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NATO's Eastern Flank in the Covid-19 Aftermath

The coronavirus pandemic and an unprecedented economic crisis which is likely to follow, raise questions about how NATO will meet the challenge of protecting its flank in the East and preventing any unnecessary armed confrontation with Russia.

At a time when many NATO member states are increasingly challenged by the need to re-evaluate their fiscal spending and implementing various cuts and savings policies, defence expenditure seems to lag behind other priorities that are necessary to support their falling economies. As a result, some countries may decide to seek savings by prolonging or even cancelling ongoing procurement or technical modernisation programmes, which were to enhance operational capabilities of their armed forces and provide a responsiveness to dramatically changing security environments in Europe.

It seems likely that the countries of Central and Eastern Europe will particularly need to implement such savings, affecting modernisation of their sometimes unevenly equipped and insufficiently developed armed forces. Although the CEE region is not as affected by the pandemic as much as Western Europe, national economies that are less mature than the older EU member states are more vulnerable to disruption to free trade or businesses growth opportunities on a global or even regional scale.

The Czech Republic is one country that has already reacted to the growing threat of an economic crisis, announcing a possible, significant delay or even cancellation of the ongoing procurement of 210 tracked Infantry Fighting Vehicles, which the armed forces desperately need, to replace obsolete, Soviet-era BVP-2s. The Czech announcement is surprising, especially given that the new IFVs should be manufactured locally, with significant involvement of the Czech defence industry, creating new workplaces and increasing tax revenues. However, the investment, the cost of which was estimated at CZK18Bn (€661M), is deemed as too expensive, especially at a time when the country struggles to fight the pandemic and prepares its weakened and shaken economy for the upcoming crisis.

Neighbouring Slovakia also has to make final decisions on the future of a number of procurement programmes, especially the acquisition of 81 VYDRA 8×8 wheeled armoured vehicles, intended for local manufacture, with significant assistance from the Finnish company, Patria. An even more significant turn of events took place in Poland, until lately a country at the forefront of military modernisation in the CEE region. The Polish Ministry of Defence has already announced that a number of procurement or modernisation programmes will be delayed or cancelled. This does not include some major acquisitions that represent a breakthrough in Poland's defensive capabilities, such as the F-35A LIGHTNING II multirole fighter aircraft, PATRIOT-based medium range air-and-missile defence systems or HIMARS rocket artillery systems. It seems that the Polish Navy will be the hardest hit, as a number of its programmes will be or have already been slashed. In the post-coronavirus reality the Navy will not get new coastal defence vessels or next generation small attack craft - nor even the conventional submarines of which the country is in desperate need.

The Baltic States - Estonia, Latvia and Lithuania - seem to be in a slightly better situation, as their respective defence authorities have been less willing to announce serious cuts in defence spending so far. On the contrary, new procurement and modernisation programmes have already been announced, such as the multinational, pan-regional project to design a new wheeled, armoured vehicle in cooperation with Finland. This is unsurprising given their proximity to Russia, and lessons learned from Ukraine.

At this stage it is unreasonable to predict how the pandemic and subsequent economic crisis will affect the security of NATO's eastern flank and how particular member states react to the growing instability east of its borders. Limiting defence expenditure seems to be inevitable, but the questions are, to what extent? and how much will the limitations compromise ongoing efforts to modernise materiel and enhance operational interoperability and capabilities within the Alliance?

Michał Jarocki

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■ Soft Body Armour for Australia

(ck) The Australian MoD has contracted Craig International Ballistics to deliver Soft Body Armour to the Australian Defence Forces for an initial AUS$1M. This contract will provide the Australian Armed Forces with 750 soft body armour inserts to replace the old armour currently in service. Craig International Ballistics has developed a new Kevlar fibre for body armour and the Australian Army will be the first military in the world to receive body armour with this new Kevlar material. According to the company, the new armour offers a higher level of protection and is much lighter than current soft armour. Craig International Ballistics employs around 35 people and has been manufacturing body armour systems manufactured in Australia since the late 1990s.

■ The 1,000th SHERPA

(ck) The Arquus Limoges teams have completed the production of the 1,000th SHER-PA armoured vehicle. It is a major milestone for the SHERPA family, which was founded in 2006 and has constantly evolved since. Deployed in all theatres of operations and in all configurations, the SHERPA serves daily in a wide range of forces. In its different versions, the SHERPA can tackle most missions and carry most of the equipment of defence and security forces. The SHERPA family currently comprises four base models: the SHERPA SCOUT, an armoured vehicle for liaison and reconnaissance seating 4 or 5 soldiers, also available in the Station Wagon version; the CARRIER, fitted with a bed for troop or systems transport; the APC, for troop protected transport; and the SHERPA SPECIAL FORCES, designed for missions behind enemy lines. Unveiled at Eurosatory 2006, the SHERPA has received acclaim for its compacity, mobility and payload. The NSPA (Nato Support and Procure-

Photo: Arquus

ment Agency) ordered SHERPA vehicles in a communications systems carrier version for the ISAF (International Security Assistance Forces), then deployed in Afghanistan. Since 2006, Chile, Lebanon and Indonesia have acquired SHERPA vehicles to reinforce their police and security forces' capabilities. An

ASSAULT LADDER version was then developed by Arquus in 2014 to fight organised crime and terrorism; India, the Brazilian Federal Police, as well as the French GIGN have selected that version. In 2016, the French Minister of Defence, Jean-Yves Le Drian, announced a contract for 300 SHERPA vehicles to be delivered to Kuwaït. Since 2006, SHERPA vehicles have been produced at the Arquus site in Limoges, with a dedicated production line; over the past 14 years more than 1,000 SHERPA vehicles of all versions and configurations have rolled off that production line. The Arquus plant produces up to two SHERPA vehicles per day.

■ ASELSAN Maintains its Export Momentum

(ck) ASELSAN, a Turkish defence and technology company, has signed another sales contract for the supply of Advanced Remote-Controlled Weapon System (RCWS) for the naval use of the Kingdom of Bahrain.

Photo: ASELSAN

Following a record-breaking 2019, ASELSAN is maintaining its momentum in exports and production for the current year. Aside from the latest sale of the RCWS to the Gulf, ASELSAN, which has been present in the market for more than a decade, has provided the countries with technological solutions through direct sales, transfer of technology programmes, local production and joint venture companies. ASELSAN plans to make further investments and enhance its field of activities in the member states of the Gulf Cooperation Council (GCC) in general and the Kingdom of Bahrain in particular. As an outcome of ASELSAN's growth strategy, ASELSAN's RCWSs with various configurations are currently being used in 20 countries for land and naval platforms.

■ Bullet-Proof Armour for Finland

(ck) The Australian bullet-proof armour manufacturer XTEK Limited has won a contract to supply its lightweight ballistic plates to the Finnish Army. XTEK launched a new fabrication centre in Adelaide in February and announced its first commercial order in March for use in Australian law enforcement.

The Finnish sale, worth more than AU$1M, is XTEK's first international order. The new Adelaide manufacturing centre is equipped with the company's XTclave composite materials curing and consolidation technology to manufacture lightweight ballistic armour plates and helmets. The machine, about the size of four shipping containers, runs cycles of ultra-high isostatic pressure at high temperatures to achieve composite curing of thermoset and thermoplastic resin. According to the company, their US compliant small arms protective insert plates are up to 30% lighter than other products and have buoyancy potential, while the light helmets can stop AK-47 MSC bullets and fragments. The Finnish purchase order has come from CPE Production Oy, a supplier of high-performance lightweight ballistic protection solutions to the Finnish Defence Forces and other European defence customers.

■ New Replenishment Vessels for the French Navy

(ck) Chantiers de l'Atlantique has announced that it has begun construction on the first of four new Bâtiments Ravitailleurs de Force (BRF) - replenishment vessels - that it is building for the French Navy. In a ceremony held in the machining workshop of Chantiers de l'Atlantique, in the presence of Florence Parly, Minister of the Armed Forces, and Admiral Prazuck, Chief of French Navy, the first steel plate of the hull of the first of the four new vessels was cut. This ceremony marked the start of the construction of the first vessel of the FLOTLOG programme. In January 2019, the French MoD contracted the consortium of Chantiers de l'Atlantique and Naval Group with the construction of the BRF. Deliveries

Photo: Naval Group

are scheduled from the end of 2022 until 2029. This order for the French Navy is part of a Franco-Italian programme led by OCCAR, on behalf of DGA, the French Defence Procurement Agency, and its Italian counterpart NAVARM. The BRF, with a capacity of 13,000 m3, will provide logistical support to the combat vessels of the French Navy and will carry fuel, ammunition and spare parts, as well as food. Compliant with international standards, they will be adapted to support the aviation group constituted around the aircraft carrier CHARLES DE GAULLE, flagship of the naval air force group. Chantiers

de l'Atlantique will carry out the global design and the construction of the four ships and ensure the integration and the implementation of the embedded systems. Naval Group will be responsible for the design, development and integration of the platform's military systems. The combat system of the four ships, whose architecture is based on the Naval Group's POLARIS Combat Management System, will ensure protection against close threats and fight against asymmetric threats.

■ HERON UAV for Greece

(ck) MoD representatives of Greece and Israel have signed the first agreement between their respective ministries to lease the Israeli HERON system developed by Israel Aerospace Industries (IAI). In light of the Covid-19 crisis, the agreement was signed digitally. The Israeli system will be used primarily for border defence. As part of the agreement, the Israel MoD will lease the HERON system to Greece over a period

Photo: IAI

of three years, with an option to purchase the system upon completion of the leasing period. The HERON system, which is being leased in its maritime configuration, is equipped with both day and night activity platforms, maritime patrol radars and satellite communications, and offers extended operational endurance in a wide range of scenarios including maritime patrol, marine and land border protection, search and rescue, disaster management and more. The system is operational in the IDF and naval forces around the world and has demonstrated its capabilities in Greece as well.

■ Remote Weapon Stations for Canadian Army

(ck) Kongsberg Defence & Aerospace has signed a contract with General Dynamics Land Systems - Canada for delivery of the PROTECTOR Remote Weapon Stations (RWS) to the Canadian Army valued NOK500M. The PROTECTOR RWS will be integrated on Canada's fleet of Armoured Combat Support Vehicles. Canada signed their first PROTECTOR RWS contract in 2005 followed by additional contracts in 2012 and 2014. "We are very pleased to be chosen again as the supplier of Remote Weapon

Photo: Kongsberg

Stations to the Canadian Army. This confirms the strong position of KONGSBERG's PROTECTOR RWS, and continues the close relationship between KONGSBERG and the Canadian Army and General Dynamics Land Systems – Canada," says Pål E. Bratlie, Executive Vice President Kongsberg Defence & Aerospace AS. "In the midst of the most uncertain and difficult economic times in our lifetime, we are very pleased to win this order in spite of the Covid-19 pandemic. Our business base is long-term and solid, with an order backlog that provides a strong foundation for continued operations into the future," says Eirik Lie, President Kongsberg Defence & Aerospace AS. KONGSBERG has, for more than two decades, been a leading global supplier of Remote Weapon Stations, leveraging millions of hours of operational use in all conditions, based on 20.000 delivered systems for 23 countries. The PROTECTOR RWS has continuously evolved to meet increasingly demanding requirements, utilising technological advancements in order to meet new threat scenarios. The Canadian Army will receive the latest generation PROTECTOR RWS, a Remote Weapon Station prepared for wireless control, counter UAS capability, multi-sensor fusion, as well as other new functions required by the expanding user community. The systems for Canada will be produced in parallel with five other programmes, - creating synergies in supply base and project execution for the benefit of the customers.

■ Anti-Jamming GNSS

(ck) Meteksan Defence, a developer and integrator of high-tech systems for defence platforms, is offering a product that will prevent the jamming of the Global Naviga-

Photo: Meteksan

tion Satellite System signals, which is one of the most significant threats in the operational environment. Since Global Navigation Satellite System (GNSS) signals travel a long distance before they reach the receiver, they are weakened because of atmospheric effects. As a result of this, signals can be easily suppressed by various jammers, the receiver loses signal tracking, fails to function or can crash. It is critical to suppress jammer signals to protect military platforms. In response to this issue Meteksan Defence has completed the development of the ANTI-JAMMING GNSS product that supports GPS, GLONASS, GALILEO, BEIDOU satellite signals and can work on multiple frequency bands. Thanks to the Meteksan Defence ANTI-JAMMING GNSS product, the direction of the jamming signal can be determined and suppression of the jamming signals can be achieved by using spatial filtering. Jamming signals are filtered by using signal processing techniques, and the original signal without the jamming signal is reconstructed again for delivery to standard GNSS receivers. The Meteksan Defence ANTI-JAMMING GNSS also includes a built-in GNSS receiver capable of decoding GPS satellite signals for calculating position, velocity and time information. This way, without needing an external GNSS receiver, Meteksan Defence ANTI-JAMMING GNSS can provide output filtered GNSS RF signals and calculate position/velocity/time information from the filtered signal. Thanks to the antenna design infrastructure owned by Meteksan Defence, it can develop CRPA antenna designs and offer a variety of antennae specific to the platform. The ANTI-JAMMING GNSS has been developed for military platforms such as helicopters, unmanned aerial vehicles, and missile systems.

■ China: Two New Type 094A SSBNs

(uw) The People's Liberation Army Navy (PLAN) has commissioned two TYPE 094A nuclear submarines (SSBN). TYPE 094A is supposed to be an enhancement of the 094, also known as the JIN class. Details, however, are scarce. The South China Morning Post states that there are hydrodynamic improvements to the sail and the bow section, as well as technological upgrades to radar, sonar and torpedoes. The 135-metre-long boats with a displacement of 11,000 tons are armed with twelve JL-2 Submarine-Launched ballistic missiles (SLBM). Their reported range of 7,400 km could enable them to reach the US' Great Plains from a firing position close to the Kuril Archipelago and would make New York within reach of

a patrol south of the Aleutian Islands. From the East China Sea the eastern border of Poland could be reached; not the American west coast, but Anchorage in Alaska. The JU LANG 2 missile (JL-2, NATO designation CSS-N-14) is the submarine-launched version of the DF-31, China's most advanced intercontinental ballistic missile (ICBM). It provides China with a viable sea-based nuclear deterrent. Each missile carries one warhead (no MIRV). China is planning to build six 094 units of TYPE 094/A. Four were seen at the Navy's 70th birthday parade in April 2019. The next generation of Chinese strategic submarines (SSBN) is under development. TYPE 096 should be able to carry 24 JL-3s – with an estimated range of more than 10,000 kilometres. In December 2019,

the JL-3 missile was successfully tested from a position in the Yellow Sea and was reportedly fired by a TYPE 094 submarine, the target area was in the northwest of the Gobi Desert. JL-3 should have multiple warheads (MIRV). A first test was announced in November 2018. Chinese sources expect the JL-3 to be fully developed by 2025 and available for the new TYPE 096 SSBN. Following information in Chinese media, the development of the missile is now separated from work on the TYPE 096 submarine in order to accelerate its development. On 8 May 2020, the Editor-in-Chief of the pro-government Global Times, one of China's two English-language daily newspapers, said that the country should have 1,000 warheads available in a relatively short period of time in order increase deterrence and also to effectively counter American intimidation. According to Statista, China had an arsenal of 290 nuclear warheads in 2019.

■ SSN SUFFREN to Start Sea Trials

(ck) The sea trials of the SUFFREN, the first BARRACUDA class nuclear attack submarine, have just begun. They will enable the French Defence Procurement Agency (DGA) and the French Navy to test the performances of the submarine at sea before her delivery later this year. A total of six BARRACUDA class vessels will be added to the French Navy's fleet by 2030. This series of sea trials

follows the divergence of the nuclear reactor which took place in December 2019 and the dock tests carried out since the launch of the submarine on 12 July 2019. The operations successively took place in the assembly hall as well as in the dry and water-filled docks to test equipment and systems, such as the combat system. Trials are conducted by joint teams from Naval Group, TechnicAtome and French authorities. Sea trials constitute a crucial phase of qualification of on-board installations for a nuclear submarine and are aimed to ensure water-tightness in the underwater environment and manoeuvrability, as well as the performance of the combat management system, tactical weapons and other high-tech equipment. The SUFFREN is the first of its class, intended to replace the generation of RUBY-type SSNs. Naval Group is in charge of the production of this series of submarine, from the design and construction of the ship and its information systems, to the manufacturing of the main components of the nuclear reactors as well as the maintenance of the ships in Toulon. The SUFFREN is one of the world's stealthiest submarines. This discretion, combined with her advanced detection capabilities, guarantees her acoustic superiority. For the first time, thanks to the SUFFREN class submarines, the French Navy will have a deep strike capability with MBDA's naval cruise missiles (NCM). The latest generation of SSNs also allows the discreet deployment of Special Forces underwater, in particular thanks to its "divers hatch" and the optional carrying of a dry deck shelter allowing for the deployment of underwater vehicles.

■ Loitering Munition for Israel

(ck) Israel's MoD has placed an order for RAFAEL's SPIKE FireFly loitering munition. Jointly developed by RAFAEL and the MoD, FireFly weighs only 3 kg and provides behind-cover precision attack capabilities for the dismount-

ed soldier. Ordered for the Ordered for the IDF ground forces ground forces, FireFly was designed for fighting within the urban arena where situational awareness is limited, the enemy is behind cover, and precision is critical. FireFly is rapidly deployed within seconds. It is portable, durable and includes a rugged airframe to withstand the harsh environment of urban combat. Its single-user operation is designed for the dismounted soldier – light, small, and agile. Firefly features a dual seeker, target tracker, homing algorithms, computer vision, Safe & Arm fusing mechanisms, and a rugged tablet-based HMI (Human Machine Interface). The operation of FireFly is very intuitive, with no special skills required. FireFly enables overmatch to break combat deadlock and has a lethal effect on stationary and moving targets with or without line-of-sight to operator. FireFly has an abort/wave-off capability and full, safe returnability to the operator up to attack command. It can be operated day and night and has a low visual and acoustic signature.

■ LITENING 5 EO/IR Pods for Leonardo M-346FA

(ck) RAFAEL will supply 5th generation LITENING-5 and RecceLite systems to equip Leonardo's M-346FA light combat aircraft. This is the first integration of 5th generation EO pods to Leonardo's M-346FA platform. The M-346FA is the multi-role combat variant of the jet trainer. The FA variant is also able to operate as a multi-role tactical aircraft, capable of air-to-surface, air-to-air and tactical reconnaissance missions. Integrated with RAFAEL's pods, the jet will now have stand-off capabilities using the LITENING 5 multi-spectral airborne targeting pod. The LITENING 5 pod is in use by 27 air forces and carried by over 25 platforms globally. LITENING

Photo: Rafael

5 delivers real-time, forward-looking infrared (FLIR+SWIR) and day HD colour camera imagery. Its high-resolution sensors and effective EO/IR design ensure reliable operation at significant stand-off ranges. LITENING 5 allows the operation of all types of air-to-surface smart weaponry, such as laser-guided, GPS-guided and EO/IR imaging-guided munition. LITENING pods have logged over 2 million flight hours, with more than two-thirds in contingency operations worldwide. With the RecceLite ISR system, the light-attack aircraft will be able to perform target search, using advanced AI, ATR (Automatic Target Recognition) at the interpretation ground station, and other smart algorithms for efficient

detection, tracking, and sensor-to-shooter closure. Using its advanced ISR, image processing, and artificial intelligence, the system achieves optimal data-exploitation, at the ground station, of intelligence data relayed in real-time and mission execution in near-real-time. RecceLite has been delivered to 13 customers world-wide and integrated onto various aircraft, including the F-16, F-18, JAGUAR, AMX, TORNADO, TYPHOON, GRIPEN, HERON TP, REAPER and others. It is used by air forces in Europe, the Far East and South America.

■ Armoured FOX Transport Vehicles Configured for EOD Role

(ck) Unexploded ordnance, mines and improvised explosive devices pose a grave threat to troops. The German Bundeswehr is currently taking delivery of a newly developed system for countering these threats. Specifically configured for an EOD role, Rheinmetall's new variant of the FOX/FUCHS 1A8 armoured transport vehicle – known as the KAI – can detect and identify unexploded ordnance and similar battlefield hazards. Thanks to its electronics and a precise, multi-jointed manipulator arm featuring state-of-the-art sensors, bomb disposal experts will now be able to reconnoitre, mark and identify suspicious objects from a safe distance. Delivery of these systems is already underway, and expected to be complete in 2020. The order is worth a figure in the mid-double-digit million-euro range. The FOX reinforces the Bundeswehr's array of heavy-duty EOD vehicles, and is designed to investigate vulnerable points which the Route Clearance System – partially supplied by Rheinmetall as well – cannot reach. The KAI is intended to serve as a stand-alone system capable of operating without the Route Clearance System in a convoy support role. Protected from mine and IED blasts, the FOX is equipped with advanced force protection elements and mine-resistant seats that keep the crew's feet safely off the floor of the hull. The most prominent feature of the FOX KAI is the multi-jointed manipulator arm, with a maximum operating reach of over ten metres and a load-carrying capacity of 400 kg. This enables EOD personnel operating in the FOX fighting compartment to investigate suspicious locations and to examine and identify ordnance and booby traps from a safe standoff. The manipulator can accommodate two other tools. One of these is a dual sensor, the 80 centimetre variant employed by the Route Clearance System. It can be used for investigating suspicious spots and determining whether ordnance has been buried there. In addition, there is a tool camera. Mounted on a tilt-and-pan head, this device can optically examine hard-

to-view places such as drainage pipes, the sides and undersides of bridges or locations behind walls in order, for example, to detect the presence of an explosive device. To enable visual reconnaissance, the system features high-performance optronic technology. Other core elements of the KAI are its water-air spade system, with a maximum operating pressure of 400 bar, and a ripper chisel. This enables the EOD crew to uncover suspicious objects which cannot be clearly identified. Marking can be done digitally either in the system by means of exact GPS coordinates, or with an optical marking device for the dismounted bomb disposal engineer. Moreover, the manipulator arm can be mounted with a recovery system for removing persons from a danger zone.

■ Saab Delivers the First GlobalEye

(ck) On 29 April 2020, Saab delivered the first GlobalEye Swing Role Surveillance System aircraft to the United Arab Emirates. The UAE had ordered three GlobalEye aircraft, with the initial contract signed in late 2015. In November 2019 the country announced its intention to complete a contract amendment for the purchase of an additional two systems. GlobalEye is Saab's new airborne early warning and control solution and provides air, maritime and ground surveillance in a single solution. GlobalEye combines Saab's new ERIEYE Extended Range Radar and a range of additional advanced sensors with the ultra-long range GLOBAL 6000 aircraft from Bombardier.

■ Second Patrol Vessel for Italian Navy

(ck) The launching ceremony of the second Multipurpose Patrol Vessel (PPA) for the Italian Navy was held on the 22 May 2020 at Fincantieri Shipyard in Riva Trigoso, Genova. The ship has been named after Francesco Morosini, 108th Doge of the Serenissima Republic of Venice and General Sea Captain of the Venetian Fleet (1688 – 1694). Due to the Covid-19 crisis, the ceremony took place in the presence of a handful of guests. However, all the Italian Navy traditions were respected: the

Photo: OCCAR

blessing of the ship, the cutting of the ribbon and the smashing of a bottle of Italian Spumante against the hull, a way of wishing the best of luck for the ship's future life at sea. Mrs Carola Morosini was the Godmother of this second PPA launching ceremony. Under the supervision of both the Italian Naval Armament Directorate and OCCAR PPA Programme Division, the Italian Ship (ITS) FRANCESCO MOROSINI (P431), is expected to sail the Tyrrhenian Sea starting for its sea trials by the end of summer. Based on a common platform, PPAs are built in three different configurations: LIGHT (two ships), LIGHT PLUS (three ships) and FULL (two ships). The LIGHT version has a complete set of artillery; the LIGHT PLUS version adds a missile firing capability with actuators also for ballistic missile defence; the Full version will be able to operate in all traditional warfare domains, Surface, Air and Underwater. Light and Light Plus have been developed with the "fitted for" approach: every system on the Full can quickly be deployed also on Light and Light plus, facilitating operational flexibility and growing capabilities during the ship's life. FRANCESCO MOROSINI is the second PPA in light configuration and its delivery to the Italian Navy is scheduled for March 2022.

■ Tethered SkyStar Aerostat System for Cost-Effective Surveillance

(ck) During the ongoing Coronavirus crisis, governments around the world want to ensure that, while most citizens are staying indoors, their borders and strategic facilities are protected. RT LTA Systems, developer and manufacturer of the SkyStar aerostats family, is offering its SkyStar 180 aerostat systems at a special price for a limited time. The SkyStar 180 aerostat systems are produced in RT's new assembly line, and available for immediate delivery. SkyStar is a self-contained, mobile, cost-effective tactical system comprising a ground control station, a ground system module, a tether, a lighter-than-air platform, a stabilised payload platform and a sensor suite. SkyStar aerostat is a cost-effective means for border control, HLS, defence, and security missions, as it provides persistent surveillance and communication over long periods at a minimal cost. Only two people are required to deploy the system. The SkyStar aerostats can operate in harsh weather conditions, and offer availability of over 85% in any given area. The systems have already accumulated more than 2 million operational hours worldwide.

Diehl Contributes to European Security

Right from the start, Diehl Aerospace has been involved in the two-year concept phase (Joint Concept Study) for the development of the European FCAS (Future Combat Air System). The aim of the project initiated by Germany and France - which Spain has since joined as a further partner - is to develop a New Generation Weapon

Frédéric Migot is Head of Military Programs at Diehl Aerospace.

System (NGWS) by 2040. In Germany, this system is to be gradually expanded into a global air-based defence system and replace the EUROFIGHTER fleet later. This guarantees the sovereignty of Europe in foreign policy and military matters.

The development of the new air combat system requires several years of preparation before the actual development phase can begin in 2028. In the first phase of the concept study, the operational requirements for the new weapon system are defined and the technology gaps and the necessary technology demonstrators are identified. Diehl Aerospace has been involved in the study right from the start and has already made important contributions in various technology domains. At the beginning of 2020, the demonstration phase was launched. It is expected to last until 2026. The first flight tests of the Next Generation Fighter should then take place. With its expertise, espe-

cially in the avionics sector, and its proven experience in international cooperation, Diehl Aerospace will play a major role in this decisive phase.

With Diehl Aerospace into the Next Programme Phases

The next step will be to bring the required technologies to a sufficient level of maturity before the development and construction of the first demonstrators can begin. In addition to the two system leaders, Dassault and Airbus Defence & Space, Diehl should also play a crucial role here: "In the first partial phase, we have already made many important contributions to various national technology studies. Now we want to contribute our globally recognised expertise in the field of avionics to the joint project in the further phases of the project," reports Frédéric Migot, Head of Military Programmes at Diehl Aerospace.

Greatest Expertise in Avionics

Diehl Aerospace is a German first tier supplier for avionics. The company has the required experience in developing

and implementing national and international technology projects. For many years, the innovation leader has invested enormous amounts of time and money in research and development and has established itself as the largest and leading supplier of avionics systems in Germany. The company thus has great expertise in civil and military projects, inter alia, in the fields of cockpit avionics, flight control, integrated modular avionics and utility systems.

Ability to Cooperate at an International Level

Germany, France and Spain have emphasised that they want to develop the technologies required for FCAS/NGWS together and based on the geo-return principle. Firstly, this requires a strong German aerospace and defence industry, but also the readiness and ability to successfully implement cooperative projects. Diehl Aerospace has demonstrated its international cooperation capability in numerous Franco-German and international projects, partnerships and programmes. For example, in the military segment, the company worked with European partners including its joint venture share-
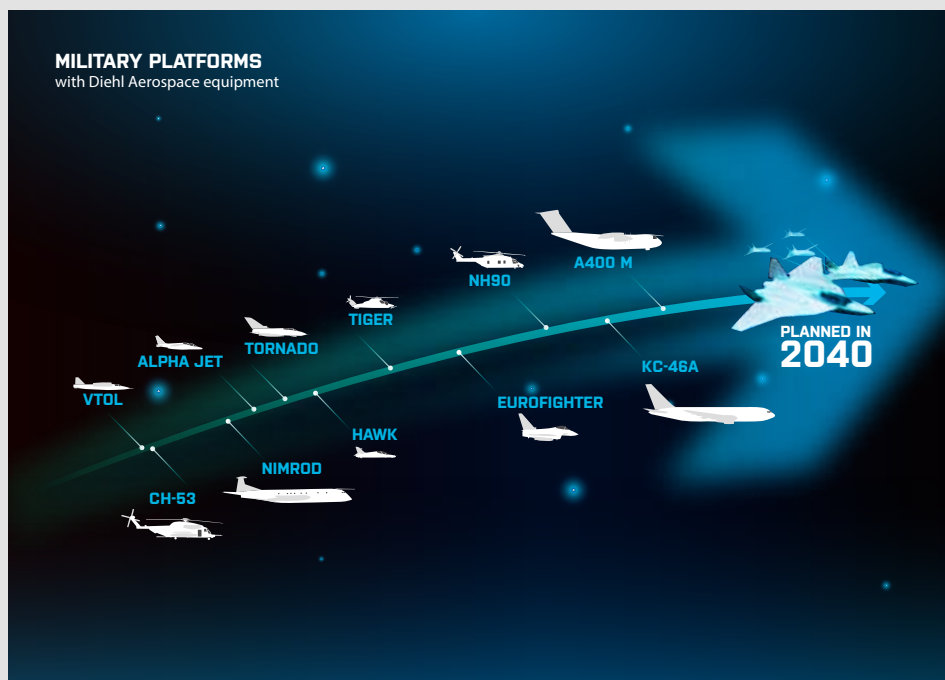

Diehl Aerospace has a proven track record in military aerospace over several decades.

Photos/Graphics: Diehl Aviation

holder Thales, inter alia, on the development and series production of avionics and equipment systems for the Airbus A400M, TORNADO, EUROFIGHTER, NH90 and TIGER.

"We have repeatedly confirmed our European and international ability to cooperate with numerous alliance partners and in the most diverse constellations. We are able to cooperate far beyond national borders at any time. We have proven this not only at Airbus, where we have been working together successfully and pooling our expertise since the first A300 program," Frédéric Migot stresses. Already existing collaborations with French partners can be further expanded for FCAS.

Securing European Sovereignty

FCAS is the most modern and complex defence programme in Europe for the coming decades. This is a network of existing and future weapon systems, manned combat aircraft and unmanned systems such as drones and satellites. Unlike individual specific weapon systems, FCAS can be deployed in a wide variety of situations and scenarios. This will strategically secure the future security and defence policy sovereignty of Europe in the long term. Diehl can make an important technological contribution to this, for example to the development of NGWS –

Committed to innovation: The implementation of cutting-edge technologies in the process of production and development has made Diehl one of the innovation drivers in both military and civil aviation.

but also for the further development of the EUROFIGHTER, the remote carriers as well as for the implementation of the networked system of systems.

Diehl Aviation: The Sector's Innovation Driver

Diehl is already one of the world's leading research and development companies for aircraft systems and cabin solutions. The company has permanently increased its investments in research and development. Today, Diehl has not only extensive experience in the implementation of national research and development projects and international funding programmes. "By now, we have also become one of the sector's innovation drivers. This has enabled us to become the largest equipment supplier and supplier of avionics systems in Germany," says Frédéric Migot. Diehl is leading in the areas of flight control, integrated modular avionics, cockpit display systems as well as mission and platform avionics.

Cutting-Edge Technology to Secure Jobs

The participating companies will not be the only ones benefiting from the targeted integration of German cutting-edge technology into the FCAS program. FCAS will at the same time increase German and European technology expertise and thus secure highly qualified jobs in the long term. This in turn will have a positive effect on the national and European value-creation chain and thus on the economic development of the aerospace and high technology sector. "We have the ambition to take over this role as avionics lead, to develop technologies, deliver products and also to define their specifications. The high demands on the FCAS system as a whole can thus be met," Frédéric Migot is sure.

Versatile core competencies for the NGWS are among the strengths of the German supplier.

Firms & Faces

SOVERON D to Receive BSI Certification

(ck) The German Federal Office for Information Security (BSI) has granted Rohde & Schwarz certification at classification level SECRET for the joint radio system of the German armed forces (SVFuA). The certification allows transmission of data and voice, and therefore classic command and control capability, at the following levels: unclassified, restricted and SECRET. In 2017, following many years of joint development, the German procurement authority BAAINBw signed a contract with

Photo: R&S

Rohde & Schwarz for the procurement of the SVFuA (series designation SOVERON D). SOVERON D operates on the principle of software defined radio (SDR) and offers secure, trustworthy communications. When development ended in 2016, it was determined that SOVERON D met the requirements for certification. Certification in line with the internationally recognised Software Communications Architecture (SCA 2.2.2) standard for SDR radio systems was a prerequisite for customer acceptance. In the future, SOVERON D will also use the ESSOR high data rate waveform that was developed within the framework of the trans-European interoperability initiative for armed forces at the tactical level. In line with the SDR concept, further waveforms can later be loaded on SOVERON D as software. The project is on track to deliver the first series-produced units to customers.

Novel Heat Exchanger for RPAS

(ck) General Atomics Aeronautical Systems, Inc (GA-ASI) has partnered with Australia-based Conflux Technology on the devel-

Photo: GA ASI

opment of a heat exchanger. The part is being developed using a metal Additive Manufacturing process for possible integration onto GA-ASI's line of Remotely Piloted Aircraft Systems (RPAS). Since cooling or heat exchange is a crucial issue in size and weight constrained UAVs and RPAS, fundamental efficiency gains require heat transfer innovations. Engineers hope to achieve these gains by blending thermo-fluid dynamics with the Additive Manufacturing process. Conflux Technology is an Additive Manufacturing applications company based in Geelong, Victoria that specialises in thermal and fluid engineering and is providing design expertise in the optimisation of Additive Manufacturing heat exchangers to increase the performance of RPA. GA-ASI and Conflux will develop novel thermal solutions for application to the next generation RPAS to allow enhanced endurance and lower manufacturing costs, as well as more flexibility in product design and integration.

IAI to Acquire the Z Family of Off-Road Vehicles

(ck) Israel Aerospace Industries (IAI) continues to diversify its ground operations with the acquisition of the manufacturing of Zi-bar, Zmag, and ZD vehicles from off-road vehicle manufacturer Ido Cohen. The all-terrain vehicles will be upgraded for military and homeland defence applications with a range of intelligence, radar, and communication systems manufactured by IAI's ELTA Systems, including the DRONE GUARD system for drone detection and

Photo: IAI

foiling, air defence, and intelligence collection systems. Under the deal, IAI will receive rights to the design of the vehicles and will market them to defence entities in Israel and abroad following their upgrade. Ido Cohen will continue to manufacture and sell the vehicles for civilian applications.The vehicles are manufactured entirely in Israel. They offer excellent performance even in difficult off-road conditions. IAI will adapt them to operational military and homeland defence configurations in line with the needs of IAI's customers.

IAI's Innovation Center

(ck) The first development cycle of Israel Aerospace Industries' (IAI) Innovation Center was successfully completed this week. The Innovation Center operates in collaboration with Starburst, a global accelerator that specialises in aerospace, and has just completed its first 13-week cycle. During this time, three teams completed Proof of Concept (PoC) ventures involving robotics, autonomous operation, and artificial intelligence for space and satellite applications. Following the accelerated development stage, the ventures will continue to evolve in the operational environment of IAI's various groups. IAI has already selected the ventures for the second cycle of the Innovation Center. R&D managers, aided by IAI's Innovation Administration, screened the ideas submitted by employees based on business feasibility, market relevance, and applicability to the future battlefield. The shortlisted ventures will start their development by the end of the month at IAI's Innovation Center. IAI invests millions of dollars every year in in-house R&D. The IAI Innovation Center is a startup model, providing IAI's engineers with a path for testing their ideas and developing a PoC within weeks. The Innovation Center adds to IAI's technological capabilities for future product lines. IAI's Innovation Center uses open innovation methodologies to encourage technological diversity and in-house entrepreneurship. The development teams undertake a fast engineering process to create a minimum viable product (MVP).

Cooperation Agreement for German Shipbuilding

(ck) German shipbuilder Lürssen has agreed on a long-term cooperation in naval shipbuilding with German Naval Yards Kiel with a view to improving the structure of the German shipbuilding industry and bolstering its efficiency and sustainability. The two companies will pool their existing military and naval surface shipbuilding activities into a joint company led by the Bremen-based Lürssen Group. The two shareholding families have successfully laid the foundation for a contractual agreement for the joint company. The joint venture is subject to approval by the authorities. This merger addresses the German public customers' request to establish industrial structures that guarantee reliable domestic availability and an efficient cost structure. The recent classification of the entire naval shipbuilding industry as a German "key

Firms & Faces

technology" by the German government supports such a request. Strengthening of the domestic naval shipbuilding industry through a combined entity between Lürssen and German Naval Yards Kiel meets government objectives and strengthens the ability to compete on a global scale.

tkMS to Acquire Oceana Shipyard

(ck) thyssenkrupp Marine Systems has signed a contract to acquire the Oceana shipyard in Brazil. The seller is Aliança S A, a company owned by CBO Group (Rio de Janeiro, Brazil), a leader in the offshore support vessels sector and one of the largest employers of qualified maritime personnel in the Brazilian market. Oceana has been chosen as the preferred shipyard for the building of four TAMANDARÉ class frigates for the Brazilian Navy. The transaction is subject to the approval of the Brazilian antitrust authorities and the official entry into force of the frigate contract is expected towards the middle of this

Photo: tkMS

year. With Oceana, tkMS has an excellent infrastructure for building the most modern frigates of the Brazilian Navy. The shipyard also offers the prospect of taking follow-on orders, not only locally, but also in other South American countries. The Oceana shipyard was set up in 2013 for the production of high quality and technology offshore support vessels and is ideal for large-scale projects. Over the next two years, up to 800 local employees are to be recruited for the TAMANDARÉ project alone. Delivery of the frigates is planned to take place between 2025 and 2028. Águas Azuis – a joint venture of thyssenkrupp Marine Systems (Lead), Embraer Defense & Security and Atech – will be responsible for completion of the four frigates.

Saab's New Fighter Radar in the Air

(ck) Saab has completed the first air trials of its new fighter X-band Active Electronically Scanned Array (AESA) radar, which will be offered as an addition to Saab's PS-05/A radar family. The radar, which is designed for fighter aircraft and can be adapted to a variety of platforms, was successful in the trials, collecting data whilst detecting and tracking objects. A version of the new AESA antenna has been sold to a US Government customer. During the air trials the host aircraft was a GRIPEN D aircraft, which is currently offered with Saab's latest Mk4 radar; the new version of the radar can be offered to GRIPEN C/D operators as an upgrade. The new AESA radar features GaN, a material that gives lower power consumption and improved heat resistance which enables wider bandwidth and greater reliability, availability and efficiency. Benefits of the new fighter X-band AESA radar will include, for example, better performance against small targets, enhanced Electronic Counter-Countermeasures (ECCM) capability as well as improved ability to support more advanced weaponry.

New CEO at VSMPO-AVISMA

(ck) The Board of Directors of VSMPO-AVISMA, the world's largest aerospace titanium producer, has appointed Maxim Kuzyuk as acting Chief Executive Officer. He will succeed Mikhail Voevodin after 11 years in this role. The appointment comes in the context of the Covid-19 crisis, where the grounding of planes has had a detrimental effect on the global aerospace industry. Maxim Kuzyuk has a track record of implementing efficiency improvement programmes. He is a change agent, who is customer and innovation focused. Previously, Kuzyuk served as Head of VSMPO Business Development and he has now been tasked with adapting the company to new market needs and ensuring financial performance.

Photo: VSMPO-AVISMA

New Executive Vice President at Thales

(ck) Christophe Salomon has been appointed Executive Vice President, Thales, Land and Air Systems. He will be part of the Thales Executive Committee. He succeeds Alex Cresswell, who has been appointed Chief Executive Officer and Chairman of Thales in the UK. Salomon, a graduate engineer of the Ecole Polytechnique and Sup' Aero, joins Thales from EDF where he held the position of Chief Information Officer from 2017 and was responsible for driving the group's Digital Transformation and Cyber Security Business. Prior to this he spent five years in the Office of Jean-Yves Le Drian at the French Ministry of Defence and 13 years in various roles at the French Defence Procurement Agency (DGA).

CZG Acquires a Minority Stake in Swedish Spuhr

(ck) CZG (Česká zbrojovka Group SE), one of the leading European producers of firearms, has announced the acquisition of a minority stake in Spuhr i Dalby AB, a Swedish manufacturer of optical mounting solutions for weapons. CZG's acquisition of Spuhr creates mutual synergies in terms of products, customers and

Photo: CZ

geographical presence. Spuhr's product portfolio consists of optical mounts, accessories and upgrade kits for weapons, making it complementary to CZ's core business. The cooperation with CZ is a strategic milestone for Spuhr, giving the company access to new markets, high-end testing technology and research. The Spuhr mounts and accessories are used by many military and law enforcement units around the world, including the Swedish, Dutch and Danish Army, German Police and Portuguese Navy. Spuhr works closely with the armed forces and manufacturers around the world. Some of the products are the result of military requirements for new solutions, while other products, such as the IDEAL SCOPE MOUNTS SYSTEM (ISMS), are the result of their own shooting and hunting experience.

Qualifying Armour on MBTs

Curtis Hand

At the Bofors Test Center in Sweden, with advanced test equipment and complete laboratories experts can test everything, from components to complete weapon systems. At the extensive proving ground they perform tests for both defence materiel manufacturers and civilian companies from all over the world.

It is the expert opinion of Stefan Kroll, President, Bofors Test Center that "when it comes to qualifying armour it is all about firing on so-called 'target stacks' with different kind of guns, ammunition and shaped charges."
Everything from small arms up to 120 mm APFSDS and missile warheads are used. Most of the tests have standards, but Kroll assures, of course tailoring of new standards also exists.

Testing the Limits

Kroll remarked that when it comes to testing Main Battle Tank (MBT) armour, the only difference is "the levels of violence you use. The better the armour, the more power is required."
During their test regimen, Kroll's team at Bofors Test Center has most of the types of guns, ammunition and shaped charges used around the world in stock to perform this kind of testing. With their unique network of contacts, it is fairly easy to purchase the ammunition or ordnance that they do not have in stock. In some occasions it is easier for their customer to bring the "threat ammunition" they feel is the biggest threat.

Timing is Everything

The armour testing phase comes in when designing / building an MBT – very early, before welding the construction plates and parts together, and later on welded samples to see if the welding itself creates too soft or brittle areas. Also when the MBT is present and ready, there is always the matter of the external add-on and reactive armour. Those plates or modules are typical parts of an upgrade kit on an existing MBT. They are tested the same way as the main construction.

Measuring Survivability

Survivability is a very complex question on high system level that cannot be measured with testing only. It is about the balance between protection and "movement capability" and also own firepower. All these questions have to be specified and reduced to single tests with measurable results. While the end-user customer can undertake much of that work, it is applied to the manufacturers efforts as detailed measurable requirements. Testing is all about verification on this deep level. According to Kroll, Bo-

Photos: Bofors

Stefan Kroll, President of the Bofors Test Center

Testing armour at the Bofors Test Center

fors Test Center, for example, measures a capability to withstand a well-defined threat - a certain projectile in a certain material at a certain velocity – by firing it in real life on a sample of the MBT construction steel. He said that whether this threat is relevant or not is up to the team who writes the requirements together with the company who provides the MBT. "An MBT itself is just a small piece in a bigger system. It depends on where and when the MBT will be put in action. Who is the enemy? Do we have airborne threats or not? EMP threats, et cetera," broached Kroll. Meaning these and other factors require consideration within any MBT armour testing project.

Covid-19 and Terrorist Groups

Andreea Stoian Karadeli

Although pandemics alone do not cause conflict or unrest, through the contexts they create together with the reactions of states, they can lead to political unrest and violence. Moreover, as a seemingly unavoidable side effect, pandemics also provide an opportunity for extreme or terrorist groups to pursue their agendas.

As the world faces an invisible enemy called Covid-19, extremist and terrorist groups are ready to exploit the current crisis to their own advantage. Seemingly strategic enemies, both right-wing and Salafi Jihadi groups, are becoming rhetorical allies through mutually reinforcing hate speech, using fear to to advance their violent goals by exploiting the turmoil and panic caused by the coronavirus pan demic. They often use similar tactics and the same messaging applications and forge mutual strategies to reach a wider audience.

In view of the current crisis and the weaknesses in national and international security during the pandemic, there is an increased need to assess the response of terrorist groups to Covid-19 in terms of propaganda material and plotting of attacks. This article examines a) how some of the terrorist groups from a broader ideological spectrum are shaping their propaganda and calls for action within the framework of the possibilities they see in relation to Covid-19, and b) how disinformation campaigns and conspiracy theories reinforce this propaganda.

Covid-19 and Terrorism

For extremist and terrorist groups, the 'corona crisis' is both an opportunity to confirm their views and apocalyptic assumptions as well as an opportunity to call for action to launch attacks, either by spreading the virus or by attacking critical

Photo: US Air Force

CBRN Exercise COMMANDO TERROR at Hurlburt Field, FL. A simulated explosive residue necessitates initial decontamination procedures.

infrastructure in 'enemy countries'. The violence that these groups promote is, in reality, a primitive expression of their struggle for meaning, acceptance and legitimacy. Based on the online material published so far, the current pandemic has rovided extremist groups with the chance to spread hatred, violence and disinformation and to reach a wide audience, currently in self-isolation at home. Since one of the main strategies of these groups is to exploit confusion and fear - two main characteristics in these times of uncertainty - their claims are usually more successful in reaching the 'hearts and minds' of people who suffer the psychological, social, political and economic consequences of isolation such as boredom, loneliness or a lack of future prospects.

The most basic strategy for saving lives during the pandemic - social distancing - can actually increase the risk of consumption of material released by extremist groups spreading misleading information, fake news, conspiracy theories and hate speech.

In other words, more time spent in self-isolation at home can become a facilitating factor in the experience of radicalisation at home. It has been shown that terrorist disinformation is capable of parasitising the fears and phobias caused by other factors, just as in the case of a pandemic. The extremist narrative offers two main elements that are key in a world confronted with the Covid-19 crisis – certainty and meaning – both of which are provided by a fundamentalist ideology. Millions of people living in self-isolation today turn to social media, where they become easy targets for either Salafi Jihadi or extreme right (or left-right) groups that exploit widespread confusion and fear in order to fuel hatred. Although governments have made great efforts to provide accurate information about Covid-19 online, they still need to address the rise of conspiracy theories and the role that this rhetoric plays in the calls for increased targeted violence against vulnerable communities. This task becomes even more difficult when dangerous propaganda is

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hidden in so-called 'grey zone' extremist material, the removal of which is prevented by automated algorithms that recognize terrorist symbols, music and content.

Moreover, fear is a crucial element known to all extremist groups and can be played as the best card, especially in contexts like the one created by Covid-19. Daesh made it clear in one of its publications that more dangerous than the epidemic itself is the fear that has spread among the population and can plunge society into chaos. However, even terrorist groups are not immune to the virus, and although their narratives may try to claim to be ahead of the virus, the truth is that they are still unsure how to react to what is going on and what the longer-term effects of the virus will be on their actions.

All these groups share a key common goal – to attack the designated enemy - in any context, but especially now when they are most vulnerable. Although they are largely similar in rhetoric, strategies and means, each group has its own specific response to the Covid-19 pandemic, depending on its capabilities and local circumstances.

Salafi-Jihadi vs. Right-wing / Left-wing Extremists

Daesh dedicated its latest issues of the weekly magazine Al-Naba to the current situation, publishing a well-documented briefing before many of the governments around the world had given any information to their own citizens. In January, Al-Naba reported that "a new disease is spreading death and panic" in "communist China". As the virus spread to Iran, the newsletter stressed that the infection was God's punishment for Shiite Muslim "idolatry". The rhetorical line developed on Covid-19 has evolved as the geographical range of the virus and the human toll has become clearer. Although the virus is perceived as a "soldier of Allah" who came as punishment for the "infidel governments", it still poses a threat to the members of Daesh and they must seek help from God to be protected. Apparently, the practice of the duty of "Jihad" offers them protection from the virus. Daesh's main aim is to sow the seeds of distrust of the government by spreading disinformation and malicious information - while using the unfolding events to underpin their view of the world and confirm their predictions. There are three main pillars in Daesh's propaganda regarding Covid-19: firstly, the confirmation of its ideological rhetoric regarding the virus; secondly, the provision of information on how to prevent infection with the disease

- an infographic entitled Shari'a guidelines for dealing with epidemics; thirdly, a call for action to exploit the vulnerabilities that many countries are currently facing and carry out attacks and to free their fellow combatants, their wives and children, who are held in camps or prisons in Syria and Iraq.

The situation in the camps, as well as in Syria and Iraq, is fragile and resembles a powder keg that could explode at any time, as the international community is already weakened and too vulnerable by the pandemic to respond effectively. The virus that is spreading in the prison camps

To combat the spread of the virus, in April 2020, the coalition provided the Syrian Democratic Forces (SDF) with face masks, hand washing stations, hand disinfectants and bleach worth US$1.2 million, which, according to the officers, will be used in the region's prisons and hospitals. The prisons where Daesh prisoners are held cannot simply set some lower-risk prisoners free - as some Western prisons did when the Covid-19 pandemic spread around the world. Moreover, the tens of thousands of children in prison camps are already vulnerable to radicalization, and a Covid-19 crisis could make the situation
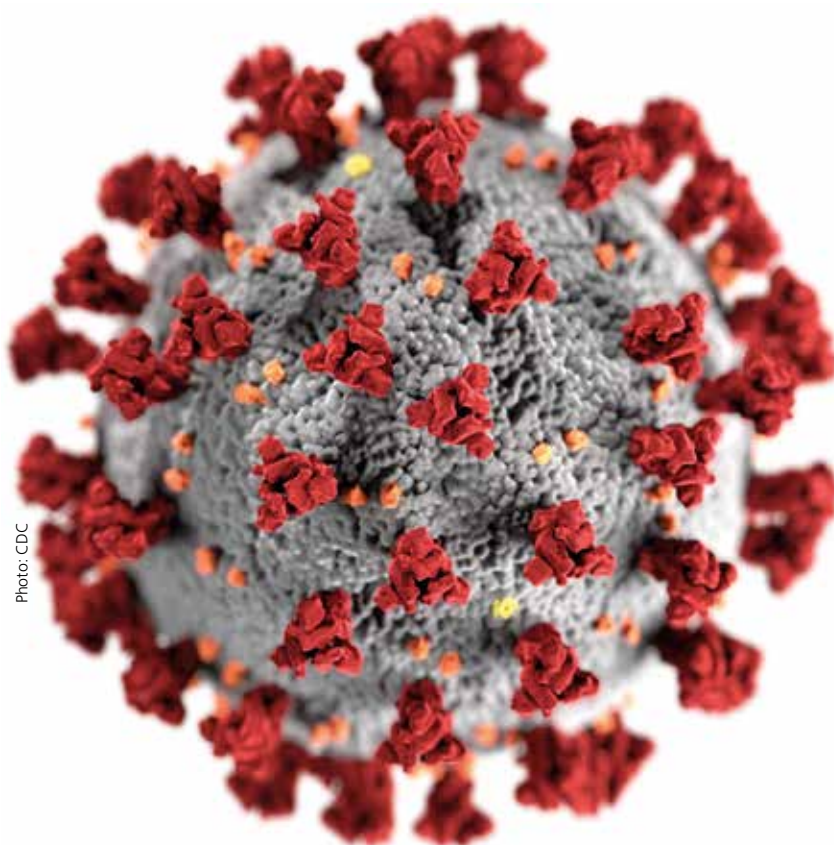
Photo: CDC

Coronaviruses are a group of viruses that have a halo, or crown-like (corona) appearance when viewed under an electron microscope.

in Syria and Iraq could be the kind of distraction that Daesh pointed out when it urged its members to take the opportunity to work towards the liberation of fellow combatants and their families in the prisons, where they "are at risk of disease in addition to submission. The release of any number of them would strengthen their operational capabilities and threaten to undo years of coordinated efforts to contain the militant group. On the other hand, if the conditions in the camps and prisons deteriorate and the virus gets out of control, the fact that these militants or their families will die will only further confirm the extremist propaganda.

worse. In a video posted online in Turkish, an anonymous woman demonstrates the living conditions in one of the camps near the Turkish border while pointing at two minors. The video serves as a way of highlighting the lack of a common strategy by the international community regarding the camps where the families of the fighters are being held. At present, these camps are the perfect environment for further radicalisation and the spread of extremist ideology, although officials of the International Coalition Against Daesh claim that they are working with NGOs and SDF to improve conditions in these areas.

Another group active in Syria, and the leading jihadist coalition of Idlib, is Hayat Tahrir al-Sham (HTS). This group operates a so-called 'Salvation Government' (SG) as a civilian arm, which also has a kind of health ministry under its control. The SG began earlier and more thoroughly than the Assad regimein taking preventive measures, including the following: distributing guides to motorists, publish-

that takes a more 'state-like' approach. In a 4-minute report published by the News Agency of Sham, a media company of the SG in Idlib, the quasi-state demonstrates its preparations against COVID19 with a preventive quarantine centre, distribution of information to local traders, pictures of clean-up efforts and so on. The HTS's own representation is that of a saner organisation than some churches in the US,

oners in their prisons, they have also tried to point out more pragmatic steps, such as setting up camps to treat people in areas under their control. Taliban images show how their members maintain social distancing while wearing protective clothing, while claiming that the pandemic is "sent by Allah for the disobedience and sins of mankind". The Taliban also announced the establishment of medical centres, including in areas such as Afghanistan's Paktika province, just months after the group was blamed for the attack on the government-run medical centre in the same area. All this posturing, coupled with the fact that they are seeking the help of aid agencies and health workers that they had previously targeted, is accompanied by talks about a ceasefire in areas where they oppose the Afghan government. All this begs the question whether their approach to fighting COVID19 is to actually build a health system, or whether it is simply a cynical attempt to portray the group in this way.

