

European Security & Defence

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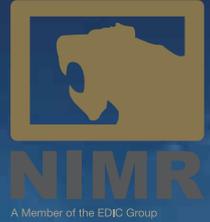
SP Artillery: A Present Need

- Russian Nuclear Strategy
- UAE Defence Planning
- Anti-Submarine Warfare
- Italy's Forza NEC Programme
- Biodefence
- Border Security
- CHINOOK Upgrade in Spain
- Mine Warfare Platforms





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Europe Needs Partners to Secure Stability



The "Pathways to Peace" report recently presented by the World Bank and the United Nations provides a picture of the global security situation which looks completely different to that which its somewhat naive, optimistic sounding title might lead one to believe. The number of armed conflicts has trebled in the past ten years. In 2016 there were ten times as many deaths due to war than in 2005. According to statistics by the UN Refugee Agency, over the same period the number of people forced to leave their homelands due to armed conflicts or persecution has almost doubled.

At present, however, wars between states are the exception. Internal conflicts predominate, very frequently with overt or covert foreign involvement. It is in these that the bitter logic of every civil war comes to the fore: Even when the guns fall silent, this still does not mean that a solution has been found. It is often an impossible task, or one which will be drawn out over generations to come, to unite a shattered society once again within the framework of a stable state. Libya provides an immediate contemporary example of this, and for almost 30 years Lebanon has been showing how protracted and vulnerable a peace process can be in the wake of a civil war.

There is no global order which could put an end to this increase in conflicts. For a brief period after the end of the Cold War, it seemed as if the Pax Americana could offer such a framework. But very rapidly, at the latest with the turmoil in Iraq, it became clear that the USA does indeed have the power to intervene anywhere in the world, but is not in a position also to maintain control in the long term in the places in which it takes action, or to shape regional order in line with its own conceptions.

The Americans are nevertheless a super power, and will remain so in the future. This is not the case with the Europeans. To mention them in the context of a global security framework as a decisive player means to risk a gale of laughter. It is true that they may still be an important factor in terms of the world economy, even if today they have lost the leadership in technology in a good number of sectors, and overall are facing more intensive competition than previously, the rules of which they are no longer able to dictate. It is also beyond dispute that the Europeans have a vital interest in global stability, because their wellbeing depends on reliable supply chains, trade routes that are not subject to threat, and access to sales markets. But there is a substantial discrepancy between the perception of what their actual interests are, and the means to uphold them. The Europeans like talking about the responsibility they bear for peace and stability, and they talk about it a lot, sometimes giving the impression that they have not noticed how their role in the world has changed in the past 75 years. However, they do not have the resources, nor the political will, to practise power projection anywhere. Thus they are not succeeding in establishing stability right on their own doorstep, in North Africa and Middle East, nor even on their own continent, as shown not only by the Ukraine crisis.

If the Europeans want their interests to be safeguarded, they need partners who do have the power and the means which they themselves do not. In this context, the preferred partners are and remain the United States. This perception is today unpopular, and, since the access of Donald Trump to office, a cruder concept of anti-Americanism has become widespread in Europe, which in some countries has even become manifest in government circles. The result is a dangerous self-overestimation, in which dreams of strategic autonomy are beginning to feature. Europe, however, does not have a choice between an independent role in world politics or a continuation of the alliance with the USA. Rather, the choice is only between insignificance or transatlantic cooperation.

The experience of the last 25 years also shows, however, that not even the combined capabilities of the Europeans and the Americans are sufficient to stabilise crisis regions. That needs regional partners. These will only be found, and only be moved towards a lasting cooperation, if they are not constantly being lectured as to how they should best set their own houses in order. The basic principle in international law, originally conceived as a rule that would establish peace, namely not to interfere in the internal matters of other states, has in recent times somewhat slipped people's memories. Donald Trump has rediscovered it. The Europeans should try to make friends with it. If they adopt a policy of a wagging finger of admonition, they will earn only a pitiful shake of the head or sarcasm, but not partners.

Peter Bossdorf

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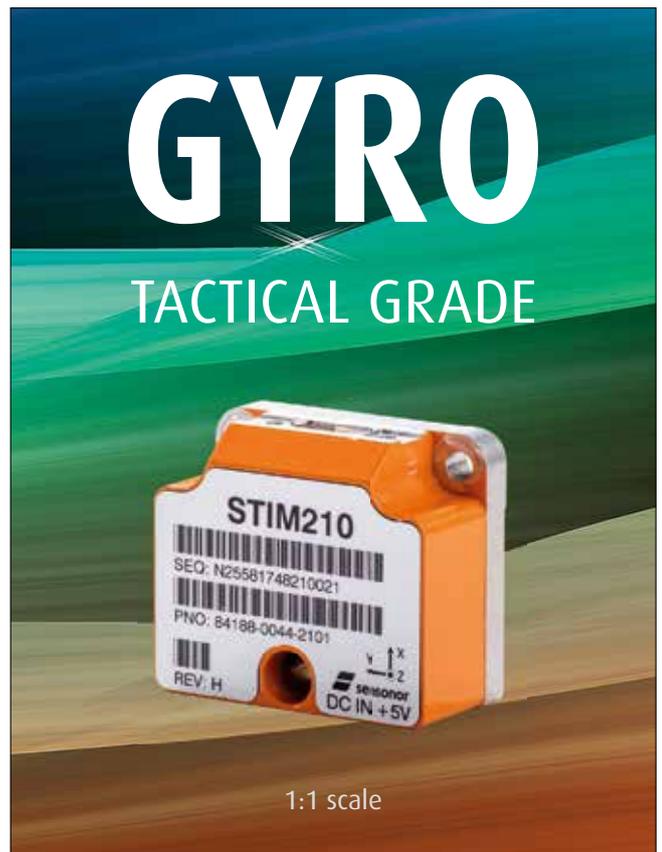
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■ Airport Safety Against Drone Flyovers

(df) HGH Infrared Systems has introduced a new solution to detect, track and classify any types of drones. Edouard Campana, Sales Director at HGH Infrared Systems, said: "SPYNEL 360° panoramic thermal camera and its CYCLOPE software are frequently



Photo: HGH Infrared Systems

used against drones to ensure the security of national and international events, critical infrastructures, airport and more. The real-time visualisation and detection of multiple targets makes it a unique sensor for ultimate situational awareness." The CYCLOPE automatic detection software provides advanced features to monitor and analyse the 360° high resolution images captured by SPYNEL sensors. The ADS-B plugin enables aerial target identification and the aircraft ADS-B data can be fused with thermal tracks to differentiate an airplane from a drone.

■ Electronic Defence Systems for German Corvettes

(df) Indra will equip the second batch of K130 corvettes of the German Navy with its latest generation RIGEL electronic defence system. The company has announced the

Photo: Indra



corresponding signature of an important contract with naval systems company Atlas Elektronik. Indra will deliver five RIGEL RESM/RECM systems (Radar Electronic Support Measures/Radar Electronic Countermeasures). These systems constitute a key technology that allows a ship to track the electromagnetic space and detect active radar emissions in its environment. It also allows multiple active threats to be countered simultaneously by means of disturbance and deception techniques. Indra stated it has incorporated broadband digital reception technology into its system to guarantee the

maximum sensitivity and detection range possible, which provides superiority to the ship. "All these capabilities have been tested with excellent results in the most difficult and complex real electromagnetic scenarios. The system offers optimal response time and precision in this type of environment," the company said. "The solution meets the demands of NATO countries, which require the highest levels of performance."

■ US Orders TROPHY

(df) Leonardo has been awarded a contract worth about US\$80M to provide the US Army and Marine Corps with additional TROPHY active protection systems. Developed by long-time partner Rafael Advanced Defense Systems, TROPHY provides combat-proven protection against anti-armour rocket and missile threats, while at the same

Photo: Leonardo



time locating and reporting the origin of the hostile fire for immediate response. The system uses active electronically scanned array radar to provide continuous 360-degree protection for the vehicle. Once a threat is detected, the onboard computer classifies the threat.

■ New Long Range Anti-Ship Missile

(df) Lockheed Martin announced it has received a USD172M contract from the US Navy and Air Force for Long Range Anti-Ship Missile (LRASM) production. LRASM is designed to detect and destroy specific targets within groups of ships by employing advanced technologies that reduce dependence on intelligence, surveillance and reconnaissance platforms, network links and GPS navigation in electronic warfare environments. LRASM will therefore play a significant role in ensuring military access to

Photo: Lockheed Martin



operate in open ocean/blue waters, due to its ability to discriminate and conduct tactical engagements at extended ranges. "LRASM brings a game-changing capability to both the US Air Force and the Navy," said David Helsel, LRASM Director at Lockheed Martin Missiles and Fire Control. "This second production lot will provide anti-ship missiles for both the B-1B and F/A-18E/F, bringing sea control back to our warfighters."

■ GPS Sustainment Contract

(df) The USAF has awarded Lockheed Martin the GPS Control Segment Sustainment II (GCS II) contract to continue to sustain and further modernise the Global Positioning System (GPS) satellite constellation's ground control system through 2025. This is the follow-on contract to Lockheed Martin's current GCS contract awarded in 2013. Under the GCS II contract, the continued upgrade of the GPS Architecture Evolution Plan Operational Control Segment (AEP OCS) will allow the GPS legacy ground control system to support GPS III satellite on-orbit operations, developed under the GPS III Contingency Operations (COPs) programme. COPs will enable the AEP OCS to support the positioning, navigation and timing missions of the Air Force's new GPS III satellites, which began launching in 2018. In addition, GCS II will sustain the operational M-code capability being deployed in 2020

Photo: Lockheed Martin



that is in development under the M-code Early Use (MCEU) contract. Operational M-code is a critical warfighter capability to support missions in contested environments. "Lockheed Martin's experience integrating GCS projects as well as the system engineering and software integration performed on GPS III Contingency Operations (COPs) and M-Code Early Use (MCEU) position us well to deliver GCS II," says Maria Demaree, VP/GM Mission Solutions for Lockheed Martin Space. "We look forward to supporting the Air Force as it deploys the next generation GPS III satellites and their new capabilities for our warfighters."



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■ IRON FIST LIGHT Active Protection System

(df) RADA Electronic Industries has announced that Phase II of the IRON FIST LIGHT (IFL) Active Protection System (APS) for the BRADLEY Fighting Vehicle is moving forward. The IFL system is a lightweight APS,



Photo: RADA

providing enhanced survivability for armoured and tactical platforms. RADA's software defined radars identify and precisely track incoming threats, from any direction, in real time. The system then intercepts the threat by launching a small warhead and activating it at a safe distance from the protected platform at a precisely calculated moment, defeating the threat through a shock-wave effect. In phase II of the IFL for BRADLEY project, RADA expects to receive near-term orders for the supply of radars for qualification testing, and the current potential is to equip one US Army Brigade of BRADLEY armoured vehicles. This phase is expected to continue into the years 2020 and 2021.

■ HORNET AESA Radar Upgrade

(df) The US Marine Corps has selected Raytheon's APG-79(v)4 AESA radar to equip its F/A-18C/D classic HORNET fleet. Delivery will start in 2020 and be completed by 2022. The APG-79(v)4 is a scaled version of the APG-79 AESA radar integrated on the US Navy and Royal Australian Air Force's SUPER HORNETS and EA-18G GROWLERS. "With AESA radars, fighter jet pilots and crews tip the scales in their favour over their adversaries," said Eric Ditmars, Vice President of Raytheon Secure Sensor Solutions. "Now that the APG-79(v)4 is slated to fly on the classic HORNET, Marine Corps pilots will be able to identify, track and engage more targets over a greater distance than



Photo: US DoD

ever before." Crews will therefore see improved radar reliability, reducing maintenance hours while increasing availability for flight. Because APG-79(v)4 shares more than 90% commonality with APG-79,



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the Marine Corps will also benefit from the same global sustainment and upgrade path already in place for the system.

■ EVOLVED SEA SPARROW MISSILE

(df) Raytheon has announced the award of a US\$ 37,902,562 cost-plus-fixed-fee modification to previously-awarded contract N00024-16-C-5433 to exercise options in support of EVOLVED SEA SPARROW MISSILE (ESSM) design agent, in-service support and technical engineering support services. Fiscal 2019 other coun-



Photo: Raytheon

try; fiscal 2018 weapons procurement (Navy); fiscal 2019 research, development, test and evaluation (Navy); Foreign Military Sales; and fiscal 2019 operations and maintenance funding in the amount of \$16,663,004 will be obligated at time of award, and funds in the amount of \$208,225 will expire at the end of the current fiscal year. This is a sole-source contract pursuant to an international agreement between the US and nine other countries.

■ Brazilian Army Receives RBS 70 NG

(df) Saab has announced the award of a contract with the Brazilian Army for deliveries of RBS 70 NG – the latest generation of the



Photo: Saab

RBS 70 man-portable air defence system. The RBS 70 NG's modular design allows it to reuse all existing generations of RBS 70 missiles up to the new BOLIDE 4th generation all-target VSHORAD missile. With the BOLIDE missile the RBS 70 NG aims at the complete threat spectrum from fixed and rotary wing air-

craft down to small targets such as cruise missiles and UAVs, out to a range of more than 9 km and with altitude coverage in excess of 5,000 m. The combined shaped-charge and pre-fragmented warhead makes the system capable of defeating armoured air targets such as attack helicopters and CAS aircraft as well as armoured ground targets like APCs. In addition to the RBS 70 NG system, the order also includes training systems, camouflage systems and other associated equipment.

■ Communication System for Norwegian Coast Guard Vessels

(df) Saab has signed a contract with Vard Group AS to take on the communication integrator role for the Norwegian Coast Guard project P6615. Saab has announced it will provide the Norwegian Coast Guard's three newly ordered vessels with Saab's complete Integrated Communication System, TactiCall, consisting of both internal and external communication. TactiCall is based on voice-over-IP technology and interconnects all communication technologies regardless of radio band, frequency and hardware. "The third generation of TactiCall is able to meet the customer's tough requirements. It combines and matches both human and tactical conditions and is easy to operate," said Ellen Molin, Senior Vice President and head of Saab's business area Support and Services. Delivery will start in 2021.

■ LEOPARD 2 and PzH 2000 for Hungary

(gwh) The Hungarian armed forces have ordered from Krauss-Maffei Wegmann (KMW) 44 new LEOPARD 2 A7+ main battle



Photo: KMW

tanks and 24 new PzH 2000 self-propelled howitzers. Hungary will also receive twelve used LEOPARD 2 A4 main battle tanks from KMW for training purposes. This will enable Hungary to equip one tank battalion and one artillery battalion each with modern combat vehicles. The new weapon systems are intended to replace the corresponding Russian-made equipment still in use. The use of combat vehicles in accordance with European standards is a step towards improving the interoperability of Hungarian and European armed forces. The order value is estimated at over €1Bn. It is expected that the first vehicles will be delivered no later than the end of 2020. Hungary recently ordered 16 H225M multi-purpose helicopters and 20 H145M multi-purpose helicopters with the HForce weapon system. The extensive procurement of weapon systems is part of the ten-year military development programme, Zrinyi, which has been in op-

eration since 2016 and is intended to renew weapon systems and equipment of the Hungarian armed forces.

■ JLTV for Slovenia

(gwh) Slovenia has ordered 38 Joint Light Tactical Vehicles (JLTV) worth €16 million through Foreign Military Sales through



Photo: Oshkosh

the US Government, to be put into service from 2021 under the designation LKOV 4x4 (LahkoKolesnoOklepnoVozilo). Remote-controlled Kongsberg M153 weapon stations for light and heavy MG and 40 mm grenade launchers are also to be ordered for the vehicles. 18 JLTV are used by special forces. The remaining 20 vehicles will be used by the Middle Battalion Combat Group for national defence and the achievement of NATO goals. The measures are scheduled to be completed in 2023.

■ H225M Helicopters for Indonesia

(ck) The Indonesian Air Force has ordered eight additional twin-engine multirole H225M helicopters as part of the country's fleet-strengthening initiative for a Combat Search and Rescue-capable fleet. Under the agreement between the Indonesian MoD and PT Dirgantara Indonesia (PTDI), the 11-tonne helicopters will be delivered to the air force upon completion of the mission equipment customisation at the PTDI



Photo: Airbus Helicopters

facility in Bandung, Indonesia. PTDI is a key supplier of the helicopter's rear fuselage and main airframe; the two companies expanded cooperation in 2017, to include support and services dedicated for the Indonesian military fleet of helicopters. The helicopters will join the air force's existing fleet of six

H225Ms to perform similar Combat Search and Rescue missions. The H225M is currently in service in France, Brazil, Mexico, Malaysia, Indonesia, and Thailand and has recently been ordered by Hungary, Kuwait and Singapore.

■ SAR Helicopters for the German Army

(ck) The German Procurement Authority, BAAINWBw, has ordered seven H145 helicopters to replace the German Armed Forces' obsolete Bell UH-1D search and rescue (SAR) fleet; the Bell helicopters entered into service in the early 1970s. The new aircraft will be delivered in 2020. Airbus Helicopters will also be responsible for logistics support, repair, and maintenance of the helicopters. The German armed forces are responsible for SAR operations in the event of aircraft accidents and therefore maintain a fleet of SAR helicopters on permanent standby which are also available for disaster management operations. Among other features, the H145 LUH SAR (Light



Photo: Airbus Helicopters

Utility Helicopter Search and Rescue) helicopters are equipped with high-performance cameras, searchlights, emergency beacon locator systems, medical equipment, rescue winches and load hooks that can be used for fire-extinguishing tanks for example. The H145M, the military version of the H145, is a tried-and-tested helicopter that has also been ordered by Serbia, Hungary, Thailand and Luxembourg. The German Special Forces operate 15 H145Ms as light support helicopters. Powered by two Safran ARRIEL 2E engines, the H145 is equipped with full authority digital engine control (FADEC) and the HELIONIX digital avionics suite.

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■ CBRN Simulators for The Netherlands

(ck) The Netherlands' MoD has contracted Bagira Systems, a developer of training software for mission readiness, and Van Halteren Defence (VHD), a Dutch services provider, to supply a simulator for the MoD's National Chemical, Biological, Radiological and Nuclear (CBRN) Training Centre, and to maintain and operate it for a period of 15 years.



Photo: Bagira

The centre provides CBRN education, training and support for military personnel and first responders. The simulator will train for various CBRN scenarios; it features Bagira's B-ONE 3D imagery software to enable interactive training in a highly realistic and dynamic environment. With a standardised skeleton and interchangeable animation, B-ONE enables the creation and presentation of many different CBRN events, exercising all levels

of command and all relevant functions involved to operate under environmentally effected situations. The simulator follows up on the trainees' performance while identifying hazardous substances and reacting to changes at the scene and to threat involvement; it also allows after action review and lesson-learned assurance, and makes use of smart devices.

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■ Boeing Completes NATO AWACS Upgrades

(ck) Boeing has completed the upgrade of the last of NATO's 14 Airborne Warning and Control System (AWACS) aircraft. Upgrades include five full-colour digital displays in each aircraft, replacing the 1970s-era dials, and provide crewmembers with customis-



Photo: Boeing

able engine, navigation and radar data. These digital capabilities also allow NATO to consolidate crew responsibilities. The upgrade also enables the NATO E-3A fleet to meet current and future European air traffic management requirements. The first modernised NATO AWACS plane was modified at Boeing's facilities in Seattle and delivered to NATO in November 2016. The remaining 13 aircraft underwent modernisation work in Manching, Germany. NATO's AWACS fleet is the Alliance's first integrated, multinational flying unit, providing rapid deployment, airborne surveillance and command and control for NATO operations.

■ US Navy Orders POSEIDON Aircraft

(ck) The US Navy has contracted Boeing with the production and delivery of additional P-8A POSEIDON aircraft. The contract has a total value of US\$2.4bn. Ten aircraft will be



Photo: Boeing

added to the current inventory of P-8As in the US Navy fleet; five jets are destined for Norway and four aircraft for the UK, bringing the total UK acquisition to nine aircraft. The UK and Norway are acquiring the Boeing aircraft through the Foreign Military Sales process and will receive a variant designed for the US Navy called the P-8A POSEIDON. The UK will receive their first aircraft in 2019 and Norway will begin receiving aircraft in 2021. The P-8 multi-mission maritime patrol aircraft is a military derivative of the

commercial Boeing 737 and designed to perform anti-submarine and anti-surface warfare. The aircraft has been modified to include a bomb bay and pylons for weapons – two weapons stations on each wing – and can carry 129 sonobuoys. The aircraft is also fitted with an in-flight refuelling system.

■ Mission Computer for Fighter Aircraft

(ck) The US defence contractor Tactical Air Support, Inc. (TacAir) has contracted Curtiss-Wright to provide a cockpit-accessible rugged data recorder and a pre-integrated mission computer to upgrade TacAir's fleet of F-5AT (Advanced Technology) TIGER II supersonic fighter aircraft. Under the contract, Curtiss-Wright will provide TacAir with its Commercial Off-the-Shelf (COTS) PARVUS DuraCOR 8042 processor and Data Trans-



Photo: Curtiss Wright

port System 3-slot (DTS3) Network Attached Storage (NAS) file server. The DTS3 file server supports FIPS 140-2 hardware encrypted solid-state storage of mission data. It communicates seamlessly via Ethernet with Curtiss-Wright's modular mission computer. The contract, worth more than US\$1M, will run through the second quarter of 2019.

■ Mobile Fire Support Simulator

(ck) Elbit Systems UK has delivered a mobile Close Air Support (CAS) and fire support simulator to the British Army; the Joint Fires Mobile Trainer (JFMT) is now in service with the Joint Terminal Attack Controllers (JTAC) and Fire Support Teams (FST) of the 1st Artillery Brigade. The UK Joint Air Land Organisation (JALO) accredited the JFMT in August 2018 as it met all US and NATO requirements to deliver simulated CAS training. The JFMT



Photo: Elbit Systems UK

can simulate all controls currently allowable (types 1, 2, and 3, Full Motion Video, Rotary Wing, Night/IR, Remote Observer and Laser Target Designation). Whilst also available for purchase as a standalone system, in this contract the JFMT is supplied as a fully serviced training package in a versatile 20 ft trailer able to be deployed by vehicles. The system comprises a trainee station, an instructor/operator station (IOS) and a pilot station console. Visuals are provided within a high resolution dome configuration coupled with a powerful and intuitive Computer Generated Force (CGF) and Semi-Autonomous Force (SAF) application. Image Generation is multi-spectral allowing use of in-service Night Vision Devices in conjunction with a range of emulated equipment, such as laser designators, radios and binoculars, providing trainees with a high fidelity "train as you fight" experience. The service is managed and maintained by ex-military experts.

■ BLACK HORNET for US Army

(ck) For a sum total of US\$39.6M, the US Army has bought an unspecified number of FLIR's BLACK HORNET nano-UAVs. The BLACK HORNETs will support platoon and small unit level surveillance and reconnaissance capabilities as part of the Soldier Borne Sensor (SBS) programme. In June 2018, the US Army awarded the first SBS phase contract to FLIR for an initial batch of BLACK HORNETs. These systems are being delivered now to the US Army for initial integration into the force. Thus far FLIR has delivered over 8,000 BLACK HORNETs around the world.



Photo: FLIR

■ Naval Radars for Norwegian Coast Guard

(ck) Under the P6615 Programme, Hensoldt will equip the Norwegian Coast Guard with new Arctic Coast Guard Vessels with TRS-3D naval radar and MSSR 2000 IFF Systems. The TRS-3D and IFF Systems are currently in operation onboard the three NORDKAPP offshore patrol vessels. The systems will be decommissioned, upgraded and then re-installed on the Arctic Coast Guard Vessels. The contract includes an option for the upgrade of the TRS-3D and IFF Systems of



Photo: Hensoldt

the SVALBARD vessel. Under the contract, worth more than €20M, Hensoldt will deliver three TRS-3D radars including the latest solid-state technology and signal

processing software and will deliver them from 2021, in parallel to the building programme of the new vessels. The TRS-3D includes a secondary MSSR 2000 I radar for IFF. It operates all current IFF modes, including the latest "Mode S / Mode 5" standard, which is a precondition for joint operations with NATO and allied forces.

