equipped with all necessary test equipment.
(3) Authorised companies under NSPA contracts carry out missile specific component tests.
(4) And finally, Reliability Test Firings (RTF) are performed at a certified firing range by using the Reliability Test Vehicle (RTV) that remotely controls the Firing Mount System (FMS) or by firing as MANPADS against a remotely controlled target.
The results of the various ammunitions surveillance activities will be thoroughly evaluated resulting in a recommendation for the extension of the shelf life of missiles that will be presented to the SP nations for their decision.

Sustained System Knowledge

All services and logistics support provided by NSPA staff hinge on knowledge, experience and personal engagement of the subject matter experts at NSPA. Continuous training, coupled with low personnel attrition rates, allow nations to wield a unique capability. Through permanent exchange and cooperation with national experts on a daily basis and via recurring dedicated technical and logistics working groups amongst NSPA, the member nations and industry further contributes to building and sustaining this unique knowledge base.
NSPA's capabilities and resources complement those of the member nations in the STINGER domain. Consolidation savings have been achieved and the promotion of cooperation further improves the STINGER system's availability and interoperability amongst the nations. Proven achievements and the available expertise motivate NSPA to promote the expansion of the STINGER Support Partnership. The services are available to the STINGER user nations.
NSPA is set to support STINGER for the years to come. ■

NSPA's STINGER Surveillance Test Vehicle

Twenty Years of IRON DOME

Arie Egozi

After being upgraded to intercept new threats, the Israeli IRON DOME rocket interceptor has been tested successfully against a mix of rockets and UAVs, and salvoes and swarms of both.

The series of tests will enable Rafael to upgrade the existing rocket batteries deployed along Israel's borders. On 22 March, a rocket was launched from Gaza towards the Israeli city of Beer Sheva. The IRON DOME radar calculated that its trajectory would mean the rocket would land in an open space and one interceptor was launched.

During the series of tests, the upgraded IRON DOME system intercepted salvoes of rockets and UAVs. The US has been closely following the recent test series. The US Army has recently deployed two IRON DOME systems of its own. Rafael is teamed up with Raytheon for the IRON DOME contracts with the US Army.

The threat scenario for the recent series of tests was based on the most updated threat assessment prepared by the Israeli Defence Forces (IDF) intelligence services. This assessment was prepared after the Israeli intelligence bodies analysed some of the recent attacks carried out by Houthi rebels in Yemen against targets in Saudi Arabia. This test took place at a site in southern Israel with the participation of Israeli Air Force (IAF) fighters. The new version of the IRON DOME system will be delivered to the IAF and the Israeli Navy for operational use and will strengthen Israel's multi-tier missile defence capabilities. The upgraded system was launched in one scenario to intercept a swarm combined of BANSHEE TARGET UAVs and rockets. The upgraded IRON DOME managed to intercept all the aerial targets.

Photos: via author

An upgraded IRON DOME system undergoing tests

Export Perspectives

The frequent missile attacks on Saudi targets, and the possibility of such attacks against targets in the UAE, in response to the peace agreement with Israel, has forced these two countries to evaluate the purchase of the IRON DOME system.

Israeli sources have said that Washington has been informed about this intention, while pointing to the failure of the Saudi air defence systems to foil the major attack on Saudi Arabian oil facilities.

On 14 September 2019, different types of drones and missiles were used to attack the State-owned Saudi Aramco oil processing facilities. The attack was carried out by Houthi rebels in Yemen operating under direct orders from Teheran. Recent reports state that Iran has supplied the Houthi rebels with advanced cruise missiles and armed drones. Israeli sources also report that the recent US withdrawal of its PATRIOT anti-missile defence batteries from Saudi Arabia has opened the door for the deployment of other air defence systems in the Kingdom.

On 3 December 2020, the Arab newspaper Al-Khaleej Al-Jadeed published an article entitled "The United Arab Emirates is looking to buy the 'IRON DOME' system made in Israel." The article states that according to reports, the Saudi Kingdom's Crown Prince, Mohammed bin Salman "fell in love" with the Israeli- made air defence system, the

Author

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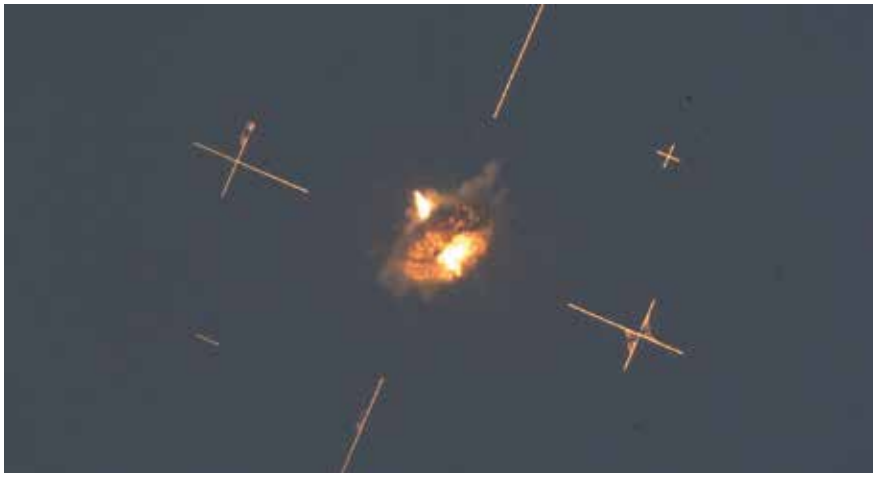
IRON DOME, and has been trying to purchase it ever since the policy shift towards Israel in the Gulf region began.
An Israeli defence source, who talked on condition of anonymity said that if the UAE and Saudi Arabia decided to purchase the Israeli system, the deal would be with Rafael's American partner, Raytheon and that "this of course [of action] will have to get the approval of the Israeli Ministry of Defence" the source said. Israeli sources have also said that the UAE has already taken some steps to evaluate the chances of buying the Israeli developed IRON DOME system. A source in the Israeli Defence Ministry said that the UAE was very worried about a possible Iranian action against it as a result of the peace agreement with Israel.

Defensive Capabilities

The IRON DOME system detects, assesses and intercepts a variety of shorter-range targets such as rockets, artillery and mortars. It is effective day and night and in all weather conditions, including low cloud cover, rain, dust storms and fog. It features a first-of-its-kind multi-mission launcher designed to fire a variety of interceptor missiles.
The IRON DOME's TAMIR missile intercepts incoming threats launched from ranges of 4 - 70 km. TAMIR missiles feature electro-optical sensors and steering fins with proximity fuse blast warheads. The majority of TAMIR missile components are procured through the Raytheon Missiles & Defense supply chain in the United States.
In Israel, the IRON DOME systems are deployed mainly along the border with Lebanon and with Gaza. In recent years, it has achieved more than an 85% kill rate. The development of the IRON DOME is led by the IMDO in the Ministry of Defence. The prime contractor for its development is Rafael Advanced Defense Systems Ltd. The system's MMR radar is developed by ELTA, a subsidiary of Israel Aerospace Industries (IAI), and the command and control system (BMC), is developed by mPrest.
Head of the Israeli Missile Defence Organisation in the Ministry of Defence, Moshe Patel stated: "Thirty years after the First Gulf War, which led to the establishment of the Israeli Missile Defence Organisation, and ten years after the IRON DOME's first operational interception, we have achieved a significant leap forward in the technological capabilities of the IRON DOME system. In the three test campaigns conducted in the last few months, the IRON DOME system demonstrated outstanding capabilities against evolving threats, including successfully intercepting salvoes of rockets and missiles as well as intercepting multiple UAVs simultaneously. The new configuration of the IRON DOME system will be delivered to the IAF and Navy for operational use, and will further strengthen the State of Israel's multi-tier missile defence array."
Executive Vice President and General Manager of Rafael's Air and Missile Defence Division, Brig. Gen. (Res.) Pini Yungman stated: "Rafael and the IMDO have been continuously upgrading IRON DOME's capabilities over the last decade, constantly improving its technological and operational performance. Our forward-looking approach allows us to address projected threats that are emerging around us. The capabilities that were demonstrated in this last test will ensure additional protection to the State of Israel."

IRON DOME has been upgraded to intercept new threats.



TAMIR missiles intercept incoming threats launched from ranges of 4-70 km.

BARAK and ARROW

Israel is upgrading not only the IRON DOME. On 22 March, IAI completed a series of successful live firing trials with the BARAK Air Defence System. The trials tested the system's capabilities in a range of scenarios and threats, including the interception of an assaulting ballistic target by the BARAK ER (extended range) interceptor.
The BARAK ER missile, developed by IAI, combines the capability to intercept air defence threats at a long range of 150 km and ballistic targets as part of IAI's BARAK interceptors' family of various ranges. The extended range capability is made possible in part by adjusting the interceptor and MMR radar capabilities to a 150 km range. The vertically launched missile includes a booster, a dual-pulse rocket motor, and an advanced radar homing seeker. The BARAK was developed by IAI in cooperation with the Indian Ministry of Defence and is deployed by the Israeli and Indian Navies. A ground version was also developed and this version has proved its capability to intercept new threats. Israeli sources say that the IDF will not deploy the ER version and that the potential customers are to be found in foreign countries.
Israel has a multi-tiered rocket and ballistic missile defence system comprised of IRON DOME, DAVID's SLING and also the ARROW ballistic missiles interceptor. Only recently, IAI unveiled the ARROW 4, the upgraded version of this ballistic missile interceptor. It has winglets, which according to experts are needed to intercept hypersonic missiles. These, according to Israeli sources, are not in the hands of Israel's enemies, but as one of them admitted "things in the Middle East change very fast". ■

Aircraft Carrier Self-Defence

Doug Richardson

The 1939-45 conflict saw the aircraft carrier supplant the battleship as the ultimate capital ship, but also highlighted its potential vulnerability.

On 24 July 1945, US carrier-borne aircraft scored several bomb hits on the Japanese aircraft carrier AMAGI, which was then located at Kure Naval Base. Further hits were sustained during US air strikes on 28 July, and on the following day, AMAGI capsized, taking her place in history as the last carrier to be lost in action. The 1939-45 conflict had seen the aircraft carrier supplant the battleship as the ultimate capital ship, but also demonstrated its potential vulnerability. A total of more than 40 carriers were lost – 21 from the Japanese Navy, 12 from the US Navy, and 7 from the UK's Royal Navy.

None of the conflicts between 1945 and 1982 saw a major threat being posed to carriers. During the Indo-Pakistani War of 1965, VIKRANT - the Indian Navy's sole aircraft carrier – was being refitted, so took no part in the conflict, but during the Indo-Pakistani War of 1971, she was deployed as part of operations against what was then East Pakistan. Attempts by Pakistan's submarine GHAZI to locate the carrier were unsuccessful. US aircraft carriers were able to operate with impunity in the Gulf of Tonkin during the Vietnam War, given that North Vietnam lacked the military capability to attack them.

The only post-1945 conflict in which both sides deployed carriers was that over the Falkland Islands (considered to be the Malvinas by Argentina). British attempts to locate the Argentinean carrier VIENTICINO DE MAYO resulted in only one brief sighting by the submarine SPLENDID, while the Argentinean plan to use carrier-launched A-4 SKYHAWKs to attack the British task force had to be called off when near-calm weather conditions in its operating area prevented the VIENTICINO DE MAYO from travelling fast enough to generate the level of wind over the deck needed to launch a strike.

Author

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Photo: US Navy

Sunk by US aircraft while in harbour, Japan's AMAGI was the last aircraft carrier to have been lost in action.

Defence Against Anti-Ship Missiles

The losses recorded between 1939 and 1945 showed that the traditional threats to aircraft carriers were posed by aircraft and submarines. This remained the case for several decades, but today's carriers must also cope with subsonic, supersonic, and hypersonic anti-ship missiles.

Two decades ago, the threat posed to carriers by ballistic missiles seemed relatively minor, given the rarity of ballistic warheads equipped with the manoeuvring capability and terminal guidance needed to home onto carriers during the relatively brief terminal stages of flight. This is no longer the case. China has fielded the DF-21D (CSS-5 Mod-4), which is thought to be an anti-ship version whose manoeuvrable re-entry vehicle (MaRV) incorporates a terminal guidance system. Iran has claimed an anti-ship capability for its KHALIJ FARS, an anti-ship variant of its FATEH-110 missile. This is equipped with a 650 kg explosive warhead and a terminal guidance system with a reported accuracy of 10 m.

2021 should see the Russian Navy taking the KINZHAL hypersonic air-launched ballistic missile into service. Carried by a modified MiG-31K fighter, this flies a complex trajectory after release, and has a reported range of 2,000 km.

China's latest anti-ship weapon is an air-launched ballistic missile armed with a hypersonic glide vehicle. Carried under the belly of the H-6N bomber, it is probably intended to target large warships such as aircraft carriers. Its Chinese designation is unknown, but it has been assigned the designation CH-AS-X-13 by the US.

Today's carrier fleets contain only a tiny fraction of the number deployed in 1939-45 - a mere 11 (USA), two (China), and two (UK), while France, India, and Russia each operate only a single carrier. These modest numbers make their operators more vulnerable to losses than in the past.

Point Defence Systems

An aircraft carrier will enjoy defence in depth. Traditionally, this is starting with

its own fighters operating at combat-air-patrol locations at the outer edge of the defended area, while medium or long-range SAM systems carried by surface escorts should impose a heavy level of attrition on attackers. Currently, an attacker is more likely to be countered by the SAMs fired by the escorts, while short-range defence will be the task of the carrier's own SAM systems, close-in weapons systems (CIWS), and countermeasures such as EW and acoustic jammers. While EW systems might be able to confuse the terminal guidance systems of incoming anti-ship ballistic missiles, the task of intercepting such weapons will almost certainly have to be assigned to the carrier's escorts.

One potential future point-defence system could involve directing highly-directional bursts of high-power microwave energy towards an incoming threat with the intention of disrupting or destroying its electronic subsystems. BAE Systems has proposed a microwave weapon whose antenna array could be installed on the Mk38 mounting currently used for the 25mm cannon.

The US Navy's NIMITZ class carriers are armed with RIM-7 SEA SPARROW or NATO SEA SPARROW missiles, plus three or four PHALANX CIWS or RIM-116 ROLLING AIRFRAME MISSILE (RAM) launchers for use at short range. Soft-kill defences consist of the AN/SLQ-32A(V)4 countermeasures suite, plus SLQ-25A NIxie towed torpedo decoys.

Developed specifically for use on aircraft carriers, the SLQ-32(V)4 consists of two (V)3 systems, (one mounted on each side of ship), plus a common computer and display console. The (V)3 was the first SLQ-32 variant to offer an active radar-jamming capability, and is fitted to other major surface combatants such as cruisers and large amphibious ships.

The follow-on GERALD FORD class have two RIM-162 ESSM launchers, and two RIM-116 RAM launchers, plus three PHALANX CIWS. The power demands of the NIMITZ class are close to the maximum that the vessel can provide, but only half of the electric power generation capacity of the NIMITZ class is currently being used. This ensures a comfortable reserve able to meet the demands of future onboard systems, including directed-energy weapons able to engage incoming threats, and dynamic armour protection systems (DAPS) intended to blunt the effects of the warheads of missiles or other delivery systems.

The amount of steel armour needed to protect a ship or combat vehicle against

Photo: US Navy

Crewmen load a NATO SEA SPARROW missile onto a launcher aboard the NIMITZ class aircraft carrier DWIGHT D. EISENHOWER.

Photo: Raytheon

Raytheon's RIM-166 Rolling Airframe Missile weighs only 74 kg, but has a maximum range of around 10 km.

Photo: US Navy

Test firing of a Raytheon PHALANX close-in-weapon system aboard the aircraft carrier NIMITZ (CVN 68) during a live-fire exercise in the North Arabian Sea.

Photo: MoD France

As this launch of an ASTER 15 demonstrates, France's CHARLES DE GAULLE is one of the few Western aircraft carriers to carry a medium-range SAM system.

Photo: via author

When delivered from a Russian shipyard, India's VIKRAMADITYA – seen here as it reached India – had no antiaircraft missile system, but BARAK was installed through an early modification programme.

Photo: Crown Copyright

A crewmen exercises with a machine gun installed on the UK carrier QUEEN ELIZABETH. This class of light weapon can act as a last-ditch defence against swarming light surface craft or drones.

all projectiles would pose an impractical weight penalty. Proposed as a future upgrade to the GERALD R. FORD class carriers, DARPS would be based on two layers of relatively thin armour. A strong electric field between these would disrupt the jet of ionised gas produced by a shaped-charge warhead.