Political Extremism

Just like the Salafi-jihadi examples, extremist groups of the far-right and the far-left also see a confirmation of their ideological views in the pandemic. For many on the far-left, the source of the virus and the reason for the difficulty faced by societies in coping with the pandemic is the destructive nature of capitalism – the aggressive expansion of markets and means of production or globalisation among other factors. The 'system' also enables greed and hoarding – well embodied by the western 'toilet paper crisis' – to develop at the expense of poorer strands of our societies, thereby further enhancing social division. Finally, the containment measures to combat the pandemic are portrayed as an opportunity to take away liberties and impose authoritarian rule, often described as fascist. Hence, the current crisis confirms both their worst fears and what they have advocated for years. For many on the far-right, the pandemic validates numerous conspiracy theories, where the pandemic is a result of the deep state and, therefore, the measures and information are to be neither implemented nor believed. Perhaps of greater concern are the interpretations of the virus as being 'foreign', brought by foreigners into western countries and created by a foreign power to decimate western civilisation. This interpretation has led to an increase of attacks on 'foreigners', notably of Asian heritage, and in some more extremist circles even to suggestions of a 'cleansing' of western societies. Branded as such, the far-right's anti-foreigner and anti-immigration

Photo: US Air Force

A US Air Force medical technician writes down patient information in the Ramstein Medical Clinic's coronavirus disease 2019 screening drive-thru at Ramstein Air Base, Germany, in March 2020.

ing an information video and essays by the Minister of Health, drawing caricatures on walls to show children what to do and what not to do about viruses, carrying out temperature controls at border crossings from Turkey, sterilising schools, mosques, government buildings and other infrastructure, launching an awareness campaign for internally displaced persons in rural Idlib, Aleppo, and Turkish-controlled Afrin (where the SG has a limited presence), organising coronavirus teachings for clergy, and holding local forums by doc tors and deans of medical schools to explain the SG's plans (with appropriate social distance between participants). SG also closed markets, set up quarantine tents for suspected virus carriers until they can be properly tested, and initiated remote training via pre-recorded WhatsApp videos. On 23 March, the authorities also set up an Emergency Response Committee to coordinate the entire administration, chaired by Abdullah al-Shawi on behalf of the President of the Secretary-General.
Ideologically, preferring science to religious guidelines, HTS offers an interesting insight into what is an Islamist group

which have refused to be shut down in the face of the pandemic. At the same time, the HTS has suffered from the coherence in its messages, as some of its leaders refused to follow the rules and continued their work as before.
At the beginning of the Covid-19 crisis, although Al-Qaeda seemed silent, its news agency — Thabat Media Agency — published an article written by Khalid al-Sibai entitled 'Corona: Annihilation of the Unjust and a Testimony of the Believers'. The piece describes Muslims who have died from the virus as martyrs and calls on Al-Qaeda affiliates to exploit the current situation by carrying out more attacks against their enemies. Like Daesh, al-Qaeda has used its propaganda resources to highlight the opportunity presented by the pandemic and to strike when their enemies are most vulnerable.
The Taliban or 'Islamic Emirate of Afghanistan', as it calls itself, has proven to be one of the more vocal groups in terms of their reaction to the pandemic. In addition to publishing several official statements on the Covid-19 outbreak, calling on the Afghan government to protect Taliban pris-

rhetoric is seen by them as justified, as is the failure of the neo-liberal system. Therefore, regardless of the extremist position – ideological or religious – the pandemic acts as means of reinforcing these positions within their specific interpretations.

ISIS and Al Qaida affiliated material did not suggest any new attack methods but rather focused on the opportunities that were presented to their followers. No need for something special but 'business as usual' should be enough to enhance the damage done by the virus. In that sense, the Al-Naba editorial's exhortation to violence is not news, as for Daesh it is always time for violence. What matters instead is what the group is capable of and what its operating context allows. If that context becomes more permissive, Daesh can better organise and execute resource-intensive, complex attacks at substantial human cost. In far-left circles, calls for plunder or the destruction of businesses are made to accelerate capitalism's downfall. The logic being that if people become needy enough, the oppression of capitalist societies will become obvious and in turn, the oppressed will demand and impose a more just system. Whereas the far-right's calls for actions have focused on the mass infection of traitors and foreigners or targeting those it views as responsible for the pandemic. Like with the far-left, the far-right calls to action also aim at accelerating the demise of the current liberal system and implementing a new order aligned with their views. An intriguing particularity of the far-right's calls for action to date has been to encourage spreading the virus to specific groups, whether by coughing deliberately at people or contaminating goods in stores with saliva. This is a sharp contrast to other extremists' positions, who ask their supporters to be cautious and avoid becoming infected. This tactic appears motivated by a dismissal of the coronavirus' effects ('just the flu') for specific groups or a 'survival of the fittest' mentality. Worryingly, numerous individuals – mostly men – are acting on these calls, contaminating goods in supermarkets or coughing at people, while claiming to be infected. This is a clear weaponisation of the coronavirus, even at its most primitive (and natural) and further demonstrates that the use of 'bio-weaponry' does not need to be sophisticated to be dangerous. As the recent history of terrorism further underlines, effectiveness can be found in the simplest methods. So far, we have seen that extremists can easily use the current pandemic for 'positive

Civil protection volunteers at the health checkpoint at Guglielmo Marconi Airport in Bologna, 5 February 2020

reinforcement' and indoctrination, benefitting their strategic aims and tactics. However, beyond the calls for action, it is often circumstantial factors that can both act as an incubator and a nudge for extremist violence. In the case of the current crisis, disinformation plays a huge role in polarisation, fear and fostering emotional insecurity, all of which play a huge role in the 'defensive' interpretation of violent actions by extremists.

Conclusion and Recommendations

The Covid-19 pandemic has the potential to weaken domestic security efforts and international counter-terrorism cooperation, allowing terrorist groups to better prepare attacks and escalate campaigns of insurgent warfare on battlefields worldwide. Security officials warn that extremist groups may become emboldened during a time when governments and authorities are focused on the sweeping changes to societies and economies brought on by the crisis. Quarantine has also created new 'soft' and tempting targets: care homes and hospitals, the only locations where large numbers people are now likely to spend their days – and where every country's ability to protect its citizens is currently being tested. The pandemic has also potentially provided extremists with a cheap weapon at their disposal: the virus itself. It is possible that the Salafi-jihadi groups will use the Covid-19 crisis to instigate more fear in Western countries, and the more localist Islamist and jihadist militias groups, such as the Taliban,

Hamas and Iran's Shi'a militias, will likely use the insecurity to strengthen their grip on the local populations, taking advantage of political-security vacuums to present themselves as credible actors. While improbable that a white supremacist group can successfully carry out even a low-scale WMD attack, much more likely during the pandemic would be small-arms and critical infrastructure attacks.

In order to cope with the effects of the Covid-19 pandemic, whether it is in regards to the terrorist threat or other relevant dimensions of security, there is a deepening need for a multidisciplinary understanding and strategy development, which encompasses perspectives from all spheres of our lives such as psychological, social, economic, political, educational, medical, anthropological, cultural and administrative. Bearing in mind also the increased use of the internet and social media during the self-isolation period, it is extremely important that social media companies and governments develop their strategies to identify, monitor and remove disinformation and extremist propaganda spread by groups representing a wide ideological spectrum. It is important not to forget the threats that have been present on the political scene before Covid-19 and to remember that they have not disappeared. Instead, they can seize the opportunity and hit when we are most vulnerable. Counterterrorism professionals should continue to monitor terrorist footprints, which are spreading and mutating like a virus and adapting to the new international context. ■

Bittium's Next-Gen Tough SDR Radios

Bittium, the Finnish pioneer in tactical software defined radios, known from its very successful Bittium Tactical Wireless IP Network (TAC WIN) radio family, is now starting the large-scale deliveries of a new product family of next generation tactical SDRs, including Bittium Tough SDR Handheld for dismounted soldiers and Bittium Tough SDR Vehicular for vehicle installations.

The tactical radios are a result of a long history in research and development in software defined radios as well as deployment of tactical networking solutions. Following the success of the Bittium TAC WIN as a wireless backbone network for modernising tactical communications, the new tactical radios expand the product offering to individual soldier and vehicular level tactical radios. This enables bringing broadband data transfer and voice to all mobile troops starting from brigade level and all the way across the battlefield.

The handheld and vehicular radios can be used stand-alone or together with the TAC WIN network to produce and share real time situational awareness, including location, image, voice, video, and sensor data. This improves the performance and the effectiveness of the tactical troops, and leading the troops is easier based on the up-to-date situational awareness and more reliable connections.

The Bittium TOUGH SDR combination caters to a highly mobile force.

Photos: Bittium

The Bittium TAC WIN is a wireless backbone network for tactical communications.

Coalition Networking with ESSOR

The two radio platforms are provided with a set of waveforms. They can be used with the wideband Bittium TAC WIN Waveform, already operational with the Bittium TAC WIN system, and the proprietary Bittium Narrowband Waveform. The third option is to use the ESSOR High Data Rate Waveform also for coalition operations. Bittium has been a national champion in the European Secure Software-defined Radio (ESSOR) programme since its beginning in 2009. Currently the programme is enhancing the operational capabilities of the ESSOR waveform. With the waveform, broadband data transfer, cooperation and direct communications between different national troops, starting already from the patrol level, are made possible.

The handheld and vehicular radios can flexibly use the most appropriate waveform with the best fit considering the conditions and the mission. Using several waveforms, even simultaneously, improves compatibility and enables operations on different levels and missions. Waveform portability allows seamless porting of legacy or national proprietary waveforms with national COMSEC and TRANSEC.

The Tough SDR Vehicular is designed with two independent channels able to simultaneously run an instance of TAC WIN, ESSOR or Narrowband waveforms. This allows the vehicular radio to automatically connect with TAC WIN backbone while also autonomously networking with other tactical SDRs, such as Tough SDR Handheld, running ESSOR or the Narrowband waveform.

Innovative Features for Dismounted Troops

The Bittium TOUGH SDR Handheld radio provides voice and data over the widest frequency range, from 30 MHz completely covering to 2500 MHz, for the individual soldiers such as squad or platoon leader.

The uniquely wide range of frequency bands improves combat survivability significantly.

The radio is a perfect match for replacing legacy CNR in service with different defence forces. It will help to modernise the tactical communications infrastructure by bringing data-on-the-move, improved situational awareness and C2 applications to dismounted troops, not forgetting the best-in-class user interface and usability for easy operation.

Managing the devices on the field is made easy with tactical device management suite allowing operators for example to configure the radio over web interface and conduct remote SW upgrades. The radio also has a secure application sandbox that provides flexibility for integration of different C2 applications, such as BMS and blue force tracking and other customer proprietary configurations.

Other features of the handheld include wired or wireless integration with tactical COTS tablets or smartphones, including Bittium Tough Mobile product family's ultra-secure smartphones running Android OS.

Deployment Starts from Finland

At first, Bittium starts the large-scale deliveries of the Tough SDR radios to the Finnish Defence Forces. The handheld and vehicle radios are renewing the Finnish Defence Forces' existing stock of CNRs with the modern, broadband data transfer radios to support the reformed combat doctrine of the Finnish Defence Forces together with the Bittium TAC WIN system, which is already used by the Finnish Defence Forces. In the first phase, the new tactical radios will be used by the Army.

In addition to the initial up to €10.5M order, the purchase agreement between Bittium and the Finnish Defence Forces includes additional purchase options, valued up to €207M. Accordingly, the Finnish Defence Forces have an option to buy additional tactical radios and related accessories, training and system management for the use of Army, Air Force and Navy.

Bittium has also supplied the Tough SDR Vehicular radios together with the ESSOR HDR Waveform to the pilot vehicles of the Spanish Army's VCR 8x8 vehicle programme to demonstrate the capabilities and performance of the system. In addition, deliveries to the Estonian Defence Forces commenced at the end of 2019. In Estonia, delivery of Bittium Tough SDR radios and Bittium TAC WIN system's products continues the reform that aims to improve the Estonian Land Forces' IP data transfer capability and availability. Modernisation of tactical communications will take place also in Austria where the Bittium TAC WIN system has been selected as the new IP-based tactical communications system for the Austrian defence forces. The seamlessly interconnected, reconfigurable family of tactical radios is offered to customers around the world. The radios will cater to a highly mobile force structuring a resilient, adaptive and secure network. Together with Bittium TAC WIN, the whole portfolio reflects a design philosophy towards improved usability, ease of maintenance and zero-configurability.

Public-Private Partnerships – A Defence Industrial Policy Choice in The Post-Covid Era?

Manuela Tudosia

Faced with looming economic recession, the lessons learnt from the Covid-19 crisis are vast and go beyond the question of public health. They include the issue of sustainable manufacturing capacity, security of supply, and smart, well-structured, technological innovation. Will defence industries be asked to pay a "COVID dividend" by our politicians, or will they be included in a societal dialogue to act upon these lessons learnt?

In the past two months, the world witnessed an impressive mobilisation of various industries to provide much needed equipment in the fight against Covid-19. Big and small companies alike offered their support to governments. Many new technologies, like 3D printing or Artificial Intelligence, proved their utility but also raised many policy and societal questions.

For governments, the crisis revealed untapped resources within their national industrial bases and also a challenge to adapt regulatory and bureaucratic processes to the urgency of the moment, so product quality and safety are not compromised.

The defence and aerospace industries made no exception in this effort. Some examples of how defence industries contributed could illustrate this fact and provide insights on industrial policy steps that could be considered in the future.

Defence Industry and Covid-19

The lack of Personal Protective Equipment (PPE) and ventilators was salient. Governments were competing for the same re-

Photo: US Air Force

Due to a shortage of disposable masks, the US Air Force has been using its 3D printers to make face shields to combat the Covid-19 pandemic.

sources, trying to avoid fraud by unscrupulous suppliers, and enforce quality and safety regulations under severe time pressure.

Raytheon Technologies Corporation, one of the largest aerospace and defence companies in the transatlantic space, includes Collins Aerospace following the Raytheon-UTC merger. As suppliers of essential components for cargo aircraft like the C-130, Collins played an intrinsic role in securing transportation of key supplies during the crisis. In addition, the company used nearly 70 3D printers across Raytheon Technologies' global locations to produce face shield headbands.

Lockheed Martin, global security and aerospace company, produced more than 50,000 protective gowns and 27,000 face shields.

In Europe, the defence industry sector came up with concrete solutions and showed remarkable capacity to integrate and promote innovation from Small and Medium Sized Enterprises (SMEs) and universities.

Romarm is the largest supplier of military equipment, ammunition, and maintenance

services in Romania, having 15 subsidiary factories under its supervision. During the crisis, Romarm added three lines to its usual production lines to secure, at maximum capacity, manufacturing of up to 8000 surgical masks per hour per production line. In addition, an FFP2 mask production line was installed, with a manufacturing capacity of around 3000 masks per hour.

The company also explores possibilities to support manufacturing of ventilators, and several prototypes available on the Romanian market are under consideration. A significant challenge is the dependency on external markets for certain small but essential ventilator components. Many suppliers are based in China – a country still in need for such equipment. However, as we will see in this article, some European defence-related industries started to propose solutions during the crisis.

Romarm also teamed up with Stimpex SA, a Romanian SME specialised in CBRN protective equipment, to manufacture a newly

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3D printed masks sit inside the medical warehouse at Tripler US Army Medical Center, Hawaii.

developed portable isolator for the evacuation of patients contaminated with biological agents, including SARS-CoV-2. The prototype isolator was developed in record-time by a Scientific Research Center of the Romanian Military Equipment and Technologies Research Agency in collaboration with Stimpex.

Like Raytheon Technologies in the US, companies belonging to the French aerospace and defence group Safran provided significant support. As suppliers of turbine engines and other components for helicopters and for A400M military transport aircraft, the group played an intrinsic role to assure availability of patient transportation.

Safran Aero Boosters, the group's Belgian subsidiary, offered to use its 3D printing machines to produce spare parts for ventilators. In only two weeks, the company managed to successfully test a flow meter and to make it available to hospitals. The company also proposed to a university team of researchers to industrialise a ventilator prototype developed by the team.

Safran as well as Leonardo UK, another leading defence player in Europe, quickly converted their production lines to produce PPE for medical use. Safran is also working with authorities to adapt for medical use protection masks originally intended for soldiers, and Leonardo proposed an improved helmet and mask system to enable helicopter crews to continue fly during the pandemic.

Initiatives extend beyond the current management of the crisis. Restart of economic and social activities in a safe environment is essential.

Airbus, global leader in aeronautics and space, partnered with Koniku Inc. – US biotech SME - to co-develop a solution for the identification of biological hazards by adapting and extending research activities on a previous solution that was focused on contactless and automated detection of chemicals and explosives on-board aircraft and in airports. Co-operation between the two companies started in 2017 and its benefits are clearly visible today.

These examples remind about the capacity of defence industries to swiftly adapt to changing circumstances. From a practical perspective, they also highlight the challenge of having to quickly switch R&D focus and production lines during fast moving scenarios. This includes the challenge for the workforce to adapt and apply its expertise to new scenarios and unexpected requirements.

Paradoxically, the biodefence sector seems to have anticipated this type of challenges when it advanced the idea of "flexible manufacturing". It is perhaps because viruses, like threats in general, tend to mutate.

Could our defence industries have provided even more support if the idea of fast changing requirements was already part of a pre-existing manufacturing model supported by Public-Private Partnerships (PPP)? Or, could they do so in the future to support better response to unexpected civil emergencies or security threats to our society and way of life?

"Flexible Manufacturing" in the Bio-Defence Sector

- In 2012, the US Biomedical Advanced Research and Development Authority (BARDA) established three Centers for Innovation in Advanced Development and Manufacturing (CIADM). Structured as Public-Private Partnerships (PPPs), the objectives of these Centers were:
- to provide core services for the advanced development and manufacturing of CBRN biopharmaceutical countermeasures (CM);
- in an emergency, to accelerate development and manufacture of CM by providing surge capacity;
- to provide specialised workforce development through training programs aligned with regulatory guidelines;
- to explore emerging and innovative technologies that could be applied to current or future medical CM development efforts, including through collaborations with small companies. According to

Medical Countermeasures.gov, exploring such technologies in this framework would also "reduce risk, increase yield, and ultimately to reduce total life-cycle costs through flexible manufacturing, consolidating other costly product development expenditures, or any other economy-of-scale opportunities."

To date, BARDA funded three Centers and concluded with major biopharmaceutical companies PPP agreements that could be renewed for up to 25 years. Under these contracts, the awardees "retrofit existing facilities, or build new facilities to incorporate flexible, innovative manufacturing platforms that can be used to manufacture multiple products."

The PPPs' governance process is overseen by a governmental Advanced Development and Manufacturing Steering Committee that advises on the prioritisation of projects and establishes specialised working groups, monitors program functionality and infrastructure, and supervises product development.

The Centers proved their utility during the Covid-19 crisis. US BARDA has recently partnered with the CIADM established a few years ago at the company Emergent BioSolutions, to develop Covid-19 Human Immune Globulin (HIG). BARDA's funding will support the collection of plasma and the manufacture of the therapeutic for clinical evaluation in patients later this year.

Public-Private Partnerships in the Defence Sector

Public-private partnering is known to the defence sector. The end of the Cold War triggered major transformation of the Armed Forces and of defence industries. Economically, the "peace dividend" called for major cuts in defence spending. Mission-wise, the new strategic environment required forces to adapt from a relatively static posture to a deployable and highly mobile one. In addition, after 9/11 – and especially in the last decade – defence forces were increasingly called in support of civil authorities at home. The Paris or Brussels 2015 and 2016 terrorist attacks, but also the Covid-19 crisis, are reminders of this.

Defence transformation did not happen at once but was a recurrent process with inputs enshrined in national, NATO and EU defence policy reviews (e.g. US Quadrennial Defense Review; UK Strategic Defence Review) and outputs visible as further reorganisation to optimise costs while increasing availability, performance and longevity of defence systems.

Defence industries were not spared from these changes but had to adapt in kind. In parallel to the post-Cold War reorganisation and privatisation, industry had to adapt to armed forces' urgency to optimise life-cycle

Soldiers from the 551st Medical Company (Logistics) and the 627th Hospital Center unload tri-walls of medical supplies as they arrive at Joint Base Lewis McChord, Washington, in support of Covid-19 relief efforts March 30, 2020.

sustainment costs as part of their logistics transformation. Minimising cost and logistics footprint was essential.

Acquisition costs, while the most visible, are not necessarily the highest. Product sustainment throughout life cycle can trigger much higher costs unless effective life cycle sustainment planning is implemented. It is today widely agreed, for example, that the demand for sustainment of a system is likely to be lower if this is already well-planned in the early stages of the life cycle. However, when the system is already acquired, the initial product support strategy (e.g. maintenance, supply, manpower) can be improved to optimise remaining life-cycle sustainment costs. In addition to sustainment, support services (e.g. air refuelling) can be an important cost driver.

Against this backdrop, the "Outcome-Based Contracting (OBC)" or "Performance-Based Logistics Contracting (PBL)" emerged in the new millennium as a public-private business model that can help optimise customer support and improve operational readiness at reduced ownership costs. As opposed to traditional transactional contracting, in PBL the government procures an outcome – such as system or service availability – and seeks to reduce overall costs by placing more responsibility on the industry. The latter is incentivised to find innovative ways to reduce costs, including through investments, in exchange for a set of rewards that depend on the delivery of the required outcomes at reduced total cost.

There are several definitions for OBC or PBL. Most importantly, PBL structure and contractual constructs can vary depending on project scope, context or cultural factors, including national approaches on the role of industry in relation to the state. For example, in the beginning, PBL was mostly used by armed forces in the Anglo-Saxon countries but the model started to progressively gain more attention in continental Europe. The US C-17 GLOBEMASTER III Sustainment Partnership is one of the best-known programmes that include PBL contracts. However, many more such examples exist. Indeed, PBL has been implemented for various system levels, from Integrated Logistics Support for an entire system or system-level support service, to sub-systems (e.g. radars), or components (e.g. tires).

A common characteristic in PBL is the collaborative – and often long-term - relationship between the customer and industry, structured as public-private partnering. In product support, PPP is understood by US DoD as "a cooperative arrangement between an organic product support provider and one or more private sector entities to perform defence-related work, utilise DoD facilities and equipment, or both" (US DoD Public-Private Partnering for Product Support Guidebook). They allow the private sector to utilise existing organic facilities and infrastructure, which can have several benefits e.g. avoidance of capital investments, reduction of operating costs, access to laboratories and trained organic work force, or establishment of collaborative relationships between the public and the private sectors. Partnerships can provide synergies that neither partner could generate separately.

Public-private collaborations in the defence sector were not implemented only in the context of PBL. They were also used e.g. in cyber-defence, humanitarian assistance and disaster relief, military medicine, or to facilitate cooperative R&D – to name just a few.

With various governance models, and perhaps not always "perfect", PPPs have generally proven their utility by leveraging competence, infrastructure and best practices from both the public and private sectors.

Defence industries are particularly well placed to activate in a public-private partnering framework. Traditionally subject to strict quality standards and a need to guarantee reliability of their supply chains, these industries remain strategic government partners not only to respond to sudden crises but also to anticipate and prepare for future ones.

Conclusion

Faced with looming economic recession, the lessons learnt from the Covid-19 crisis are vast and go beyond the question of public health. They include the issue of sustainable manufacturing capacity, security of supply and smart, well-structured, technological innovation.

Will defence industries be asked to pay a "COVID dividend" by our politicians, or will they be included in a societal dialogue to act upon these lessons learnt? The impact of major crises, and Covid-19 is one of them, is always considered in governments' strategic defence reviews. Such crises can even trigger defence reviews outside the regular cycle. Under the pressure of the moment, temptation may be high to cut defence spending even more. In this case, it is urgent to stop and think twice.

Instead, decision-makers should ask how we can better use the potential of our defence industries. By their very nature, our defence industries have an extremely qualified work force and a thorough know-how of implementing technical civilian and military standards. Often, their manufacturing lines produce for both the military and the civilian sectors. There is even a high probability that, like "flexible manufacturing" in biodefence, defence industries can adapt and switch their manufacturing capacity to meet a more diverse set of needs than today.

Nonetheless, a prerequisite for this would be a first step made by the public sector in starting a dialogue regarding key technological areas and gaps where manufacturing and supply chain needs are not met at present. These should cover both potential requirements in civil emergencies as well as complex security requirements. Indeed, Covid-19 crisis showed us how much simple needs and supplies do matter. Moreover, political capital is often built on simple things. Health security, food, energy, communication, but also well-being and sports, they all matter and are a continuum to advanced technologies like AI or big data, which nowadays can be key to securing the former.

After the Cold War, defence industries were asked to diversify. Let us diversify smart, by leveraging the potential of Public-Private Partnerships where governance is assured, for example, by multinational agencies like the NATO Support and Procurement Agency or the European Defence Agency. ■

Does a French Exception Still Exist?

Giulia Tilenni

The most important French strategic documents and the speeches on nuclear deterrent delivered by President Macron in February 2020 at the Ecole Militaire and the Munich Security Conference explain France's security policy and international role within and outside multilateral frameworks.

In 1958, following the establishment of the Fifth Republic, General de Gaulle wanted to restore France's rank as a world power. After a meeting with US Secretary of State John Foster Dulles in the same year, President De Gaulle said, "If France ceases to be a world power, it ceases to be France". One year later, he said that a country like France must wage its own wars and make its own efforts if it wants to remain coherent with its history, its role and its "soul".

The policy of grandeur, which dates back to King Henry IV and has developed under the Cardinal Richelieu and, later on, Emperor Napoleon I, had been rediscovered by General de Gaulle. He aimed at giving France a unique role within the West in which the UK was aligned with the US and Germany had limited political power. While supporting the US in various crises during the Cold War, France asserted its independence, acquiring its own nuclear deterrent (A-bomb in 1960, H-bomb in 1968) and withdrawing from NATO's integrated command in 1966. To counterbalance the US's irresistible power, France also pledged great political capital to the European integration process and established privileged ties with the newly established African states.

Albeit in a different fashion, President de Gaulle's strategic legacy has been pursued by all presidents of the Fifth Republic. Therefore, it is not surprising that the four White books, the Strategic Review, and the most important speeches on foreign policy and defence delivered by French Presidents consider the international environment as part of the country's security policy. Thus, all the documents on which the French defence posture is based on, assign a crucial role to balancing independence and the capability of maintaining a strong international role.

Photo: US Navy

In 2017, the US led the Bastille Day Parade in Paris as the country of honour commemorating the centennial of US entry into World War I as well as the long-standing partnership between France and the US.

As the stance outlined by President de Gaulle is the basis of French security policy, it has had a key impact on France's stance within the most relevant multilateral organisations – the UN, NATO and EU among others. The 2017 Strategic Review emphasised that "only a strong France, master of its own destiny, can respond to major contemporary crises, promote its values and highlight the importance of its interests. This ambition cannot be achieved without diplomacy and a defence supported by a large, strong and credible army, capable of tackling all kind of threats in all operational environments". Over the years, France has worked extensively to maintain and, where possible, increase its international weight, both within the international organisations in which France drives reform processes and outside the given international framework. French multilateral efforts include, among others, pledging human and material resources to coalitions of the willing (usually by participating in combat missions), building ad hoc cooperative frameworks (such as the Euro-pean Intervention Initiative) and playing the role of mediator when possible (for instance, to calm down tensions between the EU and Russia following the crisis in Crimea).

The Importance of Multilateralism

As one of the five countries having a permanent seat in the Security Council, France assigns an important role to the UN. The gradual transformation from a bipolar to a multipolar world began in 1989 and the emergence of non-state actors has increased international tensions in the last decades. The fact that this multiplication of actors has not been followed by a revision of the existing multilateral frameworks has undermined the trust of some states in international institutions and their activities. Convinced of the need for common rules for the international order, France continues to regard the UN as the main guarantor of that order. Nevertheless, France recognises that the inability to find effective solutions

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to global humanitarian crises, partly caused by the paralysis of the Security Council due to veto powers, has dramatically reduced the cases in which the UN is called upon to resolve disputes. Despite their increasing deployment in recent decades, the effectiveness of peacekeeping operations has often been called into question, particularly with regard to the appropriateness of their mandates and the selection and training of soldiers, as well as their lack of preparedness. In view of this, France has been working to strengthen the UN Security Council by proposing a collective and voluntary agreement between permanent members in 2013 to waive the use of the veto in the event of mass atrocities identified by the UN Secretary-General. In September 2019, this French initiative was supported by 102 UN member states, but no decision has yet been taken in the Council. In addition, France has long advocated for the enlargement of the Security Council in both categories of membership, permanent and non-permanent. It supports the accession of Brazil, Germany, India and Japan to permanent membership and greater representation for African countries. Indeed, continued efforts to conclude the ongoing intergovernmental negotiations on reform and the admission of Germany as a permanent member have been identified as priorities for Franco-German diplomacy, as set out in the Aachen Treaty, signed in 2019 and that entered into force in January 2020.

President Donald Trump holds a bilateral meeting with French President Emmanuel Macron on 3 December 2019.

A Special Role in NATO

France is one of NATO's founding members and hosted the organisation's HQ from 1949 to 1966. France actively supported the creation of the Alliance as it marked the official involvement of the US in European defence, thus ensuring the preservation of peace in the continent at a time when international uncertainty was at its highest level. However, the creation of NATO did not fully ease tensions between France and the US, which mainly concerned the Suez Crisis (1956), the intervention in Vietnam (1954) and US response to the Cuban crisis (1962). At the same time, NATO's structure and objectives have rapidly diverged from France's international ambitions, especially concerning the development of a fully autonomous nuclear deterrent. After failing to conclude a reform of NATO's military command aimed at including France and the UK, President de Gaulle has pursued a gradual disengagement from NATO's commitments which, culminated in the country's withdrawal from the Alliance's Integrated Military Command Structures in March 1966.

In the following years, France remained engaged in NATO's activities, thus minimising the military impact of the withdrawal and preserving interoperability, participating in NATO-led military operations from the 1990s on, namely in the Balkans and Afghanistan.

In 2009, President Sarkozy announced the return to NATO command structures, but only under certain conditions: maintaining nuclear independence and full discretion over France's contribution to NATO operations; non-participation in a number of jointly funded expenditures agreed upon prior to return, including the fact that no French forces will be placed under NATO permanent command in peacetime. To maintain its nuclear independence, France decided not to join the NATO Nuclear Planning Group, which determines the Alliance's nuclear policy. All of this considered, the country has,

Photo: Tauno Tõhk

On 13 November 2017, a number of European countries signed the PESCO agreement for more structured defence cooperation. Indeed, France has promoted some of the most ambitious PESCO projects.

therefore, an exceptional position within the organisation.

The Importance of European Cooperation

Since the creation of the first European institutions in the 1950s, France has called for establishing a European defence cooperation. Since the approval of the Lisbon Treaty in 2010, French commitment for the development of a real and effective European defence has become stronger. The 2017 Strategic Review identifies the EU as the most important layer of cooperation for the country, followed by bilateral cooperation and transatlantic cooperation. Identifying common strategic interests and launching common defence programmes are at the core of French ambitions for a European defence. France has promoted some of the most ambitious PESCO projects (e.g. ESSOR and the development of the fully EU-developed MALE RPAS) and has been extensively working for the development of common military capabilities. France is convinced that these programmes will allow for better responses to current threats, something that European countries cannot achieve on their own, and will also strengthen the EU's strategic autonomy.

The fact that France also has an exceptional position within this framework may undermine defence cooperation. One of the key points is that France is a nuclear state with a peculiar chain of command and a specific concept of strategic autonomy. The 2019 Information Report by French Senators Le Gleut and Conway-Moret (written after six months of field research in several European countries)

explains how the French institutional framework and semantics influence the perception of the EU allies. For example, the French idea of strategic autonomy is almost opaque to the other European countries.

The French Constitution is an additional source of complexity for European cooperation. While the French President sets foreign policy objectives and has the power to authorise military intervention, the European allies require the approval of the national parliament before any intervention, which has important implications for timing and effectiveness.

What's Next?

Since the outlines of its basic strategic posture in 1958, France has been able to gain an important international role, and to acquire a relevant position within the organisations it participates in while pursuing President de Gaulle's belief system.

The return to NATO's Integrated Military Command Structures in 2009 represents a notable example. In line with the international ambitions typical of grandeur, France can use its leading position within the Allied Transformation Command as a way to reform the organisation from the inside. At the same time, France continues to be at the frontline of EU-NATO relations. Indeed, France continues to reaffirm the need for Europe to increase its strategic autonomy from US and the Alliance, while calling for the creation of an EU pillar within NATO. In this context, French reintegration in NATO one-year before the entering into force of the Lisbon Treaty (which finally establishes the basis for an effective European defence)

and of the NATO Strategic Concept (which enhances the Alliance's cooperation with other international organisations) seems far from being a hazard.

France has progressively acquired the important role of mediator between the UN, NATO and the EU, and President Macron's speech on nuclear dissuasion, delivered in February 2020, reaffirms the relevance of the country's international commitment.

Nevertheless, it is important to note that an active French role in international organisations remains fully subordinate to the country's national interests and ambitions. In other terms, the more the scopes of the organisation are in line with French foreign policy objectives and give France a central role, the more it will be committed to. However, French Presidents do not hesitate to question the organisations functioning when this not reflect its strategic goals. The complex relationship with NATO provides, once again, an example. The 2017 Review recognises the crucial role of the Alliance in the defence of Europe and of the Mediterranean and welcomes the efforts to better adapt the organisation to the current geopolitical scenarios and international threats at its gates. Nevertheless, President Macron has harshly criticised NATO, defining it in "brain death" in an interview given in November, after US President Trump's repeatedly condemned EU member states efforts to increase their defence collaboration , calling on allies to pledge more resources to the Alliance. According to President Macron, the US stance towards NATO promoted by his counterpart questions the eventual activation of Article 5, especially because the US is pursuing a gradual disengagement from Europe.

The divergence of French and US/NATO vital interests seems to have a crucial role here. As the NATO agenda is more and more divergent from the French one (the first one being focused on the Eastern flank of Europe, the second one on the Southern flank), France needs to gradually disengage from NATO if it wants to preserve the capacity to conduct military operations alone. The long-lasting engagement in the Sahel (scarcely supported by NATO allies) and the need to fight terrorism at home put French soldiers and material at risk of overstretch. Furthermore, as US and European countries' interest diverge, President Macron envisages a 'window of opportunity' for convincing several European countries that synergies between France and other Europeans are by nature stronger than US-Europe ties built around alignment to US foreign policy. ■

Arquus – Taking Charge of Complex International Programmes

Photos: Arquus

Emmanuel Levacher,
the President of Arquus

Interview with Emmanuel Levacher, President of Arquus

ESD: What are the major advances since the company has rebranded as Arquus?

Emmanuel Levacher: Arquus recently celebrated its second anniversary on 24 May 2020. The rebranding was a great opportunity for change across the companies that formed the Renault Trucks Defense group. The companies have fully merged, and we now have only one entity, Arquus, with standardised processes, common systems and methods. We have also created a new Operations Division, which is now in charge of all programme-related aspects, from contract management to vehicle delivery. Our Aftersales Division has also grown considerably, with new support contracts for the French

Army, now totalling more than 20,000 vehicles. We are now one company, and as one company, we are more efficient, more productive and more creative than ever!

In 2019, we had a record year, with more than 2,200 vehicles delivered, from the light VT4s to the French Army to the heavy MSVS trucks to Canada. The company actually recorded 38% growth in 2019. 2019 was the first year of the GRIFFON. Alongside our partners Nexter and Thales we have delivered the first 92 vehicles to the French Army and the programme is going very well, despite the impact of the COVID outbreak. The French units are currently discovering the vehicle, and are extremely pleased with its new capabilities, especially in terms of mobility. The CAMO programme with Belgium also gave us new possibilities for future activities in Europe.

Since 2018, we have also delivered more than 1,300 VT4 light 4x4 vehicles to the French Army, which are currently being dispatched to all units, both in France and overseas. More than 3,000 still have to be produced in our plant in Saint-Nazaire.

We also scored a first export order for our new HORNET RCWS range, which crowns the effort put into developing a new small-calibre fully French RCWS capability.

ESD: What were your most important export programmes in 2019?

Emmanuel Levacher: We've had a few major export programmes recently. We are currently delivering SHERPA vehicles to Kuwait according to the contract announced by the French Ministry of Defence in 2016. Thanks to these deliveries, we have actually delivered our 1000th SHERPA last month! That is a very exciting milestone, that proves the relevance of the SHERPA concept and sets the scene for future commercial success for the vehicle. A second key programme is the delivery of BASTION armoured vehicles to the G5 Sahel countries to support their efforts against terrorism. That programme was coordinated and funded by Europe, and it demonstrated absolutely the central role of the BASTION family in very demanding environments like Africa. The BASTION has recently reached the 500th production unit, that is a total of 1,000 vehicles for the VLRA & BASTION family. That family keeps growing and upgrading, with a new powerplant for BASTION and a fully new version of the FORTRESS, the FORTRESS Mk2, which brings even more mobility and protection.

Last, but not least, our contribution to the MSVS programme for Canada. Under that programme, Arquus has militarised more than 1,500 trucks in multiple different versions, in partnership with other fellow Volvo Group companies. To tackle that programme, Arquus has set up a modern production line at our Marolles-en-Hurepoix facility, and this is an organisation that could be recreated for any future truck programme. MSVS has shown the ability of Arquus to take charge of complex international programmes and coordinate activities at multiple industrial plants. The last MSVS truck was delivered to Canada at the beginning of 2020, and has received universal praise from the Canadian Forces. It has already been successfully deployed both in foreign and domestic operations.

ESD: Please tell us about your Research & Development Activities.

Emmanuel Levacher: Our current development strategy focuses on technological

The 6x6 version of the new Arquus ARMIS truck family

bricks, available for implementation on any vehicle in our current or future ranges.

Energy is a good example of our capabilities in R&D. Since 2015, we have been experimenting widely in energy production, management, and storage, as well as in solutions that might reduce fuel consumption. Thanks to our VAB ELECTER demonstrator, we have shown since 2016 that we could reduce fuel consumption by about 40% on military vehicles. To achieve that performance, we rely on the latest technologies developed by Arquus and by the Volvo Group.

Energy management is a huge environmental issue, to reduce the global footprint of modern armies, but also to cut spending on fuel and to reduce the need for the ubiquitous and vulnerable fuel convoys in operational theatres.

Electrical power offers new tactical capabilities, with stealthy manoeuvrability, silent watches, as well as the use of energy-consuming systems such as lasers, radars and so on, which is now asked for by most armies. That is why our SCARABÉE light reconnaissance vehicle, which we might offer as a successor to the VBL, is natively hybrid and equipped with all our latest innovations.

Combined with automation, remote-control and robotics, these applications could redefine land warfare. Our SCARABÉE vehicle is thus designed to operate with an automated trailer, which will provide additional power production and storage systems, as well as space for operators, equipment or tactical systems. It will thus be able to conduct autonomous missions, effectively multiplying capabilities on the battlefield. We are also investigating long-term R&D prospects such as hydrogen.

Innovation relies on collaboration and partnerships, so Arquus has very close relationships with several European companies to keep developing these assets. These technological bricks, especially regarding energy and automation, could very well be offered for future European land programmes.

The innovative Arquus SCARABÉE has completed development and is ready for production.

ESD: Please tell us about some of the systems you intended to exhibit at Eurosatory 2020?

Emmanuel Levacher: As we all know now, the Eurosatory exhibition has been cancelled due to the Covid-19 outbreak. That is a major disappointment for Arquus, which has not missed a single show for decades, and which has always made huge announcements during Eurosatory.

Now, due to that long-running record with the show, we have decided not to cancel the announcements we were hoping to make and to keep in touch with our partners through a new means of communication: a virtual showroom, which we have called Arquus e-xpo, which will be online starting on June 8 at e-xpo.arquusdefense.com. Thanks to the Arquus e-xpo, we will be able to showcase our latest innovations throughout June and July. The platform will be updated regularly, and all are very warmly invited to come, discover and discuss our achievements over the last two years.

We are very proud to present our new ARMIS range. The ARMIS range comprises of three different trucks, 4x4, 6x6 and 8x8, which fully answer the needs of the armies, both for tactical and logistics missions. Designed and produced in France, these new ARMIS trucks cover a wide range of versions, from troop transport to mobile repair workshop, and benefit from a century of experience in military trucks. They are specifically designed to meet the needs of both domestic and foreign operators, featuring very high levels of mobility, endurance, versatility, as well as reduced maintenance needs. The use proven technologies to meet military requirements.

Maintainability has been a central issue since the conception of the ARMIS truck range, and it has also benefitted from the expertise gained by Arquus in supporting diverse vehicle fleets around the world. This focus on maintainability means that the maintenance and associated logistics aspects of ARMIS should be greatly reduced in comparison to previous generation vehicles. We will be able to provide a very high level of service and guarantee maximum uptime thanks to our organisation, global logistics and brand-new maintenance platform in Garchizy.

Next subject of importance is SCARABÉE. The SCARABÉE is currently entering its final development phase and is getting ready for industrialisation. I am very proud to announce that the vehicle is now available commercially for all markets.

On top of the Arquus e-xpo, we would be very happy to present all these innovations during a more traditional event, which we are working to organise at the end of 2020. So please keep in touch for more news!

ESD: Thank you.

The interview was conducted by David Saw

The Protected SHERPA vehicle

Redefining Mobile Artillery: How AM General is Changing the Game

A the Future Indirect Fires Conference in Bristol, UK., Major General (Ret'd) Mark McDonald from the US Army gave a presentation on AM General's new mobile howitzers that use soft recoil technology. Mark is a lifelong gunner and previously commanded the US Army Fires Center of Excellence.

ESD: We have heard about the new technology of soft recoil but why is it advantageous for anyone to change their legacy recoil systems?

McDonald: The battlefield has changed, and we are in a new environment for artillery. First, our posture is much different than it was during the Cold War. Countries are no longer forward deployed in large numbers along a contested border. And in fact, unlike then, no one really knows where the next contested border may be. So, this requires increased mobility and greater agility to build combat power exactly where it is needed very quickly. That means our new artillery systems must be both strategically and tactically mobile, allowing our fires capability to get to the fight quickly and when there, survive. To achieve this, systems must be lighter weight, but possess the same lethality. Recent events have shown that no matter how much you armour an artillery piece, it will not survive counterfire. The suite of munitions available to an enemy can defeat even heavy armour. So, the answer is to be somewhere else when the counterfire is delivered. While auto-loaders reduce risk to the force, they also contribute to excessive weight, reduce strategic and tactical mobility, and in the end deliver only a marginal improvement in rate of fire. Ultimately, new artillery pieces should be designed so they can deploy on a range of transportation options, be employed quickly on the battlefield, be survivable, and deliver long-range lethality. Soft

recoil allows you to create, light and mobile howitzers, get them to the fight quickly, and survive while destroying the enemy far better than legacy systems.

ESD: So, what is soft recoil and how does it work?

McDonald: With a soft recoil system, the tube is actually under pressure that pushes the tube forward. In the firing sequence, just before propellant ignition, the tube is released, and the pressure rapidly moves the tube forward. A few milliseconds later, the propellant ignites and the force of the tube mass moving forward reduces the rearward movement of recoil, in some cases by almost 50 %.

ESD: How can this new technology be applied to future Artillery systems?

McDonald: This technology is not completely new. Soft recoil was tested by several countries in the 1970s. It was a purely mechanical arrangement back then and it just did not work properly. The engineers in our partner company, Mandus Group, advanced and improved this technology, coupling it with existing hydro-pneumatic recoil systems to perfect the technology. In essence, this is a hybrid soft recoil system. Towed howitzers essentially take the entire shock of firing and transfer this energy into the ground. With a reduced recoil system, towed howitzers can now be mounted in the cargo area of light weight, slightly modified trucks. This greatly increases their mobility and reduces the manpower of getting a towed gun into action. Towed guns can take up to 10 minutes to emplace and about the same amount of time to depart a firing position---on the modern battlefield, that's just too long. And towed howitzers realistically can only move a few times a day

due to crew fatigue. Our mobile howitzers can get into action in under 2 minutes and out of action in about a minute. Since the labour of going into and out of action is at a minimum, mobile howitzers can easily move after every mission.

ESD: This must be a tremendous advantage with the advent of better enemy counterfire capability.

McDonald: It certainly is. Counter fire today comes in two forms, first, the traditional counterfire from acquisition due to firing. Second comes from observation from drones that will litter the sky. Both of these capabilities exist on today's battlefield. So, it's not enough to get in position and wait to fire, you will be acquired before you even shoot. You must hide or be constantly on the move. Mobile howitzers give you the ability to do both.

ESD: Please tell us a little about the two systems you have developed.

McDonald: Sure. We have designed and built two systems for military use. Our 105mm system is called Humvee HAWK-EYE. It is really a product improvement of two existing systems in the US Army inventory. We have taken the prime mover, the Humvee and the M119 towed howitzer and created a mobile howitzer by using soft recoil technology. The result is mobile howitzer that is quick into and out of action and extremely survivable. The performance characteristics of the howitzer are exactly the same as the existing howitzer. Shells, fuses, and muzzle velocity are exactly the same. The only difference is the howitzer is now mounted on a patented soft recoil system and of course it is completely digitized. Our 155mm mobile howitzer is called BRUTUS. It is essentially the same concept

The BRUTUS soft-recoil howitzer

as HAWKEYE except the technology has been scaled to use the M777 towed howitzer and a medium tactical platform as its prime mover. As with the HAWKEYE, the M777 cannon performs exactly the same on a mobile system as it does in a towed configuration. Both systems have been tested and are being reviewed for possible inclusion into the US Army.

ESD: Since you are reusing the existing truck and cannon, the cost for the system must be less than acquiring a completely new system.

McDonald: It is considerably less expensive in terms of acquisition. Other cost savings come in the form of reduced personnel required to operate the howitzer. Since there is very little labour in emplacing the gun, the majority of the labour is needed for ammunition handling. You can reduce the crew by at least two and still have improved performance. Additionally, the engineers made the howitzer very simple so maintenance is greatly reduced. Since we use existing systems, there is no need for any additional special tools.

ESD: You mentioned that howitzer performance is the same as the existing systems. In this day of increasing range and lethality, isn't that a significant drawback.

McDonald: While howitzer performance is the same, lethality actually increases. Our mobile systems include a direct fire camera that includes a range finder and it calculates a ballistic solution. The system is accurate in direct fire up to 5,000 metres. I have seen HAWKEYE engage 8 rounds on a target at 3100 metres. Seven were direct hits and the 8th had effects on the target. There is also an intangible increase in lethality through increased survivability. If your systems are towed, by day five of the conflict you will only have a few howitzers left. If you are mobile you will have the majority left through the entire fight. Because of the increase in mobility, you can easily fight within the range of an enemy's guns. If, in the future, a decision is made to increase the tube length and range, we can easily upgrade our base system to handle the increased size, weight and recoil of future systems.

ESD: There are other mobile wheeled howitzers on the market, what makes yours so different?

McDonald: There are three main differences that makes our system better: Soft recoil, lack of heavy armour, and lack of an automated loader.

Soft recoil, as discussed earlier, allows us to use a much lighter vehicle. Couple that with little heavy armour and our howitzer comes in at less than 35,000 pounds. Other systems on the market can weight anywhere from 60,000 to 80,000 pounds. These excessive weights severely limit or prohibit, strategic and in some cases tactical mobility. Automated loaders are great but in reality they only give you about a two-round-per-minute increase and that is only for the first three minutes. In some cases, if the auto loader breaks, the gun is simply out of action. Both of our systems are manually operated but require less manpower due to the close proximity of the ammunition vehicle Our 155 offering only requires ammo to be moved about 10 feet from the ammo vehicle to the cannon. Additionally, the ammo remains at waist level, greatly reducing the effort to quickly shoot the cannon.

Also, both of our howitzers are completely operational in a degraded environment. If automation goes out, we use a manual back up. If power is out, we also have a manual back up. We built in manual redundancy to reduce vulnerability on the modern battlefield. You can even pull out the old aiming circle and lay it like we did 50 years ago. It will stay in action and remain lethal and ready.

ESD: You have developed HAWKEYE and BRUTUS for the US market. Are these systems exportable?

McDonald: We would be very happy to talk to international partners about HAWKEYE and BRUTUS. Just like we did for the US systems, we can tailor our systems to a country's own truck and howitzer to produce a mobile howitzer system unique to customer's specific requirements. Reuse of existing equipment allows a country to completely modernise their towed artillery at a reasonable cost. Remember we will reuse the truck, cannon, special tools, sights etc. Also, existing ammunition stocks are usable as the cannon has not changed. It is a simple and cost-effective way to modernise any towed howitzer system.

ESD: Thank you.

The interview was conducted by Stephen Barnard.

The HAWKEYE soft-recoil howitzer fitted on a HUMVEE

The Donbas Conflict and the Future of Armoured Warfare

Reuben F. Johnson

Kiev

More than six years since the beginning of the war in Ukraine's eastern Donbas region - and after what is in excess of 13,000 deaths on both sides - it is possible to come to some conclusions about the Russian advantages in the conflict. While the fighting has not proceeded along the lines of what is normally thought of as a conventional military operation, what falls out of the years of this war, which is often kept at a low boil so as to not prompt the entrance of other nations into the fight, are some distinct indicators of how the Russians are preparing for future engagements.

First of all, there is truth in the observation that Russia has been sending its personnel into the Donbas almost as a kind of an initial training ground before they are then deployed elsewhere. Often those personnel are then sent on into Syria for additional combat experience. This has created the false impression that there is some common, "cookie cutter" model of operations that the Russian military is engaged in being practised in parallel in both conflicts.

On the contrary, the Russian operations in Ukraine and Syria – as well as other operations in previous conflicts like the invasion of Georgia – show that Moscow's military prosecutes conflicts under distinctly different sets of objectives and divergent approaches. Therefore, it is not a valid approach to be looking for an A to Z textbook that one can expect Russian military units to follow - a

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Reuben F. Johnson is a 30-year veteran of reporting on the defence sector and analysing political-military affairs in the former USSR and Eastern Europe, the PRC and SE Asia and Latin America. His articles have appeared frequently in US, European and Asian defence and public affairs journals and he is also a long-time consultant to the Department of Defense. He is based in Kiev, Ukraine where hs has covered both the 2004-2005 Orange Revolution and the 2013-2014 Maidan Revolution.

A road to Artemivsk littered with Ukrainian tanks and vehicles just outside of Debaltseve, Ukraine

kind of template that they would utilise in any given conflict. It is also equally inaccurate to project that current-day Russian warfare would be based on the doctrinal approaches that dominated military thinking during the Soviet period.

There is an argument to be made that the most recent conflicts have featured a substantial increase in the use of non-kinetic methodologies and what have been referred to as "hybrid" approaches to overcoming an adversary, but these again cannot be codified into a pre-programmed set of options that are always brought to bear.

Supporting Moscow's Narrative

The primary driver for the campaign in the Donbas not to follow any pre-programmed Russian operations plan was a set of political considerations. These were issues that supersede normal battlefield imperatives that dictate combat units being committed in the most effective or expeditious manner. Bringing Russian military power into the fight, in this case, has other imperatives besides the goal of achieving a set of military objectives. Moscow's initial narrative was that the outbreak of hostilities were solely the product of a pro-Russian separatist movement in which there was no Russian involvement - and that President Vladimir Putin's "Little Green Men"

did not even exist. In the initial phases of the conflict this called for a minimal and at times even obscured Russian presence on the battlefield. Instead, the plan called for handing over large quantities of weapons platforms delivered from Russia into the separatists' hands.

The almost overnight acquisition of such a considerable fleet of military equipment was "officially" explained by Moscow initially as the spoils of war in a rather feeble attempt to once again hide Russia's intervention in the conflict. This narrative was that these vehicles fell into separatist hands after a force of these pro-Russian units successfully attacked and overran a Ukrainian military armoured vehicle base in Artemivsk. This Ukrainian installation contained almost 800 types of different armoured vehicles, including an estimated 250 tanks, but most of these were in the process of being refurbished and were not ready for combat.

Despite the reality that obtaining any significant quantity of useable armour that could be deployed in battle from what is essentially a repair and maintenance base is impossible, the truth is that the separatist formations had not actually even taken the base from the Ukrainian military. During the spring and on into the summer 2014, separatist units tried to take over this installation in five different assaults and were unsuccessful on each attempt.

Origin of Artillery Attacks on Ukrainian Military Positions in Eastern Ukraine. This war has continued since 2014 with minimal apparent Western engagement.

The source of the separatist armoured force has instead come across the border in one long column of Russian military equipment after another. These vehicles, which had their identification markings and traditional vehicle numbering removed in an attempt to mask their origins, made regular transfers of ownership across into Ukraine at border crossings where Russian units control these movements.

The volume of equipment and frequency of these crossings has been such that mass transport of such an amount of equipment and weapons can neither be camouflaged nor concealed. Attempts to move them in smaller numbers or engage in any other subterfuge would disrupt the armaments supply tempo for the separatist groups fighting on behalf of the Russian Federation. This battlefield imperative has revealed that Russian-origin vehicles constitute the majority of the materiel being deployed against the Ukrainian military.

Russian Armour: How It Is Being Supplied

Re-supply of armoured units with new platforms was observed in August 2018 by an Unmanned Aerial Vehicle (UAV) operated by the OSCE Observer Mission, which reported sighting two such columns in the occupied regions of the Donbas. One of these columns entered Ukraine in Manych, 70 kilometres from the regional capital of Donetsk, and a second column was moving in the opposite direction and crossed back over into Russia. These sightings by the OSCE confirmed three realities that the Ukrainian military had long been trying to make the international community recognise.

One is the simple fact that the some of the latest and most effective weaponry in the Russian arsenal has been supplied by Russia. Moreover, the commander of the Ukrainian forces in the Donbas has stated that these crossings are taking place "constantly" and that these columns of armour and heavy-laden lorries are the tell-tale signs of a Russian incursion.

(Ukraine has informed the international community about these crossing on numerous occasions but has not been able to gain official recognition from certain states that this activity is taking place until the OSCE sighted these transfers. Confirmation by the OSCE was considered to be a major step in receiving official recognition of this activity.)

A second issue is that the separatists operating these vehicles had to have been extensively trained by the Russians. A Colonel in command of the Ukrainian 93rd Brigade stated "yesterday's miners can't just find a tank in their mines and instantly learn how to drive it without special training." Many of the locals from the separatist units are former coal miners, which is one of the primary industries in the Donbas, and they continue to receive Russian training.

Finally, while personnel being trained by the Russians have learned how to operate Russian armoured vehicles, there apparently has been no parallel activity to train them in maintaining them.

Ukraine's intelligence service has reported that since the beginning of 2018, more than 40 armoured fighting vehicles have been delivered to Ukrainian separatists as replacements for broken down hardware. The movement of columns out of Ukraine and back into Russia is for disabled vehicles that require mainte-

nance or other servicing - which could not be repaired on the territory of the occupied territories in the Donbas.

Former NATO intelligence officers who spoke to ESD stated that Russian intervention in the Donbas was not well thought through. This can be seen first of all by the "poor performance of the units in battle and their very low levels of leadership and discipline." The other failure, as noted above, was the lack of preparation of the separatists in maintaining the equipment being supplied to them by Moscow.

In the very beginning in 2014, said one former defence attaché who was deployed in the region, "the logistics for these armoured vehicles were dire at best. You would see tanks and IFVs supplied by the Russians - but then no servicing vehicles at all coming up with them. Supporting infantry and other personnel would be trailing along behind them in regular civilian vehicles – private automobiles and ordinary delivery vans. So, the first time there was a need for any serious servicing of these vehicles it was time to drag them back across the border to Russia."

Russian Units in The Donbas

The Ukrainian "statelets," as they are known, that Moscow has established in the Donbas are the Donetsk People's Republic (DNR) and the Lugansk People's Republic (LNR), the two regional capital cities of eastern Ukraine. Multiple analysts looking at the current military situation say that the continuous traffic of military hardware being shipped out of Russia into these occupied zones has created significant armoured formations in both "republics.".

According to Ukrainian intelligence reports, these pro-Russian enclaves now have in their arsenal 475 tanks, about 1000 armoured fighting vehicles, over 700 artillery systems and more than 200 multiple launch rocket systems. These platforms are almost entirely Soviet/Russian-design equipment which were passed to these "military corps" of DNR and LPR groupings from bases in Russia.