Multi-Mission Radars for Finland

(ck) Finland has contracted ELTA Systems, a subsidiary of Israel Aerospace Industries (IAI), to



Photo: IAI ELTA

supply Compact Multi-Mission Radars (C-MMR) ELM-2311 to the Finnish armed forces. The radars will provide the Finnish Army with the ability to locate and track incoming Rockets, Artillery shells and Mortars (RAM), and shall provide an interface for alerting the Army's counter weapons systems. Supporting multi-mission capabilities, the radar can simultaneously operate as Artillery Weapon Location and Air Surveillance radar, thereby seriously inhibiting an opponent's use of aerial threats. The radar system is scheduled to be delivered in 2021.

Protected SUVs for US Marshals

(ck) UK-based Jankel Tactical Systems, a producer of armoured vehicles, has been contracted to supply armoured Chevrolet SUBURBANS and Toyota LAND CRUISERS to the US Marshals Service, America's first federal law enforce-

ment agency and the US Customs and Border Patrol. In 2018 Jankel's Civilian Armoured Vehicle (CAV) business grew

by 300% due to increased orders from Jankel's core clients: the US Department of Defense; US Department of State; the Canadian Department of National Defense; and



Photo: Jankel



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■ BRIMSTONE Missile for PROTECTOR

(ck) MBDA has been contracted to integrate its BRIMSTONE high-precision strike missile onto the Royal Air Force's PROTECTOR RG Mk1 remotely piloted aircraft which is the weaponised version of MQ-9B SKYGUARDIAN. BRIMSTONE and PROTECTOR will provide key new capabilities to the Royal Air Force's ISTAR force, enabling them to engage high-speed moving and manoeuvring targets, including maritime fast attack craft for the first time. The PROTECTOR can carry three lightweight BRIMSTONES per

Photo: MBDA



weapon station, and so offers a much higher payload than the REAPER it will replace. Integration of BRIMSTONE onto PROTECTOR follows a series of firing trials from the REAPER/PREDATOR B aircraft in the US that demonstrated BRIMSTONE's performance increase. In 2018 the UK MoD announced a £400M contract with MBDA for the Capability Sustainment Programme (CSP) of the BRIMSTONE missile, to build new missiles and extend this missile's service life beyond 2030.

■ PATRIOT for Sweden

(ck) To enhance transatlantic security, the US DoD has contracted Raytheon to produce Sweden's PATRIOT Integrated Air and Missile Defense System including spare parts, support and training. The contract has a total value of US\$692.9M. The contract calls for Raytheon to build and deliver an undisclosed quantity of PATRIOT fire units and GEM-T interceptor missiles. PATRIOT is a missile defense system consisting of radars, command-and-control technology and multiple types of interceptors, all working together to de-

Photo: Raytheon



fect and defeat ballistic missiles and other threats. Sweden's PATRIOT procurement will also provide joint training opportunities for the Swedish and US armed forces, and enhance military interoperability. Besides Sweden, six other European nations depend on PATRIOT: Germany, Greece, the Netherlands, Spain, Romania and Poland.

■ Trucks for Swedish PATRIOTS

(ck) The Swedish armed forces have contracted Rheinmetall to supply vehicles for transporting Sweden's PATRIOT air defence systems. Starting in 2021, Rheinmetall MAN Military Vehicles (RMMV) will supply Sweden with forty high-mobility trucks from its HX series, including 16 tractor trucks and 24 transport vehicles. The order is in the double-digit million-euro range. The HX2 vehicles feature heightened mobility, ruggedness, versatility and can handle rough terrain. They also feature protective add-on modules for safeguarding the crew. HX2s are among the world's most widely used military trucks, with some 10,000 currently

Photo: RMMV



in service around the globe; the current user nations include the United Kingdom, Australia, New Zealand and Denmark. Norway, Sweden and Germany have all placed substantial orders with Rheinmetall MAN as well.

■ New Communications Systems for Danish Navy

(ck) The Danish MoD has contracted Rohde & Schwarz to implement NATO's Broadcast and Ship / Shore Enhancement One (BRASS EO) architecture for HF communications for the Danish Navy. For ro-

bust and autonomous long-range communications, Rohde & Schwarz is equipping twelve ships, two coastal stations and a training facility. Rohde & Schwarz is to provide a single-source solution that includes the communications system and a comprehensive service package. The Danish Navy will be the first user to implement the new NATO target architecture BRASS Enhancement One Target Architecture (BRE1TA) for HF communications within the fleet. In addition to procurement and installation, the contract includes 15 years

Photo: Rohde & Schwarz

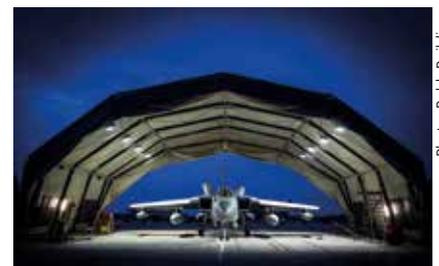


of maintenance, service and support. Life cycle costs were also a key part of the evaluation process. BRE1TA offers simplified routing, resulting in faster transmission of military information between coastal stations and seagoing units in accordance with STANAG 4406; and IP services can be provided over shortwave links in accordance with STANAG 5066. Backward compatibility with NATO BRASS Initial Core Capability (ICC) and NATO legacy systems ensures interoperability with other branches of the armed forces and NATO units.

■ Deployable Military Infrastructure for the UK

(ck) The UK MoD has contracted Rubb Buildings Ltd to provide military shelters, repairs, refurbishments, spare parts, training, Post Design Services (PDS) and support for infrastructure which can be deployed in the field. The contract is worth £9.5M and could be extended for an additional year. Rubb has recently fulfilled a five-year contract, with a value of £6.86 million with the MoD, which ran until October 2018. The new contract ensures that Rubb will continue to provide vital equipment for the MoD.

Photo: Rubb Buildings



Rubb is a producer of defence structures and hangars for the military sector. The company has been a long-standing supplier to the UK Armed Forces, going back to 1979 when the RAF tasked the company to supply military buildings for the "Red Arrows", the RAF's aerobatics display team.

■ RUAG to Modernise Swiss Helicopters

(ck) RUAG will upgrade eight COUGAR helicopters of the Swiss Air Force's transport helicopter fleet. Procured in 1998, the helicopters' electronic flight control, navigation and communication systems require modernisation. The upgrade includes new flight management computers, a precision navigation system for instrument flights, a collision avoidance system, which alerts pilots to aircraft in

critical proximity, and a system developed by RUAG which emits an audible signal when the rotorcraft leaves a defined flight level. The package also features helmet mounted displays, for projecting the most important flight data onto the pilot's visor, as well radio equipment and satellite phones, for ensuring safe and efficient communication. RUAG will also equip the helicopters with the latest IDAS-3 self-defence system. This system alerts the crew to radar, laser and electro-optical waves, as well as missiles. It also issues countermeasures, such as dispensing decoys.

■ Realistic Target Practice

(ck) For the first time, the Spanish Combat Air Command (MACOM) has used unmanned, moving land targets in military exercises. The targets were provided by SCR, a subsidiary of everis Aerospace, Defense, and Security Group. SCR provided two kinds of target systems - the RRS-1 (land target) and SCRAB II (aerial target) systems. The RRS-1 land target is an unmanned 4x4 vehicle with a range of up to 10 kilometres, and a maximum speed of

65 km/h. SCRAB II is a high-end air target with two jet engines, ready for integration with a wide variety of payloads. Specifically, SCR provided the SCRAB II (aerial target) and RRS-1 (land target) systems for the annual exercise Dardo 2018. The unmanned moving ground vehicles were



Photo: RUAG



Photo: SCR

used as targets for the AGM-65G MAVERICK air-to-surface missiles launched from F-18 aircraft. During the manoeuvres at Bardenas Reales shooting range (Navarra), three RRS-1 land targets were used. According to an Air Force statement, the use of these platforms "makes it possible to notably increase the realism of the exercise."



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■ HMS QUEEN ELIZABETH Completes Flight Deck Testing

(hum) With its arrival at Portsmouth on December 10, 2018, HMS QUEEN ELIZABETH completed a four-month sea trial, including the first flight operations on the US West



Photo: Royal Navy

Coast, largely unnoticed by the general public. This is remarkable in that the Royal Navy, after years of abstinence, has been able to continue with aircraft carrier operations. The ship's logbook shows the first landing of an F35 on September 25. On November 19, the end of the flight tests, 202 take-offs via ski jump, 187 vertical landings, 15 so-called "shipborne rolling vertical landings" (SRVL), and 54 bomb drops were recorded. A historic port visit in New York took place between October 19-23, where the ship was the platform for a US-UK trade forum led by the British Secretary of Commerce Dr. Liam Fox. According to the available estimates, it can be assumed that the schedule for the start of operations of HMS QUEEN ELIZABETH can be adhered to – with a first deployment in late 2020 or early 2021. The commissioning of the sister ship, HMS PRINCE OF WALES, is expected within the next 18 months.

■ New Link-M Tactical Data Link System

(koe) MilSOFT, a Turkish software technology company, has made their indigenously developed tactical data link system (Link-M) public. According to the company, this new link system follows the footsteps of NATO's Link 22. Company sources assert that Link M



Screenshot: MilSOFT

will be capable of working on V/UHF and HF radios. Interoperability with other NATO data links is possible with the data forwarding capabilities of the company. A CMMI 5 holder, MilSOFT has been the producer of data link processors of all NATO Tactical Data Link sys-

tems. MilSOFT has also operationally proven its Link handling technology on many platforms with Link 11/ 16/22 data forwarding capability. Link M will be able to work with customer-selected COTS radios, modems and crypto systems, which eliminates the restrictions created by some countries / organisations. The MilSOFT business development team will, understandably, seek non-NATO customers for the high standard data link capacity, in order to gain the quickest return on their long-term investment. Being also a manufacturer of open architecture Combat Management Systems (CMS), MilSOFT can inter-connect Link-M with the latest technology CMSs. If a country has chosen to work with legacy CMSs, then a gateway system can also be supplied to the customer in order to provide interoperability.

■ Test Vehicle for Urban Operations

(vww) The Royal Tank Regiment and a team from the 1st Armoured Infantry Brigade of the British Army have developed a CHALLENGER 2 test vehicle for urban operations. Experience gained in Iraq was taken advantage of in the development of the CHALLENGER. The combat value increase includes: urban camouflage paint; a clearing blade; extensive camera equipment (among



Photo: British Army

other things on a mast on the turret, several on the chassis and one on the 120 mm main gun); a tablet screen attached to the outside of the rear of the tank, via which accompanying infantry can view and retrieve the camera images; mounts and containers at the rear for weapons, explosive ordnance and access tools; an unmanned ground vehicle for reconnaissance; a new machinegun concept (two 7.62 mm GPMGs, one heavy 12.7 mm MG); and a 60mm mortar remotely controllable and under armour protection. The "STREETFIGHTER CHALLENGER" will now be tested over a longer period of time. A further test vehicle with innovations is also to be developed in the near future.

■ Norway Orders More HK416 from Heckler & Koch

(vww) The Norwegian Ministry of Defence has commissioned Heckler & Koch to supply

11,000 HK416 assault rifle sets in the scope of a contract valued at €22M. Delivery will start in 2019 and run for 36 months. 7,000 of these new weapons will replace the old AG-3 rifle in the Heimwehr. Norway was the first customer to introduce the HK416 as its standard assault rifle. The HK416N – the official name for the standard weapon – has been in the force since 2007. In its basic configuration it has a 16" barrel, a Quadrail



Photo: Johannes M. Schnell/Forisvaret

hand guard and Aimpoint Comp M4 optics as standard. In addition, Norway also fields a short version with a 10.5" barrel under the designation HK416K. The gas-operated loader with short-stroke gas piston and rotary breech is part of a modular weapon family that has been steadily expanded and is now in service in numerous NATO countries.

■ PIK-AS Presents LED Lights for Military Ambulances

(ah) Under the motto "Our lights aren't just lights, they are designed to save soldiers' lives", PIK-AS Austria presents its new LED high intensity light at IDEX in Abu Dhabi. Type PA293007 is tailored to use in military ambulances, providing white light (4000 K) at highest intensity, blackout functionality with green, red, or blue light, stepless dimmability in all colour modes and integrated temperature protection. The compact and robust design meets the relevant military



Photo: PIK-AS

standards, including MIL-STD-461. The product is designed to provide best lighting conditions for medical attendance in military ambulances and was developed according to requirements from the field. The manufacturer has announced to make a version with integrated backup battery available in the near future to provide for power failures. PIK-AS' products can be seen at IDEX stand 07-D47.



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Leading The Situational Awareness Revolution

Reflections on Russian Nuclear Strategy and Policy

Stephen Blank

When the US Government announced its withdrawal from the INF treaty due to universally acknowledged Russian violations of the treaty, a flood of critical articles immediately ensued. However, none of those articles mentioned Russian nuclear strategy or policy, reflecting commentators' ignorance if not neglect of both subjects and their refusal to analyse Russia's nuclear behaviour and the reasons for it.

This essay seeks to provide at least some of that analysis and, in doing so, reaches disquieting conclusions.

ity emphasising non-nuclear deterrence in current and future military planning. We cannot explain this priority by hid-

Asymmetric Strategy

Nuclear weapons represent priority parts of Putin's so-called asymmetric or indirect strategy. Chief of the General Staff General Valery Gerasimov has admitted that Russia has violated the INF treaty, and his description of Russia's enhanced nuclear and aerospace strike capability highlights nuclear weapons' priority. Similarly, a video accompanying Putin's annual speech to the Federal Assembly on 1 March 2018 showed missile systems that also violated the INF treaty. Moreover, in his annual speech to the Valdai Club, Putin stated that Russia would reject pre-emptive strikes and would only fire a retaliatory strike once it had become clear that Russia was under attack. Since Russian systems have often reported false attacks, this amounts to the dangerous policy of launch-on-warning.

Nuclear weapons are critical not only because they are procurement priorities, but also because Russia clearly envisages fighting a limited nuclear war. Admittedly, Russia's most recent military doctrines emphasise non-nuclear or conventional deterrence. But procurements and exercises like the recent Zapad 2017 and Vostok 2018 exercises point to an anticipation of actual nuclear war fighting. Moreover, the 2017 "Foundations of Russian Federation Naval Policy" states that tactical nuclear weapons are efficient deterrents of conflict escalation, because they can cause critical damage to the enemy. If this is not advocating a first or even a pre-emptive strike then it is mendacious. Therefore, controversies over the role of nuclear weapons in Russian strategy and the question of whether or not Russia has a high or low threshold for nuclear use remain unresolved.



Photo: The White House

In 2010, US President Barack Obama and Russian President Vladimir Putin agreed on the nuclear arms reduction New START.

Nuclear weapons have been the unceasing priority in Russian procurement for the new defence plans through 2020 and now 2025. And this occurs despite doctrinal statements and practical activ-

ing behind the clichés that Russia values nuclear weapons because they endow it with great power status and because it cannot compete with NATO's superior conventional technologies. While both points are true, Moscow actually retains a comfortable margin of superiority along all of its borders vis-a-vis NATO. Moreover, NATO is reluctant to rearm and certainly cannot mount anti-Russian offensives, as Moscow knows. Nowhere does Russia predict that combat operations are in sight or imminent, and its strictures against US missile defences in Europe that supposedly are the greatest military issue dividing East and West and a threat to strategic stability are a canard, as Russian writers freely admit.

Author

Dr. Stephen Blank is a Senior Fellow at the American Foreign Policy Council. He is the author of numerous foreign policy-related articles, white papers and monographs, specifically focussed on the geopolitics and geo-strategy of the former Soviet Union, Russia and Eurasia. He is a former MacArthur Fellow at the US Army War College.

An Inveterate Adversary

We must first grasp that Russia is at war with the West and sees it as an inveterate adversary. Indeed, Putin is intensifying Russia's militarisation. In November 2017, Putin demanded that the Russian economy prepare itself for wartime production and mobilisation and for defence spending worth US\$321Bn by 2025. Recent reports suggest that the Zapad 2017 exercise was at least partially about taking command of the Belarusian armed forces and launching offensives to connect Russia to Kaliningrad by land, forcing Baltic neutrality by occupying these states, and then preparing for further offensives against Warsaw while threatening, if not using, nuclear weapons. And Vostok 2018 featured nuclear attacks from the Arctic and was coordinated with an immediately ensuing nuclear exercise. The US Defence Intelligence Agency argues that Moscow is building and modernising its military forces to prepare for virtually any contingency to "conduct the range of conflicts from local war through regional conflict to a strategic conflict that could result in massive nuclear exchange." To be sure, many Russian analysts now argue that the defence sector, much like its Soviet predecessor, is virtually autonomous. Therefore, this sector essentially produces con-



Photo: Alan Wilson

Russia has been upgrading its Soviet-era TU-22M3 BACKFIRE strategic bombers in recent years.

ventional and nuclear weapons for which no real mission is indicated. Rather they are only producing what they can do. Producers subsequently rationalise the mission, often couched in offensive and very threatening terms, to suit existing production instead of matching production to strategy. If this analysis is correct, then the Russian defence industry, like its Soviet predecessor, can supply many reasonably high-tech weapons to the MoD and the military. But also like its predecessor, defence industry is regressing by imposing unfocused conventional and nuclear capabilities upon the state. This trend also comports with the dominance of the military and military rhetoric in policymaking and creates a powerful stimulus for a policy stressing military answers and threats of force first rather than last.

Russia's Nuclear Programme

Russian nuclear modernisation programmes encompass all three legs of its triad of air, sea, and land-based nuclear weapons along with short, intermediate, and long-range nuclear weapons. According to General Paul Selva, USAF Vice Chairman of the Joint Chiefs of Staff, Russia is also developing new tactical nuclear weapons to tailor its forces to virtually any contingency. And that is only one of over 20 Russian programmes currently underway to manufacture and deploy nuclear weapons, including a heavy ICBM, new bombers, new SLBMs, and missile submarines. Moreover, given current procurement plans and counting rules under the New START (Strategic Arms Reduction Treaty), Russia could actually increase its nuclear

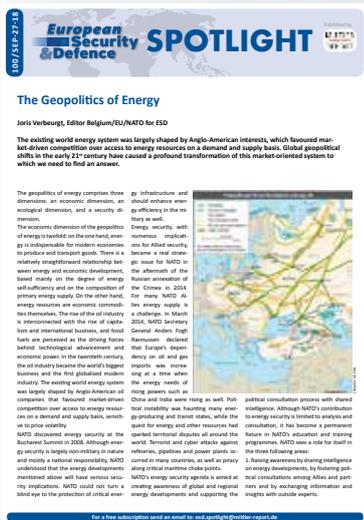
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weapons and still comply with that treaty. Finally, all conventional plans and exercises have an accompanying nuclear component, integrating nuclear options into operational plans and rehearsing them beforehand. Submarine-based nuclear strikes from the Arctic accompanied the recent Zapad 2017 and Vostok 2018 exercises, as did the much less heralded nuclear exercises in Novosibirsk involving some of Moscow's newest nuclear weapons. This followed a pattern of coinciding nuclear and conventional exercises for Zapad 2009 and 2013. And those episodes also suggest that the Arctic may not be a zone of peace in Moscow's assessment. Thus it appears that Russia's concept and programme for nuclear weapons presents it with an apparent advantage over the US as an objective to be attained if not an actual

it is neutral like Sweden, or that increases its defence efforts, like Denmark. Moscow has not only threatened individual states like Denmark, Sweden, Norway, Poland, and the UK with nukes if they seek to defend themselves; it has threatened any European state that may store US INF missiles as part of NATO's deterrent with nuclear strikes, and that can only mean first or even pre-emptive strikes against those targets. Furthermore, Putin has recently announced that the AVANGARD hypersonic nuclear missile will be deployed in 2019, although not all Western analysts are convinced that Moscow's hypersonic missiles will actually be ready for deployment. No less disquieting is the fact that in the recent Vostok 2018 exercises Russian forces and the Ministry of Energy conducted large-scale exercises to

in the expectation of a NATO nuclear strike or conventional attack in tandem with the US missile defence system on its nuclear C4ISR that would destroy its nuclear capability. Moreover, Russia's PERIMETR defence complex, the "Dead Hand" of the 1980s is not only alive and functioning but has also been modernised and improved. Finally, Putin has threatened all of Europe that any state that hosts US INF-capable missiles will be targeted with nuclear weapons as if that is not already happening.

These remarks notably reinforce Russia's belief, despite the laws of physics and dozens of official briefings, that Washington is planning a first strike on Russian nuclear weapons. Therefore, Moscow must answer or retaliate if not pre-empt in kind by launching on warning, even before being attacked, even though warning has historically been notoriously unreliable. Since NATO has already said that no new US nuclear missiles will be deployed in Europe and US missile defences cannot eliminate Russia's nuclear weapons, Russia's threat assessment visibly inclines to hysteria and worst-case analysis. Moscow is also developing low-yield high-precision nuclear weapons. When Russia refers to high-precision weapons it does not specify whether they are conventional or nuclear, because many systems like the ISKANDER missile and all fighter-bomber units are dual-capable. Its tactical nuclear weapons are apparently intended to both compensate for conventional capabilities that may be lacking and to respond to conventional strikes. In other words, tactical, if not other, nuclear weapons will be used in a first-strike mode. Exercises in Europe, Asia, and the Indian Ocean confirm this first-strike use of Russian nuclear weapons.

Photo: President of Russia



In his annual speech to the Valdai Club, Putin stated that Russia would reject pre-emptive strikes and would only fire a retaliatory strike once it had become clear that the country was under attack.

condition. As Mark Schneider writes, "Contrary to popular belief, the United States does not enjoy nuclear parity with Russia. In fact, Russia has nuclear superiority. The illusion of nuclear parity is created by the following: 1) comparing the Russian active stockpile with the US active and inactive stockpiles, 2) ignoring the 10-1 Russian advantage in tactical nuclear weapons, 3) dismissing the modernisation asymmetry, 4) disregarding the massive Russian advantage in nuclear weapons production capability, and 5) ignoring operating practices that keep more Russian warheads on alert than American.

No Nuclear Parity

Russian political and military figures not only threaten nuclear responses to conventional attacks; they also raise the prospect of pre-emptive and/or preventive nuclear strikes and freely make nuclear threats against any state "rash enough" to join NATO, if

restore electric grids and power supply after an attack. In other words, Russia rehearsed an EMP (Electro-Magnetic Pulse) operation and its aftermath, strongly suggesting that it either expects one or is intending to launch one. Significantly, Moscow sought to conceal the purpose of that exercise and divorce it from Vostok 2018 by suggesting it was done to prepare for the Siberian winter. Moscow has also rehearsed nuclear operations, such as a nuclear strike against Sweden in 2013. This occurred in the context of overflights and subsequent nuclear threats against every Northern European state from the UK to Finland and dovetails with the GPS jamming of Norway and Finland during NATO's recent Trident Juncture exercise. And Colonel General Viktor Yesin, former CINC of Russia's nuclear weapons, has now also threatened that if Washington leaves the INF treaty and deploys missiles in Europe Russia could shift to a pre-emptive strike doctrine

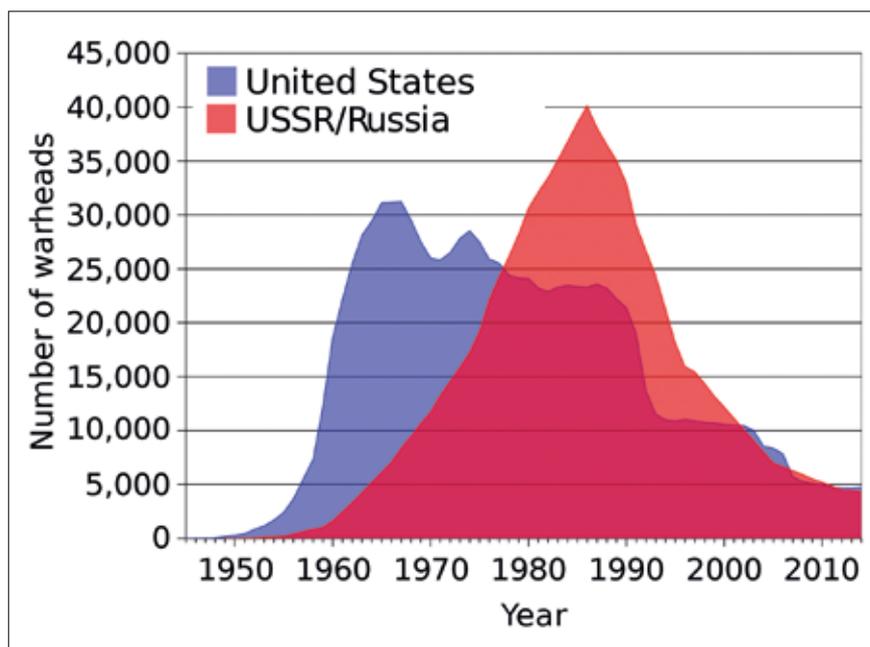
A Growing Stockpile

Preparing for nuclear war scenarios, Moscow has also deployed the new SARMAT heavy ICBM that possesses 10 metric tonnes of throw-weight and will reportedly carry 10 heavy and 15 medium warheads. Its launch weight is about 170 tonnes and its destructive potential is 8 megatonnes and will clearly be Moscow's main counterforce weapon. Similarly, Moscow is also building the Status-6 Maritime Multifunction System, a nuclear-armed high-speed weapon with a range of 10,000 km that can be deployed at a depth of 1,000 metres and allegedly carries a 10-megatonne weapon; it was among the weapons Putin "unveiled" in his Federal Assembly speech in March 2018. And while Washington has known about most if not all of them, Putin's purpose here was to intimidate Western audiences while playing up his stewardship of Russia's great power to his

domestic audience. Yet he did not disclose many other nuclear programmes, such as weapons that are low-yield and tailored to smaller contingencies.