Currently undergoing a refit, and not expected to return to service until 2022 at the earliest, ADMIRAL KUZNETSOV is Russia's sole aircraft carrier. It uses the 3K95 KINZHAL vertical-launch SAM system – the naval equivalent to the land-based 9K330 TOR (SA-15 GAUNTLET) – as its primary air-defence system. This is supplemented by eight CADS-N-1 KASHTAN CIWS armed with 3K87 KORTIK SAM systems and twin 30mm rotary cannons. Six AK-630 guns are available to give a minimal-range defence against air targets, while a single RBU-12000 UDAV-1 rocket launcher provides a degree of anti-submarine capability.

Unofficial reports have suggested that the Project 2300E nuclear-powered aircraft carrier proposed as a replacement for the ADMIRAL KUZNETSOV could be armed with S-500 PROMETEY surface-to-air missiles. Currently being developed in land-based form, this heavy SAM system would give the vessel a significant ABM capability.

When it entered service in 1987, the Russian aircraft carrier BAKU, later renamed the ADMIRAL GORSHKOV had a powerful self-defence capability, being fitted with 24 × 8-cell SA-N-9 vertical SAM launchers, 2 × 100mm guns, 8 × AK-630 30mm CIWS, and 2 × RBU-6000 anti-submarine rocket launchers. In 2004, she was sold to India, and received a modernisation that included a BARAK 1 SAM system that had formerly been carried by the Indian frigate GODAVARI, plus four AK-630. Renamed VIKRAMADITYA, the carrier entered service with the Indian Navy in 2013. The BARAK 1 was replaced by a BARAK 8 system during a subsequent refit.

China's LIAONING was originally laid down as the second Project 1143.5 (ADMIRAL KUZNETSOV class) carrier for the Soviet Navy, but was taken over by Ukraine following the dissolution of the Soviet Union in 1991. Purchased by China in the later 1990s, it entered service with the PLA Navy in 2012. Its self-defence capability is provided by three Type 1130 CIWS, and three 18-cell HQ-10 SAM systems. A similar armament was selected for the follow-on SHANDONG, a developed version of the LIAONING. Commissioned in 2019, SHANDONG is likely to

be followed by several more carriers of an all-new design, the first of which was laid down in 2017.
The Type 1130 CIWS is based on an 11-barrelled 30mm rotary cannon with a rate of fire of 11,000 rounds/minute, and maximum range of 3 km. The mount carries a single cannon with two 640-round magazines, a TR47C radar, and an OFC-3/H/ZGJ-4 electro-optical fire control system.
Similar in concept to the Rolling Airframe Missile, the HQ-10 is available with launchers of 8, 15, 18 and 24 missile capacity and a reaction time of close to 10 seconds. These fire a missile some 2 m long able to engage subsonic targets at ranges of up to 9 km, or supersonic targets at up to 6 km.
France's sole aircraft carrier CHARLES DE GAULLE is unique in being one of the only two Western carrier to be equipped with a medium-range SAM system. It has four eight-cell A-43 SYLVER launchers for the MBDA ASTER 15, a surface-to-air missile with a maximum range of more than 30 km.
Shorter-range air-defence coverage is provided by two six-cell SADRAL launchers armed with MISTRAL short-range missiles, plus eight GIAT (now Nexter) 20F2 20mm cannons. Soft-kill defences consist of an ARBR 21 Detector, ARBB 33 countermeasures suite, ARBG2 MAIGRET Interceptor, four launchers for SAGAIE decoys, and SLAT (Système de lutte anti-torpille) torpedo countermeasures.
The Italian carrier CAVOUR is smaller than CHARLES DE GAULLE, but has a similar ASTER 15 system, also based on four eight-cell A-43 SYLVER launchers. It also carries two Oto Melara 76/62mm Strales guns, three OTO Melara Oerlikon KBA 25/80mm anti-aircraft guns, and two ODLS-H/ODLS decoy launching systems.
While most carrier operators see the need for these vessels to carry SAM systems for self-defence, the UK Royal Navy seems to disagree. Three PHALANX CIW are the sole anti-air systems mounted on its new QUEEN ELIZABETH class carriers - the 30mm Automated Small Calibre Guns also carried are intended for use against fast attack craft. Unofficial reports have suggested that a containerised version of the MBDA SEA CEPTER SAM system remains a potential add-on armament for the future.

Surface Craft

The potential threat posed by manned and unmanned small surface craft can be countered at short range by the PHALANX, and at longer ranges by Thales MARTLET air-to-surface missiles carried by the carrier's AgustaWestland AW159 WILDCAT helicopters. Based on the technology of the earlier STARBURST and STARSTREAK short-range surface-to-air missiles, MARTLET weighs only 13 kg, and uses laser beam-riding guidance. It has a maximum range of 8 km and carries a 3 kg dual-effect shaped charge and pre-fragmented blast warhead. Up to 10 missiles can be carried under each of the optional weapon wings of the WILDCAT helicopter.
While high-technology weapons such as hypersonic anti-ship missiles and anti-ship ballistic missiles represent the most stressing threat that a carrier might face, it is important to remember potential 'low-tech threats'. While no operational aircraft carrier has been lost in combat since 1945, the Vietnam War saw a successful attack by saboteurs against the CARD, a US Navy BOGUE class escort carrier built during the early 1940s, and now being used as an aircraft transport. While the ship was moored dockside in Saigon on 2 May 1964, a Viet Cong team used a canoe to approach CARD, and successfully attached explosive charges to the hull. These subsequently detonated, blowing a hold in the hull and killing five crewmen. CARD was successfully patched, then towed to Japan for repair. It returned to service in December 1964, and remained in service until 1970.
Like the suicide bombing of the ARLEIGH BURKE class destroyer COLE while the vessel was at anchor in Aden for refuelling in October 2000, the attack on CARD showed how vulnerable a warship can be when not under way or in harbour. This is a threat that the USN has recognised. Deployed on aircraft carriers and large-deck amphibious (LHD and LHA) platforms, the Ball Aerospace STALKER Long Range Electro-Optic Sensor System (LREOSS) was intended to detect, classify and identify potential threats to these ships. The follow-on AN/SAY-3 Improved STALKER (I-STALKER) LREOSS due to be installed on two USN NIMITZ class nuclear-powered aircraft carriers is intended to improve situational awareness against threats such as fast-attack and fast-inshore-attack craft.
If self-protection measures fail, a well-designed and well-built aircraft carrier is still a difficult target to sink. This was demonstrated in 2005 by the fate of the USN carrier AMERICA. Nine years after it was decommissioned, this KITTY-HAWK class vessel was towed to a USN exercise range to become the target of a carefully-planned Sinkex (sinking exercise). Over a four-week period, AMERICA was subjected to preplanned attacks by missiles, bombs, and torpedoes, but remained afloat. Eventually it was boarded by a demolition team who planted the carefully-placed explosive charges needed to finally sink it. The lessons learned from that Sinkex influenced the design of today's GERALD R FORD class carriers. ■

Photo: via author

A television camera transmitted this image of the last moments of the US Navy carrier AMERICA when she was deliberately sunk after surviving four weeks of attacks by US weapons and warheads.

Enhancing Squad Communications

Converged voice and radio communications with Radio over IP (RoIP)

Shaun Fischer and Charlie Kawasaki

Today, multiple echelons - platoon, company, battalion, brigade, and division – are all trying to communicate with each other using different mechanisms, whether via line of sight (LOS) radios or beyond line of sight (BLOS) satellite communications (SATCOM).

All these echelons need to maintain communications within their own units and within their command structure, to support intel, operations, call for fire, logistics and other communications requirements. The challenge is how to most effectively connect the warfighter at the tip of the spear at the squad level, up through the echelons, and even to the enterprise network.

Imagine a dismounted squad with an injured soldier. The squadron is carrying their tactical radios, which may be using the soldier radio waveform, and they need to communicate with a Medivac en route to retrieve the injured soldier. Because the airborne platforms primarily use SINCGARS and the squad may be communicating over SRW, they cannot directly talk with each other. There is a clear need for a standardising method or protocol to connect networks of different types and different types of radios and waveforms. The solution is to use Radio over IP (RoIP) to convert the radio's audio signal from analogue to digital, into a format that is similar or compatible with VoIP. Using RoIP, a cross band can be created through the company commander's vehicle, between the SRW and SINCGARS networks, enabling the squadron to relay information about the injured soldier directly to the Medivac before it lands.

There is an ever growing need to connect every soldier, every platform, and autonomous and robotic systems to the network, to pass situational awareness information, to maintain communications. In today's multi-domain operations and battle environment, the problem of network interoperability and voice convergence is growing exponentially. The Army needs to be able to communicate not just with the Navy, Air Force and Marines, but with coalition partners as well. What's more, the battlefield lacks the familiar infrastructure of cellular networks and dedicated Ethernet and IP networks. Instead, the warfighter must take those networks with them into the battlefield.

Photos: PacStar

The PacStar Modular Radio Center (MRC) integrates SCI's TOCNET-G4 UVMS to bridge modern and legacy radio networks with industry-standard IP networks.

PacStar 463 integrates the TOCNET engine to provide a scalable solution that brings different types of communications networks into a single user interface and allows all these different platforms to communicate.

Tactical communications today is still primarily based on radios. There are a great variety of radios out in the field, both legacy and modern, and these radios have varying levels of capabilities. Some are analogue and some are digital. They use a growing number of disparate waveforms, and they all have different types of interfaces and connectors. But the challenge isn't just how to communicate from LOS device to LOS device. To achieve the goal of unified communications, LOS networks must be able to communicate with BLOS networks. Communications have to reach over the hill, or across great geographical distances.

RoIP enables the remote access of radio networks, from various devices such as laptops and smart phones, or even VoIP phones, and helps to enhance interoperability by bridging or cross banding different radio waveforms and networks. It also enables connectivity via conferences or talk groups to extend reach and participation across the different networks.

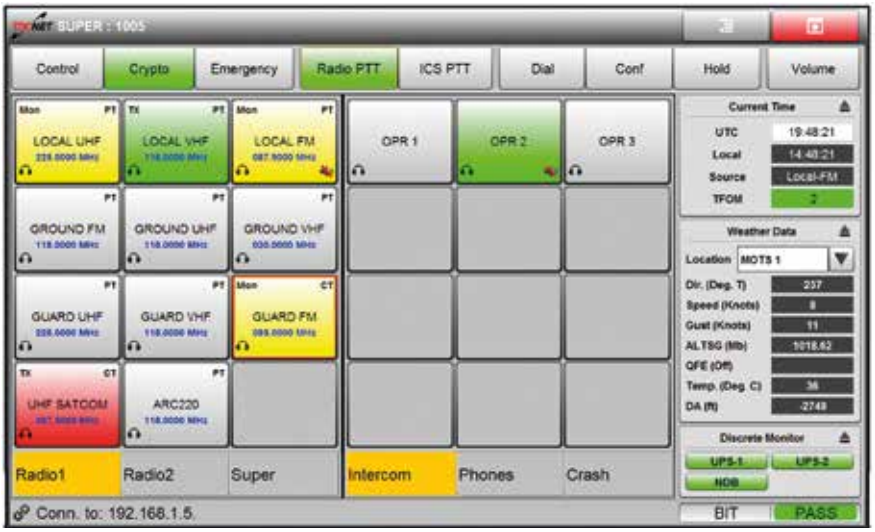
Authors

Shaun Fischer is Director of Portfolio Management at SCI Technology and **Charlie Kawasaki** is CTO at PacStar, a Curtiss-Wright Defense Solutions subsidiary.

Relaying and Cross Banding

With RoIP, after the radio audio is digitised, multiple digital signals can be connected together, with other radio signals, or with other types of communications assets. Relaying can be used to connect multiple radios of a similar type or waveform into a single communication channel. Cross banding, which is similar to relaying, instead links multiple radios of different types or waveforms together that would not otherwise normally be able to communicate with each other. RoIP supports relaying and cross banding, making it possible to extend the range of tactical radio communications, either by relaying the same signal using a repeater, or by extending network interoperability, so an LOS radio, for example, can be bridged onto a SATCOM network for greater reach.

RoIP is not necessarily required for bridging radio communications. Two local radios could be connected and digitally bridged through an intercom system, for example. But RoIP enables radio communications to be relayed and cross banded across an IP network, making it the best solution for extending the range of communications over a satellite link or over a multiple satellite hops.



TOCNET Soft CAU provides "single pane of glass" user interface for voice convergence.

RoIP and unified communications enable voice convergence, integrating different types of networks, both similar and disparate, including radio, VoIP, SATCOM, and even telephony, into a single network that simplifies connectivity and supports multiple types of user interfaces, making all accessible through a single user interface. That means that a soldier in the middle of combat can focus on the mission rather than having to figure out how to communicate across different types of communications channels. Even better, RoIP enables voice conferences to be established so that participants at all different locations can gain the same situational awareness at the same time.

The PacStar 463 RoIP engine. TOCNET-G4 is standard UVMS for USSOCOM GMV 1.1

Example of a Deployable RoIP Solution

Solutions exist today that provide full unified communications capability at the tactical level, while eliminating the integration, setup and management complexity, and licensing costs associated with Enterprise type RoIP hardware components. An example of a more capable unified communications solution for voice and data networks is provided by the Curtiss-Wright PacStar 463 RoIP/Voice Convergence Engine, deployed in a PacStar Modular Radio Center, that integrate SCI's TOCNET-Generation Four (G4) Unified Voice Management System (UVMS) to bridge modern and legacy radio networks with industry standard IP networks.

Typical radio gateways provide analogue to digital conversion of radio audio to a basic IP audio format accessible, through an Ethernet interface, by external voice clients such as Motorola's WAVE 5000. These gateways are often limited to this purpose by design. PacStar 463 goes beyond the capabilities of a typical radio gateway. It integrates the TOCNET engine to provide a scalable solution that brings different types of communications networks into a single user interface appropriate for use by expeditionary command posts, tactical or combat vehicles, and dismounted soldiers, and then allows all these different platforms to communicate.

TOCNET UVMS enables the module to operate independently from external voice clients and external VoIP call managers like Cisco Unified Communications Manager (CallManager). It supports remote radio control, and enables relaying, cross banding, and VoIP capabilities, while providing complete interoperability with 3rd party solutions, including Cisco UCM and WAVE 5000. It can also provide redundancy when needed for operation without such systems.

PacStar 414 Radio Sleds adapt a wide variety of tactical/LMR radios.

What's more, any PacStar 463 RoIP Module can be linked with any other PacStar 463 RoIP Module or any other TOCNET enabled platform, to form a broad, feature rich network communications experience.

At the tactical level, PacStar 463 provides all the same capability available from enterprise class solutions, such as Cisco CallManager and Motorola WAVE 5000, while eliminating the additional integration complexity, computing resources, and configuration/setup, etc., otherwise required. The result is significantly reduced size, weight and power (SWaP), simplified logistics, and lower costs since there is no need to license Enterprise capabilities.

Providing built-in remote radio control, true VoIP calling, and conferencing from a single software application, the module reduces system complexity and increases usability with a single pane of glass approach. It provides four radio channel interfaces for audio and remote control, 2 GbE interfaces for VoIP, network interoperability, and connectivity, and a serial maintenance port. Its mission recorder can simultaneously record up to 48 audio streams from multiple RoIP modules for post action reports and training.

When combined, RoIP, radio relaying, and cross-banding deliver flexibility to military PACE (Primary, Alternate, Contingency, and Emergency) planning, helping to mitigate the challenges associated with DIL (Distributed, Intermittent, and Limited) networks. That means, in any given situation there will be multiple ways to communicate. If a radio is jammed or fails, the squad can still communicate with their intended destination or command structure. Moving into urban combat, with lots of obstructions and interference, the warfighter must rely on multiple different paths to communicate with their team. RoIP delivers the critical flexibility and utility needed by the next generation, integrated tactical network. These additional capabilities will provide significant value to the warfighter, and when extended to coalition partners, increased compatibility and the ability to interoperate will multiply mission effectiveness. ■

Photo: PacStar

PacStar`s tactical comms solution enables warfighters to securely transmit sensitive data using Wi-Fi and LTE-enabled devices.

Photo: BlueWireless

5G as a Game-Changer for Defence Critical Systems

Blu Wireless is working with a number of customers in the defence sector to apply and extend its mmWave technology, which is currently being deployed for 5G applications, to tactical comms at the network edge. ESD had the opportunity to speak to Mark Barrett, CMO and Defence Lead of Blu Wireless.

ESD: What is the impact of 5G upon tactical comms networks at subunit / forward edge level?