But while the separatist formations in Ukraine now feature a high-profile presence of Russian military hardware there has still been a considerable effort to minimise the presence of actual Russian military personnel.

Russian forces have also been equipped with progressively more advanced air defence systems and some of the most advanced electronic warfare equipment in Moscow's arsenal. Both of these assets were put in place as force protection to keep the Ukrainian air force from being able to strike Russian regular military units, many of which are composed of "contract soldiers" - those serving under agreements for pay scales comparable to the private sector, rather than units of conscripts.

In large measure, Russian regular formations were only used in combat against major Ukrainian-held objectives and supported by main battle tanks and IFVs and equipped with modern, encrypted communications systems and reconnaissance drones.

EW: What Gives Russian Armour the Edge in the Donbas

Ukrainian units and intelligence services have sighted and verified the use of 44 different kinds of weapons being employed in the Donbas – all of which could only have come from the territory of the Russian Federation as they were never in the Ukrainian inventory. These range from trucks and tanks, to more advanced systems that are the latest iterations of post-Soviet-era designs. For example: the PANTSIR-S1 air defence system – an anti-aircraft platform armed with two paired 30 mm cannons, which was accepted into service into the Russian armed forces only in 2012: Ukraine has never acquired this weapon system. In the same category is the T-72B3 tank, which is the main battle tank of the Russian army for those units not yet upgraded to the T-90. It differs from other tanks of similar configuration in that it has a new fire control system fitted with a Belarusian SOSNA-U gunsight. Introduced in Russia in 2011, it was never delivered to Ukraine. Use by the Russians of this tank in the Donbas was confirmed when one of them was captured in Ilovaisk by Ukrainian troops.

Another armoured system used in the Donbas is the BPM-97, which is also a Russian-only armoured 4 x 4 MRAP vehicle, with some specific features that differentiate it from other platforms of its kind. It exists in several configurations, some of them used by special forces of the Russian Federation since 2009, but has never been delivered to Ukraine in any military configuration. The well-known mercenary corporation ChVK (Частная Военная Компания) or the private military company the Wagner Group, has used the vehicle, which was originally designed for the Border Guards Service in Russia due to its smaller size and manoeuvrability. Wagner Group took certain measures to obscure their employment of the BPM-97 in Ukraine during the battle for Debaltseve. (The mercenary company also made use of the BPM-97 during their operations in Syria.) But it is not just having these more advanced platforms that gives the Russians and their surrogates the edge over Ukrainian armed forces in the Donbas. At the beginning of the conflict, the Ukrainian military found itself at an disadvantage due to the advanced reactive armour technology and active anti-ATGM protection fitted to Russian vehicles. In the early phases of the Donbas war

Ukraine's military had no anti-tank missiles with a tandem warhead that could penetrate the armour plating of the T-90 and advanced T-72 models. This vulnerability was eliminated when units in the Donbas began receiving the first new-design SKIF ATGM from the Luch Design Bureau in Kiev. Ukraine had also requested that it be permitted to acquire the US-made Raytheon FGM-148 JAVELIN ATGM, but the purchase was blocked on multiple occasions by the Obama White House. After the Trump Administration took office in January 2017 this policy was reversed and in 2018 Ukraine's military was given the option to procure the missile. In the meantime, the effective use of armour by the Russians in the Donbas has been augmented by the expanding commitment of some of their most modern electronic warfare (EW) systems. Confirmed in numerous reports by both Ukraine's intelligence services and the OSCE Monitoring Mission, Moscow has equipped separatist units from Donbas with the KRASUKHA-2 1L269 jammer, the Bylina RB-109A REPELLENT-1 and the LEYER-3 RB-3418.

These are some of the latest Russian EW systems and they only began to be deployed with combat units after 2010. As with the advanced armoured vehicles discussed above they have never been possessed by the Ukrainian army. The RB-3418 has also been used in the field in Donbas operations in conjunction with the Russian-made ORLAN-10 UAV, which has a considerable loiter capability of up 16 hours and operates at distances in excess of 100 km.

Aside from being able to use the considerable Russian EW assets to essentially blind the Ukrainian military's sensors and constantly disrupt their situational awareness, the ORLAN-10 allows separatist units to pinpoint the location of Ukraine units, which accounts for the increasing lethality of Russian artillery and rocket attacks.

A Frozen Conflict

More than a year ago, a senior political leader in the Donbas gave an assessment of the conflict in the more recent past, stating "when the first casualties started, nobody believed it would last so long. The worst thing is, that people have gotten used to the conflict … for instance, they can tell by the sound of flying objects what kind of weapon it is and even its calibre. Everybody's pretty tired of this. People who live along the contact line don't care who's president [of Ukraine], they just want the war to stop," he said.

Two elements keep the fight at a stalemate in which one side cannot displace the other. One is that while the commit-

ment of armour makes a difference – in both numbers and the modernity of the tanks themselves – it is not enough by itself. American advocates of heavy armour forces have analysed the loss by the Ukrainians at the battle of Debaltseve as validation that "tanks still matter."

But the Debaltseve fight shows once again that while combat vehicles must have the combat potential needed in the present day, armour still has to be integrated effectively with infantry, and artillery into a combined arms order of battle. Both sides have been learning these lessons, but Ukraine still lacks the numbers of personnel and equipment in sufficient numbers to be able to re-take the entirety of the Donbas.

Ukrainian soldiers from the 25th airborne brigade on the outskirts of Marinka, Donetsk region, eastern Ukraine.

At the same time, the separatist formations suffer from what could be called the lack of a legitimate motivation to prosecute the war. The separatists are not fighting for their own nation, but instead for the interests of Moscow. Russian military units support them and at times do all of the heavy lifting for them, but they will not and cannot fight the entire conflict for them.

Lt. Gen Sergei Nayev, the Ukrainian commander in Donbas, told the daily Golos Ukrainy in 2019 that "Russian mercenaries who are shelling peaceful cities and villages, killing women, children and old people have no right to call themselves servicemen. To be a serviceman means to be a person of honor and courage. To be a true serviceman means to be ready to defend one's native land to the last breath. He who craves for a foreign peaceful land is a marauder and a criminal rather than a serviceman."

As long as the conflict is characterised by this kind of a standoff there seems little chance for it to come to an end. ■

The Army's Contribution to the Bundeswehr Capability Profile

Photo: Bundeswehr

Alfons Mais

Our increasingly imponderable security environment is unlikely to improve, even though we may find ourselves in a "new" normality once the waves of Covid-19 have abated. We should not run the risk of stumbling from a pandemic crisis to a security-policy crisis.

LtGen Alfons Mais has been the Chief of Staff, German Army, since February 2020.

For Germany as a continental middle power, the land dimension will continue to be the decisive one. But the increasing interconnection of the land, sea, air, cyber, and space dimensions requires the Bundeswehr as a whole to be capable, in the future operating environment, of multinationally and multidimensionally conducting command and control in high-intensity combat operations.

Since the decisions taken at the 2016 Warsaw Summit, NATO has once again focused on the succinct formula: "Threat determines the requirements." There is a lot of catching up to do in terms of operational readiness and the challenges that modern high-intensity warfare poses for organic major units. A balance must be achieved between the tasks of international crisis management (ICM) and those of national and collective defence.

Potential adversaries of the Alliance are once again named more clearly than before in strategic papers, not least because they are able to quickly leverage an intelligent transfer of available state-of-the-art technologies for military benefit, and to conduct hybrid destabilisation operations below formal conflict thresholds. They are on their way toward outmanoeuvring the modernisation efforts of European armed forces.

Military capability requirements are expressed in the targets that NATO sets for its member states. The NATO Defense Planning Process (NDPP) represents the means and the toolkit. This process is conducted at four-year intervals and, in consultation with the participating nations, determines the military capability targets on which the member states undertake to deliver.

The Bundeswehr capability profile translates this commitment into a national ambition. Even in times of Covid-19, the following must apply: Good planning must never be detached from the present situation, but the present situation must never be allowed to stand in the way of good planning. For this reason, let us now take a look ahead.

The Army in the Bundeswehr Capability Profile

From 1990, for a period of about 25 years, the Bundeswehr worked toward generating the peace dividend and thus contributed substantially to achieving the state objective of stable finances.

That led to a clear focus on stability operations within Armed Forces and Army planning. The organisational efficiency of the Bundeswehr was prioritised over its overall military effectiveness pursuant to Article 87a of the German Basic Law. Smaller operational structures in the

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Lieutenant General Alfons Mais is Chief of Staff, German Army

Photo: NATO

Meeting of the North Atlantic Council

form of tailored-to-the-mission sub-contingents of the basic army organisation served as the benchmark for procuring equipment. In the context of a collective-defence scenario, however, combined arms operations require much more! They need integrated, fully manned, and equipped military structures in order to be available at short notice for various policy options. Land forces and thus the Army must prevail against an opponent who is skilled in employing both hybrid and highly lethal conventional means while flexibly leveraging his freedom of unilateral action.

The Bundeswehr capability profile kicked off a paradigm shift, recognised as long overdue, in terms of planning. The needs of the hour are to establish cohesive, structural operational readiness for Army major units and their enablers. We need to give them the capability to become effective over long distances in an employment area outside of Germany within the time frame ("notice to move") stipulated by NATO and, furthermore, to ensure their logistic supportability and sustainability in a combat environment.

In the Bundeswehr capability profile, the contribution of the land forces is defined in terms of structure, not of capabilities. This first kick-off is thus of a quantitative rather than of a qualitative nature and aims to equip brigade-and-higher-strength units in a manner that is rapid and task-oriented and to reduce the modernisation backlog so as to once again enable combined arms operations. In short, the intent is to move away from simple cost efficiency and toward a type of military effectiveness that can safeguard the interests and security of the Federal Republic of Germany even in the face of recession and increasing tensions.

Cohesive, effective structures concern the land forces as a whole. In this context, the capability profile speaks in terms of integrated forces. The Integrated Force (Systemverbund Land), in addition to the Army brigades and divisions, includes all the support elements of other major organisational areas required for an operation.
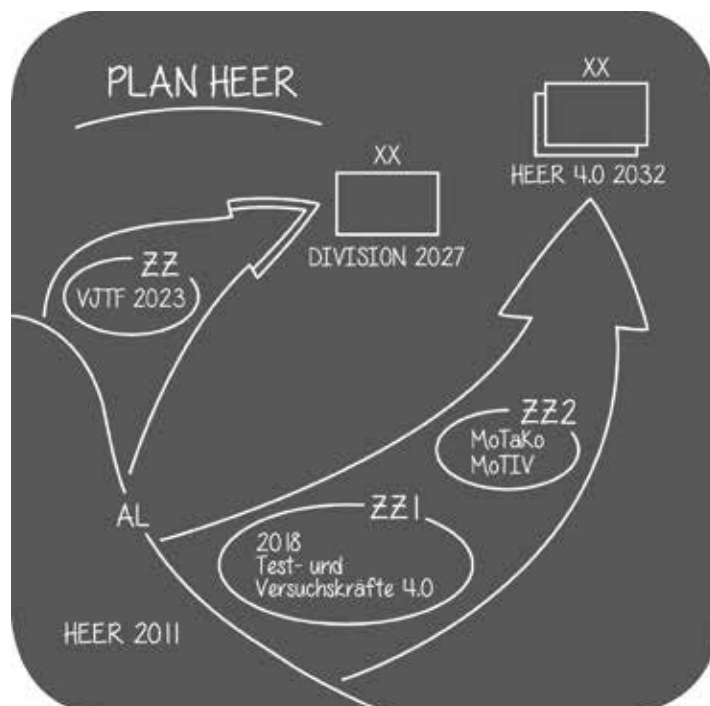
The Army Plan, a strategic communication aid

Achievements of the Capability Profile to date

Over the past few years, the logic of the Bundeswehr capability profile has contributed substantially to promoting the paradigm shift represented by the Bundeswehr reorientation toward regarding ICM and national and collective defence

The German Army provides a robust and credible deterrence force for NATO

as equally important. It defined the rationale and targets of the initiated realignment measures. The core business of the land forces – conventional combat operations, with military operations conducted by major units – has once again taken centre stage.

The following categories have been formulated anew as the measure of operational readiness: responsiveness, provision of personnel and training levels, equipment, logistic sustainability (especially in terms of ammunition), interoperable command-and-control capabilities, and the closing of capability gaps such as in the areas of air defence, joint fires, countermobility and mobility (bridge- and mine-laying capabilities). In order to progress as rapidly as possible on the long journey toward effectiveness in combat, the so-called "dynamic availability management" has been shelved. Even it was an artefact of the efficiency strategy thus far pursued and the guiding principle for the maintenance of the Army's training and exercise capability, many of its tools currently still need to be used to compensate for a lack of materiel. The revitalisation of abandoned capabilities has been initiated: Extended all-arms air defence will give the Army brigades and divisions the means to defend against immediate airborne threats posed by micro and nano unmanned aerial vehicles.

That is certainly a starting point from which to proceed to more technologically sophisticated solutions. The same holds true for reactivating equipment from old stocks, such as the mine layer 85, which will provide Army major units with quick, initially small-scale relief as regards the Army's lack of countermobility capabilities until a future mine-laying

system, enabling modern technological solutions, is introduced. Furthermore, the capability profile unambiguously illustrates the defence requirements needed to actually enable the Army, the land forces, to accomplish their core mission. These acknowledged Army requirements are documented in the ministerially approved Vorhabenplan Heer (Army Project Plan).

The Army Plan

The Army Plan comprehensively outlines the gradual yet parallel approach with which the Army intends to reach the capability profile it has been tasked with building. The Plan also serves as a strategic communication aid. It combines the quantitative and the qualitative components of Army planning. The upper "advance arrow" represents the gradual buildup of a mechanised division pledged to NATO by 2027. This division will dispose mostly of already available capabilities and known materiel, yet will, in the medium term, be the cornerstone with which responsive major units are kept ready for VJTF and NRI.

The lower "advance arrow" points toward the two follow-on divisions that in future are to put to integrative use technologies that exist but have not yet been tapped by the German armed forces. These cohesive major units, in particular, must be designed in such a way as to provide a plethora of new options to policymakers in future conflict scenarios, both in a context of national/collective defence and of stability operations. But what are the capabilities that are required? The key to answering this essential question is conducting potential analysis for pos-

sible adversaries. Their future methods of conducting operations, their doctrinal approach, their tactics and technique, their existing capabilities, and extrapolated future capabilities, the requirements of the Alliance and our own ideas on future operations of the land forces are decisive in this context. In short: Both "quantity and quality" and "efficiency and effectiveness" must be optimised in the future divisions.

In the 2000s, the political and military focus on operations abroad in times of budgetary constraints made the industrial outsourcing of the previous decade along with a modularisation of brigade- and-higher-size units with a concomitant centralisation of support forces a practical solution. The disadvantage of this organisational principle is management of numerous inherent interfaces. This disadvantage remains manageable for a plannable, continuous provision of services and contingents – typical for the operations in Afghanistan, for instance. Under conditions of uncertainty and time pressure in a complex environment along with stringent demands in terms of responsiveness and swift manoeuvrability, the disadvantages of this concept become evident.

Equipping the armed forces to be equally capable of conducting ICM and collective defence will therefore demand new solutions and long-term lines of development, which need to be drafted and debated. While ICM, based on the current organisational principle, can be continued effectively, the new world requires major units that can, on an ad-hoc basis, operate and fight (with a 9-to-180-day notice to move). Without a prior force generation, these units must be operationally effective immediately and organically dispose of all capabilities to rapidly deploy over long distances. With regard to national and collective defence, the "train as you fight" principle will be complemented by "organise as you want to operate."

Commitment:
An Adequate German
Contribution to NATO

Based on the commitments that Germany has made repeatedly on a policy level since 2016, NATO expects an adequate German contribution to a credible collective defence. With its geographical position and its economic status, Germany as a continental middle power can make a substantial contribution using militarily relevant major units of the land forces that have the potential for reliev-

ing other partners particularly during the early stages of an Article 5 contingency along the eastern border of the Alliance. Along with providing an effective logistic hub in the centre of Europe, Germany will then become a "main contributor" in the event of a potential Article 5 contingency on NATO's eastern flank. The major US-exercise EUROPEAN DEFENDER 2020, which unfortunately has just had to be discontinued, has shown once again: US reinforcements for air and naval operations in the Euro-Atlantic area are available significantly faster than US land forces. The European NATO members have use their own land force contributions to close this time gap.

The more options the German land forces provide for their political leaders, the more they can contribute to achieving the required deterrence effect on the eastern border of the Alliance and the more valuable Germany's contribution to the Alliance will be in general – also with regard to cohesion.

Division 2027

The next planning step after VJTF 2023 is the buildup of Division 2027.

If armament projects envisioned in the ministerially approved Army Project Plan for the Division – which come at a relatively moderate price and are effective when considered from all angles – are implemented, we can keep our commitments to NATO and make a contribution of great military value to the Alliance. The realisation of Division 2027, if implemented as planned and intended, and embedded at a still-to-be-planned corps level, indeed promises a significant improvement of European combat power on the continent. For the land forces, it represents the backbone which Germany as an enabling nation can provide to our European partners across the entire spectrum, from "deep" integration (with our NLD partners, for instance), to training, exercise, and equipment support (such as for Poland, Lithuania, the Czech Republic and Hungary). In this sense, the planned implementation of Division 2027 is a litmus test also in the eyes of our European partners. By today's standards, it furthermore offers "the best bang for the buck" and is an investment that would cover many of the commitments pledged to NATO.

The Army in the Upcoming Capability Profile

Collective defence with phases of high-intensity combat against a peer or even partially superior adversary along the boundaries of the Alliance is the determinant for our planning considerations. The backlog – a natural result of an exclusive concentration on international crisis management – is enormous, as are the challenges the German Army faces. In the field of materiel and equipment, to highlight just one of the major challenges, the Army will have to manage parallel modernisation and procurement measures. Some big-ticket items are almost at the end of their life cycles while the corresponding successor systems have not yet reached full operational viability.

In future, procuring new and additional weapon systems instead of modernising them once again seems the more prudent approach. A numerical increase of major combat systems will increase, especially for complex systems, the availability of platforms at the soldiers' level for purposes of training and exercising.

Personnel Ceilings

By restructuring its training, the Army intends to reallocate personnel in order to strengthen its logistic and command-and-control capabilities, which were deliberately undersized in the ARMY2011 structure. This follows the itinerary begun in the context of the Bundeswehr realignment measures in terms of personnel. The Army has already factored in potential personnel-efficient innovation gains. It will make maximum effective use of its assigned personnel ceiling of 60,787 active-duty billets (+20,000 reservists). Deficits will be counterbalanced exclusively by means of internal optimisation, because we have everything we need and we will be able to do what needs to be done.

Development of our Understanding of Warfare and Doctrine

The path toward Division 2027 is clearly described, but other important steps in the capability profile for the period after 2027 need to be refined and clarified. The Army Project Plan is approved and stakes out the path in terms of quantity. It already includes parts of the lower "advance arrow" of the Army Plan. The Army must now identify the qualitative requirements that need to be addressed from 2032 if we want to prevail against an adversary whose strength is at least equal to ours. For this purpose, the Army has begun to prepare operational guidelines for land forces which put more emphasis than before on known adversary doctrinal approach and methods, shortly, to the future face of war.

This will help to align capability development with actual operational demand, with a clear-cut overall operational concept. The purpose of targeted doctrine development is to set sustainable priorities. Budgetary constraints alone demand this. Here is a rough outline of parts of this concept: The Digitalisation of Land-Based Operations (D-LBO) programme will enable us to operate with smaller command posts, accelerate decision-making cycles, implement the "sensor-to-shooter" concept, increase the range of reconnaissance and effects, and strengthen interoperability with our partners in general.

We will generally elaborate for more mobile and faster forces that are capable of more than just conventional manoeuvre warfare, and thus open up new options for the political level.

Conclusions

With regard to 2023 and 2027, it is possible to realise the Army Plan and simultaneously continue ongoing operations, standby commitments, and realistic training and exercises, if the ministerially approved Army Project Plan is implemented and backed with the necessary resources. Day-to-day operations will not be granted a reprieve.

Beyond VJTF 2023, the primary objective is to realise Division 2027, which will generate a high-value asset for NATO. Implementing the planned measures, for instance in the framework of the initial steps toward digitalisation, remains a necessity also after Covid-19, in order to adequately respond to the threat situation and to uphold cohesion within the Alliance.

In terms of what to implement for the 30s and 40s of this century, we still have some more time to deliberate. The Army will actively support and assist in shaping these deliberations. ■

Asymmetric Warfare

Suman Sharma

The effort to achieve a strategic political outcome through indirect confrontation using a wide range of means without waging direct land, air and naval war against another country is inevitably classified as asymmetric warfare, which is further subdivided into hybrid and grey zone warfare.

Lieutenant General Vinod Bhatia of the Indian Army Centre for Joint Warfare Studies says: "The new grey zone warfare is in the strategic area, while hybrid warfare is at the operational and tactical level of warfare. Nation states and non-state actors are using emerging technologies and areas – such as space, cyber, special operations, underground and informational warfare – to impose costs on their adversaries." A networked world has led to virtual social warfare, which has led to Sun Tzu's theory of 'winning without fighting'. COVID 19 is a further indicator that non-traditional threats will take on the same significance, if not more so, in future conflicts, bringing with it unprecedented challenges.

Grey Zone Warfare

Grey Zone Warfare is fought in many areas and dimensions in many important combat zones that directly affect the enemy. In general, these are cyber and virtual, intelligence operations, maritime, psychological warfare, infosphere and aerospace. The Grey Zone Warfare can be understood as a state between war and peace, where the enemy hopes to make territorial and geopolitical gains without conducting obvious military actions.

In a grey zone scenario, instruments such as diplomacy, politics, economics, information and covert warfare are used to achieve goals without triggering a conventional and high-risk armed conflict. Typical for grey zone operations is that they unfold gradually, are non-military in nature and are usually unassignable. They target specific vulnerabilities of countries. However, asymmetric struggles in the

Photo: US Army

In asymmetric warfare, the classic 'boots on the ground' are no longer the key element. US Army Rangers, as part of a combined Afghan and coalition security force operating in Ghazni Province, Afghanistan, await a CH-47 for extraction.

grey zone do not necessarily have to unfold gradually. One example is that Russia was able to carry out the occupation of Crimea with the help of illegal organisations, small green men and hostile locals. Once the course was set, the Western alliance found itself in a deadlock, where it had to decide whether to risk war to liberate Crimea from Russia, or to let Russia keep Crimea; or to use its own grey zone methods to impose sanctions on Russia for having violated international law.

The maritime sector has the greatest potential for carrying out operations in the grey zone because of its accessibility to all governmental and non-governmental actors. The famous Chinese strategist Sun Tzu wrote 2,500 years ago: "To achieve a hundred victories in a hundred battles is not the peak of skill: subjugating the enemy without fighting is the peak of skill". Victory without fighting is, therefore, the goal of grey zone warfare.

The South China Sea, with an area of 3,500,000 square kilometres, is known for its oil and gas reserves worth billions of US dollars. Six countries are involved in

the ongoing conflict over territorial integrity - Brunei, Taiwan, Indonesia, Malaysia, Philippines, Vietnam and China.

China uses a grey zone approach in the South China Sea by covertly employing their conventional apparatus, just stopping short of an armed conflict, with the aim of avoiding any major clash.

Since activities in the grey zone are non-attributable and operate with the element of deniability, countries, therefore, often indulge in activities that seem harmless, using tools such as media and psychological warfare, legal remedies and economic arm wrestling. Actions of the aggressor are, in most cases, carried out by proxy actors, with the aim that they cannot be held responsible. Disinformation campaigns and the use of cyber-attacks are commonplace, as it is difficult to attribute them to a specific perpetrator.

Cyber, Space and Drones

Space and cyberspace have added new dimensions to warfare as they are re-

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On 27 March 2019, India's Defence Research and Development Organisation successfully launched an anti-satellite missile, engaging an orbiting Indian target satellite.

motely controlled, thereby minimising physical collateral damage. As the rules of warfare are being rewritten, contemporary warfare is now a national effort at all levels, including the will of the people. Space based assets have also become pivotal to strategic security, playing a critical role in the conduct of future land operations. India is one of only four countries to have developed an anti-satellite missile at home, with the rocket having been tested in 2019. The other countries are the US, Russia and China. ASAT systems are force multipliers because they can shoot down satellites of enemy countries, putting the entire network of operations out of action and blocking everyday activities.

In addition to the ASAT rocket systems, states use satellites in space for information gathering and monitoring. An important example were the US satellites that were 'blinded' by Indian scientists in 1998 while conducting nuclear tests in Pokhran, Rajasthan.

The Commander-in-Chief of the Indian Army, M.M. Naravane, once said: "The nature of war is unchanging, but its character has changed. Icons of 20th century warfare such as main battle tanks and fighter planes are about to disappear". He added that the armed forces of the future would consider using block chain technologies and direct energy weapons such as lasers.

Cyber activity is a crucial dimension as recent attacks on key facilities such as the nuclear power plant in Koodunkolam

in southern India or the Saudi Arabian oil factory in Aramco (which have been widely claimed to be the deed of Iran) have shown.

From defence websites being hacked to national elections being rigged in the favour of a particular candidate – these are some examples where cyber activity has been used as a weapon. Countries have been forced to set up Cyber Commands as operational war commands and there are also strict regulations in place for uniformed personnel to refrain from social media activity.

Data collection through websites and the misuse of databases is what countries fear, forcing communist regimes like China to develop their own web platforms like Baidu, WeChat, and Zoom. While Chinese platforms are banned in some countries, Russia bears the main blame for interference in US elections through hacking.

While technology has made warfare as easy as pushing a button, it has also brought with it the risks of security and information protection. As combat aircraft operate on mission computers and missile systems, and because all weapons operate with coded software, there is always the challenge that national security is at risk.

Army Chief General Naravane says: "The display of his military might has created this aura of China's undisputed military leader in key technology areas," adding also that "Terrorist groups are far more adept at dealing with social media than the armies of the 21st century. ISIS is far more adept at dealing with social media with devastating effects compared to the armies of the 21st century of the US and UK".

In May 2019, India established its first cyber defence agency to pool similar activities between the Ministries of Interior, Defence, Foreign Affairs, Information and Broadcasting and Science and Technology, which are under the Prime Minister's Office.

Drone warfare is well considered by all countries because the number of human casualties from the attacking country is almost zero, the precision strike rate and maintenance and operating costs are low compared to jets. Drone warfare has recently taken on a new meaning after the assassination earlier this year of Iranian Major General Qassem Soleimani of the Islamic Revolutionary Guard Corps by US Special Forces using an MQ-9 REAPER, considered one of the deadliest unmanned aircraft in the world.

While drones were used by NATO forces in Afghanistan and Iraq following the

'Cold War', Pakistan has also seen drone attacks on its soil.

Non-Contact Warfare

In the field of non-contact warfare, artificial intelligence (AI) and robotics are gaining in importance. Armed AI has already appeared in many variations. It has been increasingly integrated into the weapon systems of the world's leading military forces, and some experts even argue that the main revolution in the military field since the atomic bomb is the advent of robot-supported warfare. 'Killer robots', combat drones, and hypersonic missiles and vehicles have revolutionised tactical combat space.

Hybrid Warfare and Non-State Actors

Asymmetric wars are not always a purely domestic phenomenon, as is evident in South Asia. Since its foundation, Pakistan has been using non-state actors to promote its foreign policy goals. From the capture of Kashmir by Lashkari tribesmen in October 1947 to the guerrilla war of 1965 to liberate Kashmir under code name 'Operation Gibraltar' and 'Operation Vijay' in Kargil in 1999, Pakistani Jihadi elements are active in the valley until today.

Global Jihad has been the sole aim of Lashkar, whose fighters have been engaged in campaigns in Afghanistan, India, Bosnia and Herzegovina, Tajikistan, Iraq and possibly also Chechnya as well. Non-state actors have been made part of foreign policy by certain nations with South Asian terror groups like ISIL and Boko Haram two examples.

S. Kalyanaraman, a researcher at the Manohar Parrikar Institute of Defence Studies and Analyses, says, "The people do not constitute the centre of gravity in terrorism; rather they are the targets. And, ironically, they are targeted precisely to intimidate them into supporting the agenda of the terrorists. In other words, what terrorists seek is not the willing support of the people but the people's meek and unquestioned acceptance of the agenda of the terrorists. For instance, during 1990 and 1991, the peak years of the terrorist campaign of the Khalistani terrorist groups in Punjab, over 5,000 people were killed in terrorist attacks. Moreover, over 3,500 of those killed in these attacks were Sikhs."

When it comes to asymmetric warfare, it is important to understand that 'insurgency' and 'terrorism' are not similar. In-

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surgents target the state apparatus while terrorists target politicians, ministers, and military officers.

By and large, India has resolved its multiple insurgency problems in the north-east, which were rampant over the past 50 years, for example, the Mizo and Naga problems. India and Pakistan agreed on a ceasefire in 2003 at the Line of Control, but ceasefire violations are common and constant infiltra-

The 'String of Pearls' is a geopolitical theory on Chinese intentions in the Indian Ocean. It refers to the network of Chinese military facilities, which run through several major maritime choke points.

tion, shelling and attacks on Indian armed forces have been a regular occurrence in the Kashmir Valley, by groups like Hizb-ul Mujahideen, Lashkar-e-Taiyyba, Jaish-e-Mohammad, Al-Badr and Harkut-ul-Mujahideen.

According to the US-based Pakistani scholar and former diplomat Husain Haqqani, "Guerrilla warfare and terrorism came to be envisaged and employed as instruments for effecting a communist revolution in several countries in Asia, Africa, Europe and Latin America. Even though Communism has now been discredited, some insurgent and terrorist groups, such as the Maoists in India, continue to practise its precepts."

Lt General Vinod Bhatia explains, "The modern concept of "Hybrid Warfare" takes its inspiration from Israel-Hezbollah War of 2006, after which US Marine Corps Lieutenant Colonel Frank Hoffman took the initiative to define the Hybrid threats and introduced the term as it is being used in the present context. Relevance of Hybrid Warfare became more prominent in the context of antagonistic behaviour between Russia and the United States."

Economic Activity

China has long been accused of its 'String of Pearls' strategy in the Indian Ocean, which is about encircling and encompassing smaller, economically weaker countries, towards its expansionist pursuits. In 2013, China came up with its 'Belt and Road Initiative' (BRI), which is primarily an infrastructure construction programme running through nearly 70 countries across Asia, Europe and Africa. Also called the '21st Century Maritime Silk Road',, countries have objected to the BRI for a lack of transparency and violation of sovereignty.

In 2016, former US Chairperson of the Joint Chiefs of Staff, General Joseph Dunford, stated that "Iran, Russia, and China employ economic coercion, political influence, unconventional warfare, information operations and cyber operations to advance their interests and they do it in a way that they know we don't have an effective response."

Information Warfare

The Russian Defence Ministry defined information warfare as the ability "to undermine political, economic and social systems; carry out mass psychological campaigns against the population of a state in order to destabilise society and the government; and force a state to make decisions in the interests of the opponents".

State-run publications in China have been busy campaigning against the stigmatisation of Covid-19 being called the 'Chinese Virus' by the West. Equally important are publications in almost all countries seen either on the right side or the left, peddling one narrative or the other.

Covid-19 as a Bio Weapon

By accusing the West of fuelling the 2019 democratic student protests in Hong Kong by providing resources and funding, China has sought to link the unrest in Hong Kong to Western democracies.

With 27,90,986 cases (still to be counted) and 1,95,920 deaths worldwide, some people believe that the Covid-19 virus is allegedly a biological weapon developed by the Chinese Communist Party in its P-4 laboratory at the Wuhan Institute of Virology. Another argument put forward in Western countries refers to how China allegedly covered up the details and facts after the outbreak of the pandemic, initially at an animal market in Wuhan in November 2019, by making informants disappear and silencing doctors. Agencies in many countries have gone to court to sue China for billions of dollars in reparations for the ongoing pandemic that has struck the world.

The spread of infectious diseases and the poisoning of enemy wells as part of biological and chemical warfare dates back to 600 BC. The use of pathogens such as anthrax in World War I and the poisoning of water wells to cause outbreaks of cholera and typhoid fever during World War II are good examples of this.

To dilute US hegemony, China's concept of 'Unrestricted Warfare' advocates combining unconventional and covert tactics. Two Chinese army officers, Colonel Qiao Liang and Colonel Wang Xiangsui, have mentioned in their ground-breaking book 'Unrestricted Warfare': "From a computer room or the trading floor of a stock exchange, a deadly attack on a foreign country can be launched from anywhere. Is there any place in such a world that is not a battlefield?

The Vice Chief of the Indian Army, Lieutenant General S.K. Saini, says: "Conventional warfare is not dead, but other areas such as cyber and space are in a supporting role. Other areas are developing and have yet to mature. Institutional and operational agility require a rethink and decentralization of decision-making. A doctrine takes three to five years to mature, yet its implementation might take a decade". ■

Photo: via author

THE SENTRY ATM SYSTEM

SENTRY is a next generation Anti-Tank Mine SYSTEM, developed and produced by Forcit Defence. The SENTRY is the first of its kind, combining advanced encrypted mesh connectivity with outstanding penetration capabilities and pressure effect.

Photo: Forcit Defence

Containing several industry-first features the SENTRY delivers unmatched stopping power and dominates battle fields by creating Anti-Access and Area Denial zones while enabling friendly ground forces to pass.

SENTRY is a fully remote-controlled system with on-demand individually encrypted radio communication and with pre-programmed autonomous mode for stand-alone use or in case of frequency jamming. The system is effective against Wheeled Heavy Vehicles, Wheeled Armored Vehicles and Tracked Armored Tanks in all terrains and weather conditions. The SENTRY has a Dual warhead consisting of EFP and Powerful main charge with a Multi-Sensor target identification system.

Initial Vision

Anti-Tank weapons have for years been a central part of Forcit Defence product portfolio. Ideas for a complete new Anti-Tank Mine weapon solution have been on the table for many years and the first sketches for the SENTRY SYSTEM where drawn in 2012. Forcit Defence vision was to "Do more with less effort", to offer a lightweight system in an All-in-one package with remote control possibility. Today all these important characters are a fact.

Design challenges that had to be overcome

As with most groundbreaking systems there were several design challenges. New innovations come with new problems. One of the bigger challenges was the jamming of the radio signal. We needed to create a system that works even under jamming and the autonomous functions in the mine makes this possible. For example, the last setting of the mine will stay active.

Penetration capability is an essential part of an ATM mine, and we have a future proof penetration capability. User-safety has been a long-standing cornerstone for Forcit product development, and it was clear for us that SENTRY ATM shall be an Insensitive Munitions compliant product.

With a sophisticated system as the SENTRY SYSTEM, there is a lot of data to be processed and analyzed. Performance indicators such as optimized detonation point and vehicle profile (type, speed, positioning and other performance related factors) are cross-checked between sensor data and the threat library. To enable fast deployment and cater future mine laying capability build-up, the SENTRY SYSTEM is compatible for use with mine laying machines.

Drafting the requirements

During early stages of the design phase it became apparent that current capabilities of ATM mines are insufficient and outdated in both penetration and target acquisition. The designed system should create great operational flexibility and enable new anti-access tactics as well as the capability to be integrated with modern area-denial C4i and CMS systems. SENTRY's development cornerstones included unparalleled penetration capability, full IM compliance, light weight and secure communications together with a multi-sensor system.

The system should combine modern sensor technology, situational awareness, machine learning, threat library and software to EFP and explosives expertise.

Threat analysis

SENTRY System executes its task autonomously. Extensive threat library allows SENTRY to recognize vehicle type for threat engagement determination, where only valuable targets are destroyed. Sensors gather data which is then cross-checked in milliseconds in order to optimize the detonation point according to both vehicle type and velocity. SENTRY is an Insensitive Munitions compliant product and due to the facts, that it has no reaction against infantry and a minimum of two independent influences needed for initiation, it is fully Ottawa Treaty compliant.

Testing

A lot of tests have taken place during the development phase and with the finalized SENTRY Unit. Huge efforts have been invested to verify the performance of the EFP. The EFP projectile has been x-rayed, motion picture photographed, and it has been shot against various kinds of targets. Sensorics has been tested to ensure target identification and to verify hits inside the spot area. Multiple kinds of vehicles have been used as targets for the sensorics tests, both wheeled and tracked, lightweight and heavy ones, over the whole speed range. Tests has been performed with mine clearance rollers installed on the tank.

We know for sure that the SENTRY´s are hitting specified targets at the right place and it will penetrate the hull for sure!

Forcit Defence, founded in 1893, is a Finnish Privately owned manufacturer of IM Defence Systems. We serve as prime contractor for defence forces and as a supplier for global OEM´s.

Forcit Defence serves customers in Air, Land and Naval Domains. Our product range includes A2/AD and Counter Mobility systems, AT-ammunition, precision fragmentation charges and next generation sea mines for shallow waters.

Forcit cooperates in development and manufacturing of warheads for all types of payload delivery vehicles and serves as a strategic manufacturing partner. Forcit has the second largest Cast Cured Plastic Bonded Explosives manufacturing capability in Europe and we can Load-Assemble-Pack warheads, from the smallest charges up to large warheads/bombs.

www.forcitdefence.com

Agile Development With Soldier Feedback

General John M. Murray is the first Commanding General of US Army Futures Command, a new four-star Army Command headquartered in Austin, Texas. He was commissioned as an Infantry officer in the US Army upon graduation from the Ohio State University in 1982. Throughout his career, General Murray has served in leadership positions and commanded from Company through Division, with various staff assignments at the highest levels of the Army.

ESD: Please tell us about the background of Futures Command, and why and how it has come to be?

Gen. Murray: In 2018, after being focused on the wars in Iraq and Afghanistan for nearly two decades, the US Army refocused efforts toward modernisation. We realised we had to make radical changes to preserve overmatch against our near peer adversaries; and in that, undertook the most significant reorganisation of the US Army since 1973.

Army Futures Command established unity of command and leads the enterprise in assessing and integrating the future operational environment, emerging threats, and technologies to develop and deliver concepts, requirements, and force designs.

One thing we knew was this wouldn't work if Army Futures Command Headquarters was behind the gates of a military installation, so we chose to embed in an innovative community in Austin, Texas. Being able to walk out of a location and quickly bump into that innovative spirit is invaluable. AFC has just about 400 personnel assigned to the headquarters, and about 26,000 worldwide.

ESD: What are the current hottest aspects of programmes and developments likely to be fielded in terms of field artillery, hypersonics and cyber defence?

Gen. Murray: Army modernisation efforts – our 31+3 Signature Systems - remain my top priority for delivering capability to our soldiers. Yet, I have to acknowledge the impact Covid-19 has had on many of us. The Army is playing a significant role in this fight to include organisations that are organic to AFC, including the Combat Capabilities Development Center and the Medical Research and Development Command who are committed to prevention, treatment

and eventually defeating this virus.

That being said, Army Futures Command remains closely tied with our industrial base on our modernisation efforts. Our priorities are: (1) Long-Range Precision Fires (2) Next-Generation Combat Vehicles (3) Future Vertical Lift (4) Army Network (5) Air and Missile Defence and (6) Soldier Lethality. These are the focus of our eight Cross Functional Teams: Long Range Precision Fires; Next Generation

Combat Vehicle; Future Vertical Lift; Army Network; Air and Missile Defence; Soldier Lethality; Assured Positioning Navigation Timing; and, Synthetic Training Environment; Air & Missile Defence; and Soldier Lethality. We also activated the Artificial Intelligence Task Force (AI Task Force) and Army Applications Lab (AAL) to support AFC efforts.

We are looking at agile development of solutions with soldier feedback. One example is the Enhanced Night Vision Goggles – Binoculars (ENVG-B). So, these are an amazing concept, two tubes to look through, instead of one, with fused thermal imagers. It allows the soldiers to operate using the technology during the day and night. They're also good during times of zero illumination – so no requirements for ambient light. We can link the ENVG-B up with a weapon's sight and the soldier's reticle is seen in the binoculars. We actually had a US Marine Sergeant, lay on his back, shoot the weapon over his head and hit five out of seven targets at 100 metres. Soldiers can actually look around corners with their rifle, or overtop of bunkers or sandbags without exposing themselves. Really incredible technology. The Army's top modernisation priority is Long Range Precision Fires. We have a Cross Functional Team at Fort Sill, Okla., working to ensure our dominance in range and lethality. This requires new weapon systems, projectiles, and propellant and propulsion systems. Let me give

Long Range Precision Fires is the US Army`s top modernisation priority; it recently successfully test-fired the Extended Range Cannon Artillery - reaching 70 kilometres using a 58-calibre gun.

you an example, the Long-Range Precision Fires CFT has successfully test-fired the Extended Range Cannon Artillery - reaching 70 kilometres using a 58-calibre gun. And in late April, the CFT successfully completed its third testing of the Precision Strike Missile, which will have substantially longer range compared to the Army Tactical Missile System, eventual hitting targets over 500 kilometres away.

I'm very focussed on finding technology to solve Army problems. We've concentrated on understanding the problems we're trying to solve first, then we will find the connection to problem-solvers. There's lots of solutions out there, but we got to make sure we're connecting them to our most important problems.

ESD: Futures Command is building on imagination: the ability not only to analyse and deduce, but also to make leaps in terms of technologies, strategies and requirements. With this in mind, what are your personal highlights?

Gen. Murray: A personal highlight is being part of this change as we move the US Army toward our goal of a multi-domain operations capable force by 2028, and an MDO-ready force by 2035. Knowing that on a future battle field a young company commander will look back and thank Army leadership for having the courage to stand up Army Futures Command and provide him with the tools necessary to dominate ground combat and bring every Soldier home to the families that trust us with the lives of their sons and daughters.

Our enduring impact is that the Army's force modernisation enterprise is a source of competitive advantage that US adversaries cannot replicate.

ESD: Does Futures Command look outside the US for ideas? Do you also ask for input from abroad, and how do people get in touch?

Gen. Murray: There are several avenues for input from our Allies and partners, depending on whether it's from an official representative of that country or someone with a good idea. The individuals with great ideas can follow the same procedures as innovators here in the US, going through our Army Applications Laboratory, getting in direct contact with our Cross Functional Teams, working with one of our university partners, or partnering with our traditional defence primes.

We are also in the process of building a foreign liaison office which handles these types of requests. Recently, our command welcomed British and Australian liaison officers to assist us, which is a step in the right direction.

To address the scope and pace of our adversaries' ambitions and capabilities, we are investing in modern capabilities designed to strengthen and evolve our alliances and partnerships. We recognise the unique capabilities and capacities each Ally and partner brings to the fight. We need to be ready to face strategic competition with joint and multi-national partners. We have to train together and assess these capabilities in exercises to demonstrate this interoperability.

ESD: Thank you.

The interview was conducted by Stephen Barnard.

NATO and the Fight Against the Covid-19 Pandemic

The First Virtual Military Committee Meeting of the Chiefs of Defence

Joris Verbeurgt

On 14 May 2020, the 183rd meeting of the NATO Military Committee took place. This gathering of NATO's chiefs of defence usually takes place at the headquarters in Brussels, but because of the corona crisis, the session was had the format of a secure teleconference. The virtual meeting was presided by the Chairman of the Military Committee, with the assistance of the Supreme Allied Commander Europe (SACEUR) and the Supreme Allied Commander Transformation (SACT). The 30 chiefs of defence discussed the Alliance's ongoing operations, missions, activities, and operational commitments. Of course, the current global Covid-19 crisis and its impact was also high on the agenda, as well as NATO's role in responding to the crisis.

After the opening speech by NATO Secretary General Jens Stoltenberg, NATO's operational commitments were discussed, namely the ongoing training missions in Afghanistan and Iraq. Since the intra-Afghan negotiations are making progress, NATO agreed to reduce its presence in Afghanistan in the scope of the Resolute Support mission to 12.000 troops. However, NATO will continue to support the Afghan government by training, assisting, and advising the Afghan security forces. Possible future engagements with Afghanistan were discussed, as were the continuing fight against terrorism and the strengthening of partnerships to promote the return of stability across the region. Second, the ongoing work on the complimentary policies that

set out NATO's military priorities and the development of a coherent approach to current and future threats was discussed. The CHODs received an update on the development of the Concept for Deterrence and Defence of the Euro-Atlantic Area (DDA) and on the NATO Warfighting Capstone Concept.

In the final session of the day, the NATO chiefs of defence addressed NATO's role in response to the Covid-19 crisis and the opportunities to further support allies, partners, and countries in need. This subject was already discussed in the different foreign and defence ministerial meetings, which took place in the course of April. In those meetings, it was decided that NATO would maintain its deterrence and defence commitments and that the missions and operations around the world would continue, despite the pandemic. However, NATO would do all it can to ensure the safety of its troops and personnel and examine how it could further coordinate the support it delivers in the fight against the pandemic. NATO's unique heavy-lift capability was called upon to ensure the timely transport of critical supplies from around the world. Hundreds of tons of medical equipment that had been donated, were delivered that way. NATO structures and networks were also used to share medical expertise among the Allies, and spare hospital capacity was offered to countries in need. Another topic of interest was the disinformation with respect to Covid-19. False and harmful narratives pose a big challenge for NATO

member states and countering those is a task that NATO would gladly accept. The Military Committee further examined and discussed the requirements to implement those decisions by the NATO members.

NATO's Euro-Atlantic Disaster Response Coordination Centre

When, in the course of the month of March, all NATO allies started to take preventative measures against the proliferation of the coronavirus, NATO declared that it would closely monitor the Covid-19 outbreak, together with other international organisations such as the World Health Organisation (WHO). NATO military medical staff would particularly monitor any potential impact for NATO troops deployed in overseas operations. At the NATO headquarters in Brussels, preventative measures were taken to reduce the risk of the further propagation of the infection disease. Staff travel was limited and group visits to the headquarters were temporarily suspended. Also, staff was encouraged to work from home as much as possible. NATO remained in close contact with the Belgian authorities to keep an eye on the development of the coronavirus in Belgium. At the same time, NATO assured that its essential work would continue and that it had robust business continuity measures and plans in place.
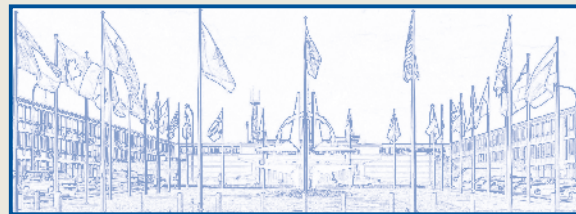
NATO's principal civil emergency response mechanism is the Euro-Atlantic Disaster Response Coordination Centre (EADRCC). It is active all year round and it is operational on a 24/7 basis. All 30 allies and 40 partner countries participate in this organisation. It was established in 1998 to coordinate both requests and offers of assistance in case of man-made and natural disasters, such as earthquakes, floods, and forest fires. Now, the EADRCC is at the forefront of NATO's response to the global pandemic. When a request for medical aid is voiced by an ally or a partner, the EADRCC coordinates the delivery of urgently needed medical supplies, such as personal protective equipment, respirators, and test kits. In the past, the disaster response centre assisted in fighting forest fires in Latvia and in Israel, and in Albania and Montenegro it responded to disasters like earthquakes, snowstorms, and floods. When hurricane Katrina hit the USA in 2005, the EADRCC was there to provide relief. NATO itself does not have stockpiles of medical supplies, but the EADRCC matches donors with recipients and enables heavy transport capabilities to assist with the complex logistics. Some examples of the work that is executed by the centre include facilitating the delivery of disinfectants from Ukraine,

Photo: NATO

The Military Committee is responsible for translating political decision and guidance into military direction, and for recommending measures considered necessary for the defence of the NATO area and the implementation of decisions regarding military operations.

ventilators from Germany, protection equipment from Turkey, and respirators from the Czech Republic; the shipment of thousands of surgical masks from Estonia to Italy and Spain; the delivery of a planeload of medical supplies to Spain and Italy from Turkey; the delivery by the US of face masks to Albania, and Bosnia Herzegovina, the delivery of protective equipment from the Czech Republic to North Macedonia, and the delivery of thousands of litres of disinfectant to Spain from Poland.

Beyond the Euro-Atlantic Area

On 05 May 2020, the United Nations Office for the Coordination of Humanitarian Affairs (UN OCHA) requested international assistance through the EADRCC. Qatar responded to the call by offering to provide airlift assets to be

coordinated by the EADRCC. The strategic airlift support includes transports from the airport of Liege in Belgium to multiple locations, mainly Accra, Addis Ababa and Johannesburg. Until 22 May, seven allied and nine partner nations had requested international assistance through the EADRCC. The requests do not exclusively come from inside the Euro-Atlantic area: nations that requested help from NATO to fight the pandemic also include countries like Georgia, Colombia, Afghanistan, Mongolia, Tunisia and Iraq.

NATO can pride itself on what it is doing. No other international organisation (not the EU, and certainly not the UN) is capable of doing what NATO is doing right now. Therefore, the corona pandemic could be an opportunity for NATO to prove to the member and non-member states that it can be more than an umbrella in case of war and that the taxpayers' money is well spent. It is clear that the structures that NATO has in place and the expertise that the EADRCC has acquired, are very useful in support of the fight against global threats of a non-military nature, like the Covid-19 pandemic. The coordinating and facilitating assistance are widely appreciated by NATO-members and partners, and so are the professionalism and proficiency of the men and women engaged in getting it all done.

Research and Technology for the Future Main Ground Combat System

Thomas Czirwitzky and Pierre Wey

The list of capability requirements for the future Main Ground Combat System (MGCS) is long. It must detect and identify threats from a distance, improve crew protection, increase firepower and mobility, and so forth. Many technological challenges have to be overcome.

The French-German Research Institute of Saint-Louis (ISL) has extensive experience and a long history of technological innovation in the field of armaments, and therefore has the requisite scientific portfolio to make a substantial contribution to this large-scale research and development project.

The Battle Tank, a Symbol of the Past with Great Prospects

The fall of the Berlin Wall symbolised the end of the Cold War and appeared to herald the demise of heavy battle tanks. During the "peace dividend" years, political and military analysts considered the battle tank a weapon of the past. For them, battle tanks were out of date in the new asymmetric conflicts, such as the fight against terrorism. Like dinosaurs, these heavy vehicles were doomed to extinction and expected to disappear from 21st century battlefields.

This assessment has now been proven wrong in two respects. First, recent geopolitical tensions have sparked fears of a return of symmetric conflict (e.g. in the Donbass region). Second, the remarkable combination of mobility, firepower and protection provided by the heavy battle tank is still unrivalled in ground warfare. In a historical twist of fate, in 2015, it was Russia, the former adversary, which showed that battle tanks had been written off too quickly. The demonstration of Russia's new T-14 ARMATA tank caused a sensation. Experts soon agreed that this new weapon would outperform NATO's best heavy battle tanks and be hard to beat technologically.

Authors

Brigadier General Dr.-Ing. Thomas Czirwitzky is the German director of the German-French Research Institute Saint-Louis (ISL) and **Dipl.-Ing. Pierre Wey** is a senior Scientist at ISL and Project Director MGCS.

The Franco-German MGCS Project

The Leopard 2 and Leclerc battle tanks used by the German and French armies were designed in the 1980s. Their combat efficiency has been significantly upgraded since they first came into service. With a view to replacing them by 2035, Germany and France launched an ambitious joint initiative in 2012. Together, they plan to investigate, design and develop the future Main Ground Combat System (MGCS). The project comprises five main stages: operational requirements analysis, concepts study, technology development and demonstration, system integration and demonstration and, lastly, system production. The first two stages have already been successfully completed.

The operational requirements analysis was undertaken in 2013 and 2014 by a Franco-German task force consisting of military and technical experts. Following this, two concept studies were simultaneously conducted in Germany and France between 2015 and 2018. They were carried out at a national level, in Germany by IABG and in France by ISL, under the authority of the respective German and French Defence Ministries. The two task forces met frequently to ensure close interaction and cooperation. These studies resulted in two system concepts, one German and one French, which were very similar in terms of their architecture and features. Both concepts describe a team of combat vehicles that can be remote-controlled or employed in autonomous mode, depending on their subsystem characteristics.

The two concepts that resulted from these studies were chosen to serve as the basis for the development of a common system and for the further development of technologies and capacity certification in the third stage of the MGCS project, which is currently under way.

Innovative Technologies from ISL

The MGCS will consist of a range of vehicles capable of manoeuvring and fighting together. Their firepower and protection capabilities will far outstrip those of a single battle tank. There will be light, medium and heavy, manned and unmanned tanks in a unit, with UAVs for additional support. The various weapon systems inside the land vehicles will be able to defeat all short-, medium- and long-range threats, and the drones will expand the system's observation capabilities, especially beyond the direct line of sight. The vehicles will offer crews much better protection, which is crucial. They will notably include a survival cell (with the crew sitting inside the chassis), active protection countermeasures and the use of robots. It is, however, important to realise that technology cannot accomplish everything. To expand the system's potential future applications and help boost cooperative combat capabilities through the use of manned and unmanned vehicles, both countries must continue to evolve their combat doctrines and even introduce innovations.

For years, there has been very little research and development in battle tanks, which is why developing innovative technologies for a future battle tank system might seem challenging. In this regard, it would certainly be helpful to coordinate a national and binational approach, and aim for a consolidated roadmap and more specifically a correlated R&D roadmap in terms of MGCS technologies.

The concept of the Main Ground Combat System

As a Franco-German research institute, ISL is perfectly placed to play a role in this binational program and contribute to the development of innovative MGCS technologies. ISL has the appropriate expertise to conduct research and development, simulations and experiments for all key MGCS features – firepower, protection, mobility and SDRI (Surveillance, Detection, Recognition and Identification) – with a view to either a medium-term (2025) or long-term transfer of technology.

Firepower

In the field of interior ballistics, ISL improves propellant performance by using 3D printing to manufacture new grains geometries and by creating submicron energetic materials. Using a plasma cartridge in an electrothermal-chemical tank gun also improves the powder ignition process, which increases muzzle velocity (up to 2000 m/s in a 120mm gun) and reduces performance differences due to temperature effects.

In the field of external ballistics, ISL can increase the range of direct or indirect fires, while improving the hit probability, thanks to projectile guidance and control. In particular, it has already developed a complete system for the control of a spin-stabilised medium-calibre projectile and tested it successfully on its proving ground. The on-board system consists in a pyrotechnic actuator and a navigation unit based on magnetometers. ISL has also developed aero-mechanical actuators which can correct the course of fin-stabilised projectiles.

In the field of terminal ballistics, ISL develops submicron-sized alternative energetic materials that substantially increase the lethality of ammunition of different calibres, and enable the use of low-cost warhead detonators that are safer, more reliable, more environmentally-friendly and REACH-compliant. In addition, ISL's current theoretical and experimental research aims to optimise further the characterisation of penetration and impact performance of kinetic penetrators and shaped charges.

Armour Protection

ISL's work on armoured platform protection includes, on the one hand, long-range protection with active countermeasures and, on the other, protection against direct hits with active and passive protective structures.