Recently, Pentagon sources and experts such as Schneider and James Howe estimated that, at the current procurement rate, Russia would have 8,000 warheads by 2026, while modernising its nuclear bunkers. This total reflects certain trends beyond what we have noted above. First, at current procurement rates, Russia will reach the New START limits during 2018 and will probably break the treaty as it has broken every other recent arms control treaty. Indeed, Moscow may well be violating the New START. For example, in listing its nuclear weapons for the official documents indicating compliance with that treaty, by early 2018 Moscow cited destroying 116 missiles while adding 26 MIR-Ved missiles that carry up to 10 warheads each, in fact adding weapons to its arsenal. Similarly, Vladimir Mikheyev, Advisor to the First Deputy General Director of Concern for Radio-Electronic Technologies (KRET) said that Russia was installing EW systems on X-101 and X-102 cruise missiles carried by the TU-95, Tu-160, and TU-22M3 strategic bombers. Russia also reported that the X-101 is the newest Russian air-ground cruise missile that is designed to avoid radar visibility. It can be equipped with a nuclear warhead and its range amounts to 4,500 km (2,800 miles). As Schneider has observed, if the TU 22-M3 BACKFIRE bomber which was not declared to be a heavy bomber, carries either the Kh-101 or Kh-102, that is a violation of the New START, since it converts the TU-22M3 BACKFIRE into an undeclared heavy bomber.

This 8,000-weapon arsenal includes larger, low, and very low-yield strategic warheads. This assessment also suggests Russia's intention to blend conventional with nuclear forces in future conflicts. Smaller-yield warheads will be deployed on new short and medium or intermediate-range missiles like the SSC-8 cruise missile (the prime suspect in the violation of the INF treaty) and the SSN-27 KALIBR anti-ship land-attack cruise missile. These new very low-yield weapons include clean weapons with little fallout, pure fusion weapons that do not require a nuclear blast to trigger them, and tailored effects weapons such as neutron bombs, electromagnetic pulse blasts and x-ray and gamma ray weapons. Thus Moscow has for some time actually been practising tailored deterrence to give it a nuclear edge at every level of the spectrum of conflict from local, or small-scale, to global intercontinental war. This points to a strategy that does not aim to escalate, but to control escalation in all phases of a future crisis. In other words, Moscow not only has the capabilities, but



Nuclear warhead stockpiles of the United States and the Soviet Union/Russia, 1945–2014. Since 2015, Russia has been enlarging its inventory. At current procurement rates, Russia could have 8,000 warheads by 2026.

also has a victory theory, including concepts of escalation management and termination of hostilities.

Meanwhile, Russia has systematically violated every arms control treaty except the New START (and as stated above, it may be violating that one too): the INF and CFE treaties, the Vienna Note on conventional exercises and deployments, and the treaty prohibiting emplacement of nuclear weapons on the ocean floor. Indeed, according to Schneider, "we now have four different Russian ground-launched cruise missiles, two revealed in US Government sources and two reported in both the Russian and Western press, which have reported ranges that violate the INF Treaty." These systematic violations of arms control treaties clearly aim to give Russia nuclear advantages vis-a-vis the US. But if the strategy is one of escalation dominance, it is also clear that Russian procurements point to a state where it can threaten nuclear strikes tailored to the occasion to retain escalation dominance, intimidate potential adversaries, and wage what it thinks are limited conventional or limited nuclear wars with impunity. Although Putin has recently announced that Russia has no strategy for nuclear pre-emption, there are reasons to doubt this based on earlier statements by Russian analysts and officials and the fact that the entire pre-emption debate has been classified. But Putin also said it does have a launch-on-warning doctrine. Putin's assertion that Russia has no nuclear pre-emption strategy directly contradicts the statement of former Chief of the General Staff, Retired General Yuri Baluyevsky, the prime author of

the 2010 and 2014 defence doctrines, who stated in 2014 that the conditions for pre-emptive nuclear strikes were contained in the classified nuclear doctrine. In 2015, Ilya Kramnik, RIA Novosti's military correspondent, wrote that Russia's 2010 defence doctrine, despite the opinion of most Western observers, "further lowered" the threshold of "combat use" of nuclear weapons. Russian policies and actions clearly reflect Russia's belief that Washington is planning a first strike on Russian nuclear weapons. Therefore Moscow must retaliate if not pre-empt in kind by launching-on-warning, or even before being attacked since warning has proven to be notoriously unreliable. In light of this threat assessment, taken in tandem with over 20 programmes now being developed for counterforce, countervalue, short, intermediate, and long-range capabilities, and the fact that nuclear weapons are fully imbricate with conventional weapons and operations across the spectrum of conflict, can we really believe that Russia is complying with the New START and is renouncing the first-strike use of nuclear weapons? Moreover, it seems that the aspects of Russian strategy presented here include at least part of the Russian "theory of victory" in a nuclear war. The facts – Russian threat assessments, procurements, exercises, violations and deployments of nuclear systems in Crimea, the Western military district, Kaliningrad and the Black Sea – undermine confidence in Russia as a reliable partner for arms control or in Russian claims that Russia is increasingly moving from nuclear deterrence to conventional deterrence. ■



Viewpoint from Washington



Trump: The Second Year

Chet Nagle

Mainstream media and a host of pundits have portrayed 2018 as a bad year for America and the entire world, because of an unsophisticated American president who is determined to destroy something called “the liberal world order”. In an endless litany, they also cite things like President Trump’s withdrawal from the Paris Climate Accord, termination of the North American Free Trade Act (NAFTA), intentions to abandon NATO, a government shutdown resulting from Trump’s insistence on a border wall to deter illegal alien migrants, and the wildly rambunctious stock market. All these events, they say, are evidence of the accelerating decline of the United States. Buried in the hysterics, however is the simple fact that 2018 was a triumphant year for Americans.

What was the good news during Trump’s second year? The US economy grew by 4.2% in the second quarter of 2018 and 3.4% in the third, resulting in the American GDP growing US\$1.7Tr larger than it was at the start of 2017. That makes it US\$8Tr larger than the GDP of Communist China. Not surprising, since it takes three Chinese workers to equal just 60% of the production of one American worker.

Unemployment fell to 3.7%, the lowest since 1969, and black and minority unemployment fell to the lowest level ever recorded. Since the start of the Trump administration, more than 3 million Americans are off food stamps, and 8 million have risen above the poverty line.

NAFTA was replaced by amicably negotiated agreements with Mexico and Canada on terms more favourable to America. And after leaving the Paris Accord, the US reduced its annual carbon output more than most members of the Accord, including Communist China, the greatest polluter in the world. This demonstrates that Trump is simply refusing to remain in any multinational agreement that does not treat US interests fairly. Instead, he is making deals with individual allies and partners, a policy that can be dubbed “dynamic bilateralism.” This policy naturally worries those nations that, at American expense, are

benefitting from their membership in NATO, the EU, and other multinational organisations. Trump’s third year will see even more changes to existing agreements.

With regard to the howls of Democrat politicians about the US Government shutdown, the longest in American history, it is interesting to reflect on the fact that the shutdown only affects “non-essential” workers. That makes one question why salaries of any non-essential workers should be paid by American taxpayers in the first place, since the government still seems to be functioning rather well.

At the start of Trump’s second year, the amazing news was that because of deregulation, lease of public lands, and the superb technology of American frackers, the United States produced 11.6 million barrels of oil per day (bpd). And the Energy Information Administration expects US crude production to rise to 12.9 million bpd by the end of 2020. Today, the US is the world’s largest producer of natural gas and the second largest in coal production. Becoming the world’s leading producer of energy means that the US is no longer hostage to oil-rich Middle East countries and forced to spend American blood and treasure to defend them in their endless and incomprehensible wars.

Despite opinions of generals who no longer serve in the Trump administration, it is impossible to explain why another American should die in the seventeen-year war in Afghanistan, a rocky opium farm that has never had an effective central government. Rightly named “the graveyard of empires”, neither Alexander the Great, nor the British and Soviet empires were able to prevail over Afghanistan’s tribal warlords. Similarly, Syria, Iraq and Libya are countries mostly in name and will have to be dealt with by their neighbours. We will likely see Trump take the few remaining US troops and most American military assets out of the region in the coming year.

But the thing that most distresses American and European elites is what they bemoan as Trump’s relentless demolition of the “liberal world order”. They seldom attempt to explain that

catchphrase or are unable to do so. But those who have read Peter Zeihan's revelatory books "The Accidental Superpower" and "The Absent Superpower", know exactly what it is that the elites and their obedient media are reluctant to explain: the Bretton Woods Agreement.

In 1944, World War II was coming to an end, and America brought its allies together at the Mount Washington Hotel in Bretton Woods, New Hampshire, to agree on a post-war economic world order. One can only imagine the anxiety of the delegates from Britain, France, Canada, Australia, Denmark, Belgium, India and other countries as they gathered in the oppressive heat to listen to the American proposals. Many surely expected Dexter White and the American team to use the unrivalled power and wealth of the United States to impose a Pax Americana in the usual way: meld all the old European empires – perhaps including the territories of the European states themselves – into a global American imperial system. Keynes, the British delegate, even wrote that the Americans "plainly intend to force their own conceptions through, regardless of the rest of us." But the American proposals were far from Pax Americana. The United States basically proposed two things: the first was free trade, and the second was that the US Navy would guarantee freedom of the seas to all legitimate commerce. The partners of America could sell to anyone else in the system, and the huge US market was open to all willing to play by American rules. The partners also had to agree to let Washington run their national security policies, a condition that quickly grew into a military alliance (mostly US muscle) that would protect Europe from the looming Red Army. NATO checked the Soviets and, with the free trade system, thus began the greatest era of peace and prosperity the world had ever seen.

Then, with no warning, the need for America to subsidise the liberal world order ended. In 1989 the Berlin Wall came down and in 1991 the Soviet Empire disintegrated. That meant that NATO could then stand on its own or not, and that the United States was free to reverse the gigantic trade deficits and massive debt accumulation that it took to maintain the Bretton Woods deal. Nevertheless, it took 25 years for the United States to elect Donald Trump, the first president to take action to extricate America from unneeded and extremely expensive multinational organisations – relics of Bretton Woods – known as the "liberal world order".

Even the multinational European Union (EU) grew out of Bretton Woods when various European countries got happily accustomed to America underwriting the liberal world order and never asking anything in return. But the fact remains that the liberal world order was crafted by the world's greatest superpower to fight a Cold War that ended a generation ago. Today's EU problems

testify to its being well past its sell-by date, and the symptoms of dysfunction are clear to even uninterested Americans.

Britain wants to "Brexiteer" away from the expensive unelected bureaucrats in Brussels who control the UK economy and sovereignty. As this is being written, Paris streets are occupied by "yellow vest" rioters for the tenth straight weekend, demanding democracy and the resignation of the Macron government. Eastern EU members like Poland, Hungary and Austria are refusing to allow a tide of Muslims to settle and change their national cultures, despite Brussels' commands. Sweden's political orientation is shifting, as Swedes watch their nation become the rape capital of Europe. Even Germany's political structure is

Photo: Barry Livingstone



The Gold Room at the Mount Washington Hotel in Bretton Woods where the historic agreements were signed establishing the International Monetary Fund and World Bank in 1944.

buckling under the stress of declining industrial production that threatens to become a recession. And, contrary to the cries of Wall Street gamblers, Trump knows it will not be a disaster for the American economy if the EU disintegrates and America then deals bilaterally with individual countries.

Finally, if the world does not destroy itself with nuclear weapons and instead falls into a global debt maelstrom that many are predicting, the American economic and military superpower, secure in its rich North American continent, will certainly suffer the least. Who can deny that the rest of the world might even be summoned to a future meeting in a Bretton Woods hotel?

Denmark's Foreign and Security Policy Strategy

Bo Leimand

Denmark is one of the most liberal, prosperous and secure societies in the world. Danish foreign policy aims to continue along this path and to preserve Denmark's security, prosperity and values in a rapidly changing world. But that is not going to happen by itself, and Denmark faces many challenges along the way.

The world is becoming increasingly unpredictable as global power relations shift. The legitimacy of rule-based international cooperation which has been guaranteeing Denmark's security, prosperity and values is increasingly being called into question.

and recent events are showing their effects within Europe and directly on Danish soil. Thanks to targeted efforts, fewer asylum seekers and irregular migrants are coming to Europe and Denmark. Nevertheless, Denmark needs to take action to address the causes of irregular migration;

2019–2020. This article deals only with the Security part, even if the Refugees, Migration and Development part remains a serious security issue after Chancellor Merkel made her historic remark in 2015: "Wir schaffen das." The political map has changed more in the last three years than it has since the fall of the Roman Empire. But before we take a closer look at the Security part, let me make a few remarks about the idea behind introducing it.

Foreign Minister Anders Samuelsen has no doubt that the world is better today than it was when our grandparents lived; that was the Foreign Minister's comforting remark when he presented the Danish Government's security and foreign policy strategy for 2019-2020.

But that was it with the good news. The strategy paper clearly shows that Denmark has recognised the severity of the attacks on its democratic institutions from many places, including the United States. The Strategy Paper treats American President Donald Trump directly and indirectly as one to watch out for. That this is a fact can be seen right now in Trump's decision to withdraw all American troops from Syria. The Americans are thus leaving the scene to Erdogan, Putin and Bashar al-Assad, and the Kurds remain defenceless. How this will end is not known at the moment, but this is foreign policy via Twitter.

The United States is questioning the value of international organisations it has helped to build since the Second World War; it is withdrawing from a growing number of agreements, including the Paris Convention, the Iranian Nuclear Convention and the UN Human Rights Council.

This is the first time that a Danish strategy paper has so strongly criticised a close ally, although the Danish Government also points out that Denmark remains heavily dependent on the alliance with the United States.

"No wonder the government is making so much effort this time to ward off the attacks on the institutions. If the foundations

Photo: MoD Denmark



Danish Minister of Defence, Claus Hjort Frederiksen

Now and in the years to come, Denmark will have to operate in an increasingly challenging foreign and security environment. Russia is threatening its neighbours and using various means to undermine the European security architecture and democratic processes. China is acting on the global stage with increasing self-confidence, economic strength and the demand for more influence. The United States is setting "America First" and has doubts about its global leadership and its willingness to defend the world order it has played a key role in building. The crises in Europe's neighbouring regions have become more entrenched. The destabilising behaviour of regional actors, including Iran, continues,

otherwise migratory pressures - particularly from Africa and the Middle East - will increase in the coming decades.

The Strategy Paper

In November 2018, the Danish Government presented a "Strategy Paper" which contains six topics of importance for Denmark: A Rule-Based International Order; Security; A Strong and Effective EU; Refugees, Migration and Development; Economic Diplomacy, Strategic Partnerships and the New Digital World order; and The Arctic.

In each thematic area, there are initiatives and priorities where the Danish Government sees the most important tasks in the period

disappear, the foundations of liberal democracy will also disappear and Denmark will no longer be one of the richest, freest and most democratic countries in the world," a diplomat told the Berlingske Zeitung.

Danish Defence Minister Claus Hjort Frederiksen said he wished Denmark to abolish the Danish defence opt-out in the EU context, but the basis must be in order and the advantages and disadvantages of the Danish defence opt-out in the EU reviewed so that the next referendum on the reservation is a referendum on exactly that and not, as Frederiksen himself said, on everything else. The new strategy was developed in cooperation between the Ministry of Foreign Affairs and the MoD and sets the course for Danish foreign and security policy over the next two years. The strategy makes it clear that Denmark – in cooperation with the United Nations, the EU and NATO – will continue to play an active role on the international stage.

This is necessary because, although the world is a better place than ever, it is changing and international cooperation is under pressure. This development requires a Danish foreign and security policy. Denmark must be committed to the world around it, fight for Danish values and ac-

tively defend Danish interests. This is the only way to ensure that Denmark remains one of the freest, safest and richest societies in the world.

Security from a Danish Point of View

Complex threats have emerged. Russia continues its aggressive behaviour in Denmark's neighbourhood. As before, terror and instability continue to emanate from the Middle East, Afghanistan, North Africa and the Sahel. Iran is still a destabilising actor and shows unacceptable behaviour in Europe and Denmark. Cyber threats remain extremely high, and, as one of the most digitised countries in the world, Denmark is particularly vulnerable. These threats pose serious challenges to Denmark.

Denmark cannot meet the challenges alone, and Denmark will receive no assistance unless it assumes responsibility in NATO, the United Nations or international coalitions – be it in the Baltic States, Iraq, Afghanistan or Mali. Denmark must play its part in ensuring that NATO remains the strongest defence alliance in the world, as unity and solidarity across the Atlantic

remain essential to Danish security. The United States is Denmark's most important ally for security policy and, through NATO, the guarantor of Danish security. Transatlantic relations are the cornerstone of Danish security interests, and it is imperative to preserve the American engagement in Europe through NATO. This requires Europeans to invest more in their own security and intensify cooperation across Europe, and Europeans must establish closer dialogue with the United States on Danish and European security policy issues. European allies will have to make greater contributions to NATO. The same applies to Denmark's contribution. The Danish initiatives show that Denmark is prepared to defend itself and our allies. The new defence agreement increases defence spending by 20%.

The security situation in the Baltic Sea region and the North Atlantic plays a central role in Denmark's security. The Danish Defence Agreement provides for the establishment of a deployable brigade, regional air defence and anti-submarine weapons, all of which serve to achieve credible deterrence. The Danish Government has decided to renew the Danish contribution to NATO's enhanced forward presence in the

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Baltic States by 2020, and Denmark will collaborate with close allies to establish a new NATO division headquarters in Latvia. The Danish Government also supports NATO's increased orientation towards the North Atlantic.

Security Initiatives in 2019–2020

The following are initiatives and areas on which Denmark will focus in terms of security between 2019 and 2020, as set out in the Strategy Paper:

- The Government will commission an external report on developments in the EU's security and defence policy and the importance of these developments for Denmark.

DKK118M to the Peace and Stabilisation Fund, including measures to prevent radicalisation, terrorism and irregular migration. The government will also launch new peace and stabilisation programmes for Syria-Iraq, the Sahel, Ukraine, Afghanistan, the Horn of Africa and the Gulf of Guinea.

- The government will, on the basis of the Danish Defence Agreement and the Danish Cyber and Information Security Strategy, strengthen digital security and Denmark's commitment to international cooperation on cyber security.
- The government will step up its efforts against foreign influence campaigns that jeopardise Danish values and interests by implementing the

Although Denmark has presented a strategy paper for only two years, many of the above initiatives will have to continue over a longer period and could be included in the next strategy paper.

Conclusion

The strategy paper focuses on the global leadership of the United States, and the United States is increasingly questioning the value of the international organisations and agreements it has helped build since the Second World War. The United States is increasingly withdrawing from its position of global leadership. These include the withdrawal from the Paris Agreement, the Iranian Nuclear Convention and the UN Human Rights Council, as well as the introduction of US tariffs on steel and aluminium from the EU. The Danish Government has said that Denmark does not agree with these decisions. At the same time, however, the Danish Government fully supports the continued leadership of the United States in several other areas, including the fight against ISIL.

Let us take the example of the US–USSR (later Russia) INF disarmament agreement on the scrapping of land-based medium missiles. Denmark was initially outraged that Trump was about to terminate the agreement, which would threaten European security, and this outrage despite the fact that it is well known in defence circles that Russia has long since developed a land-based SSC-8 medium-range missile in violation of the agreement, which NATO Secretary General Jens Stoltenberg considers to be "a threat to Europe".

Fortunately, Denmark has changed its mind. At the last NATO summit in Brussels, the Danish Foreign Minister declared that nothing would be gained if only the United States complied with the agreement – quite the contrary.

Denmark's new foreign and security policy strategy shows that international rule-based cooperation is to Denmark's advantage and that Denmark therefore regrets that the United States challenges international agreements and terminates one agreement after the other.

Looking at the Danish strategy paper and the outside world, we see a need for strong democratic political leadership. As Bismarck puts it, a brave and courageous statesman is as follows: "A statesman cannot create anything himself. He has to wait and listen to hear the footsteps of God sounding through events, then leap up and grab the hem of His garment." Let us hope that our politicians, who "grab the hem of His garment", have in mind the welfare of democracy and its institutions. ■



Photo: USMC

Denmark has participated in international peace missions for many years. The picture shows the official end of the Danish mission at Camp Bastion, Afghanistan, 20 May 2014.

- In line with the Danish Defence Agreement, the government will promote security cooperation with the Baltic Sea states and strengthen Denmark's focus on security in the Baltic Sea region through enhanced contributions to common defence in NATO.
- Through the Danish Defence Agreement, the government will improve Denmark's ability to participate in international operations with new capabilities and increase the funds for international operations by 50%.
- The government will allocate a further

Interministerial Action Plan, Danish membership of the NATO Strategic Communications Centre of Excellence and cooperation with technology companies.

- The government will set up a Defence Policy Advisory Group to bring Danish trade and research interests to the EU's new Defence Fund.
- The government will consider setting up a control mechanism to monitor foreign investment that may pose a risk to national security and public order.

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Viewpoint from Tbilisi



Challenges for the US in Europe and Asia-Pacific

Beka Kiria

Director of the Gagra Institute

For more than seven decades, members of the Euro-Atlantic security architecture have enjoyed the stability and undisputed protection of the block-based security system established by the Allies after the Second World War. The existing security cooperation on both sides of the Atlantic was seen as the political order of the Atlantic; transatlanticism became the basis for the current political framework embedded in the political modus operandi of the West and Western civilisation.

However, the Euro-Atlantic security architecture has been built on realities that have largely disappeared, which is why the Alliance is confronted with a major identity crisis. In addition, the roles and relative importance of security institutions in Europe have been subject to major changes due to global political dynamics and globalisation. The transatlantic idea in particular, as a solid link between Europe and the USA, has not witnessed an empathetic renewal for quite some time.

The European allies took the Euro-Atlantic security umbrella for granted and rarely met the two-percent spending target on defence and security, while US global dominance after the Cold War prevented the withering of existing security arrangements which rested on post-World War II realities. The US was a consistent provider of security and stability and chose to ignore the fact that only a few countries met the two-percent spending target.

As a result, at the end of the 1990s the US enjoyed almost absolute hegemony in the world, resulting in the reunification of Germany and the eastward enlargement of NATO to include the Visegrad Group, the Vilnius Group and the emerging Eastern European countries of Georgia and Ukraine. In addition, the US leadership transformed NATO into a body of norms that played an active role in managing global crises and increasing stability through the integration of national militaries.