Barrett: To answer this question we first need to define what we mean by 5G. The performance requirements for 5G were originally defined by ITU-R in 2015 as IMT2020 but this did not define the implementation standard. Original intentions were to create a 'network of networks' to integrate existing wireless interfaces (from 3GPP Mobile, IEEE Wi-Fi, Bluetooth etc.) within a single coherent standards framework. However, due to commercial conflicts between standards groups this was not possible, leading to the continued fragmentation of standards chiefly around 3GPP Mobile and IEEE Wi-Fi – both of which are aimed at delivering the 5G KPIs for sub msec latency, gigabit throughput and support for Massive IoT. Moreover, most general marketing attention is focused on 3GPP Mobile which is being marketed as '5G' – whereas the underpinning technical standards are primarily based on extensions of 4GLTE with additional features to deliver support for a wider range of frequencies (down 700 MHz and up to mmWave at 28/39 GHz) still all based on the same OFDM waveform as used in 4GLTE systems. This pragmatic approach allows ease of backwards compatibility and scaling of chipsets and network architectures for rollout by device manufacturers and commercial operators working within licensed frequency bands at the expense of sub-optimum performance, increased power consumption and continued need for a centralised core network.

On the other hand, IEEE-based 5G wireless standards, including 802.11ax and particularly 11ad and 11ay, provide the required gigabit performance within a more open peer to peer framework (supporting IP connectivity) at lower power consumption and complexity (SWAP) than 3GPP based systems. Critically, IEEE-based systems do not require a centralised core based network and already include native quality of service mechanisms which allow data stream prioritisation (e.g. voice over video over data) that avoid the need for more complex mechanisms such as Network Slicing. mmWave operation with the 802.11ad/ay standards over the licence exempt 57-71 GHz spectrum allows support for wide (2 GHz) channel widths for robust gigabit rate communications using lower modulation levels. Therefore, IEEE 5G based systems are better matched to the needs of tactical communications for the following reasons:

- Standalone, secure & stealthy
- Open – they are easily interfaced to other communications systems (via IP/Ethernet)
- Flexible use of non-commercial spectrum
- Resilient to single point failures and channel interference
- Simple and rapid set-up
- Utilise distributed, peer to peer, mesh networks rather than a centralised core, star topology network (which means there is no single point of failure)
- Flexibility to support a wide range of use cases from space, air, land and naval forces.

Crucially, Size, Weight and Power (SWAP) for IEEE 5G based systems is also compatible with the needs of vehicle level and soldier level deployments. Due to its built-in Doppler correction, the IEEE standard network can be included on almost any tactical platform. Blu Wireless is working with a number of customers in the defence sector to apply and extend its mmWave technology, which is currently being deployed for 'Rail 5G' applications, to tactical comms at the network edge. This includes Mobile Edge Compute (MEC) functionality for smart networking and first level data analytics.

ESD: What are the long-term implications of 5G at the battlefield level?

Barrett: I believe that tactical integration of multi spectral (Radar/IR/Video/ELINT/SIGNIT) sensor data from multiple sources in real time will define the future of battlefield communications. The ability of 5G (as defined above) to deliver peer to peer dynamic mesh networks will form a key part of this vision. For example, radar sensor data from one vehicle (or drone) can be combined with ELINT from another physically distanced drone and then integrated via AI into fire control systems. Thus each vehicle (or drone) can be focused on a specific capability within a cluster with the tactical 5G network used to integrate these capabilities in real time. The complexity, power consumption and size for each element can be minimised and enhanced with new capabilities as technologies mature and evolve at different rates. In turn, this reduces the complexity of procurement programmes as the requirements for each platform can be simplified and focused on one or two core capabilities. A good example of this trend is seen in the UK's Tempest next generation fighter programme for the RAF which will use 'Swarms of Drones' controlled by the aircraft to extend the total platform battlefield capability.

ESD: What are the challenges associated with 5G, especially moving up the chain of command?

Barrett: Integration of multiple data sources and communications across a wide range of operations, including space, air, land and sea, has been recognised as a key strategic challenge for the future of military command and control. A recent example is the Joint All-Domain Command and Control (JADC2) initiative from the US DoD which is aimed at integrated multiple (and legacy) communication networks with new AI data-driven command and control requirements. As described in question 2 above, 'Tactical 5G' has an important role to play in providing an open, flexible and secure communications framework as part of this initiative.

The interview was conducted by Stephen Barnard.

Lessons Learned: When Sensors are Shooters

Next Generation Intelligence, Surveillance, and Reconnaissance (ISR)

John Antal

In the fall of 2020, the second Nagorno-Karabakh War provided a glimpse of what the next generation of Intelligence, Surveillance, and Reconnaissance (ISR) will become: precision-guided munitions with active sensors.

In the past, ISR platforms primarily found targets for other systems to destroy. The recent fighting in the Caucasus, which involved two, near-equal medium powers, has shown how ISR and Precision-Guided Munitions (PGMs) are now blending to become one. During this conflict, the Azerbaijani forces used strike systems, Unmanned Air Combat Vehicles (UCAVs) and Loitering Munitions (LMs) for ISR. These systems had high-end, active sensors that generated real-time intelligence during combat. In addition, they provided accurate and real-time battle damage assessment. In the next decade, strike systems will become smaller, less expensive, and better networked. The lessons learned for next generation ISR from this conflict is dramatic, and was a key factor in Azerbaijan's decisive victory. Some of the primary systems used by Azerbaijan, principally the TB2 UCAV and the HAROP LM, provide an important insight into the future of ISR systems.

Photo: Turkish Defence Industries SSB

The trend in ISR is to merge ISR and strike capabilities into the same platform. Future ISR systems will be smaller, lighter, unmanned, and armed with long-range-precision-guided munitions.

TB2 UCAV

The BAYRAKTAR TB2 medium altitude, long endurance (MALE) UCAV was the star of the Azerbaijani war effort and is the premier product of family-run Turkish defence company Baykar. Headquartered in Istanbul, Baykar operates under the names "Baykar Savunma" (Baykar Defence) and "Baykar Makina Sanayi ve Ticaret A.Ş." (Baykar Machine Industry and Trade Inc.). The Chief Technical Officer of Baykar Makina, Selcuk Bayraktar, studied UAV development while earning his master's degrees at the University of Pennsylvania, and later the Massachusetts Institute of Technology, is also the son-in-law of Turkish President Recep Tayyip Erdoğan. The TB2 that Bayraktar produces is Turkey's first, indigenous armed reconnaissance UCAV. Operators pilot the craft from a ground control station (GCS) by direct radio link or via Turkey's TüRKSAT satellite network. During the Second Nagorno-Karabakh War, the TB2 found and destroyed Armenian tanks, infantry fighting vehicles, artillery and infantry positions. The impressive list of successfully destroyed targets included the BM-30 SMERCH Multiple Rocket Launcher System (MRLS), the 9K33 OSA (NATO designation: SA-8), and five S-300 (NATO reporting name SA-10 GRUMBLE) air defence systems. Of the 200 artillery pieces confirmed by Armenia that were lost in the war, they claimed the TB2s destroyed 120.

The TB2 is 6.5 meters long, with a wingspan of 12 meters, a distinctive inverted V-tail, and a pusher propeller. The two-blade, variable pitch propeller is powered by a 100-horespower ROTAX 912 gasoline internal combustion engine. The cruising speed is 70 knots and the maximum speed is 135 knots. Cruising altitude is 22,500 feet with a maximum altitude of 25,000 feet. Although a Turkish design, many of the original components, including the transponder, engine, electro-optical (EO), micro-munition bomb rack design, and other technologies came from other countries, many of them members of NATO. Some of these manufacturers stopped selling their products directly to Turkey when Armenian social media displayed the manufacturer logos and component markings from the wreckage of several TB2s that were downed in the fighting. Turkey is now working with Ukraine and other suppliers to secure an alternative source for engines, EO systems and miscellaneous components.

To engage targets identified by its EO sensors, the UCAV carries Turkish MAM (Mini Akıllı Mühimmat) laser-guided smart

Author

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micro-munitions developed by Turkish defence industry manufacturer ROKETSAN. The TB2 has four hard-points that can carry two MAM-C and two MAM-L micro munitions, or four MAM-Ls. The MAM-C has a multi-purpose warhead (blast fragmentation, incendiary and armour piercing) and a high-explosive blast fragmentation variant. The MAM-C weighs 6.5 kg, is 70mm long, and has a range of 8 km. MAM-L has a tandem warhead variant, effective against reactive armour, and high-explosive blast fragmentation, and thermobaric warhead versions. The MAM-L weighs only 22 kg, and is one meter long, and can be used to engage stationary or moving targets with high precision within a range of 8 km. The range can be extended to 14 km with the Inertial Navigation System/Global Positioning System option. Selçuk Yaşar, president and CEO of ROKETSAN, emphasised the multi-role ISR and strike capability of the TB2: "The design and application concept of the Smart Micro Guided Munitions allow operators to effectively neutralise time-critical targets, particularly those that arise during reconnaissance and surveillance missions. Meanwhile, thanks to their precision guid-

Photo: Bayhaluk

Turkish Defence Industries SSB

Photo: Jastrow

A HAROP LM on display at the International Paris Air Show in 2007

Photo: IAI

In the past two years, the HAROP Loitering Munition (LM) proved its combat effectiveness in conflicts in Libya, Syria and Nagorno-Karabakh.

ance and small dimensions, they offer a solution with a low collateral damage. When compared with all the other capabilities of the armed forces, a combination of the Smart Micro Guided Munitions and a tactical UAV is the most cost-effective solution. We believe that other countries will also start taking an interest in this solution soon." With the success the TB2 experienced during the Second Nagorno-Karabakh War, ROKETSTAN is exporting the system to new customers around the world, including Ukraine and Pakistan.

The HAROP

The HAROP is a "kamikaze drone", loitering attack weapon that combines the characteristics of a missile and a UAV and is designed to locate and precisely engage stationary or moving targets. The LM concept is not new, but Israel Aerospace Industries (IAI) has turned the idea into a war-winning solution, particularly for military forces that do not have access to other long-range, precision-guided options. IAI designed and produced the HAROP LM in the early 2000s. Turkey became one of IAI's first customers for HAROP in 2005 and successfully employed the system in combat in Libya in 2018-2020. Turkey's ally, Azerbaijan, then became a major customer and IAI sold the HAROP system in ample quantities to the Azerbaijani military several years prior to the Second Nagorno-Karabakh War. The HAROP's primary purpose is to attack radar and anti-aircraft systems, but during the war, it destroyed a wide range of targets that included air defence systems, command posts, and convoys of Armenian soldiers traveling to the front lines. The shrill scream the HAROP generates during its terminal dive to the target is reminiscent of the WWII-era German Stuka dive bomber and had an equally demoralizing effect. When Armenian soldiers spotted or heard the HAROP, they knew they had only seven seconds to take cover before the HAROP struck. One Armenian soldier stated: "There was no place to hide and no way to fight back."

The HAROP is EO guided and provides high-definition video of its flight and terminal attack. Accuracy is within 1-2 m. The HAROP is 2.5 m long with a wingspan of 3 m and weighs approximately 135 kg, including a 23 kg high-explosive (HE) fragmentation warhead. It has a nine-hour flight endurance, a range of about 1,000 km, and a maximum speed of 417 km/hr. During a mission, the HAROP can loiter, identify prescribed targets, dive into the target, or if no appropriate targets are identified, autonomously return to a designated landing strip. With its impressive range and loitering time of approximately six hours, the system can fly autonomously to a designated strike zone to identify targets that meet its targeting parameters. A human operator then gives the weapon the order to attack. According to IAI, "The HAROP LMs are programmed before launch by the Ground Control Station (GCS) to autonomously fly to a pre-defined 'Holding Area,' where they loiter. The MCS (mission control system) periodically checks their position and status during the route to the 'Holding Area.' The MCS operator can thus control a number of HAROP LMs that loiter over a 'Holding Area,' select one LM for target search and attack, while the others are monitored periodically. The operator directs the selected LM to the target area and uses the video image to select a target, and to attack it. The HAROP tracks the target and then dives on it, detonating the warhead upon impact. If required, the attack can be aborted and the operator can re-attack with the same LM."

HAROPs can be fired from truck-mounted "MRLS-like" platforms to create an ISR-strike capability that only elite air forces had in the past. Considering the fleeting engagement times of modern combat, the convergence of "find and strike" provides smaller forces with an important combat multiplier. This capability is particularly useful for expeditionary units. Due to its well-publicised success during the Second Nagorno-Karabakh War, IAI's HAROP has become a best-selling system and has been added to the arsenals of Azerbaijan, China, India, South Korea and Turkey. In February 2020, IAI announced it had sold a naval version of the HAROP system in three separate deals to an undisclosed customer in Asia for US $100M. This maritime version of the HAROP has an extended range and will provide a combined ISR and a lethal strike capability to a wide variety of naval platforms. It could even be installed on a cargo ship.

With accelerated technological change, the methods of war are evolving, and so are the means to conduct ISR and strike missions. In the decade to come, many ISR systems already fielded will continue in the traditional mode of providing ISR information for other munitions, but an ever-increasing number of platforms will combine ISR and attack. Merging both capabilities into one system creates a powerful combination and this points to a trend for smaller, unmanned platforms with multiple roles. UAVs, which were primarily ISR platforms in the past, are now less expensive, more available, and capable of performing both ISR and strike roles. As we connect more projectiles to a networked Internet of Battlefield Things (IOBT), sensors embedded in projectiles will "light up" the surrounding battlespace as they fly to their targets, identifying enemy systems along their route. When this occurs, the battlespace will become transparent. When we network these systems into an interconnected, multi-domain strike capability, and leverage the synchronisation in time, space and effect with Artificial Intelligence (AI), the ability for weapon systems to hide in the battlespace will become nearly impossible. To counter this, new ground combat systems must be built from the ground up, using passive and active means, to mask themselves from these ubiquitous sensors to become difficult to identify and target. The merging of ISR and strike capability, when sensors are shooters, represents a capability tested in recent combat and foretells the evolution of next generation of ISR systems. ■

Railguns and Hypervelocity Projectiles

Expanding Naval and Ground-Force Artillery Options

Sidney E. Dean

The concept of the Electromagnetic Railgun (EMRG) is decades old. However, practical implementation of the concept – which provides for sending high-intensity pulses of electromagnetic energy up two parallel rails in order to accelerate a projectile between those rails at high speeds – was not possible until the early 21st century.

The first armed service to pursue a serious development programme beginning in 2005 was the US Navy (USN). However, early enthusiasm waned. More recently, the Pentagon has turned its attention to firing HyperVelocity Projectiles (HVPs), which were originally developed for the railgun programme, from conventional shipboard artillery instead. This does not mean railgun technology has been abandoned, as research and development on that front continues in both North America and Europe.

Photo: ISL

Europe's PILUM railgun project

EMRG Advantages and Challenges

In principal, EMRG weapons can be used for offensive and defensive applications. EMRGs have some fundamental advantages over missiles and conventional artillery. Two of the greatest advantages vis-a-vis missiles are the depth of magazine and the cost-exchange ratio, factors which have also driven interest in laser weapons. Even the largest surface combatants carry a finite set of missile silos. ERMG magazines can hold hundreds more long-range, high-impact rounds than current shipboard arsenals. And at circa 86,000 US Dollars (2018 estimate), railgun projectiles are much cheaper than either offensive or defensive missiles. Other advantages include: a considerably greater range than conventional shipboard artillery; the lack of an explosive warhead on the railgun projectile, which reduces the risk of collateral damage and enhances suitability for "danger close" fire support missions; and the fact that, when compared to land-attack missiles, railgun HVPs present a greater challenge for enemy air defences.

On the other hand, EMRGs also present significant technological challenges. These include developing materials which can withstand the significant friction and heat caused by high-velocity firing. To date, rails and barrels wear out too quickly to permit operational deployment. The goal has been a barrel life of 1,000 shots before requiring replacement. Another major challenge to installing EMRGs on naval ships is the SWaP factor (Size, Weight and Power). Like lasers and microwave weapons, EMRGs require a significant amount of electric energy. Very large vessels with nuclear or all-electric drive should be capable of accommodating them. Indeed, the US Navy's ZUMWALT class destroyers were expected to be the first naval vessels to field railguns. The problem is that the majority of currently active warships have neither the powerplant nor the extra space and weight allowance for additional generators, capacitors and cooling systems which EMRGs would require. Finally, the targeting and firing system of this completely new class of weapons would need to be integrated into the existing shipboard command and control architecture.

Photo: US Navy

The first BAE railgun prototype installed at NSWC Dahlgren in 2012

Photo: US Navy

General Atomics provided its railgun technology demonstrator to the US Navy in 2012.

Photo: US Navy

Installing BAE's 32 MJ railgun prototype at NSWC Dahlgren in 2012

US Navy Railgun Programme

The 2005 EMRG programme initiated by the Office of Naval Research (ONR) initially sought to develop an additional shipboard weapon for land attack and naval surface fire support (NSFS) missions. As early as 2012, the Navy announced its expectation that shipboard railguns would fire hypervelocity projectiles at speeds between 4,500 and 5,600 mph (7,200-9,000 kph, or Mach 5.9 to Mach 7.4). In comparison, TOMAHAWK Land Attack Cruise Missiles (TLAM) and HARPOON anti-ship missiles achieve only high subsonic speeds, implying that the EMRG would have greater likelihood of overcoming enemy shipboard and shore defences. The kinetic energy released by the impact of HVPs is expected to equate the destructive power of a TLAM warhead, enabling railguns to effectively engage armoured and hardened targets.