IR solid-state and fibre lasers which are designed and developed to dazzle and damage electronic sensors are one of the possible active countermeasures against missile seekers and enemy sighting devices, night-vision devices and thermographic cameras. So far, this technology has mostly been used as a DIRCM application to protect aircraft. ISL has already outlined some application ideas for its use by ground forces.

When it comes to the development of advanced protective materials, ISL focuses on three areas of activity:

- ballistic protection of the crew and their equipment
- protection of optic equipment against laser threats
- investigation of ageing effects on material properties

To improve ballistic protection, ISL develops low-weight, high-mechanical-resistance materials, such as multilayer composites made of metal-ceramic or metal-polymer compounds which are obtained by sintering of extremely fine powders.

ISL applies knowledge about terminal ballistic effects from different kinds of threats (blasts, fragments, long-rod penetrators) to optimise the armour protection of protected platforms. Numerical simulations and firing tests serve to investigate the interaction between threats coming from different projectiles or shock waves and passive, reactive or active armours. Newly developed and secure opto-pyrotechnical detonators, which are exclusively based on secondary explosives, offer a reliable solution for the initiation of pyrotechnical components in active protection systems.

ISL develops new types of materials with non-linear optic properties to face laser threats. These materials reduce the incident laser beam significantly and behave somewhat like photochromic glass. Non-optic materials also reduce thermal laser threats thanks to new types of sintered, heat-resistant polymers.

It is a well-known fact that ageing alters materials (embrittlement of plastic, delamina-

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KMW, Nexter and Rheinmetall Contracted for Initial MGCS Architecture Study

On 20 May 2020, KMW), Nexter and Rheinmetall announced the contract award by the German BAAINBw procurement agency (acting on behalf of Germany and France) for the "System Architecture Definition Study - Part 1" (SADS Part 1) in the scope of the Franco-German MGCS programme. In light of the MGCS requirements, the three companies had joined forces in a respective joint venture, called ARGE, in December 2019.

ARGE is a German acronym standing for Arbeitsgemeinschaft, or "working group". Under German law, the ARGE serves as the contractual partner of the procurement authority. The aim of the study is to harmonise the final MGCS concepts of the previous phase, to analyse further details, and to propose a common multi-platform architecture. The three contractual partners will assess various aspects of different concepts: technical feasibility in the projected timeframe allotted for the programme; ability to fulfil the operational needs of both armies; efficiency and compatibility with national "systems of systems" (SCORPION for France and D-LBO for Germany). Workshares in the SADS Part 1 are to be distributed equally between France and Germany. The first phase of architecture work is expected to last 18 months.

The STAMINA image-based navigation system

Source: ISL

tion). The latest research in this area investigates the effects of ageing on the protective properties of materials. It enables an assessment of the long-term effectiveness of the protection, and determines the moment when protective materials should definitely be replaced.

Steps Toward Semi-Autonomous Mobility

The image-based navigation system STAMINA enables ground vehicles to move without any satellite positioning. This navigation system is not sensitive to jamming or interferences from GNSS-signals (GPS, Galileo). It can follow an itinerary determined by a simple sequence of images while avoiding potential obstacles. As well as its integration into MGCS vehicles, it has multiple civil and military applications for ground robots: freight transportation systems, autonomous emergency vehicles serving different purposes and patrol vehicles for the surveillance of critical areas. These vehicles are also capable of detecting changes in their surroundings and can provide the operator with valuable information when it comes to the detection of suspicious objects (i.e. IEDs).

SDRI

Optical and acoustic surveillance methods help improve tactical reconnaissance on the battlefield. They are an absolute necessity for future combat vehicles, since they allow the crew inside the survival cell to stay in contact with the outside world and react appropriately to the situation.

Optical surveillance using time-gated imaging in the infrared range enables users to continue to observe the surroundings even in harsh visibility conditions (smoke, fog, rain, snow, etc.). This technology captures objects from the original scene precisely and recreates a 3D image in real-time. ISL is currently developing a new image processing method that combines laser illumination and image processing to detect and track objects which are not in the direct line of sight ("see around the corner").

ISL uses specific machine learning processors to develop autonomous surveillance systems capable of detecting, analysing and classifying specific visual events in real time, such as people or vehicles trying to enter a protected zone. In acoustics, sensor networks can already detect approaching threats from
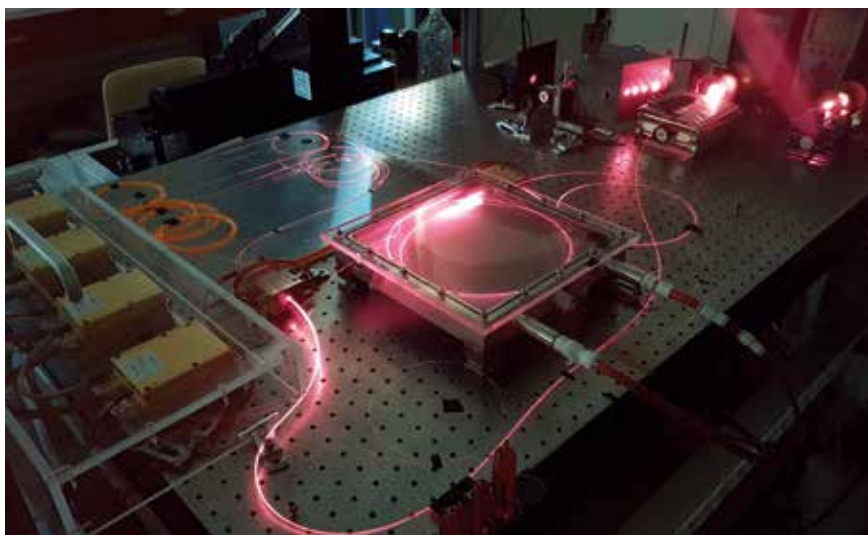
any direction. This includes threats which are difficult to detect such as UAVs. By combining acoustic warning sensors with an active imaging system, a complete system for the surveillance, detection and localisation of drones can be implemented. Furthermore, AI techniques such as deep learning can be used to improve the system performances thanks to automatic UAVs identification and tracking functions.

In the field of acoustics, ISL's latest developments include a new generation of earplug hearing protection devices. These protect soldiers from the impulse noise produced by weapons, improve their hearing and communication abilities, measure their vital functions, and provide spatial cognition and situational awareness capabilities that are unattainable with conventional noise protection devices. The three-dimensional detection of acoustic sources in an urban environment and acoustic signature reduction are the main objectives of these acoustic technologies.

Abstract

The ambitious Franco-German MGCS (Main Ground Combat System) project is the ground combat system of the future. It will come into service between 2030 and 2040 and will continue to support ground forces in subsequent decades, serving as their main combat system. The system's requirements are one of the major challenges facing its technological implementation. They include the need for it to be inherently dynamic and scalable to current and future operation scenarios, as well as adaptable to future technologies used in upgrade programmes.

ISL technologies are already available in a national and binational context. They can be immediately integrated into an MGCS. Furthermore, existing technologies must be improved for use in a military context. New technologies which could close capability gaps need to be identified and implemented so the system can adapt to future technical and operational developments.

First and foremost, the MGCS of the future must be fitted with the latest available equipment in a timely manner. ISL's scientific portfolio already provides a solid basis for this and ISL is therefore well-placed to take on this challenge. ■

Laser source for IR-countermeasures

Source: ISL

Equipping the UK STRIKE Brigades

Henry Richardson

The UK is modernising its land capabilities. A central outcome will be establishing and equipping an all-new formation for the British Army – the STRIKE Brigade.

The UK's 2015 Strategic Defence and Security Review (SDSR) introduced the 'Army 2020 Refine' vision, a significant element of which was the creation of two new 'STRIKE Brigades', to be formed by 2025 and comprising 5,000 personnel each. These STRIKE Brigades seek to field a versatile medium weight force that can self-deploy to deliver decisive effect at distances up to 2,000 km, notionally combining the lethality and survivability of heavier formations with broader utility across low, medium and high intensity operations.

Introduction to STRIKE

The intent is an agile force, expeditionary by design and better able to respond to scenarios the Army is likely to face. In the high intensity scenario, STRIKE would be the UK's first responders, deploying rapidly to meet with a (Russian) aggressor, reconnoitre, disrupt and delay without support for up to 10 days, to allow heavier and slower-to-deploy Armoured Infantry (AI) formations and allied forces to reinforce.

A core concept is that of dispersed operation. STRIKE will not seek a conventional confrontation, instead manoeuvring in de-centralised Company or smaller groups, concentrating on the force-multiplying effects of accompanying assets including missile and rocket artillery. Each Brigade will therefore operate over a relatively large area for its size – some 100 km of frontage and up to 100 km depth. STRIKE is in many ways a heavy reconnaissance screen, locating and directing fires whilst conducting limited probing attacks to disrupt and delay enemy formations. Evoking a contemporary, and heavier, take on disruptive commando

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Two British AH-64 APACHE pilots wait to be extracted from the field by an HH-60G PAVE HAWK during an exercise at Salisbury Plain, England. The UK STRIKE Brigades are to field a medium weight force that can self-deploy to deliver effect at distances up to 2,000 km.

Photo: US Army

raiding behind the lines, it seeks to be an agile force that leverages force multipliers to conduct the battle.

Equipping the STRIKE Formation

STRIKE is currently being equipped with two core families of armoured fighting vehicles (AFV): the General Dynamics European Land Systems UK (GDLS-UK) AJAX and the ARTEC BOXER.

AJAX is both the name of a family of vehicles, and the designation for the primary armoured reconnaissance variant. A development of the ASCOD platform, also used by Austria and Spain as the ULAN and PIZARRO Infantry Fighting Vehicles (IFV) respectively, AJAX is being fielded in six variants; AJAX (reconnaissance), ARES (APC), ATHENA (C2), ARGUS (engineering), APOLLO (repair) and ATLAS (recovery).

The AJAX variant is equipped with a Lock-heed Martin turret mounting the CT40, a cased telescoped 40mm gun/ammunition system developed by CTI International. CT40 uses a 40 × 255mm cased-telescoped ammunition design to provide a greater level of firepower than conventional medium calibres. The 40 mm projectiles are loaded within a 65 × 225mm case and surrounded by propellant. This configuration makes CTA rounds about 35% smaller in volume, than conventional rounds of the same calibre.

The stabilised CT40 armament is a step-change in capability for the British Army over the former armoured reconnaissance platform, the CVR(T). Also to be fielded on the UK's WARRIOR, CT40 provides overmatch against all peer conventional AFVs, and even against some legacy MBTs.

AJAX is the first truly digital vehicle the British Army has acquired, developed from the outset to be generic vehicle

Photo: UK MoD

Funding has been approved for the Mechanised Infantry Vehicle (MIV) programme to deliver around 500 BOXER armoured vehicles and form part of the Army's STRIKE brigades.

architecture (GVA) compliant, with high levels of on- and off-platform data-sharing. Designed for growth, the vehicle's architecture accommodates a 500% future increase in bandwidth. Situational awareness and surveillance systems are also the most capable fielded by the UK, critical for the vehicle's role as the Army's armoured reconnaissance platform.

BOXER is the second major component of the STRIKE formation, ordered in a £2.8Bn contract awarded in November 2019 for over 500 vehicles. Forming the core of the fighting force and carrying the bulk of its infantry component, BOXER

is the culmination of a decades-long series of programmes to provide a wheeled protected mobility capability to the Army. BOXER is unique in that it uses a modular design, splitting the automotive base chassis, called the Drive Module, from the mission-specific compartment at the rear, called the Mission Module. The Drive Module encompasses the chassis, drivetrain and driver's compartment, and is entirely independent. Mission Modules are mounted on the rear of the vehicle and can be changed quickly in the field, giving a range of logistical benefits and enabling rapid reconfiguration to meet mission requirements.

Numerous modules have been developed for BOXER, and the UK plans to acquire the APC, command, ambulance, and recovery versions. Other users, including Australia, Lithuania and Algeria, have selected versions with medium-calibre turrets for much-enhanced fire-power, but the UK is not pursuing this capability.

Supporting fires will be crucial to the success of STRIKE. Indeed, as a comparatively lightly armed and armoured force, much of its effect is achieved by fires rather than combat vehicles. One of the critical capabilities for this will be the Army's new self-propelled 155mm howitzer, being procured under the Mobile Fires Platform (MFP) programme and replacing the largely obsolete AS90 fleet. MFP is to deliver a minimum range of 30 km including multiple-round simultaneous-impact fire missions. Fast engagement and redeployment, to avoid counter-battery fire, is critical, with a requirement to conduct a fire mission in under four and a half minutes, including emplacement, two minutes of firing, and removal to at least 550 m from the firing position. Service entry is planned for mid-2028, with a full operational capability in 2032.

Alongside the tube artillery is a programme for enhanced long and medium-range rocket artillery under the Land Deep Fires Programme (LDFP) and its component parts, the Deep Fires Rocket System (DFRS) and Land Precision STRIKE (LPS). DFRS seeks a longer-range rocket system; rumour suggests the Lockheed Martin Precision STRIKE Missile (PrSM) missile from the US. LPS is a medium range rocket to be developed for the UK's M270 system. Collectively, these programmes would significantly increase UK indirect fire capabilities.

Enduring Concerns

As a vision, STRIKE is a compelling and far more sensible aspiration for the UK's limited funds and military capabilities than the heavier Cold War-esque formations it tries also to maintain. STRIKE addresses the conflicts and scenarios the UK may face in the future far better than existing, purely armoured infantry formations would. The core vehicles acquired for STRIKE are highly capable and represent genuinely good capabilities for the soldiers that will use them. As a roadmap, STRIKE is the right move for the British Army and UK capability.

The realisation of STRIKE as it stands in 2020 is, however, somewhat less clear-cut.

Photo: UK MoD

AJAX will be the future Armoured Fighting Vehicle for the British Army STRIKE Brigades.

With AJAX's 40 mm cannon representing the largest armament, the formation has been accused of lacking direct firepower. Despite calls for a 105 mm or 120 mm armed 'tank destroyer' vehicle to shore up this capability, studies to date suggest existing capabilities are enough. CT40 is one of the most capable medium calibre armaments available, and overmatches essentially any threat vehicle's armour short of contemporary MBTs. Even these would suffer significant damage and

arguably the most capable and largest air defence network in the world, and the likelihood of even limited air support during an initial high tempo engagement of the type STRIKE is intended to conduct is very low. This would be broadly true of many of the UK's peer threats. As the forward element of a UK force, or the lead screening element of a larger force, STRIKE is expected to operate in near isolation, in which context it lacks organic supporting capabilities.

support when deployed, and to ensure a baseline mobility is maintained.

Perhaps the biggest unresolved issue though is that of how STRIKE would deploy, either globally for contingent scenarios or regionally to respond to a hostile Russia.

AJAX is the most challenging point in this equation. Technically, it would be nigh-impossible for AJAX to self-deploy as intended of the STRIKE formation. It would suffer enormous mechanical and occupant fatigue over long distances, would travel at a detrimentally slow pace and would suffer significant attrition as vehicles break down or require maintenance. These are intrinsic weaknesses of tracked vehicles, which are inherently biased towards tactical mobility at the cost of strategic mobility.

As such, AJAX's contribution to the STRIKE formation is incumbent on the availability of transporters to project it. Such transporters are low in number, so much so that the UK would need to use the entirety of its fleet of 92 Oshkosh Heavy Equipment Transporters (HET) and 77 Light Equipment Transporters (LET) just to move AJAX and BOXER vehicles into theatre. This leaves practically no equipment transporters for the Armoured Infantry until they return from deploying STRIKE, significantly delaying any reinforcement of the isolated STRIKE formations.

Whilst BOXER is far more suited to prolonged road movements than its tracked counterpart, it too would be far better off deployed by equipment transporter. Long road marches impart much the same issues as AJAX, being inherent to the movement of armoured vehicles. Moving BOXERs by HET is preferable to ensure the force arrives in theatre in one piece in the best possible condition to undertake prolonged independent operations. At this time, there are no public plans to expand the HET/LET fleets to address this necessity.

The Army remains confident that these are minor issues that will be resolved by further programmes, though cannot explain how it would fulfil them. The Ministry of Defence is critically short on budget and is unable to afford its existing equipment plan, which lacks many of the capabilities discussed. Competing demand in the Armoured Infantry realm for the upgrade of (near obsolete) IFV and MBT platforms, destroys the funding that underpins the STRIKE concept. Without compromise in other areas, STRIKE is likely to fall short of the capable and valuable concept it seeks to realise. ■

Photo: UK MoD

Close cooperation with US and French forces is envisaged.

could be rendered a mobility or mission kill under sustained fire. Studies conducted by the UK's dstl concluded that existing capabilities around the CT40 gun overmatch peer threat armour.

Beyond the weapons on and in the BOXER and AJAX vehicles themselves, the Army envisages STRIKE using 'Joint Effects' for much of its offensive action – air, joint fires and multi-domain resources including electronic warfare. Divisional fires attached to the Brigades would include 155mm artillery and medium/long range rocketry, heavily supported by F-35B and APACHE aircraft as well as submarine launched cruise missiles. The Army calls this 'Integrated Effect', and it is certainly, theoretically, compelling. The concern is that much of this relies on capabilities that either do not exist or would be unlikely to be available in many of the envisaged conflicts. For example, the West often relies on the assumption that, like recent asymmetric conflicts in the Middle East and North Africa, it will enjoy an entirely permissive air environment and can rely on aircraft to deliver many of the desired effects. But Russia presents

The UK also lacks air defence capabilities: beyond a limited selection of dated VS-HORAD RAPIER FS(C) and STARSTREAK systems the country is essentially without defence against hostile aircraft. British doctrine assumes allied coverage for such scenarios, but such assumptions are hazardous. The Army's air defence assets have not seen meaningful upgrades in decades, and contemporary threats like swarming drones, low observable aircraft and cruise missiles are basically ignored. STRIKE needs its own set of air defence platforms at the very short, short and medium ranges at a minimum - including counter rocket, artillery and mortar (C-RAM) - or it will be totally exposed and vulnerable to hostile air and fires.

Within the context of organic fires, STRIKE lacks some required capabilities too. Though tube and rocket artillery are being pursued, further organic fires are required. At a minimum, STRIKE needs 120mm mortar vehicles, new counter-battery radars and dedicated non-line-of-sight anti-tank guided missile vehicles. All of these could be based on BOXER for commonality and ease of logistical

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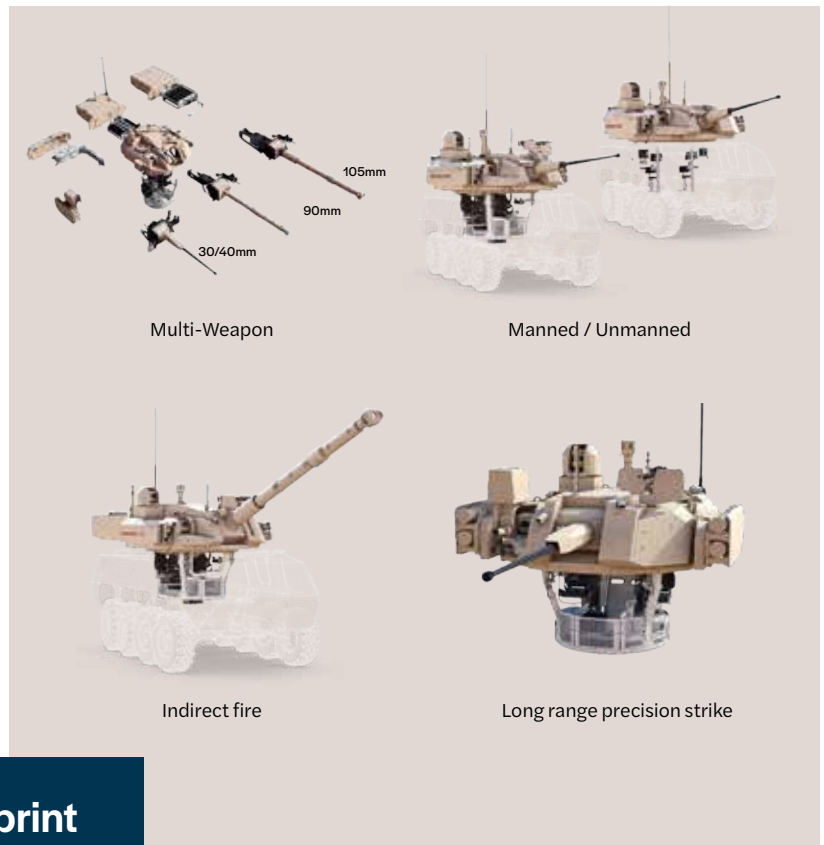
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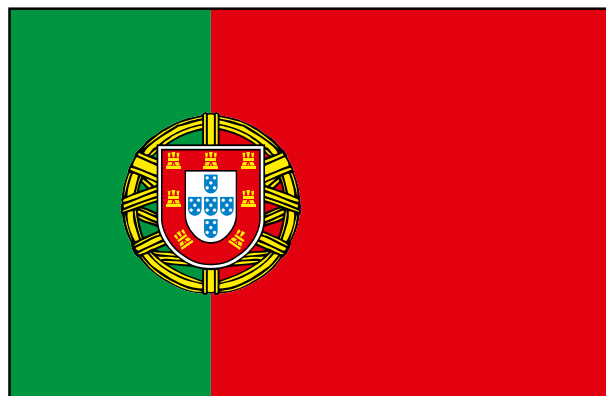
Photo: Duarte Roriz

João Gomes Cravinho,
Minister of National Defence
of Portugal

Investment in the defence sector can make a major contribution to economic revival.

The emergency created by the Covid-19 pandemic has made clear two very important points about defence capabilities. First, defence capabilities provide a vital contribution to fighting complex emergencies and not just enemy combatants. Second, we in Europe must improve our resilience by investing in key strategic capabilities. There is no denying that the near future will be fraught with uncertainty. But I strongly believe that investment in the defence sector can make a major contribution to economic revival, to employment and innovation and to greater resilience in responding to emergencies. In the context of renewed economic pressure due to the Covid-19 induced crisis, these are realities we need to underline in order to make continued investment in Defence sustainable, politically and economically, in Europe.

Additionally, the European Union has repeatedly stated as one of its key strategic priorities, the aim of becoming a leading technological and scientific power in the world. Investment in defence, which is a particularly innovative sector, will be an indispensable contributor towards that end. For that to be possible, however, we need to make sure that an adequate financial effort is made not just by each of the EU Member states, but also in a coordinated manner via PESCO and other EU instruments, with the EDA playing a very important facilitating role. For this goal, it is also fundamental to make sure that the EDF is adequately funded.

We need to ensure that the development of a European Defence Industry takes place in a way that is inclusive, both geographically and in terms of the profile of the companies involved, including SMEs, which are a major part of this sector in most European states. Making sure we are inclusive in this process is crucial to convince citizens across the whole of Europe of the benefits of investing in Defence, not just in reinforcing their security, but also in creating jobs and stimulating the wider economy. This inclusiveness is also vital in ensuring that we have a sufficiently diversified defence industry ecosystem, capable of contributing to the flexibility required for it to continue to be a major driver of innovation, in a period of accelerated transformation in Defence technologies.

The Portuguese DTIB is composed of over 400 SMEs. We are aware that this poses some challenges, but it also has some advantages. These companies have a very flexible organisational structure. They are usually oriented towards the production of dual-use technologies. Covering 21 technological and industrial sectors, they have repeatedly shown great aptitude for innovation both in terms of technologies and of production processes. Additionally, given the limited dimension of our domestic defence and security market, more than 80% of our defence companies export more than 80% of their products. The global volume of business of these companies is above €5Bn and they employ over 32,000 people. They have a proven track record for being competitive and resilient in the global defence market

and have a long experience of partnering into production systems of larger industrial defence companies.

Portugal has been focusing its efforts on new international partnerships in areas where it has a proven track record of competitive advantages: aeronautics; naval; textile; information and communication; smart materials; energy; nanotechnology; moulds. We have also identified five key areas for future development in disruptive technologies: cyber defence; robotics; unmanned systems; big data/analytics; artificial intelligence and nanocomposite materials. For Portugal, ensuring a strategic national participation in an industry that is key to an area of national sovereignty has always been complemented by the possibility of hosting industrial facilities or of including Portuguese providers of key components with the potential for knowledge transfer.

Portugal sees the Defence industrial sector as a key contributor to our security needs in a fast-changing world, as well as to the re-industrialisation of Europe, which can act as a catalyst for innovative projects, generate highly qualified jobs, further the development of new technology and the transfer of knowledge to other sectors of the economy. We therefore consider investment in the Defence industry as not only indispensable for strengthening European security, but also as vital for modernising the European economy.

João Gomes Cravinho
Minister of National Defence

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**Interview with João Gomes Cravinho,
Minister of National Defence of Portugal**

ESD: How has the Covid-19 influenced the operations of the Portuguese military? Are there examples for increased CIMIC patterns?
Minister Cravinho: The Portuguese Armed Forces have been deployed in response to Covid-19 in a number of ways, providing crucial support to the civil authorities in terms of planning, making available military healthcare facilities and products (hospital and military pharmaceutical laboratory), as well as CBRN capabilities that have been used in disinfecting key facilities (such as care homes and schools). They have also been engaged in information campaigns of best practice in public institutions (visiting over 500 schools), making an important contribution to a safe return to a degree of normality. Existing protocols for civil–military cooperation have provided an adequate framework, and we are looking into ways to incorporate lessons learned into our procedures. Portugal had a pioneering role in promoting among Allied countries in the EU and NATO the systematic and regular sharing of lessons learned by the military as a way to anticipate problems and solutions in fighting Covid-19. The sharing of lessons learned from Covid-19, regarding civil–military cooperation, will be one of the priorities of the upcoming Portuguese EU Presidency, in the first semester of 2021.

ESD: How has the refugee migration from the Middle East and Africa affected the Portuguese military?
Minister Cravinho: The Portuguese Ministry of Defence and the Armed Forces have been strongly committed to a humane response to the challenges created by the flow of refugees from Africa and the Middle East, showing active solidarity with other Member States of the EU and NATO. Both the Portuguese Navy and the Air Force have been deployed in EU and NATO missions in the Mediterranean. This has also been the case of the Portuguese Maritime Police, a militarised force under the Ministry of Defence, that has been patrolling the waters around the island of Lesbos and has rescued around 7,000 refugees in the context of Frontex Operation Poseidon since 2014.

ESD: Are you satisfied with the capabilities of the Portuguese Armed Forces, and what needs improvement or modernisation?
Minister Cravinho: I believe no country is fully satisfied with its defence capabilities. I also believe that most in Europe would recognise that after the end of the Cold War we became somewhat complacent, and that investment in this and other areas was severely restricted after the 2011 financial crisis. But we have been reversing those trends. Since 2014 and the so-called Wales commitment, Portugal has increased its investment in defence capabilities by 29%. And existing capabilities, existing modernisation and acquisition programmes, provide the required means, now and moving into the future, to implement Portugal's vital strategic aims.

ESD: What international deployments are the Portuguese armed forces currently involved in? To what extent are you supporting your former overseas territories in the military arena?
Minister Cravinho: Portugal is currently involved in 14 missions with the UN, NATO, and the EU, in 11 countries, in Africa, Asia and South America. They include a rapid reaction force responsible for the security of Kabul airport in the context of ISAF, and a quick reaction force in MINUSCA in the Central African Republic. We have been able to maintain key operational missions and to sustain our commitment to international peace and security while preserving the healthcare of our troops in this especially demanding context. Among NATO allies and EU member states there has been agreement regarding the need to continue to closely coordinate our decisions regarding these missions, making sure we keep our troops as safe as possible, but also that we do not abandon partner countries in a time of need. Portugal has a longstanding programme of military cooperation with other Portuguese speaking countries, in Africa, as well as in East Timor, with an annual budget of around €6M. The traditional focus is on education and training, in Portugal and in partner countries, with a significant presence of Portuguese instructors on the ground. But we have been widening and renewing the scope of these very important military cooperation programmes, to include, for instance, cybersecurity, military health or the sharing of lessons learned in fighting the Covid-19 pandemic. Another innovative example of this cooperation is the deployment, since January 2018, of a Portuguese patrol ship in São Tomé, in the Gulf of Guinea, jointly operated by the Portuguese Navy and the local Coast Guard, providing capacity building as well as operational capabilities in maritime security.

ESD: What effects did the establishment of Permanent Structured Cooperation (PESCO) have on Portugal's defence policy? What developments are yet to be expected in this context?
Minister Cravinho: Portugal is deeply committed to European defence in general and to PESCO in particular. PESCO is a major positive development towards a more coordinated investment in defence across Europe, allowing us to address our needs in defence capabilities. We are full participants in 10 PESCO projects, we are observers in 14 other projects, and we will continue to evaluate future opportunities to participate in more projects. Portugal currently leads 2 PESCO projects: on anti-submarine warfare (MUSA); and the Cyber Academy and Innovation Hub. We believe a collective collaborative effort like PESCO is even more important in a context that is going to be marked, probably, by greater budgetary constraints,

João Gomes Cravinho, Minister of National Defense, talking to António Brás Monteiro of ESD Portugal

due to the economic crisis created by the impact of Covid-19. Portugal is also a strong supporter of the vital role that the EDA plays in promoting a coordinated response to vital strategic gaps and has argued for the need to ensure that the EDF will be adequately funded in the new EU budget.

ESD: What are the lessons learned, and do you plan to return to conscription?
Minister Cravinho: Recruitment and retention are a problem across Europe. But as a result of a recent in-depth independent study of the problem, the Portuguese government has approved a 5-year programme with a set of measures for better recruitment, retention and reintegration in the workplace of the military. We are confident this will significantly improve the situation. These plans do not include going back to conscription. This was a costly system that provided a limited operational output. We do have a system of mandatory attendance by all citizens over 18 years of age of a National Defence Day. It is an important opportunity to make sure that all citizens know the work done by the Armed Forces and are made aware of the opportunities for recruitment, and we will continue to improve it.

ESD: What are Portugal's current key defence procurement efforts? Which of these are executed in international partnerships?
Minister Cravinho: Portugal has a Military Programming Law, which was revised and approved in June 2019, pre-committing €4.7Bn for a procurement cycle of 12 years. This law guarantees predictability, promotes interoperability and double-use technologies, as well as a strong interface between technological, industrial and scientific systems. This investment package will be used as leverage to attract funding from European programmes. Most of our key projects in terms of acquisition of defence capabilities do have a lead foreign provider, but most also include some industrial facilities in Portugal, or Portuguese-based companies providing key components or future maintenance,

and these are our key concerns. Strategic sectors accounting for 37% of the Military Programming Law include: acquisition of strategic transport capacity, acquisition of six state-of-the-art ocean patrol vessels modernisation of our frigates, strengthening of our cyber capacity, and ensuring that our soldiers are equipped with the highest-quality protection, survival and lethality equipment. In terms of international partnerships, we participate in the EU "Space, Surveillance and Tracking" (SST) programme; in the case of C4ISR (Command, Control, Communication, Computers, Intelligence, Surveillance and Reconnaissance) a network of SMEs benefit from participation in consortia and access to European funding, namely PESCO projects ESSOR and ESC2. The Aeronautical cluster is being developed by the acquisition of five Embraer KC-390 military transport planes, with key components built in Portugal, as well as the acquisition of Unmanned Aerial Systems (UAS), and the new Multinational Helicopter Training Centre (MHTC). Finally, the Shipbuilding Cluster will also be developed through an Auxiliary Oiler Replenishment (AOR) ship and an amphibious landing platform/dock (LPD) ship, as well as the six ocean patrol vessels (OPVs).

ESD: What about the deployment of unmanned systems?
Minister Cravinho: The Portuguese Armed Forces have been developing unmanned systems and both the Navy and the Army have initial capacity in this area, for military missions and civil protection. Portugal believes UAS provide a very important, versatile, resilient, and cost-effective way to improve our surveillance capability, crucial in terms of improving situation awareness in Portuguese territory in the European continent and the vast area under its responsibility in the Atlantic. They have also proved their operational worth. The Navy has deployed UAVs from its frigates, and RAVEN UAS are currently in use by the Portuguese quick reaction force in MINUSCA, improving their reconnaissance capacity.

ESD: How do you assess the capabilities of Portugal's defence industrial base?
Minister Cravinho: The Portuguese Defence Industry is mainly composed of SMEs. These SME companies are very strongly internationalised, exporting more than 80% of their production. They have shown a great ability in engaging with much larger foreign partners, as well as in innovating in key areas: aeronautics and space; naval; textile; information and communication technologies; materials and energy; nanotechnology and moulds. Our aim is to increase innovation by cross-fertilising with areas of disruptive technology, namely cyber defence, robotics, unmanned systems, big data/analytics, artificial intelligence and nanocomposite materials. Essential to this process of renewal is the ongoing restructuring of Empordef, the national holding of Portuguese defence industries, which will manage the participation of the Portuguese State in these companies, in line with these strategic and innovation priorities.

ESD: What about offsets and compensation requirements?
Minister Cravinho: More than the question of the nationality of owners or the home base of companies, we have always valued the role of Portugal in at least part of the production, the provision of key components, maintenance capabilities, and the impact of projects and companies in promoting innovation and jobs in the Portuguese economy. Strong and long-lasting relations of partnership with Portuguese companies and a proven track record of effective delivery are the primary concern.

ESD: Your VASCO DA GAMA and BARTOLOMEU DIAS class frigates have been in military service for almost 30 years. Are there plans for a frigate replacement programme, possibly as a joint effort with Chile (and/or Belgium) that operate the same class of ships?
Minister Cravinho: The Portuguese Navy is carrying out a Mid-life Update Programme for both VASCO DA GAMA and BARTOLOMEU DIAS class frigates under the Military Programming Law. The first studies and operational requirements are being drafted and we expect to have in the near future a clear view of the options to be followed in this regard.

ESD: Thank you.

The interview was conducted by António Brás Monteiro.

Strengthening Security and Defence Culture

Photo: António Figueiredo Lopes

Interview with Prof. Dr. António Figueiredo Lopes, former Defence Minister and former Minister for Internal Affairs.

ESD: You were Defence Minister in the early nineties. Looking back, how do you see Portuguese Defence nowadays?

Lopes: The 1990s was a period of transformational change at the geopolitical and geostrategic levels as a result of the end of the Cold War and therefore demanded the adjustment of the national security architecture to the new strategic environment. At the time the Portuguese security and defence sector undertook extensive reforms at two levels, one was the adjustment of the strategic guidelines and state policies to the new security environment, the second was a concurrent effort to modernise the structures and capabilities of the armed services.

From then on, due to a persistent and coherent effort of reforms, notwithstanding the constraints imposed by systemic geopolitical, economic and financial crises that have ravaged the world and Portugal throughout the last two decades, with impacts on the defence budgets, one might say that Portugal has been able to maintain its defence policy in line with both NATO and EU strategic goals. The country fulfilled a remarkable effort to pursue an active role in the international peace and security efforts, with Portuguese forces taking part in the operations promoted by both organisations.

ESD: Today you are President of EuroDefense-Portugal. What is its core mission?

Lopes: EuroDefense-Portugal is member of the EURODEFENSE network, comprising currently fifteen member states all involved in analyzing, reflecting upon and debating issues of European Union security and defence. On the other hand, these associations share a common perception about the relevance of the EU common security and defence policy considered a cornerstone for its strategic autonomy.

Therefore, EuroDefense-Portugal's mission is to prioritise the research, debate and production of relevant information about the impact on the country of EU defence and security policies, including the ones on the defence economy field. Also, we support the diligences of Portuguese enterprises and centres of technological and scientific research to cope with the European Union programmes for collaborative development of military capabilities, especially the EDIDP, PESCO and the European Defence Fund.

ESD: We heard you have been investing in young students as well. What is EuroDefense-Portugal doing for the students?

Lopes: One of the EuroDefense-Portugal goals is to strengthen security and defence culture. For this purpose, we consider youth as our main target audience, particularly the ones attending university courses, because they will be the future generation of leaders. Therefore, we regularly organise debates and workshops to promote the analysis of situations/facts relevant for the security and defence of Europe and the country. In these initiatives we also rely on the engagement of academia through the participation of lecturers, research centres or students' associations.

The results and expectations raised by these initiatives inspired the creation of EuroDefense-Youth as a forum aimed to promote meeting, socialization and learning of university students along with the purpose of providing awareness about the European security and defence situation.

ESD: How do you see the future of Portuguese Defence?

Lopes: I do believe that one of the main challenges that the National Defence faces nowadays is the requirement for a comprehensive and thorough evaluation about the capabilities of the armed forces to fulfil its future missions. To guarantee the meaningful participation of Portugal in the collective effort for the defence of Europe and the world, acting as a relevant partner in line with its commitments with the European Union and NATO, rises as another main challenge for the future.

Portugal is currently taking part in all the initiatives implemented by the EU to increase its military capabilities, taking advantage of this momentum to strengthen its national scientific, technological and industrial base. Furthermore, an adaptation is required to promote either the national defence policies and military structures to the new paradigms raised by current global strategic challenges, bearing in mind the countless and complex ones that the European Union and its member states will have to face.

Last but not least one shouldn't disregard the fact that the Mediterranean area, as Portugal has warned for long and the events of the last decade have shown, deserves to be considered as a top priority for the European Union. It is therefore time to add the Mediterranean to the European security agenda.

ESD: Thank you.

The interview was conducted by António Brás Monteiro.

Tranformation of Portuguese Defence Procurement Processes

Augusto de Melo Correia

With regard to the defence sector, according to the literature and governmental practises, the Anglo-Saxon expression "procurement", which can be translated as the process of development and acquisition of military means and equipment, contains in itself two concepts: one more comprehensive and the other more restricted.

The most comprehensive concept, used by the USA, concerns the entire long process of defence acquisition, from the most early phase of the definition/harmonization of operational and technical requirements, to technological research and feasibility studies, as well as to technological–industrial development, demonstration, industrialization/manufacturing, acquisition and entry into service.

Introduction

The narrowest concept, usually led by the United Kingdom (UK), refers only to the stage of technological–industrial development, demonstration, industrialisation, manufacturing, acquisition and entry into service.

At NATO, naturally under the influence of the USA, the most comprehensive concept has prevailed. In turn, in the EU, since the Maastricht Treaty (1992) and the subsequent creation of the Common Foreign and Security Policy/European Security and Defence Policy (CFSP/ESDP), the British influence on this subject has been evident and therefore the most restrictive concept has prevailed for some quite time.

Thus, in the EU, the consequence of the practical application of the most restrictive concept of procurement in the medium-long term has led to serious synergistic distortions and economic inefficiencies in the European defence sector, in particular as regards insufficient consolidation and excessive fragmentation of the European Defence Technological and Industrial Base (EDTIB), as

Author

Major General PILAV (Ret'd) Augusto de Melo Correia is a member of EuroDefense-Portugal.

In 2004, the Portuguese Navy procured two type 209PN submarines from Germany. Depicted is NRP TRIDENTE upon its arrival at Alfeite Naval Base.

Photo: Marinha

well as the lack of systematic concatenation between the financial resources spent on technological defence research and the guarantee of its transition to the industrial development phase of the final military product, also known as satisfactorily traversing the so-called "Valley of Death".

A proven mature and demonstrated defence technology does not overcome the "obstacle" of the "Valley of Death", usually for reasons of capital investment shortages or poor planning of military capability development and its lack of relationship with the EDITB. Whenever this happens, we are facing a regrettable situation of inefficiency of the procurement system, which results in waste of the scarce financial resources available and, of course, loss of operational readiness and military power.

However, irrespective of the UK influence, with the creation of the European Defence Agency (EDA) in July 2004 with one Directorate of Military Capabilities, one Directorate of Technological Research and another Directorate of Armament and Industry, the

concept of "procurement" has been gradually extending towards a more comprehensive concept.

This change in the "procurement" paradigm of defence became significantly evident from 2016 onwards, with the approval of the EU Global Strategy (EUGS) and its implementation in the dimensions of security and defence. On the other hand, aware of the harmful effects of this reality on the real economy, as a whole, in terms of employment, highly skilled labour, industrial skills and exports, and aware of the inexorable Law of Norman Augustine (1984) regarding the urgent need for the use and deepening of European defence cooperation, the European Commission, concomitantly with the EUGS, launched at the end of 2016 a European Defence Action Plan (EDAP), aiming at greater integration of defence, towards a stronger and more self-sufficient European Defence, in relation to the protection of the EU and its citizens, while keeping the bonds with NATO and the Atlantic relationships. This Action Plan is based on conceptual and regulatory assumptions, as for the new

The Portuguese AF Agusta-Westland EH-101 MERLIN helicopter was acquired through a procurement system based on industrial counterparts (offsets) rather than through a European or international cooperation process

mechanisms and instruments for fostering European defence cooperation and financial incentives for the collaborative development of priority common defence technologies and capabilities, strengthening the EDTIB's competitiveness and innovation, as well as creating a genuine common European Defence Equipment Market (EDEM).

With the adoption and implementation of these new mechanisms and instruments, technological and industrial defence cooperation has become the norm, through the establishment of European consortia and the facilitation of cross-border cooperation of SMEs embracing, simultaneously and concatenatedly, the technology research phase and the industrial development, production and acquisition phase of the end-user military product.

Towards a New Culture

Portugal was one of the 12 founding Allied countries of NATO and subscribers of the Washington Treaty of April 4th, 1949. In the 1960s, Portugal joined the NATO National Armament Directors Conference (CNAD), as well as its multiple groups and subgroups of armament cooperation (Army, Navy, Air Groups), and the Industrial Advisory Group of NATO (NIAG).

The first modernised SUPER LYNX Mk 95 helicopter of the Portuguese Navy made its maiden flight on 14 February 2020.

In these almost 71 years of existence of the Alliance, Portugal, in practical terms, did not participate entirely in any cooperative programme for the development and production of military capabilities within NATO.

In view of the above, it can be asserted that, except for very few specific exceptions in the area of technological defence research, usually without connection to the industrialization of the final product, in Portugal there has never been a culture, a long-term policy and a national strategy of systematic demand for participation in European or international cooperative projects, for the development of the necessary military capabilities, defined and budgeted in the various Military Programming Laws, as well as to leverage the strengthening and growth in the value chain of the National Defence Technological and Industrial Base (NDTIB).

Both those responsible for national defence planning and national defence-related industries do not have a tradition of systematic participation in international cooperative projects, from its most initial design phase, for the acquisition of large equipment and weapons systems. This phenomenon might well be due to some kind of "complex" related to the fact that in Portugal there are no defence prime contractors, but only SMEs who, until recently, regarding their scarce

capacity for technological innovation, were classified as low ssecond- and third-tier, and therefore encountered great difficulties in internationalization and integration in the prime contractors' constellations of existing and familiar subcontractors.

Fortunately, this situation is now outdated, since Portugal has a myriad of defence-related SMEs (estimated at around 500), internationally recognised for their quality, technical competence and skills and innovation capacity technology in a variety of strategic defence areas (software, computers, digital, robotics, communications, aeronautical & spatial components, E/O & I/R sensor components, textiles). In fact, today national SMEs find themselves much better placed in terms of internationalization, and by this token also in integrating and leading European consortia of defence technology research projects, either in the framework of "Pilot Projects" (2016) or in the framework of the "Preparatory Action on Technological Defence Research" (2017-2020), in anticipation and preparation for the forthcoming European Defence Fund.

Since in the Portuguese industrial make-up about 99% of the companies are SMEs, the prerequisites for the long-awaited change in culture and paradigm of the national defence procurement system have been achieved.

The advantages of participation in European collaborative defence programmes are well demonstrated, including the following:

- Ability to intervene in the definition of operational and technical requirements of the national military needs and the application of a fair cost-sharing/work-sharing formula for the full and direct participation of the national technological and industrial base;
- Mastery in terms of technological know-how and maintenance of the purchased product;
- -Economies of scale and reduction of unit costs ("non-recurring costs and recurring costs");
- Ensuring greater interoperability;
- Financial benefits resulting from the "royalties" of the sale of the product to third countries.

The main feature of the Defence Market, which differentiates it and gives it specificity in relation to other markets, is that it is a monopsonistic market, that is to say, with only a set of buyers and end-users: the governments.

Due to the lack of a national culture of systematic participation in international cooperative projects for the "procurement" of defence and the lack of genuine long-term national strategic planning, the large equipment and great weapons systems that fed the various national Military Programming Laws, for many years, were acquired based

In July 2018, Portugal ordered, through the NATO Support and Procurement Agency (NSPA), 139 VAMTAC patrol vehicles (Vehículo de Alta Movilidad Táctico). These are light armoured 4×4 all-terrain vehicles with up to four seats.

on off-the-shelf offerings and on indirect industrial offsets, through the use of heavy, bureaucratic and time-consuming international pubic competitions, with a view to obtaining indirect industrial offsets, aiming to leverage the NDTIB's technological and industrial development, rather than through European or international cooperative programmes.

After several years of experience of resorting to industrial indirect offsets in Portugal, usually inflated and technologically and industrially misdirected and with reduced impact on the technology and industrial value-chain of the NDTIB, it was concluded that, except for some very few exceptions such as OGMA with regard to aeronautical maintenance, not only was the ultimate objective of "leveraging growth in the value scale of BTIDN's technological and industrial development" not achieved, as the costs of the purchased products were increased on average by 20%.

In 2009, the European Commission addressed this thorny issue under Article 346 of the EU Functioning Treaty (EUFT), by issuing a directive with new rules on the "procurement" of security and defence technology, equipment and services, which substantially restricted the abusive recourse to Article 346, as well as the indiscriminatory use of indirect industrial offsets resulting from public procurement contracts in the fields of security and defence.

As early as 24 October 2008, the EDA Steering Committee, in the format of Defence Ministers, approved a voluntary "Code of Conduct" on Industrial Offsets, which entered into force on 1 July, 2009. In the same vein, with these actions in mind and following the "Intergovernmental Review on Defence Procurement" report of 5 May 2011, the EDA Steering Committee, in the format of National Armaments Directors, produced a publication on "Effective Procurement Methods" on 30 September 2011, which calls for the systematic reduction of the use of industrial offsets and encourages defence cooperation as the basis of a healthy and more efficient system of defence procurement.

With the restrictions imposed at the national level by DL 104/2011 on 6 October 2011 for public procurement contracts and, above all, the drastic limitation of systematic recourse to indirect industrial offsets, Portugal has resorted to the defence procurement system through the NATO Supply and Procurement Agency (NSPA), to meet its needs for more immediate capabilities. Thus, there is already a partial paradigm shift of the national defence procurement, in which, for the first time, indirect industrial offsets are no longer the essential element of the entire process of acquiring defence capabilities.

However, a radical shift in the "procurement" paradigm of defence and a new culture of national participation in European cooperative defence projects, from their very beginning stages, should only take place as the new mechanisms and instruments underway in the EU (CDP/2018, CARD, PESCO, EDF) come to fruition through their successful implementation. The success of these mechanisms is therefore the key to change. Therefore, we look forward to the first official reports on the evaluation of the implementation of these mechanisms, which are expected in the course of 2020/2021.

In addition to the above-mentioned mechanisms and instruments, to ensure the desired paradigm shift of the procurement process of national defence, it is also indispensable that two fundamental conditions be met and consolidated:

- On the one hand, national defence planning should incorporate the principles and policies of the new mechanisms and instruments employed in the EU to foster defence cooperation and defence capability development. It should also be aligned with the common priority capabilities defined in the "Capability Development Plan" (CDP/2018), and in more detail in the Strategic Context Cases (SCC), as well as with the technological research priorities identified in the Overarching Strategic Research Agenda (OSRA), and still in complete coherence, transparency, complementarity and non-duplication with the NATO Defence Planning Process (NDPP). Only following this path will it be possible to ensure the indispensable concatenation between the technological research of defence and the technological–industrial development of the final product, surpassing the tormenting "Valley of Death".

- On the other hand, it is necessary to establish and implement a national mechanism of structured and permanent dialogue between the national defence planners and the various NDTIB agents and actors (SCTN, academia, research institutes and companies). ∎

In 2005, the Portuguese Government signed a deal worth €364M to acquire 260 PANDUR II armoured vehicles. Portugal was the first country to buy PANDUR II.

Overview of the Portuguese Defence Industry

Agostinho Costa

The Portuguese industry landscape is mainly based on small and medium enterprises (SMEs) struggling to thrive in a highly demanding and competitive globalised economy.

It evolved from a state-owned bunch of enterprises whose activities were essentially directed to respond to the needs of the armed services gathered in a holding – Empordef – up to the present, in which the private sector plays a progressive role in the defence industry. Empordef was a holding with the remaining enterprises from the Cold War period, some of them created to support almost a decade and a half of war in three African theatres of operations during the sixties and seventies of the last century.

Following the same trends of other industrialized countries, the division between military and civilian technologies has also blurred in the Portuguese defence industry. Dual use is currently the rule and for most of these enterprises the military are still among their principal costumers though not the exclusive one anymore.

Currently the state has still a role promoting the defence industry but now acting as an enabler, a supporter and facilitator for the private sector initiative in line with the policy for industrial development of the country. The intervention of the state is assured through the idD – Defense Industries Platform, a state agency created in 2014 to facilitate the internationalization of the Portuguese defence technological and industrial base, exploring opportunities, reaching new markets and looking for partnerships abroad.

On the political side there is also a clear intention to promote a surge of industrialization, to create wealth, increase the rate of labour in qualified jobs and to keep the pace with the technological development of the so-called 4th Industrial Revolution. The ongoing transformation goes far beyond the ecosystem of the de-

Photo: Embraer

In July 2019 the Portuguese Government ordered five multi-mission Embraer KC-390 aircraft as part of the process to modernise Portuguese Air Force capacities to support national armed forces operations and increase readiness in missions of public interest. Deliveries are scheduled to start in 2023.

fence industry, encompassing such other sectors as the research and development centres and academia.. It's significant that engineering courses are currently the most demanded and the ones leading to a greater level of employability.

Another important trend of the Portuguese defence industry sector is clusterization, not just by option but as a mandatory requirement for the enterprises to gain the scale required to be actors in the global economy. Among others, 'AED Cluster Portugal: Aeronautics, Space and

Defence' comprises more than seventy entities directly related with a diversity of aerospace fields. This cluster gathers some of the most advanced technological enterprises of the country producing or taking part in the supply chain of cutting-edge defence products, such as the new multirole cargo airplane KC-390 presently in the early stages of its production by OGMA, the Portuguese branch of Embraer.

Other enterprises like Tekever and CEiiA are centres of engineering and product

Author

Major General PT (Ret'd) Agostinho Costa, is Vice-President EuroDefense-Portugal.

Photo: Marinha

NRP FIGUEIRA DA FOZ is SAR vessel with an overall length of 83 metres and beam of 13 metres.

development with already an important share of Portuguese defence industry innovation and product design, from unmanned aerial vehicles to avionics components more generally. Both enterprises are currently taking part in collaborative projects with other relevant players of the defence industry at the European and wider international levels.

On a different field the CITEVE (Technological Centre for the Textile and Clothing Industry of Portugal), encompasses a full range of activities, from Research and Development to production of combat fatigues and soldier protection equipment, dealing with the most advanced technological solutions in this field. One of its hallmarks is the soldier combat system, an integrated project designed to enhance the effectiveness of infantry formations, being one of the priorities within the Army's combat capability modernisation.

Two other sectors deserve particular attention, the shipyard industry and software design solutions for defence purposes. The first is a longstanding domain related with the extended tradition of Portugal as a maritime nation with a history related with the exploration of the seas. Nowadays new challenges are rising on the horizon, relating to the sovereignty missions of surveillance and protection of the Portuguese wider exclusive economic zone (EEZ). West Sea shipyard in Viana do Castelo is currently leading the upgrade of the coastal patrol fleet of the Portuguese Navy, building its brand-new coastal patrol vessels.

Enterprises in the digital sectorsuch as EDISOFT and Critical Software, whose brands are already well known internationally, are the spearhead of the design and production of technological solutions to equip aerospace and the ground forces with information systems, command and control, safety management and cyber security devices.

The commitment of Portugal to fulfil the targets agreed by NATO nations at the 2014 Wales Summit to substantially increase their annual defence spending on new equipment is also in line with the priority given by the European Union to enhance the defence industry. At last the EU recognised its relevance as a precondition for its long-desired strategic autonomy, towards a Europe of Defence.It also appears to be the dawn of a new momentum for the defence sector all over Europe and in Portugal as well.

The Portuguese Government's reaction to the demands of NATO and the European Union policies to increase the investment in defence is in line with its foreign and defence policies – always honouring its commitments and acting as a trustworthy partner. Therefore, Portugal joined the initiatives implemented by the EU to promote the European defence technological and industrial base, in particular PESCO and the European Defence Fund.

There is a shared perception that both instruments will play an important role in the future of the Union, not just fostering the EU defence capabilities but also promoting a different approach towards the way of building defence capabilities. More than just strengthen-

ing the capability of the EU to act as a relevant actor in the international arena, in line with its economic and soft power dimensions, those collaborative instruments will foster the EU to the front line of technologic innovation, shaping the future and leading the process of transformative technologies.

The enlarged responsibilities given to the idD – Defence Industries Platform along with the promotion of an extended reindustrialization policy aimed to strengthen the Portuguese economy, are major goals enshrined in the government programme. The defence industry's gathering of the most innovative and entrepreneurial minds and enterprises is expected to be among the forerunners of this process.

At the political–strategic level the military defence planning cycle did also adjust to the new paradigm, from a procurement-centred process towards another one more based in collaborative production with a strong national footprint, a win–win strategy delivering security and wealth to the country hand in hand with EU strategic goals.

The Portuguese defence industry has moved from a handful of enterprises working almost exclusively in closed circuits, answering the limited requirements of the armed forces, and evolved towards a dynamic network of knowledge-intensive industries with an enlarged business portfolio with its horizons far beyond the national economy. Dealing with the innovative and cutting-edge technologies we dare say that the defence industry will play a major role in the achievement of Portugal's development goals. ∎

Information is Our Core Material

Interview with Rear Admiral (Ret'd) António Marques, Head of the National Security Office

ESD: What is the key mission of the National Security Office (NSO)?

RADM MARQUES: The NSO is an organisation with two mission components. First, it is the national entity responsible for the entire life cycle of classified information, taking into account both the national and international (NATO and EU) rules and regulations, including the national supervisory entity for the implementation of the eIDAS EU regulation. Second, through the National Cybersecurity Centre (a sub-directorate of the NSO), it is responsible for coordinating responses to cyber-attacks at national level, contributing to free, reliable and secure usage of cyberspace by national entities, through the promotion of continuous improvement of national and international cybersecurity co-operation, with all competent authorities. Also, implementing the necessary measures and instruments for anticipation, detection, reaction and recovery of situations that, in view of imminent or actual incidents or cyber-attacks, may jeopardise the normal operation of both critical infrastructure and essential services. The National Cybersecurity Centre (CNCS) is also the Portuguese entity responsible for the implementation of the "NIS Directive."

ESD: Prevention and awareness are crucial in security. What have the NSO/GNS and CNCS been doing on these matters?