Euro-Atlantic Challenges

After the resurgence of the Russian Federation, however, the security climate in the Euro-Atlantic region changed dramatically and influenced the national strategic calculation of the USA worldwide. The NATO membership of Georgia and Ukraine became a challenging task, because the leading NATO-EU nations Germany and France opposed it. Consequently, Russia had thus vetoed the expansion of the Euro-Atlantic agreement. Russia organised the war against Georgia and Ukraine, became militarily involved in Syria and intensified the refugee crisis within the European Union, which led to the rise of populist right-wing parties closely linked to the Kremlin.

Russia is increasingly destabilising the eastern flank of NATO, which extends from Estonia to Finland. The Kremlin has supported anti-liberal tendencies within the European Union and also hacked into US elections to undermine the democratic process and test the Euro-Atlantic security structure's resilience and responsiveness. With hybrid warfare against the West, Russia is trying to dismantle the Euro-Atlantic security framework and damage the democratic process.

Instead of joining forces to ward off Russia's growing hostility towards the EU, EU Member States are therefore at a low point in their relations. Russia has practically created a resistance axis that extends from the occupied territories in Georgia and Ukraine to NATO's eastern flank and on to Finland. Russia also relies on anti-liberal supporters within the European Union as a way of building another bloc of opposition within the Union. Overall, the cost of security in the Euro-Atlantic area has risen and long-term stability has become questionable.

Germany's Position

In addition, US-German transatlantic relations are divided. Notwithstanding criticism, the German Government views the North Stream II pipeline to be a commercial project disregarding the political consequences, arguing that Russian gas is 25% cheaper than US liquefied natural gas (LNG) shipped to Europe. Criticism of the project has also been voiced by states in the European Union's eastern neighbourhood in light of Russia's growing military hostility. Since it is of great interest for the European Union to resolve the conflict between Russia and Ukraine, supporting Ukraine's role as a transit country would be an important political step in this direction.

Moreover, it is debatable whether Germany's reaction to the Russian annexation of the Crimea in 2014 and its critical attitude towards the Russian occupation of Georgia in 2008 was strong enough to prevent Russia from making further gradual annexations; it took two specific requests to make Chancellor Angela Merkel label the Russian occupation of Georgia not as "injustice" but as "occupation".

This raises the question of whether the German measures in support of Western sanctions and verbal condemnation of the Russian invasion of Georgia or Ukraine were genuine and determined. What if, at the end of the day, Germany were to ease its pressure on Russia and accept the status quo in Eastern Europe, with a direct impact on European security? Should we ignore the Russian military's encroachment, hoping that what happens in Eastern Europe will stay there and have no impact on transatlantic security?

Asia-Pacific

The EU has sought to develop the defence and security dimension. As a result, the framework for Permanent Structured Cooperation (PESCO) has been established as part of the European Union's Common Security and Defence Policy (CSDP), in which 25 countries from

28 nations are working to structurally integrate their national armed forces. The gradual Europeanisation of security on the European continent thus designates the role of the United States in European affairs, including defence and security. Meanwhile, all the above-mentioned developments concern transatlantic security and address the challenges and threats posed by the Russian Federation. It is important to note that Turkey also intends to realign its orientation. According to Ankara, the country wants to reduce its dependence on Euro-Atlantic security cooperation. Following its recent turn toward Russia, Turkey's membership in the Shanghai

Photo: US Air Force



US Pacific Air Force Airmen conduct a combat skills training exercise at Andersen Air Force Base, Guam, 1 February 2017.

Cooperation Organization also looks promising. Turkey's departure from the United States as a strategic ally could significantly weaken transatlantic relations and be an increasing burden between transatlantic partners and China.

Overall, the price of security within the Euro-Atlantic security framework has risen due to Russia's increasing aggressiveness; Russian military exercises and destabilisation efforts are captivating the US and preventing it from focusing again on the Asia-Pacific region. In the meantime, China has the advantage of building economic, military and political alliances and establishing a new politico-military order in the Asia-Pacific region.

China's Silk Road Strategy in Southeastern Europe

Frank Umbach

No other economic and foreign policy initiative has attracted so much worldwide attention as China's new Silk Road strategy. China currently finances more emerging market infrastructures than all multilateral development banks and OECD countries combined.

China's Belt and Road Initiative (BRI) – previously called “One Belt, One Road (OBOR)” – has been designed by Beijing as its new guiding economic and foreign policy framework with a focus on its southern and western neighbourhood, but reaching out to the Persian Gulf, Africa and Europe.

to enhance China's commercial, trade and other economic interests. According to official Chinese declarations, through designating it as “the project of the century” by China's President Xi Jinping, it is considered as a vehicle to open markets, expand export overcapacities, generate employ-

The framework combines the previous programmes of China's Silk Road Economic Belt and 21st Century Maritime Silk Road Strategy (MSR) and promotes major strategic investments along six economic corridors in its neighbourhood. Up to US\$1Tr is earmarked for regional investment and trade to create an integrated network of supply and value chains, particularly in production, transport and energy. It envisages massive investments in ports, airports, transnational railways, highways, container trade and fibre-optic cables as well as energy projects. This could also transform dramatically the way commerce is conducted globally, increasing the share of European-Asian trade over land routes. Currently, 90% of global container trade is conducted via vulnerable SLOCs. But they are controlled by the US navy, which China distrusts and seeks to counter by building its own blue-water navy.

In this context, China's investments in Central and Eastern Europe (CEE), including the Balkan states, are playing an increasing role with wide-ranging strategic implications on the EU's Common Foreign and Security Policy (CFSP). Three major reasons are playing a crucial role in this regard:

The European Commission had initially rather overlooked China's OBOR initiative. Instead, some EU countries have signed bilateral BRI contracts without getting Brussels involved. Beijing had already created an institutionalised “16+1” cooperation framework with CEE countries in 2012, which neither involves the European Commission and the European Parliament nor the other EU member states. These 16 European cooperation countries include 11 EU member states from CEE and five Balkan states: Albania, Bosnia-Herzegovina, Bulgaria, Croatia, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Macedonia, Montenegro, Poland, Romania, Serbia, Slovakia and Slovenia. Through its ‘16+1’ regional cooperation framework, Beijing has been able to play the individual EU countries against each other.



Photo: COSCO

The port of Piraeus has been taken over by the Chinese state-owned company COSCO Shipping.

Officially, it is neither a Chinese “Marshall Plan” nor a geopolitical master strategy. Meanwhile, the BRI involves 86 countries (rising from 65 countries in 2015) and 15 Chinese provinces.

As centuries ago during the times of Marco Polo, China views itself as the ‘Middle Kingdom’ geographically and geopolitically and, therewith, as the global centre of world trade. The BRI is not just a strategy

ment, reduce regional inequalities, promote political stability and security through development as well as prosperity and to restore Chinese spheres of influence in the Eurasian landmass and beyond. It is conceived in China's historical roots, designed as a multipurpose umbrella for its comprehensive economic, domestic and foreign policy development in order to increase its geo-economic and geopolitical influence. Ultimately, it is viewed as a renewed form of China's traditional hegemony over its neighbours and rivals belonging to a tributary system as centuries ago, but adapted for the 21st century.

The BRI was launched by Xi Jinping as the OBOR in a speech at Nazarbayev University in Astana (Kazakhstan) in September 2013.

Author

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In the EU, China's BRI has come under increasing criticism, as many Chinese investments are intransparent and have been made without any free market competition through an autocratic political system. China's recent strategic investments in critical infrastructures in Europe includes buying ports (like the Greece harbour of Piraeus) and critical high-tech companies such as the German industrial robotics company Kuka in 2016. This has resulted in new control processes being introduced in Germany and by the European Commission, which has been criticised by the Chinese as a new protectionist policy against "third countries". However, Europe's increasing economic dependence on China has more far-reaching implications, as China spent €75Bn on European acquisitions and investments only in 2016 – which is equivalent to its total European investments over the last 10 years. While Chinese investments in Southeast Europe (SEE) often follow other strategic objectives than acquiring high-tech options, they have created new economic-financial dependencies of these smaller and economically

were repeatedly postponed by Brussels and EU member states (beyond 2025). As a result, it has created a growing disillusionment and a foreign policy vacuum among the Western Balkan countries. China (and Russia) has seized the strategic opportunity by using new economic and foreign policy options.

Chinese Investments

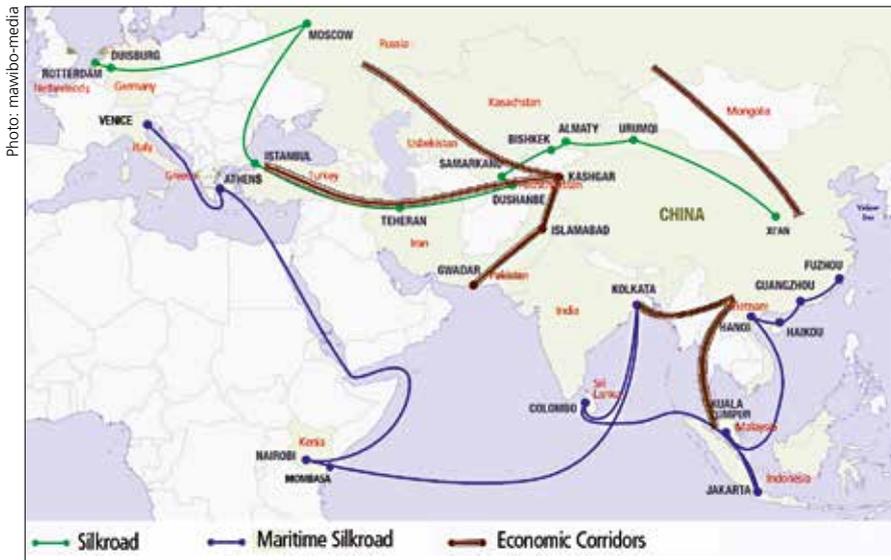
The institutionalised regional cooperation "16+1" between China and the CEE and SEE countries officially serves to facilitate, identify and coordinate Chinese investments in the region. It is part of Beijing's Eurasian Silk Road Strategy to create new land and sea corridors to expand world trade between China, Central and South Asia and Europe.

In 2017, China's bilateral trade with CEE and SEE amounted to up to US\$90Bn. China's BRI investments in the 16 European BRI cooperation countries are estimated at US\$9.4Bn. Half of these investments were made in the Balkan states of Albania, Bosnia-Herzegovina, Macedonia, Montenegro

goods within the EU-28. However, Chinese investment in Hungary has declined significantly since 2016. Compared to Southeastern Europe, the low attractiveness of Chinese investments in CEE can be explained by the much more attractive EU financing, a reformed economy and strict EU procurement regulations.

Since 2008, China has systematically exploited the financial and economic crisis in Europe. In particular, it has pledged greater financial support and investment to those countries that have been most affected by the European crisis, such as Greece and Portugal, which have always been the economically weakest countries in Europe. Through its state-owned shipping group China COSCO, China has acquired a 67% majority stake in the Greek port of Piraeus, one of the most important maritime transshipment centres in Europe. In Serbia, Beijing financed the construction of a €2Bn high-speed rail link between Belgrade and Budapest as part of a trans-Balkan rail network. It is financed by a loan that covers around 85% of the investment costs for the high-speed project. The train connections will link the port of Piraeus with the inadequately networked countries within South-eastern Europe and the rest of the EU. The Balkan states act as important land bridges and transport corridors for Chinese goods and products transported to the EU via Piraeus, Central Asia and Turkey. China is accelerating these infrastructure projects between the regional states of South Eastern Europe as part of a major regional business plan with clearly defined strategic interests. Actually, this should have been the EU's responsibility, but growing navel-gazing, Eurocentrism and focus on the EU's internal problems have prevented Brussels and its larger members from developing the traditional "poorhouse of Europe" and economically linking it more closely to the EU.

China has also increasingly invested in the energy sectors of the "16+1" countries – both in renewable energies and in new coal-fired power plants, although investments in coal-fired power plants in the region and the EU are controversial. The EU prefers to decarbonise its energy mix and abolish coal-fired power plants. In December 2017, Beijing agreed to build a new 500 MW coal-fired power plant in Kosovo, which will come on stream in 2023. China's state-owned energy companies have also invested increasingly in wind energy in nine European countries. While China's investments in renewable energies are welcomed for climate protection reasons, the lack of transparent and public tenders has been criticised by Brussels, EU member states and international organisations. Although the International Monetary



The six economic corridors of the Belt Road Initiative (BRI)

weaker SEE countries on China. They have wide-ranging economic and foreign policy implications for the EU's strategic influence in the Balkan states and SEE as well as the EU's policy towards China. According to Brussels, the EU had given some Eastern European countries full membership too quickly, although they were not sufficiently prepared. In order to avoid failures and maintain social, economic and foreign policy cohesion and functionality (with a priority of deepening the integration process before EU enlargement), the prospects for full EU membership of the Western Balkans

and Serbia, which are among the smallest and economically weakest countries in Europe. Statistically, however, this is only 5% of all foreign direct investment (FDI) in CEE and SEE; 90% of all Chinese FDI in the EU is still made in Western Europe. But China's investments in CEE and SEE have an impact on EU policies in the region. At the "16+1" summit in Budapest in November 2017, China announced new investments of up to almost €3Bn in its European partner countries. By 2015, Hungary recorded almost 80% of all Chinese FDI in the "16+1" range and wanted to become the hub for the distribution of Chinese

Fund (IMF) officially supports China's BRI, it warned in April 2018 that China is financing unnecessary and unsustainable projects in many countries that have led to high and non-repayable debt burdens. According to a US report, eight countries are already struggling with their debt service and often overpriced projects and Chinese loans, and 23 countries face significant financial management risks due to the high level of BRI borrowing. Another study concluded that 32% of all BRI projects (US\$419Bn) since 2013 have faced delays, cancellations, public resistance, mismanagement, market misjudgements, corruption and critical debates about national security.

Many BRI countries face project delays, sovereignty problems, growing environmental problems and a lack of participation of local workers. The BRI projects have a lasting impact on their economy, as they are often carried out exclusively by Chinese companies. Instead, genuine sustainable development requires the involvement of local acceptance, communication and cooperation with local authorities and community stakeholders and their interests (for example, local job creation and local enterprise involvement). In Europe, BRI projects must also comply with EU environmental laws and regulations and social standards.

China's Geopolitical Interests

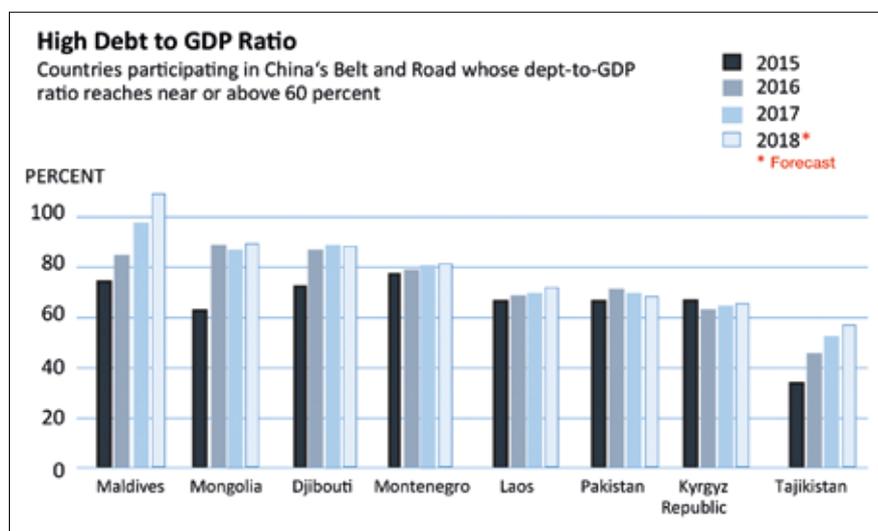
From China's perspective, five main strategic interests can be identified in the BRI's Silk Road Strategy: (1) coordinating different policies; (2) creating links between the energy sectors (including new energy import routes), transport infrastructure and digital cyberstructures; (3) reducing trade and investment barriers; (4) integrating financial markets; and (5) promoting international understanding.

The increasing economic dependence, especially of smaller European countries on China's investments, has undermined a common EU foreign policy towards China, and Beijing has been using its newly gained influence, especially in smaller European countries. In China's interest, Portugal, Malta, Greece and the Czech Republic have recently watered down the text of a declaration on an EU review process for third-country investments in strategic sectors. In July 2016, Greece, Slovenia, Croatia and Hungary prevented the EU from harsher criticism of China's assertive policies in the South China Sea.

In recent years, Chinese investment has increased EU concerns and distrust of BRI plans. China has also announced a "Digital Silk Road" and investments in foreign fibre-optic cables, telecommunications and inter-

net infrastructures, data and cloud computing services, global positioning and wireless communications, and intelligent urban sensors. They will enable the introduction of backdoor viruses and mechanisms that could reinforce Chinese cyber espionage, intelligence and propaganda missions in

China's controversial investments in foreign energy sectors have the same intentions. In recent years, China has not only been the world's largest investor in renewable energy, but also the largest investor in coal mining and coal-fired power plants. Between 2000 and 2017, the China Development Bank and



Debt of selected countries cooperating with China's BRI (as a percentage of GDP).

BRI partner countries. Beijing is suspected of being ready to export its globally unrivalled internet censorship and comprehensive political control over data collection and traffic. For the EU and other Western countries, these digital investment projects raise fundamental human rights issues by undermining the personal freedom, privacy and anonymity granted by liberal Western democracies and their constitutions. Beijing could establish similar control and censorship of the internet in BRI cooperation countries as in China.

China's investments in the Balkans and other (Eastern European) countries not only serve its economic policy objectives, but ultimately aim to strengthen its geopolitical influence and control over the economic and foreign policies of its BRI partner countries. In this way, unprofitable projects are also financed that do not generate short-term profits but are economically and politically meaningful in the medium and long term. While Chinese loans and other financial support are often very welcome in poorer countries in SEE, China can unilaterally determine the terms of its investment projects and loans. The Balkans and other countries have been in a difficult negotiating position since the beginning and often undermine their own position by taking bribes. While China actively combats corruption at home, it uses corruption as a foreign policy instrument abroad.

the Export-Import Bank of China invested more than US\$225Bn in global energy projects. In contrast to the perception in Europe, two-thirds of these investments went into fossil fuel projects. Another study concluded that between 2014 and 2017, 91% of the energy investments of the largest six Chinese banks went into fossil fuel projects.

These investments have become necessary for China's state-owned energy companies, as the government wants to reduce the share of coal in its energy mix and increase the share of renewable energy and natural gas as a measure to combat air pollution. As Beijing has an interest in its energy companies – including those operating modern coal-fired power plants – becoming the largest energy companies in the world, with the political support of the Beijing government, companies are forced to increasingly invest abroad and reduce overcapacity in their domestic market, as they no longer have growth prospects within China.

From a Chinese perspective, foreign investment, as in the "16+1" format, strengthens the economies of partner countries, creates many new jobs and links the countries of the region. But the dependence of the BRI partner countries on China has also enabled Beijing to intervene in the political decision-making processes of its foreign policy. China's dual strategy of creating economic incentives and increasing political pressure became visible ahead of the annual Asia-Europe Meeting (ASEM) summit in July

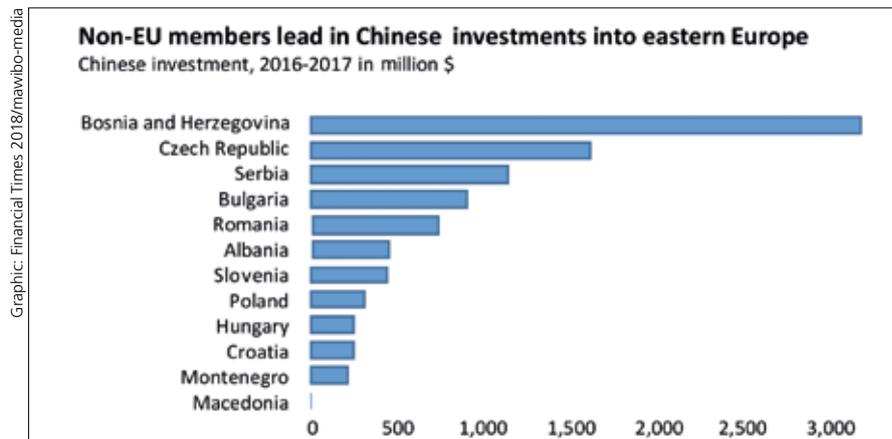
2016, when Hungary, Croatia and Greece resisted supporting the EU's joint criticism of China's maritime territorial claims in the South China Sea. Greece blocked another critical EU statement in the UN denouncing its human rights violations. Until now, Europe believed that China only wanted to acquire or steal strategic technologies by taking over European high-tech companies. There is now a suspicion that the Chinese want to gain political influence and control over EU decision-making processes by applying a "divide and conquer" tactic (like Russia) to weaken political solidarity in their CFSP. In addition, China's maritime activities were expanded in 2018, including a joint exercise with the Russian Navy in the Baltic Sea. The more China invests in Southeast Europe and the Balkans, leading to an increasing asymmetric dependence of these countries on China, the more Beijing threatens Russia's interests in the region – a challenge for Moscow similar to Central Asia, where China's growing ties have undermined Russia's geopolitical influence in its traditional backyard. China is for now carefully balancing its influence in these regions with its bilateral relations with Russia, as both countries want to marginalise the interests of the US and the EU in these regions. In the medium and long term, however, contradictions and geopolitical competition between Russia and China could continue to grow, creating new foreign policy and security dilemmas for Russia, China and the regional states. Despite the growing political-economic alliance between China and Russia, China did not invite Russia into its "16+1" framework. Instead, China has now invited Germany – as the largest investor in CEE and SEE – as an observer to the "16+1" format.

Is China Marginalising the EU's Influence in the EU?

For the CEE and SEE countries, China's investments are mostly welcome, as many EU investment promises have been disappointing. Chinese investments do not just create new jobs and economic growth in their countries; they may also produce positive economic spillover effects. They also enhance their political leverage in Brussels, as those EU member states and other SEE European countries are no longer dependent just on EU investments and the associated stringent investment conditions. But China's BRI projects in CEE and SEE face similar problems as in other regions of the world as they are plagued by corruption, delays, cost overruns, and lack of due diligence. Europe's hopes for higher Chinese investment are often guided by short-term considerations and self-interest, but they overlook possible long-

term effects. Chinese investments in critical infrastructures such as energy, telecommunication and harbours may create lasting asymmetrical dependencies, which constrain their foreign policy options and undermine a common EU CFSP.

Beijing has been able to play the individual EU countries off against each other and exploit their competing national interests, serving China's (and Russia's) general strategic interests to marginalise the EU's influence in Southeastern Europe. The challenge for the



Chinese investments in Central and East European countries in 2016/17

In contrast to Western Europe, where the Chinese are acquiring high-tech companies, sophisticated technologies and patents, China's investment strategies in Southeastern are often guided by geopolitical motives to diminish the EU's influence in the region. Today, it is becoming increasingly difficult for the EU to have one voice vis-à-vis Beijing. In the coming years, it will become a more important issue for the EU, as China's growing economic-financial influence inevitably leads to a growing security interest in the region, because China's investments and infrastructure projects need to be protected from potential threats to security. In the past, China was understandably a late comer that had no other option than to invest in politically riskier and less profitable countries. But these circumstances have their historical roots in 1945 and have changed enormously since then. Many traditional pillars of Chinese foreign policy (such as non-interference abroad, no establishment of military bases abroad, and so on) have crumbled since Beijing's global interests have increased dramatically. Beijing has become much more proactive about its diplomatic and military affairs around the world, including Europe.