The ONR contracted with BAE Systems and General Dynamics for development of two prototype railgun demonstrators, which were installed in 2012 at the Naval Surface Warfare Center (NSWC) Dahlgren Division test facility at Dahlgren, Virginia. They were designed to fire projectiles at energy levels between 20 and 32 megajoule (MJ), which would permit them to strike targets up to 100 nautical miles or 185 kilometres distant. However, it took several years of cautious experimentation and continued engineering to incrementally advance the demonstrators to actually firing at the objective energy levels, and this only within the closed testing facility.

During this time, the Navy's focus largely shifted from the land attack mission to the EMRG's potential for shipboard air and missile defence. This was motivated in part by the growing threat of saturation attacks by Russian or Chinese anti-ship cruise missiles (ASCMs) in case of a major conflict. With a postulated speed of Mach 6, HVPs fired from railgun would fly approximately 50 percent faster than currently deployed air defence missiles such as the SM2 or the ESSM. The EMRG's deep magazines and high rate of fire also make it well suited for combatting saturation attacks designed to overcome shipboard defences. Turning a major portion of the self-defence mission over to the EMRG would also permit shipboard VLS silos to carry fewer air-defence missiles and more land-attack and anti-ship missiles, enhancing overall lethality.

Programme Reset

Despite formal denials by Navy leaders, the year 2017 can be identified as a turning point for the ONR's railgun programme. At-sea testing of a prototype EMRG aboard a high-speed transport vessel, which had been scheduled for 2016 and then moved up by one year, was postponed indefinitely. Instead, the Pentagon opted for continued and prolonged land-based testing. In 2017, a new BAE-systems 32-megajoule EMRG prototype was installed at the Dahlgren testing facility, while a second technology demonstrator was installed at the Army's White Sands testing facility in New Mexico. The two facilities were designed to concentrate on separate aspects of development. The Dahlgren prototype has been used to continue technology development and testing of the railgun itself, working up to increasingly higher firing cadence and range, as well as barrel life. The White Sands facility was tasked with refining the engineering and performance of the railgun projectile, with an eye to deploying it on a variety of weapons.

As a recent Congressional Research Service report noted, "the Navy is continuing development work on EMRG, but it is unclear when production-model EMRGs will be installed on Navy ships. The Navy's FY2021 budget submission requests US$9.5M in FY2021 for continued development of EMRG, but does not appear to programme any additional development funding for EMRG in FY2022-2025." [R. O'Rourke, CRS Report R44175, Navy Lasers, Railgun, and Gun-Launched Guided Projectile: Background and Issues for Congress, updated January 12, 2021]

New Focus on HVP

The aerodynamically shaped kinetic projectiles developed as railgun ordnance by BAE Systems have now taken centre stage. The Pentagon's new focus is adapting these projectiles for firing from conventional tube artillery. This includes the 5-inch (127mm) deck guns standard on cruisers and destroyers, as well as 155mm howitzers deployed by the US Marine Corps (USMC) and the US Army, and the 155mm AGS (Automatic Gun System) deck guns of the three ZUMWALT class destroyers. The projectile is propelled from the gun via a high-energy explosive charge. There is no need to add a booster motor. Prior to firing the projectiles are encased is special "launch packages" which are optimised for the 127mm, 155mm, and railgun barrels, respectively, enabling the same-sized and shaped HPV to be fired from a wide variety of weapons.

The revised emphasis is the work of the Strategic Capabilities Office (SCO). This central US Department of Defense (DoD) office was founded in 2012 with the mission of rapidly developing new capabilities

by devising new applications for existing weapons and technologies. As early as 2015, the SCO recognised the potential to take the HVP, deploy it more quickly by adopting the gun-fired concept, and apply the technology for ship self-defence and for point defence of high value targets on land. In 2016, the then Deputy Secretary of Defense, Robert Work, stated that the gun-launched HVP promised nearly as much capability as the EMRG, but would come available much faster and without the major investment cost of a completely new weapon system. A DoD press release that same year explicitly stated that the Pentagon had shifted away from the railgun as a next-generation missile defence weapon, seeing greater potential in the gun-launched HVP.

GLGP

The programme is now advancing under two separate designations, HyperVelocity Projectile and Gun-Launched Guided Projectile (GLGP). The original term HVP was coined because the projectile, when fired from railguns, was intended to achieve hypervelocity speeds (Mach5+). When fired from 127mm guns, the projectiles reach a speed of only Mach 3, which technically remains below the hypervelocity threshold. This is one reason the term GLGP was coined for the tube-artillery fired munition. Another reason is uncertainty whether the projectile originally designed for the EMRG will ultimately be the one utilised in guns, or whether a new, specialised design would enhance performance. Both terms are currently used, but with formal differences. According to a Navy statement, HVP designates the ongoing development programmes that the SCO and the ONR are conducting in association with BAE. GLGP refers to the planned future acquisition programme and the associated performance specification, which will form the basis for procurement contract competitions.

BAE Systems designed the original ordnance for the EMRG programme, and continues to develop the projectile for use both in railguns and conventional artillery. Recent advances in high-g hardened microelectronics and sensors, thermal protection and advanced energetics have significantly increased the chances for fielding an operational system. Functional attributes include manoeuvrability and precision targeting, in addition to high velocity. BAE has also upgraded the HVP to optionally carry a 6.8 kg payload. This payload could take the form of an explosive warhead with a proximity fuse, which would further enhance the capacity to destroy highly manoeuvrable targets.

HVP/GLGP Capabilities Profile

When fired from the 5-inch deck gun, the HPV achieves a speed of Mach 3. This is about half of the railgun's muzzle speed, but is nearly as fast as STANDARD MISSILE 2 (SM2) and EVOLVED SEA SPARROW MISSILES (ESSM) currently carried for shipboard air and cruise missile defence; it is also twice as fast as a conventional 127mm shell. Some press reports cite a velocity of Mach 5 when fired from a 155mm howitzer, but these claims have not been officially verified by the Pentagon. The HVP achieves a range of 40-50 nautical miles (74-83 km) when fired from the 127mm Mk 45 gun, 70 nm from the AGS, and 43 nm from 155mm howitzers. Maximum rate of fire is equivalent to conventional artillery shells, and varies between six rounds per minute from the howitzer to 20 rounds per minute from the Mk 45.

The Pentagon has high expectations regarding HVP/GLGP performance. The USN and BAE continue to define the HPV as a multi-mission ordnance suitable for "a number of gun systems" including EMRGs and conventional artillery. Depending on the weapon and platform, the projectile is expected to combat surface targets, shore targets (fire support), and aerial targets including UAVs as well as ballistic and cruise missiles. However, the Navy's 2021 budget request focussed on the GLGP's potential for shipboard cruise missile defence, strongly implying this is the current emphasis. The budget request cited the GLGP's ability to provide sustained defence against multiple attack waves, at a much lower cost than deployment of air-defence missiles. As the budget document also points out, using deck guns to combat anti-ship cruise missiles frees up VLS silos which can be filled with additional land attack missiles, increasing the ship's lethality.

Photo: US Navy

The BAE railgun prototype was supposed to undergo at sea testing aboard a Joint High Speed Vessel catamaran in 2016 or 2017, but the experiment was postponed indefinitely.

Photo: US Navy

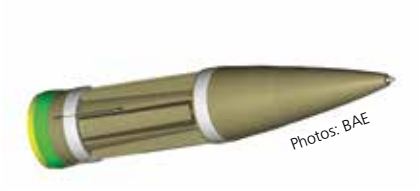
Test firing a 32 MJ railgun at NSWC Dahlgen

Photo: US Navy

A 2008 test of the early 10 MJ railgun firing a 3.2 kg projectile with a muzzle velocity of 2520 meters per second, recorded by a high-speed camera

HPV/GLGP Testing and Maturation

Testing of the gun-launched concept began in 2015 with the firing of HPVs from a land-mounted 127mm Mk 45 gun at NSWC Dahlgren, and has made considerable progress since then. In summer of 2018, the 5-inch gun of the destroyer USS DEWEY fired 20 HVP rounds during RIMPAC 2018. As early as 2017, the Pentagon



The HVP configured to fire from Navy 5-inch guns

For firing from a railgun, the HVP is encased in a conductive sabot, which is propelled from the weapon by electromagnetic pulses. Once the projectile leaves the railgun barrel, the sabot falls away and the HVP continues on to target at hypervelocity.

The HyperVelocity Projectile is 60 cm long and weighs 12.7 kg.

The HVP in the 155mm launch package, configured for firing from 155mm howitzers

Photo: US Navy

The ARLEIGH BURKE class destroyer USS DEWEY fired 20 HPV rounds from its Mk 45 deck gun during RIMPAC 2018.

announced ongoing HVP test-firing by a 155mm US Army howitzer. The first successful intercept of a cruise missile surrogate target by an Army 155mm howitzer firing the HVP reportedly occurred on 3 September 2020 at the White Sands test range in New Mexico. Target cueing was facilitated by integrating the howitzer into the joint Advanced Battle Management System ABMS) command, control and sensor network.

While there is no official date for a production and procurement decision on GLGP, there is no doubt that the gun-launched application is considerably closer than the operational introduction of railguns. HVPs/GLGPs largely overlap EMRGs with regard to advantages such as deep magazines, cost-exchange ratio, and the ability to preserve defensive missiles for the most sophisticated threats. This holds when discussing the projectiles' use in shipboard artillery or land-based artillery. When compared directly with current field artillery munitions, they also promise improved range and speed.

The prime factor favouring GLGP over the EMRG is the – comparative – ease of introducing it into the force. As guided weapons, the GLGP will need to be integrated with the AEGIS combat system and with howitzer battery fire-control systems. However, there is no need to alter power plant or ship architecture. Even if the SwaP factor could be resolved, railguns would most likely be installed on new vessels as they are built, and potentially added to existing vessels as they undergo major maintenance or overhaul – in other words, their introduction would be slow and in limited numbers. GLGP, on the other hand, can be fired from any existing 127mm or 155mm tube artillery. The US armed forces alone currently have 68 ARLEIGH BURKE class destroyers operational, with another 21 under construction or contract. US land forces have more than 1,100 155mm howitzers. Once introduced, it seems likely that close allies would have access to this technology as well. Finally, a priority fielding of the GLGP would not rule out a later introduction of EMRGs to augment tube artillery.

Photo: US Army

A US Army PALADIN howitzer downed a cruise missile surrogate target drone during a joint-force exercise at the White Sands range in New Mexico in September 2020.

PILUM & Co.

US military plans notwithstanding, numerous other nations – including Russia and China – continue to actively pursue railgun development. The Turkish firm YETEKNOLOJI began development of the fully indigenous SAHI 209 Block 2 railgun, which is designed as a 10 MJ system capable of firing 35mm projectiles at Mach 6 over a 50 kilometre range. SAHI is conceived as a naval weapon. And a five nation European consortium has been selected to conduct a two-year railgun research project for the European Defence Agency (EDA).

As the EDA announced in June 2020, the PILUM consortium (Projectiles for Increased Long-range effects Using electro-Magnetic railgun) will attempt to prove the feasibility of launching hypervelocity projectiles with precision over a distance of several hundred kilometres, or five times the range of current long-range fire support weapons. The nine participating institutes and defence firms, which are coordinated by the Franco-German Research Institute Saint-Louis (ISL), will also examine the possibility of integrating the railgun into terrestrial and naval platforms. While an operational system is still far off – the ISL speaks of developing a full-scale European demonstrator "in the next few years" – the wide-ranging interest in these weapons indicates their introduction is only a question of time and technology. ■

Acquisition in the Visegrád Four

Eugene Kogan

Despite the COVID-19 pandemic's huge cost for Visegrád Four (V4 - Poland, Hungary,, the Czech Republic and Slovakia) defence acquisitions in 2020 and beyond, programmes are going ahead, fully supported by defence budget allocations. This means that military acquisitions in the V4 are immune to the general budget decline and likely to maintain their pace into 2021.

The 2020 Czech defence budget amounted to CZK75.5Bn, while according to Jakub Fajnor from the Defence Ministry's Communication Department, "in 2021, the budget increased to CZK85.4Bn or around 1.4% of GDP." Although Czech Prime Minister Andrej Babis said that "modernisation must go on", the contract for the 210 new tracked infantry fighting vehicles (IFVs) was not signed last year due to the pandemic. Jakub Fajnor clarified to the author that "the testing of the three prototypes was postponed until spring 2021 and a call for submission of final offers will be sent to the three companies in the coming weeks. The contract will most likely be signed in August/September 2021." According to Defence Minister Lubomir Metnar, that "will alleviate the defence budget and the military will obtain new equipment, which is so urgently needed." New IFVs will replace Soviet-era BMP-1 and 2 IFVs.

Photo: Bell

As part of a wider effort to phase out the country's Soviet-era Mi-8/17/24s, the Czech MoD just bought eight Bell UH-1Y VENOM utility and four AH-1Z VIPER attack helicopters.

Czech Republic – Champion of Acquisition

Babis added that the "signing of the contract for the procurement of ballistic vests manufactured by the country's STV Group in May 2020 will go on." Metnar pointed out that "the personal protection of our service members is our highest priority. The contract signed in May will cater for the Armed Forces' requirements in this area over the next five years."

In the meantime, the MoD has ordered two Deployable Passive Electronic Support Measures (ESM) Tracker (DPET) radar systems for the Czech Army from Era Pardubice. The contract, worth CZK1.5Bn (US$66.3M), was approved by the MoD on 14 January 2020. The systems will be delivered in 2021 and 2023.

The MoD also signed a framework agreement on 21 April 2020 with Ceska Zbrojovka for up to 39,000 small arms valued at CZK2.8Bn (US$112M). The acquisition follows contracts from 2010 and 2016, when the Czech Army bought 40,000 small arms. Another contract with the Argun company for the delivery of over 30,000 helmets valued at CZK435M was signed in November 2019.

The US Foreign Military Sales (FMS) award, made on 4 September 2020 covers eight Bell Textron Corporation UH-1Y VENOM utility and four AH-1Z VIPER attack helicopters as part of a wider effort to phase out the country's Soviet-era Mi-8/17/24s. Both contracts include weapons, equipment, training of staff, provision of spare parts, and after-sales support. The entire procurement is expected to be worth CZK14.6Bn (US$660M), excluding VAT.

Finally, the country signed a deal in late September 2020 with Rafael Advanced Defence Systems (RAFAEL) to purchase four SPYDER batteries. SPYDER is a low-to-high-altitude surface-to-air missile (SAM) system. According to the MoD, negotiations regarding the exact price and terms have begun. The ministry expects the deal to be valued at about US$430M and to be finalised in early 2021, with delivery due in 2023.

The SPYDER will replace an obsolete Soviet-era 2K12 KUB SAM system to defend military and civilian centres such as industrial hubs, nuclear power plants, airports and other important facilities.

Despite the belated contract for the IFVs, 2020 will go down in the country's history as the best year for weapon systems acquisition.

Hungary on a Spending Spree

The defence budget stood at about €1.7Bn in 2020. Although other ministries have seen their budgets cut for 2021, the

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Masthead

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MoD is planning a 30% increase in defence funding to €2.2Bn for 2021, about 25% of which is earmarked for acquisition.
The major projects include the Airbus H145 helicopters, main battle tanks (MBTs) and self-propelled howitzers (SPHs). It needs to be stressed that in December 2018, Hungary signed a contract with Krauss-Maffei-Wegmann (KMW) for the delivery of 44 newly manufactured LEOPARD 2A7+ MBTs and newly manufactured PzH2000 SPHs. This was in addition to the acquisition of 12 used LEOPARD 2A4 MBTs delivered in summer 2020. The first of 24 SPHs will be delivered in February 2022 to be used for training in Hungary.
The country has also ordered 218 LYNX IFVs from Rheinmetall in a deal valued at more than €2Bn. The contract, which was signed in Budapest in August 2020, includes 218 LYNX IFVs and nine BUFFALO armoured recovery vehicles (ARVs). The contract also includes training, plus an initial supply of spare parts and maintenance support. The contract was signed by General Ferenc Korom, Commander of the Hungarian Armed Forces, and Armin Papperger, Chairman of the Board of Rheinmetall.
During the first stage of production, Hungary is set to receive 46 LYNX IFVs and all nine BUFFALO ARVs built in Germany, with delivery to be completed by 2023. In the second stage, the remaining 172 LYNXs will be built in Hungary to meet the full needs of the country's armed forces. As a result, the Hungarian Government and Rheinmetall agreed in August 2020 to establish a joint venture. The joint venture is currently built in Zala and will be suitable not only for the assembly of the LYNX vehicles, but will also be at the forefront of artificial intelligence, digitisation and robotics.
The Hungarian Air Force took delivery of 16 out of 20 ordered H145M helicopters on 21 December 2020.
Embraer has finalised a contract for the delivery of two KC-390 MILLENIUM transport/tanker aircraft with Hungary on 17 November 2020. The cost of the deal remains unknown and deliveries will be made in 2023 and 2024. According to Embraer, the contract also covers the company's training of pilots and technicians, along with logistical support and other related services.
Embraer says the procurement will "strengthen the Hungarian defence forces' capabilities specifically in the tactical airlift, air-to-air refuelling and medical evacuation roles. The aircraft will be supplied with an intensive care unit-standard medical capability."
The value of the contract, concluded in Budapest in December 2020, for Hungary's purchase of the NASAMS 2 short- and medium-range air-defence system is €410M. Representatives of Kongsberg and Raytheon Technologies signed the agreement. According to General Korom "Hungary will have one of the most modern ground based anti-aircraft systems in the world."
The main elements of the NASAMS configuration provided by Raytheon and Kongsberg are the main Hungarian rocket launchers. The AN/MPQ-64F1 Sentinel three coordinate radars and optoelectronic observation systems and Kongsberg's Fire Distribution Centre (FDC) command centres should be combined with a network-centric fire control system. It will replace the Soviet-era 2K12 KUB SAM system, which has been in use for more than 40 years.
Finally, General Korom and Stéphane Oehrli, President and CEO of Rheinmetall Canada Inc., signed the contract for the procurement of ELM-2084 air-surveillance, air-defence and artillery reconnaissance radars on 11 December. They added that equipment containing AESA radar technology from IAI ELTA will replace the obsolete Soviet radars from 2022 onwards. They also agreed on industrial cooperation.