RADM MARQUES: These are undoubtedly areas in which more investment has been made in the last few years. Over 40% of the initiatives of the current Portuguese Cyberspace Security Strategy (published in June 2019), whose action plan is coordinated by the CNCS, are related to prevention, awareness, and overall society capability building. Although activities are under development by the various stakeholders in a "whole-of-society" approach, the CNCS has been producing a set of nationwide activities that fall in this category. To name those that have a wider scope, since 2015 we have organised an annual cybersecurity conference, CDAYS, which covers the theme of cyberspace security in its multiple components, ranging from the IT to the behavioural aspects that digital security introduces in society, including the legal challenges and the fundamental national and international cooperation requirements, to name just a few. The last two editions of the conference (2018 and 2019) took place in Coimbra and Oporto and were quite successful. The 2020 edition was due to occur in June but has been postponed to the end of the year, and will be held in Estoril, a few kilometres west of Lisbon.

Concurrently, since 2018 we have been organising a National Cybersecurity Exercise, which differs from others by focusing on a specific theme. For example, the 2019 edition covered the cybersecurity challenge of national elections. The lessons learnt were quite useful to the community involved in the electoral process since we were able to identify what should be either changed or created, better to harden the overall inherent "ecosystem" (people, processes and technology).

The CNCS runs annually 3 to 4 editions of an onsite course that aims to give a broad perspective of cyberspace security to the attendees. It describes the cyberspace landscape in Portugal, including major stakeholders, national and international juridical frameworks; and covers cyber defence, cybercrime, cyber intelligence, cyber diplomacy and cybersecurity components of the overall cyberspace security realm, including future trends in this area, finishing with an exercise to enable the students to put into practice the major "take-aways" of the course.

In line with this, partnerships with agents from both the public and private sectors have been developed which will increase the reach of the CNCS awareness campaigns, thus enlarging the scope of our activities in a true whole-of-society approach. Within this framework, throughout the whole year, the CNCS deploys teams in several national locations to give lectures and conferences. Complementarily, every other month a specific 2.5-hour get-together is organised around a specific cyber security theme in a format where, for each presenter, another is called to constructively challenge the former, creating a debate from which all present learn. We called it "Cyber Themes". Recent themes have included Quantum technologies, IOTs, SCADA, block chain and cultural change.

Last but not least, CNCS has developed and deployed a first edition of a Massive Open Online Course (MOOC) called "cyber secured citizen", which any citizen can attend, taking into account the best cyber hygiene practices at home, at the office and while travelling. So far, more than thirty thousand attendees have registered and finished the course. Another two MOOCs are being produced; one aimed to show how to better identify fake news, and another to help citizens to buy safely online.

ESD: Materiel – providing staff with the tools to do their jobs – is also essential. Is the overall acquisition budget enough, and what proportions do you spend on software versus hardware (or other purchasing categories), and do the NSO/CNCS engage in any R&D themselves?

RADM MARQUES: The overall budget that is provided is complemented through EU funding, made available to EU member states to put into practice the several directives and regulations created by the EU to improve the overall cybersecurity maturity level of the Union Agencies and member states. As budget execution is a function of team size and competence, the main priority in this area has been the procurement of suitable people along with a relevant investment in both education and training.

As far as R&D is concerned, we partner with national research institutes and universities to develop projects covering areas of applied AI in the field of cybersecurity, and quantum technologies in the area of quantum key-distribution and software-defined networks. We are working with the EU to create a network of cybersecurity competence

Rear Admiral Gameiro Marques and António Brás Monteiro at NSO

centres, which we are convinced will further develop the cooperation in R&D in this area of knowledge.

ESD: What is the best way for a potential supplier to find out about NSO/CNCS purchasing or acquisition plans?

RADM MARQUES: One of the first steps is to make sure that the potential supplier is known and meets the necessary eligibility requirements for a competitive bid. One of the main requirements is compliance with Facility Security Checks (FSC) for the level of security that may be required for the tender at stake. Having said that, for all unclassified tenders CNCS follows public procurement rules, including publicity provisions. This means that public tenders are publicised through JOCE (the Official Journal of the European Union). Naturally, since our activities are in the domain of national sovereignty, we tend not to purchase COTS products. In fact, most of the tools (software) used in our day-to-day operational activities are specifically developed within the CERT (Computer Emergency Response Teams) community, for that community.

ESD: Do you think the CNCS Staff is sufficient to monitor Portuguese cyberspace?

RADM MARQUES: The CNCS does not actively monitor Portuguese Cyberspace: CNCS acts on information gathered from multiple sources to produce an aggregated situational awareness picture in order to act on it. As far as staff is concerned, we are actively engaged in procuring suitable personnel for the team, searching for people who are eager to learn in the most challenging and complete international cybersecurity programmes that exist, whilst offering a job that not only is intellectually enriching but also fulfilling and rewarding. We are aware that the demand for these skills in our soci-

ety is high, but we are sure that the overall experience that we can offer at the CNCS is unique, given our whole-of-society approach to cybersecurity.

ESD: How do you protect your most critical assets?

RADM MARQUES: First, organisations must identify those assets, considering their relevance to the business or main activity. Then, a risk-based approach should be developed, including the definition of scenarios for the loss (be it partial or total) of the service or asset and the development, testing and training of measures to mitigate those risks under the scenarios that have been identified. The Chief Information Security Officer (CISO) should have the lead of the overall process. At the same time, either through an on-location Security Operations Centre or through Cybersecurity Managed Services, monitoring of these services – the organisation's crown jewels – should be enforced and reported upon more frequently than others.

The CNCS has published a set of documents to help organisations (both public and private) better to protect their assets (people, processes and technology) from potential compromise. These are the National Cybersecurity Framework, that identifies security controls, maps security goals, provides guidance and gives examples. The framework is not a list of actions to fulfil; it is a reference guide to a risk-based approach to cybersecurity. Simultaneously, a Roadmap for Minimum Cybersecurity Capabilities has been developed and published, providing a five-step path for organisations to comply with the minimum Cybersecurity Capabilities. These documents define what all organisations must have and how to reach a higher cybersecurity maturity level.

ESD: You assumed your position as the Director General of NSO in 2016. Today, four years later, what do you regard as your major achievements, and which challenges or objectives are yet to be mastered?

RADM MARQUES: Looking back, I can tell you that time "has gone in a second". A lot has been achieved, but a lot has yet to be. The CNCS brand has consolidated and is now better known in Portuguese society. A new strategy has been developed and the proper mechanism to manage its execution has been established and is working adequately. The transposition of the NIS directive into national law has been achieved and we have consolidated our participation in several national and international groups in order to improve further our knowledge and reach. The national CSIRT network has increased, and is alive and healthy with more than forty members from both private and public sectors. CNCS/CERT.PT is also a member of the FIRST network, which has proven to be a benefit in its daily work. Our reach increased and a set of new doctrinal elements have been developed and are available for the society to use and deploy. Meanwhile, our national cyberspace knowledge capability has been improving steadily, aiming to give the community of interest a deeper insight into what is occurring within the national cyberspace.

The future challenges lie, particularly, in the area of implementation of the Cybersecurity Act, namely those related to the EU-wide cybersecurity certification framework for ICT products, services and processes. That includes continuous improvement in the overall cybersecurity maturity level of our society, acknowledging that security is a collective responsibility, where we must be able to set our priorities right, empower our people, "train as we fight", learn faster and better from our own experiences, and ensure the understanding of how technology is changing the very nature of society. We must also bear in mind that good preparation leads to good performance. This means that the better we invest in educating our citizens in the area of cybersecurity through simple and clear messages, conveyed by appropriate communication strategies, the better we, as a whole, will be able to take advantage of the digitalisation of society and use it securely. Here, as in other domains, Portugal has a clear objective to be a strong and trustworthy partner and contributor both at national and international level, to the overall cybersecurity of society.

ESD: Thank you.

The interview was conducted by António Brás Monteiro.

Providing Security in the Central African Republic

Carlos Branco

Portugal has been an active security provider and, in this regard, has been working on many fronts. Portuguese soldiers and police have deployed in four continents with NATO, the European Union (EU) and the United Nations (UN).

The commitment of Portugal to security in the Central African Republic (CAR) is a phenomenon that speaks for itself. Portuguese soldiers and police officers have been engaged in the CAR with the UN and the EU missions protecting civilians,implementing Defence Sector Reform programmes and supporting the reform of the internal security forces.

Portugal has contributed to the UN Multidimensional Integrated Mission in the CAR (MINUSCA) since January 2017 with a military and a police contingent. Portuguese soldiers with MINUSCA have a particularly challenging mission. They are the Quick Reaction Force (QRF) of the Force Commander. This means a company-plus-sized unit, nearly 180 soldiers, in permanent readiness to deploy in any part of an area of operations with approximately the same dimensions of France and with only 600 km or so of asphalted roads. They operate in a harsh environment sometimes very far from Bangui, where emergency evacuations of the sick or wounded from the combat area are not an easy job.

They have engaged several times in direct combat, responding swiftly to threats posed by armed rebels to the civilian population. They were instrumental to the success of MINUSCA on various occasions, especially around Bambari, the second-largest town of the country, when it was threatened by warlords' militias. As the result of the assault on the headquarters of the "Union for Peace", carried out by the Portuguese QRF in January 2019, the group joined the negotiations in Khartoum that ended up with the signature in Bangui of the 6 February peace agreement. The skills exhibited in combat by the Portuguese contingent were praised several times by the MINUSCA leadership. The Portuguese also introduced NATO planning procedures in MINUSCA. Portuguese nationals hold the position of deputy force commander since September 2018.The country also contributed with police officers to the MINUSCA Police component, and from September 2014 until September 2016, a Portuguese have held the position of MINUSCA Police Commissioner.

Portugal also participates in the EU Training Mission CAR (EUTM-RCA) with a contingent comprising a few tens of personnel, which included a few Brazilian officers. The EUTM-RCA activity is focused on Defence Sector Reform, which fits within the overall Security Sector Reform process coordinated by MINUSCA. The EUTM-RCA is also involvedin the important task of providing strategic advice to the Ministry of Defence, the General Staff of the Armies, the Presidential Cabinet and Internal Security Forces. Starting in January 2018 and for 18 months, the mission was commanded by a Portuguese general.

Still in the framework of the EU, Portugal pays close attention to the new EU Advisory Mission in CAR (EUAM-RCA), a mission with the aim of supporting the reform of the internal security forces, and providing advice at the strategic level to the Ministry of the Interior, the internal security forces, the police and the gendarmerie. The Head of EUAM-RCA is a Portuguese national. ◼

Photo: Carlos Branco

Author

Major General (Ret'd) Carlos Branco, former Director, Cooperation & Regional Division, IMS, NATO HQ

Fostering Ambitious Large-Scale Initiatives

Photo: José Neves

Interview with José Neves, AED Cluster President

ESD: What are the AED Cluster Portugal key strategic objectives?

José Neves (JN): AED Cluster Portugal's strategic objectives lie within four main building blocks – Funding and Regulatory; People and Competences; Innovation and Value; Markets and Opportunities – with a clear mission to accelerate our members' growth strategies, by building synergies.

For the Markets and Opportunities, AED targets a significant visibility increase of its members, projecting our products, skills and competences abroad, while maximising a stronger integration on global supply chains. We are also focused on attracting high added-value foreign investment.

For the Innovation and Value, the cluster fosters the development of novel value-added solutions among its members, to leverage innovation collaboration and promote technology as part of i4.0, while increasing operations efficiency.

In People and Competences, our goals are to fill the workspace gap, raise an innovation mindset, increase cluster intra/inter collaboration, and grow the representativeness of the Portuguese ASD Cluster's ecosystem.

Regarding Funding and Regulatory, AED targets an increased cooperation and coordination between Government, the National Scientific and Technological Institutions and the Industry. As well, we promote the access to funding mechanisms for our members, with already success business cases.

ESD: The Cluster involves several companies, institutes and academia. Can you give us some numbers and figures?

JN: We have already more than 80 members, representing an overall turnover of €1.72Bn. The Cluster already exports 87% of its production and enables around 18,500 jobs, which is quite significant in Portugal.

More relevant, our members efficiently cover a wide range of complementary activities and skills. Among them, we can highlight: Research & Development, Design and Engineering, Manufacturing, MRO, Tooling, Consulting & Services and Governance Institutions.

ESD: Last year the Cluster announced a €40M investment in Portugal from Airbus, through their company STELIA Aerospace. Which investment is it and what was the Cluster's role here?

JN: STELIA has already started investing in a new manufacturing site, at Santo Tirso, Portugal, which will be dedicated to the assembly of aeronautical structures, especially subsets for the A350 and the A320 family of Airbus, which will be sent and integrated at STELIA Aerospace Méaulte and Rochefort manufacturing plants. It should have around 300 people by 2023, when it will reach cruise speed.

According to STELIA, the choice of Portugal was dictated for several reasons, namely due to the knowledge already existing in the aeronautical sector, namely at the IEFP level, which is complemented by the availability of labour with strong potential. As well, with Portugal being a a member country of the European Union, plus geographically close to the French production units of STELIA Aerospace, optimised logistical flows are possible.

Relevant players on this process included the Portuguese Ministry of Foreign Affairs and AICEP, being that, as it has happened for a long time, through a very fruitful collaboration, AED has always provided guidance and support in all matters related to the aeronautical sector. In this case, among other things, by engaging STELIA as soon as possible with the national ecosystem to identify synergies. An outcome of that was STELIA's active participation in 2019's AED Days, during which the official announcement was made.

ESD: Recently AED Cluster Portugal received the label of "Strategic National Competitiveness Cluster" for Aeronautics, Space and Defence from the Portuguese Government. As its President, what are your next steps?

JN: I strongly believe that the efforts and initial investments, already performed by our members, will foster sustainable growth and a fruitful future for the AED cluster at a global level. The Portuguese ecosystem has already given proof of its value and it is, still, facing a big growth potential. I do see today that the cluster, and its members, have already established a solid footprint in the three sectors and are fully capable of tackling the challenges these industries will face in the next decades. For us that is clear and, as a Cluster, our purpose is to show that to the world.

Among our strategic objectives we intend to go one step forward by fostering ambitious large-scale initiatives, such as the launch of Cluster mobilising projects, to leverage the Cluster's international visibility. As an example, in 2019, AED sponsored two proposals under the national funding: i) FLY.ME, for the study of an autonomous aerial vehicle solution targeting the emerging theme of urban and suburban air mobility; and ii) VIRIATO, aiming for the development of a suborbital launch vehicle that will serve as a test and validation platform for various components for a future Portuguese micro launcher.

Our vision is very clear, it is to make Portugal an international reference within the Aeronautic, Space and Defence industries. And, I do highlight two steps: First, in the context of Portugal, as a nationwide Cluster we have the opportunity and the responsibility to convey this message, to be able to really gather all main national stakeholders towards this objective and to keep pushing all of them to an efficient collaborative network and this growing national dynamic. Second, at the international level, we don't want to be a great partner, we want to be the best, and this is already happening. We have been showing to international players that we are a valuable player, and it can be seen by the level of interest from major international players and by the numbers AED represents today. As President of AED, and despite theCovid-19 pandemic, I do see a big momentum building up and this is the time to use it.

ESD: Thank you.

The interview was conducted by Antonio Bras Monteiro.

One of Portugal's Largest Players in Defence

Photo: Edisoft

EDISOFT is a joint venture between Thales, NAV Portugal and the former Portuguese Defence holding Empordef which delivers critical systems for land, sea, air, space and cyberspace. ESD had the opportunity to talk to Fernando Braz de Oliveira, Head of Naval Systems at EDISOFT.

ESD: In defence, you became known in Portugal for naval systems and vessel traffic systems. What kind of products have you developed?

De Oliveira: EDISOFT is a joint venture between Thales, one of the largest players in defence, space, safety and security, aeronautics and transports. Whereas NAV Portugal and the Portuguese MoD promote and deliver innovative and state-of-the-art security critical systems, for defence, land, sea, air, space and cyberspace.

In the nowadays challenging environment, EDISOFT positions itself together with a skilful and competent team of Portuguese engineers, aiming to produce and maintain critical and military solutions for our clients, focused on providing our customers permanent access to the most advanced solutions for the aeronautics, space, security, cyber security and defence domains.

In the naval domain, we continued our original path in close proximity and intimacy, linked to the Portuguese Navy evolution, where we stand by their side from the early nineties with the maintenance and sustainability of the VASCO DA GAMA programme, and lately we stand ready to address the challenge to deliver an adequate, efficient and tailored solution for the Operational Capability Enhancement programme of the VASCO DA GAMAclass frigates, ensuring its operation value throughout their life cycle foreseen until 2035. Our commitment and knowledge of the Navy allowed us to support the resurging of the Naval Military Construction, delivering two OPVs (Offshore Patrol Vessels) on time and on budget tailored to the specific requirements of the Navy.

ESD: The consortium WestSea-EDISOFT is acknowledged in Portugal for its innovative military shipbuilding. What have you done so far?

De Oliveira: EDISOFT in a successful national consortium with WestSea, a naval shipyard up north of Portugal, at Viana do Castelo, were able to produce a unique platform, the Portuguese OPV class VIANA DO CASTELO, a project that represents the success of the Dual Role Military Naval Construction.

This ship is the perfect and harmonised conjunction of the naval construction experience and the integration of the excellency of a technological partner, EDISOFT.

We were able to develop and produce modern onboard solutions for automation and efficiency, implementing the ship platform management, command & controll systems and a dedicated information sharing system.

The project has the guarantee of the best operational references from the Portuguese Navy, supported by its sustainability along the life cycle of the ship.

The project is characterised by its robustness, scalability, flexibility and versatility.

The proven record of more than 10 years of real life operations, granted this platform the Navy stamp of excellency, recognising its excellent performance at sea, when exploring its multirole capabilities either by acting alone or in a joint effort on the areas of national sovereignty and responsibility, or in multinational international support missions.

Its characteristics make it a valuable platform to perform duties such as Maritime Search and Rescue; Fishery Protection and Control; Transiting Lanes Control; Prevention and Combat of Oil Pollution at Sea, and Prevention and Combat of Illegal Activities (drugs; illegal migration, arms control and others).

Aiming at the follow on of this successful project we are developing a Decision Making Support System, which stands as the evolution of the existing onboard C2 system called C4SEA, an EDISOFT product, that can be further adapted to other plat-

Photo: Edisoft

Latest generation offshore Patrol Vessels (OPV) of the VIANA DO CASTELO class

forms and requirements, integrating the actual sensors and unmanned vehicles.

C4SEAmodule helps the decision making process and optimises resources; it is a unique tool to maximise the command decision process. The system provides the commanding officer with a complete and clear situational awareness with respect to external threats, and internal resources.

The system is a GIS-based interface showing the current position of the OPV and the surrounding traffic, and it incorporates and fuses all available data, supported by warning algorithms in order to provide alerts on anomalous behaviour detection of marine vessels.

EDISOFT's main goal with the OPVs is to continue producing it for the Portuguese Navy to fill the gap posed by the decommission of the old corvettes, and scale it to the Portuguese-speaking countries ensuring a common and valuable platform sharing the same education, training, maintenance and follow-on support with its navy customers.

With regard to other domains, EDISOFT has in its DNA a combination of expertise that allows us to position Portugal in other markets, such as Space and EO "Earth Observation", taking the advantage of the strategic position of EDISOFT´s Teleport at Santa Ma-

The EDISOFT OPV Integrated Bridge.

ria Island in the Azores. This Atlantic facility, together with our "Technological Astronauts", an excellent team of local engineers, leverages our competences, serving clients that need hosting systems with a clear view over EMEA & LATAM regions.

In EO we use algorithms and expert analysis tools that are able to generate added value products 24/7, processing large amounts of data ensuring timeliness of data delivery (Near Real Time).

With our product OCEANEYE, we are able to provide EMSA "European Maritime Safety Agency" the ability to detect infringers at sea in our area of responsibility. This product allows an extended maritime surveillance capability, which can be customised for specialised services and activities.

ESD: You have also been specialising in cyber security. What have you been doing in this field?

De Oliveira: EDISOFT also represents a cyber success story continued along the years, with a focus on the financial services, utilities, government and critical infrastructure sectors with international strategic coverage of some of the Portuguese-speaking countries, winning multi-year complex Cyber Security Projects and having reference customers worldwide.

We deliver the state-of-the-art security tools and technologies leveraged by our local team cybersecurity expertise and proven competences in many different national and international complex cyber projects, along with the support of a truly global technological solution player such as the Thales Group, with their unique expertise, resources and cyber solutions portfolio.

We stand as the cyber threats evolve ready to support and produce customised solutions to cybersecure some of the most demanding customers worldwide.

We aim at serving critical and military customers with our skills and competences, in a collaborative and cooperative approach, adapting solutions to client needs and requirements. We are proud to serve you.

ESD: Thank you.

The interview was conducted by Antonio Bras Monteiro.

EDISOFT is a key partner of the Portuguese Navy

EDISOFT TELEPORT in Santa Maria Island in the Azores

Mission Critical Software Systems

Photo: Nuno Silva

Interview with Nuno Bustorff Silva, Business Development Manager, Defence Market at Critical Software

ESD: For over 20 years, you have worked on technologies across several industries.
In the defence sector, you have been developing C4ISR solutions for military purposes. What are your plans for the future?
Silva: Our main focus has always been mission critical systems, meaning, to provide dependable software for ADS sectors. Specifically in terms of defence, we have experience and domain knowledge in areas such as situational awareness, Command and Control (C2), Tactical Data Links, integration of sensors and weapons, simulation for training, transfer of data over radio frequency channels (tactical levels), amongst other skillsets. We combine all this knowledge with our technical capabilities to provide services and custom solutions to our clients. Even though we have pre-developed solutions, Critical Software's core business is to provide bespoke engineering services to our customers. We have been an international company since day one. We pride ourselves on having clients like NASA, ESA, BAE Systems, Leonardo, Airbus, Esterline and Embraer. Being a certified company with CMMI Level 5 and highly specialised in software development, integration, verification and validation and safety analysis has proven to be crucial to work with market leaders.
Regarding service provision in the defence market, our focus for the near future is to increase our footprint internationally, namely Europe, North America and Australia. For that, we count on our 900+ engineers, covering several engineering capabilities.

ESD: You have also been developing Oversee, an information system to support the security of life at sea. Is this still being used in Portugal and Ireland?
Silva: Oversee is a solution developed as part of a strong and lasting partnership we are proud to have with the Portuguese Navy. This is a platform that helps maritime agencies to improve their operational efficiency and effectiveness through use of an integrated approach to operations management. It is particularly focused on Security of Life at Sea (SOLAS) activities, with an emphasis on Search and Rescue, law enforcement and environmental protection.
This high-end Maritime Rescue Co-ordination Centre system provides a real time geo-referenced display complete with traffic information (AIS, SAT-AIS, VMS, LRIT, and radar), GMDSS distress alerts (COSPAS-SARSAT, DSC) and METOC, all overlaid on cartographic and hydrographic layers. This presents the data in an integrated way, enabling decision-makers to make rapid yet informed decisions. The system was designed to comply with IAMSAR guidelines and SAR best practices, tackling Search and Rescue activities in both maritime and inland domains.
Oversee has been used by the Portuguese Navy for seven years now. It is indeed used in Ireland, but also by countries such as Vietnam and Papua New Guinea. Nowadays, Oversee supports SOLAS activities taking place in 7000+ M Km^2 of worldwide sea.

ESD: You also have offices in the UK. What are your plans for the future when it comes to new markets?
Silva: Critical Software's first office in the UK has been around for 15 years now. But allow me to clarify that besides having an office, we do in fact own a company based in the UK. We founded it to support the huge amount of work commissioned in the defence sector by Agusta-Westland, now known as Leonardo. Then, we began using a cross-fertilisation strategy, and leveraged these capabilities to start work in other mar-
kets. Nowadays we are working in a range of other UK markets, for example in energy, where we continue to work with the Data Communications Company (DCC) by providing support to their smart metering initiative.
Up until now our capacity to combine Portuguese and UK characteristics – technical, competencies, domain knowledge, scale, and so on – has produced positive results. Of course, the UK has now withdrawn from the European Union, but we still believe that there are relevant and promising opportunities to be grasped, where we can create value added to both economies. We are committed to maintaining and indeed growing our presence in the UK market. In fact, we have just opened another office in the UK to support our railway segment.
We're also confident that we can replicate our success in the UK in another European market, namely Germany. We already have an office and a company in the country. We are currently working with some large clients in railway and aeronautics, but our biggest success up to now is our joint venture with BMW in the automotive sector. This partnership is focused on developing software both within and without the company's iconic cars.
In the realm of defence, we already have key projects in Germany, yet our goal is to increase our presence in the German defence market further still.
Other geographies are also being considered for expansion in our activities. We plan to grow by working alongside companies for whom our technical skills, domain knowledge and available manpower could make all the difference. We want to be our clients' preferred partner for developing their toughest and most ambitious projects.

ESD: Thank you.

The interview was conducted by Antonio Bras Monteiro.

Integrated Systems for Advanced Solutions

Photo: GMV

Interview with Alberto de Pedro, CEO of GMV

ESD: GMV is an old Spanish group. But 15 years ago, you bought a Portuguese company, Skysoft.

Alberto de Pedro: GMV is a privately owned technological business group with an international presence. Founded in 1984, GMV's goal is to support our client's processes by dint of technologically advanced solutions, providing integrated systems, specialised products and services covering the whole life cycle. These range from consultancy and engineering services up to the development of software and hardware, the integration of turnkey systems and operational backup.

Within the sound strategy of international growth and development, in May 2005, GMV bought a stake in Skysoft, a Portuguese firm with very similar business lines and target markets to GMV's. In 2007 the process was completed, with operations then being knitted seamlessly into the rest of the business group. Since then GMV in Portugal has been growing in people, business and competences.

Within the Defence and Security arena, and for more than 30 years, the areas where GMV provides services are command and control systems, intelligence surveillance and reconnaissance (ISR) systems, navigation, systems for future soldier, cyber defence, simulation and training.

ESD: You developed technologies for the intelligence community, cyber defence, space programmes, surveillance and security. May you exemplify some of them?

Alberto de Pedro: First, we would like to highlight a couple of products associated to the two centres of excellence of GMV based in Lisbon, related to avionics and maritime. The shiplocus@ suite, a multi-application platform focused on port management and maritime traffic operation that covers the needs of harbour authorities and port operations in different areas and services. In Portugal, shiplocus@ has already been deployed in the Azores and Madeira Archipelagos, and in the Port of Sines. The XKY RTOS (time and space partitioned real time operating system) is a ground-breaking commercial operating system compatible with highest aeronautic certification requirements (DAL-A). XKY is intended to serve as the backbone of integrated modular avionics (IMA) implementations that are expected to be key in novel aeronautic programmes.

In the Cyber Domain GMV has today a fruitful relation with CINAMIL, Research Centre for the Portuguese Army, which led to the execution of several contracts for EDA, including (among others) the development of the European Cyber Defence e-learning and training platform, or the usage of artificial intelligence in cyber-ranges.

GMV's expertise in C4ISR is built on a track record of more than 20 years, which led to the development of a suite of multiuser and multi-mission products supporting planning, execution and monitoring of different levels of command operations. Main drivers of this suite's design are standardisation and interoperability with external systems that will enhance effectiveness.

ESD: Last year you signed a contract with NATO for an innovative ISR project called "CSD Enduring Solution". Can you tell us what it will do and how it is implemented?

Alberto de Pedro: This contract for the Coalition Shared Data (CSD) Services Enduring Solution upgrades the results of NATO's MAJIIC2 (Multi-Intelligence All-Source Join Intelligence Surveillance and Reconnaissance Interoperability Coalition) to an operational state. In that way, CDS will maximise the use and interchange of Intelligence Surveillance and Reconnaissance resources by NATO member states. The proposed solution is composed of three main components: CSD ISR Product Library Services, Workflow Services and Stream Services.

ESD: Recently you coordinated the Iberian test of the maritime security project MARISA. It's an EU project with the Portuguese Navy and other entities. What have you achieved so far?

Alberto de Pedro: MARISA targets the integration of Big Data with multi-sensor data-fusion; this ground-breaking technique involves the mining of data from different sources to glean useful, top-quality information, applied with maritime safety and security in mind. This is possible thanks to the development of a set of interoperable tools for easy access of the data generated by the various technological resources now up and running. GMV is responsible for system design, the development of anomaly-detecting and level-1 data-fusion algorithms, as well as carrying out the integration and operational trials.

GMV provided two main components guaranteeing different levels of fusion for tracking and anomaly behaviour analysis and developed a new adaptor from Common Information Sharing Environment (CISE) to MARISA. The anomaly behaviour's component deals with a sophisticated and impressive set of rules leading with different scenarios (entering, leaving, loitering, speed change, course, rendezvous…) and data. All these elements were successfully demonstrated to operational stakeholders representing a unique toolkit not comparable with any of their existing systems.

Still in the maritime domain, to highlight that in 2019, together with 24 other partners led by Leonardo, including the Portuguese Navy, GMV performed live trials for the OCEAN2020 (Open Cooperation for European mAritime awareNess) project. This PADR project, implemented by EDA, was able demonstrate enhanced situational awareness, in a maritime environment, through the integration of legacy and new technologies for unmanned systems, ISTAR payloads and effectors. A new set of trials is planned for 2020.

ESD: Thank you.

The interview was conducted by Antonio Bras Monteiro.

4x4 Armoured Vehicles

Sidney E. Dean

The armoured vehicle spectrum is quite broad, and includes many 4x4 systems. The 4x4 configuration has the advantage of being generally more mobile than larger and heavier vehicles, whether tracked or 6x6/8x8 wheeled systems.

At the same time, these vehicles are designed from the beginning with a significant armour suite and offer a higher level of protection than up-armoured vehicles such as the HUMVEE. They are available in numerous variants, including general purpose tactical transports (personnel and cargo), scout vehicles, light armoured fighting vehicles with turret mounted guns, and specialized units such as field ambulance or command vehicle.

Textron COMMANDO

One of the most ubiquitous and versatile examples is the COMMANDO family of vehicles which has been in production since the Vietnam War. Textron Marine and Land Systems currently produces three different lines of COMMANDO vehicles built on a common chassis. They are designated respectively as Advanced (optimised for internal security, armoured personnel carrier or APC, and reconnaissance), Select (APC, MedEvac, and direct fire support vehicle) and Elite (reconnaissance/surveillance/target acquisition, command and control, liaison vehicle). Depending on variant and mission, weapons options include a remote-con-

Photo: Textron

The Textron COMMANDO SELECT direct fire vehicle with 90mm cannon

trolled weapon station (RWS) or turret dual-armed with a machine gun and 40mm grenade machine weapon; a 30mm to 90mm guns; anti-tank guided missiles (ATGMs); or a 120mm mortar. Depending on variant, the three-person crew can be augmented by up to eight soldiers.

Performance parameters are similar throughout the family. Cross country and obstacle clearing characteristics include a 1.5-metre fording capability, a gradient and

side-slope handling of 60% and 30%, respectively, and head-on clearance of circa 60% high obstacles. The v-shaped monocoque hull provides ballistic and blast protection up to STANAG level 4. Road speeds run in the 100-110 kph range, with an on-road mission range of nearly 650 kilometres. Curb weight varies with configuration, but averages around 15,000 kg. The current COMMANDO vehicles are configured with a so-called digital backbone which enables monitoring of on-board systems; it also allows them to accept a wide range of current and future vectronic and sensor systems, and plug into battlefield networks. The vehicles can be airlifted singly by CH-53; up to six can be loaded onto a C-130, and roll off combat ready.

Oshkosh JLTV

Oshkosh Defense's Joint Light Tactical Vehicle or JLTV weighs in at 6,400 kg, less than half the COMMANDO's mass. This translates into greater manoeuvrability and a somewhat higher top speed of 120 kph. The smaller vehicle does come with a lower level of protection. The A-structure, or base vehicle, includes a blast-deflecting vee-shaped hull, bulletproof windows, an armoured crew cabin, blast-protected seats and an automated fire extinguishing

Photo: KMW

The Armoured Multi-Purpose Vehicle produced by KMW

The AMZ ZUBR vehicle in the command and control configuration, with a remote weapons mount

Photo: Polnakaczor

system. The modular B-kit add-on armour suite provides enhanced protection against small arms, fragmentation, and underbody threats, effectively increasing crew protection to MRAP levels. A forward looking camera enhances driving safety and situational awareness.

Modularity is one of the JLTV's major assets. It comes in two basic variants, the two-seat Combat Support Vehicle (CSV) and the four-seat Combat Tactical Vehicle (CTV). The CSV has a flatbed which can haul cargo or be outfitted with a shell; prototypes of a CSV mounting surface to air missiles, a 105mm howitzer, or an ambulance module have been presented. The CTV comes in three sub-variants which are optimised, respectively, as troop carriers or weapons platforms mounting automatic weapons up to 30mm, ATGMs, or air defence weapons. Oshkosh expects to regularly upgrade the JLTV over the coming decades, so that this class of vehicle – or an immediate derivative – might serve through the end of the century.

AM General and Arquus

US Firm AM General has partnered with France's Arquus on modifying and manufacturing the French designed 12,500 kg BASTION APC. The US-built variant is marketed through the US government's foreign military sales channel. The armoured vehicle is based on the chassis of the unarmoured Arquus VLRA truck. It is optimised for peacekeeping, reconnaissance and combat missions. Exportability is enhanced by the optional left- or right-hand drive. In addition to the APC role, it can be configured as an

ambulance, command vehicle, maintenance vehicle or cargo transport. Capacity includes 2 plus eight in the APC role. The BASTION is suitable for all operating environments. The motor is certified for operations at -32 degrees Celsius. The central tire inflation system and run-flat tires maintain mobility over broken terrain. The vehicle can scale a 60% incline and cross an 80 centimetre trench; fording depth is one metre. On road speed maxes out at 110 kph, with a 1,000 km unrefuelled range.

Standard armament consists of a single machine gun (7.62mm or 12.7mm) or 40mm grenade weapon on a ring mount or RWS. Passengers can deploy personal weapons through six firing ports in the hull. Survival equipment includes blast resistant seats,

smoke grenade launchers, a sniper acoustic detection system, laser detection system, an IED jammer, and day/night wide area surveillance cameras. Ballistic and blast protection are rated up to Stanag level 3 and level 2a/2b, respectively.

Arquus

Arquus also offers the French-built 14.5-ton FORTRESS which is based on the BASTION. It can be configured as a troop transporter or logistics vehicle; the APC variant can itself be reconfigured as a command vehicle, ambulance or repair/maintenance vehicle. The armoured monocoque hull provides protection against ballistic impact as well as mine and IED blast. The vehicle requires a crew of two, and can seat eight combat ready dismounts (APC configuration). The FORTRESS can accommodate a wide range of ring- or RWS-mounted weapons up to 30mm guns. Internal configuration includes the full-range of the Arquus BattleNet vectronics system for networking onboard systems and weapons as well as plugging into tactical data networks. The FORTRESS offers excellent mobility over all terrain types, and is in service not only with French forces but also with several African and Middle Eastern nations. Speed and range parameters are 120 kph and 1,200 kilometres, respectively. The FORTRESS can be airlifted by C-130/M400 class aircraft.

Nexter ARAVIS

Another multi-tasking armoured vehicle is the Nexter ARAVIS. Some 300 have been produced, with the majority delivered to Saudi Arabia between 2013 and 2016. French reconnaissance forces and combat

The new MILOŠ 4x4 armoured personal carrier of the Serbian Police anti-terrorist unit (SAJ) on the Police Day parade in Belgrade

Photo: Srđan Popović

The Zetor GERLACH armoured vehicle with RWS

engineers have deployed their ARAVIS, designated Véhicule Blindé Hautement Protégé or highly protected armoured vehicle, to Afghanistan, Syria, and Africa. Alternate uses are as convoy escort, fire support, MedEvac or command and control vehicles. For observation missions the ARAVIS can be outfitted with the Thales Margo 5000 surveillance which includes mast-mounted electro-optical sensors and a laser rangefinder/targeting system. In APC mode the vehicle carries a crew of two plus six dismounts.

The 12,500 tonne ARAVIS utilises a specially patented modular armour which Nexter has named SafePro. It offers protection up to Stanag level 4 against mines and IEDs as well as against 14.5mm armour-piercing rounds and 155mm artillery shell fragmentation. This is the highest level of protection of any contemporary 12,000 kg class vehicle. Weaponry typically consists of a top-mounted RWS with either a 12.7mm machine gun, 40mm grenade weapon or 20mm automatic cannon. The vehicle offers high mobility in urban and cross-country terrain. Road speeds of 100 kph and a range of 750 kilometres are achieved.

Iveco MPV and MMPV

The 18-tonne 4x4 Medium Protected Vehicle (MPV) has its roots in a joint Italo-German agreement between Iveco and Krauss-Maffei-Wegmann (KMW) in 2008. The core design is created by placing an armoured shell on top of the all-terrain TRAKKER MOTS truck chassis. The shell incorporates both the cab and the mission compartment. The latter has a standard size of 13 cubic metres, expandable to 16 cubic metres for the ambulance and intensive treatment vehicle. To maximise occupant safety, the shell

is designed to separate as a whole from the chassis in case of a major explosion, allowing the energy from the detonation to dissipate rather than focus on the occupied portion of the vehicle.

The Iveco MPV is currently being produced in ambulance, troop carrier and route clearance variants. The modular aspect of the MPV is evident when viewing the standard five-vehicle route clearance convoy. Each of the five vehicles is optimised for a particular contribution to the mission of detecting and neutralising IEDs and other threats. Specific equipment for these vehicles include sensor masts for reconnaissance and manipulator arms for mine and IED neutralisation. The MPV's terrain performance includes a fording capability of up to 120 centimetres (with preparation). Gradient and side-slope capacity are given at 60 and 30%, respectively. Road speed exceeds 90 kph. Run flat tires and a central tire inflation system enhance terrain mobility.

Iveco has also developed a Medium Multirole Protected Vehicle (MMPV) based on its proven Light Multirole Vehicle (LMV). The 8,000 kg vehicle accommodates five, and mounts either a manually served or RWS-based weapon. The vehicle has a welded ballistic steel monocoque augmented by roll bars. IED protection is further enhanced by the addition of a third hinge added to each door and the use of new materials. Crew comfort is enhanced by a new ergonomic design. The 8-speed transmission, suspension and electronic stability control system are all new, enhancing off-road performance and safety. The Netherlands armed forces signed a procurement order for an initial batch of 918 MMPV, which will carry the in-

service designation 12kN. Deliveries are slated for 2022-2026.

Armoured Multi-Purpose Vehicle

Rheinmetall and Krauss-Maffei-Wegmann (KMW) describe their jointly developed Armoured Multi-Purpose Vehicle (AMPV) as "the next generation of protected vehicles." It is generally considered comparable to the US armed forces' new Joint Light Tactical Vehicle, but is heavier with a higher level of protection. The steel and composite armoured passenger cell provides a high level of blast and fragmentation protection, and features NBC filtration. Bullet-resistant windows provide a wide field of vision. Add-on armour is available for high threat environments. The ergonomically configured interior minimises passenger fatigue. Handling characteristics are compared to those of an SUV, with a turning circle of 15 metres, making the AMPV suitable for field and urban deployment. The independent suspension and central tire pressure control system facilitate operations in difficult terrain. The vehicle can climb a gradient of 70%. The maximum road speed is 110 kph, with a 700 kilometre operational range. AMVP can be configured with any type of RWS, and can typically be armed with either a machine gun (up to calibre 12.7mm) or a 40mm grenade machine weapon.

Two variants have been designed. KMW describes the smaller variant, designated Type 1, as ideal for service as an agile liaison or patrol vehicle. The Type 1 seats four, has a gross weight of 7,500 kg, and can be internally transported by CH-53. The type 1 is still in the conceptual phase. The Type 2 is larger, with a base weight of 10,000 kg and a payload capacity of 2-2.5 tonnes, depending on armour configuration. Passenger capacity is five including the driver. The Type 2 can be airlifted by C-130-class aircraft.

AMZ ZUBR

Polish manufacturer AMZ-Kutno produces three armoured 4x4 vehicles. The heaviest is the 14,000 kg ZUBR, which is based on the Iveco EuroCargo 4x4 truck license-built in Poland. The ZUBR is available in four variants: APC, command and control, air surveillance (with an N-26 radar), command and control, and short-range air defence (armed with GROM missiles). The APC can carry two crew plus ten combat-equipped infantrymen and is equipped with a remote weapon station mount-

ing a machine gun or 30mm automatic grenade weapon. The hull is vee-shaped to deflect mine and IED blast. The sides of the vehicle are also angled outward to deflect ballistic threats. The crew/passenger compartment is armoured to STANAG level 4 against armour-piercing rounds and artillery fragmentation, and to level 3a/3b against anti-personnel mines. Additional modular armour can improve this protection level. The high wheel base, independent suspension and run flat tires offer good off-road handling, including a fording capability of 70 centimetres and approach/departure angles of 35/33 degrees. The vehicle can tow a 1,500 kg trailer. Performance includes a top road speed of 100 kph and a range of 1,000 kilometres.

A production standard USMC JLTV in General Purpose (GP) configuration, this example fitted with a deep fording kit and tire chains

Tatra / HCP HUSAR

Polish manufacturer H. Cegielski-Poznan (HCP) presented the new HUSAR 4x4 armoured vehicle at Warsaw's MSPO 2017 expo. Designed in cooperation with the Czech firm Tatra Defense Vehicle, the high mobility HUSAR features a modular design that simplifies maintenance and upgrading; this also simplifies optimisation for various mission types including command and control, reconnaissance, and anti-tank configurations. Operations are possible in a wide range of climatic zones including high and low temperature environments. Standard armament solutions involve an RWS with a choice of machine guns or automatic grenade weapon. Optional equipment include NBC protection and an active protection system.

The 13,500 kg vehicle has a payload capacity of 1,600 kg. Seating is available for the driver, gunner and four dismounts. The bolted ed hull provides level 3 protection against ballistic threats and level 2a/2b blast protection. The protected drivetrain and independent suspension allow the vehicle to adapt immediately to changing terrain. Tire infla-

tion and deflation are controlled from the cockpit. The vehicle can master a 1.2-metre fording depth and 40 degree side slopes. Top road speed is 110 kph. Maximum range varies from 300 km cross country to 500 km on road.

BOV 16 MILOSZ

The BOV 16 MILOSZ armoured vehicle designed by Yugoimport entered production in 2016. The multi-purpose combat vehicle is offered in several variants including special operations reconnaissance, artillery reconnaissance, command vehicle, anti-tank vehicle and ambulance. The turning radius is nine meters, making the vehicle highly suitable for urban and field operations.

The 14,000 tonne vehicle can mount machine guns and grenade weapons, anti-tank guided missiles, short-range air defence missiles, and telescopic masts with electro-optical /infrared sensors and radar. Sensors also include hull-mounted day and night-vision cameras to aid the driver. Run flat tires preserve the vehicle's mobility for 50 km after tires suffer serious damage.

The sheet steel armour offers Stanag level 3 ballistic protection in front and

level 2 on the sides, and level 2a/2b blast protection. Additional modular armour is optional. Damaged armour segments can be replaced in the field. Five portholes in the hull permit mounted crew to fire their personal weapons under armour. The vehicle seats eight including the driver and gunner. Four of these personnel are seated in the rear section and disembark quickly via a hydraulic ramp, while the remaining crew disembark through standard vehicle doors.

Zetor GERLACH

The 12 tonne GERLACH armoured vehicle developed by the Czech Republic's Zetor Engineering is available in five configurations including personnel transport, open-bed cargo transport (1,500 kg capacity), and ambulance. The combat vehicle variant was presented in 2019. In addition to a machine gun or grenade weapon equipped RWS, the new variant can deploy a mortar or anti-tank guides missiles.

Regardless of configuration, the GERLACH presents as a highly mobile terrain capable vehicle. The turning radius of 7.5 metres is among the narrowest for vehicles of this class. During testing the fully loaded prototype was able to master a one-meter trench, a 70% gradient and a 40% side slope. The vehicle achieves a top speed of 125 kph on road, and has an 800 km operational range. During testing, the vehicle demonstrated the capability to tow a 28 tonne truck for one hour without overheating the engine.

Depending on configuration the Gerlach can accommodate up to six persons including the two-person vehicle crew. The overpressurized crew cabin features multi-layer Rheinmetall armour which provides STANAG Level 3 protection against ballistic threats and level 2 protection (upgradable to level 3) against blast threats. The double-floor vee shaped hull is specifically tailored

The BASTION 4x4 APC is built in the US by AM General.

to minimise the threat from mines; during testing the prototype survived an 8 kilo TNT charge detonating directly beneath the vehicle. In addition, the cabin is designed for noise and vibration dampening, minimising crew fatigue. Zetor stresses that all major components are manufactured and procured in the EU, in hopes of appealing to European users.

Photo: Iveco Defence Vehicles

A convoy of Italian Army Iveco Medium Protected Vehicles

Otokar COBRA

Otokar's battle-tested COBRA armoured vehicles have a modular design which permits customisation in a large variety of configurations including (but not limited to) APC, combat support vehicle, reconnaissance and surveillance, or NBC reconnaissance. The COBRA can optionally be equipped with two hydraulic thrusters and a joystick control, making it one of the few 4x4 armoured vehicles with an amphibious capability (at a speed of 8 kph).

The 6,700 kg vehicle seats up to 9 occupants. The cab and passenger section as well as the engine compartment are armoured. The angular design of the steel-armoured monocoque enhances protection by naturally deflecting projectiles (including armour-piercing munitions) and blast energy from anti-personnel and anti-tank mines. A dual-floor structure further mitigates shock waves from mines. A variety of weapon stations or turrets can be mounted, bearing automatic weapons up to 20mm as well as ATGMs and air-defence missiles. These stations can also carry night-vision periscopes, thermal imaging sensors and fire control systems.

The more conventional looking COBRA II offers enhanced ballistic and blast protection as well as increased payload and internal volume, while matching the original variant's mobility, modularity and amphibious capability. The 13,500 kg vehicle seats 10 including the driver and commander. The

APC variant includes firing ports. Maximum road speed is 110 kph, with a range of 700 km, somewhat better than the original CO-BRA's performance.

FNSS PARS

The FNSS PARS is available in four configurations: command and control (with a RWS-mounted 12.7mm machine gun), armoured tactical vehicle (RWS with a machine gun or 40mm grenade weapon), reconnaissance and surveillance (telescopic sensor mast), or anti-armour (remotely operated ATGW mount). The driver and commander displays are linked to externally mounted day and night vision cameras. The vehicle and the four-person crew are protected by modular armour, transparent ballistic armour cockpit windows, explosion and leak resistant fuel tanks, mine resistant seats, and CBRN protection.

The PARS has a low centre of gravity and a fully independent double-wishbone suspension which enhances operations on rough terrain. It can master 70% vertical slopes and 40% side slopes. The automatic transmission includes an axle-lock for improved traction on slippery surfaces and soft soil. A front-mounted hydraulic winch permits self-recovery. The PARS also has two permanently mounted propellers which provide an amphibious capability with no preparation required; this permits manoeuvres in deep and quickly flowing

waters. Maximum road speed is 110 kph, with a range of 700 km. The turning radius is 7.5 metres.

Nimr ABJAN 447A

The newest member of Nimr's ABJAN family of vehicles is the ABJAN 447A MRAV (Multi-Role Armoured Vehicle) introduced at IDEX 2019. The mission profile encompasses tactical response, reconnaissance, counterinsurgency and special operations. The 447A accommodates seven soldiers (two crew plus five dismounts) in forward facing blast attenuated seats. The two front doors are hinged forward while the two rear doors are hinged at the back for quicker egress of the dismounts.

The MRAV accepts a roof-mounted RWS with a choice of machine guns or Gatling guns. It is similar in size to the ABJAN 440 unveiled in 2015, but provides a higher standard level of protection. The engine compartment is also protected. This additional armour increases the basic curb weight to 9,700 kg. Additional modular ballistic and blast armour can be mounted. A self-sealing fuel tank is standard. Road speed tops out at 120 kph. The independent suspension, strengthened axles, and central tire inflation system enhance terrain handling while the cabin's ergonomic design improves crew comfort over previous vehicles. Off road handling includes crossing a one metre ford, a 78 centimetre trench, and a 40 centimetre obstacle, along with climbing a 60% incline.

Hatehof WOLF

While the majority of 4x4s discussed here employ armoured monocoques, there are exceptions such as the Hatehof WOLF. This vehicle, manufactured by Rafael and by Carmor Integrated Vehicle Solutions (formerly Hatehof ltd.), is based on a commercial off-the-shelf Ford F550 truck, with an armour shell placed over the chassis. This solution reduces costs, and simplifies maintenance and upgrades. Damaged armour can be easily replaced. Conversely, the armour shell can be lifted off a worn-out vehicle and applied to a new one. The eight-ton vehicle can be equipped with an RWS and carry up to twelve combat troops plus the driver

Credit: Nimr Automotive

The Nimr ABJAN 447A Multi-Role Armoured Vehicle armed with a Dillon Aero Minigun M134D in a Platt 550 protected weapons mount.

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.**
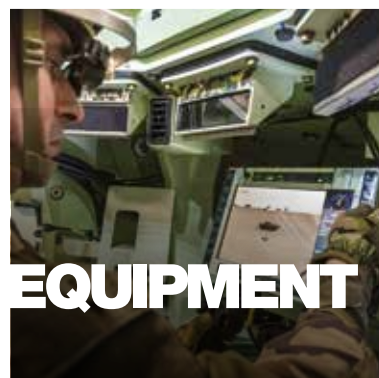
ARMORED VEHICLES

TURRETS & GUNS

AMMUNITION

EQUIPMENT

ARTILLERY SYSTEMS

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K N D S

A MARAUDER armoured vehicle of the Azeri armed forces with a roof-launched reconnaissance UAV

and gunner. It was designed primarily for urban, internal security, and peacekeeping operations, with the intent of replacing the Israeli Defense Force's (IDF) slower and less mobile M113 APCs in these tasks. Functions include patrol/APC, logistic transport, Medevac, and command vehicle. Aside from the IDF another five operators – including the Romanian army's military police – currently deploy the WOLF.

Carmor MANTIS

Most recently, Carmor introduced the 6,000 kg MANTIS at Eurosatory 2018. This highly unconventional armoured 4x4 resembles a dune buggy in shape and performance, combining high levels of all-terrain manoeuvrability, survivability and lethality. The driver is seated forward in a cockpit-style configuration, enjoying an enhanced field of vision. The sloped nose of the vehicle further improves visibility. Driver situational awareness is further aided by the all-digital layout, the optional cockpit-integrated night vision, and several side- and rear-mounted cameras which constitute a panoramic surveillance system.

Various configurations are currently available, with passenger capacity ranging from three to six (in addition to the driver, gunner and commander who constitute the basic crew). The mission profile includes strike, reconnaissance, command and medevac. Top-mounted weapon options include foldable RWS systems or turrets, mounting a choice of automatic weapons (up to 30mm), missiles, or 120mm mortars. The reconnaissance variant can be equipped with a telescopic mast mounting optical and thermal sensors as well as radar. This variant can also deploy unmanned aerial and ground systems.

The MANTIS monocoque incorporates a multi-layer composite armour, with level 3 ballistic protection and level 1 blast protection; this can be upgraded to level 4 ballistic and level 2a/3b blast protection. The sloping, angular hull design also contributes to projectile and blast deflection. Blast protected seats and a floating floor provide further occupant protection against mines and IEDs. VATEC multispectral concealment material applied on the inner and outer surfaces of the monocoque can minimise the vehicle's infrared, visual, radar and radio-frequency signatures. This not only enhances survivability but provides an overall tactical advantage during surveillance or approach to target. Top speed is 120 kph, range is 700 km.

Paramount MARAUDER

South Africa's Paramount produces the 4x4 MARAUDER which can be configured as an APC, an ambulance, a command vehicle, or as a fire support vehicle armed with either ATGMs, a turret or an RWS. It is in service with the armed forces of Azerbaijan and several African nations. Depending on configuration, the vehicle weighs 15,000 to 18,000 kg. Payload capacity is 4,500 kg. In the APC mode it carries 2+8 personnel. The extra-large payload capacity permits carriage of extra fuel tanks and supplies, enabling long-range reconnaissance or strike missions. The double-skinned hull armour provides Stanag level 3 ballistic protection. The vehicle has also been tested to survive an 8 kg TNT charge detonating under the hull or a 14 kg mine charge detonating under a wheel; the hull can survive a side-on IED blast equivalent to a 50 kg TNT charge. The very robust chassis and drivetrain permit a top speed of 120 kph over rough terrain, a speed most other armoured vehicles achieve on-road. The operational range is 700 kilometers.

Diversity reigns

A wide range of sizes, payloads, and operational parameters are represented between the extremes of the Textron COMMANDO and the Carmor MANTIS. This underscores the diversity of missions, operating environments, and resources which manufacturers and military services take into account when designing and procuring military systems. The review of current and new 4x4 armoured vehicles underscores that this category of military vehicle is in high demand, and will continue to display a diverse range of design and performance profiles.   ■

A COBRA armoured vehicle of the Azeri Army

MILOSH 4 x 4
Multirole armoured tactical vehicle

Digitisation of Land-Based Operations

Tamir Eshel

Our previous article on land forces digitisation in ESD 5/2019 featured current military communications solutions. We discussed networks based on Software-Defined Radios (SDR), satellite, and cellular communications, and how they transfer information to establish data-driven military ecosystems. A year later, our report looks farther into the future as we focus on evolving trends.

SDR remains the essential building block for modern armies, as it provides the most practical, flexible, and future-proof investment for military forces. Leading armed forces modernisation programmes already implement SDR systems at the tactical net-work level, utilising waveform adaptability to connect both legacy and modern radios.

SDR Building Blocks

Modular SDR system design enables users to evolve, fielding advanced capabilities in small steps, ensuring that fielded systems do not 'run out of technology' too soon. Unlike commercial systems that offer lower cost, even for the 'militarised' systems, electronic gear that is designed specifically for the military must endure much longer service. Slower obsolescence requires a modular design, enabling through-life upgrading and modernising. As such, SDR becomes a 'tap' for the communications pipeline, continuously adapting to meet evolving user needs and the system's architecture.

SDR radios may be based on different architectures, but they all retain the modularity and commonality to employ waveform protocols and comply with user-defined communications. Different waveforms enable the same necessary hardware to support different frequencies, hopping techniques, security, latency, bandwidth, and energy consumption. Some systems also address customer's concerns about sovereignty, supporting particular locally designed network operation and encryption integrated into their system.

Implementing suitable waveforms, a modular, multi-channel radio may enable users to set one module of the radio to comply with legacy protocols, communicating with an old radio. At the same time, another is maximised for top performance connecting to the cloud over highly secured datalink. One of the waveforms critical for the evolution of modern and future networks is the Multi-hop Mobile Ad-Hoc IP Networking (MANET). This capability is implemented in different technologies but provides a common advantage – a resilient network

Digitisation enables real time visualisation of the battle picture and digital command and control.

Photo: Nokia

that operates without a master station thus has no single point of failure. A significant benefit of this ad-hoc net architecture is that the network increases performance as more user join – in contrast to current combat net radios that become impossible to manage when the number of users increases above a certain level. For example, Rafael's BNET SDR radio network employs its unique multi-channel reception MANET to support over 1,000 users. The waveform is optimised to match changing traffic and variable link conditions (mountains, urban, forested, airborne, etc)

Elbit Systems offers another advantage - remote management capability for the network and its individual radios. Its E-Lynx radio, recently selected by the Swiss military, is no longer dependent on settings done by the user; this can also be done remotely, thus ensuring network agility and resilience, especially when facing interference and electronic warfare. Each radio supports up to 100 preset channels per waveform. Users and system operators can change settings and encryption key, thus enabling users and combat formations to maintain the level of agility required in modern warfare.