Strategic Perspectives

With China's growing investment challenges bringing new economic opportunities and strategic risks, the EU has been increasingly forced to address the impact of Chinese investment on its markets and the CFSP. BRI is the most visible expression of China's global ambitions and expands China's sphere of influence worldwide. Through its "16+1" Regional Cooperation Framework in Europe,

EU and the regional states of South Eastern Europe is not Chinese investment as such, but the conditions and effects of this investment. Mistrust has grown in Europe and globally as many Chinese companies lack transparency about their ownership, business plans and investment strategies. China's notorious "debt trap diplomacy" is called this because it does not support the local economy but sends its own imported labour to facilitate its access to natural resources, opens markets to its low-cost export goods and prevents countries from escaping Chinese debt, which ultimately distracts BRI cooperation countries from their own economic growth potential. The EU should respond with a more active investment strategy and a strategically designed regional policy; otherwise, it will not just lose its own geo-economic influence in SEE but inevitably play into the hands of Beijing and its own autocratic political order in the region. Rising critique of China's BRI around the world may create new ways of working with China and Chinese companies that offer more mutual benefits. Such criticism may force Beijing and its companies to apply international standards to their investment projects for greater transparency and sustainable development in BRI partner countries. The EU must encourage Beijing to recognise that depoliticisation of investment strategies starts at home. A positive learning curve on China's side could also create new synergies between China's BRI and the EU's Trans-Europe Networks and the EU-China Connectivity Platform. At the same time, Chinese investment in critical infrastructure and takeovers of European high-tech companies must be viewed more

critically in light of Beijing's "Made in China 2025" (a ten-year plan to transform China into a high-tech power, dominant in 10 industries). In Germany, the government plans to tighten legislation for non-EU companies that have a significant stake in German companies from sensitive strategic sectors or critical infrastructures such as defence, energy and telecommunications. It enables the federal government to examine or block acquisitions of up to 10% (compared to 25% under previous legislation). Ultimately, the challenges for German industry and the government are not only China's investment in German robotics and artificial intelligence companies through the theft of their technologies, but ultimately political control and geopolitical power. Free trade advocates, including EU countries like Finland, Sweden and the Netherlands, fear new forms of protectionism by the EU which might create new investment barriers that could harm the EU itself. This argument is supported by smaller and economically weaker EU countries that are already dependent on Chinese investment, such as Portugal, Greece, Malta, but also the Czech Republic. The share of Chinese investment in Portugal, Ireland, Italy, Greece, Spain and Cyprus has risen from 8% in 2009 to 33% between 2012 and 2014. These countries have already said that they would suffer from investment barriers against China and want to be compensated by the EU.

EU policy must be officially guided by the principle of reciprocity. Investment must not be a one-way street, as the Chinese Government does not grant European companies the same opportunities and rights as the EU grants Chinese companies. Last September, the European Commission published its long-awaited strategy of "sustainable, comprehensive and rule-based connectivity" entitled "Connecting Europe and Asia - Building Blocks for an EU Strategy" as an alternative approach to China's BRI. The EU has defined "connectivity" to be "economically, fiscally, ecologically and socially sustainable in the long term". Contrary to expectations, however, the new EU strategy neither reviews China's BRI nor the balance of benefits and risks, nor does it mention BRI

by name. Rather, it is a normative framework, a set of rules and a response to China's BRIs to codify the EU's position and at the same time define the EU's red lines. It is not a zero-sum strategy, but the EU strategy clearly reflects growing concerns. For example, in international investment disputes, the EU is seeking a neutral arbitration mechanism based on international law, while China wants to create new international trade tribunals for its BRI projects based on existing Chinese judicial, mediation and arbitration institutions and laws.

China's secret agenda and the ambiguity of BRI and its investment policy will continue

to create mistrust and resistance in Europe, as Beijing has already experienced in Central and South Asia and Africa. Insufficient transparency of China's BRI projects is inevitably linked to the increasingly autocratic and nationalist political system under President Xi Jinping. European companies could also try in the future to decouple their business interests from Beijing's overarching agenda and long-term strategic interests. But in the medium and longer term, they risk damaging and undermining their own business interests, the rules of Western governance and international law on which they have relied for decades. ■

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Viewpoint from Jerusalem



Paying the Price of Western 'Victory'

Tamir Eshel

The Kurdish question is deeply affected by the lack of stability in the Middle East. With a population of +35 million, the social fabric to which the Kurds belong is divided among four nations in the Middle East: Turkey, Iran, Iraq and Syria. Kurds mainly live in remote, rural regions of these countries, in landlocked areas where they depend on the regime or their economic and trade neighbours.

This area was further dissected by the national borders imposed by Britain and France after the collapse of the Ottoman Empire. In 1920, the Turks agreed to establish a Kurdish autonomy in the eastern part of Turkey and northern Syria, as part of the establishment of the Turkish Republic. This was part of the conditions imposed on the nation by the victorious Allied powers that developed from the defeated Ottoman Empire, but a promise that was never fulfilled.

Since the end of the First World War, when this minority came closest to establishing an independent state, the Kurds have been involved in many regional conflicts. They fought against Saddam Hussein's regime, perpetrated terrorist acts in Turkey, resisted Iran's revolutionary guards in the Zagros Mountains and battled the Assad regime in Syria.

Short-Lived Hopes

Recent conflicts provided the West a chance to rectify this injustice, as the Iraqi Kurds allied with coalition forces against the Iraqi Government, providing instrumental support for US Special Forces operating in the region. With American influence in the country, the Kurds received partial autonomy and were able to exploit the region's oil.

Factioned in rivalries, alliances and interests, the Kurds could not benefit from their support for the West. Some oriented themselves to local regimes, while igniting conflicts by providing shelter and assistance to terrorists across borders.

With the US withdrawal from Iraq that resulted in the rise of the Sunni militant extremists (ISIS), the Kurdish Peshmerga (whose name translates as "those who face death") militia proved to be the only force that could stop the movement of ISIS south. The Kurds lost many of their oil fields to ISIS but succeeded to keep ISIS out of Kurdish territory. They received extensive air and fire support from coalition forces but relied primarily on their own fighting forces on the ground battles, minimising the need for US 'boots in the ground'. Iraqi Kurdistan also provides logistical backing to a smaller group called Kurdistan Democratic Party of Iran (KDPI). Since 2015, KDPI has increased its opposition to the Iranian regime and was mentioned as one of the conduits the US might use when battling Iran.

When in 2011 Syria descended into civil war, the Kurds established the People's Protection Unit (YPG) militias to face both government action and hostile Islamic factions that rebelled against Damascus. With significant parts of Syria falling into the hands of ISIS, this Kurdish militia was the only effective force that could stop the extremists' takeover of Eastern and Northern Syria. YPG were also widely supported by coalition forces, receiving training, equipment and air support. In the past two years, 2,000 US soldiers and Special Forces have helped the YPG routing ISIS from areas it controlled east of the Euphrates. While Iraqi and Syrian Kurds faced the threat of ISIS, their militant brothers in Turkey continued to battle the Turkish Government through acts of terror launched by the Turkish Kurdistan Workers Party (PKK), the most militant and extremist Kurd faction and the only one blacklisted as a terrorist organisation.

Theoretically, the four states of the Middle East with a significant Kurdish population each have security relations with the US and the West that could unite such a nation and pave the way for its independence. Despite their strong support in the West, however, the Kurds remain divided and indecisive about whether, how and when to stand up for independence.



Photo: US Army

Peshmerga soldiers prepare to conduct a combined arms live-fire exercise near Erbil, Iraq, 11 October 2016.

The collapse of ISIS in Iraq in 2017 raised hopes for Kurdish statehood, reflected in a sweeping majority of Iraqi Kurds who voted for independence. But it was opposed by Turkey, Baghdad and the West, which feared further instability in the region. The Iraqi Government response was swift and decisive, as Iraqi security forces moved into the Kirkuk region and seized it from the Peshmerga. The West betrayed the Kurds again when it refused to support its ally.

The Shia Crescent

With Iran tightening its grip on the region, an independent Kurdistan would have created a buffer that would challenge Iran's aspiration to expand its control through the 'Shia Crescent' across Iraq, Syria and Lebanon. The coalition forces that helped fight ISIS supported the Kurds and other militant groups in Al Hasakah, Dier ez-Zor, and Raqqa – Kurdish controlled governorates, in eight facilities that provided training, intelligence, coordination and logistics support and practically enforced that buffer zone even without a Kurdish independent state. The only location where American forces were 'on the ground' outside the Kurdish controlled area was the small garrison at Al-Tanf, a small village that was a strategic thorn that restricted

Iranian freedom of movement into Syria. Located at the south-eastern border of the Homs governorate, Al-Tanf was the only border passage between Iraq and Syria east of the Euphrates that was out of YPG control. As such, the American presence there prohibited movement of military forces and supplies from Iran to Syria and Lebanon. This point was a tension point that repeatedly came under attack, by irregular Syrian militias supported by Russia. It was a sensitive political issue that eventually caused President Trump to announce 'victory' and command an unexpected full withdrawal from the American fight against ISIS. Although the pullout has been slowed and will eventually span over several months, the announced withdrawal is a major setback for the Kurds but a sigh of relief for Iran and Turkey.

Turkish Fears

Today, the Turks face an increasingly nationalist Kurdish generation with growing expectations and aspirations. With the presence of the Kurdish regional government in Iraq, a newly formed Kurdish region in Syria, and Iran's own Kurdish region, soon Turkey would see nothing but Kurdish entities at its southern borders. That's why Turkey acted against the Kurdish enclave in Afrin earlier this year, under a quiet agreement with Moscow. The recent agreement with US President Trump, in which President Erdogan committed to 'route ISIS' from their remaining positions in Southern Syria, will enable the Turks to deal with the Kurdish forces in the east of the country in the same way.

While France was mentioned as a potential supporter for the Kurds in Syria, the Kurds realised the immediate danger from Turkey and opted to approach the Syrian Government for support. As US backing seems unstable, to say the least, the Kurds would rather settle the conflict with the Syrian regime than see the Turks invade into their areas in Eastern Syria, as they seized Afrin in northwest Syria few months ago. With Kurdish independence now off the table, Eastern Syria will likely determine the power balance of forces in the region, as Turkey, Iran, Russia and Israel struggle to establish long term interests in Syria, that has just begun healing from the eight-year civil war.

US-Turkish Relations in Crisis

Eugene Kogan

In recent years Turkish President Erdogan has turned his country towards the East. In so doing he is risking a break with his NATO allies in the West.

To understand the extent of the crisis in US and Turkish relations, the author focuses on the period between 15 July 2016 and October 2018 and presents a multi-dimensional analysis of bilateral relations. The failed coup in Turkey on 15 July 2016 was a turning point in bilateral relations. The coup has left many questions from US officials about the nature of the coup unanswered by their Turkish counterparts. In addition, President Recep Tayyip Erdogan's request for the extradition of US-born Muslim cleric Fethullah Gulen, whom Erdogan called the head behind the coup, was repeatedly rejected by the US Department of Justice because of insufficient evidence. This point is disputed by Turkish officials who claim that they have provided sufficient evidence of Gulen's complicity in the coup to obtain his extradition.

A New Generation of Officers

In addition to the already tense relations, there is the question of Turkish military service at NATO headquarters in Brussels and in various NATO member states, including the USA. Several high-ranking officers asked for political asylum in the USA and elsewhere after the failed coup. According to undisclosed sources, the number of asylum seekers in the US varies between several dozen and one hundred / one hundred fifty and all are senior officers. For recently re-elected President Erdogan, these officers remain a thorn in the side, and he would be more than happy to have the officers arrested. But his request is not being granted so quickly. In this context, it must also be remembered that Erdogan has eliminated thousands of NATO-trained

officers of the Turkish armed forces and promoted a new generation of military officers loyal to him as commanders-in-chief. This new officer generation has a Muslim identity and mistrusts NATO in general and the United States in particular.

air defence system is not compatible with NATO standards and cannot be integrated into NATO's air defence system.

Turkey must therefore limit itself to its own architecture. In addition, the S-400 could jeopardise F-35 operations, as Russia and its

allies receive valuable electronic and signal intelligence data not only about Turkey, but also about all members of the F-35 Club. That was and is the reason for the Senate to temporarily suspend the delivery of the aircraft to Turkey. There were also tensions with Washington

over US support for Kurdish militants in Syria (known as People's Protection Units or YPG) in the fight against the Islamic state militia (ISIS). Turkey regards the Kurds as militant terrorists, while the USA sees them differently, and this question remains a point of contention between the two countries, despite the agreement reached between Turkey and the USA on 4 June 2018.

The agreement stipulates that Kurdish militants can withdraw from the Syrian city of Manbij until September 4. Erdogan declared on 3rd September that "the United States is delaying the implementation of an important bilateral agreement providing



Photo: mawibo media

To the military issues mentioned above, we must add Erdogan's decision to procure the S-400 air defence system manufactured in Russia, a decision taken at a time when relations between NATO allies and Russia are at a very low level. Erdogan's decision to buy the system from Russia and his steadfast attitude not to give up this procurement is vehemently condemned by angry US senators. In return, these senators blocked the delivery of the F-35A to Turkey, although Turkey had already signed a contract with the US company Lockheed Martin in 2002 for the purchase of 100 F-35As. It should be noted that the S-400



Photo: mawibo media

Incirlik Air Base in Turkey has a US Air Force complement of about 5,000 airmen. The US Air Force and the Turkish Air Force are the primary users of the air base.

Author

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for the withdrawal of the YPG from the Syrian city of Manbij". Eric Pahon, defense ministry spokesman, said on 11 September that "it is not that easy. We want to make sure that we do this for the security of all, for us, for the Turkish soldiers and for the people of Manbij," and he went on to say that technical preparations had been made for a joint patrol with the Turkish Army, which finally began on 1 November 2018. In addition to tensions in the security sector, economic relations between the two countries have also intensified. Finally, the inappropriate behaviour of President Erdogan's personal security forces during Erdogan's visit to the UN General Assembly in New York in May 2017 and the unlawful detention of some 15 to 20 Americans have intensified relations between the US and Turkey. Although the release of Pastor Andrew Brunson on 12 October 2018 improved relations between the US and Turkey, relations remain cool. Moreover, public opinion in Turkey about the US is very negative. As a result, the improvement of bilateral relations is not in sight. It must be stressed that the crisis in relations between the US and Turkey is affecting the cohesion of the NATO alliance, as both countries are members of the alliance. The US remains the main actor, while Turkey has been turning away from the alliance for some time, which is denied by Turkish officials. The current difficulties in bilateral relations will not improve in the foreseeable future. The last section of the article describes what the US should do in the present context, and the conclusion illustrates the severity of the US-Turkey crisis, which NATO allies tend to underestimate or perhaps consider temporary.

Military Relations

No US companies bid for a Turkish attack helicopter contract back in 2006 after Turkey insisted on full access to specific software codes, which the US refused to share, considering it a security risk. As a result, the Turkish Aerospace Industries (TAI), in collaboration with the Italian AgustaWestland, has produced 50 T129 helicopters for the army. At the moment, T129 may not be exported to Pakistan.

On August 13, 2018, President Trump signed the National Defence Authorisation Act (NDAA) for 2019, approving a military budget of US\$716Bn and including a temporary ban on the supply of Lockheed Martin F-35A stealth jets to Turkey due to diplomatic tensions with Ankara. The NDAA 2019 requires a written review of the operational and defensive threats to the F-35 within 90 days resulting from Tur-

key's procurement of the Russian S-400, as well as a review of Turkey's participation in the F-35 programme and the nature of US military relations with respect to the use of the Incirlik Air Force Base by US forces and major weapon systems such as the PATRIOT SAM, F-16 FIGHTING FALCON and CH-47 CHINOOK, AH-64 APACHE and UH-60 BLACK HAWK helicopters. The ban on F-35 deliveries can only be lifted after these risks have been analysed, conclusions drawn and political recommendations presented on 11 November.



President Trump and President Erdoğan gave a joint statement at the White House on 16 May 2017.

The diplomatic crisis between the USA and Turkey not only affects the F-35 programme, but also jeopardises the sale of 30 TAI T129 attack helicopters to Pakistan. The USD1.5Bn export contract signed in July 2018 is Turkey's largest single defence sale to date. However, the sale is not taking place, because the US has vetoed the export of the LHTEC CTS800-4A turbines that power the T129. LHTEC is a joint venture between Honeywell and Rolls-Royce. No decision has yet been taken.

Economic Relations

Erdogan has protested against the prosecution of Hakan Atilla, Halkbank's Deputy Director General, in a New York trial for violating US sanctions against Iran. As Halkbank is one of the largest state-owned banks in Turkey, Ankara fears that a US Treasury fine against the institution could have a domino effect on the Turkish financial system at a time when the economy is in serious crisis. The Erdogan government wants to obtain the release of Deputy General Manager Hakan Atilla from a US prison for violating sanctions against Iran and sentenced to 32 months in May 2018. However, it is unlikely that Hakan Atilla will be released in the foreseeable future. As in the case of Fethullah Gulen, Erdogan does not understand that

the US Department of Justice is an independent institution and President Donald Trump has no influence on its decisions. The convicted Hakan Atilla will have to serve his sentence in the USA. No decision has yet been made regarding the US Treasury's fine on Halkbank.

In May 2018, Trump announced that the US would withdraw from the international agreement on Iran's nuclear programme and reintroduce sanctions against Tehran. Trump's government also threatened other countries with sanctions if they did

not stop oil imports from Iran. According to data published in May 2018 by the Turkish Energy Market Regulatory Authority (EMRA), Iran remained Turkey's largest crude oil supplier despite a 20% decline in the first quarter of 2018. On 24 July, Turkish Foreign Minister Mevlut Cavusoglu said: "Turkey will not implement US sanctions against Iran". Previously, Ankara had sent the same message to a visiting delegation from the US Treasury Department. And on 25 July, Erdogan called Iran "a neighbour and strategic partner", which further strained relations between the US and Turkey.

President Trump further intensified his controversy with Turkey on 10 August 2018 by imposing higher tariffs on metal imports, exerting unprecedented economic pressure on a NATO ally and exacerbating the turmoil in Turkish financial markets. Trump said tariffs on "aluminium will now be 20% and steel 50%. Our relations with Turkey are not good at the moment" and may not improve in the foreseeable future.

Social Relations

A US grand jury has indicted 19 people, including 15 members of Erdogan's personal security forces, for the attack on demonstrators against his regime outside the Turkish

Photo: US DoD

embassy in Washington, DC, in May 2017. The incident outraged American lawmakers, especially after a video appeared showing Erdogan watching the beatings until local law enforcement intervened.

John McCain, Chairman of the Senate Committee on Armed Forces, said after the attack: "This is the United States of America. We don't do that here. There's no excuse for this kind of thuggish behaviour."

The release of Andrew Brunson led to the US Treasury Department's lifting of sanctions against Turkish Justice Secretary Abdulhamit Guel and Home Secretary Suleyman Soylu on 1 August, 2018. In return, Erdogan also lifted sanctions against US Home and Justice Ministers. Despite the lifting of the sanctions, further points of contention burden relations between the two countries. As Senate Armed Forces Committee member Ben Sasse said after Brunson's release, "There is still work to be done and President Erdogan has a long way to go before acting like the NATO ally we expect him to be." Pastor Brunson was imprisoned for about two years.

Also unpleasant is the fact that in 2017, according to the Pew Research Centre, 72 percent of Turks surveyed said they had a negative opinion of the US, compared with 44 percent in 2013. Anti-Americanism in Turkey is stronger than in Venezuela, Lebanon, Tunisia, Indonesia and even Russia. It can be said that anti-Americanism in Turkey is not a temporary phenomenon, but a deeply rooted feeling that will not disappear any time soon.

What Needs to be Done?

In order not to be vulnerable to potential Turkish blackmail, Americans should withdraw unneeded weapons and personnel from Incirlik Air Base and generally reduce the American profile in Turkey and prepare for a time when the United States will be forced to leave the Incirlik base. At the moment, this may sound like a far-fetched idea, but the current deterioration in relations recommends such a move. And the sooner such a step is taken, the better it would be for the US, as Turkey can no longer be considered a trusted ally of the US – a point denied by both American and Turkish officials. Whether or not Greece can replace Turkey as a major air base facility for operations in Syria and the eastern Mediterranean remains to be seen. The visit to Greece in September 2018 by General Joseph Dunford, Chairman of the Chiefs of General Staff, opened up such an opportunity. Erdogan and his government are watching the developing relationship between the US and Greece with great concern, but they have to blame themselves. The US Department of



Photo: US Army

Kurdish activists wave Kurdish and American flags during the regional government's New Year celebrations in Dahuk, Iraq. US officers participated in the celebration. The Turkish authorities are deeply suspicious of American support for Kurdish separatism.

Defence is also providing financial support for the modernisation of a strategic airbase in Jordan. The Muwaffaq Salti Air Base near the Jordanian border with Syria and Iraq has played a key role for the US in the fight against ISIS. The US has already taken precautions if relations deteriorate and Turkey prevents the US from using Incirlik Air Base. It should be remembered that in May 2017 Turkey refused to allow members of the German Bundestag's Defence Committee to visit German staff working on Incirlik Air Base as part of a NATO mission. As a result, the German contingent was transferred from there to Jordan. This set a precedent that can be repeated.

The Western impulse to neglect Turkey is unwise, as it continues to drift into the hands of President Vladimir Putin and towards Eurasia, partly because Erdogan is constantly moving Turkey in this direction by disregarding the advice of its NATO allies. Every reprimand from the West is ignored by Erdogan; Western politicians should remember this and not keep repeating blunders from the past.

Therefore the warning of Matthew Bryza of the Atlantic Council in Washington is very vague. Bryza had warned in the Washington Post on 15 August 2018 that "Turkey is now weakening NATO, damaging the influence of the US in the Middle East and in the coalition, whose fight against ISIS is far from over". All three problems are already occurring today, even if Washington continues bilateral relations despite Turkish misconduct. Unfortunately, Turkish President Erdogan needs pressure to understand the implications of his misconduct. That is why the US Government should speak out loud and clear against Erdogan and not be too timid.

For example, the US should take the initiative to update the 1949 North Atlantic Treaty (also known as the Washington Treaty) and insert a new article on the right of suspension and eventually expulsion and penalties

for misconduct of a NATO member. In addition, NATO veto power should be lifted, so Turkey could no longer block the proposed changes. And NATO's decision-making process should be by qualified majority rather than consensus; it simply takes too long. We must remember that we are no longer living in 1949, but in 2018, and much has changed.

Turkey currently enjoys NATO protection as a NATO member, but Turkey is harming the Alliance by joining forces with unfriendly NATO countries such as Iran and Russia. Alignment is no longer a temporary phenomenon, but a trend that is likely to continue. Turkey's strategic value as a loyal NATO ally has declined over the years, but the myth of Turkey's strategic value remains and many US officials continue to believe in the myth. It is obvious that words alone will not stop Erdogan's turning away from the US and NATO towards Russia and Eurasia. Erdogan's folly will cost Turkey dearly and may destroy the image of Turkey as a bridge between West and East.

Conclusion

In conclusion, as long as Erdogan remains president, bilateral relations are unlikely to improve. But even if Erdogan is no longer president, it would take a while to repair the damaged relations, as much damage has already been done. Erdogan's assertion that Turkey would "start looking for new friends and allies" should be taken with a grain of salt, as finding real friends and allies takes many years.

It should be remembered that the good things that the US has done for Turkey in the past are usually forgotten, while the bad things are remembered. Therefore, the severity of the crisis between the US and Turkey is not a temporary phenomenon, as some NATO allies may wish, but a long-lasting process with profound consequences. ■



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The United Arab Emirates – Strategic Context and Defence Planning

David Saw

The exceedingly complex security situation in the Middle East sees security planners in the United Arab Emirates (UAE) facing an unprecedented number of security threats. In the past, the UAE would seek to influence events via diplomacy or the provision of funding; now they find themselves involved in active military operations in the Middle East in Yemen and beyond.

To understand the strategic context that the UAE operates within, it is necessary to provide some background on this country in terms of its population, geography and economy. The UAE consists of seven emirates: Abu Dhabi, Ajman, Dubai, Fujairah, Ras Al Khaimah, Sharjah and Umm Al

Quwain. The UAE became independent in December 1971, with six emirates joining the new nation, with the seventh, Ras Al Khaimah, joining in 1972.