Poland – An Amendment Bill to Cushion the COVID-19 Pandemic

The Polish Ministry of Finance has prepared an amendment bill for the 2020 budget that was adopted by the Council of Ministers on 20 August. The changes mean that defence spending has been increased from PLN49.8Bn (about US$13.5Bn) to PLN52.8Bn (about US$14.3Bn). The extra funds will be used to finalise extra equipment acquisitions, within the framework of the current Technological Modernisation Plan.

The Polish Government signed an order for the acquisition of 18,000 MSBS GROT C16 assault rifles worth PLN160M (US$40M), bringing the total supplies to the Army by manufacturer Fabryka Broni Lucznik-Radom to 68,000. A contract was signed in April 2020.

The Armament Inspectorate of the Ministry of National Defence (MoND) has launched a tender to acquire 29 KAJMAN ARVs, with the option of acquiring an additional 37 vehicles in June 2020. The vehicles are to be used for reconnaissance and recovery tasks and accompany LEOPARD 2PL and LEOPARD 2A5 MBTs and KRAB SPHs.

The cost of the programme, including the creation of a logistical support centre, is to be between PLN1Bn (about US$250M) and PLN2Bn (about US$500M). The delivery deadline has been set for 30 November 2025.

The MoND has also signed a contract with PGZ for the acquisition of 60 ROSOMAK-S wheeled armoured personnel carriers (APCs) in September 2020. According to the ministry, the value of the contract for these APCs is more than PLN105M (€23.6M) with equipment deliveries due to take place in 2021-22.

The ministry announced in September 2020 that the country has accepted four offers to potentially supply an undisclosed number of 4x4 APCs. They are: the FORTRESS Mk2, jointly offered by France's Arquus and Poland's H. Cegielskil-Poznan plant; HAWKEI, developed by Thales; PATRIOT II, offered by Huta Stalowa Wola and Czech defence Group Tatra Export; and the TUR V, developed by Polish vehicle-maker AMZ Kutno.

Thus far, the ministry has not provided tender participants with detailed technical specifications. Under the plan, the APC will be manufactured in Poland, and the first APCs are to be delivered to the Polish military two years after the contract is awarded.

Slovakia – Controlled Spending

Compared with the three aforementioned countries, Slovakia's defence acquisitions are proceeding at a slower pace because of the country's specifics and controlled spending. According to the MoD Spokesperson Martina Koval-Kakascikova, "the country's defence budget was about 2% of GDP in 2020 but declined to 1.75% in 2021."

In August 2019, it was reported that the Slovak Air Force (SAF) was drawing up requirements for acquiring between 8 to 10 new modern trainer aircraft which will prepare pilots for flying F-16 Block 70 (also known as F-16V) aircraft. The aircraft currently being evaluated include Leonardo's M-345, the BAE Systems HAWK and the Aero Vodochody L-39NG.

The final choice will not only take into consideration the aircraft and its integrated training system, but also the opportunity for cooperation with Slovak defence companies. According to the Defence Minister,

Jaroslav Nad', "the country intends to spend about €10M per aircraft. Thanks to the new trainer, our next F-16 pilots will be able to fly many hours in Slovakia and not have to complete all training in the United States. This will save us millions of Euros." The final decision has not yet been made though.

On 27 May 2020, the Slovak Government endorsed the proposal by Defence Minister Nad' to cancel 424 4x4 multi-role tactical vehicles valued at €321M. According to Koval-Kakascikova, "currently, the parameters of the acquisition programme are revised. It is known, however, that the MoD is interested in involving a large number of Slovak defence industry enterprises."

On 13 January 2021, the government agreed with the MoD's proposal to procure 17 mobile 3D short- medium and long-term radars valued at €148M including VAT, from Israel Aerospace Industries. The winning bid guarantees the reinvestment of 35% of the contract price, or about €50M in Slovakia. According to Minister Nad', "Israel agreed to involve local defence industry in the project." The delivery timeline for the radars is between 2022 and 2026.

Photo: MoD Hungary

Hungary has recently signed a contract with Krauss-Maffei-Wegmann (KMW) for the delivery of 44 newly manufactured LEOPARD 2A7+ MBTs.

Photo: Rheinmetall

Hungary has also ordered 218 LYNX IFVs from Rheinmetall in a deal valued at more than €2Bn.

Photo: Fabryka Broni

The Polish MoD ordered another batch of 18,000 MSBS GROT C16 assault rifles worth PLN160M (US$40M), bringing the total supplies to the Army to 68,000.

RAFAEL announced on 5 March 2020 that Slovakia has chosen the company's SPIKE LR II missile for its infantry and military vehicles. The deal between RAFAEL and the Slovak MoD also includes dismounted advanced integrated control launch units.

Conclusion

The abovementioned acquisition programmes reveal a lack of cooperation between the V4 countries and therefore the potential for savings that could be invested in the development of local defence industries. Nevertheless, the acquisition programmes show that the leadership of the V4 are determined to acquire new and modern weapon systems. It also shows the countries' efforts to be at the forefront of NATO's acquisitions and also to be net contributors to NATO's overall military capabilities. ■

The author would like to thank Jakub Fajnor, Press Section, Communication Department, Czech MoD and Martina Koval-Kakascikova, Spokesperson of the Slovak MoD for assistance in the preparation of this article.

Securing Littoral Borders

Understanding Threats and Challenges for Maritime Borders

Tony Kingham

Maritime borders present huge security challenges for the border protection community, with dramatically varied terrain, from mountains and cliffs, to beaches and swamps, and often tens of thousands of kilometres of extended coastline with multiple isolated bays, inlets, estuaries and islands, all of which can be exploited by terrorists, illegal migrants, drug and arms smugglers, human traffickers and for organised crime.

The challenges the authorities face in controlling maritime borders has been clearly illustrated by the difficulties which the UK Government has had in preventing illegal migrants landing on its shores, despite favourable local conditions. After all, the English Channel is one of the busiest shipping lanes in the world, where weather conditions are often extremely hostile and beaches suitable for landing mean longer sea journeys for migrants in unsuitable vessels.

Despite this, the number of migrants reaching the UK's shores in 2020 is estimated to have been around 9,500, quadruple that of 2019. This illustrates just how difficult it is to properly police the maritime borders, even for one of the richest and most highly developed countries in the world.

Now contrast this with another European example, namely Greece. With 13,780 km of coastline, Greece has over 6,000 islands and islets scattered in the Aegean and Ionian Seas, of which only 227 are inhabited. This means tens of thousands of inlets, bays and channels which human traffickers, drug smugglers, or terrorists can utilise.

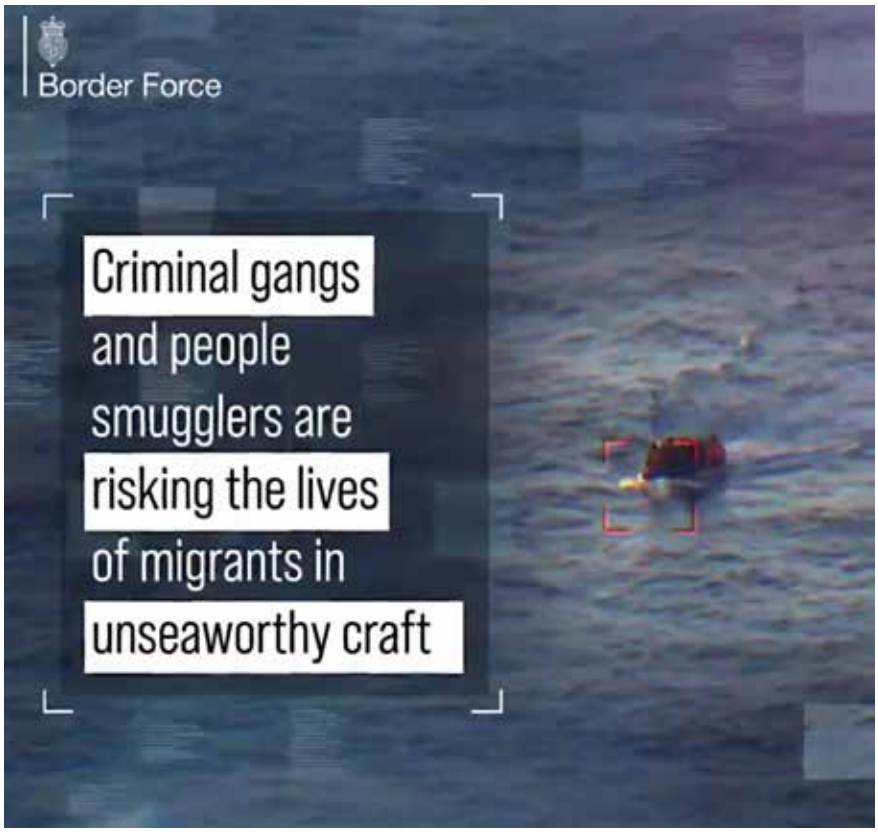

Photo: UK Border Force

The UK Border Force has had considerable difficulties preventing illegal migrants landing on its shores.

Submersibles

In the US, in addition to the more commonly used methods of smuggling drugs into that country, such as fast speedboats and light aircraft from all points south, there has been an increase in the number of submersibles and semi-submersibles being used. Despite the fact that these submersibles are often built in primitive South American jungle workshops, they have been shown to be highly effective and capable. Indeed, it was recently reported that the first 'detected' drug-carrying submersible reached Europe from South America. This means submersibles are not just a regional problem, but a global threat to national borders.

Another favoured technique used by smugglers is to cache drugs at sea, in a river or harbour, fixed to buoys or simply sunk to the bottom at recorded GPS coordinates, to be picked up later by local craft or divers. This means it is necessary to have some sort of underwater detection and tracking system, as well as effective mapping of the harbour, river, estuary or seabed. This would be necessary so the authorities are aware of what is underwater in given locations, and consequently, what should not be. And then, of course, there are drones.

Often, the first face-to-face contact that crews of commercial vessels or pleasure craft have with local authorities is after they have dropped anchor in harbour or have docked at the quayside. For drug smugglers, this is the time of highest risk and whenever possible, is to be avoided. This is why they will look for isolated beaches, coves, inlets or river estuaries to offload their illicit cargo. Nevertheless, even here they remain vulnerable, as the authorities will also recognise likely points of ingress and deploy their resources accordingly.

So, it is a better option for them to anchor offshore, perhaps in the lee of remote cliffs, out of sight of coastal radar and optical surveillance, and simply fly their drugs by drone to an awaiting accomplice on the cliff top.

Drones

On 1 November 2020, Singapore-based company F-drones completed what they claim to be the world's first commercial ship-to-shore drone delivery at night. De-

Author

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Photo: Frontex

The European Border and Coast Guard Agency (Frontex) operates a maritime HERON RPAS.

livering a critical 3 kg spare part to the bulk carrier BERGE SARSTEIN, anchored 5 km offshore, the flight took just seven minutes. Now, this author has no evidence to substantiate this claim, but I would confidently assert that this was not the first 'commercial' drone delivery at night. Far from it. Organised criminal gangs and especially drug traffickers, are well known to be early adopters of new technology, after all, we have seen numerous examples of drones being used to smuggle drugs into prisons. And of course, for drug traffickers, cost is no barrier.

Just a quick Google search for 'heavy lift drones', and on the first page one can buy a very capable JT20L-606 drone, with a 20 kg payload and a 15 minute flight duration for only €12,600. Drones are here to stay and their capabilities will only improve. Therefore, drone detection and mitigation must now form part of any maritime border security system.

However, it is notoriously difficult for conventional radar to identify these small, fast moving, unmanned aerial vehicles, especially in the maritime environment where the reflective nature of moving water makes it particularly difficult.

Furthermore, the difficult coastal conditions do not just pose a problem in drone detection. Weather, such as coastal fog, mist, and storms, in addition to the regular traffic of legitimate commercial shipping, ferries, pleasure craft, fishing boats, jet skis and scuba divers mean the littoral zone is a fast moving, ever-changing and cluttered environment. This all means that littoral border security constitutes a truly a multi-dimensional challenge encompassing air, land, sea and subsea environments.

Border-Protection Technologies

Effective border security along the littoral must be multi-layered and include multiple technologies. Different technologies to be considered include radar, sonar, electro-optics, FLIR, lidar, diver detection systems, Unmanned Aerial Systems (UAS) and aerostats. The key to this multi-layered approach is knowing precisely what technologies to choose, in what mix, and how to integrate them into one effective system.

Key systems providers include some of the biggest names in the world of defence, as well as many new tech companies that have entered this burgeoning sector.

Hensoldt are Europe's largest sensor systems house, offering a wide range of state of the art systems. These range from radar such as the SPEXER family and SharpEye coastal radars, to mobile and stationary EO/IR surveillance systems such as the NIGHTOWL range, used for object tracking and identification. Hensoldt also offer their own proprietary C2 system.

Blighter Surveillance Systems manufactures a solid-state micro-doppler radar system that is deployed in 35 countries globally, including along the sensitive Korean peninsula's 39th parallel border. Blighter's C400 radars for coastal security have a modular, non-rotating, entirely solid-state design.

US company Echodyne produces highly compact solid-state beam-steering radar sensors. Echodyne combines patented Metamaterial Electronically Scanning Array (MESA™) technology and Acuity™ intelligent radar software to achieve maximum radar performance at low cost.

Anduril's core offering is its Lattice, AI software that collects data from mesh-connected sensor assets (such as Anduril's Sentry towers and Ghost sUAS) and classifies them using machine learning. These tracks are fused into a single autonomous operating picture, alerting agents in real-time and providing intelligence for rapid and accurate response.

Robin Radar Systems specialises in the tracking and classification of drones by combining purpose-built radars with unique software algorithms.

STYRIS software from Airbus is designed to collect, process, consolidate, distribute and display data from a wide range of maritime sensors. The software consolidates data gathered from sensors like radars, automatic identification system (AIS), radio direction finders (RDF), cameras, weather stations and sonars. These companies and others will be attending the World Border Security Congress in Athens on 8 - 10 June, which is the premier international border security event and represents an excellent opportunity to learn about these systems in person.

Finally, it is clear that UAS or drones pose not only a potential threat, but going forward, will become a game-changing asset.

In October 2020, Airbus, in partnership with IAI of Israel, won the contract from the European Border and Coast Guard Agency (Frontex) to provide and operate a medium-altitude long-endurance Remotely Piloted Aircraft System (the maritime HERON). The service is expected to be delivered in either Greece, Italy or Malta. The loitering capability of these top-end systems offers incredible flexibility and operational reach. But systems like the HERON are at the top-end of the spectrum.

Smaller commercial drones, whether piloted, autonomous or tethered, are becoming increasingly capable and less and less expensive, offering real force multipliers for overstretched border services.

If, as the famous Duke of Wellington once said: "The whole art of war consists of guessing at what is on the other side of the hill", then the same can hold true with "The whole art of border surveillance consists of knowing what is on the other side of the hill or bay or clifftop." When integrated with other systems, drones certainly offer that capability. ■

Photo: Blighter

Blighter`s C422 Coastal Security Radar

Dynamic Encryption

Eavesdropping on smartphones and the hacking of messages and files is easier and more widespread than most companies think. Smartphone security is still an overlooked area in many businesses. Often, companies only recognise the need to secure their phones after a data breach has been discovered, that is, if the breach is discovered at all.