Such protocols continue to evolve and are particularly useful when joint-forces, multi-do-

main, or coalition operations are concerned. Once such waveforms are implemented, they enable users to weave new, agile, and more complex operational capabilities utilising established information services.

Such ubiquitous networking will free military users from the constraints of the current communications network, just as the 'always on' internet and mobile data communications transformed our personal lives, commerce, and business.

The Combat Cloud

Access to information, intelligence, and common situational sharing, and management of fires are all part of combat support services enabled by the network along with administrative services reporting, logistics, and mobility management in-service support. Today, such services flow at the bases, but shrink to a trickle on-field deployment, as the links that support those networks require complex point-to-point radios to establish narrow-band connections. Modern and future networks based on dedicated military radios or 'militarised' commercial services are being developed and fielded to provide wideband connections that support such 'defense cloud' services.

Driven by wearables and a host of connected devices, real-time analytics are enhancing safety and efficiency in commerce and will do the same on the battlefield. Soldiers, sensors, weapons, vehicles, and hardware will be connected to the network-accessible information processing and storage centers (clouds) for better monitoring and management, safer operation, maintenance, and timely repair.

For the armed forces, access to mission-critical data and applications is vitally important. But guaranteeing that access is easier said than done. First, because connectivity is often limited in real-life combat situations. Second, because communication networks — whether copper cable, 4G, Wi-Fi, or satellite — need to be fully protected against hostile interception and jamming. And third, because conventional clouds, by definition, are shared resources, with vast centralised data centres hosting data under the complete control of the hosting provider.

Military users seek to operate their clouds, or at least have more control over their operation. At the last Eurosatory show, Thales launched the Nexium Defense Cloud, a highly secluded private cloud infrastructure system. The company teamed with Microsoft to integrate its Azure Stack, a flexible service-oriented hybrid cloud environment that will be used as the baseline system. Thales will integrate its connectivity and end-to-end cybersecurity and encryption solutions. This will enable users to handle the most sensitive data while keeping it hosted at DODs headquarters or deployed in the field. Microsoft was also selected by the DOD to provide a large-scale cloud solution under the US$10Bn JEDI programme. Amazon has contested this selection and is stalling the programme until a legal resolution is found.

Built as a robust, balanced and highly efficient service-system of systems, a hybrid cloud is oriented to support the defense enterprise at the strategic level. To extend these services and support combat formations and contingency operations, a 'Combat Cloud' is formed as an extension of the cloud, delivering 'Fog Nodes' to support users in forward echelons on demand. Fog Nods are loaded with parts of the data services and applications, stored forward, and served to users much faster than if such services would have been delivered from the main cloud.

Such a cloud comprises many distributed elements that offer scalability, flexibility, and resilience. Based on the very high-capacity infrastructure supporting military headquarters and data centers, a cloud often supports hardware configuration that is extensible and redundant, thus avoiding overload and single point of failure.

To access these data centers and services, users employ different communications means, including secure wireless, terrestrial networks, and SATCOM, ad-hoc networks, and datalinks. Data networking transferred over the system can be configured to support voice, video, and data, at the different quality of service (QOS) supporting every user at any time, with the priority appropriated to the user and mission requirement.

With such services, soldiers can be located and managed with pinpoint accuracy using a combination of biometric and location-based technology. These tools help to minimise injury while on training, and improving survivability and recovery of wounded in combat. Additionally, as combatants and assets are instantly identified, they can operate in smaller, widely dispersed groups that can be joined at will, lending strategic advantage in combat situations.

Smart Things

These capabilities are neither invented nor sourced to the defense industrial community but depend on maturing commercial technology of Internet of Things (IoT) – low-cost elements combining sensors, processors, and communications to perform. As such, they are not secured to meet anything close to military standards.

Given the risk of IoT compromising the military network and entire hybrid and combat cloud, is it worth the risk?

C2 for Dismounted Forces

Systematic recently unveiled its new dismounted C2 offering, SitaWare EDGE 2.0, which brings a number of enhancements over the earlier version that is already in service with regular and special forces.

According to Jesper Annexgaard, Systematic's product manager for small and mobile devices, EDGE 2.0 features a new mapping engine that offers full 3-D capabilities. It also has a range of geo tools, such as for terrain analysis. Further improvements are focussed on the user experience, with changes made to the interface and the alignment of the look-and-feel of the system with the other members of the SitaWare C2 suite. Annexgaard explained that the emphasis is on providing optimum situational awareness to the dismount and ease of use, enabling them to focus their attention on conducting operations, rather than working the system, "The interface is designed to be uncluttered, but provide easy access to menus and tools. It also features an integrated chat function, enabling the map to remain on-screen at all times." EDGE 2.0 has a responsive design and can operate on any Android-compatible device, with the layout and resolution adjusting according to the orientation, Annexgaard said.

The system provides Red and Blue force tracking and can receive plans and orders from higher echelons, as well as disseminate reports across a network. EDGE 2.0 utilises Systematic's SitaWare Tactical Communications protocol, which enables large volumes of data to be transmitted over limited bandwidth. According to Annexgaard, Systematic sees this as a differentiator for the system in the dismounted domain, where communications are often limited. Annexgaard explained that while it can integrate seamlessly with other elements of the SitaWare suite, EDGE 2.0 is also able to share mission-critical data with non-SitaWare users. He added that the system is in the early stages of fielding with several armed forces.

Screenshot of the SitaWare Edge 2.0 interface, showing the 3-D map mode.

The constant flow of multi-modal information from thousands, even millions of sensors, devices and systems create a massive 'Big Data' reservoir on the cloud, a resource that becomes useful only when information is tapped, filtered, and processed. Data mining, fusion technology, and analytics are some of the tools enabling analysts to extract information from this big-data pool.

Network and programme managers must be aware of the cybersecurity risk of IoT. At the start, they should address IoTs as hostile cyber devices. Therefore, rules, boundaries, and restrictions should be implemented before rushing toward an all-connected Military IoT (MIoT) world.

IoT applications almost readily available for use today are distributed sensors – from border and perimeter surveillance, through unattended ground sensors (UGS) to different surveillance systems used in urban terrain (such as 'smart city'). These systems could be linked using existing commercial communications networks or dedicated 'sensor networks' that do not compromise information security of other hierarchies on the network but provide an essential service in peacetime or other than war scenario.

A different application employs information technology over existing communications to provide tactical forces with new levels of flexibility, efficiency, and speed. Rafael's FIRE WEAVER connects the combat maneuver elements with the effectors participating in the land battle, creating a 'fires exchange'. Units in contact with the enemy 'publish' a tender to the FIRE WEAVER exchange as a call for fire, specifying the exact target location. The tender is instantly distributed to all fire elements connected to the system. Contenders will be selected, based on 'bids' of each effector, positioned within range, ready to fire, within the safety limits, in the shortest time and the lowest cost.

FIRE WEAVER acts as an exchange connecting the most efficient response to the call for fire by closing a rapid, precise, effective, and secure sensor-to-shooter loop. The system instantly evaluates all options within the relevant rules and restrictions – considering safety limits, keep-out zones, rules of engagement, or legal aspects. The system can process multiple requests and multiple fires simultaneously, thus maximising the utilisation of combatants and effectors.

Israel plans to deploy FIRE WEAVER with the first combat brigade in 2022. A year later the system will be fielded for operational testing with the German MoD, to provide advanced experimentation as part of the "glass battlefield" experiment (ErzUntGlas)". The project undertaken by Atos, will try to eliminate the "Fog of War", by using a network of unmanned aerial vehicles and sensors, communications, and information processing utilising the FIRE WEAVER.

Processing at the Edge

Although the data centers can handle all the data they get, transferring sensor data over wireless requires bandwidth, energy, and human resources that are often scarce. By reducing the amount of data transmitted to the cloud-connected devices can minimise bandwidth requirement and transmission time (thus avoid detection), without reducing the information delivered on reported events. The key to such capability is employing smart sensors with 'edge processing'. By enabling the sensor to 'understand' the situation and separate a meaningful event from an ordinary one, sensors would transmit only the relevant events, the smart sensor judges as valid. Such processing usually involves the use of neural network processing, artificial intelligence, and machine learning.

The system components of the "glass battlefield" experiment undertaken by the German armed forces
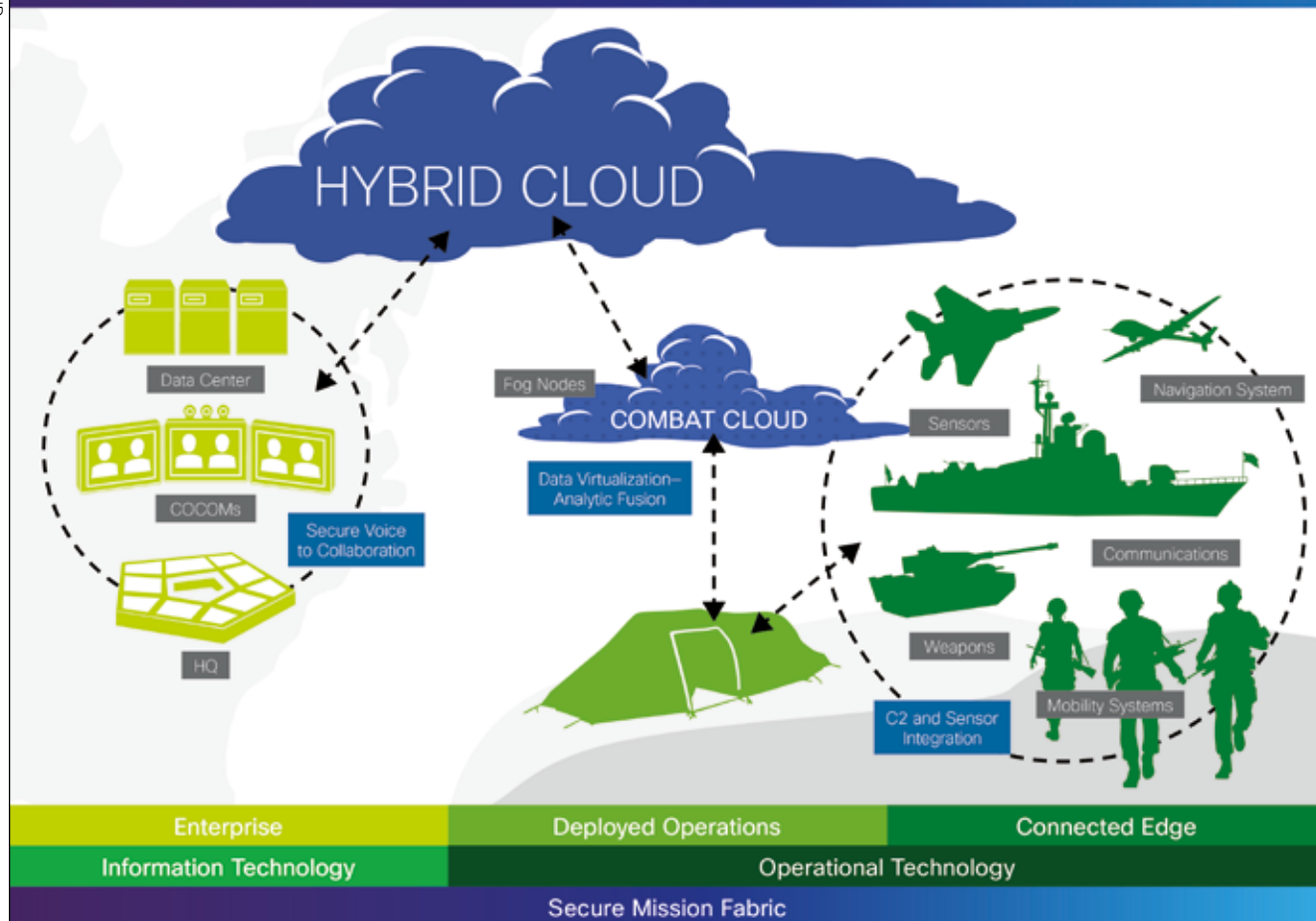
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According to a CISCO vision, the "Internet of Everything for Defence" will pave the way for the connected battlefield of the future.

Other applications of dedicated networks would be used in support of large groups of autonomous robotic vehicles, whether land-based, aerial, or maritime. Employing a node to every unit in the swarm help set a mesh-like MANET, that extends across the entire area and airspace where the units operate, offering an autonomously managed, resilient network that is tougher to defeat, than a group of robots under human control. Autonomy is essential for such an operating architecture, as a human operator for each unit will not contribute to its operability but rather slow it down and make it more vulnerable.

Increasing the number of connections on the MANET presents significant opportunities and benefits, but also rising security concerns about unauthorised monitoring or seizure and control of critical-to-military operations.

An Opportunity and a Risk

Facing the high cost of dedicated military radio networks, military users have adapted commercial networks for peacetime operation, backup services, primarily for enterprise support of military operations.

Current military-commercial networks are based mainly on 3G and 4G LTE. Some of those networks, such as IAI's TAC4G employ hardened systems and nodes based on 'militarised' LTE. At the same time, SDR radios support waveforms tapping commercial networks where they are available, thus enabling defense applications to tap the bandwidth, availability, and commonality the commercial networks offer.

The next generation of networking, known as 5G, provides a quantum leap in performance compared to 4G LTE. 5G provides many of the advantages offered by modern SDR, namely MANET, Mobile-to-Mobile (M2M) links, and practically unlimited networking capacity supporting a fully networked cloud space and internet-based apps services.

5G providers promise that defense applications based on 5G technology will provide the 'missing link' to enable high-speed information aggregation, access, and distribution the military is missing today. They even defined a new term - Command, Control, Communications, Computing Combat systems Cloud (5G-C5ISR). Defense system architecture based on this 5G-C5ISR can harness end-point processing, big-data solutions, leadership information dissemination along with troop-to-troop, device-to-device, and user-to-system connectivity.

Despite the attractive benefits and affordability of 5G technology, the military has not yet embraced it, at least not for combat operations. Nevertheless, The US DoD considers 5G technology to support peacetime operations in the continental US and abroad, but retain dedicated to military networks for combat operations overseas. The US is wary of the potential risk of network and information vulnerability to foreign actors. Such risk may occur from the use of foreign technology in the system infrastructure or system operation that could compromise information and applications. The network technology can also compromise other networks that are connected to those compromised networks.

This risk brought the US government to pressure its NATO allies to ban using Chinese technology on their future 5G networks. This pressure failed to gain universal acceptance in Europe, as France and the UK approved Huawei to bid on local 5G networks.

From a Kill Chain to a Kill Web

With smart sensors becoming ubiquitous, the flow of intelligence and battlefield information increases, enabling military users to become more alert and responsive to changes

and opportunities. Networked sensors and actors (a.k.a. effectors) are harmonised to support a faster, more effective and decisive action, implementing faster Observe – Orient – Decide -Act (OODA) loop, also known as 'kill chain'. Today, such capabilities are 'hard-wired' in dedicated applications, responding to strict operational rules of engagement and centralised control of the use of force. These procedures were dictated by western nations in the past 30 years of military superiority over asymmetrical opponents, fighting non-state and state-supported terrorists, guerilla in low low-intensity conflict.

After decades of force reduction to their military forces, the US and NATO cannot rely on their qualitative overmatch of the Russian threat. In the air and on the ground, NATO and the US military lack the combat-ready Order of Battle (ORBAT) both in quantity and agility, to concentrate the assets needed to defeat a decisive, deliberate attack. A preemptive offensive move against the air and missile defense would also be costly, as the current doctrine requires extensive support and strike packages to pave through the enemy Anti-Access Area Denial (A2AD).

With uncertain air support, land forces move to obtain new capabilities that can respond quickly and decisively against opposing forces. Different forms of unmanned and autonomous platforms and weapons offer such capabilities – in the form of individually con-trolled loitering weapons, drone swarms, and smart, guided weapons. Such platforms carry sensors, information processing, commlinks, and weapons.

To effectively operate these weapons, two levels of communications are used, forming a 'Kill Web'. One is the inter-drone network that links multiple autonomously operated platforms and smart weapons, to act in unison toward a common goal. A higher level of control links the human operator with the kill web, providing overall control of the entire pack and attack of specific targets. A Kill Web enables users to quickly deploy these capabilities, rapidly group to locate and attack the enemy's weak point, and asses the level of damage inflicted.

Securing Data and the Cloud

Part of the cloud's resilience is the protection of the information that goes in and out. Facing a growing risk of cyberattack, sheltering behind firewalls is not sufficient to protect the entire system and the information that flows through it. According to Cisco, protection of the modern Internet of Everything (IoE) complex should extend to the tactical edge by employing a new, distributed computing environment known as the Fog. According to Cisco, Everything must be secure from the sensor and information it provides to the end-users on the Fog and the data center on the enterprise cloud.

Applying security measures to sensors and devices requires encryption at the point of aggregation. This is applied either within a 'smart sensor', or its associated 'smart modem'. Both require adequate storage and computation for encryption.

The Fog - the new distributed computing layer that closely couples sensors, devices, analytics, and end-users at the battlespace, enables the evolving operational doctrine of distributed control. This Combat Cloud and its Fog Edges must be secured to ensure data integrity and protection throughout the data lifecycle. It delivers the ability to collect, aggregate, and manipulate data locally and securely connect to enterprise and cloud repositories for further analytics and use.

When deploying modern military information systems, connectivity and security go hand in hand, to ensure every user can deliver and access information instantly and securely. Security measures must protect the entire data chain. Once secured at the data source and fog edge, security, and protection must maintain an unbroken trust from the source, through the intelligent network and into data centers. Similarly, information must be secured when distributed, replicated, and manipulated by lawful users. As military operators wait for those services to mature, system architects have a long way to go to win their trust. ■

UK Moves Ahead on Active Protection Systems (APS)

Christopher F. Foss

Leonardo UK has confirmed that in November 2020 it will complete, on schedule, the contract for the ICARUS Technology Demonstrator Programme (TDP) which in the longer term will enable the British Army to field agile automatic Active Protection Systems (APS) on its current and future armoured fighting vehicle (AFV) platforms to enhance their survivability against a wide range of battlefield threats.

Following completion of a competitive selection process, in June 2017, the UK Defence Science and Technology Laboratory (DSTL) awarded the ICARUS TDP to Leonardo UK with a value of £10M. The ICARUS TDP forms a pillar of the UK DSTL Active Integrated Protection Systems (AIPS) strategy. While Leonardo UK are the prime contractor, there are a number of sub-contractors that former part of the ICARUS team. Including Abstract Solutions, Frazer Nash, Lockheed Martin UK, Rheinmetall BAE Systems Land (RBSL), Roke Manor Research, SCISYS CGI and Ultra Electronics.

Outputs and Objectives

A key requirement of the APS is that it should detect and defeat threat anti-tank missiles (ATM) and unguided projectiles with the latter including the widely deployed Russian RPG-7 type weapon. According to Ray Hopkins, Vice President Capability for Leonardo UK, "The following outputs have been accomplished:

1. Modular Integrated Protection Systems (MIPS) system model established defining the MIPS architecture
2. MIPS DATA Model developed to define the data flows both internal and external to the MIPS system

Photo: Leonardo UK

The UK ICARUS Technology Demonstrator Programme is a key part of a programme to enable the British Army to field Automatic Active Protection Systems on its armoured fighting vehicles to enable a wide range of guided and unguided threats to be neutralised.

3. MIPS Data Infrastructure defined based on the use of a Time Sensitive Network (TSN) infrastructure and Data Distribution Service (DDS) middleware
4. Software architecture developed for the MIPS Controller that supports verification and validation of the system using a synthetic environment
5. Commercially available APS sub-systems acquired for the purposes of physical system integration and MIPS system demonstration
6. MIPS Human Machine Interface (HMI) defined that facilitates system control via a GVA compliant crew station
7. Framework established for a Draft Modular Dependability Case
8. Basic structure and content defined for the MIPS standard "

By the end of the TDP the following objectives to be delivered under the programme include:

1. MIPS demonstrator system integration
2. Demonstration and evaluation of the MIPS system architecture and control solution using the acquired APS sensors and effectors that have been adapted to interface to interface with the MIPS architecture
3. MIPS system architecture using a synthetic environment
4. Development of the GVA based MIPS HMI for demonstration purposes
5. Completion of the MIPS Data Model including the recommendation of enhancements to the GVA Land Data Model
6. Completion and issue of the Modular Dependability Case Framework
7. Completion and issue of the Draft MIPS standard

The TDP is essentially a proof of concept programme to develop a MIPS approach that includes an APS Electronic Architec-

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ture (EA) that is founded on Modular Open System Architecture (MOSA) and Model Driven Design (MDD) principles. This will provide a common infrastructure and enable commercial off the shelf APS sensors and countermeasures to be selected and integrated into a system that which can be rapidly tailored to counter the evolving threats and with the UK maintaining sovereign control over the system level design and tactics associated with the layered countermeasure response.

Standards

The TDP combines both hard and soft kill countermeasures to defeat the threat and will end later this year with a demonstrator which will be developed to Technology Readiness Level 5 (TRL 5) maturity, enabling the MIPS system solution to be demonstrated in a simulated environment. In addition, Leonardo UK is leading a UK industry APS Community of Interest and Action (UKACIA) working group in conjunction with DSTL with the aim of this group being to engage with UK industry to ensure that the very best APS technologies available – now and in the future – are considered within the MIPS EA.

A UKACIA meeting was held in the UK earlier this year and this was attended by 28 different industrial organisations covering seven different countries. The UK and other NATO countries are working together to establish a NATO standard for a "Land DAS Architecture" – STANAG 4822. Leonardo UK has already played a key role in the development of the UK's Generic Vehicle Architecture (GVA) standard the NATO related NATO-GVA (N-GVA) standard. The TDP outcome will also include a Dependability Case that will provide for the safe deployment of modular, automated solutions in the complex land environment. In addition, there will be a reference MIPS Capability Modelling & Integration approach that will be used to de-risk the specification, procurement, integration and deployment of the "best in class" APS equipment, sensors and effectors from the marketplace. The programme will also provide an understanding of the impacts associated with the fielding, deployment and operation of automated, modular APS solutions and an integrated approach to platform survivability across the Defence Lines of Development (DLoDs). There will also be a roadmap for future development of UK APS sovereign capability to deliver future Operational Advantage (OA) and assure UK Freedom of Action.

Integration

The installation of an APS onto an AFV is not an easy task and while there is usually sufficient room on an MBT turret, for example, there may well be insufficient room on other platforms due to installation of commander's and gunner's sights, remote weapon stations, laser detectors, electrically operated grenade launchers, camera's for situational awareness, acoustic gunfire detection devices and in some cases electronic devices to counter Improvised Explosive Devices (IED). In addition, hard kill APS could have an impact on people in the close proximity to the platform who could, when the platform is deployed in an urban environment be civilians.

It is understood that in the short term the British Army is expected to acquire an off-the-shelf APS solution on its RBSL CHALLENGER 2 main battle tanks (MBT) to be followed by what is expected to be MIPS-compliant APS on other platforms including the General Dynamics Land Systems UK AJAX family of vehicles, WARRIOR infantry fighting vehicle and BOXER (8x8) mechanised infantry vehicle (MIV). Of these only the AJAX FOV is currently in production and none are currently deployed by the British Army. In some parts of the world, especially during counter insurgency

Cover Photo: UK MoD

Annual subscription rate: €82,50 incl. postage

CHALLENGER 2 MBT fitted with the Hensoldt MUSS soft kill APS on the turret roof which was put through a series of trials in Australia under the QinetiQ headed project MEDUSA

(COIN) type operations, the main threat is from unguided weapons such as the RPG and IED. Due to the wide range of threats, which depend on where the platform is to be deployed a one-size-fits-all solution does not exist for all threats according to Leonardo UK. They added, "a singular, full spectrum, layered integrated APS solution is considered to be neither affordable nor physically capable of being installed on all armoured platforms and neither would it be necessary for it to be integrated for all platforms for all operational scenarios".

It is logical that owing to the number of different platforms to which potentially a MIPS APS could be fitted, the UK could opt for a MIPS System Integrator to ensure coherence, commonality and re-use across the vehicle fleet. Ray Hopkins added, "Leonardo is well suited to meet this potential requirement as we already operate in a similar Pan-fleet role under a contractual framework arrangement with the Danish Defence Acquisition and Logistics Organisation (DALO)".

Under this framework, Leonardo has been contracted to deliver a GVA-compliant infrastructure that comprises modular hardware and re-usable software to provide Local Situational Awareness (LSA) across the complete Danish Army fleet ranging from

the LEOPARD 2 MBT through to the latest PIRANHA 5 (8x8) and their trucks. While in the short term MIPS will provide the platform with protection against ATM and RPG type weapons, in the longer term the aim is to provide a fully integrated, modular and layered system that will detect, track and defeat a wide range of threats and also provide the crew with situational awareness and target cueing.

Future APS Technologies

According to Leonardo, future APS technologies that could benefit from integration as part of a MIPS approach could also include future Electronic Counter-Measures (ECM) and Directed Energy Weapons (DEW). In the past, the main way to provide enhanced protection of AFVs on the battlefield was to increase the level of protection by providing additional passive armour or explosive reactive armour (ERA) or a combination of these. This has led to AFV's that are larger, heavier and more difficult not only to transport overseas but also to be utilised in theatre as they have a higher ground pressure and their size and weight limits their employment.

Potential near-term COTS could include elements from the RAFAEL Advanced Defense Systems Trophy hard kill system which has been proven in combat by the Israel Defense Force on the MERKAVA Mk 4 MBT and is also being installed on General Dynamics Land Systems M1A2 ABRAMS for the US Army. Elements from the Elbit (previously Israel Military Industries) IRON FIST APS selected for the new Israeli EITAN (8x8) APC could also be a contender.

In addition to the ICARUS TDP contract, the DSTL placed a £7.6M contract in mid-2016 with QinetiQ to evaluate the Hensoldt Multifunctional Self-Protection System (MUSS) soft-kill APS which is currently deployed on the German Army PUMA Armoured Infantry Fighting Vehicle (AIFV). MUSS is a soft kill APS and jams the incoming threat before it impacts the platform.

This programme, called Medusa, was completed late in 2019 with the system installed on a CHALLENGER 2 MBT with most of the live trials undertaken in Australia and information from this feeds into the broader UK AIPS programme. While QinetiQ was the lead other contractors included the now RBSL, Frazer-Nash Consultancy and Textron ESL. The Australian trials were conducted as part of the AUS/UK bi-lateral partnership between DSTL and DST Group (Australia) and also supported by the Anglo-German MoU held with BAAINBw. ■

Combat proven RAFAEL Advanced Defense Systems TROPHY active protection system integrated onto a MERKAVA Mk 4 MBT of the Israel Defense Force

Armour Renaissance in the French Army SCORPION Transformation Programme

David Saw

The French Army is in the midst of an ambitious transformation effort, the SCORPION (Synergie du contact renforcé par la polyvalence et l'info valorisation) programme, that will totally redefine how it will conduct military operations and will require the acquisition of new combat systems to make it a reality. These new combat systems are starting to enter service with the French

with France's SCORPION battlefield digitisation architecture and its German equivalent. For France interoperability between ground forces, air forces and other assets is an essential part of the SCORPION architecture, as is interoperability with allied forces.

If the MGCS represents the future of French heavy armour post-2035, up to that point it is the LECLERC that remains at the pinnacle of

to the LECLERC XL configuration by 2025, with the rest of the fleet completing the upgrade over the following three or so years. It is important to state that programme timetables that were generated before the Covid-19 outbreak must now be considered as uncertain. As with other parts of Europe, France shut down its economy and government expenditure has risen alarmingly in the struggle against Covid, while tax income has declined. How long it takes the French economy to recover will be the crucial determinant of the amount of funding that could be available to fund defence programmes. There is also the 2022 presidential election to take into account, a change in government will inevitably impact on defence spending.

Photo: ARQUUS

The Véhicule Blindé Multi-Rôles (VBMR) GRIFFON will replace the VAB in French Army service and more than 90 vehicles out of the 1,872 on order have already been delivered. Belgium has also ordered the GRIFFON, as shown here, with 382 vehicles to be acquired.

Army in limited numbers, in parallel with this many existing combat systems are being upgraded to extend their service lives and allow them to operate with the architecture of the SCORPION programme.

In this article, the objective is to focus on the acquisition of new armoured vehicles and the upgrade of existing armour assets to meet the requirements of the SCORPION programme. As far as the acquisition of new armour is concerned, French programmes will run from the present day right out to 2035 and the delivery of the first Main Ground Combat System (MGCS), the next generation Franco-German tank that will replace the LECLERC in French Army service. Many saw the announcement of the first part of the System Architecture Definition Study (SADS Part 1) for the MGCS. The three partners in the programme, Krauss-Maffei Wegmann (KMW) and Rheinmetall in Germany and Nexter in France, will now work towards a 'common multi-platform architecture' for the MGCS that will be compatible

French armour. To remain in service through to 2035 it was necessary to upgrade the performance of the LECLERC with Nexter being awarded a contract to upgrade 200 tanks to the LECLERC XL configuration. This will have both military and industrial implications, first the military will benefit from increased combat capabilities for its tank and its integration into the SCORPION architecture, while Nexter will reinvigorate its tank industrial capabilities. What provides this integration is the Système d'information du combat Scorpion (SICS) Battle Management System (BMS) and the Thales COMBAT softwaredefined radio system. Other additions are an RWS mounting a 7.62x51 mm machine gun, plus a modular add-on armour package. The upgrade will also look to replace obsolescent components with more modern and supportable components.

As of 2019, the French Army had 241 LECLERC tanks in service, as previously noted the numbers of tanks to be upgraded number 200. The plan is to have upgraded 122

Replacement Options

The replacement of legacy armour is a key part of the overall SCORPION programme, one of the systems to be replaced is the AMX-10RC that was originally built by Nexter and entered service during the 1980s. Continuing the tradition of French wheeled armour, the 6x6 AMX-10RC was equipped with a 105 mm gun and had a 17 tonne combat weight. The vehicle was put through an upgrade programme, with Nexter being awarded a contract to upgrade 256 AMX-10RC vehicles to the AMX-10RCR configuration in 2000. The first upgraded vehicles were delivered to the French Army 2005 and the programme was completed in 2010. Currently the French Army has 250 AMX-10 in the inventory.

While the AMX-10 was a capable vehicle, it had one drawback in terms of weight, which limited its ability to deploy to French areas of interest in Africa for example. To meet this requirement the French Army opted to acquire a different wheeled armour system in the form of the ERC-90 SAGAIE produced by Panhard (a legacy company of ARQUUS). This is a 6x6 vehicle that is roughly half of the weight of the AMX-10RC and is equipped with a 90 mm gun. The ERC was developed by Panhard in the 1970s as the successor to the AML wheeled armour vehicle family and entered service with the French Army during the 1980s. There are currently some 80 ERC-90 vehicles in service with the French Army. Both the AMX-10RC and the ERC-90 were credible armoured vehicles that could bring

The French Army currently has some 241 LECLERC tanks in service. Of these, 200 are to be upgraded to the LECLERC XL configuration by Nexter, with 122 upgraded tanks to be in service by 2025. The tank will then be fully integrated with the French the French Army SCORPION architecture.

effective firepower to bear via their 105 mm or 90 mm gun armament. The successor vehicle to these two systems takes a different path in terms of armament choices, that vehicle is the Engin Blindé de Reconnaissance et de Combat (EBRC) JAGUAR. The JAGUAR armament package consists of a 40 mm CT cannon, two MBDA MMP anti-tank missiles and an ARQUUS HORNET RWS with a 7.62 mm machine gun. This is a 25 ton 6x6 vehicle and, as with all vehicles acquired under the auspices of the SCORPION programme, it will have the SCORPION vetronics system, the SICS BMS and the CONTACT radio system. Apart from replacing the AMX-10RC and the ERC-90, the JAGUAR will also replace the version of the VAB vehicle equipped with the HOT missile system for the anti-tank mission. There are currently 300 JAGUAR on order and the plan is to have 150 delivered by 2025. The JAGUAR vehicle has also been acquired by the Belgian military with 60 vehicles on order as part of the CaMO wheeled armour modernisation programme.

The Nexter VBCI wheeled IFV will also come under the umbrella of the SCORPION programme. There are currently some 629 of these in service with the French Army. The intention is to put these vehicles through an upgrade programme as they have an important role to play in the French Army structure and have plenty of operational life remaining. There will also be the eventual introduction of a replacement to the Sagem FELIN (Fantassin à Equipements et Liaisons Intégrés) integrated soldier system. The first FELIN systems were delivered to a training establishment in May 2010, with the first operational unit taking delivery in September 2010. Another aspect of the SCORPION programme is its emphasis on the integration of advanced technology into ground forces operations, this will see the arrival of unmanned systems, both UGS and UAS, and there will be moves to utilise the potential of artificial intelligence to maximise the possibilities offered by the overall SCORPION programme architecture.

New Additions

Another new system being acquired under SCORPION is the Véhicule Blindé Multi-Rôles (VBMR) GRIFFON. This is a 6x6 vehicle and will eventually replace the VAB in French service; at present, there are 2,671 VAB with the French Army, with this number set to be reduced to 1,545 by 2025. The Direction Générale de l'Armement (DGA) procurement agency placed the first GRIFFON order for 319 vehicles in April 2017; the first vehicles were delivered to the French Army in 2019, and over 90 vehicles are now in service. The objective for 2025 is to have 936 GRIFFON in service.

In total 1,872 GRIFFON are to be acquired by France in multiple variants. More recently, in December 2019, the contract for the mortier embarqué pour l'appui au contact (ME-

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Bren-Tronics – silent watch and universal charging capacities for future armoured vehicles

Designed with the military tactical vehicle requirements in mind, Bren-Tronics 24V Li-Ion 6T batteries are the next generation solution. Bren-Tronics introduced the first commercial Li-ion 6T in 2015, prior to the military specification from the Ground Vehicle System Center (GVSC). There are more than 2,000 of these batteries in use today worldwide, addressing the three basic requirements of military vehicle manufacturers and customers: energy, weight and space.

This solution has a high output energy of 103Ah and nominal energy capacity of 2.7kWh and replaces three standard AGM 6T batteries for one quarter of the weight and half the space.

The United States Ground Vehicle System Center (GVSC) has been studying the technology and working on a specification for more than five years now. In 2019, Bren-Tronics introduced two 6T batteries that meet the GVSC specification, offering the highest capacity 24V lithium ion battery meeting the specification available today The batteries can also be charged in less than one hour and provide power for multiple loads.

In addition, Bren-Tronics is always eager to offer the lightest and smallest charging solution to fit into vehicles. The VMC mini is our latest universal vehicular charger meeting the vehicle qualification requirements such as vibration and MIL-STD 1275. This vehicular charger is qualified to charge more than 25 different sorts of rechargeable batteries in a safe manner inside a vehicle on the move. This vehicle charger has been the choice of several European armies to equip their future soldier programmes.

The innovative Arquus SCARABEE vehicle could provide the basis for an answer to the French Army Véhicule Blindé d'Aide à l'Engagement (VBAE) requirement for a reconnaissance and liaison platform to replace the VBL in French Army service.

PAC) system was awarded by the DGA, this consists of a Thales 120 mm 2R2M mortar mounted on a variant of the GRIFFON. In total 54 system have been ordered, the first will be delivered in 2023, with the remainder delivered between 2024 and 2027. The GRIFFON is also the largest element of the Belgian CaMO programme, with 382 vehicles on order and deliveries in progress.

The other major in-production armoured vehicle programme for the French Army is the Véhicules Blindés Multi-Rôles (VBMR) Léger SERVAL, being produced by Nexter and Texelis. In total 2,038 SERVAL vehicles are to be acquired in three different versions and 16 separate variants. The first order placed by the DGA covered the acquisition of 636 vehicles under a contract announced in February 2018. By 2025 the French Army expects to have 489 SERVAL in service.

Also to be acquired in the scope of the SCORPION programme is the replacement for the Engin Blindé du Génie (EBG) armoured engineer vehicle, the new system known as the MAC will be on a wheeled platform and is described as an engineer combat support vehicle. Mobility is to be similar to the other SCORPION wheeled armour systems, and some 100 systems are expected to be acquired.

The Panhard VBL is used by the French Army as a reconnaissance and liaison platform. Currently some 1,394 VBL are in service. ARQUUS is presently putting large numbers of VBL through the ULTIMA refurbishment and upgrade programme, with the objective being that the VBL fleet in 2025 will consist of 733 ULTIMA variants out of 1,387 in service. Under the SCORPION programme there is a requirement to replace the VBL with a successor vehicle known as the Véhicule Blindé d'Aide à l'Engagement (VBAE) that should enter service around 2025.

The VBAE could be a very interesting programme. In outline, the vehicle will be a 4x4 in the eight to ten ton range; multiple vehicle variants are envisaged and the aim is to have a higher level of protection than the current VBL. To complete its mission the VBAE will feature high mobility and a low signature to evade detection. Meeting the VBAE requirement could see new propulsion solutions offered, for example hybrid or perhaps even electric. Certainly reducing the noise signature of the vehicle would seem to offer the opportunity to employ an electric motor as the vehicle advances to contact.

Originally the SCORPION programme was seen as a battlefield digitisation effort, but it expanded into something far more complex than that. Perhaps it would be best to consider it as creating a structure and providing the tools for the French Army to confront both present day and future threats. In the context of armour the SCORPION programme has undoubtedly acted as the catalyst for a total refresh of the French armoured vehicle fleet. ■

New Fuzing Systems Technologies for Safer and More Effective Munitions

Building upon over a century of experience, JUNGHANS Defence has emerged as the leading supplier in the field of fuzing systems. The company, a joint venture between DIEHL and THALES businesses, has been supplying major international Armed Forces, as well as ammunition and missile companies, with efficient and reliable fuzes and Safety & Arming Devices (SAD).

The company harnesses most of the European skills and known capabilities in this domain, in two centres of competences, in Germany and in France, excelling in all relevant technologies, whether for mechanical or electronic fuzes. The product range covers all types of ammunition fuzes, including a wide range of artillery and mortar fuzes, and fuzes for aircraft bombs as well as for infantry grenades, rockets, missiles and torpedoes.

As a key element of weapons and munitions, fuzes directly contribute to the munition performance, with regards to terminal effect optimization and safety and reliability, as well as operational flexibility. In order to address modern warfare requirements, fuzes have to be 'smarter' and provide additional functionalities while meeting increasingly demanding safety and reliability requirements.

New generation fuzes recently developed by JUNGHANS Defence encompass a wide range of solutions and technologies, from mechanical state-of-the-art fuzes, compliant with the latest safety standards, to fully electronic fuzes, based on "in-line" technology.

The main developments in the area of mechanical fuzes are related to their capabilities to be used in modern weapon systems while still meeting compliance with safety standards. This is the case, for instance, with the new generation

Photos: JUNGHANS Defence

DM183

of fuzes for mortar rounds or rockets. These fuzes incorporate additional safety features which allows a full compliance with the latest safety standards (e.g. STANAG 4187), while being compatible with modern weapon systems.

In the area of proximity fuzing, JUNGHANS Defence also offers next generation fuzes.

Based on both its sixty-year old background and experience in this field, and allied with new technologies in microwave and Digital Signal Processing electronics, JUNGHANS Defence has recently developed new radar-based proximity fuzes. These fuzes are either suitable for cost efficient solutions, e.g. with FLAME multi-option fuze for mortar, or for more sophisticated multi-role fuzes for naval artillery, such as the FREMEN fuze family.

FREMEN76   *FLAME*

The FREMEN naval fuze proximity sensor is based on FMCW radar and smart digital signal processing. It is able to detect a number of set targets in various attack configurations, and to precisely detonate the munition to achieve optimal terminal effect.

JUNGHANS Defence is also able to provide fuzing solutions at the cutting edge of technology for fully electronic fuzing systems, for example in the area of so called "in-line" Safety and Arming Devices. This concept is based on the use of the EFI deto-

nator (Exploding Foil Initiator) which enables safe and flexible designs to be used without requiring firing train interruption. This technology is already used in the aircraft bomb fuze FBM21, and high-end missiles for hard-target and air-defence missions. JUNGHANS Defence's new developments in this field and in particular with LEEFI technology (Low Energy EFI) enable in-line S&A systems to be smaller, affordable and easily conformable, thus allowing their use in new generation munition warheads.

LEEFI-based Multipoint Initiation Electronic S&A Device

A significant change in the area of fuzing systems for ammunition is the recent development of guided and 'smart' munitions either for gun-launched or air-dropped munitions. These sophisticated munitions still demand fuzing functions, fully integrated within the munition (e.g. Safety and Arming Devices, proximity sensor module). The fuze designer is now required to provide new concepts to meet these changing and challenging demands. Based upon our company background and on recent technological developments, JUNGHANS Defence is able to propose to their partners versatile and flexible solutions; either based on electro-mechanical or fully electronic technology.

Leveraging upon the company background and ability to master and integrate new fuzing technologies, JUNGHANS Defence is in the prime position to offer customers and partners 'smart' and reliable state-of-the-art fuzing solutions.

Digital Command of Urban Combat

Doug Richardson

Many of the characteristics of urban warfare pose significant command and control problems. It often involves small units operating independently in order to cope with an evolving tactical situation.

In a March 2017 briefing, Lieutenant General Stephen Townsend, the commander of the Combined Joint Task Force-Operation Inherent Resolve (the military intervention against ISIL forces in Iraq and Syria) described the operation conducted between November 2016 to July 2017 in order to recapture the city of Mosul in Iraq as being "the most significant urban combat to take place since World War II; it is tough and brutal. House by house, block by block fights". A US DoD manual 'Urban Operations' published in that year warned that urban operations "have historically demanded large amounts of manpower, are usually time intensive, and require decentralised command and control — a trend that will more than likely continue."

Many of the characteristics of urban warfare pose significant command and control problems. It often involves small units operating independently in order to cope with an evolving tactical situation. Intense but isolated short-range fire fights are likely to occur quickly, and could prove decisive in a matter of minutes, making it near-impossible for military units to receive fire support or the assistance of other resources.

Mapping

Accurate and up-to-date maps are essential if soldiers are to operate in unfamiliar territory. City landscapes can range from the glass and concrete typical of a central business district to slum districts consisting of run-down buildings, or even shanty towns made up of improvised buildings made from materials such as plywood, corrugated metal, or sheets of plastic. Surface features such as tall buildings, ruined buildings, streets and alleys, all constrain the attacking forces, but will probably be

Author

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In urban combat scenarios, soldiers have to deal with degraded radio communications that do not work well not work well underground or deep within buildings.

Photo: via author

well-known to the defenders, who could also be familiar with the internal layout of buildings and of potential routes that are not shown on military or civilian maps.

Given the speed with which towns and cities can evolve, it is likely that existing maps of the combat zone will be out-of-date. Lacking streets and public utilities, the shantytowns that often exist in and around urban areas in underdeveloped countries may have an irregular layout, and lack named streets, numbered addresses, and easily identifiable buildings.

ISR

To be effective, the information from intelligence, surveillance, and reconnaissance (ISR) systems must be integrated, and made available to the front-line units that need it. Buildings and other features shown on maps and other types of geographic data must be given some form of unique identity, so that all units taking part in an operation can have shared knowledge of terrain features, including waypoints, locations to be captured, reported enemy positions, and areas such as the location of non-combatants, and known religious and medical facilities. Faced with the need to

conduct urban operations in the terrain of its neighbours, since operation Defensive Shield in 2002 against the West Bank, the Israel Defence Forces (IDF) have been able to subdivide the terrain of Palestinian areas, allocating each building in a town or city a unique four-digit designation.

Another problem is that advancing forces may create their own routes that are totally independent of the streets and alleys shown on existing maps. Heavily armoured Caterpillar D-9 bulldozers were used by the IDF during operation Cast Lead in the winter of 2008/9 to create routes through buildings and walls in Gaza. These allowed advancing forces to bypass ambush sites, minefields, and the location of IEDs and other prepositioned explosives such as buried antitank munitions. They also denied enemy forces the use of many pre-planned fields of fire for small arms and antitank weapons.

Underground Features

Underground features such as sewers, drainage systems and other utilities, or even a subway system will add to the complexity of the tactical situation. Infantry units must be able to communicate, navigate, and attack enemy forces in underground pas-

sages ranging from narrow to wide form. During the 1982 Lebanon War, the IDF used accurate and highly detailed maps, supplemented by imagery gathered by reconnaissance aircraft and UAVs. These surface maps were supplemented by maps of the sewers and other underground tunnels that the IDF had obtained from their Lebanese allies.

A recent example of the problems that underground features can create can be seen in Ukrainian attempts in 2014 to defend Donetsk Airport against rebel forces of the self-proclaimed Donbass Republic. The situation was complicated by the presence of tunnels, bunkers, and underground communications systems, and the almost totally destroyed facility was finally ceded to the rebels in early 2015 after fighting that has been described as a 'mini-Stalingrad'.

Communication Problems

Command and control can be made difficult by communications problems. In addition to blocking vision, buildings may also physically block line of sight transmissions and partially absorb radio signals, while electrical power lines may further degrade radio communications. Radio communica-

tions do not work well underground or deep within buildings.

These urban structures and the limited output power of man-portable radios will combine to degrade communications at brigade level and below. This could make it difficult to maintain a common operational

picture, to transfer orders and requests for support, and to co-ordinate the various elements of a combined arms team.

Communications problems in urban terrain have plagued several military campaigns over the last half century. During its experience in Northern Ireland between the

Photo: French MoD

A French MoD graphic showing a SCORPION IFV with a bulldozer shield clearing obstacles in urban combat

Photo: US Marine Corps / Lance Cpl. Robert Alejandre

US Marines look at an ANDROID phone with enhanced BEARTOOTH radio capabilities, which allow them to talk, text, and see teammates on a map without requiring cellular service or Wi-Fi, during Urban Advanced Naval Technologies Exercise 2018 (ANTX18).

late 1960s and late 1990s the British Army found that although its LARKSPUR A41 VHF radio system worked well in terrain that provides a reasonable line of sight between individual users, the equipment was bulky and heavy, and its performance in urban locations such as Belfast and Londonderry left much to be desired. By the early 1970s, the British were using smaller radios that operated in both the VHF and UHF bands.

During the 1982 Lebanon War, the IDF made extensive use of encrypted communications and regular changes of operating frequency, but their Syrian and PLO opponents had poor communications security, so the IDF was able to monitor message traffic in order to determine the enemy's locations and tactical plans.

During the first Chechen war in 1994-1996, the Russian forces committed to this conflict were drawn from a number of sources, including the MoD, and the Min-istry of Internal Affairs (MVD). Since these used different communications hardware and procedures, command and control (C2) problems were inevitable.

Communications by the Russian forces and Chechen rebels were transmitted in the clear (unencrypted), but the shortage of Russian personnel able to understand the Chechen language made rebel communications largely secure. Since the rebels had access to Russian radio equipment, they were able to eavesdrop on Russian communications. Chechen snipers added to Russia's C2 problems by deliberately targeting soldiers seen to be carrying radios.

By the time of the second campaign some five years later, the Russian forces were using radio equipment that operated on a wider range of frequencies, and fielded electronic warfare (EW) units able to detect, monitor, and jam Chechen communication networks, or

to establish the co-ordinates of these accurately enough to allow them to be physically attacked.

Rebel units used hand-held radios to maintain contact with higher-level commanders, and were able to maintain a clearer tactical picture than their opponents. As a result, the final Russian victory came at a high price in terms of casualties, and involved extensive destruction of the city.

Command and Control

In any military action, there is a risk that commanders lose control of the battle. This has the potential of happening more quickly in urban environments than in open terrain. C2 activities in urban warfare are likely to become decentralised. As their soldiers advance through the city's streets and alleys, and probably have to enter buildings or underground tunnels, small-unit leaders need to make rapid but informed decisions. While this is going on, the ability of higher echelons of command to maintain situational awareness is likely to be significantly degraded.

During operation Cast Lead in 2008/9, IDF forces in Gaza operated at brigade level, rather than being centrally commanded from Tel Aviv. Each brigade was allocated its own objectives, and allowed to make its own tactical decisions, and brigade command¬ers were given control of assets such as fixed-wing combat sorties, attack helicopters, and UAVs.

If they are to have maximum effectiveness, forces committed to urban combat will require a high level of situational awareness. They will need to know not only the current location and status of their own units, but also of enemy forces and their activities. This level of tactical knowledge will require the effective use of reconnaissance aids, including UAVs (unmanned aerial vehicles), robotic ground vehicles, and other sensor systems. Such is the importance of these reconnaissance aids that they are the subject of a separate article in this issue of European Security & Defence.

Persistent ground coverage by UAVs and manned aircraft is needed to help identify and track enemy forces. As IDF combat units advanced during operation Cast Lead, UAVs flying 500 m ahead of them transmitted imagery of the terrain, giving soldiers the ability to locate enemy positions, including potential ambush sites.

Electronic Battle Management

While some electronic battle-management systems are designed for use by senior commanders, or use at battalion or brigade level,

Photo: Rheinmetall Defence

Rheinmetall GLADIUS provides local situation awareness and allows the exchange of text messages and graphical information

urban warfare needs systems able to serve down to patrol level, allowing users improve their situational awareness by exchanging detailed intelligence on people, locations, and enemy activity. The following selection from the range of systems intended to work down to such low levels will give an idea of what is available or under development.

General Dynamics Mission Systems' Tactical Ground Reporting System (TIGR) is available in versions for use in command posts, vehicles, or on laptop computers used at company level. A version designated Tac SA was developed in 2011 for use by the British Army. Part of the US Army Common Operating Environment (COE), the Mobile/handheld CE (M/HHCE) is based on the Nett Warrior mission-command system, which runs on an Android commercial satphone that is linked into the Army tactical network via a USB connection to a data-capable Rifleman encrypted tactical radio. It can relay text messages and other information between commanders and lower echelons. Nett Warrior was a follow-on to the Land Warrior system used by the US Army in Iraq and Afghanistan to allow combat leaders to view maps and other tactical information, including the current locations of subordinate leaders and their men.

SICF (Systeme conformation pour le Commandement des Forces) is a French Army command information system developed by Thales France. It operates from Land Component Command down to brigade level. In order to provide C2 functions down to small units such as special operations teams, Thales worked in conjunction with the French special operations command (COS) to develop the Smart and Seamless Command and Control (S2C2) system. This provides geolocated displays with map overlays, and can transfer text messages or other orders in real-time.

The Système d'Information Terminal Combattant Débarqué (SIT ComDé) is the current dismounted variant of SAGEM's battle-management system, and forms part of the French Army's FELIN integrated soldier scheme. It is based on lightweight computer hardware and the RIF-NG tactical radio. It allows units to communicate and exchange tactical information, while individual soldiers can use an Interface Homme Machine incorporating a colour screen to show the position of nearby friendly forces, and to send and receive text messages. SIT ComDé can also be used to control a robotic ground vehicle. France will use the ATOS Systeme d'Information du Combat Scorpion (SICS)

to replace existing battle management systems (BMS). The versions for company and battalion command levels use a mouse and keyboard, but the dismounted soldier and platoon commander variants have a touchscreen interface intended to make them user-friendly for soldiers who are familiar with today's smart phones and social media. Germany's Rheinmetall GLADIUS provides local situation awareness, and allows the exchange of text messages and graphical information such as tactical sketches. Visual information can be displayed either on a hand-held control unit, or on a helmet-mounted monocular. GLADIUS entered service in 2013, and was followed five years later by GLADIUS 2.0, a modular open-architecture version available in three variants – light (radio and headset only), basic (BMS for section commanders) and advanced (BMS for platoon commanders). The latter two include a tactical display.

One potential solution to the problem of maintaining effective radio communications in an urban environment adopted by battle-management systems such as GLADIUS is the use of Mobile Ad hoc NETworks (MANETs). These do not rely on a pre-existing infrastructure. Each node forwards data intended for other nodes using routes

Exhibition Update – June 2020

As at 27 May 2020, of those that are relevant to the ESD 2020 schedule, to the best of our knowledge, the following exhibitions have been affected by the Covid-19 coronavirus:

EuroAsia	Postponed to 11-13 Sep 2020		**EW Europe**	Postponed to 16-18 Nov 2020
Quad A	CANCELLED		**ADM Seville**	Postponed to 9-11 Sep 2020
IT²EC	Postponed to 1-3 Sep 2020		**DEFEA**	Postponed to 11-13 May **2021**
Security Birmingham	Postponed to 22-23 Sep 2020		**Balt Military Expo**	Postponed to 20-22 April **2021**
Xponential	Postponed to 5-8 Oct 2020		**Hypersonic Weapons Conference**	NO CHANGE (as at 27 May 2020)
SOFIC	CANCELLED		**Close Combat Shrivenham**	Postponed to 20-22 Oct 2020
IDEB	Postponed to 28-30 Oct 2020			
ILA Berlin	CANCELLED		**Farnborough International Air Show**	CANCELLED
CTX	Postponed to 8-10 Sep 2020		**SMDC**	NO CHANGE (as at 27 May 2020)
BSDA	Postponed to 14-16 Oct 2020		**Land Forces 2020**	Postponed to 1-3 Jun **2021**
NITEC	Postponed to Spring **2021**		**ADEX**	NO CHANGE (as at 27 May 2020)
UDT	Postponed to 8-10 December		**MSPO**	NO CHANGE (as at 27 May 2020)
CANSEC	NO INFORMATION		**SMM**	Postponed to 2-5 Feb **2021**
HEMUS	Postponed to 30 Sep-3 Oct 2020		**KSK Symposium**	Postponed to 21-23 Sep **2021**
KADEX	Postponed to 10-13 Jun **2021**			
SEDEC	Postponed to 15-17 Sep 2020			
EUROSATORY	CANCELLED			

Notes:
1. This list covers relevant events originally scheduled between 22 Apr. and 21 Sep. 2020.
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The NessControl Tactical C4I system can be used for terrain analysis, navigation, blue force tracking, target acquisition, and target management.

that are created dynamically and based on current network connectivity. If the link between any two nodes is broken, the network will automatically find an alternative route. The resulting tactical MANETs are formed automatically as the mission proceeds, and will end when the mission is over. Designed to work with smartphones and tablets, Elektroniksystem- und Logistik's TARANIS Soldier uses offers the dismounted soldier a digital map that displays the location of units in the area, plus tactical symbology and messages. The company's KOMMFAST is a simple C2 system for use at the lower tactical levels. Compatible with

Now in service with regular and reserve divisions of the IDF, Israel's TSAYAD (Hunter) Digital Army Programme (DAP) was devised to provide all ground units with communications down to the level of the individual soldier. One of its components is the Elbit TORC2H InTegrated OpeRational Command Control Headquarters battle management system, which is used down to the level of battalion or company headquarters. Another is the SHACHAR C2 system for dismounted infantry.

In 2008, Russia fielded the STRELETS individual soldier C2 system as part of the larger RATNIK soldier system. STRELETS equips the

The shantytowns in and around urban areas in underdeveloped countries have an irregular layout, which requires sophisticated navigation aids.

existing Bundeswehr communication equipment, and available in vehicle-mounted and dismounted configurations, it provides map, situation, and navigation functions.