The UAE has a total land area of 83,600 square kilometres, which is roughly the same land area as that of Austria, al-

The three largest emirates (Abu Dhabi, Dubai and Sharjah) are the home to some 85% of the population, with a total of 86.5% of the population being classified as urban dwellers. There is an important demographic concern for the UAE due to the fact that it suffers from a low fertility rate of 1.73 children born/woman. In comparison, the Swedish fertility rate is 1.87. Both fertility rates are below the level necessary to retain current population levels.



Photo: US Air Force

The United Arab Emirates Air Force (UAEAF) acquired 55 F-16E and 25 F-16F Block 60 aircraft from Lockheed Martin, with deliveries between 2004 and 2006. The F-16 purchase was evidence of the importance of the US as a defence supplier and as a guarantor of security for the UAE.

Author

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though the UAE population at 9.701 million is in the region of a million people larger than that of Austria. Of this 9.701 million population only 11.6% are actually Emirati, 59.4% of the population are South Asian expatriates (India, Pakistan and Bangladesh), 10.2% are Egyptian, 6.1% from the Philippines and the remainder from other parts of the world. Of the active workforce in the UAE, a total of 85% are expatriates.

Energy Issues

There was a time when the most valuable commodity produced within the UAE was pearls, but the arrival of cultured pearls at the end of the 1920s would eventually decimate that industry. What would transform the UAE was oil, and oil still remains incredibly important in the UAE economic mix today, but recognising that its oil will not last forever, the UAE has looked to diversify its economy from overdependence on oil in recent years.

According to the authoritative “BP Statistical Review of World Energy (June 2018),” the total proven oil reserves of the UAE at the end of 2017 amounted to 97.8 billion barrels or 13,000 million tonnes, which equals 5.8% share of the world total or the eighth largest oil reserves in the world. In 2017, the last year for which there are full figures, oil production was 3,935 thousand barrels per day, or 176.3 million tonnes for the year. This amounted to 4.21% of global oil production. Some 62% of UAE oil production is exported to Japan.

The vast majority of oil in the UAE, over 90%, is located in Abu Dhabi. Dubai’s oil resources peaked in the 1990s, but it still has reserves of some 4 billion barrels. As regards the other emirates, Sharjah is reported to have reserves of 1.5 billion barrels, while Ras Al Khaimah has 100 million barrels of reserves. The decline in Dubai’s

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oil resources acted as the catalyst for them to embark on an economic diversification programme that, in the main, has been very successful. This led to the UAE as a whole looking to reduce its dependence on the oil industry as the primary revenue gen-

The importance of natural gas to the UAE is twofold: firstly, it is used for crude oil recovery via injection into the wells. The other significant usage for natural gas is in electricity generation. The UAE in 2015 produced 127 TWh of electricity, all

To this end, the Emirates Nuclear Energy Corporation (ENEC) was established as a state-owned company in Abu Dhabi to implement the nuclear power plant project. The International Atomic Energy Agency (IAEA) has been closely involved in the UAE nuclear programme, ensuring that the programme is transparent and complies with all international regulations and treaties. On receiving international assurances on the secure supply of nuclear material, the UAE has agreed to refrain from domestic enrichment and reprocessing.

ENEC selected a site for the nuclear station at Barakah in Abu Dhabi, and then commenced the bidding process for the station, attracting nine expressions of interest, which led to three concrete bids. In the end, the bid from the Korea Electric Power Corporation (KEPCO) was selected as the winning proposal. This would see four APR-1400 Pressurised Water Reactors (PWR) being supplied in a contract with an eventual value of some US\$25Bn. The Barakah nuclear power plant is expected to supply 25% of UAE electricity needs at 25% of the cost of generating power from natural gas. Electricity will also be supplied to neighbouring states via a regional power grid. The first two reactors at Barakah are due to come online this year. The third reactor will follow in 2020, and the reactor four is scheduled to come online in 2021.

The Barakah nuclear project is extremely important to the future of the UAE and is obviously a very expensive undertaking. It also presents the UAE with a highly visible strategic vulnerability. In December 2017, Houthi rebels in Yemen claimed that they had targeted the Barakah nuclear plant for a missile strike. The Houthi are engaged in a civil war against the Yemeni Government, a government that is backed by the UAE and other members of the Gulf Cooperation Council (GCC) both financially and militarily. In July 2018 the Houthi claimed that they have disrupted operation at Abu Dhabi airport with one of their SAMMAD-3 armed drones. The Houthi do have Iranian-supplied missile capabilities, but at this stage there is no evidence that they would have the ability to strike targets in the UAE.

There is no doubt that a missile threat does exist as far as the UAE is concerned, whether that comes from the Houthi or directly from their Iranian sponsors. This threat has led the UAE to invest in a comprehensive missile defence shield.



The UAE received its first new-build Dassault MIRAGE 2000-9 aircraft in 2003 and also upgraded its existing MIRAGE 2000EADIRAD/DAD fleet to the MIRAGE 2000-9 standard. A successor to the MIRAGE fleet has long been discussed with little result, but Qatar's purchase of the Boeing F-15, Dassault RAFALE and Eurofighter TYPHOON will lead to greater interest in new combat aircraft for the UAE.

erator for Gross Domestic Product (GDP). By 2017, oil and hydrocarbon-related activities only accounted for 30% of the UAE GDP; the government target for 2021 is that non-oil economic activity will account for 80% of GDP.

The UAE also has natural gas resources, with total reserves amounting to 5.9 trillion cubic metres or 3.1% of the world total. Natural gas production in 2017 amounted to 60.4 billion cubic metres or a 1.6% share of the world total. Natural gas is not an export commodity for the UAE, indeed their demand for natural gas has outstripped supply and led them to sign an agreement with Qatar, known as the Dolphin Project, under which a pipeline was constructed from Qatar to the UAE, which has supplied Qatari natural gas since 2007. The current rupture in relations between the UAE and Qatar has exposed a weakness in the UAE energy mix, and this has further strengthened the policy of energy diversification that the country has embarked upon.

from fossil fuels – 125.5 TWh from natural gas, and 1.5 TWh from oil, according to official figures. Electricity demand is continuing to grow, from both domestic and industrial customers, and it must be remembered that electricity provides the power for the desalination plants that provide potable water for the UAE.

Going Nuclear

Back in 2008, a report on UAE energy needs noted that by 2020 electricity demand would more than double and that natural gas resources would only be able to meet 50% of the requirement for electricity generation. The UAE would invest heavily in renewable energy under the Masdar Initiative, but determined that renewables would at best meet only 6-7% of electricity generation demand by 2020. It was then established that the only solution to future electricity requirements and long-term energy security was nuclear power.



Photo: NIMR

NIMR Automotive became part of the Emirates Defence Industries Company (EDIC) in 2015. Originally, the company was established to build light tactical vehicles, but its product range has grown to encompass armoured vehicles for military and law enforcement applications, as well as logistics vehicles. The establishment of EDIC in 2014 was part of a policy by the UAE Government to grow the indigenous defence industry.

At the pinnacle of this capability is the Lockheed Martin Terminal High Altitude Area Defense (THAAD) system. This was ordered in 2011 and the UAE has two complete THAAD systems and their ground components in service. This is backed up by the Raytheon PATRIOT PAC-3 system ordered in 2008; the contract included the supply of 288 PAC-3 missiles and 216 GEM-T missiles. The UAE is looking to further enhance the performance of its PATRIOT systems through the acquisition of the MSE missile. The UAE also intends to link its missile defence system with those of its GCC partners to provide an integrated regional missile defence capability.

Money Matters

While it is government strategy to move beyond oil as the prime revenue generator for the UAE, it is still vitally important. When oil was trading at over US\$100 per barrel, that was immensely satisfactory for the oil producing states; for the UAE it is estimated that their minimum price per oil is roughly US\$70 per barrel. That is the level at which all costs are paid off and a surplus flows to the government. The higher the oil price, the more revenue that accrues to the government and that is accompanied by increased activity across the whole national economy, resulting in a distinct rise in the economic growth rate.

The problem for the UAE is that in recent years the oil price has been less than helpful to their economy. Back in 2012 the spot price for oil in the Dubai market was US\$109.08 per barrel, in 2013 it was US\$105.47 per barrel and in 2014 it was US\$97.07 per barrel. However, in 2015 the price dropped to US\$51.2 per barrel, in 2016 it was down to US\$41.19 per barrel, rising to US\$53.13 in 2017. Across

2018, the low price per barrel was US\$56.47 in December, while in October the high of US\$78.96 was reached. As a whole, the average oil spot price in 2018 was US\$69.191 per barrel, the best price since 2014, and this led to an uptick in UAE economic growth. Prospects for the oil price in 2019 are still uncertain though, in mid-January the Dubai spot price was US\$58.86 per barrel.

Low oil prices and price fluctuations were obviously a concern for the UAE Government. On the other hand they were sitting on immense financial reserves, and these were more than enough to cope with a reduction in oil revenue. These oil price fluctuations and the eventual drawdown of oil reserves made it essential that the UAE diversified its economy and, as previously noted, much has been achieved in this regard. One of the main engines for economic diversification in the UAE has been its sovereign wealth funds. Initially funded from oil revenues, these have become large and diversified investment vehicles in their own right, with both domestic and international investments. In an era where soft power options are seen as strategic advantages, the size of the UAE sovereign wealth

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funds gives them significant soft power possibilities internationally.

According to the Sovereign Wealth Fund Institute, the Abu Dhabi Investment Authority, established in 1976, has assets of US\$828Bn and is the third-largest sovereign wealth fund, behind the Norwegian Government Pension Fund (Assets: US\$1,032.69Bn) and the

the best return possible on their investments. The sovereign wealth funds also invest domestically to jump-start non-oil enterprises to diversify the local economy and their economic power also draws in foreign companies to take part in joint ventures with local partners, leading to the arrival of foreign technology and expertise, as well as Foreign Direct Invest-

semiconductors from 2013 onwards. Subsequently, a military cooperation agreement was signed between the UAE and Serbia in 2014. As a part of this agreement, the UAE is to fund weapons developments in Serbia that would also be viable for use by the UAE military. One of these programmes is the Advanced Light Attack System (ALAS), a missile system, one variant of which is being developed for UAE coastal defence needs.



Photo: US DVIDS

Defence Industry

Government-backed investment has led to the creation of an indigenous defence industrial capability within the UAE, covering the design, development and production of defence systems, their maintenance, overhaul and through-life support and other services such as training. One of the organisations at the centre of the indigenous defence industry is Tawazun Holding. They describe themselves as an outgrowth of the Tawazun Economic Council (TEC) which was founded in 1992 “to support a vision of comprehensive and sustainable economic and social development within the UAE.” Tawazun acts as a strategic investment holding company focused on defence and specialised manufacturing.

Missile defence is an area in which the UAE has invested heavily, ordering the Lockheed Martin Terminal High Altitude Area Defence (THAAD) system in 2011 to add to the Raytheon PATRIOT PAC-3 system that they already had in service. The UAE is looking to integrate its missile defence system with those of its regional allies to deal with growing missile threats.

China Investment Corporation (Assets: US\$900Bn). As far as the UAE is concerned, there is also the Investment Corporation of Dubai, established in 2006, with assets of US\$209.5Bn. In 2002, Abu Dhabi created another sovereign wealth fund known as the Mubadala Investment Company; this currently has assets of US\$125Bn. This was followed in 2007 with another new fund, the Abu Dhabi Investment Council (ADIC), which currently has assets of US\$123Bn. In March 2018, Abu Dhabi decided to merge these two funds, injecting ADIC into Mubadala, giving the organisation assets of US\$248Bn and making it the eleventh-largest sovereign wealth fund globally.

These sovereign wealth funds are more than just a sizeable international soft power asset, though they are important in that regard. Their objective is to secure the future of the UAE through obtaining

ment (FDI) to benefit the local economy. Strategic investment does play a role in UAE defence and foreign policy planning. For example, there have been substantial investments in Serbia in recent years across many sectors of the local economy. The UAE is a major food importer and that could be considered a strategic weakness, thus necessitating secure food supplies. This led to the Al Dahra Agricultural Company investing US\$400M in a joint venture with the Serbian Government covering agriculture in 2013. In addition, the UAE also provided a US\$400M loan for agricultural development in Serbia. The Abu Dhabi Investment Authority provided Serbia with a US\$1Bn low-interest loan in 2014, while other UAE corporations invested in Serbian property and even the local airline.

Mubadala also made substantial investments in Serbia in aerospace manufacturing, telecoms, renewable energy and

In 2010, Tawazun acquired a 60% stake in NIMR, a company originally formed in 2000 to develop and manufacture light tactical vehicles for regional military forces. Investment follows and a new manufacturing plant as well as research and development facilities are established at the Tawazun Industrial Park in Abu Dhabi; separately, a metal fabrication facility is established at Al Ain in Abu Dhabi. Then, in December 2014, the UAE Government announced the formation of the Emirates Defence Industries Company (EDIC) jointly owned by Mubadala and Tawazun Holdings. The formation of EDIC represents a serious effort by the UAE Government to support the development of a defence industrial base that will not only meet the needs of the UAE, but also become a serious player on an international stage. The importance attached to EDIC by the UAE was illustrated by the appointment of Luc Vigneron as its

Chief Executive Officer (CEO). Previously, he was the CEO of Thales and prior to that the CEO of NEXTER.

Amongst the assets of EDIC is NIMR, which was transferred from Tawazun to EDIC in 2015. The company has now expanded its produced range to armoured vehicles and logistics vehicles. EDIC Caracal is focused on the design, development and manufacture of small arms, covering pistols, submachine guns, assault rifles and sniper rifles for military, law enforcement and sport applications. Caracal also has subsidiaries in Germany, Brazil and the US. Also part of EDIC is Barij Munitions. This company manufactures a complete range of small arms ammunition from 5.56x45mm to 12.7x99mm, 40mm grenades, artillery rockets, 155mm artillery HE rounds and aircraft bombs.

EDIC also looks to form joint ventures with foreign companies, as evidenced by Thales Advanced Solutions (TAS) in Abu Dhabi. EDIC has a 51% share in TAS, with Thales Communications having a 39% share and Thales International a 10% share. The company is active in the SATCOM, radar, radio and networked communications sectors. Another joint venture is Barij Dynamics; this company

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In late 2018, EDIC Caracal was selected as the winner of an Indian Army requirement to provide 93,895 Close Quarter Battle (CQB) carbines, with the Caracal CAR816 5.56x45mm NATO calibre system. The CQB carbine is to replace the old Sterling 9x19mm submachine gun that was manufactured under licence in India, as well as other older weapons. Although no contract has been signed as yet, the CQB carbine is classed as an Urgent Operational Requirement (UOR). However, it is believed some of the losing bidders for the contract have protested the decision and this could delay contract signature.

The Indian Army has also generated a separate requirement for up to 360,000 CQB carbines; these would be manufactured under licence in India and this would therefore be a long-term programme. Caracal is expected to bid for this programme.

is 51% owned by EDIC and 49% by Denel Dynamics. The aim is to develop, manufacture, assemble and integrate precision guided systems. The company already manufactures strap-on guided bomb kits for standard NATO MK81 and MK82 bombs. Bearing in mind the difficult financial situation of Denel and of the South African Government, it has been rumoured in the Middle East that EDIC could be very interested in the acquisition of the whole of Denel Dynamics.

The UAE is preparing itself for a post-oil future and is looking to develop a diversi-

fied and high technology economic mix. Fortunately, it has no shortage of funding and can therefore plan for the future with some confidence. However, the UAE is located in a dangerous part of the world and therefore has to invest heavily in defence and security to deal with a complicated range of threats, both domestic and foreign. Again, the UAE has the financial means to provide for its defence and security. Where potential problems could arise is due to the lack of Emiratis, who only account for 11.6% of the UAE population. ■

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Ten Years, Ten Nations: The COE CSW – a Decade of Success

Achim Winkler

In 2007/2008, Flotilla 1 of the Germany Navy established the “Centre of Excellence for Operations in Confined and Shallow Waters”, or COE CSW. A decade later, on the occasion of its 10-year anniversary, time has come to take stock and explain what this extraordinary organisation is all about.

At the beginning of the millennium, at a summit meeting in Prague, the North Atlantic Council decided to streamline NATO and significantly reduce its personnel. The planning of the new command structure already showed that some tasks could no longer be performed in the future. Concerned about the loss of competencies and expertise, the idea was born to establish so-called Centres of Excellence or COEs, which would prevent such deficits and provide additional support for NATO's transformation process. At the same time, these were not NATO offices, but those operated by a NATO member state as a so-called "host nation" or "framework nation" and staffed internationally in order to make their expertise available to the Alliance and its member states.

Photos: NATO CoE CSW



The NATO CoE CSW



The idea fell on fertile ground. Various NATO countries accepted this challenge in the interest of the entire Alliance and created corresponding departments – also in Germany. The COE CSW was founded in 2006 by the staff of the still

Author

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young Flotilla 1 in Kiel and was initially put into operation as a national office at the end of 2007. One year later, its English name became a programme and with the participation of Greece, Turkey and the Netherlands the COE CSW officially became an international office. Only half a year later, on 26 May 2009, it was finally accredited by NATO at an inaugural ceremony. COEs are only accredited if their expertise is not adequately represented elsewhere in NATO – visible evidence of COE CSW's unique selling proposition. With the accreditation it was practically equated with a NATO headquarters and became a "maritime think tank" on the Kiel Fjord.

Meanwhile the number of participating nations has increased to ten, as Poland, Italy, Finland, Lithuania and Denmark have joined over time. Additionally, the US participates within the framework of the bilateral "Personnel Exchange Programme", which is an option open also to friendly partner navies outside of NATO, with Finland being an example.

The Maritime Environment

The number of NATO COEs has increased over the years; currently there are 25. Only three of them deal with maritime topics. In addition to the COE CSW in Kiel, there are the COEs for Naval Mine Warfare in Ostend, Belgium, and for Combined and Joint Operations from the Sea in Norfolk, Virginia, USA. All the other COEs primarily deal with land operations, cyberspace, and some special topics. This may seem logical, since all current conflicts, be they in Afghanistan or Eastern Ukraine, in Iraq or Syria, or even in Mali, Somalia or the Sudan, are all carried out almost exclusively on land. Very often, however, there is also a maritime aspect, which occasionally is profoundly meaningful, but not visible at first glance.

Some facts and figures illustrate this point: It is well known that about 70% of the earth is covered with water, while land and therefore the primary habitat of mankind makes up only 30%. Less known, however, is that of the 200 or so countries in the

world, there are only 40 so-called land-locked countries without direct contact with the sea. The remaining 80% of the countries have a coast and thus direct access to the oceans. It is also very probably not known that about two-thirds of the world's population occupies a 200-kilometre-wide coastal strip and that the majority of the large metropolises are located in this area. Europe, which is comparatively small, is extremely dependent on the marine environment. In particular, on average around 90% of raw materials and energy sources are supplied from countries out-



side the European Union, most of which are by sea. The piracy problem in the Gulf of Aden on the Horn of Africa, one of the most frequented sea routes in the world with up to 25,000 ships per year, has painfully demonstrated this in the last ten years. These figures vividly illustrate the importance of the oceans. Almost simultaneously, they separate and connect the continents. At present, massive refugee and migration movements in the Mediterranean, the so-called southern flank of NATO – and ultimately the EU – prove the great importance of the maritime environment. Such and similar developments are to a large extent immediate consequences of land conflicts.

Confined and Shallow Waters

The "confined and shallow waters", grouped under the name COE CSW, are part of the maritime environment. The terms have specific geographical definitions. "Restricted waters" are essentially coastal waters that are often very rugged or characterised by offshore islands. "Shallow water" is what NATO defines as water with a depth

of between 10 and 200 metres. This typically includes ports and port approaches and – in anticipation of amphibious operations – all transitional areas from water to land-like beach sections. All these marine areas, some of which are affected by extreme winds and current conditions, are nautically demanding and generally restrict the free movement of shipping and, in particular, naval forces. The mere creation of a comprehensive tactical-operational picture in these sea areas, the land-based corridors, poses a particular challenge. This is exacerbated by the possible use of weapons by a potential adversary from either side, with extremely short warning and response times.

The German Navy has decades of experience with the deployment of forces in such maritime areas. North and Baltic Sea home waters exactly fit into the definition of "narrow and shallow waters". For this reason, it is only logical that Germany, as a "host nation", has given this task to a COE that supports precisely this topic. Many other navies also have experience in this relevant area. It is equally logical to bundle these competences in the COE CSW in order to be analysed, discussed and consistently thought through within the framework of the international dialogue. Operational procedures and principles are further developed, tested and continuously checked and adapted, such as those re-

lated to increasingly intelligent sensors and effectors as well as shorter reaction times for a modern and contemporary deployment of naval forces in "narrow and shallow waters".

Example: Focus of Work in Harbour Protection

Member states agree on the COE CSW's work programme annually in the Steering Committee. To avoid duplication, the work programme of all COEs and NATO offices is continuously coordinated and coded by the Supreme Allied Command Transformation (HQ SACT) headquarters in Norfolk, Virginia.

The general order of all COEs can essentially be divided into four categories. First, the development of teachings and standards; second, the development of concrete concepts and their implementation in practice; third, the analysis and evaluation of all measures; and last but not least, the broad field of teaching, training, exercises and certification. As an example, this sequence is demonstrated for the COE CSW on the basis of "port protection".

Since antiquity, the term "asymmetric threat" has been known and refers to threats that lurk in ambush and usually emanate from irregular troops. Since at least the terrorist attacks of 11 September 2001 in the USA, this term has acquired a new and very topical quality. Bomb attacks on coalition troops in Afghanistan are examples of this type of threat. A spectacular example in the naval field is the attack on the US



During exercise NOCO 2013, the Harbour Protection Module (HPM) assisted in generating a situational picture.

destroyer USS COLE on 12 October 2000 in the port of Aden in Yemen. A small boat, occupied by two men and loaded with explosives, targeted the side wall of the ship and exploded. The result was 17 dead and 39 injured US sailors as well as a severely damaged and deactivated warship. Nobody recognised in time that the boat was a floating bomb and thus a high-level threat.

Ships and boats are mobile and manoeuvrable and therefore able to stay away from a threat. Fixed infrastructures such as port facilities are not capable of doing so. At the time of the attack, the USS COLE was anchored to a floating bridge and was therefore immobile. Attacks on the port facilities themselves would also have consequences. Naval ships in operation – no matter where in the world – depend on intact ports, as they are indispensable for all logistical aspects such as the supply of fuel,



The HPM being loaded onto a ship for testing during Exercise NOCO 2013



The COE CSW's colours

water, ammunition, spare parts, food and mail, for repairs and for simple things such as the recovery of crews. Ports are therefore indispensable and need special protection. NATO's regulation ATP 74 (Allied Maritime Force Protection Against Asymmetric Threats in Harbour and Anchorage) establishes regulations for the protection of ports.

The Capability Gap: "Harbour Protection"

The protection of ports in countries where the "host nation" is too weak or unwilling to protect NATO forces requires special capabilities. At the beginning of the millennium, NATO recognised this deficit and defined it as a capability gap in 2012; meanwhile, the protection of ports and other critical infrastructure has become one of the most important issues. A special working group, the Specialist Team on Harbour Protection (STHP), was set up under the leadership of the Portuguese Navy. The COE CSW is a qualified partner in this body for operations in the area of the coast and its forelands. The declared aim was to develop NATO regulation on the basis of a corresponding doctrine which initially had only one title: Allied Tactical Procedures (ATP) 94.

In various workshops and conferences, the problem was first analysed in an international dialogue, thoughts exchanged, solutions discussed and results worked out. The focus was on a comprehensive situational picture that was available to all participants in real time. A self-sufficient and mobile deployment tool for a command cell was needed. The challenge was to tailor it to the specific needs of port security. Information from own and remote sensors had to be collected, processed, displayed and distributed, and the own forces had to be integrated into secure communication and deployed in a targeted manner. After all, the entire system had to be able to cope with a three-dimensional threat.