"There is a huge dark figure. Companies do not necessarily know if and when their communication was intercepted," says Hans Hasselby-Andersen, CEO of Dencrypt. "The intercepted data may be used discreetly, so you may never find out or only suspect it long after. It could be that your invention suddenly appears in a product from a competitor, or that a business deal goes awry, and you never find out why."

Dencrypt develops and markets encrypted communication solutions that enable companies and public organisations to communicate business-critical and sensitive information in a safe and secure way.

The Threat is High

According to various assessments, the threat of cyber espionage against authorities and companies is very high and growing. This applies to many organisations, including those operating in critical sectors such as transportation, energy, telecommunications, finance, and health care.

According to Hans Hasselby-Andersen, many companies in the private business sector are vulnerable.

"Companies that are either research-intensive or have production in parts of the world where one is more exposed to surveillance should think about how they communicate digitally. With sufficient resources and technical insight, it is not particularly difficult to hack and eavesdrop on phone conversations in the mobile networks around the world. "

Dynamic Encryption

Dencrypt's communication solutions are based on a special encryption principle, Dynamic Encryption. It works by adding an encryption layer on top of an existing fixed encryption algorithm to provide extra protection. Cryptanalysis – code breaking – normally requires large amounts of data encrypted by the same method. As Dynamic Encryption is constantly mutating, cryptanalysis is rendered nigh-on impossible.

Photo: Dencrypt

Hans Hasselby-Andersen is the CEO of Dencrypt

Dencrypt Communication Solution

Dencrypt enables smartphone users to communicate securely. The apps for voice communication and messaging use end-to-end encryption to protect data. This allows commonly available, but unsecure, data channels, such as Wi-Fi or mobile data networks, to be used for sensitive communication. Dynamic Encryption is applied to provide the highest protection level.

Encryption is the Future

Dencrypt's solution is Common Criteria certified, the international standard for IT security. On this basis, the Danish Defence Intelligence Service, as well as NATO, have given the solution accreditation to be used for classified communication.

Dencrypt has research activities that go further into the future and are currently leading a research project on so-called quantum-safe encryption. The project is carried out in collaboration with the Technical University of Denmark and the Danish Armed Forces.

"When quantum computers become powerful enough to solve the mathematical challenges that encryption is based on today, it will affect our IT security. The research project is aimed at finding robust cryptographic algorithms that can be implemented in the communication solutions of the future."

The First War Won Primarily with Unmanned Systems

Lessons from the Second Nagorno-Karabakh War

John Antal

The Second Nagorno-Karabakh War was fought between Armenia and Azerbaijan from 24 September to 10 November 2020. This 44-day war resulted in a decisive military victory for Azerbaijan.

Armenia was out-fought, out-numbered, and out-spent and lost even though they controlled the high-ground in a mountainous region that favoured traditional defence. Azerbaijan's alliance with Turkey, and close technological support from Israel, strategically isolated Armenia. In addition, Turkey's posturing influenced the Russians not to intervene to support Armenia. That Azerbaijan attacked Armenia during the pandemic was an additional factor. The fact that Azerbaijan won the war is not extraordinary, considering the correlation of forces arrayed against Armenia. What is exceptional is that this was the first modern war primarily decided by unmanned weapons. In this war, the Turkish-made BAYRAKTAR TB2 Unmanned Air Combat Vehicle (UCAV) and the Israeli-made HAROP Loitering Munition (LM) dominated the fighting and provided Azerbaijan with a war-winning advantage. Here are ten lessons derived from a deep study of the open-source information about the conflict.

Photo: Image capture from Azerbaijani MoD video

An Azerbaijani HAROP Loitering Munition (LM) strikes an Armenian D-20 Howitzer as a second HAROP "kamikaze" LM flies past to strike another target.

Know Yourself and Know Your Enemy

The First Nagorno-Karabakh War was a protracted conflict fought between1988 to 1994. The war ended in Armenian victory and the occupation by Armenia of most of Nagorno-Karabakh. The Azerbaijanis did not want a repeat of that disaster. They researched their opponent, studied recent changes in the methods of war, adopted the latest weapons and proven tactics from Turkey's experience in Syria and Libya, and trained their forces. Azerbaijan foresaw a niche advantage over their enemy and outspent Armenia six-to-one, investing more than $24Bn in the decade before the war to purchase the latest Unmanned Aerial Vehicle (UAV), UCAV, and LM technology from Turkey and Israel. One of the primary lessons of the Second Nagorno-Karabakh War is to "know yourself and know your enemy," and act on that knowledge.

Maintain the Initiative

Buying the best kit does not alone guarantee success in war. Training, organisation, and leadership are key. Turkey helped train Azerbaijani operators for their newly acquired Unmanned Aerial Systems (UAS) prior to the conflict. Armenia knew of this but did not react in time. Importantly, Azerbaijan had an effective plan, mobilised first, struck first, and then maintained the initiative throughout the war. The first to move in the three-dimensional game of chess that is modern war, and to integrate and synchronise fires and manoeuvre into a unifying concept, gains a tremendous advantage, and this is what Azerbaijan did. Armenia reacted to Azerbaijani moves from the first day of the war and never recovered.

Dominate as Many Domains as Possible

Azerbaijan fought in all five domains (land, sea, air, cyber, and space), while Armenia fought in the land, air, and cyber domains. Azerbaijan used Turkish satellites and ac-

Author

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cessed commercial satellites for data transmission and information. Azerbaijan commanded the land, air, space, and cyber domains for decisive moments during the first two weeks of the fighting to devastate Armenian air defences and this gave Azerbaijan air supremacy over Nagorno-Karabakh. From that moment on, the Azerbaijanis continued to fight in all domains to their advantage. The ability to see, decide, and engage targets for UCAVs, LMs, and long-range artillery. Once Azerbaijan won air supremacy by destroying Armenian air defences using UCAVs and LMs, the Azerbaijanis then manoeuvred ground forces to occupy key terrain and critical objectives. The ground manoeuvre was often contested, and the Armenians inflicted casualties on the Azerbaijani ground forces, but most engagements were won

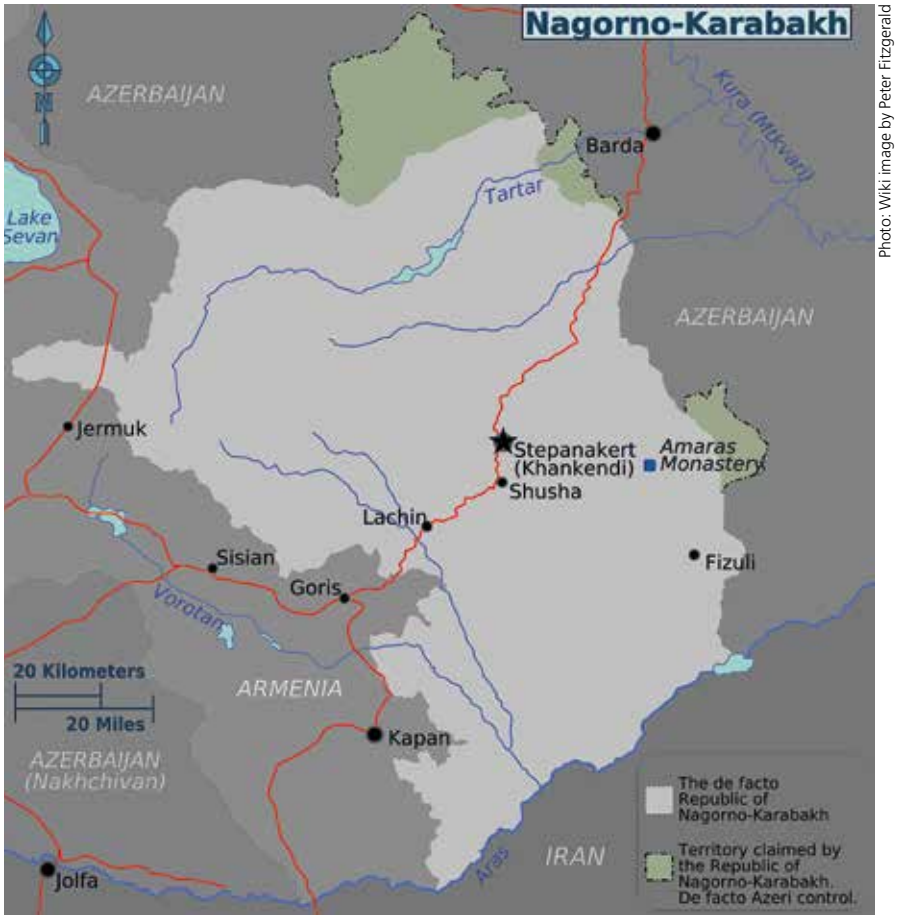

Photo: Wiki image by Peter Fitzgerald

Map of the Nagorno-Karabakh region, depicting the key towns and the road from Goris-Lachin-Shusha-Stepanakert, known as the Lachin Corridor

in multiple domains, and dominate the ones that matter during decisive periods, is the essence of war in the 21st century.

Precision Fires Enable Manoeuvre and Manoeuvre Exploits the Effects of Fire

Fires have enabled manoeuvre in many wars, but the use of precision fires in this war was telling. The war was won by Azerbaijan with precision stand-off weapons, primarily UAS and artillery. Most of the casualties inflicted upon the Armenians were from TB2 UCAVs (approximate cost is US$3.5M) that launched smart micro-munitions, the HAROP "kamikaze" LMs (at a cost about US$70.000 each), and other UAVs that designated by UCAVs, LMs, and UAVs spotting for artillery, before close-combat engagements occurred. Electronic Warfare (EW) "fires" also played an important role, to set the conditions for the UCAV and LM assaults, and there are reports that the Turkish KORAL EW system was used to prepare the battlespace prior to these attacks, as the Turks have demonstrated in combat operations in Syria and Libya. The Azerbaijani ground forces took several weeks to secure about 70 kilometres in the southern, lowlands of Nagorno-Karabakh, before turning north to take key terrain along the Lachin Corridor and the strategic town of Shusha. Throughout this effort, the Azerbaijanis method was to employ precision fires to enable ground force manoeuvre.

The Battlespace is Transparent

Azerbaijani sensors, mostly mounted on UAVs, gave the Azerbaijani military a clear, 24-hour, unblinking view of the battlespace. Armenian positions that were camouflaged in the traditional way were still identified by electro-optical and thermal cameras. Intelligence Surveillance and Reconnaissance (ISR) platforms were merged with strike capability in the forms of the TB2 and HAROP. High-definition, full-motion-real-time videos from these platforms provided ISR, destroyed systems and personnel, and provided accurate battle damage assessments (BDA). Although both sides had plenty of tanks, it appears that tanks seldom got within shooting range and most engagements were fought at stand-off distances. Combined arms can still be decisive, as air platforms cannot take and hold ground, but only if ground forces survive long enough to move within direct fire range. During the war, there were more standoff engagements, than close combat fights.

Masking

During the war, the Armenians could not hide. Physical camouflage was ineffective. One Armenian soldier said: "We cannot hide, and we cannot fight back." Unable to mask from enemy sensors and precision strikes, the Armenians were demoralised. If camouflage is no longer enough, then a new concept of "masking" is required. Masking is the ability to become hard to detect and difficult to target. Masking involves a full spectrum effort to employ all active and passive means to confuse, disaggregate, disrupt, jam, and deceive the enemy's sensors and targeting network. Masking will require new systems that minimise thermal and electronic signatures. Masking will also require new tactics, techniques, and procedures (TTP). In the modern battlespace, you either mask or die.

Top Attack is the Decisive Method of Engagement

The proliferation of affordable and effective top attack systems, as exemplified by the TB2 and HAROP, is a significant trend. It is no longer necessary to have a big cannon to penetrate the front glacis of a tank's armour if you can destroy the tank with great accuracy from the top. Videos confirm that Azerbaijani top-attack UAS strikes destroyed as many as 185 Armenian tanks, 90 armoured fighting vehicles, 182 artillery guns, 73 multiple rocket launchers, 45 air defence systems, and 450 other vehicles. The scale of these

strikes by unmanned systems is stunning and unprecedented. In the long counterinsurgency wars of the past 20 years, insurgents attacked vehicles from the bottom with improvised explosive devices (IEDs). The IEDs now fly, and the top of an armoured vehicle is the Achilles heel of modern war.

Photo: Image capture from Azerbaijani MoD video

An Azerbaijani TB2 UCAV used smart micro-munitions to strike an Armenian position under a bridge.

Active Protection Systems and Air Defence

The war highlighted the requirement to defeat top-attack munitions. Most active protection systems, like the Israeli-made TROPHY system, do not protect armoured vehicles from top-attack munitions. To survive in this new environment, a layered, multi-capable, full-spectrum, air defence against top attack munitions, missiles, aircraft, and low-speed and high-speed threats, is vital. The lesson learned here is that future wars require a "spherical defensive system," a mobile protective bubble. Active defence, to protect vehicles and personnel from underneath, lateral and top attack, will require new systems and will represent a significant investment by military forces. To survive, key platforms must be capable of disrupting, deflecting, or confusing incoming direct-fire and top attack munitions with either on-board systems or complimentary systems that accompany them. Many legacy systems, such as the M1 Tank, are already reaching their maximum weight and available surface area capacities. Additional systems, preferably unmanned systems, could provide this capability to legacy platforms to enhance survivability in the new multi-domain battlespace.

Win the Information War

Both sides waged an information campaign against the other, but the Azerbaijanis prevailed through their use of full-motion video footage from UAS and precision guided munitions. The images of Armenian air defence platforms, artillery, tanks, infantry fighting vehicles, and troops being decimated in these videos played on all available social media outlets. Many of Armenia's Russian-made air defence systems were videoed with their radars spinning just before a HAROP or smart-micro munition blew the system to pieces. These videos showed how Armenia was losing the war and could do nothing to stop the Azerbaijani attacks, even when they were attempting to fight back. This footage influenced Armenia to surrender to Azerbaijan's cease-fire terms and helped to deliver a decisive victory to Azerbaijan. These videos also became a successful marketing message and the TB2 UCAV and HAROP LM are now the hottest items on the international weapons market.

War Now Moves at Hyper-Speed and is More Connected than Ever Before

The pace of battle is now extremely fast. Engagements in the war were executed in real-time by multi-domain effects and battles were decided very quickly. Wars may still be long, as they are a test of human will, but a continuous chain of catastrophic engagements as experienced by the Armenians is demoralising and can destroy the will to fight. Using unmanned systems, the kill-chain accelerated. A kill-chain represents how an attack is structured and consists of target identification, dispatching a force to engage the target, deciding to attack the target, and then engaging the target. Most kill-chains today have a human performing the "decide to attack" function. As the human-in-the-loop (HITL) kill-chain transforms to an AI-leveraged human-on-the-loop (HOTL), or human-out-of-the-loop (HOOTL) kill-web, the speed of combat will quicken beyond human cognition and AI assistance will be required to control the fight and win.

The lessons of the Second Nagorno-Karabakh War represent a significant change in the methods of war. The use of UASs in this conflict, however, should be considered in context. Bad weather, effective air defence, and Counter Unmanned Aerial Systems (CUAS) could have worked against the Azerbaijanis. As it turned out, the weather was good up until the last week of the war, the Armenian air defence was not effective against the Azerbaijani UAS onslaught, and the few Russian-made CUAS systems that the Armenians possessed proved ineffective. Nevertheless, the synchronisation of new weapons makes the modern battlefield more lethal and offers opportunities for a skilled opponent to use them to advantage. Most important for today's military, this war has significance similar to the impact of the 1973 Yom Kippur War. The lessons of the 1973 War influenced the development of tactics and weaponry during the Cold War and beyond. For example, the US military conducted a thorough study of the Yom Kippur War, derived a new doctrine called AirLandBattle, and developed new systems, the "Big 5" – the M1 Main Battle Tank, BRADLEY Infantry Fighting Vehicle, APACHE Helicopter, BLACK HAWK Helicopter, and PATRIOT Air Defence System. These warfighting platforms, although significantly upgraded, remain the mainstay of the US Army's striking power today. The methods of war, however, are changing and the recent fighting in the Caucasus provides insights for wars to come. As the first war won primarily with unmanned systems, we neglect the study of the Second Nagorno-Karabakh War at our own peril. ■

An Azerbaijani TB2 UCAV uses smart micro-munitions to strike an Armenian position in the left side of this image and then locates another target to the right. The TB2 destroyed the second position moments later.

Viewpoint from New Delhi

Photo: Suman Sharma

The Second Indo-Pak Ceasefire Agreement – How Long Will It Last?