According to the Israeli company TSG IT Advanced Systems, its NessControl Tactical C4I system was designed to be used by special forces. It runs on small computers and PDAs, and uses VHF and UHF tactical radios or cellular and satcom systems as communications links. It can be used for tasks such as terrain analysis, navigation, blue force tracking, target acquisition, and target management.

individual soldier with a UHF personal radio able to handle voice, data and video, while a system module able to use the Russian GLONASS and US GPS satellite constellations can provide positional data. Platoon commanders also have a VHF radio intended to provide company-level communications. STRELETS is modular, so can be integrated with weapon sights and a laser rangefinder. Unit commanders also have a manpack terminal incorporating a seven-inch touchscreen. Deployment of RATNIK has been under way for some time, and around quarter of a million may have been delivered, but it is not

clear what portion of these have included STRELETS.

In recent years, the USMC has field-tested a number of lightweight systems based on commercial smartphones. These included the BEARTOOTH, a small, lightweight device radio developed by the Montana-based BEARTOOTH Radio company. When plugged into a smartphone, this provides infantry platoons with the ability communicate via voice or text messages, and see the location of nearby friendly forces. Based on a 900 MHz digital transceiver with an output power of 1W, it offers 8km line-of-sight range for voice communications, and 16km for text. Under non-line-of-sight conditions, these ranges fall to 3.2 and 6.4km respectively.

Other C2 applications involve loading dedicated software applications into smartphones, but the potential dangers inherent in the use of this class of system emerged in 2018. Following revelation of the problem by a 'whistleblower', the US Marine Corps published a warning that vulnerabilities had been found in the Kinetic Integrated Low-Cost Software Integrated Tactical Handheld (KILSWITCH) created by the US Naval Air Weapons Station China Lake, and the Android Precision Assault Strike Suite (APASS) developed by the US Air Force Research Laboratory. Intended to support air-to-ground strikes, these software applications were intended to be run on approved hardware such as the Mesh Network Manager (MNM) and the Marine Air Ground Tablet (MAGTAB), but some individuals had been installing them on standard commercial-grade devices. The latter practice was "not authorised, could present a significant vulnerability in compromising Marine Corps data, and may be a violation of Marine Corps Orders and/or the Uniformed Code of Military Justice", users were told.

The use of commercial hardware as the basis for front-line command and control tasks seems set to continue. Intended to create an interactive virtual testbed that can be used to evaluate operational concepts for future combat operations, DARPA's Prototype Resilient Operations Testbed for Expeditionary Urban Scenarios (PROTEUS) will create software that can be run on a tablet or other personal device in order to enable the real-time integration of ground troops and supporting forces such as manned aircraft and UAVs. This capability would allow the creation and recomposition of force packages as required in order to maintain the combat initiative when operating in complex urban environments. ∎

The System that Never Was?

Thomas Withington

Project MORPHEUS is an ambitious planned overhaul of the British Army's C2 and battle management systems. Might global and domestic events now endanger the programme?

The British Army has broken with tradition for its future combined battle management and communications system. Project MORPHEUS takes its name from the god who takes human form and appears in dreams in the Latin narrative poem Metamorphoses penned by the Roman poet Publius Ovidius Naso. Previous battle management and communications systems used by the force were saddled with more pedestrian appellations: The current BOWMAN system, which commenced service in 2005, replaced the erstwhile CLANSMAN communications system which had debuted in 1976. CLANSMAN in turn replaced the British Army's LARKSPUR radio system which commenced its deployment in the immediate post-Second World War era, entering service in the early 1960s.

BOWMAN

BOWMAN is far more than a tactical communications system. The effort, led by General Dynamics, worked to deploy a communications and Battle Management System (BMS) for the British Army, hence the sardonic 'Better Off with Map and Nokia' alternative acronym for the system when it was experiencing teething problems during its service entry at the turn of the century. BOWMAN was designed to carry conventional telecommunications, tactical communications and internet services, not only across the battlefield but also to ships and aircraft assisting land operations. Designed as a secure system employing the UK's Type-1 PRITCHEL encryption, and capable of linking externally with allied communications and BMSs, BOWMAN could also link with the British Army's FALCON trunk communications system, the UK's SKYNET satellite communications constellation and military and civilian telecommunica-

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One example of the many transceivers comprising the British Army's CLANSMAN radio system. This particular specimen was the PRC-320 which was a solid-state HF transceiver.

Photo: Milton Flannel

tions networks; all of which were provided through the BOWMAN Gateway.

The BMS component of BOWMAN is built around a software application called COMBAT. This provides cartographic information, and blue/red force locations together with navigation and reporting functions. The communications element of BOWMAN includes a communication management system enabling networks to be planned, frequencies allocated and security levels to be determined. All these capabilities and services are provided using the Windows-based BOWMAN Common Operating Environment. This also links together the BMS and communications elements of BOWMAN. BMS and Command and Control (C2) information is provided to units on end user devices. These can be either handheld tablet or laptop style devices for dismounted troops, vehicle terminals and static terminals which can be used at the headquarters level.

Several transceivers were procured as part of the BOWMAN initiative which are described in more detail below.

MORPHEUS

Project MORPHEUS represents a break with the past for the British Army while at the same time incorporating a several elements of the BOWMAN architecture. The entire MORPHEUS ensemble is being procured by the UK MoD's Defence Equipment and Support (DES) organisation which buys materiel on behalf of the British armed forces. MORPHEUS will be procured and introduced into service by the Battlefield and Tactical Communications and Information Systems (BATCIS) team. This forms part of the DES' Defence Digital organisation which buys communications and information systems across the British armed services. A decision was taken by

the MoD in 2015 that rather than purchasing an entirely new battle management and communications system, the existing BOWMAN architecture would be used as a foundation to build upon to meet the MORPHEUS requirement. Specifically, the BOWMAN Combat Infrastructure 5.6 (BCIP 5.6) version of the ensemble will be used as the baseline. BCIP 5.6 is relatively new, having been fielded with the British Army and Royal Marines from 2015.

BCIP 5.6 included a smorgasbord of improvements to the existing communications and BMS infrastructure used by the British armed forces. A presentation on the migration from BOWMAN to MORPHEUS entitled 'Delivery of Tactical Communications in the 21st Century', published by the Royal Signals Institution (RSI), a professional advocacy organisation for the British Army's Royal Corps of Signals, detailed the improvements heralded by BCIP 5.6. As stated above, BOWMAN is both a battle management and communications system including computers as well as radios. As part of the BCIP 5.6 effort enhanced processing power was added to these computers, along with hardware improvements such as touchscreen End User Devices (EUDs) for commanders. The computer's operating systems were upgraded to the Windows-8.1 software standard, along with other software improvements such as a three-dimensional mapping system. Headquarters received new servers which can comfortably and safely host third-party software, while dismounted troops received Panasonic Tough Pad tablet EUDs. In the communications domain, BCIP 5.6 improved the bandwidth of the Very High Frequency (VHF: 30 megahertz/MHz to 300MHz) waveforms and networks hosted by the BOWMAN architecture, while making data packaging more efficient. A new tactical internet was also introduced which was easier to plan, use and reconfigure. Fielding of the BCIP 5.6 configuration commenced in 2017 and was scheduled to be completed by 2020.

BCIP 5.6

Thus, BCIP 5.6 will form the basis of MORPHEUS. The new architecture will include several elements: A Battlefield Management Application (BMA) will provide mission planning tools and enhanced situational awareness compared to the current BOWMAN battle management component. At the communications level, MORPHEUS will have a radio backbone, known as TIBR (Tactical Internet Backbone Radio), using Radio Over Internet Protocol (ROIP) standards. This will supersede the High-

Capacity Data Radio (HCDR) element of the existing BOWMAN communications system which also uses IP standards to carry data at rates of between 288 kilobits-per-second (kbps) to 750 kbps using wideband and narrowband waveforms. This traffic is carried across a 225 MHz to 400 MHz Very/Ultra High Frequency (UHF) mesh network using ITT/L3Harris AN/VRC-340 V/UHF vehicular/fixed tactical radios. Dismounted troops will be furnished with the Dismounted Situational Awareness architecture which will include transceivers and EUDs to host the battle management software used by MORPHEUS, notably the Panasonic Tough Pads discussed above.

One of the big changes for MORPHEUS vis-à-vis BOWMAN is that while the latter had General Dynamics (GD) as its prime contractor, the former will see a notably more open approach by which the MoD will acquire technology to support MORPHEUS as and when required from multiple vendors. Nonetheless, GD is involved with the initial stages of MORPHEUS. The company is leading the effort to transform the BCIP 5.6 architecture into the building blocks for the MORPHEUS capability under the Evolve to Open (EVO) phase of the initiative. Intrinsic to this effort is ensuring that the BCIP 5.6 architecture can evolve to an open standard to enable the MORPHEUS architecture to be capable of 'spinning on' new systems and capabilities procured as the architecture evolves. At the end of this process, the MoD will own the baseline architecture upon which the MORPHEUS capability will be built. Intrinsic to this is developing a common suite of standards for MORPHEUS' infrastructure, network and applications. This will allow the disparate elements of MORPHEUS procured during its service life to be slotted into the overall architecture with relative ease.

In terms of the physical layer of the communications element of MORPHEUS, there is the possibility that additional competitions could be staged to procure new transceivers to replace those currently used by BOWMAN. Using the modular approach discussed above could see standards being made available to tactical radio vendors to ensure that their transceivers can slot into the wider MORPHEUS network with ease. Presently, the army uses the Leon-

ardo H-4855 UHF (300 megahertz/MHz to 30GHz) Personal Role Radio which furnishes infantry troops at section level and below by squads and fireteams. The H-4855 is not considered part of the BOWMAN network and is not connected to it. This is not the case for the General Dynamics UK/PRC-354 VHF radios used at the section level which is connected to the BOWMAN network, as are an array of manpack radios. These include the UK/PRC-355 five watt manpack and its 16W UK/PRC-356 counterpart. Sev-

Photo: Panasonic

Panasonic Tough Pad EUDs have been provided to dismounted troops as part of the BCIP 5.6 evolution of BOWMAN. Such devices are increasingly ubiquitous on the battlefield.

eral vehicular radios also encompass the BOWMAN architecture including the UK/VRC-358 16W system. High Frequency (HF: 3 MHz to 30 MHz) transceivers include the UK/PRC-325 20W manpack, the UK/VRC-328 100W vehicular system and its UK/VRC-329 fixed site equivalent. To provide the self-managing IP backbone linking the respective echelons of the British Army's manoeuvre force together, the force uses the UK/VRC-340 high capacity data radio. Initially, MoD plans called for the EVO initiative to conclude in 2021 following the completion of laboratory tests of the communications and battle management architecture forming the basis of MORPHEUS. That said, at the time of writing (spring 2020) much of the UK, and the rest of the world was in varying stages of 'lock down' in response to the global Covid-19 pandemic. Thus it would not be surprising if these dates began to slide significantly. Transitioning MORPHEUS from the laboratory to the field is expected to focus on equipping a British Army brigade with the kit, by which point an initial operational capability is expected to be declared. Once again, this date will now almost certainly slip.

Several contracts to develop MORPHEUS have already been awarded. The MoD launched the programme in June 2015

and established the so-called 'MORPHEUS Systems House'; a consortium of PA Consulting, Roke Manor and QinetiQ. This was tasked with addressing the potential capabilities which could meet the MORPHEUS requirements. One novel feature of this initial stage was that the initiative was thrown open not only to established defence companies but also companies small and medium enterprises within and without the defence domain, and academe. The rationale behind this being to find the most cost-effective options for the various components of MORPHEUS even if these be available from non-traditional suppliers. This was followed with the BCIP 5.6 and EVO contract award to GD worth US$442M in 2019 prices. This represented the first formal contract awarded for the programme. One year later, in September 2018, Elbit Systems was awarded a contract worth US$54.3M in 2019 values. This covered the delivery of the MORPHEUS battle management component. Contemporary reports stated that the contract covered the award of a 'fieldable' Battle Management Application (BMA) to fulfil part of the MORPHEUS requirement. For all intents and purposes, the BMA (Battle Management Application) performs a similar task to the COMBAT software application furnishing BOWMAN. It is intended to be used by all echelons of the manoeuvre force to facilitate mission planning, execution and to enhance situational awareness. The BMA provides a common operating picture to commanders at all echelons. Meanwhile, in August 2018, the MoD published a request for information regarding a MORPHEUS systems integrator to take the programme to its so-called 'Main Gate' decision. This is MoD jargon for the point at which the ministry decides whether or not to financially commit to the entire programme. This decision was originally schedule for December 2020. As the discussion below states this date, like several others associated with MORPHEUS, now seems almost certain to slip. Beyond this, a further contract worth US$6.5M was awarded to TP Group to provide additional support to the overall MORPHEUS initiative. There was no further information as to what precisely this covers.

Dream or Nightmare?

The RSI's presentation stated that the MORPHEUS architecture is expected to be deployed from 2023 although this date will now be in flux. Moreover, the existing BCIP 5.6 configuration of BOWMAN was expected by the MoD to remain in service until 2028 to allow the transition of the British Army's brigades from the BOWMAN to

MORPHEUS architecture. With the delays to MORPHEUS looking all but certain, it would not be unreasonable to assume that BOWMAN will remain in service for some years to come, possibly up to the end of the decade and beyond. The anticipated costs for MORPHEUS may also increase. Back in 2014, the MORPHEUS programme was expected to cost US$5.4Bn at 2019 values. These expected delays, not to mention the very real possibility of a global economic slowdown and commensurate squeeze on public spending in the UK in the wake of the Covid-19 crisis could see a rise in the cost of the programme, with less MoD money to pay for it. From the communications perspective, many of the transceivers procured as part of BOWMAN will be circa 25 years old by the time they leave service. While far from ideal it would not be unrealistic to expect that a few more years of life could be eked out of these radios. The MoD was contacted for more information regarding the current status of the MORPHEUS initiative and the programme's future, but the author received no response to several inquiries. Nonetheless, sources close to the UK's Secretary of State for Defence Ben Wallace have told the author that there is a need to significantly cut back a number of expensive programmes across the British armed forces over the next five years. Given that MORPHEUS is currently embryonic at best, there is every possibility that the programme could be greatly reduced, or cancelled altogether, with the British Army having to instead rely on the BCIP 5.6 incarnation of BOWMAN for the foreseeable future.

Global events may also intervene. The UK's expected departure from the European Union's (EU) single market and customs union on 31 December, in the wake of her formal departure from the EU on 31 January, will bring added economic discomfort to the country. The consultancy and auditing firm KPMG predicted on 23 March that the UK economy may contract by 2.6% in light of the Covid-19 pandemic, although there was the possibility that this could increase to 5.4% in the event of a prolonged pandemic which as of the time of writing shows no immediate signs of abating. Should a 'no deal' Brexit go ahead, as seems possible as the pandemic effectively puts negotiations between the UK and the EU over their future relationship on hold, these predictions could worsen. Such external influences form the backdrop of the MoD's desire to save cash. Through no fault of its own, Project MORPHEUS increasingly resembles an ambitious programme with a deeply uncertain future. The risk is that the dream of improved battle management and connectivity could remain exactly that. ■

One of the features of BOWMAN's battle management element is its suite of Battlefield Information Systems Applications (BISA) which can be used by force elements for specific tasks. Here a soldier from the Army's 24 (Commando) Regiment, Royal Engineers uses the Makefast engineering BISA software on their EUD.

Potential uncertainty over the future of MORPHEUS could see the programme being cut back or cancelled outright and may mean that the army will need to stretch out the life of its existing radios further into the future.

A World of Hertz

Thomas Withington

Barring satellite communications, High Frequency (HF: three megahertz/MHz to 30MHz) is the only means of communication which can be comfortably carried by a soldier or mounted on a vehicle, aircraft or ship capable of reaching distances of thousands of kilometres.

HF achieves this using an elegantly simple principle: The frequencies contained in the high frequency waveband cannot penetrate the ionosphere. This is an ionised layer of the atmosphere between 60 kilometres/km and 1,000 km above the Earth's surface. As HF transmissions cannot penetrate the ionosphere, they return back to Earth making the ionosphere a global trampoline upon which HF transmissions can bounce across the world. HF traffic can travel intercontinental ranges as the ionosphere allows them to outflank the Line-of-Sight (LOS) range restrictions incumbent in Very High Frequency (VHF: 30MHz to 300MHz) wavebands and above. This is particularly important for land forces which are mainly reliant on radios with LOS range limits.

To put things in perspective, when using VHF or Ultra High Frequency (UHF: 300MHz to three gigahertz) wavebands a soldier's V/UHF radio may have a LOS range of almost six kilometres.

HF vastly improves such ranges but there is a problem. A basic tenet of radio engineering is that the size of the antenna required to transmit at a given frequency is one quarter the wavelength of the frequency it is handling; the higher the frequency, the shorter the wavelength and the shorter the antenna. In the HF domain, antennas can be large. At the lower end of the waveband at frequencies of three megahertz, radio waves are 99 metres/m long. Things get a little better at the upper end of the waveband where 30MHz transmissions have wavebands of 9.9 metres. These frequencies translate into antenna sizes of 25 metres and 2.5 metres respectively. Despite these antenna sizes HF radios have become a key tool for troops on the move who need beyond LOS communications, but may be unwilling or unable to use SATCOM.

This is just as well. Several recent and ongoing conflicts have taken place in gargantuan theatres. As this article is being written, despite the near-global Covid-19 lockdown, French Army troops and their allies in the Sahel involved in Operation Barkhane were continuing to cross swords with a smorgasbord of violent Islamists. Taking its name from the evocative crescent-shaped dunes bedecking the Sahara Desert, this ongoing campaign is occurring in a theatre over three million square kilometres (1.2 million square miles) in size. The Sahel region is a hardscrabble, sparsely populated, parched strip of land forming a natural border between the Sahara and Africa's more verdant areas further south.

The Sahel, and the nature of the operation poses some serious challenges. The coalition's opponents are highly mobile, and manoeuvre across the entirety of the region. Correspondingly, troops are having to chase their foes across thousands of kilometres. True, Satellite Communications (SATCOM) offer one means by which troops can stay in touch across these distances, yet SATCOM has its disadvantages: Countries like France have sovereign systems like the Syracuse constellation which providing communications across X-band (7.9GHz to 8.4GHz uplink/7.25GHz to 7.75GHz downlink) and Ku-band (14GHz uplink/10.9GHz to 12.75GHz downlink) frequencies. However, other nations supporting Operation Barkhane like Burkina Faso, Chad, Mali,

Photo: French MoD

The French-led Operation Barkhane is taking place in a huge theatre which illustrates the challenges of providing long-range communications in such areas. HF offers a potential solution to armies unable or unwilling to pay for SATCOM.

Author

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Mauritania and Niger lack national military SATCOM assets and have no choice but to rely on commercially leased bandwidth. This is expensive, not only in terms of airtime costs, but also because mobile SATCOM terminals which must be acquired. A written statement supplied by Barrett Communications says that "being relatively cost-effective to buy and free to air makes HF increasingly attractive to end users with limited budgets."

Secondly, satellite coverage may not always be available in specific areas, and the bandwidths of commercial operators can occasionally become saturated with attendant risks that coverage maybe unavailable, or be severally restricted. In contrast, the ionosphere offers global coverage, and cannot be inundated: "HF has seen a renaissance in the market place," says Colin Horner, head of sales in the electronics division for Leonardo's land C4ISR business: "Before that, it had tended to be a backup to SATCOM." He adds that the cost of SATCOM is prompting some armies to look afresh at HF, as is the growing menace of Anti-Satellite (ASAT) weapons. Four nations – India, the People's Republic of China, Russia and the US – have performed tests of ASAT systems derived from surface-to-air missiles and their ballistic cousins over the past 20 years. Furthermore, armies in the field cannot rule out the possibility that their SATCOM systems may suffer electronic attack: Russia's KRET R-330ZH ZHITEL ground-based electronic warfare system covers a waveband of 100MHz to two gigahertz. This could enable it direct jamming against some UHF SATCOM transmissions in wavebands of 240MHz to 270MHz. It is important to note that HF communications are not immune to jamming, although the peculiarities of high frequency radio make it challenging to jam.

Mobile HF

The operational and tactical requirements of theatres like the Sahel has thrown the need for mobile HF into sharp relief. Two technological trends have made mobile HF a reality: The first is ALE or 'Automatic Link Establishment' and the second is the miniaturisation of electronics. ALE absorbs much of the management burden associated with HF. As noted above, high frequency transmissions depend on the ionosphere, but this brings a unique set of challenges. This stretch of the atmosphere is capricious. The efficiency of HF communications is influenced by a host of factors including the time of day, time of year and levels of solar activity. All these factors affect the behaviour of the ionised atoms in the atmosphere, and thus how efficient HF communications are at any point on the globe at any particular moment. These considerations translate into calculations of maximum useable efficiency and frequency of optimum transmission. Maximum usable frequency is the highest frequency that can be employed at any given moment for communications using the ionosphere for reflection. Given that the ionisation of the ionosphere changes on an hourly basis in accordance with time of day and year, the maximum usable frequency will calculate the highest frequency for HF communications on half of the days in a month. The frequency of optimum transmission refers to the highest frequency which can be used 90% of a given month. As a rule of thumb, this latter frequency is around 15% lower than the monthly maximum

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Photo: Barrett

Barrett Communications has become a market leader in the provision of mobile HF sets for military and civilian users alike. Their Barrett 2050 HF radio clearly illustrates how high frequency transceivers have miniaturised.

Photo: Thales

Thales has performed field tests of wideband HF systems as part of the SALAMANDRE high frequency communications project that the firm has performed on behalf of the French defence procurement agency.

usable frequency. Knowing such information is paramount to ensuring that HF communications can be used efficiently. For much of the last century during which HF communications have been in widespread use, highly trained radio operators would need to manually make these calculations to ensure that their sets would work. Even though software helps high frequency radio no end Barrett stresses that it is still essential for "operators to have a true understanding of HF propagation theory." This focuses on the "correct frequency selection at the right time of day for the particular region, the HF radiating power required to emit efficient and viable signals over the required distance and all of this in conjunction with a correctly fitted and maintained radiating antenna system."

Advances in software have taken much of this painstaking work out of a radio operator's hands, placing HF communications within the grasp of troops who no longer require specific training to be able to use high frequency radios. ALE uses algorithms which will compute the ideal frequencies for an HF radio to use at any given moment based on the parameters discussed above. ALE also provides an HF radio with a unique address, much like a phone number. A user can 'dial' a specific HF radio using this address, and similarly to contacted in the same fashion. Once the address is dialled, the operator will select an idle channel for the call to be made. The ALE will then confirm that this channel is idle. The recipient radio will receive a brief call from the ALE of the caller's radio. The recipient's ALE receives this call and confirms that this radio is the intended receiver. This completes the electronic 'handshake' between the

two radios and communications can now commence. One of the great strengths of ALE, says a written statement from Rohde and Schwarz, is that "during communications, the individual frequencies are automatically tested for their transmission quality and set without the operator having to intervene." Barrett's statement concurs noting that ALE "has given operators the ability to have the best frequencies assigned to a link at a given location and time of day between varying transmitting HF transceivers within a network."

The exacting nature of reliable HF communications has created a need for systems which can help manage these complexities. Leonardo's HF-7700 HF automated high frequency management system uses a Windows-based operating system and connects to any standard HF military radio capable of being remote controlled. The software performs traffic management and automatic link establishment and is configurable for the emerging fourth-generation ALE standard discussed in more detail below. The ALE capability embedded within the HF-7700 system allows legacy HF radios that lack ALE capability, to connect to the system allowing these radios to enjoy all the ALE benefits says Mr. Horner: "We are completely radio agnostic." The HF-7700 can be used in mobile, static, airborne or ship-mounted configurations, and as well as being used to manage a single HF set it can handle several radios in an HF network. A version of the HF-7700, known as the HF-2000 has been in service with the Swedish armed forces since 2008 to manage their HF communications: "Automation is the key," says Mr. Horner, "the operator does not necessarily need a whole lot of experience in HF to use the HF-7700," he continues, summarising its contribution as "flexibility without complexity."

Regarding the physical layer, the size of HF radios has reduced exponentially since the Second World War. This has been helped in no small measure by electronic miniaturisation. The advent of the integrated circuit, popularly known as the silicon chip, in the 1960s helped to greatly reduce the size of electronics like radios. Secondly, the number of individual circuits which can be accommodated onto a single chip has increased during the intervening years, helping to reduce size still further. As the oft-quoted mantra of Moore's Law states, the number of individual transistors which can be accommodated on a single circuit roughly doubles every 18 months. This theory

articulated by Gordon Moore, engineer and co-founder of the Intel Corporation, holds true today as it did when he made the prediction in April 1965. The downstream benefit for tactical communications is that the HF radios of yore previously consigned to specialist radio rooms on warships, or loaded onto large vehicles which could accommodate all of the necessary apparatus are now largely a thing of the past, with HF transceivers comfortably housed in backpack or even dashboard-mounted configurations greatly increasing their mobility.

Distance has been the primary driver for the renewed interest in HF over recent years, not only in the mobile domain, but more generally argues Ed Jones, regional sales manager for Codan Communications: "Mobile operations have been the domain of line-of-sight communications (VHF/UHF) but with the requirement for Command and Control (C2) from the higher echelons and commands, located possibly hundreds of kilometre away, a reliable, operator friendly, secure high frequency man portable radio supports the need for effective mission command." Mr. Jones states that HF has a key role to play, particularly as regards C2: "HF is traditionally used to support the overall mission command, with the passage of operational information, either by voice or data transmission, including situational reports, daily reports and unit supply status, aiding the battlefield picture for the higher command elements." As such, HF supports a panoply of applications including "strategic high frequency backhaul," notes the Rohde and Schwarz statement, providing a 'robust and cost-free alternative to SATCOM between deployed forces and headquarters."

Nonetheless, one of the limitations of HF is its ability to handle data. This is an important consideration. Land forces are continually increasing the quantity of zeros and ones that they move around the battlefield. Situational awareness and C2 depends upon the carriage of everything from maps and position updates, to still and video imagery and written reports. At present, HF is perfect for "robust voice communications, but limited data transmission," continues Rohde and Schwarz' statement.

4G

Over the longer term, HF technology is expected to develop yet further via the evolution of fourth-generation ALE which Mr. Jones believes will become the industry standard in the coming years,

Rohde and Schwarz agrees: "The most prominent feature will be HF wideband communications using 4G ALE." In a nutshell, 4G ALE takes the existing spectral sensing capabilities a step further while ensuring that the user has the maximum amount of bandwidth possible. This is an important consideration as, traditionally, HF communications have been unable to offer the data rates of their V/UHF counterparts. Until the advent of 4G ALE high frequency radios typically managed data rates in the order of 100 kilobits-per-second (kbps), get the next five years will see this increasing to rates of circa 240kbps across a 48 kilohertz channel, notes a document published by Collins Aerospace.

The advent of 4G ALE has been made possible via the US Department of Defence's Military Standard 188-110D (MIL-STD-188-110D) which governs interoperability and performance standards for data modems.

The standard covers the design criteria for data modems to ensure communications interoperability. This is important as HF radios designed to these standards will exploit the design requirements enclosed therein to provide wider band HF communications than have been hitherto possible. From a technical perspective, these advances are achieved using approaches which include the aggregation of disparate HF channels into a single 'block' to widen the bandwidth available to an operator, or by splitting the transmission across several channels and beaming it through the ether, with these transmissions then being reassembled by the recipient radio: "The benefits of dynamically adapting bandwidths … to avoid interference and optimising the throughput all improve the passage of data throughout an HF network," notes Mr. Jones, "enhancing the data available to the commanders managing and directing operations." ■

Photo: Luis Fonseca

Portugal: Beyond Fighting SARS-CoV-2

António Brás Monteiro

A few weeks ago I had the honour of meeting our Defence Minister in his office and we discussed, among other things, the pandemic. The Minister told me about a document that made me proud to be Portuguese – it concerned the deployment of the armed forces in the fight against Covid-19 in a European context. According to a checklist of 23 points, the document classified the countries of Europe, with Portugal ticking off about 90%. Some European countries were in a completely different situation, so I compared some of these countries (especially those with the same population) in terms of mortality rates and total number of infections. The conclusion was simple: countries that did not deploy the armed forces (AF) had significantly more deaths and infections than Portugal. Of course, there are other facts that should be taken into account, such as cultural habits, population density and whether and when they started the lockdown. Nevertheless, it is clear that the armed forces have saved lives in Portugal and in other European countries.

The Portuguese Armed Forces have done a great deal - from testing civilians, providing military hospitals, field hospitals and tents, producing antiseptic gel, masks and visors, assisting with logistics and transport, emergency plans, repatriating citizens, organising refugee centres, disinfecting civilian facilities, feeding the homeless and setting up new Commands for bilateral foreign assistance (transport, hospitalisation, medical care). The Ministry of Defence, the AF Social Action Institute, the Veterans League and the Armed Forces have done remarkable work in the fight against the pandemic. But do they have time for anything else?

The Covid-19 Period

To show that life goes on, Portugal will host the second ministerial meeting of the Macron European Intervention Initiative, which has grown over the last two years and aims to build a common strategic defence culture.

By 2020, it was planned that 1,738 Portuguese military personnel would participate in 22 UN, NATO and EU missions, as well as in bilateral and multilateral missions. Portugal is currently involved in 14 UN, NATO and EU missions in 11 African, Asian and South American countries. Recently, the submarine TRIDENT took part in several NATO and EU missions; the patrol ship TEJO headed a new FRONTEX operation and ZAIRE deterred pirates in the Gulf of Guinea; the frigate CORTE-REAL was deployed for 33 days; the air force identified ships for drug trafficking and illegal immigration in the Mediterranean and paratroopers were sent on peacekeeping missions to the north of the Central African Republic.

Mike Pompeo's visit to Lisbon, where he was received by the Minister of Defence, showed that the strong Portuguese – US relations are continuing. Portugal and India strengthened defence cooperation by signing three cooperation agreements between companies, and last December the Defence Minister visited Besmayah, Iraq, where Portuguese defence personnel trained Iraqi military and security forces.

The 2020 defence budget shows that Portugal is making efforts to reach 2% of the GDP in terms of defence spending; €2.4Bn has been earmarked for national defence which represents an increase of 23.1% in comparison with 2019. In this context, the year began with the dissolution of the state holding company Empordef SGPS and the reorganisation of the public defence sector, which provides the tools for national defence with which the country can meet the challenges of the next decade. The consolidation of the role of the State in the management of the sector's public holdings is also crucial for strengthening the defence industry in the European market and in international cooperation programmes in response to commitments made to NATO and the EU, notably PESCO. Also noteworthy is the protocol on cooperation between the security services and armed forces to better address threats to national security.

While fighting a pandemic, Portugal continued its efforts to engage in the UN, NATO, the EU and other bilateral and multilateral missions, in addition to SAR and MEDEVAC operations. Not bad for a country where the armed forces represent 0.24% of the total population.

Air and Ground Systems for Short-Range Reconnaissance

Doug Richardson

Until the dawn of military aviation a century ago, commanders always wanted to know what lay beyond distant hills or just over the horizon. The infantry squad of today has the more modest requirement of wanting to know what might be lurking behind a nearby wall or terrain ridge, or in the case of urban operations what might be lurking around the next street corner.

Since tactical air assets may not be able to provide a timely answer, there is a requirement for lightweight and rapidly-deployable reconnaissance systems. The goals of short-range reconnaissance are to determine the location, strength, and potential tactical weaknesses of enemy forces – information needed in order to determine a suitable course-of-action.

Unmanned Air Vehicles (UAVs) have become an established method of providing situational awareness for ground forces, but many existing types are controlled at a higher level than that of infantry squads, so getting coverage of the local combat area could take more time than is available to front-line soldiers during a fast-evolving tactical situation. For units which need urgent reconnaissance information, the most obvious solutions are small remotely-controlled air or ground vehicles equipped with cameras and other sensors.

As any major defence exhibition will demonstrate, there is no shortage of small UAVs or even unmanned ground vehicles (UGVs), but in many cases the manufacturer of the hardware and the soldiers who need such recce aids will have very different ideas as to what constitutes "lightweight" or "easily deployable".

Ideally, what the front-line soldier needs is a tiny hand-launched UAV, and this has led to the development of ever-smaller and lighter designs. Many larger models are powered by a small piston engine, but the smaller hand-launched examples use electric motors.

Author

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Photo: FLIR

BLACK HORNET has now been ordered by around 30 countries.

Mini-UAVs

With manufacturers now offering systems that can be categorised as 'mini-UAVs' or even 'micro-UAVs' and 'nano-UAVs', the US Army has now fielded a range of lighter-weight systems. At company level, it uses the hand-launched Aerovironment RQ-11 RAVEN in -11A and -11B variants. Procured as an urgent wartime requirement, and used in operations Enduring Freedom, Iraqi Freedom, and New Dawn, the RAVEN series is reported to be in service with around 10 countries. The RAVEN has a wingspan of 1.37 metres, weighs 1.8 - 1.9 kg, and has a tactical radius of 10-12 km.

The USMC is known to operate Aerovironment's RQ-12A, a 1.5 kg micro-UAV with a wingspan of 1.02 m, a maximum speed of 45 kn, and operating altitude of 150 m, and an endurance of 50 min. Other known users are Australia and the Netherlands.

At platoon level, the US Army will deploy the Short-Range Reconnaissance (SRR)

UAV. Six rival off-the-shelf commercial designs from Altavian, Lumenier, Parrot, Skydio, Teal Drones, and Vantage Robotics were evaluated in 2019 and early 2020 against a requirement for a UAV weighing 1.4 kg or less that would be able to fly continuously for 30 minutes, and be able to land at a vantage point overlooking a target area in order to extend its total mission time. In April 2020, Parrot announced that was working with its US partner NEOTech to build a final prototype batch for delivery to the US Army and the Defense Innovation Unit (DIU) in July 2020.

When it created its PD-100 BLACK HORNET micro-UAV, the Norwegian company Prox Dynamics gave a new meaning to the term "tiny". Taken into service by the Norwegian and UK forces, and used by the latter during combat operations in Afghanistan, the complete system weighs only 1.3 kg, and includes an air vehicle that weighs only 18 g. This tiny rotary-winged air asset has an airspeed of about 18 km/hr, a line-of-

sight range of 1.5 km, and an endurance of about 25 minutes. Launched by hand and controlled via a tablet, it carries a tiny video camera whose real-time output is down-linked to its user.

The BLACK HORNET

In 2016, the US Army tested the BLACK HORNET improved version of the PD-100 during Maneuver Battle Lab Army Expeditionary Warrior Experiments at Fort Benning in Georgia, and US special operations forces are reported to have used the system operationally.

In December 2016, Prox Dynamics was acquired by FLIR Systems in a deal worth US$134M. Following a UAV "fly-off" at Fort. A.P. Hill, Virginia, that tested three rival systems, the US Army awarded FLIR Systems a US$2.6M order for 60 BLACK HORNET III UAVs on 30 May 2018. These would enter service as the Soldier Borne Sensor (SBS) system. The hardware that had been used in the fly-off was later fielded by a Brigade Combat Team, and the Army announced the long-term goal of providing most of its infantry squads with one Soldier Borne Sensor system. This would consist of a base station equipped with a hand controller and display unit, and two air vehicles – one equipped for day missions and the other for use at night. The first US unit to take the system into action was a brigade of the 82nd Airborne that deployed to Afghanistan in 2019.

The BLACK HORNET III air vehicle is 166 mm long and a total weight of 33 g. It has a two-bladed main rotor or 123 mm diameter, and a two-bladed tail rotor mounted at the end of a slim tailboom. It has a ceiling of more than 1,000 m, and an endurance of 20 minutes. Two alternative payloads are available - one for day use and combining two EO cameras, and a night configuration with sensor-fused imagery from one EO camera and one thermal imager.

Like the PD-100, BLACK HORNET III uses a joystick-based control unit and a separate display. The air vehicle can be flown under manual control using imagery from the on-board sensors, or guided by GPS along a pre-programmed route. The original PD-100 version could sometimes lose its radio link and/or GPS signal when operating in urban conditions, but the BLACK HORNET

The DRAGON RUNNER mini UAV in bomb disposal configuration

III version is designed to operate in GPS-denied conditions such as the interior of buildings. The air vehicle will fly a return-to-base route once its mission has been completed, or if it loses datalink connectively

A Vehicle Reconnaissance System variant mounts an array of four launch containers (known as 'cassettes') for air vehicles. The system can control one or two air vehicles simultaneously, and integrate these into a battlefield management system. FLIR Systems plans a developed version that would allow the air vehicle to return to its launch cassette at the end of the mission, so that it can be recharged for further use.

BLACK HORNET has now been ordered by around 30 countries. Perhaps the biggest problem this system faces is its cost. When the UK ordered a batch of 160 BLACK HORNET systems in 2013, the pricetag was £20M.

Four-rotor quadcopter drones have proved popular with civilian users, so it is hardly surprising that this layout has been adopted for military applications. Examples include the Aeryon SCOUT, which weighs 1.4 kg without a payload, and China's DJI Mavic Pro which weighs just under 0.75 kg, and has an endurance of just over 20 minutes. Mavic Pro is reported to be used by the Israel Defence Forces as a company-level asset. EMT's FANCOPTER has a less conventional configuration which combines two coaxial rotors used to provide lifting power, and three small steering rotors. It weighs 1.5 kg, and has an endurance of around 3 hours.

Ground-Based Systems

Ground-based robotic systems have been used for more than 40 years, but most early examples were relatively heavy and

EMT's FANCOPTER may look like something out of a science-fiction novel, but it is a practical vertical-takeoff UAV.

The four-rotor Aeryon SCOUT quadcopter drone has been adopted for military applications.

designed for Explosive Ordnance Disposal (EOD) tasks. Their payload included TV cameras, manipulator arms, and systems intended to neutralise explosive devices. Since the manipulator arms were sized to handle relatively heavy loads, these vehicles were relatively heavy, and had to be transported to their operating location. To be an effective tactical reconnaissance aid, a UGV needs to be light enough to be carried to a frontline position.

For propulsion, the normal solution is to use battery-powered electric motors to drive wheels or tracks. On a small vehicle, these tracks will often be made from rubber or a similar material, but in some cases a specialist form of track better suited to sandy or muddy terrain is used.

Some UGVs are based on a miniature version of the tracked or wheeled chassis used by manned fighting vehicles, but some have an articulated chassis that will be better suited to rough terrain and the task of climbing or descending stairs. One example of this is the Delta Micro. Originally developed by Inuktun Services. This is manufactured by the Canadian company Recce Robots International (R2i2). Delta Micro is driven by two electric motors. As its original designation as the Variable Geometry Tracked Vehicle (MVGTV) indicates, the vehicle's configuration of three wheels per side allows the shape to be altered to match the tactical situation. In its sensor-raised configuration, the tracks take on a triangular layout.

The sensor payload of UGVs often consists of one or more day-only or day/night TV cameras able to display imagery of the area around the vehicle, and a microphone able to capture nearby sounds. Some form of built-in source of visible-light or infrared light is also carried.

Control of the vehicle and its sensors is normally handled by a unit that will allow the vehicle to be set to travel at a desired speed, steered, and stopped as required. It may

well have the ability to direct the camera and light source towards an area of interest. Just as with the vehicle itself, this hardware should be as light as possible. It may be custom-designed, or based on a PC, tablet, or smart phone Communications between the ground station and the vehicle can be either by cable or via a radio link. While a cable will be of limited length - probably less than 100 m - a radio link could in theory operate at ranges of up to 1 km. In practice, the performance of a radio link could be affected by the local terrain, and in built-up areas associated with urban warfare could be limited at around 300 m.

Throwable Systems

By acquiring Endeavor Robotics in February 2019, FLIR Systems was able to add the First-Look UGV to its product line. Optimised for operation in areas in which it is difficult for a UGV to manoeuvre, FirstLook is designed to cope with climb obstacles up to almost 18 cm in height, to turn in place, and to self-right if capsized. The last of these features in important for a UGV that is marketed as a 'throwable' system. It weighs 3 kg, and carries an audio subsystem, plus colour TV cameras that incorporate zoom lenses and an illuminating light. Another throwable UGV in this weight class is Nexter's four-wheeled NERVA LG. Prototypes weighed 4-5 kg, but 3 kg is the target weight for production examples.

The PocketBot three-wheeled UGV was developed by Novatiq as a throwable system. It weighs 0.85 kg and is equipped with a forward looking optical sensor with an X8 zoom lens that can be trained in elevation and depression, an IR illumination source, a microphone, and a small loudspeaker. These audio subsystems are linked to a bi-directional communications link, so allow the operator to talk with persons located by the UGV.

Another design that incorporates a two-way audio communications link is the 1.3 kg DRAGON RUNNER Mini tracked UGV developed by QinetiQ North America. Like the control link of this throwable UGV, the on-board two-way audio subsystem has a maximum range of 200 m, and according to the manufacturer, communications can be maintained through up to four interior walls of a building.

An even more dramatic delivery system is used by the SG Robot developed by the South Korean company Hanwha. Less than 0.65 kg in weight, and propelled by a combination of two wheels and a trailing arm, this UGV is designed to be launched in the same manner as a rifle grenade, and delivered to target areas up to 250 m away. When used against targets more than 100m distant, a second UGV will be needed in order to serve as a communications relay. The vehicle carries a low-light TV camera, as well as a small explosive or tear-gar warhead that can be triggered by radio command.

Not all throwable systems incorporate propulsion. As its name suggests, the 0.6 kg Sphere developed by Russia's SET-1 is of spherical configuration. Designed to be thrown into an area of tactical interest, it is 90 mm in diameter, and has no propulsion system. It relies on the weight of the lithium-ion batteries housed in its lower hemisphere to orientate the unit after it lands in the target area. The upper hemisphere contains an array of four cameras that provide 360-degree coverage, a microphone, and a transmitter that sends the imagery to an Operator Control Unit.

Urban warfare can create problems for many types of UGV. For example, a vehicle dispatched along the rail tunnels of an underground rail system, could face the potential situation of having to get from the rail level to that of the platform of a station, while exploration of the station could involve hurdles such as a passenger ticket barrier which has jammed in the closed position. One novel approach to UGV mobility is the URBAN HOPPER developed by Sandia National Laboratories. As its name suggests, this 5 kg unit can jump to heights of up to 8 m. This capability allows it to enter buildings through ground-floor windows, or to cope with a flight of stairs.

One problem with UGVs is that they must avoid obstructions such as rocks, tree stumps, and patches of impassably-steep terrain, while not venturing into hazardous areas such as bogs. For the moment, a UGV needs hands-on guidance from its operator, but artificial-vision software could prove a long-term solution to this task. As with UAVs, technology is providing the front-line soldier with personal-recce capability that would have seemed close to science fiction some 20 years ago. ∎

Towards Trustworthy Military Autonomous Systems

Tamir Eshel

With warfare becoming more complex, sophisticated and lethal than ever before, armed forces are considering adopting surrogates for missions deemed suitable for machines.

These could be tasks that are too dangerous for humans, too difficult (beyond their physical capabilities), or too repetitive or otherwise dull for a normal person to pursue. These three Ds (danger, difficulty and dullness) defined the first generation of military robots, which practically replaced the human with a machine that performed the same function.

Typical examples include unmanned aircraft flying over enemy territory to collect intelligence, or robots assisting experts in handling unexploded bombs and Improvised Explosive Devices (IEDs), on Explosive Ordnance Disposal missions. Meanwhile, compact robotic tractors support infantry squads by carrying their loads, and remotely controlled vehicles patrol borders, maintaining vigilance over long and potentially dangerous roads, thereby reducing the risk of casualties on hot borders. While these systems use varying degrees of automation for their tasks, their operation often requires multiple operators and technicians to perform supervised or otherwise controlled or managed operations.

Manned–unmanned combat teams might dominate the battlefield of the future.

From Automation to Autonomy

Autonomy refers to a level of independence devolved to a machine to accomplish specific tasks. Autonomy may imply periods of complete independence or, for the more complex parts of a mission, a level of operator supervision. Both modes provide new opportunities, as they enable machines to undertake more tasks with less support and personnel.

Tele-operated remotely controlled and robotic systems are becoming more autonomous as they become 'smarter', enabling the machine to take more 'responsibility' through the mission phases. Some of those activities, such as the take-off and landing of drones, improve safety, as the system eliminates the human error that often causes mishaps. On land, trucks following each other in a convoy may operate au-

tonomously, or be supervised from a drone or from one of the vehicles. Without drivers, such convoys can be smaller and faster, and require minimal escort, offering many advantages for logisticians.

Autonomy does not always mean that the system operates completely by itself. Rather, it implies the facilitation of specific tasks within a mission and ensures the relevant platform can continue the mission and return safely to its base even when the control link is lost. Some autonomous systems empower the mission controller, by delegating specific tasks the machine can do better, enabling the human controller to focus on the more complex, high-level tasks. For example, autonomous drones can exploit Artificial Intelligence and Machine Learning (AI/ML) to filter the multitude of data from their various sensors, providing their operators with only the most relevant information.

Manned fighter planes also become 'autonomous', in respect to sensors and data processing, as pilots do not monitor individual sensor feeds, with AI/ML acting as

a filter, providing the most useful data to the pilot. With machines diving into endless volumes of information, they are not limited to processing information in real time, but employ 'Space-Time Adaptive Processing' techniques combining real-time sensing with historical data, determining anomalies or patterns unpredictable by normal processing. These methods empower the latest approaches in countermeasures and electronic attack.

Adversary Autonomy and Counter Autonomy

The development of AI has increasingly become a national security concern with all leading military powers racing to implement AI, specifically in military applications and intelligent weapons. "Whoever becomes the leader in this sphere will become the ruler of the world," said Russian president Vladimir Putin. But it is China that has great ambitions in this area, planning to become the global leader in AI research by 2030. While AI and autonomous systems

Photo: Tamir Eshel

The ATHENA artificial intelligence server designed by IAI

have big potential, they are also vulnerable to attack.

Vulnerable to deception, interference and easily located on the battlefield by the electromagnetic emissions they depend upon, mission-critical and military AI/ML systems should be designed to protect against such attacks. DARPA and the European Defence Agency (EDA) are both pursuing parallel studies exploring Protection Against Enemy Interference (EDA) and Guaranteeing AI Robustness Against Deception (GARD), both addressing adversarial attempts to alter, corrupt or deceive such systems. These studies are set to prevent the chaos that could ensue in the near future, when attack methodologies, now in their infancy, have matured to a more destructive level.

Autonomous lethal weapons are already operational with the 'loitering weapons' category, combining the long endurance, reconnaissance of a drone with the guided attack capabilities of a missile. Designed as an affordable and disposable asset, LM leverages autonomy as a key for effective use. Unlike the larger drones, loitering weapons are launched from a forward location, sometimes by the combat elements themselves, and perform missions against targets suspected to be in a specific area. Hence, users need to respond quickly and intuitively, focus on the mission rather than flying the drone. To meet these requirements, the loitering weapon supports various functions enabling autonomous operation on certain mission phases, switching between operating modes by user command. For example, take-off and flight to a designated area are done automatically, while entering attack mode or aborting an attack are done by user command. A high level of autonomy and robustness, particularly in GPS-denied locations, enables the loitering weapon to avert soft-kill means employed by enemy counter-UAS

techniques, although 'hard kill' remains as effective as any other air defence weapon.

Designing a Trustworthy Machine

Traditionally, tasks that utilise autonomy are based on procedural processes, resulting in robotic systems that are prone to decision errors. Therefore, humans still do not trust machines for critical decisions. The next level of autonomy will utilise 'Learning Enabled Components', sensors, processors and algorithms coupled with neural networks and artificial intelligence enabling a 'learning process', as Learning-Enabled, Cyber Physical Systems (LE-CPS) will gradually adapt to the unstructured environment they operate in.

DARPA is exploring learning machines under the Assured Autonomy programme. Instead of relying on human supervision for problem solving, such machines will be able to explain their recommendation, and learn from the supervisor's response. Such intelligent machines may also inform the user about their 'competency' to perform

Photo: via author

The DRAGONFLY loitering weapon

a specific task under certain conditions (weather, visibility, degraded mobility, and so on). Portraying the 'probability of success' to the user enables the human to assess the robot's ability to perform the task and decide whether to rely on the machine or on other means to perform the task. DARPA is pursuing these functions under the Competency-Aware Machine Learning (CAML) programme.

Some autonomous systems are already calling the shots in situations where the human is too slow to respond. Active Protection Systems – employing 'hard kill' against incoming rockets and missiles – employ sensors, protectors, and countermeasures to defeat such threats in fractions of seconds. Systems like the StrikeShield from Rheinmetall are set to engage the incoming threat in a fully autonomous manner. Other systems also add important situational awareness information. Rafael's TROPHY, for example, points the countermeasures at the incoming threat, and also 'suggests' to the commander to engage the source of fire – either using the vehicle on which the system is mounted or with other elements in the combat formation. Unlike the automatic employment of 'hard kill', it leaves the decision to the commander to aim the gun at the target and open fire, since the commander may consider other tasks are more important at that time.

Autonomy and Man-Machine Teaming

Used by Special Weapons and Tactics (SWAT) law enforcement agents and counter-terror operatives, DOGO is a smart robot that acts as a means of surveillance in urban enclosures. DOGO is sent ahead of the agents to scout into a fatal funnel, to provide situational awareness and remote engagement capability, thus decreasing the risk to the entire team. Until DOGO, the

only way to achieve this task was to send a team member into a potentially deadly situation, risking them suffering enemy and friendly fire. As the agent, DOGO also carries a weapon – an automatic handgun that can be aimed and operated by remote control.

The robot combines eight video cameras into a live panoramic view of the scene. The scene displayed on the RANGER remote control unit provides an intuitive 'point and move' or 'point and shoot' capability, with which the user can point the robot, move to a required location, aim and shoot at a selected target with high precision.

General Robotics, the developer of the DOGO tactical robot also employs advanced algorithms to enable counter-terror operatives to optimise their close quarters combat (CQB) capabilities while minimising the risk to agents. In 2019, the company introduced the DOGO 2, enabling faster and efficient target engagement in unfamiliar settings.

Autonomy is making strides supporting dismounted combat formations with versatile platforms that are field-configurable to meet the needs of the warfighter. Rheinmetall's MISSION MASTER all-terrain robotic vehicle is designed with this capability in mind. MISSION MASTER can be deployed in places that are difficult to access, whether operating autonomously or serving in 'mule' mode, following its human operator. Fitted with a mast-mounted sensor pack it assumes a reconnaissance role, and on other missions it is loaded with a remotely operated weapon station or rocket launcher, to function as a mobile fire support platform. With the first unit delivered in 2019, Qatar became the first user of the MISSION MASTER robot.

The MISSION MASTER platform is based on an electrically powered 8x8 rover controlled by an 'Advanced Robotic Intelligence System' (ARIS) developed by Provectus Robotics Solutions. ARIS combines feeds from on-board sensors with semi-autonomous and autonomous control algorithms delivering flexible operating modes. For example, the system has implemented deep learning technology enabling the robot to recognise and follow a person, enabling 'leader–follower' function and improving operation with humans.

ARIS is NATO STANAG 4586 compliant and designed as a platform agnostic framework, handling mapping, planning and autonomous handling functions. The system also includes perception and positioning subsystems, with chassis and payload control interfaces enabling efficient integration with different platforms and payloads.

The HERO-400EC loitering weapon

These essential capabilities led Rheinmetall Canada Inc., the subsidiary of the Düsseldorf-based Rheinmetall Group to secure a 100% holding in Provectus, ensuring the know-how and support for its growing unmanned ground vehicle activity.

In the near future, modern combat vehicles will be able to operate 'unmanned' or at least remotely controlled, with the introduction of 'drive-by-wire' capabilities as part of the vehicle architecture. With autonomous control systems like IAI's ATHENA, such vehicles will be able to operate as unmanned or autonomous platforms.

Some vehicles already have a certain level of independence. The CAESAR truck-mounted self-propelled howitzer from NEXTER utilises an optional self-loading capability, enabling the crew to operate the vehicle by remote from a distance. Patria designed its AMV 8x8 armoured vehicle with 'drive-by-wire' technology that will enable driverless operation in the future. And the Optionally Manned Combat Vehicle, part of the US Army Next Generation Combat Vehicle (NGCV) programme will have this capability. Leveraging this unmanned capability in a manned–unmanned

teaming environment, the US Army plans to test optionally manned fighting vehicles and ground robotic vehicles in a platoon, performing missions currently done by a company, or even a battalion. The robotic platoon will be able to dominate up to 75 square kilometres, leveraging the capabilities offered by advanced manned–unmanned teaming. Army robotics experts consider that by thinly spreading combat elements across the area,

The Kalashnikov REX-1 C-UAV weapon.

and deploying numerous communications nodes to establish a secure and independent MESH network, unlike a cellular or combat net radio network, such a combat formation will be 'hidden' within an 'always on' network, that will not represent a clear hierarchical structure to the adversary.

Teaching Sensors to Look for Targets

Employing certain signal processing algorithms, sensors can be 'taught' to perform specific tasks. With the increasing computing power available for signal processing, the demands on sensors and systems for complex processing are increasing. This includes, for example, recognising shapes, patterns or movements from different angles. Such 'Machine Learning' processes teach systems to recognise certain objects, and thereby present the user with a 'suspicious object' or an 'alert' rather than a picture. An example is ThirdEye's passive drone detection system MEDUSA, which uses infrared cameras to detect drones over long distances at day and night. Utilising target libraries the system is trained to recognise, these machine learning systems employ compact circuitry to enable detection of different targets against complex backgrounds, below the horizon and in a cluttered scene.

Smart Vision for Intelligent Vehicles

With the advent of AI/ML, platform-mounted camera systems have become smarter, with their new responsibility to process video streams for object recognition or target tracking. Having multiple sensors delivering such situational understanding on a vehicle takes a different AI/ML processing approach. The Canadian company Pleora Technologies has intro-

duced a 'plug-in' AI solution as part of its RuggedConnect smart video switch, that couples multiple video sources on a vehicle over Gigabit-Ethernet AI/ML processing. The system leverages a commercially available processor that adds decision support capabilities to the platform.

For example, with driver assistance services, the system spots changing soil conditions, gradients and obstacles. These functions are supported by a library developed by Mission Control Space Services of Canada. This Vehicle/Terrain AI Safety System provides real-time terrain data, even in very rough, low-visibility, and changing environments, to help increase safety and intelligence while lowering costs for defence departments. Another library developed by Lemay.ai provides threat detection, identification and classification functions for the gunner and commander.

Autonomous Weapon Control

By the mid-2020s, as the US Army is expected to field the first 'Optionally Manned Fighting Vehicles' (OMFVs). Even in manned operation the vehicles' sensors and weapons will employ an 'autonomous turret' concept. Such a turret will also be used on the 'Robotic Combat Vehicle', a smaller robotic platform that will be able to operate with the OMFV as part of the manned–unmanned team.