For the practice-oriented parts, a container tested by the Armed Forces Technical Service 71 (WTD 71) in Eckernförde was found

to be suitable and selected as a demonstrator called LEXXWAR, or Long Term Experimental Setup for Asymmetric Warfare – a compact cell with a high computer and screen capacity, which was also designed for the integration of various internal and external subsystems. Luck and chance were both there when this decision was made, as the ongoing work to protect the ports became a home game for the COE CSW crew due to the relative proximity to the WTD 71. Through this close cooperation, the LEXXWAR container was tailored to the requirements of port protection.

The annual Baltic Sea exercise NORTHERN COASTS (NOCO), in which almost all Baltic Sea countries participated, was a suitable venue for practical tests. In 2013, 2014 and 2015, COE CSW and WTD 71 participated with the demonstrator in the NOCO manoeuvres, which were integrated into the respective scenarios in cooperation with the training team. From the outset, the main target group was the sea battalion of fleet 1, which was able to introduce the necessary requirements for such a system from the point of view of the future user and the personnel responsible for port security. The following is an example of a successful deployment. An exercise scenario during NOCO 2013 included an operation to evacuate civilians from the Swedish island of Gotland. The LEXXWAR container on board the supply vessel ELBE provided valuable support for the overall situation on the Swedish mainland. Thus the basic suitability of such a system could already be demonstrated at this early stage. Therefore, it was called the Harbour Protection Module (HPM).

In addition to the NOCO exercises, HPM was also tested in summer 2015 during a major

Portuguese naval manoeuvre in Portimao, the largest port on the Algarve coast. In a very complex scenario, the system was technically supervised by WTD 71 but operated by the Portuguese Navy, which is indicative of its suitability for international use. These and other findings, to include identified deficits, were recorded and fed into the further development of the HPM and an associated technical regulation. Likewise, these findings were also the basis for the development of the ATP 94, which was also updated in the context of several workshops and conferences by the STHP. Following the ratification by the nations, ATP 94 became effective on 9 October 2017 as the official NATO regulation for protecting harbour facilities. The COE CSW made a significant contribution to its development and was recognised by NATO. The award of the Military Cross of Honour 2nd Class by the Portuguese Navy speaks for itself.

International Reputation

With these and many similar activities of international importance, COE CSW has made a name for itself on the international stage. Participation in and organisation of large conferences such as the Kiel Conference Se-

to these activities, the team enjoys a unique reputation as the world-renowned Munich Security Conference asks COE CSW for advice and action. This "flagship project" was permanently enshrined in a contractual agreement. The further increasing significance of maritime security issues is thus clearly taken into account.

Conclusion and Outlook

After 10 years of intensive and successful work, this small COE CSW team of only 45 is firmly established in NATO. In addition to a small administrative support team, it consists of experts from various disciplines, about a quarter of whom are multinational. Having started with three nations, there are now ten, and more have expressed interest in participating, so in the future more national flags may be hanging in front of the COE CSW building.

Due to the immediate proximity to Flotilla 1, national and international expertise and professional competence for maritime operations in offshore waters, namely the "restricted and shallow waters", are ideally bundled for mutual benefit. The Baltic Sea with its heterogeneous conditions is an ideal "test site" for many problems; the results

maritime law, to name but a few. The list will probably not become any shorter – orders and inquiries on individual topics are increasing. With regard to the newly defined task of home defence and alliance defence, the variety of topics will expand considerably. There is no question about the necessity of the COE CSW with a view to the future.

This is in line with the view of COE CSW Director, Rear Admiral Christian Bock: "The need to focus on the maritime sector in all its facets is becoming more intense. This applies to the oceans in general and the coastal regions in particular, both from the sea and from the land side. It is not necessary to quote the former Federal President Dr. Horst Köhler with his 'Maritime 21st Century'. Legal issues in the South China Sea, operational threats from long-range cruise missiles from land to sea, protection of all sea communication lines over water and in the form of underwater cables and pipes are only some of the topics and challenges.

'Confined and Shallow Waters' are both challenging and sensitive at the same time for the operation of maritime forces – regardless the further development of maritime skills and capabilities. The COE CSW



The Kiel Conference organised by the COE CSW

ries with international presence is the basis for this. There is great interest in maritime safety issues. Among others, the COE CSW has meanwhile concluded eight cooperations with internationally recognised universities, academies and committees, such as the European University Viadrina in Frankfurt an der Oder in Germany, the United States Naval War College in Newport, Rhode Island, and the World Maritime University in Malmö, Sweden. It is an active member of various working groups on maritime safety and international maritime law. In addition

can almost always be easily transferred to other geographical hotspots in the world. Therefore, COE CSW is not only useful for NATO and the member states, but also for friendly partner countries such as Finland and Sweden.

The portfolio of topics is diverse. Aspects of the deployment and defence of submarines in shallow waters, amphibious and maritime special units, maritime mines and drones in all three dimensions are just as much a part of everyday work as dealing with asymmetric threats and international

has done successful pioneering work in various topics over the last ten years. The findings benefit the German Navy, the entire North Atlantic Alliance and also friendly and participating partner nations.

And the interest to participate is increasing; not just from the side of security-political institutions like the Munich Security Conference, but also from the side of other maritime think tanks and nations, for example Singapore. With regard to the next decade, the COE CSW will continue to be a success story." ■



The Brussels Backdrop

President Trump and NATO: a Mid-Term Review

Joris Verbeurgt

President Trump has been in office for two years now – time for a mid-term review of his stance on NATO and on his attitude towards the European allies. In this Brussels Backdrop, we will cover President Trump as a person, his “America First” programme and his statements on NATO until he was elected president. The next Brussels Backdrop will then recount his policy towards the Alliance and the allies.

Trump the Man

On 20 January 2017, Donald J. Trump was sworn in as the 45th president of the United States. When he announced his official candidacy to run for president in June 2015, few political commentators believed he stood a serious chance. Many thought that his candidacy was yet another stunt from the foul-mouthed New York tycoon to draw media attention to his somewhat eccentric and narcissistic personality. To the surprise of many and to the disgust of the Republican establishment, he not only won the Republican nomination – he also beat all-time favourite Hillary Clinton in elections that are considered historical from more than one viewpoint. His no-nonsense style and his “America First” programme had clearly caught on with the American public and expectations of the people were running high. Equally high were at first the disbelief and then the anger and fear among Trump’s opponents in the Republican and Democratic Party, in the Washington establishment (including the Pentagon) and among America’s European allies. What could one reasonably expect from a president who was an outsider to the post-Cold War political order? From a president who made, lost and regained billions of dollars in real estate and ca-

sinos? Who regularly made sensational TV appearances and even hosted a show “The Apprentice”, in which his favourite quote was “You’re fired!”? Who made no secret of his contempt for Washington politics and who mocks practically everything that is not ‘American’ (apart from his 25-year younger wife Melania, a former model with Slovenian roots), and who uses Twitter as a primary means of communication?

America First

Now, what exactly are Trump’s views on international security? Indeed, little is known about them. Historically, the slogan “America First” dates back to the interwar period when the America First Committee advocated a non-interventionist policy in World War II and emphasised American patriotism, self-reliance and unilateralism. Quite naturally, the slogan cultivates a genuine mistrust towards globalisation, “one world” ideologies and international organisations. But “America First” is not an ideology in the sense of a complex and coherent articulated world view that combines hard information, historical background, and personal values, used to formulate strategies or allow rational decision-making processes. Trump does not have much of an ideology, which makes it even more difficult to explain his policy, let alone to predict his next move. From a political viewpoint, Trump is kind of an enigma: throughout his long career as businessman and investor, he bounced back and forth between declared affinity for the Democrats and the Republicans and donated vast amounts of money to candidates of both parties. His lack of political affiliation or ideological commitment made scholars and political commentators turn to Trump’s

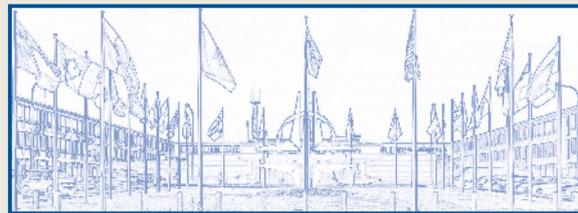
psychological profile in order to explain his behaviour and policy issues, including alliance relations; they examine every one of his policy statements, speeches or tweets on the subject through the prism of his alleged narcissistic personality or admiration for ‘strong’ leadership, his desire to be loved, his family relations or his financial motives.

Since we cannot rely on an ideological or policy-oriented explanation of Trump’s attitude towards NATO, we will follow the evolution of his views on international security and collective defence throughout his life, taking into account his particular personality traits that make him an atypical president.

Before Trump Became President

Contrary to popular belief, Trump’s criticism of NATO and some of the allies is by no means a recent thing; already in 1987 (!), when Ronald Reagan was in power and the Cold War was yet undecided, Trump criticised unfair burden sharing among NATO members. When he was considering running for president in the 1988 elections, he ran an open letter in several major newspapers in which he maintained that “America should stop paying to defend countries that can afford to defend themselves.”

Thirteen years later, in the aftermath of the NATO Kosovo air campaign and the deployment of KFOR (alongside SFOR in Bosnia), he argued in his book “The America We Deserve” that some European countries would use NATO to shift the burden of international responsibility on the USA. He wrote that “their conflicts are not worth American lives. Pulling back from Europe would save this country millions of dollars annually.”



In March 2016, Trump's campaign really took off. Asked by the Washington Post what he thought of NATO, Trump replied that NATO was "a good thing" and that the US should not retreat, but he also pointed out that the US would bear the brunt to counter Russia's threats against Ukraine, even though it was the security of European allies that was most affected. In this context, he said that "the world is taking advantage of the United States. Uncle Sam has been both overly generous and stupid, we are not as wealthy as we once were, and we need to change all of that." He continued with the rhetorical question of why countries that were close to Ukraine were not addressing the problem and why it was always the USA that had to take the lead and possibly risk a third world war with Russia.

When asked by CNN to comment on statements he made earlier in the Washington Post, he explained that "NATO is costing us a fortune, and yes, we're protecting Europe with NATO, but we're spending a lot of money. Number 1, I think, the distribution of costs has to be changed." Trump insisted on "rethinking" the American engagement in NATO, because the US would pay too much for the protection of others; he seemed to be willing to abandon NATO unless changes were made to the Alliance, especially with regard to the funding.

In a July 2016 interview, just before accepting the Republican Party's nomination, Trump went one step further by proposing restrictions on NATO's Article 5 collective security guarantee. He stated that he would not automatically extend the security guarantees to all NATO members: NATO's assistance would depend on whether or not the distressed nations had met their obligations to NATO. More specifically, a Russian attack on the Baltic States, for example, would not automatically result in the military involvement of all NATO allies – under President Trump, the United States might well step aside. This view represented a sharp break with US external relations and holds the risk

of the Alliance becoming obsolete in the long run. After all, when push comes to shove, what good is an alliance if not all members are equally committed?

Trump's message startled the allies and alarmed the Polish-American community. With the elections ahead, Trump met with the Polish National Alliance during a surprise meeting in Chicago in September

budget. The increase was also motivated by the desire to reverse the cuts implemented between 2008 and 2013. In other words: Poland enacted a defence policy very much in line with Trump's desire of fairer burden sharing between the allies.

Trump's position on the maldistribution of burdens in NATO and its effect of undermining US commitment to the alliance is



Photo: DoD

President Donald Trump laying a wreath at the Tomb of the Unknowns at Arlington National Cemetery in Arlington, VA

2016, where he said: "As president I will honour Poland's sacrifices for freedom. We're committed to a strong Poland, very committed, totally committed, and a strong Eastern Europe as a bulwark for freedom and security," and Trump concluded: "We want NATO to be strong, which means we want more nations to follow the example of Poland." It is noteworthy in this context that in 2015 Poland spent around 2.22% of its GDP on defence, more than the 2% required by NATO standards, and much more than some Western European allies spent annually on their defence capabilities. What is more, when faced with the worsening security situation, the Polish Government increased its 2016 defence

not new; it is a belief he has been holding for four decades. President Obama also regularly complained about allies "free riding" at the expense of the American taxpayer. It was the tone and wording of the message that was new: blunt and unrestrained, calling a spade a spade without sparing anyone. Though alarmed and shocked, most European capitals were not very interested in Trump's statements, as they believed he would lose the elections to Hillary Clinton and not become President. The second part of our assessment of two years of Trump presidency will examine US foreign policy under Trump and his course of action towards NATO and the European allies.

Anti-Submarine Warfare Systems and Developments

Sidney E. Dean

Given the hidden, covert nature of the quarry, anti-submarine warfare (ASW) is among the most challenging aspects of naval warfare.

Increasingly stealthy technology is reducing the acoustic and thermal signature of modern submarines, making their detection and neutralisation even more difficult. ASW requires the integration of several elements, namely the ASW platform, the sensors to acquire and track the target, and the weapons to destroy it. As submarine fleets and their capabilities are expanding globally, so are the various assets designed to counter them. ASW platforms come in many sizes and types. They include manned surface vessels, hunter-killer submarines, and aircraft. Increasingly, unmanned systems are entering the fray.

Surface Vessels

Most multi-mission warships around the world are equipped to perform ASW as part of their operational spectrum. However, in light of serious existing or developing threats, some nations deploy vessels optimised for ASW. Experience has shown that specialised vessels perform better at their primary task than multi-mission ships do.

The UK is a case in point. Britain's Type 23 frigates developed in the 1980s were widely regarded as the world's premier ASW surface combatant of that era. They were designed to meet the Soviet submarine challenge in the North Atlantic, specifically in the strategically vital stretch between Greenland, Iceland and the UK known as the "GIUK Gap", until being refitted as generalised combatants after the end of the Cold War. As the renewed Russian submarine threat is materialising in the same waters, the Royal Navy



A P-8 POSEIDON launches a Mk-54 torpedo during flight testing.



The medium displacement unmanned surface vehicle (MDUSV) prototype SEA HUNTER is moored at Joint Base Pearl Harbor-Hickam, Hawaii. Autonomous USVs like SEA HUNTER are creating a new paradigm for Navy surface forces, as they are capable of carrying a variety of payloads and performing many missions, including operations independent of manned Navy ships.

Photo: US Navy

Photo: US Navy

Author

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is introducing the Type 26 as a successor. "The government has committed to eight Type 26 ships and they will be the mainstay of our anti-submarine warfare capability," said Rear Admiral Alex Burton, commander of UK maritime forces, in 2017. He referred to the frigates' dual capabilities for both offensive pursuit of enemy submarines and for defence of carrier task groups against enemy attack submarines. The Type 26 hull is designed to minimise acoustic signature, reducing the likelihood of detection by submarines. The ship will be equipped with the Type 2150 Next Generation Bow Sonar produced by Ultra Electronics and the towed Sonar 2087 produced by Thales as the primary ASW sensors.

The hull-mounted Type 2150 advanced sonar provides active and extended wideband passive monitoring. According to the manufacturer, the Type 2150's novel Digital Array Module architecture comprises transducers with in-dome acquisition, matching and power amplification electronics, thereby reducing the inboard footprint compared with similar sonar systems. The sonar can operate in either an omnidirectional mode or perform a concentrated sector search with an increased likelihood of target detection even in cluttered environments. Special modes can be activated to enhance performance during heavy weather or when tracking close contacts. Finally, the Type 2150 employs a wide transmission bandwidth to avoid mutual interference from other ships while conducting multi-ship operations.

The Type 2087 towed array sonar augments the hull-mounted array by emitting lower-frequency signals than the Type 2150 and by operating at various depths. The lower frequency transmissions propagate farther than higher frequencies, thus providing a considerably larger detection range. This permits the ship to detect enemy submarines from well beyond the submarine's range of engagement.

Australia has opted for a derivative of the Type 26, to be dubbed the HUNTER class.

Submarines

One of the most potent ASW platforms is the attack submarine. Operating in the same environment as their prey, and being similarly configured, attack submarines can hide their own presence while they hunt for the enemy. The German Navy's 212A class is a case in point. Developed by HDW in Kiel and placed in service in 2005, the Type 212A can switch between diesel propulsion and Air Independent Propulsion (AIP) fuel cells. When using AIP, the boat can stay submerged for three weeks, patrolling at low speed while producing

virtually no vibration, heat or acoustic signature. The 212A and its export variant 214A are considered the most silent submarines in the world, making them ideal ASW platforms. ASW sensors include the hull-mounted FAS-3 flank array sonar (passive, low- to medium frequency), the TAS-3 towed array sonar (passive, low-frequency), and the WASS hydrophone suite. The US Navy (USN), which owns no diesel-electric boats, routinely incorporates allied submarines in its own ASW exercises, and from 2005-2007 leased Sweden's AIP-equipped HSwMS GOTLAND to play the opposition force during ASW training.



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Photo: Crown Publishing



Australia's DoD defines the planned HUNTER class frigates as "Australia's new anti-submarine warfare platform". A derivative of the British Type 26 frigate depicted here, the nine HUNTER class vessels will deploy EuroTorp MU90 ASW torpedoes and the MH-60R helicopter.

A proposal currently under consideration would establish a US Navy "ASW aggressor squadron" of diesel-electric submarines which would be used to train USN ASW assets of all types – ships, submarines, and aircraft – to combat conventional submarines. Additionally, the USN is planning to acquire a next-generation attack submarine which (unlike the current, land-attack-oriented VIRGINIA class) will be optimised for ASW and Anti-Surface Warfare operations. Provisionally dubbed the SSN(X), this nuclear-powered submarine will be larger than the VIRGINIA class and is expected to carry a considerably larger torpedo arsenal, thus returning to the Cold War configuration of a blue-water hunter-killer submarine fleet primarily tasked to defeat peer-level enemy submarines.

One significant ASW challenge is the development of more advanced anechoic coatings which make submarines harder to detect by sonar. ASW submarines prefer to operate with passive sonar to avoid betraying their own presence, but passive sonar is less effective than active sonar against anechoic targets. To address this quandary, the Pentagon's Defense Advanced Research Projects Agency (DARPA) is currently working to team manned attack submarines with unmanned underwater vehicles (UUV) specifically designed to assist in ASW. The UUVs would be carried aboard the attack submarine and deploy through torpedo tubes. Under the Mobile Offboard Clandestine Communications and Approach (MOCCA) concept, one or more unmanned and unarmed sub-

marines would patrol using active sonar, while a nearby attack submarine would monitor the sonar echo with its own passive sensors (bistatic sonar procedure). Assuming that the manned vessel knows the UUV's precise location, it can triangulate the distance and location of the target and either approach or engage at stand-off range. Some analysts postulate that the UUV could even lure enemy attack submarines into an ambush. BAE Systems and Applied Physical Sciences Corporation (Groton, CT) received contracts in late 2017 for phase one (preliminary sonar and communications concepts) of the three-phase, 51-month MOCCA project.

Unmanned Systems

China might be going a significant step further. In July 2018, the Hong Kong-based South China Morning Post reported that the People's Liberation Army Navy (PLAN) is developing "large" unmanned submarines guided by artificial intelligence, capable of long-range autonomous operations in the South China Sea and western Pacific Ocean. The reconfigurable mission bay is intended to carry a variety of reconnaissance, anti-surface and ASW payloads, including torpedoes. Weapons launch would require human intervention, the Post reports. In addition to deploying weapons, the submarine could potentially ram its targets, a researcher told the newspaper. Such a strike would require a high degree of stealth on the part of the UUV; while the Post did not reference this, the Chinese defence publication "Ordnance Science and Technology" in 2017 discussed a series of envisioned biomimetic UUVs, including one 12-metre-long variant which could potentially pass as a whale on enemy sensors. In any case, the primary task of armed unmanned submarines would be to challenge United States Navy forces in these strategic waters, serving as a force multiplier for the regular PLAN combatants. Diesel-electric propulsion would permit several months of operation before returning to base. The Post reports a target IOC in the mid-2020s. However, some Western analysts question the validity of the report, or at least the stated level of progress, given the PRC's record of keeping vital military research secret until fielded. Unmanned ASW platforms are not confined to underwater. With the development of artificial intelligence and secure wireless communications systems, autonomous surface vessels have become feasible. The US Navy is currently testing the SEA HUNTER, a prototype medium



Credit: Atlas Elektronik

Atlas Elektronik's Integrated Sensor Underwater System (ISUS) is a modular system of attack submarine sonars and processors which can be configured to customer specifications.

displacement unmanned surface vehicle (MDUSV). Initially developed by DARPA, the project transitioned to the Office of Naval Research in January 2018 for further development and was recently designated a classified programme. The 135-tonne USV is capable of littoral and high seas operations, with an intended range of 10,000 nautical miles and at sea endurance of 30-90 days. The vessel can carry various payloads, including an ASW suite. Originally designated the Anti-Submarine Warfare Continuous Trail Unmanned Vessel (ACTUV) by DARPA, the unarmed USV uses hull-mounted sonar and an on-board sensor data processing suite to detect and identify diesel-electric submarines. It can track submerged targets for weeks, until they surface or return to port. If the target is classified as a threat, the USV can transmit target coordinates to manned ships or aircraft. Shorter-range vessels are also being optimised for the ASW role. Elbit's 12-metre-long SEAGULL USV has an at-sea endurance of four days. The remotely controlled vehicle can be operated from a mothership or from shore. Satellite links permit the SEAGULL to deploy to a distance up to 3,500 kilometres from the control con-



Photo: WASS

The BLACK SHARK Advanced (BSA) developed by WASS is among the best-performing heavyweight torpedoes in service.

sole. The USV can deploy various towed sonar arrays including side-scan sonar and the high-resolution Kraken KATFISH synthetic aperture sonar for detecting objects near the seafloor in a cluttered environment. The modular multi-mission USV can be armed with lightweight torpedoes for the ASW mission. Small enough to be carried by most warships, the SEAGULL offers considerably greater mission endurance and range than helicopters, enabling its deployment as an

ASW picket force or as a scout ahead of a surface vessel. Atlas Elektronik's 11-metre ARCIMS is an alternate option. While primarily a mine-countermeasures USV, it can be configured with an ASW module to detect, classify and locate submarines. Unlike the SEAGULL, the ARCIMS is unarmed. Multiple ASW-configured USVs could prove particularly useful as a surrounding screening force for high-value targets such as aircraft carriers and amphibious groups.



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Photo: Outisim

Flight testing of a Chilean Navy CASA C-295MPA PERSUADER maritime patrol/ASW aircraft

Aircraft

Maritime surveillance/ASW aircraft have the advantage of covering a large reconnaissance zone in a short period of time. Introduced in 2013, Boeing's P-8 POSEIDON (based on the civilian Boeing 737) is the most recent high-performance maritime surveillance aircraft to enter service. Powered by two CFM 56-7B jet engines, it can deploy 2,400 nautical miles to a patrol zone, conduct surveillance for eight hours, and return to base without refuelling. While designated a multi-mission aircraft, ASW is a priority. The P-8 carries 129 sonobuoys – 30% more than any other maritime patrol aircraft in service today. The plane simultaneously deploys a mix of sonobuoys operating in passive and active mode. The Multi-Static Active Coherent (MAC) acoustic search system utilised by the P-8 provides considerably greater sensitivity for wide-area searches and in challenging acoustic environments, improving the likelihood of detecting targets in shallow waters. The weapons bay can carry five Mk 54 torpedoes, with anti-surface missiles carried on underwing pylons. Six nations currently operate or have ordered the P-8.

Turboprop-powered aircraft remain a popular option for maritime patrol and ASW missions. The maritime multi-mission variant of the Airbus/CASA C-295 utility aircraft, the C-295MPA PERSUADER, has six external hardpoints for anti-ship and anti-submarine ordnance (including torpedoes, mines and depth charges). A specifically ASW-oriented variant was certified in 2010 and was procured by Chile. With a cruise speed of 311 knots, an operational radius of 2,300 nautical miles and an endurance of 11 hours, systems such as the CASA are an option for nations wishing to defend littoral waters against mid-level opponents.

Sonars are not the only ASW sensors for aircraft. Magnetic Anomaly Detectors (MADs) mounted on fixed-wing aircraft or deployed as towed systems on rotary aircraft can penetrate the ocean to detect minute variations in the Earth's magnetic field caused by the passage of submarines. MADs have been in service for decades, but state of the art systems are smaller, lighter and more powerful than legacy systems. This permits the surveying of deeper ocean layers and allows their use on smaller helicopters and even UAVs. CAE recently introduced the MAD-XR (Extended Role) which weighs only 1.5 kg compared to 27 kg for CAE's legacy MAD.