Suman Sharma

The English painter Emma Chase once said, "Some battles don't have a winner. Sometimes the best a good General can hope for is a ceasefire." In this sense, India and Pakistan took a second shot at peace by entering into a ceasefire agreement in February 2021, after the first agreement signed in November 2003 failed to elicit the desired result in maintaining peace along the 740 km long LoC (Line of Control). In what was touted as the result of back-channel efforts by both National Security Advisors, peace was actually brokered during a telephone call between the Director Generals Military Operations (DGMO) from both sides.

The 2003 ceasefire agreement reached between the warring nuclear neighbours was also the brainchild of the then DGMOs following the 1999 Kargil conflict. But the agreement turned out to be a failure following constant shellings at the LoC, the International Border (IB) and the Actual Ground Position Line (AGPL) in Jammu and Kashmir. In 2013, the situation worsened after the beheadings of two Indian Army soldiers at the border, allegedly by Pakistan. Former DGMO of the Indian Army, retired Lt. General Vinod Bhatia says, "The US, UN and many other nations have fully supported the renewed ceasefire agreement, as the daily duels along the LoC are perceived as a trigger for a spiral between the two nuclear armed nations."

In what is seen as a result of Pakistan's dwindling economy, pressure from the Financial Action Task Force (FATF), the Trump administration's 'Doha Accord' (now under review by the Biden administration), and with Pakistan losing its status as a strategic US ally, the new agreement is viewed by experts with a mixed response. A total of 5,100 ceasefire violations (CFV) by Pakistan were reported by India, with Pakistan in turn reporting 3,003 CFVs carried out by India along the LoC in 2020, signalling an unprecedented spike. These figures raise questions about the success and lifespan of the new agreement, especially with the upcoming summer when the snow melts, thereby paving the way for irregulars to be trained and inserted by Pakistan through launch sites at the border. However, the Indian Army has successfully prevented CFVs along the LoC east of Zojila in the snow bound areas of Drass, Kargil and Batalik. Maj. Gen. BK Sharma, Director, United Service Institution, argues, "Given the imponderables in the relations between India and Pakistan, it's very difficult to put a timeline regarding the longevity of this ceasefire agreement. What is important at this time is that this initiative has the endorsement of the Pakistani Chief of Army Staff and therefore there is hope for this to stay for some time. It is not in India's interest to have problems at the LoC and the LAC at the same time."

However, the first sign of a thaw in the 'icy no-talks' relationship became visible in early February this year when Pakistan's Army Chief, General Qamar Javed Bajwa, advocated 'peaceful coexistence' and 'mutual respect' for the first time since the Balakot air strike by the Indian Air Force (IAF) in February 2019, which destroyed more than 300 terror launch sites. General Bajwa's stance was suitably reciprocated by the Indian side when New Delhi allowed Pakistani Prime Minister Imran Khan to fly through Indian air space for his Sri Lanka visit. It has hitherto been the stated position of the Narender Modi-led Government that 'terror and talks cannot go together', leading to the freeze in dialogue between the neighbours.

Lt.Gen. Bhatia states that "India and Pakistan now need to talk at the political, diplomatic and military levels to seek a reasonable resolution ensuring relative peace. As the Pakistani Army drives the country's India Policy, the Indian military could lead the talks for once, though naturally under political direction. It is easier for military professionals to engage in straight, no nonsense talking, which may result in peace even if fragile and temporary. A major factor determining the way forward will be to analyse Pakistan's compulsions in renewing the ceasefire, to analyse whether it is a 'tactical initiative or a strategic imperative' or possibly both."

Armenia: A Tectonic Fault

Dr. Gayane Novikova

The full-fledged Karabakh war (September 27 – November 9-10, 2020) has become a watershed in the post-Soviet history of Armenia.

It will take time to evaluate human, territorial, economic, political, and moral losses, to recover, to strengthen the sovereignty of the country, and to overcome the aftermath of this war. The aims of this article are a) to discuss the challenges Armenia is facing currently and b) to attempt to offer ways out of this dangerous situation. Some parts of this puzzle are still missing; many questions remain unanswered.

Dynamics of the Conflict

At the foundation of the first Karabakh war (1991–1994) was a collision of two principles of the Helsinki Declaration: the right for self-determination and territorial integrity. Correspondingly, the principal parties to the conflict were the Armenian population of the former Nagorno-Karabakh Autonomous Oblast' (NKAO) and the newly-independent Republic of Azerbaijan. The war ended with the Armenian side's military victory. An open-ended ceasefire agreement brokered through Russian mediation was signed on 11 May 1994 by the military leadership of Azerbaijan, Armenia, and the Commander of the Nagorniy Karabakh Army of Defence. Further negotiations were initiated within the framework of the OSCE Minsk Group. However, important shifts in the very nature of the Nagorniy Karabakh conflict (NKC) occurred over the next 26 years.

- The ethno-political conflict between the Armenian ethnic minority and the state inside Azerbaijan gradually transformed into a territorial conflict between the unrecognised Nagorniy Karabakh Republic (NKR, fully backed by the Republic of Armenia) and the Republic of Azerbaijan.

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Photos: Diana Ananyan

The village of Shoshin in Nagornyi Karabakh, on 15 November 2020

- Initially de jure an intra-state conflict, the NKC became transformed into a de facto international conflict between Armenia and Azerbaijan after the exclusion of the representatives of the NKR from the negotiation process in 1998.
- The approaches of the parties to a resolution of the conflict were incompatible. Both Armenians and Azerbaijanis claimed the territories of the former NKAO and seven regions (controlled since the 1994 ceasefire by the Armenians) as their own historical lands. Therefore, these territories were called in the Armenian political lexicon "liberated" vs. "occupied" in the Azerbaijani terminology. The final goal of the negotiations for Armenia and the NKR was international recognition of the NKR and a guarantee for life and security for its population. For Azerbaijan, the aim was the return of the territories (the former NKAO included) by all means to its full jurisdiction.
- The Armenian sides chose mainly a passive attitude, focusing on the preservation of the status quo established in 1994. They were ready to discuss a mutually acceptable compromise. The Azerbaijani side adopted a proactive strategy, emphasizing its right to resume the war and, therefore, rejecting any possible compromise.

Trapped by the Status Quo

A psychological factor played a quite negative role in Armenia's approach to the resolution of the conflict. The 1994 military victory was taken for granted and the negotiations were perceived as a tool to achieve (with the help of the international mediators) the most favourable resolution of the conflict for the Armenian sides. At the core of the modus vivendi was a formula – "territories in exchange for a status of Nagorniy Karabakh" – and a misguided assumption: the international community will recognise the NKR's independence sooner or later.

An attempt by the first Armenian President Levon Ter-Petrosyan to resolve the conflict in accordance with the above-mentioned formula ended in his resignation in 1998. The next two Presidents,

Robert Kocharyan and Serzh Sargsyan, did not exclude (although neither did they openly support) the possibility for a step-by-step solution.

The stagnation of negotiations caused a gradual transformation from conflict resolution to conflict management. The Armenian sides had viewed the situation on the ground as relatively secure; however, they emphasised the necessity to increase the capacities of the OSCE monitoring mission along the Line of Contact and to exclude the "use of force or the threat of force." Meanwhile, unable to offer any significant modification of the Madrid Basic Principles, the mediators preferred to focus upon a "necessity to prepare the societies for the peace." In the meantime, Azerbaijan – along with a build-up of its military might – was becoming more exasperated and aggressive. Openly blaming the OSCE Minsk Group for its inability to resolve the conflict through negotiations and simultaneously generating and promoting anti-Armenian sentiments through a bellicose and hatred-inciting rhetoric, President Ilham Aliyev had been preparing his society for revenge and a war against the NKR and Armenia. The territorial claims of the Azerbaijani leadership became louder and louder.

Shahumyan Region in Nagornyi Karabakh, on 15 November 2020

Clear indications of Azerbaijan's shift toward a resolution of the conflict through military means were the shooting down of the Armenian helicopter MI-24 in November 2014 by the Azerbaijani Armed Forces and – more significantly – the four-day war in April 2016. The latter revealed the poor preparedness of the Armenian sides for war and signalled a serious change in the balance of power in the area of the conflict. The April war became also a catalyst for an eruption of political instability inside Armenia.

After the 2018 Velvet Revolution, the Pashinyan government tried, in regard to the NKC, to adopt a proactive position

The hospital in Stepanakert, capital of the unrecognised Nagornyi Karabakh Republic

that included several provocative – especially from the Azerbaijani viewpoint – statements and actions. Azerbaijan responded in July 2020 with a direct attack on Armenia's territory, followed by a full-scale new generation war against the NKR and Armenia on 27 September. The active military actions ceased on 9-10 November 2020, after the signing of the trilateral Armenian–Azerbaijani–Russian ceasefire agreement.

The Deepening Internal Crisis

The military defeat revealed the depth of the internal crisis now faced by Armenia. The motley, wide-ranging political opposition – which currently includes also several high-ranking military commanders and former Presidents Kocharyan and Sargsyan – has labelled Prime Minister Pashinyan "a traitor" who should be deprived of the right to negotiate with Azerbaijan. Demanding his "immediate" resignation, the opposition is advocating the establishment of a "national salvation" government. Pashinyan and his team, in turn, have rejected any wrongdoing, arguing that the war was unavoidable and its catastrophic consequences were predetermined by the politics of the previous governments.

It is obvious that the opposition has been unable to mobilise a significant protest movement capable of forcing Pashinyan to resign, and the government has been unable to provide a more or less clear roadmap out of multiple crises. A divided, frustrated, and confused society is seeking an answer to one question mainly: "Who is to be blamed for this catastrophe?" A prolongation of this political confrontation is definitely weakening the Armenian state. It endangers the nation's sovereignty, questions its ability to defend its own national security interests, and directly influences its strength in further negotiations with Azerbaijan regarding the status of the NKR.

Another important factor is the state of the Armenian Armed Forces. A combination of strategic mismanagement, serious tactical mistakes, and the absence of political power and courage – either to use all available weapons and to demonstrate a willingness to fight for every inch or to sign a ceasefire agreement at an early stage of the war in order to avoid human and territorial losses – resulted in a devastating military defeat. Its moral consequences are even more devastating.

The opposition's tents in front of the Parliament building, Yerevan

What Next?

In the short term, it is necessary to design a roadmap that will address an acute and multilayered humanitarian crisis. Indispensable are:

- the use of all possible mechanisms to address the issue of missing people;
- a return of all prisoners of war and civilians, as well as the bodies, held by Azerbaijan in violation of international humanitarian law and the ceasefire agreement;
- a provision of adequate medical and psychological treatment to thousands wounded soldiers, compensations for the disabled, and the families of dead and missing people;
- a provision of housing, jobs, medical assistance, etc., to the tens of thousands displaced persons in both the NKR and Armenia.

Owing to very limited resources, the measures introduced by the authorities are temporary and inadequate to provide substantial support for these strata. At this stage, it is necessary to apply for international economic and medical assistance. It is necessary to interrupt an ongoing delimitation and to prevent a demarcation of borders between Armenia and Azerbaijan (especially in the Syunik and Gegharkunik regions of Armenia) in order to reduce anxiety and a population exodus. The border issues should be resolved through negotiations in accordance with international law, and a full respect for and recognition of the rights of the citizens of Armenia and the NKR, rather than as a result of permanent pressure and security threats from Azerbaijan.

Even small – but effective and visible – progress on these issues can reduce tension in the society and prevent further radicalisation (in particular, involvement of the army in ongoing political processes). A restoration of social trust is crucial: it will prepare a basis for free and fair snap parliamentary elections and will, to some extent, slow down emigration.

In the mid-term, the state should address the needs of the Armenian army by focusing upon its rebuilding. The abrupt end of the war and provisions of the ceasefire agreement prevented more human and, probably, territorial losses on the one hand and, on the other hand, raised many questions. Nevertheless, Armenia needs a strong army owing to the activity of an aggressive and openly anti-Armenian Azerbaijani–Turkish political and military alliance. A complex revision of national security and defence strategies, as well as a reassessment of the army's capacity-building, should be undertaken.

The next five years will be critical for Armenia, which is, from economic, political, and diplomatic viewpoints, currently a severely weakened state. It is unrealistic to assume that the state will be able quickly to restore its pre-war capabilities; however, a sober analysis will allow a prioritisation of those strategic areas capable of stimulating economic growth.

This period will be challenging for the Armenia–NKR relationship. The defeat has revealed many disagreements between the authorities in Yerevan and Stepanakert. In accordance with the ceasefire agreement, Russian peacekeepers can remain in the territory of Nagorniy Karabakh – as a guarantor of the security of Armenians – for five years; by the end of this period each party to the conflict can veto their presence. In fact, all discussions concerning the future of the NKR are taking place between Russia and Azerbaijan; Armenia has been pushed aside. It is important to prevent a crisis between Armenia and the NKR in order to a) withstand Azerbaijan's pressure, b) preserve the unity of the two parts of the Armenian nation, and c) defend the interests of the NKR population in the international arena. The complete restoration of economic and social connections will be very challenging owing to the post-war reality on the ground.

Armenia's diplomatic efforts should become very proactive both to prevent any attempt by Azerbaijan (and Turkey) to define the Karabakh conflict as fully resolved, and to retain a focus upon the problem of the international recognition of a status of the NKR. These efforts should include a full guarantee for the physical security of Armenians, protection of their human rights, and preservation of the Armenian heritage in the territories now under Azerbaijan's control.

Armenia must utilise the potential of the Diaspora by wisely using its diplomatic means and tools, and re-evaluate its role in the state- and institution-building. It must offer to the Diaspora a social contract and provide a legal basis for its broader participation in Armenia's economy, politics, and social life.

Only after the achievement of a relatively stable and secure environment based on a full-scale peace agreement will it be possible to implement regional cooperation projects. Armenia should not make any further concessions without a complete de-blocking of its borders by Turkey and Azerbaijan and without international guarantees of security for its territory and population. As Golda Meir stated: "You cannot shake hands with a clenched fist."

Malaysia: COVID-19 and Political Uncertainty Overshadows Defence and Security Development

Dzirhan Mahadzir

With the country continuing to battle the COVID-19 virus, there has been little large-scale procurement or development undertaken for the Malaysian Armed Forces (MAF), the Royal Malaysian Police (RMP) and the Malaysian Coast Guard (MCG).

This situation may well continue given the cost of containing the pandemic and its effect on the Malaysian economy. In addition, Prime Minister Muhyiddin Yassin has stated that once the situation in Malaysia is contained, a general election will be held as Muhyiddin's Perikatan Nasional sees a general election as the best way of enhancing its slim parliamentary majority by gaining opposition seats. As such, any major defence or security spending is unlikely to be undertaken until after a general election.

However, some procurement has been undertaken or tendered, along with deliveries of equipment contracted for by previous governments, together with procurement related to the operations of the National Task Force (NTF) which was established in April 2020. The NTF is headed by the Malaysian Armed Forces to manage an integrated multi-agency response to preventing the entry of illegal immigrants into Malaysia. A total of 19 Malaysian government agencies come under the NTF with the MAF, RMP and MCG carrying out the operational tasking of border patrols and interceptions with the entire ongoing operations known as Ops BENTENG. The issue of preventing illegal immigrants entering the country has been a priority given the fears that immigrants may contribute to the spread of COVID-19.. As a result, procurement for the MAF, RMP and MCG in regard to the NTF has been of priority,

Photos: Dzirhan Mahadzir

An International Armoured Group JAWS 4x4 APC of the Royal Malaysian Police (RMP). The RMP is looking for additional armoured vehicles for service in East Malaysia.

though much of the equipment purchased has been items such as 4x4 vehicles, all-terrain vehicles, motorcycles, rigid hull inflatables, small drones and surveillance, optical and illumination devices, all of which are necessary for the border patrols and for the interception of immigrants entering via land borders or the sea in small boats.

Littoral Combat Ship Troubles

The troubled six ship MAHARAJA LELA class Littoral Combat Ship (LCS) programme continues to be in limbo. Technically a corvette class ship, based on the Naval Group GOWIND design, the Royal Malaysian Navy (RMN) chose the LCS classification to downplay the ships' capabilities amidst concerns that the programme might be seen as part of a South-East Asian naval arms race. Construction began in 2015, but by 2017 the programme had fallen behind schedule and subsequently the then Pakatan Harapan government revealed in 2019 that the programme was behind schedule with the first ship missing its planned delivery date of April 2019 and was now scheduled for delivery in April 2023. In addition, the programme would require additional funding of MYR 1.4Bn (EUR 285M) to enable completion of the ships.

The Pakatan Harapan government, up until its ouster in February 2020, had made no decision on resolving the issue, and thus the matter was inherited by the Peri-

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katan Nasional government, which has yet to make a decision on the matter at time of writing. Defence Minister Ismail Sabri told Parliament in August 2020 that the government had three options regarding the programme; the first option was the appointment of Naval Group as the rescue contractor to the programme, using the balance of funds from the MYR 9.1Bn (EUR 1.85Bn) ceiling cost of the contract to complete at least two ships. The second option was to allow Boustead Naval Shipyards, the constructor of the ships, to complete two ships with the balance of funds from the ceiling cost, while the third option was for the government to cancel the contract with Boustead Naval Shipyards and initiate its own efforts to salvage the programme.