Both systems will benefit from the Advanced Targeting and Lethality Automated System (ATLAS) the Army has asked industry to explore. Fusing feeds from multiple multi-spectral sensors and sensing disciplines (visible, NIR, SWIR, MWIR, LWIR, LADAR, LIDAR), ATLAS will be able to develop situational awareness, detect, classify, recognise and identify different targets and set to engage those targets under the most relevant rules of engagement.

The Israeli Army has already demonstrated such capability on the CARMEL future combat vehicle technology demonstrator. The vehicle employs multi-intelligence sensor fusion, associated with centrally processed AI/ML to provide the crew with clear representation of threats and targets, enabling the crew to focus on the most critical targets, ensuring the vehicle's survivability and mission success.

The first phase of the CARMEL programme tested a revolutionary new concept proving such a combat vehicle can be operated effectively by two persons under closed hatches. The test results clearly demonstrated not only that it can be done, but that given a high level of situational awareness and understanding, a crew of two under armour is far more effective, even in the most complex situations. A key for the efficient performance was the delegation of missions to 'virtual crewmembers' that assume certain tasks. These include driving or situational awareness of specific sectors, while the human operators take charge of the more complex tasks and decisions, as well as supervising the operation of lethal effects. The first phase examined three different designs from Israel's leading defence companies. Despite the high level of automation and AI, all concepts reiterated that human dialogue based on a common display in the cockpit is essential for efficient teamwork.

The next phase – CARMEL 2.0 – will test an armoured vehicle that will implement the sensor-rich two-man crew concept with additional capabilities, performing a mission for a tank platoon using a single manned vehicle with two robotic companions.

A Moral Responsibility?

As intelligent machines become increasingly involved in combat support, command and control, Lethal Autonomous Weapon Systems (LAWS) are becoming more realistic and controversial. Advocates and critics of autonomous weaponry disagree over whether such systems can be equipped with algorithms sufficiently adept to distinguish between targets to satisfy the laws of war. So far, the United Nations have failed to bring an agreement on regulating or limiting some of these weapon categories. In the absence of an organised campaign to highlight the moral and legal controversy of the new technology, it seems the military powers and industrial complex are set to race forward making LAWS a reality for the soldiers, but a nightmare to the advocates. ∎

CBRN: Protecting the Force

Dan Kaszeta

Chemical, biological, radiological, and nuclear (CBRN) weapons are considered significant threats to military operations. Over the last twenty-five years, the concept and discipline of "force protection" has evolved.

Protecting military personnel from CBRN weapons is nothing new, dating back to 1915. The traditional disciplines in CBRN force protection – individual and collective protection, contamination avoidance, detection, decontamination, and medical countermeasures – have largely been addressed in detail. However, as with the previous two articles on CBRN subjects this year in ESD, there's relatively little attempt to look at the subject as a cohesive whole.

The Concept

The concept of "protecting the force" from CBRN threats can be analysed along three different axes. The first axis is protecting the individuals that comprise the force, i.e. soldiers, sailors, airmen, and essential support contractors. The traditional CBRN defence technology areas of detection, individual protection (for example masks and suits) and medical countermeasures (e.g. vaccines and treatments) are firmly part of this rubric. Individual protection often comes at a cost to performance, even though the current generation of protective clothing and respirators are far less burdensome to use than their predecessors. Individual protection is well-covered by major CBRN industry stalwarts, such as Avon (UK) and the Scott division of 3M (USA). Protective clothing is produced by many manufacturers around the world, with companies like Blücher (GE), Lion (USA), and Paul Boyé (FR) as particular examples. Medical countermeasures come from many sources, but Meridian Medical Technologies, part of Pfizer (USA), and Emergent Biosolutions (USA) are examples of specialty manufacturers in that space.

Individual protection has also been enhanced by a fundamental change in CBRN detection instrumentation. Detection and

Photo: Red Scientific

Force Protection is a hard concept to conceptualise and even harder to implement.

identification of chemical warfare agents and toxic industrial has always been part of force protection. The last 15 years, however, have seen a fundamental change in this area. Led by the US Army, which is the single largest military CBRN client on the planet and a major proponent for change in this area, the "Joint Chemical Agent Detector" (JCAD) programme resulted in the production of smaller, better, and more affordable chemical detectors that could be easily worn and carried by individual soldiers or mounted on practically any vehicle. Smiths Detection (UK) won this contract with its LCD-series of detectors and became the largest manufacturer of chemical warfare detection. These devices are literally a fraction of the price, volume, and weight of their predecessor and rival devices. Other manufacturers in this space, such as Bruker (DE) and Environics (Finland) provide solid offerings in this space, but have not been able to replicate Smiths' market share.

The second axis of CBRN force protection is reconstitution of systems and equipment. Military capability to project force around the world and to conduct offensive and defensive operations relies on a bewildering array of systems. Systems can be things like fighter aircraft, tanks, and aircraft carriers. Pretty much by definition, only the "N" in CBRN is any good at destroying systems. However, the rest of the CBRN hazards can

contaminate systems. Contaminated systems mean that performance is degraded due to the need for operators to wear protective equipment and that equipment becomes harder to use.

Furthermore, contaminated systems can cause injury or death to personnel near them. In the case of ground vehicles, they can spread contamination, thus increasing the size of a hazardous area.

Contamination Avoidance

Protecting equipment and systems relies on two major disciplines – contamination avoidance and decontamination. Contamination avoidance is the art and science of knowing where contamination might be located, in both time and space domains so that manoeuvre units can avoid the problem entirely by being at a place (or time) that minimises risk. Contamination avoidance relies heavily on detection, warning and reporting networks to spread information, and modelling that can predict hazard areas. Although it is dated, Allied Technical Publication 45, a NATO document, is still the standard in this area and it is used by some non-NATO countries as well. As far as industry is concerned, Bruhn Newtech (Denmark) is one of the leaders in this segment.

Author

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Photo: US Air Force

CBRN specialists approach the decontamination site during a CBRN exercise at Keesler Air Force Base. The Force Protection exercise simulated an explosion causing a mass casualty event.

CBRN Decontamination

The counterpart to contamination avoidance is the discipline of CBRN decontamination. Decontamination is aimed as much towards protecting systems and equipment as it is about protecting individuals. This primary countermeasure, decontamination, is not so much about protection of the contaminated assets as it is about the rapid reconstitution of assets so that they may re-enter the battle quickly. Cristanini (Italy), OWR and Kärcher (Germany) are the industrial providers of great repute in this area.

Protecting individuals and reconstituting equipment are subjects that have been analysed at length over the years, including in my own articles in this publication. But there have been fewer efforts to look at a bigger picture. The third axis along which one can slice CBRN force protection is that of protecting capability. There is a sophisticated web of technology, communications, and logistics that allows modern militaries to operate around the world. Dynamic military operations rely on "systems of systems" which can themselves be vulnerable to CBRN threats in several different ways. The idea that CBRN threats are most likely to be delivered as battlefield weapons on the frontline as an extension of conventional weapons is old and only partially valid. CBRN weapons are more likely to have wider effects if used to disrupt command and control, communication, and logistics. Indeed, during the Cold War, much of the Soviet bloc's effort on chemical weapons went into delivery systems such as SCUD and FROG missile warheads that could

strike at ports, airfields, and storage depots deep in the West's rear, thus causing more chaos and confusion than if similar amounts of chemical warfare agent were used in attacks on the front line. When one looks at conflicts and likely combatants in CBRN scenarios, there may be prolific use of doctrine and systems that originated in the Cold War-era Soviet bloc.

CBRN vulnerabilities to military capability are best illustrated by example. Imagine a combat (or peacekeeping) operation in Yemen. Such an operation would likely require a complex logistical operation using airfields, seaports, and possibly overland supply routes. A chemical attack employing persistent chemical warfare agents, such as Mustard or VX, that was targeted at seaport infrastructure and the land transport routes out of the port could seriously diminish operational tempo for a long period of time until necessary decontamination could be undertaken. As another example, an incapacitating chemical agent or biological agent that causes sudden illness at a major forward headquarters could cause significant disruption to operations by interfering with the complex command and control arrangements necessary for modern military operations.

Capability Protection

The primary way to protect capability as a whole is to apply the same measures and technologies that are applied to protecting personnel and for protecting equipment. The overall problem is that no military has ever invested sufficiently in CBRN force protection to be able to provide equal defen-

sive capability everywhere at all times. Such a state of affairs is likely to mean that commanders and logisticians will have to make decisions about allocations of resources. It will also mean that the traditional practice of favouring front-line combat units when it comes to CBRN personnel and technology over rear-echelon units. The experience of many a CBRN NCO and officer is that frontline combat units receive higher priority in CBRN defence than combat support and logistics units. In the US Army, for example, infantry battalions will have a CBRN officer and infantry companies will likely have a CBRN NCO, whose job it is to uphold CBRN readiness. That same reserve battalion could easily have an older generation of protective equipment than the "front line" units.

But a reserve transportation battalion may have no CBRN staff, or if they are lucky, one CBRN sergeant for a large, dispersed force. However, when one looks at the overall big picture, that transportation battalion full of reservists with over 100 heavy cargo trucks is likely to be keeping a lot more than one infantry battalion in the fight by keeping it fed, watered, fuelled, and in ammunition. An honest assessment might yield the revelation that that transportation battalion, and the supply routes on which it drives, may need more protection than an individual combat battalion in many scenarios. If modern military leaders want to engage with the topic of "protecting the force" from CBRN threats, then they must grapple with this sort of fairly complex analysis. This correspondent, who has been a participant and observer in CBRN affairs for three decades, has rarely seen the type and level of vulnerability analysis that would address the CBRN threat to global and regional military capabilities as a whole. While some fairly elegant work has been done to look at systemic vulnerability issues in C3I and logistical domains due to more conventional threats, truly "big picture" CBRN vulnerability assessment of interconnected issues is rare. The single biggest thing that the world's militaries could do to address "protecting the force" is to engage in this type of higher-level analysis. Such efforts will derive the information necessary to make decisions about where to best employ detection technology and decontamination assets, as well as scarce CBRN specialists.

The Covid-19 Pandemic

The nature of modern warfare has long made the old paradigm of "front line" troops obsolete. The potential use of CBRN weapons in either "deep strike" or unconventional ways shifts the "front line" to

ports, headquarters and supply routes. The heroic front line may be decontamination soldiers and truck drivers. Which leads to our present global crisis, the Covid-19 pandemic. It is now axiomatic that the heroes in civil society are cleaners, delivery drivers, and nurses. It would be negligent for this publication to ignore both the impact and lessons given by the Covid-19 pandemic.

Covid-19 is a pressing reminder that the largest CBRN threat to military force in decades, is now one that comes from natural origins rather than acts of warfare. The current worldwide Covid-19 crisis should serve as a reminder that the "B" in CBRN predates all of the other disciplines. For millennia, disease was the largest producer of military casualties, not combat. Even in the modern era, force protection involves protecting armies from diseases endemic in their theatre of operations. Historically, diseases like typhus, malaria, typhoid, yellow fever, dysentery, and smallpox (to name only a few) have had significant impact on military operations. Much of the field of so-called "tropical medicine" originally derives from efforts to protect European military forces deployed in areas with endemic diseases little understood by European medics. By the time this article reaches print, the crisis will have continued to evolve. As of the time of writing of this article, Covid-19 was already beginning to have an impact on military readiness. Exercises are being cancelled or curtailed. Naval vessels are being quarantined. Movement of both individuals and units is being reduced or completely halted. Training is being suspended in many places. As the pandemic grows,

The US Army in Europe relies on five Force Protection Condition (FPCON) levels –Normal, Alpha, Bravo, Charlie and Delta. The levels increase from lowest condition at Normal to the highest and most protective at Delta.

militaries around the world will continue to incur casualties. Military readiness will suffer in several ways. First, illness and death, even if only in small percentages, will cause attrition in military units that will affect the ability to deploy or fight. Second, as militaries enact sensible health measures such as quarantines and isolation, most types of military training will be reduced or suspended. Operational tempo of existing conflicts seems to have not yet been diminished, but it is likely only a matter of time.

Another aspect of the Covid-19 pandemic is that militaries around the world will be increasing focused on support to civil authorities. This is not a bad thing, in itself, as many military capabilities will be needed to support response and resilience efforts to protect the population from this virus. Military units are already providing transportation, aviation, logistics, planning, policing, and other kinds of support around the world. Reservists are being recalled to duty to assist. As the Covid-19 crisis evolves, it will be a test of how well military forces

around the world can support their own civilian populace. Every aspect of military support to civil authorities will be under scrutiny. Civil-military relations, which vary greatly around the world, will become a subject of keen interest this year.

The defence and security aspects of the pandemic have caused concern at the international level. NATO has begun to seriously consider the problem. Jens Stoltenberg, NATO's Secretary General, held a series of consultations with member states from 24 to 26 March 2020. Pooled NATO assets are beginning to be brought into use to help. For example, C-17 cargo aircraft from NATO's "Strategic Airlift Capability" have been carrying medical equipment, including 100,000 protective suits, from South Korea to Romania. However, NATO suffers from a lot of internal and external stresses that pre-date the current crisis. How it will respond as an institution will be an interesting case study.

None of the aspects of CBRN force protection described earlier in this article have served to protect militaries from this menace. The Covid-19 pandemic will likely turn out to be the biggest disease-based threat to military operations and readiness in many decades. By comparison, the official statistics for the Vietnam War show that the US military only suffered only 938 deaths from infectious disease during the conflict, over a period of many years. This is a testament to preventive medicine. But can the US military get through a few months of a Covid-19 pandemic without incurring the same level of deaths?

While some societies, particularly totalitarian ones, may be able to quarantine their military forces, for most countries, the military resides within society or not very far away from it. A public health crisis in the general population will almost invariably affect the military population, particular ones with high contagion like COVID-19. As with the 1918 flu crisis, long forgotten but now being painfully remembered, civilian public health and biological resilience efforts are actually a component of force

Soldiers from the CBRN Joint Task Force Civil Support (JTFCS) are prepared for role-players to come through their Mass Casualty Decontamination line at Exercise Guardian Response at Muscatatuck Urban Training Center, 4 May 2019.

Photo: US Army

sick and incapacitated military cannot provide effective support to civil authorities in their time of need. Contagion does not observe the gates at military bases in or near communities. Sick civilians will eventually make military personnel sick, and sick soldiers and sailors will go home and make the civilian population sick.

Protecting the population, which was the subject of an article in ESD 4/2020, is not a stand-alone discipline, nor is force protection. When confronted with virulent pathogens like COVID-19, they are the same. Shortcomings in civil preparedness bear directly on military readiness when it comes to pandemics. While it is easy to catalogue such shortcomings in light of the present crisis, there are clearly areas where common effort can pay off in both categories. Rapid development and deployment of biological diagnostic technology to identify pathogens would aid both civilian and military protection efforts. Likewise, rapid development of vaccines is a clear "win" in both categories. Stockpiles for emergencies can be broadened and shared. The reality is that both civilians and soldiers face biological threats, whether they are artificial or natural. More "joined-up" thinking, planning, and acting is called for.

There is an apt expression, possibly apocryphal and possibly coined by the late William Patrick, a US biological weapons developer. "Biological warfare is public health in reverse." The present crisis points out that deficiencies in public health processes, institutions, and infrastructures, when confronted by a communicable pathogen of such ferocity as COVID-19, that the converse of Patrick's proposition is equally true. A lack of public health leaves us all vulnerable to things like biological warfare or natural outbreaks of new biological threats. Every scientific indicator points to the fact that Covid-19 is not man-made. But the effects are much the same. The mess that the world finds itself in is surely an indictment of both population protection and military force protection measures. "Protecting the force" needs to look towards a broader horizon of threats, as does "protecting the population." Covid-19 is bad and it will get worse before it gets better. But we need to learn from it.

"Protecting the force" is a hard concept to conceptualise and even harder to implement. But both long-standing basic principles and hard-learned lessons from current affairs need to be examined. ■

protection. A sick populace cannot operate industry and infrastructure, and industry and infrastructure that is not staffed cannot support military operations. Conversely, a

India Concludes Major Coronavirus Repatriation

Suman Sharma

India is currently conducting the world's largest evacuation exercise to bring back Indians trapped around the world due to the outbreak of the Covid19 pandemic. The exercise is codenamed the Vande Bharat Mission. In 1990, when Kuwait was occupied by Iraq, about 170,000 Indians living in Kuwait were repatriated by the official Indian airline Air India. Now, the Indian Armed Forces and the national carrier Air India, along with naval warships, military transport aircraft and commercial airliners, is participating in two phases in what is the largest peacetime repatriation program to date, to bring nearly 200,000 home from 33 countries, including Qatar, Saudi Arabia, Singapore, United Kingdom, United Arab Emirates, USA, Malaysia, Philippines, Bahrain, Armenia, Thailand, Italy, Nepal, Belarus, Nigeria, Bahrain, Kuwait, Oman, Kazakhstan, Australia, Ukraine, Indonesia, Russia, France, Singapore, Ireland, Kyrgyzstan, Kuwait, Japan, Georgia, Germany, and Tajikistan.

Three Lockdowns

After three lockdowns announced by Indian Prime Minister Narendra Modi, it was decided to bring home Indians working and living abroad. According to Civil Aviation Minister Hardeep Puri, "more than 200,000 Indians living abroad had reported for repatriation. Apart from the Air India flight, two ships were also sent to the Maldives to repatriate almost 1,000 Indian holidaymakers, while another left for the Gulf.

The Indian Navy has identified about 14 ships from four of its commands for this purpose – the Western Naval Command based in Mumbai, the Eastern Naval Command based in Vishakhapatnam, the Southern Naval Command based in Kochi, and the Tri Service Command in Andaman and Nicobar.

In the first phase between May 7 and 15, the Indian naval vessels INS JALASHWA, a Landing Platform Dock, and INS MAGAR, a Landing Ship Tank, together brought back 900 Indians from the Maldives to Kochi in the southern Indian state of Kerala under the code name "Samudra Setu", while the Indian naval vessel Kesari delivered 500 tons of food to the Maldives under the code name "Mission Sagar".

The Indian Air Force is on stand-by with about 30 aircraft, including Boeing C-17 GLOBEMASTER and Lockheed Martin's C-130J SUPER HERCULES. Meanwhile, Air India with its fleet of Boeing 777 and 787 DREAMLINERs will operate non-scheduled flights from London Heathrow.

In view of the large number of Indians requesting a return, elderly people, pregnant women, people in medical emergencies, and mourners or people with serious illnesses in their immediate family are given preferential treatment over stranded tourists.

A First Responder in the Region

In the second phase of the "Mission Vande Bharat" from 16 to 22 May, the Indian government plans 149 repatriation flights, including 11 Air India Express flights from Dubai to India, and the Indian Navy will send two of its ships to the Gulf region and one to the Indian Ocean.

A spokesman for the Indian Ministry of Foreign Affairs said: "As part of the Sagar mission, the government has sent the Indian naval vessel Kesari to the Maldives, Mauritius, Madagascar, Comoros, and Seychelles. This ship was sent in response to the request for assistance from these countries. It has two medical teams on board, Covid-19 related medicines and essential food. This assistance is inspired by the Prime Minister's vision - security and growth for all in the region. This is also consistent with India's role as a first responder in the region. In recent days, more than 12,000 Indian nationals have returned safely".

Indian Navy's Rear Admiral MD Suresh, Chief of Staff, Southern Naval Command has stated that upon return, the ships would be thoroughly disinfected before embarking on their next missions. Passengers on board naval vessels are screened before boarding, their luggage is disinfected and they are issued with identification cards according to the different zones designated on board the vessel.

Government agencies have provided appropriate emergency medical facilities on board ships and aircraft. The Indian Navy vessels involved in the exercise have sophisticated medical and quarantine facilities on board, with trained medical personnel able to deal with emergencies such as pregnant mothers, sick children, and the elderly.

Logistic Support for the Multinational BOXER Fleet

Robert Elvish

The NATO Support and Procurement Agency (NSPA) brings nations together by providing multinational cooperative acquisition and in-service support solutions that allow nations to develop and sustain capabilities and to combine their efforts, consolidate and share resources and take advantage of economies of scale.

The unique Support Partnership (SP) structure in NSPA provides a proven legal framework that allows two or more nations to follow common logistics support goals in the national capability spectrum. Nations provide direct governance and guidance whereas NSPA manages the support requested by the nations.

Photo: Rheinmetall

The BOXER support partnership will be strengthened in future by the British BOXERs.

The Netherlands, Germany, Lithuania and the United Kingdom are members of the BOXER Support Partnership and benefit from cooperative in-service support for their BOXER fleets. A dedicated team of 20 NSPA experts in the BOXER System Management Group delivers this support. They are the centre of expertise for Life Cycle Management and Integrated Logistics Support for BOXER armoured vehicles.

The Ribbon of Time

In 2013, The Netherlands and Germany established an initial BOXER support structure at NSPA. Both Nations acquired their systems through OCCAR ((Organisation Conjointe de Coopération en matière d'Armement / Organisation for Joint Armament Co-operation)) and decided to establish a cooperative in-service support structure at NSPA to support their BOXER fleets. In 2018, Lithuania joined the Support Partnership ensuring a smooth transition from production to in-service support and immediately able to benefit from NSPA's support. In addition to the technical logistics support, NSPA also delivered the Spike missiles and ammunition for the mounted weapon systems on the Lithuanian BOXER vehicles.

In January 2020, the UK joined the BOXER Support Partnership. The UK will benefit from the existing experience and an established support network that NSPA has put in place. This will ensure that by the time the first vehicles enter into service it will have a capable support structure in place which can be adapted to meet the UK's growing needs. At the same time, current partner nations benefit by sharing resources and non-recurring costs while exploiting commonalities and economies of scale.

At this moment in time, the BOXER Support Partnership has four member nations with NSPA set-up to support this modern fleet ramping up to 1200 BOXER armoured vehicles over the next several years.

Current BOXER Fleet Support Portfolio

The NSPA Air & Land Combat System programme office provides acquisition and life cycle support solutions for 12 Multinational Support Partnerships. These include missiles (AMRAAM, Sidewinder, HARM/AARGM, TOW/ITAS, SPIKE, and Stinger) artillery systems (MLRS and PzH 2000), Night Vision and Opto-electronics equipment, Tactical Unmanned Aerial Systems and armoured fighting vehicles including the LEOPARD, DINGO, Light Armoured Vehicle (LAV) as well as the BOXER.

The current BOXER fleet support portfolio includes technical and project support

Author

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Photo: Bundeswehr / Marco Dorow

BOXER has demonstrated its reliability in the field for almost a decade now

through experienced project managers, engineers and technicians. This provides transparency and a structured project control framework to stakeholders in order to achieve project results in a timely and cost-efficient manner. Brokerage support and Stock management including more than 1100 line items selected by nations are held on-site in Luxembourg ensuring prompt availability of spares.

Remaining spares are available through existing outline agreements or competitive procurement. A highly skilled procurement team with deep experience dealing with the key vendors supporting the BOXER fleet ensures a responsive and accountable network of suppliers.

BOXER – A Flagship Support Partnership

BOXER has quickly become the flagship Support Partnership for land weapons systems in NSPA. Its success lies in the cooperation amongst all of the key stakeholders including OCCAR, ARTEC and the nations.

The BOXER Support Partnership balances the nations' interests to achieve their goals. NSPA expects new BOXER user nations to benefit from the established BOXER Support Partnership structure.

The robust support structure, currently in expansion to support a common fleet of 1200 vehicles, the ongoing cooperation and new initiatives with industry and OCCAR and the available in-house expertise all point to the continued success of the BOXER Support Partnership. ■

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Directed Energy Developments

Joris Verbeurgt

Directed energy weapons (DEWs) are weapons that use highly focussed energy to damage or destroy their target. They can be used against personnel, missiles, all sorts of vehicles, and optical devices.

Three main types of highly focussed energy have been identified for their practical use in warfare: laser (emitting Light through a process of optical Amplification based on the Stimulated Emission of electromagnetic Radiation), microwaves (a form of electromagnetic radiation with specific wavelengths and frequencies), and particle beams (a stream of charged or neutral particles, moving at near the speed of light). Sound (a mechanical type of energy that causes waves of pressure due to vibration) is a fourth type of DEW, but the possibilities for military application seem rather limited.

Historical Developments

The first DEW usage is attributed to the third century BC famous Greek mathematician, physicist, engineer, inventor, and astronomer Archimedes. According to legend, he set the fleet of the Romans on fire as they invaded his Sicilian hometown of Syracuse by focusing the sunlight on a single point on their ships with the help of a mirror (or a series of mirrors) with an adjustable focal length. It is debatable whether this event really took place, but modern scientists have proven that, at least in theory, Archimedes' DEW could have worked.

The search for DEW really took off in the 1930s as the world was preparing for a second world war. In the process of exploring the feasibility of a 'death ray', the British Air Ministry discovered that radio waves could be used for the detection of aircraft, thus giving the starting signal for the development of radar in Britain. The Germans conducted experiments with a 'sonic cannon' that caused vertigo and nausea (and potential lethal vibrations) in the target body by concentrating and amplifying sound. However, the weapon was deemed vulnerable and unpractical, and the research was soon abandoned. Another Wunderwaffe under construction was the 'Rheotron', an X-ray beam weapon designed to bring down aircraft. In 1945, it was captured by the Americans and further developed.

A Directed Energy Effector developed by MBDA undergoing testing

Effects

The deployment of DEW enables a wide range of high-level defensive and offensive non-kinetic options. In conjunction with kinetic energy systems, the DEWs can serve as a force multiplier.

When used against personnel, DEWs cause a variety of bio-effects. The use of microwaves can cause breathing difficulties, nausea, pain, vertigo, and general systemic discomfort. Interference with the breathing system of the target, gives the highest chance of a lethal outcome. The use of light and repetitive visual signals can induce epileptic seizures and provoke the occurrence of vection (illusions of self-motion) and motion sickness. DEWs also can be integrated in Active Denial Systems (ADS) designed for area denial, perimeter security, and crowd control.

When used against weapon systems, facilities, ships, vehicles, and equipment, the possibilities of DEWs seem endless: laser can be used in anti-missile defence, or to blind satellite sensors, destroy ammunition depots, or neutralise Unmanned Arial Vehicles (UAV's). DEWs can cause permanent physical damage or temporary system disruptions and can result in fires or electric shocks to critical services. Electronic components, systems, and networks, from a high-tech plane or missile to the radio of a common soldier, can be destroyed or disrupted.

Advantages

The last decades have seen an exponential growth in investments, research, discoveries, and applications in the field of DEW. DEWs have certain advantages over conventional weaponry: first of all, the use of DEWs may be cheaper than their conventional counterparts; the effects of the deployment of DEWs, although potentially lethal and destructive, can also be mitigated, and therefore, the outcome of a conflict can be less expensive. Besides an economic reason, the logistical and operational advantages are manifold: logistical problems, in terms of ammunition supply, are significantly reduced. As long as there is enough energy to power the DEW, its functioning is assured (a so-called 'deep magazine'). Also, the use of DEW is, in certain operational contexts, discreet: radiation above and below the visible spectrum is invisible and does not generate sound. This makes DEWs also very suitable for purposes of crowd control. DEWs travel nearly at the speed of light and have near infinite range, making them hard to discover or to counter. This characteristic also makes them very suitable for space warfare. Another advantage is that DEWs are essentially unaffected by gravity, day or night conditions, and the Coriolis effect (an effect whereby a mass moving in a rotating system, such as the earth, experiences a force that tends to deflect moving

Photos: Rheinmetall

A 10 kW DEW turret developed by Rheinmetall

objects to the right in the northern hemisphere and to the left in the southern). The almost perfectly flat trajectory makes the aim more precise and considerably extends the line-of-sight range.

Disadavantages

After decades of research and development, directed-energy weapons are leaving the experimental stage, and it is likely that they will be deployed as practical, high-performance military weapons in the near future. However, two main disadvantages slow down the deployment on the battlefield.

First, the lack of experience with this kind of weapons makes it very difficult to predict their impact on the battlefield and on modern warfare in general. There is a consensus that the large-scale deployment of DEWs will revolutionise modern warfare, but how their integration in the existing weapons systems and operational planning processes can be achieved, is still a matter of debate. There are no 'best practices' and a lot of the thinking with regard to the political, strategical, operational and tactical consequences still needs to be done. Consequently, the development of doctrine and the writing, testing, and evaluation of the operational and tactical manuals is also still in an early phase. Training

on the level of the individual soldier or the unit is possible, but large-scale joint exercises involving numerous conventional weapons systems, is yet a fiction.

Second, there are the legal constraints: little is known about the potential damage these weapons can inflict on human physical and psychological welfare, as well as against the civilian infrastructure. Some DEWs can cause the same effects as chemical weapons and radiation levels, energetic outbursts and temperatures can potentially reach levels comparable to those of nuclear weapons. Therefore, the large-scale deployment of DEWs in real conflicts will necessitate revisions or extensions of the existing law of armed conflict, humanitarian law, rules of engagement and international treaties. The fact that DEWs are particularly useful for spatial warfare, which itself is a legal minefield, further complicates legal matters.

Recent Developments

DEWs have been in the Research and Development phase for the past several decades. In recent years, R&D was speeded up and DEWs are gradually making their way from the drawing table and prototypes to military testing programmes. When the legal, tactical, and operational difficulties are overcome, the next steps will be acquisition, force

integration, and finally, deployment on the battlefield. So far, Turkey is the only country that has DEWs in active service and it is reported to have shot down a Chinese-made drone in Libya with a laser weapon mounted on the back of an armoured car in August 2019. However, this does not imply that Turkey is ahead of all other nations in the development and deployment of DEWs: Ankara is just prepared to take more risks with weaponry that is not yet fully tested or hundred percent operational. Countries that invest heavily in the development of DEWs are the US, Israel, Russia, China, India, and the UK.

USA

It is no surprise that the US leads the race for operational DEWs. Between 2017 and 2019, the Defense Department doubled the annual budget for DEWs to US$1.1Bn. The Pentagon, the DARPA, the Air Force Research Laboratory, the US Army Armament Research Development and Engineering Center, and the Naval Research Laboratory are all researching DEWs to counter ballistic missiles, to develop hypersonic cruise missiles and hypersonic glide vehicles. The systems of missile defence are expected to become an operational reality in the course of 2020.

The US Air Force procured laser weapons to knock down drones from the sky. They work by heating an object until it catches fire, melts, or explodes. To defend against large swarms of drones, the USAF also bought a microwave weapon from the same provider Raytheon. Unlike a laser's tight beam, the microwaves propagate in a cone shape, meaning they can engage many targets at once. The weapons come in a container-sized box, are C-130 transportable, and can easily be mounted on a small All-Terrain Vehicle (ATV). Deployment can take place within a couple of hours.

Lockheed Martin is working hard to provide capable DEW's for use on the battlefield. Innovative fibre lasers, sophisticated beam control, and auxiliary technologies are combined with platform integration to enable offensive and defensive capabilities against a growing range of threats to military forces and infrastructure. Today, Lockheed Martin's technology can defend against small rockets, artillery shells and mortars, small UAVs, small attack boats, and lightweight ground vehicles that are approximately a mile way. As fibre laser power levels increase, Lockheed Martin is convinced that the systems will be able to disable larger threats across greater distances.

Israel

Israel is already familiar with DEWs, as it has numerous operational laser-based countermeasures against infra-red missiles, the

Photo: US Navy

The USS PORTLAND used its high-power laser weapon, the Solid State Laser - Technology Maturation (SSL-TM) Laser Weapon System Demonstrator (LWSD), to destroy a UAV during trials in May 2020.

At a December 2019 MFIX Raytheon's high energy laser and high-power microwave destroyed 45 drones.

so-called Directed Infra-Red Counter Measures (DIRCM). In January 2020, Israel announced a breakthrough of a laser-based missile interception system, complimentary to the IRON DOME system. The system is still under development, but the breakthrough regards the power of the laser beam on the one hand and its accuracy on the other hand. The Israeli laser should also be able to overcome atmospheric disturbances. Israel has invested heavily in R&D and can count itself among the leading countries in the field of high-energy laser systems. Demonstrations of Israel's capabilities are scheduled throughout 2020. The Israeli system, most likely developed with the help of the US, would not only be effective against missiles and projectiles, but also against aircraft and drones. The new system offers three main advantages to Israel: it would lead to a drastic reduction in the cost of interception; it would overcome the limitation imposed by the numbers of intercepting missiles since directed energy requires no physical interceptors, and the scalable power makes it useful against a variety of human and non-human targets.

Russia

Russia has an operational laser weapon to perform the tasks of Air and Missile Defence. In 2017, Russia already started equipping its armed forces with the PERESVET, as the laser is called, and early 2018, it came on experimental combat duty. It is believed that since December 2019, five rocket divisions of the RVSN (Strategic Missile or Rocket Forces) have PERESVET on operational combat duty, in combination with the road-mobile Intercontinental Ballistic Missile (ICBM) launchers. However, the main function of PERESVET is to protect military bases and other locations from penetrations of UAV's into their territory. Disadvantages of PERESVET are the enormous consumption of electricity and the difficulty to provide it, and the fact that it doesn't perform effectively in bad weather conditions. But none the less, Russia is keeping up with other powers in the development and deployment of DEWs.

China

China recently disclosed the development of a new DEW, known as the 'Chinese Laser Gun'. Although little detail was disclosed on the new weapon, the system is said to be designed for instantly obliterating targets near a coastal line, including small boats and UAVs. The weapon will first be used by the Navy of the People's Liberation Army against low-end asymmetric threats. The scalable power levels of the system allow firing a non-lethal beam to dazzle a suspect vessel, and fire stronger beams to physically destroy a target. In addition, the Chinese Navy has begun trials at rough sea of the HAIYANG-SHAN, its warship-mounted electromagnetic railgun installed on a tank-landing ship. The electromagnetic railgun is expected to be operational by 2025.

India

India has the vision for laser weapons as well as the scientific talent to absorb and build on the technology. Two laboratories of the Defence Research and Development Organisation (DRDO), the Centre for High Energy Systems and Sciences (CHESS), and the Laser Science & Technology Centre (LASTEC), have been working on developing laser weapons technology for the last few years. In July 2018, they achieved a first success with a vehicle-mounted 1-kilowatt laser weapon system. Since that initial test, India is progressively building more powerful laser weapons. It also seeks to establish partnerships with Israel and the US to profit from their know-how on the development of DEWs. India has long borders, a huge airspace, and with Pakistan as an enemy, and China as a regional competitor, India needs to contain the escalating costs of air defence. Laser-based weapon systems could provide an affordable solution. They can not only target drones, but also handle the increasing non-traditional threats that India is confronted with. Even more, laser weapons could turn out to be cheap anti-satellite weapons for a country that is determined to play a major role in the space race.

United Kingdom

The UK was among the first countries in the word to start experimenting with DEWs. It also developed one of the first operational laser weapons in the world, DRAGONFIRE. In 2017, a consortium of high-tech companies was assigned US$37M to develop a prototype of a laser gun under the lead of the Defence Science and Technology Laboratory. The system combines multiple laser beams to create one of the most powerful laser weapons systems yet developed. In its effort to prepare the armed forces for the battlefield of the 21st century, the UK MoD decided in July 2019 to drastically increase the R&D budget for DEWs. Starting in 2023, a number of tests will be conducted involving the Royal Navy and the Army, with a budget of US$162M. Within a decade, this Novel Weapons Programme should generate an output which is ready for use in combat. The new programme includes two high-energy laser demonstrators – one on-board a ship for air and surface defence applications, and a similar laser mounted on a land vehicle for short-range air defence and counter-surveillance applications. The third programme is aimed at demonstrating a high-power radio frequency weapon mounted on a land vehicle against aerial drones and to counter enemy movements. The weapon is designed to disrupt and disable an adversary's computers and electronics.

Conclusion

This short overview of what is currently going on in the world of DEWs clearly demonstrates that the question is no longer if DEWs will play a major role on future battlefields, but when. Until recently, the destructive use of laser, particle beams or microwaves was reserved for science fiction movies like Star Wars, but it is becoming reality as we speak. The coming decade might witness a revolution in warfare comparable to the invention of gunpowder or the introduction of aircraft on the battlefield. For now, laser is the most popular type of highly focused energy for military applications. Laser has been used by the military for quite some time (to guide missiles to their target, for example), but much of the research now is focused on deploying laser as a weapon to disrupt or destroy UAV or smaller vehicles. It is only a matter of time before laser will be able to destroy larger targets. Microwaves and particle beams seem less popular at this time, but we have to take into account that the research and experiments are surrounded by the greatest secrecy. In order to evolve more, a solution has to be found for the high need of electric power that the implementation of these high-voltage weapons require. In the near future, we will see DEWs make their appearance on the battlefield. Much has to be learned yet with regard to the science behind directed energy and their applications in a military context, but the results so far are very promising. Especially in space, which is becoming more and more militarised, DEWs will be key for any power who desires to play a role there. ■

The Continuing Evolution of the Combat Helmet

David Saw

For more than one hundred years the combat helmet has been an essential part of the personal equipment of the soldier. In that time, helmet designs have evolved dramatically, as have the materials used to construct helmets.

There is also far more medical information available which allows helmet designs to be fully optimised to provide the highest levels of protection. Despite all of these advances, the evolution of the combat helmet continues as new data becomes available and understanding of changing mission requirements leads to new helmet solutions.

Another factor that has influenced helmet design is that there is a vast amount of recent combat experience to take into account, Operation Enduring Freedom in Afghanistan began in late 2001. This was subsequently followed by operations in Iraq and since then operational activity has spread across the Middle East, into Africa and beyond. All of this combat experience inevitably generated a lot of lessons, and this saw changes across the whole spectrum of equipment, from boots, to uniforms to Personal Load Carrying Equipment (PLCE) to body armour and other protective equipment. Responding to the requirements generated by almost two decades of combat has been aided by the fact that there have been significant advances in materials technology over that time period.

It is also important to take into account the medical aspects of developing effective soldier systems and, crucially, to increase the ability of the soldier to avoid or survive serious wounds or trauma. Experience is vital here. Over the years of the 'Troubles' in Northern Ireland, the Royal Victoria Hospital in Belfast developed enviable expertise in treating victims with gunshot wounds, becoming a global centre of excellence in the field. Lessons drawn from Belfast would be applied internationally, and would also contribute to the development of medical systems and devices that would increase survival rates in the wake of gunshot wounds. Combat in Afghanistan, Iraq and elsewhere has provided important information on the treatment and prevention of wounds, and even non-combat injuries. In parallel with

Photo: Commonwealth of Australia

Australian infantry of 2nd Battalion, Royal Australian Regiment (RAR) on exercise. Australia will be acquiring a new combat helmet after SORD Australia were awarded a contract to develop a new 'Concussion Reduction Helmet' to lessen the risk of Traumatic Brain Injuries (TBI).

this, there has been consistent funding of research covering medical factors and materiel factors seeking solutions to issues raised during combat operations. Combat operations still continue, and, as we shall see, lessons are still being learned and critical research is still ongoing.

Starting Point

The trench warfare of the First World War led to an urgent requirement to provide protection against the overhead threat of shrapnel and fragments. The solution was the helmet and the first to field a helmet were the French Army in 1915, in the form of the M15 ADRIAN helmet (an evolved version was introduced in 1926). The M15 ADRIAN had limitations, the steel used was very light in comparison to what other helmets would use. On the other hand, the crest on top of the helmet would help to deflect fragments and the liner was designed as an element of shock protection. As we shall see, the design of the ADRIAN helmet has suddenly become very interesting to those working on next generation helmets.

The next year saw the arrival of two significant helmet designs, the German STAHLHELM and the British BRODIE design. The STAHLHELM was inspired by the medieval Sallet helmet and offered good neck and side of the head protection, the final evolution of this helmet design was the M-56 steel helmet as used by the DDR Nationale Volksarmee (NVA). The British BRODIE helmet was also inspired by a medieval helmet used by archers; the helmet provided no protection to the side of the head though.

The BRODIE design remained in first-line service with Britain until replaced by the MkIII helmet in 1944. In turn this was replaced by the MkIV helmet in 1959, this was the last British steel helmet. The Mk6 helmet, made of ballistic nylon, entered service in the early 1980s. Then came the Mk6A in 2005, followed by the evolved Mk7 design in 2009. This was superseded by a part of the British Army Project VIRTUS personal protection system, where the Revision BATLSKIN COBRA helmet came into service from 2015. The same helmet was also selected by Denmark. Key characteris-

tics of British helmets in the post-steel era were weight reduction, increased ballistic protection and ergonomic design.

The first helmet used by US was the British BRODIE design and this remained in service until the end of 1941 when it started to be replaced by the iconic M1 steel helmet. The M1 would remain as the standard helmet through to 1985. The M1 helmet design would be widely adopted by NATO and throughout the world, until it started to be replaced from the mid-1980s. For the US military, the successor to the M1 was developed under the Personal System for Ground Troops (PASGT) programme, with the PASGT helmet becoming the de facto standard from 1985 onwards.

The next stage beyond the PASGT helmet was to be the Modular Integrated Communication Helmet (MICH), although non-US helmet solutions had also been evaluated as potential PASGT successors. The MICH helmet entered service in 2001. It was followed by an evolution of the MICH design in the form of the Advanced Combat Helmet (ACH) from 2002 onwards, with the design evolving further into the Enhanced Combat Helmet (ECH) which started entering service from 2013 onwards. The successor to the ACH/ECH will be the Integrated Head Protection System (IHPS), which started entering service in 2019.

The transition from the PASGT through to the current ECH and beyond to the IHPS, has seen weight reduction, increased ballistic protection and changes in helmet structure and shape to better integrate with the other aspects of soldier equipment. The key point with the IHPS is that it offers the same level of ballistic protection as the ECH, more importantly the new helmet is said to offer double the level of protection provided by the ECH in terms of blunt impact injury or trauma to the head of the soldier. The challenge of ballistic protection has been resolved. Now the emphasis is on dealing with an issue that is increasingly become critical – that of Traumatic Brain Injury (TBI).

Tackling Trauma

In January 2020, an Iranian missile attack on US forces at Ain al-Assad air base in Iraq saw eight missiles hit the base. The US forces were dispersed and in bunkers having had an attack warning. No US troops were killed or seriously injured in the attack. However, it later became clear that injuries had occurred, with 110 of the US troops on the base being diagnosed with TBI at various levels of seriousness. The cause of the TBI was the blast shockwave caused by the impact and detonation of the incoming missiles.

An image of the testing process in the Duke University study on "Primary blast wave protection in combat helmet design." The US ACH helmet is being tested on the left, with the French ADRIAN helmet of 1915 being tested on the right. The ADRIAN demonstrated better blast wave protection characteristics.

According to the Defense and Veterans Brain Injury Center (DVBIC) in the US," a Traumatic Brain Injury (TBI) can be classified as mild, moderate, severe or penetrating. The severity is determined at the time of injury. A TBI is a blow or jolt to the head that disrupts the normal function of the brain. It may knock you out briefly or for an extended period of time, or make you feel confused or "see stars" (alteration of consciousness). Not all blows or jolts to the head result in a TBI. The most common form of TBI in the military is mild. Concussion is another word for a mild TBI."

The primary causes of TBI in the military are blasts, bullets, fragments, falls, motor vehicle crashes and rollovers, sports and assaults according to the DVBIC. On deployment the primary cause of TBI is blast. Physical symptoms of TBI include headaches, sleep disturbance, dizziness, balance problems, nausea and vomiting, fatigue, visual disturbance, sensitivity to light and ringing in the ears. Cognitive TBI symptoms are concentration problems, temporary memory loss, attention problems, slow thinking and difficulty in finding words. Emotional issues caused by TBI include irritability, anxiety, and mood swings. The DVBIC notes that TBI can cause prolonged or even permanent neurological damage, even early onset dementia.

How prevalent is TBI? According to the DVBIC, between 2000 and the third-quarter of 2019 the number of US service members diagnosed with TBI totalled 413,858. From a high point of 32,834 TBI cases in 2011, numbers had been reduced to between 17,000 and 18,000 cases per annum from 2016 to 2018. The figures for nine months of 2019 were 15,262 TBI cases, suggesting the final numbers for 2019 were liable to be at the higher end of the spectrum. It is important to note that multiple concussions, even at the relatively low end of the TBI spectrum can lead to neurological damage.

The modern helmet has certainly met the test as far as protecting against ballistic threats, but clearly there is now a shift in emphasis to find enhanced protection levels to defeat the threat posed by TBI. The TBI injuries sustained at Ain al-Assad put the spotlight firmly on the TBI issue. Then, in February 2020, a university research study into helmets came out with the claim that the French ADRIAN helmet of 1915 provided better blast wave protection than the ACH currently deployed by the US military.

The Past Guides the Present

A team of PhD students at the Department of Biomedical Engineering, Pratt School of Engineering at Duke University, Durham, North Carolina had conducted a peer re-

The Enhanced Combat Helmet (ECH) in use with the US Marine Corps. The ECH started entering service in 2013, supplementing the Advanced Combat Helmet (ACH). The next generation US helmet is the Integrated Head Protection System (IHPS). US helmet evolution is characterised by reduced weight and increased ballistic protection.

viewed study entitled "Primary blast wave protection in combat helmet design: A historical comparison between present day and World War I." This had made the claim about the greater blast wave protection of the ADRIAN helmet over the current ACH, based on an extensive testing regime that saw researchers evaluate the performance of the ACH, in comparison with World War 1 helmets such the BRODIE (as used by the British and the US), the STAHLHELM used by Germans and the ADRIAN.

The Duke study notes that, "Since World War I, helmets have been used to protect the head in warfare, designed primarily for protection against artillery shrapnel. More recently, helmet requirements have included ballistic and blunt trauma protection, but neurotrauma from primary blast has never been a key concern in helmet design." The authors of the study went on to state that "only in recent years has the threat of direct blast wave impingement on the head – separate from penetrating trauma – been appreciated." To provide more data on blast wave protection, the objective was to "compare(s) the blast protective effect of historical (World War I) and current combat helmets, against each

other and 'no helmet' or bare head, for realistic shock wave impingement on the helmet crown."

The testing process in the Duke study was described as follows: "Helmets were mounted on a dummy head and neck and aligned along the crown of the head with a cylindrical shock tube to simulate an overhead blast. Primary blast waves of different magnitudes were generated based on estimated blast conditions from historical shells. Peak reflected overpressure at the open end of the blast tube was compared to peak overpressure measured at several head locations. All helmets provided significant pressure attenuation compared to the no helmet case. The modern variant did not provide more pressure attenuation than the historical helmets, and some historical helmets performed better at certain measurement locations. The study demonstrates that both historical and current helmets have some primary blast protective capabilities and that simple design features may improve these capabilities for future helmet systems."

The World War 1 helmets were all manufactured using similar materials, although it was noted that the French steel was thinner, and all of the helmets provided protection against

blast. Where the ADRIAN helmet differed from the others was that it had a crest on top of the helmet crown and it was believed that this crest might have an effect in terms of deflecting shock waves. During testing, the peak reflected pressure on the helmet crown of the ADRIAN was the lowest of all of the helmets tested in terms of brain injury risk, substantially better than the other World War 1 helmets. More surprisingly, while the ADRIAN was rated as having a one percent moderate bleeding risk in terms of brain injury, the ACH was rated as having a close to five percent moderate bleeding risk.

The crest on the ADRIAN certainly seemed to play a role in improved blast protection, but the study also noted that the helmet brim was also important, as was the level of coverage of the head offered by the helmet. The different structural layers in a modern helmet can provide increased protection as "a shock wave is reflected every time it encounters a new material with a different acoustic impedance." The Duke study demonstrates that blast protection can be increased through structural layering, and enhanced helmet designs that have optimum design crest and brim. All of which indicates that the search for the perfect helmet continues. ■
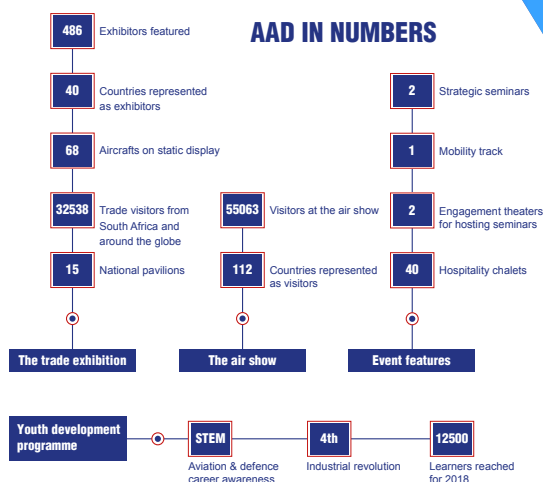
Protected Vision

David Saw

As with so many other areas of military equipment, experience gained over the past nearly two decades of intensive combat around the world by western militaries has seen significant changes in personal protection-related areas. In the past it seemed to be assumed that protective equipment such as body armour was nice to have, then combat experience came into play and nice to have suddenly became an essential piece of equipment.

Combat experience provides the metrics for the development of operational re-

Too much weight reduces mobility, increase fatigue and risks injury. However, even a minimal increase in weight can deliver a significant boost to protection in critical areas. While there has been much emphasis on improved body armour and helmets, there has also been improved understanding of the need to provide effective protection for eyes.

A scenario from Afghanistan; a vehicle-based patrol drives into an ambush, an IED is detonated and the patrol vehicle subsequently finds itself in a hole caused

loss of vision. Hence the logic of equipping soldiers with ballistic eye protection.

There are other threats to confront where eye protection has an important role to play, light and heat being a case in point. Light could be accounted for by lasers or generated by explosions and fires, with heat resistance also important to protect against burns for example. Chemicals also present a threat, these could include fuels, cleaning agents, solvents, acids and, of course chemical agents. Biological threats include viruses and bacteria, bodily fluids and a host of other contaminants. Confirmation of the importance of eye protection is evidenced by the importance placed on eye protection as part of Personal Protective Equipment (PPE) utilised by medical personal and others during the current Covid-19 outbreak.

When the British Army introduced an advanced integrated body armour, helmet and integrated load carriage system as a part of the VIRTUS programme, also included were ballistic glasses, goggles and a visor system. The ballistic glasses acquired were the Revision SAWFLY model, it should be noted that Revision divested themselves of their eyewear business, selling the business to ASGARD Partners, a New York-based private investment company in October 2019. The inclusion of eye protection as part of VIRTUS, which was based on the lessons of British Army combat experience in Iraq and Afghanistan, illustrates how understanding of threats to the eyes has grown, leading to recognition of the need to take action to minimise the threat. ■

Under Project VIRTUS the British Army introduced an advanced integrated body armour, helmet and integrated load carriage system. Also acquired as a part of VIRTUS were ballistic glasses, goggles and a visor system. Eye protection is now regarded as an essential part of soldier protective system requirements.

quirements and the solutions that meet those requirements. Ongoing R&D stimulated by military requirements, as well as civilian-based R&D provides new materials and, often, new thinking that can be applied to current and future military needs. If one compares the quality, functionality and even the weight of body armour in 2001 to what is available today, it is obvious that immense progress has been made. In terms of protection though it not just about body armour though, helmet design has advanced dramatically in the same time period. The British Army used the Mk IV steel helmet for over 20 years, yet in the modern era (since 2005) it has introduced three different new helmet types each of which offers increased protection and better ergonomics.

There are limitations on the level of personal protection that one can equip a soldier with, one key takeaway from all of these recent combat operations is that we are overloading the troops on the ground.

by the blast and surrounded by a cloud of dust and muck. The patrol vehicle was designed to mitigate the effects of such an IED strike and the crew have survived the blast, the fact that they were wearing body armour and helmets has protected them against fragments and debris, and reduced concussion effects. More importantly they were wearing protective eyewear, had they not then the fragments from the IED and all the particulate matter generated by the blast could have blinded some or all of them.

Change the environment and the risks still exist, for example a patrol in an urban environment comes under fire and hostile rounds striking a building generate fragments and clouds of particulate matter. Abrasions to the eye caused by foreign bodies and lacerations to the eyelids are common problems encountered in these environments. Eye injuries can lead to temporary blindness and at worst to permanent

The Gentex Corporation Ops-Core Mk1 performance protective eyewear system was introduced in 2019. These might look like a very sleek pair of glasses, but they feature a strong metal frame and multiple potential lens options including ballistic protection and Advanced Laser Eye Protection (ALEP).

Provincial Confusion

Charles Rampling

Over the weekend of 18/19 April 2020, rural Nova Scotia saw the worst mass shooting incident in Canadian history. The perpetrator, Gabriel Wortman, aged 51, was responsible for the deaths of 22 people, and three injured. Wortman was killed by a Royal Canadian Mounted Police (RCMP) officer at a service station on 19 April.

As with the École Polytechnique mass shooting in Montréal in December 1989, where 15 were killed including the perpetrator, the Nova Scotia shootings resulted in major changes to Canada's gun control laws.

Regulations covering personal possession of firearms in Canada, while not as restrictive as some of those in Europe – for example the UK – were certainly far more onerous than those commonly applied in the US.

Wortman had a firearms license at one point, but had been found guilty of assault in 2002. Consequently, he was put on probation, obliged to undergo anger management counselling and banned from the possession of weapons. However, probation meant that Wortman did not have a criminal record. Later, in 2013, a neighbour reported Wortman to the police, for domestic violence and possession of a substantial quantity of weapons, believed to be illegally held.

Nothing was done.

A Rapid Response

The aftermath of the Nova Scotia mass shooting included a rapid response from the Canada's left-of-centre Trudeau government, which had been promising new gun control measures since its election.

Nova Scotia provided the catalyst to act against 'assault weapons' and 'military-style weapons.'

Under the terms of the new law some 1,500 different weapons have been banned, but what was included on the banned list initially led to some confusion and subsequently, indeed, astonishment.

As one might imagine, prominent on the banned list are M16, M4, AR-15 and AR-10 type rifles. Perplexing, however, was the listing of the Blackwater BW-15, an Airsoft toy gun; AR15.com - a website on the M16/AR-15 platform; and the Black Rifle Company, who are best known as supplier of (excellent) coffee.

To be fair, over ten years ago Blackwater PMC ordered 400 AR receivers, though only 50 were ever built: Black Rifle was the name of a small Arizona-based company that made AR receivers: and the company that owned the AR15.com site did manufacture AR receivers once upon a time.

Some of the other items on the banned list are even more curious.

For example, it is difficult to believe that Canadian civilians are sitting on 60mm, 81mm and 120mm mortars sourced from Argentina, Austria and Chile.

Standalone and UBGL40 mm grenade launchers are listed.

We are moving into eyebrow-raising X-Files territory with inclusion of the RPG-2 and RPG-7, as well as most current light anti-tank weapons including the M72 among many others. Canadian lawmakers even list the M40A1 106mm recoilless rifle, as well as World War 2 anti-tank rifles from Britain, Finland, Germany, Japan and the Soviet Union.

Since when has a Soviet M1942 45mm anti-tank gun been an assault weapon?

And how many Canadians use the Japanese Type 97 20mm anti-tank rifle - which weighs some 52 kg and was last built in 1943 – to rampage around the countryside and shoot up the towns?

Canadian law goes on to name a selection of US, European, Soviet and even Iranian anti-tank missiles as newly-banned items. One wonders if Canadians really are in the habit of picking up their TOW or JAVELIN missiles under a local bar counter. Perhaps to go with their air defence weapons? We're only mildly surprised that STRELA, IGLA, STINGER and STARSTREAK all make the list...

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