As of February 2021, the government had yet to make a decision on how to proceed. The problems with the LCS programme makes the RMN 15 To 5 Transformation Plan initiated in 2017 highly unviable now. The 15 To 5 plan called for the transformation of the RMN's fleet of 15 different ship classes to just five classes and included plans for an additional six LCSs to add to the six ordered and also 12 more heavily armed and equipped variants of the KEDAH class (MEKO 100 based design) Next Generation Patrol Vessels in service. As Boustead Naval Shipyards are the in-country builders and the holder of the Malaysian rights to build both ship classes, the additional ships are unlikely to be contracted given Boustead's problems with the current LCS construction.

A BAE HAWK of the Royal Malaysian Air Force (RMAF). A tender for 12 Light Combat Aircraft will be held in 2021 for additional aircraft to be purchased, allowing the RMAF's HAWK and MB-339CM fleet to be phased out.

New and Ongoing Programmes

A small number of programmes have been initiated or were ongoing in 2020 and at the beginning of 2021.In May 2020, the RMN received the first six of 12 SCANEAGLES Unmanned Aerial Systems provided by the United States with the remaining six to be delivered in 2021. Operations with the six SCANEAGLES delivered, however, only began in February 2021 as the RMN opted to wait until US technical personnel were in country to provide support; the entry of these personnel was delayed due to COVID-19 restrictions imposed by both countries regarding overseas travel and entry requirements. The RMN's second KERIS class Littoral Mission Ship, KD SUNDANG, arrived home from China in January 2021 after being accepted from shipbuilders China Shipbuilding International Corporation. The ship had originally been scheduled to be handed over in April 2020, but the pandemic resulted in the handover being postponed. The remaining two of the four KERIS class ordered are expected to be delivered in August and September 2021 respectively.

The Malaysian Army meanwhile is expected to take delivery of 18 Nexter LG1 105 mm howitzers in 2021, with the guns ordered in 2018 and also wrap up the balance of the 257 vehicle order of the Deftech AV8 Gempita 8x8 AFV, of which some 40 plus vehicles remain to be delivered in 2021. A tender was issued in October 2020 for 20 4x4 armoured personnel carriers for service with Malaysia's UNIFIL contingent in Lebanon with the tender currently in the evaluation stage.

Meanwhile, the Royal Malaysian Air Force (RMAF) despatched to Indonesia the first of its three CN-235 transport aircraft to be converted to Maritime Security Aircraft under a US sponsored capacity building programme. The conversion work will be carried out by manufacturer PT Dirgantara in Indonesia, while the mission systems integrators will be US companies Science and Engineering Services International and Integrated Surveillance and Defence Inc. Two separate tenders for the supply of two Maritime Patrol Aircraft and three Medium Altitude Long Endurance (MALE) Unmanned Aerial Systems for the RMAF were issued in August 2020 and are currently in the evaluation stage with a decision expected in the first quarter of 2021. The Airbus C295 and Leonardo ATR72 are said to be among the contenders for the maritime patrol aircraft tender, while the MALE UAS contenders include the Kronsthadt Group ORION E, Leonardo Falco EVO, CAIG WING LOONG and TAI ANKA. The RMAF also expects to initiate a tender in 2021 for at least 12 Light Combat Aircraft to carry out both the light attack and lead in fighter training roles performed currently by the BAE HAWK 100/200 and Leonardo's MB-339CM.

The Royal Malaysian Air Force will convert three of its CN-235 transport aircraft into Maritime Security Aircraft under a US-sponsored programme, with the first aircraft already dispatched for conversion in 2020.

The Malaysian Coastguard is expected to receive the first of its three Damen 1800 Offshore Patrol Vessels in 2021 with the remaining two in 2022. The 83 metre OPVs, known as the TUN FATIMAH class are built locally by THHE-Destini Malaysia with the primary armament consisting of a single 30 mm Aselsan SMASH remote control weapon system, along with on-board machine guns. A flight deck and hangar allows a single medium-sized helicopter to be embarked. The Royal Malaysian Police has been given approval to initiate the procurement of 18 armoured vehicles for operations in the Eastern Sabah Security Zone and a contract is expected to be awarded in 2021 once the RMP has finished its evaluations. The Royal Malaysian Police currently operates a small mix of IAG JAWS APCs, Streit TYPHOON MRAPs and Shinjeong BARRACUDA APCs, along with a number of aging GKN Sankey SAXONs and Cadillac Gage V150 APCs.

Conclusion

The COVID-19 situation, together with the current Perikatan Nasional's slim parliamentary majority, has largely resulted in both civil and military security procurement programmes being given less priority in most cases, except for procurement related to Ops BENTENG. The cost of financial relief and economic stimulation and support programmes by the government to overcome the effect of the pandemic on the economy will constrain Malaysia from extensive spending on its military and civil security. In any event, it remains to be seen if the Perikatan Nasional government will remain in power if it decides to hold a general election in 2021. As such, just how Malaysia's civil and military security sector develops will only be seen once a general election has taken place. ■

An IFV-25 variant of the AV8 GEMPITA AFV. The Malaysian Army's order for 257 vehicles will be completed by the end of this year.

Russian-Turkish Relations: Moscow Calls the Tune

Eugene Kogan

The relationship between Russia and Turkey is an unequal one. Turkish President Recep Tayyip Erdoğan does not like playing second fiddle in the Russian-Turkish orchestra, conducted by Russian President Vladimir Putin. However, at every twist and turn, Putin holds more leverage over Erdogan than the other way around.

Putin will cooperate with Turkey as long as it suits Russian interests. He would quickly end the relationship if Turkey were to turn against him and tried to return to the Western fold from which it has drifted away ever since the failed coup on 15 July 2016. Erdoğan is aware of this and, as a result, is leading Turkey ever deeper into the Russian fold since the European Union, the United States and NATO all remain suspicious of him and his administration's goals and are simply unwilling to assist him in his various military activities in Libya, Syria and, most recently, in the South Caucasus. Putin provides Erdoğan with the leeway and breathing space but still keeps the Turkish president on a tight leash.

Photo: Russian Presidential Executive Office

For years now, Turkish President Tayyip Erdogan has been a frequent visitor to Moscow.

Russia Keeps Turkey in its Gas and Nuclear Power Plant Net

Although Turkey remains dependent on Russian pipeline gas, the percentage of this dependency has declined from more than 50% in 2016 to only 14% in June 2020. It should be stressed, however, that despite such a steep decline, the opening of the Russian-Turkish Stream gas pipeline to Turkey in January 2020 means that Gazprom will continue to remain Turkey's primary supplier and, therefore, will limit Turkey's room for manoeuvre.

In August 2020, President Erdogan announced that a Turkish drilling ship had discovered the country's largest natural gas reserve in the Tuna-1 area off the Black Sea coast. Whether or not Turkish Black Sea gas will be competitive remains to be seen. But what is clear is that it will take longer than expected for Erdogan and his administration to start extracting the gas; namely, about three years from the time of the discovery. Although the terms of Turkish energy security have improved, Turkey remains dependent on Russia for the foreseeable future, something which binds the two together.

Moscow is building Turkey's first nuclear power plant (NPP) in Mersin Province. According to Anastasia Zoteeva, CEO of the Akkuyu Nukkleer AS project company established by Russia in Turkey, "the project is the first to use Rosatom's build-own-operate (BOO) model. Under a long-term contract, the company is responsible for the plant's design, construction, maintenance, operation, and decommissioning."

Rosatom State Corporations hold a 99.2% stake in the project company, the cost of which it estimates at about US$20Bn. Zoteeva added that "within 10 to 12 years, Turkish personnel will replace Russian personnel at the plant."

The newly constructed Akkuyu NPP again binds Turkey to Russia for the foreseeable future since the plant's security arrangements will remain in the hands of Russian, not Turkish personnel, with Turkish staff taking over the plant's maintenance and operation 10 to 12 years in the future.

Russia Continues to Engage with Turkey on the S-400

In July 2020, it was reported that the Head of the Rostec Corporation, Sergei Chemezov, during a meeting with President Putin, announced that "Russia is preparing to supply the second batch of the S-400 air-defence system to Turkey." The parties are awaiting Turkey's final decision. According to the Russian news agency, RIA Novosti, Director General of Rosoboronexport, Aleksander Mikheev, said in August 2020 that "Russia and Turkey signed a contract for the delivery of the second batch of the S-400. The two sides continue to negotiate the financial parameters of the contract." In November 2020, it was reported that the Head of Turkey's Presidency of Defence Industries (SSB), Ismail Demir, said that "Tur-

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Photo: via author

The 96L6E Surveillance and Tracking Radar of the Russian S-400 system being deployed in Turkey

key is ready to buy the second batch of the S-400 on the condition of the technology transfer and joint manufacture." Demir's statement was reiterated by Erdogan's statement made in January 2021 that "Turkey will hold talks with Russia in January about the purchasing of a second S-400 battery." There was no further information on the issue. It is evident, however, that negotiations between the two countries over the purchase of the second batch of the S-400 continue despite the harm that it inflicts on US-Turkey relations.

Ceasefire Agreement between Armenia and Azerbaijan

On 9 November 2020, the Nagorno-Karabakh ceasefire agreement was signed by President Vladimir Putin, Azerbaijani President Ilham Aliyev and Armenian Prime Minister Nikol Pashinyan. Not a word was said about the role of Turkey and its resolute support of Azerbaijan in the 44 day war. In other words, Putin has shut down Erdogan's role with the latter reduced to the role of second fiddle in the Russian-Turkish orchestra. To sweeten the bitter pill, the two sides agreed to construct a Russian-Turkish or Turkish-Russian Observation Centre to monitor the ceasefire between Armenia and Azerbaijan over the Nagorno-Karabakh region. The name of the joint centre depends on whom you ask. The centre began to operate on 30 January 2021 in the Agdam region of Azerbaijan but with a caveat that Turkish personnel were not allowed to enter what is left of Nagorno-Karabakh while about 2,000 Russian peacekeepers guard the territory.

In order to seize the initiative which Erdogan had lost to Putin on 9 November, Erdogan proposed a six-country regional cooperation platform including Armenia, Azerbaijan, Georgia, Iran, Russia and Turkey on 10 December. Commenting on Russia's perspective on the initiative, Erdogan said that "President Vladimir Putin is positive about it. The two sides have agreed to further develop this initiative." At the moment, it is difficult to evaluate the feasibility of Erdogan's initiative without more details. Still, as a gesture of cordial relations between the two, Putin informed Erdogan about the 9 November ceasefire agreement.

Once again, Putin made the next move and invited Aliyev and Pashinyan to Moscow for trilateral talks on 11 January 2021. The talks focused on unblocking all economic and transport links in the region; namely, between Armenia, Azerbaijan and Russia; between Azerbaijan, Armenia, the Nakhichivan Autonomous Republic and Turkey; and Armenia, Nakhichivan and Iran. Georgia was left out in the cold. This is seen as Russia's way of punishing western-oriented Georgia for its misbehaviour and this is despite the fact that Azerbaijan and Turkey are Georgia's partners in the Baku-Tbilisi-Ceyhan (BTC) oil and the Trans-Anatolian Natural Gas (TANAP) pipelines, as well as the Baku-Tbilisi-Kars (BTK) rail link. In other words, Russia is playing chess like a Grandmaster vis-à-vis the three "Lilliputs" namely, Armenia, Azerbaijan and Iran, by excluding Georgia and still leaving Turkey enough room for manoeuvre without any loss of face.

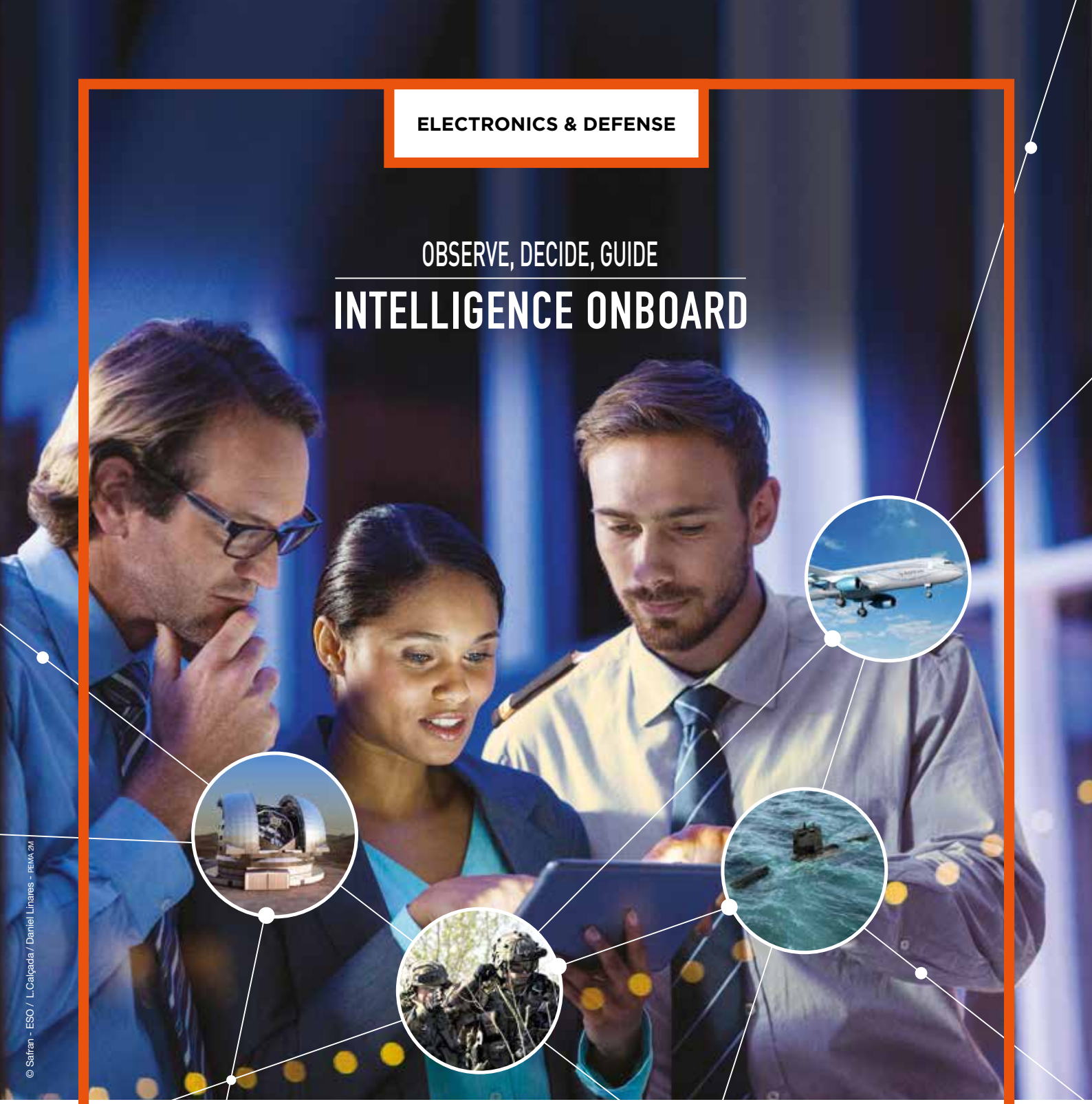
Photo: via author

A part of the Russian S-400 system is unloaded from a AN-124 transport aircraft in Turkey.

Successful Information Operations in Turkey

Moscow carries out information operations in Turkey through the Sputnik news agency, which is largely supporting the opposition. Despite that, Sputnik's operations in Turkey have not been shut down as they have been in several EU member states, but continue to sow seeds of discord, something which is typical of the Russian programme. Although Moscow is not interested in which side prevails, it is interested in influencing the narratives on both sides and in disseminating pro-Russian content. When pro-Russian information supports the government's position, the pro-government networks disseminate it. When the information contradicts the government's position, the opposition networks pick it up. As a result, Russia is the clear winner and Putin again has the upper hand over Erdogan. Checkmate!

In conclusion, Putin outfoxes Erdogan by using all the means and tools at his disposal, as well as by appealing to Erdogan's vanity, while at the same time showing the Turkish president that he is a junior partner in the bilateral relationship. According to retired Turkish Ambassador Murat Bilhan, "Behind Putin's smile, Russia remains a big state and can show its claws [to Turkey] whenever it is convenient. Russia is a superpower and Turkey is a regional one." That is the crux of the matter and that is how Putin corners Erdogan and keeps the relationship going. Finally, the EU, the US and NATO should not blame themselves for Erdogan's deeds; namely, the deepening rift between Turkey and the West. They should also take Erdogan's statements that "he wishes to improve relations with the EU and the US," in particular with a pinch of salt. ■



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