Shipborne helicopters are frequently the primary ASW asset of surface fleets. The MH-60R SEAHAWK produced by Lockheed Martin/Sikorsky is widely believed to be the world's most advanced ASW

helicopter. In service since 2005, it is currently operational with the US, Australian, Danish and Saudi navies. The MH-60R can deploy 25 sonobuoys, but the primary ASW sensor is the integrated Thales/Raytheon AN/AQS-22 Airborne Low Frequency Sonar (ALFS) dipping sonar. Thales reports that the ALFS has four times the area coverage and at least three times the acoustic capability of previous dipping sonars, enabling faster area searches and longer-range target detection. The sonar employs multiple frequencies, adapting to changing environmental conditions in both deep and shallow waters. The MH-60R carries up to three ASW torpedoes. In addition, the helicopter can relay sensor data to ships and armed aircraft within line of sight. The helicopter's 400-nautical-mile operational range can be extended through use of external tanks.

Torpedoes

Torpedoes of various classifications remain the standard ASW ordnance (depth charges have largely been phased out of most navies' arsenals). Heavy torpedoes are deployed by submarines against surface and submarine targets. Their size and strong propulsion systems generally provide an advantage in terms of speed, range and warhead. The state-of-the-art BLACK SHARK heavy torpedo produced by Italy's WASS introduced in 2004 has a range of 50 kilometres and a speed of 50 knots. Details of the high-explosive warhead are classified. The six-metre

Photo: Leonardo



Leonardo's latest-generation light torpedo, the A224 Mod 3

long BLACK SHARK is guided by fibre-optic cable. Sensors for target acquisition and homing include wake sensors, and the Advanced Sonar Transmitting and Receiving Architecture (ASTRA) active and passive multi-frequency acoustic head. The torpedo has a low-emission electrical propulsion system to delay alerting the target, and a sophisticated Acoustic Counter-Countermeasures (ACCM) suite. In 2018, the Italian Navy agreed to purchase the next-generation variant, the BLACK SHARK Advanced (BSA) torpedo.

Aircraft and surface ships deploy light torpedoes for ASW. Leonardo's A224 Mod 3 lightweight torpedo introduced in 2011 represents state-of-the-art capabilities for this category. The 2.75-metre-long weapon weighs less than 265 kg in aircraft configuration and can be fitted on vessels as small as Elbit's SEAGULL. The Mod 3 has been designed to attack latest-generation submarines equipped with anechoic coating and countermeasures. The targeting sonar can operate in active, passive, or dual mode, utilising narrow or broad band search, and is capable of detecting submarines resting on the ocean floor. The advanced digital signal processor introduced in the Mod 3 utilises a Fast Fourier Transformer algorithm which enables it to detect even low-emissions targets in cluttered environments and at ranges exceeding 2,100 metres; it can track and classify several targets simultaneously and differentiate between the actual target and countermeasures. An electronic propulsion control system permits the torpedo to vary its speed (burst speed: 38 knots) in order to maximise endurance (up to 13,500 metres) and hit probability.

Extended-Range Torpedoes

Light ASW torpedoes deployed by surface ships are normally fired from torpedo tubes fixed on deck. Rocket-assisted light torpedoes – sometimes referred to as ASW missiles – can be fired from vertical launch system canisters. The RUM-139 ASROC (Anti-Submarine ROcket) system introduced into the US Navy in the 1990s pairs standard Mk 46 or Mk 54 light torpedoes with a two-stage solid fuel rocket with a 22 km range. The rocket jettisons the torpedo at a pre-calculated point of its trajectory. The torpedo descends on a parachute, which releases it close to the ocean surface; upon submerging, the torpedo begins normal target approach procedures. The ASROC system permits engagement of submarine targets from extended range; by deploying the torpedo into the water relatively close to the target, this system also reduces warning time.



Photo: ELBIT

Elbit's SEAGULL USV, configured for ASW, launches a lightweight torpedo.

Relatively few navies utilise this technology. In 2014, the PLAN introduced the ASROC-like Yu-8 "missile torpedo" on its Type 54 frigates and Type 52 destroyers. Television footage depicting what is believed to be the Yu-8 during PLAN manoeuvres shows a three-part system consisting of a small solid-fuel booster, a tur-

Deployment of torpedoes from aircraft requires special consideration to prevent damage to the ordnance. Typically, fixed-wing and rotary aircraft release torpedoes at low altitude, with a drag chute attached to slow the weapon's descent. In 2018, the US Navy ordered the High Altitude Anti-Submarine Warfare Weapon Capability



Photo: US Navy

A US Navy MH-60R SEAHAWK deploys the AN/AQS-22 Airborne Low Frequency Sonar.

bojet engine, and the Yu-11 lightweight torpedo which was first identified in 2015. The Yu-8 is believed to travel at up to 30 km at Mach 0.9, with planned upgrades which could increase the range to 50 or even 70 km. Once released, the three-metre-long Yu-11 torpedo is believed to have an operation depth as great as 600 metres. The Russian Navy already achieves a 50 km range by mounting torpedoes on the 91RT and 91RE variants of the KALIBR cruise missile.

(HAAWC) Air Launch Accessory (ALA) for integration on the P-8 POSEIDON. The ALA consists of folding wings and a GPS guidance system, which are attached to a Mk 54 torpedo, enabling the weapon to glide in a controlled descent. This permits release of the ordnance at altitudes of up to 9,200 metres, and considerably increases the stand-off range for weapon release. Each P-8 will be able to carry five HAAWC-equipped torpedoes, with IOC planned for 2020. ■

Battlespace Digitisation: Italy's Forza NEC Programme

Luca Peruzzi

The Italian MoD wants to digitise its armed forces. For this purpose, a few years ago a development process was initiated, which is nearing completion. Developments are now being reviewed in technical-tactical experiments known as Operational Integration Sessions (SIOs).

The Italian Armed Forces' Forza NEC (Network Enabled Capability) programme has significantly progressed since its inception in 2006. In 2010 the first contracts were awarded to an industrial team

headed by what is today Leonardo. The digitisation process of the Italian Army has now reached the preliminary phase "Concept Development and Experimentation" (CD&E), which is scheduled for comple-

tion in 2021. CD&E is intended to verify and test the capabilities, systems and assets that will then go into the serial production and spin-off phases. The latter will allow the mature digitised capabilities to be certified and prepared for procurement, once they have met operational requirements, as demonstrated by technical-tactical experiments known as Operational Integration Sessions (SIOs).

ESD had the opportunity to hear from military and industry representatives about the latest Forza NEC developments and to participate in the second and final SIO in 2018 on the Monte Romano training ground of the Italian Army near Viterbo, where for the first time the Army's Aosta Medium Brigade was integrated into the digitisation process.

Distributed Sensors

The objective of the Forza NEC programme is to deploy state-of-the-art land forces consisting of three land Brigades, a joint landing force and relevant enablers, all equipped with platforms, systems and stand-alone products integrated into a digitised and networked infrastructure. "The digitisation process is irreversible as only forces with advanced C4ISTAR capabilities are able to deal with current and future threats and deployment scenarios. With the digitisation of our armed forces, the operational tempo is changing, providing us information superiority, interoperability and the avoidance of friendly fire thanks to the advanced C2. It is a cultural revolution in which the individual soldier must see himself as a distributed sensor in an overall picture," said Brigadier General Bruno Pisciotta, Commander of the Aosta Brigade.

The five main areas of capability development of the Forza NEC programme relate to the digitised Command and Control (C2) and Communication Information Systems (CIS), to the sensors on unmanned platforms and other systems,

Photos: Luca Peruzzi



The Italian Army is equipping its medium brigades with a first-generation FRECCIA 8x8 AIFV while working on a new-generation model.



A key enabler of Forza NEC C2 is the Iveco Lince 2 equipped with a C2 suite including SATCOM.

the effectors (Future Soldier or Individual Combat System, ICS) and to combat vehicles such as CENTAURO MGS and FRECCIA AIFV, and future versions) and the Integration Test Bench (ITB) represented by all specialised modelling and simulation centres.

As the technical-tactical experimentation campaigns are to train units and personnel with Forza NEC systems already in operation, and to test and validate new capabilities, the second phase, SIO 2018, saw the deployment of next-generation open architecture C2 software and COTS-based hardware packages for both soldiers and vehicles, the targeting and communication command kit (TCCK) in the final operational configuration, tent-based and mobile digitised command posts (CPs) as well as a number of capabilities and assets, such as a counter-UAV system, which are being readied for operational use.

The Italian Army's Pinerolo Medium Brigade was the first main unit to receive Forza NEC capabilities and assets and



A Forza NEC command post deployed during the SIO activities

has been involved in all SIO campaigns. With the on-going digitisation of the Aosta Brigade and the Pinerolo's deployment to Afghanistan, the former unit has been conducting the second SIO 2018 campaign by deploying its assets from its Sicilian barracks. From mid November to early December 2018, more than 1,200 soldiers, 118 tactical vehicles, 96 weapon systems and 65 commercial and special vehicles - mostly from the Aosta Brigade units, supplemented by the Tactical Information Brigade (formerly RISTA-EW

Brigade) and other units, and supported by the Army's Centre of Simulation and Validation (CESIVA) – took part in a series of exercises to verify the Forza NEC C2 architecture and compare the capabilities of digitised and non-digitised units. The exercises culminated in a live demonstration of operational capabilities in the presence of the Italian Defence Minister, international military observers and Attachés. The Aosta Brigade deployed and established a tactical network bubble based on Brigade and Regimental digitised CPs which were temporarily transferred from Pinerolo Brigade, while the experimental bubble was centred on a reduced number of vehicles and infantry teams equipped with new command, control and communications equipment managed by CESIVA personnel.

Tactical Command and Control

The second SIO 2018 saw the deployment of new tactical command and control (TC2) for infantry team leaders and C2D EVO software and hardware suite for vehicles together with SIACCON 2 ADV (Advanced) automated C2 employed by higher echelons. In order to overcome the limitations of current Forza NEC C2, Leonardo developed and tested a new open architecture – a plug-and-play system for both dismounted soldiers and vehicles. The TC2 runs on Windows 10 and uses ruggedized version of Panasonic's COTS FZ-M1 tablet with a 7 inch touchpad display. The C2D EVO suite is compliant with the new NATO Generic Vehicle Architecture (GVA). While the TC2 software will be completed in 2019 and then procured on a massive scale, the C2D EVO is available as a prototype for architecture evaluation. The first vehicle to receive the C2D EVO is the second-generation FRECCIA AIFV designated EVO (Evolved).

Leonardo's targeting and communication command kit (TCCK) is based on the same portable hardware family. It was shown in the final operational capability configuration, fully integrated with the Forza NEC ar-



Part of Forza NEC are the STRIX DF and CREX B1 mini-UAVs and unmanned ground vehicles.



The ORSO 4x4 Tactical Multi-Purpose Vehicle in a route clearing configuration

ARMED FORCES

chitecture; it is scheduled to complete qualification in 2019. Having demonstrated full interoperability in Bold Quest live exercises with NATO communications equipment, the TCCK is being used by the Italian Special Forces, San Marco marines and artillery units for seamless situational awareness, targeting and fire coordination. The TCCK is also being considered for providing a tactical picture with Leonardo's Software Defined Radio (SDR) for aviation platforms which are not equipped with a C2 suite integrated into the avionics. Simultaneously, the Italian Army has developed an integrated fire support system to provide artillery and mortar units with a network capability.

The Brigade (T6 node) and Regiment (T5 node) digitised CPs are, respectively, based on 9 (6 expandable and 3 fixed) and 3 (2 expandable and one fixed) ISO 20' shelters with 44 and 22 workstations. Both use the SIACCON 2 Advanced (ADV)



The CENTAURO Mobile Gun System (MGS) will be replaced by a new generation platform with a turret equipped with a 120mm/45 calibre gun.

automated C2 system to communicate with SICCONA's vehicular C2 and navigation system, C2N-BFSA (C2 Navigation-Blue Force Situational Awareness) and the soldiers' TC2 using HCDR (High Capacity Digitised Radio), HF (CNR-2000) and VHF SRT 635/V to be replaced by Leonardo's 4-channel Software Defined Radio (SDR), in addition to large-band VM3 Software Defined Radios (SDRs).

CP Vehicles

The digitised CP with spaces for up to 18 SIACCON 2 ADV workstations accommodated the Tactical Information Brigade's command during the exercise. The Italian Army and the industrial team also demonstrated a deployable CP version (T5 node) of the 4x4 ORSO Tactical Multi-Purpose Vehicle (TMPV). In its new configuration, the deployable CP with all C2, navigation and BFSA systems and Leonardo's four-channels SDR and SATCOM-on-the-move (SOTM) fits on one vehicle instead of two. Another new C2 vehicle is the Iveco DV LINCE 2 NEC light multirole vehicle (LMV) able to act as a T2, T3, or T4 C2 node. The LINCE 2 is more mobile and comes with a higher survivability and available payload (1,500 kg) when compared with the first-generation LINCE. The LINCE 2 NEC's allows a near-real time data-flow at very long distances, ensuring increased BFSA standards. Its Communication Information Systems (CIS) features Leonardo's new 4-channel SDR which replaces four different radios. Moreover, it has a Multiservice Switch Router (MSR 165 EVO), SOTM, intercom and active self-protection with Leonardo's GUARDIAN H3 jammer and the HITROLE remote-controlled gun. At the moment, the LINCE 2 NEC is under qualification. A first batch of 40 vehicles have been acquired. The Iveco DV is also the platform for the LINCE 2 RTSA (Reconnaissance, Targeting, Surveillance and Acquisition) and other LINCE 2 vehicle versions.

At the SIO 2018, the Tactical Information Brigade participated with an ARTHUR counter-battery radar system based on a customised and more powerful C-version provided by Saab and Leonardo to the Italian Army (4 systems in service); it incorporates a SIACCON 2 ADV workstation and air and ground unmanned vehicles. In addition to the mini/micro-UAVs STRIX DF and CREX B1, which were used for real-time monitoring and reconnaissance during the live demonstration with Leonardo's TCCK, Leonardo's TRP2 unmanned ground vehicle (UGV) was also demonstrated.



The Italian army pays special attention to cyberwarfare, as the second SIO 2018 showed.



During the second SIO 2018, the Italian Army and industry showed the latest communication equipment for dismounted soldiers.

Effectors

Among the displayed effectors was the Individual Combat System (ICS), including the soldier equipment developed under the “Soldato Futuro” programme and nowadays based on Leonardo’s SMART SOLDIER solution. Together with the TC2 software and a wearable ruggedised tablet, the equipment kit includes the soldier’s hand-held SDR, a press-to-talk headset to communicate at short distances with the vehicle crew, batteries, a new protection vest and wearable night vision and weapon sights for both Beretta’s ARX-160A3 assault and the new ARX-200 sniper rifles.

The latest vehicles developed under the Forza NEC programme were also on display. In addition to the first-generation CENTAURO MGS developed by Iveco DV and Leonardo and equipped with a SICCONA command, control and navigation system, the 6th Cavalry Regiment of the Aosta Brigade also deployed a CIO FRECCIA AIFV in service with the 6th Bersaglieri Regiment; the vehicle is distinguishable by Leonardo’s JANUS EO/IR surveillance turret and the new GUARDIAN



A new Boeing/Leonardo CH-47F equipped with a portable Targeting and Communication Command Kit (TCCK) to allow C2 networking

the new integrated fire system and TCCK. In July 2018, the MoD’s Land Armaments Directorate awarded the CIO Consortium a contract to develop and produce the first batch of 11 second-generation CENTAURO Mobile Gun Systems (MGSs), including a

eye-safe laser. The Italian MoD and CIO are also considering a new generation FRECCIA EVO 8x8 AIFV with a new hull and turret design; a development and acquisition contract is expected for 2019 while additional first-generation FRECCIA vehicles will be upgraded under a separate contract. Leonardo also acknowledged they are working on a new battlefield radar family employing latest generation technologies to satisfy a wide range of missions and both the domestic and export markets.

Paying particular attention to forward operating base (FOB) protection and logistics support, the Italian Army displayed the containerised Active Defence Component (ADC) and a counter-UAV system, in addition to logistic monitoring systems used by the service to improve efficiency and availability while reducing costs. Being acquired in three sets, the ADC consists of a CP with six operators managing extendable towers with Leonardo HITROLE remotely-controlled weapon systems, sensors and protected operator stations, as an alternative to remote CP control. The Italian Army’s C-UAV within the Forza NEC programme is a customised version of the suite being acquired under the Italian MoD’s programme. The common C-UAV system sees Leonardo as prime contractor, together with Elettronica and IDS (Ingegneria dei Sistemi). Leonardo provides the C2, system integration and the JANUS EO/IR sensor, while IDS supplies the BLACK KNIGHT X-band dedicated surveillance and tracking radar and Elettronica the direction finder. Among the effectors, Elettronica provides the jammer and Leonardo the HITROLE gun system with machine guns or a 40mm grenade launcher. The army is also testing a shotgun cartridge for close-range neutralisation. ■



The Iveco 4x4 TMPV in the observation and force protection version is part of the route clearing package.

H3 jammer antennas. Also on display was the ORSO 4x4 Tactical Multi-Purpose Vehicle (TMPV) in the C2, Ambulance and Route Clearance versions.

The artillery showed a 155 mm PzH-2000 self-propelled howitzer. The 24th Artillery Regiment of the Aosta Brigade presented a 155/39 mm FH-70 gun battery and the 185th Paratrooper Artillery Regiment 120 mm mortars, all of which are managed by

single prototype brought to full production standard and two years of support. The CENTAURO II is to be delivered in the last half of 2020. It will feature a new hull and turret design and a 120 mm/45 calibre smooth-bore low-recoil force (LRF) gun coupled with a computerised fire-control system and an automatic target tracker. The Commander and the Gunner will have Leonardo’s ATTILA day/thermal sights and

Self-Propelled Artillery: A Clear and Present Need

Tim Guest

Artillery tactics and requirements are changing. Though towed and self-propelled (SP) tube and rocket artillery have lived alongside one another until now, the need for greater mobility as a key element of survivability now emphasises SP artillery as the preferred asset in a wide-area theatre such as Europe.

Tracked or wheeled, guns or rocket, SP artillery has become increasingly important to face the modern threats, particularly in an uncertain, future Europe. This article looks at some of the latest

Awakening – the Need for SP

For far too long, members of the NATO Alliance have had their guard lowered to traditional threats, focusing instead on counter-

professionals now agree that collaboration and sharing collective expertise and ideas is the best way to build a future NATO artillery force and capability effective against any future threat. Such things as resupply, ammunition developments, C4I and FCS, range and weapon delivery, and mobility – pretty much everything – that are currently covered in cobwebs now require new thinking and technologies, enhancements, improvements, replacements; a weakness in any one of the links in the artillery-ecosystem chain, and artillery effectiveness will fail.

For one, mobility is now seen as fundamental to surviving in a future NATO/ 'old adversary' conflict. Tactics have changed and operational experiences, such as recent events involving artillery in the Ukraine, show that a lack of mobility and remaining too long in one position can have dire results. Hence, more emphasis on SP artillery solutions that offer increased manoeuvrability, lethality, platform survivability and reduced sensor-to-shooter timeframe. While there currently remains a future for towed systems like the L119 light gun in 'hot-spot' scenarios, the 'SP-platforming' of towed systems is gaining momentum and developments such as the HAWKEYE HUMVEE-mounted 105mm SP system might well spell an end to towed counterparts.

Changing Tactics Favour SP – Ukrainian Lessons

With a resurgent Russia, NATO needs to speed up its pace of modernisation and improve its capabilities even as soon as 2020. Russian fires, electronic warfare and locating capabilities outrange anything the US and NATO currently has. A current 5–7-minute sensor-to-shooter time capability is no longer fast enough and artillery systems need to achieve a 3-minute sensor-to-shooter timeframe to ensure survivability, otherwise they will risk being located and targeted before they have the chance to scoot from their firing position.

The experience of Ukrainian forces in the Donbass region against 'pro-Russian' forces has shown a clear need to change and develop artillery tactics to face the threat in Europe, as well as employ more agile and mobile artillery systems. Rapid movement



Photo: UK MoD

NATO is currently staring down the barrel of a quantitatively and potentially qualitatively superior adversary and needs its SP tube and rocket assets boosted to face an uncertain future in Europe.

tactical reasoning behind the growing preference for SP artillery, together with moves towards SP system procurement by certain NATO members and some of the latest SP system developments on the menu.

insurgency. Allied armies have taken their eyes off such things as joint fires/precision fires, and a generation-long period has resulted in a technological and tactical capability slippage across NATO. At the same time, 'the competition' has been allowed, in no uncertain measure, to catch up and surpass the Alliance's one time position of strength.

Things are, however, changing with the stark realisation across the Alliance that they must, and fast, not only at individual force level, but as a collective. Artillery pro-

Author

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Photo: UK MoD

SP tracked or wheeled artillery will need to adopt rapid shoot-and-scoot tactics to be able to fire and move within the enemy's decision-making circle. Pictured are two British AS90s.

and greater mobility together with extending the range of artillery out beyond 40 km are seen as key. New shoot-and-scoot tactics in which batteries move rapidly in and out of firing positions, with fire missions lasting no more than two minutes before

moving, need to be employed. And while one battery in one location is firing, another in a different position is loading, and a third might be in a waiting area preparing to move to a firing location. (Such tactics are not dissimilar to those employed by LANCE

missile troops during the Cold War). A second fire mission might resume 15-20 minutes after the first, and so on. This kind of rapid 'carousel' type of tactics will rely on speed, and means that autonomous SP artillery systems are by far the most appropriate in such future scenarios. The Ukrainians see a 2-minute fire mission timeframe as essential to survivability, moving within the enemy decision-making circle before it completes. That decision circle is down to about 3 minutes, (in the Cold War it was 10 min). Another important realisation of Ukrainian forces has been that guns need to reduce their consumption of ammunition, making it important to increase the accuracy and probability of hitting the target without unnecessarily expending rounds on repeated fire adjustment. This is also something the Ukrainians feel will be aided by the use of precision ammunition such as BONUS or 155mm SMArt. Reducing ammunition use will also reduce the need for frequent re-supply, the point at which artillery and any arm is at its most vulnerable. Such new tactics will only be achievable, however, if SP systems can deliver suitably rapid rates of fire of 6-10 rounds per minute. That will only happen using sophisticated automated loading systems and



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Photo: via author

The HAWKEYE HMMWV

digital firing systems that re-lay after each round in ultra quick time, thereby aiding first round accuracy. Ukrainian artillery experienced rates of 275 rounds per barrel per day in scenarios where six minutes was all it took for artillery-locating radar to locate a firing position and for counter-battery fire to be returned.

Range improvements are also emphasised by the Ukrainians; SP systems need to achieve ranges beyond 40-42 km to reach the adversary's batteries. They see moving from 152mm systems like the 2S19 MSTAS, the 2S5 GIATSINT-S and the 2S3 ACACIA 2C19, to the latest tracked and wheeled 155mm tube and rocket launch systems, as key to achieving these longer ranges.

SP Long-Range Precision

Whereas in the mid-80s there was a tactically acceptable discrepancy between NATO armour numbers and those of the Soviet Union, today, with the Alliance's eye having been off the ball for the past 25 years, Russian armour and artillery outweighs NATO's even more than it did in numbers all those years ago. But this time there's also a qualitative disadvantage at play. So, if a conflict were to arise between NATO and Russia, the Alliance would need to take out some of the adversary's capability in quick measure to balance the scales. This is where Long-Range Precision Fires (LRPF) and the deep fire capability of SP rocket artillery would be

critical and, together with the mobility afforded by being self-propelled, would aid survivability on a modern battlefield.

Rocket artillery delivers the longest ranges of any artillery and various systems have been in several NATO inventories over the years. Some are ageing Soviet-era systems like the BM-21 GRAD variants in use with several nations. And while several fleets of US-made tracked MLRS have been out of service for some time, (for example, Denmark, The Netherlands and Norway), there is broad agreement that new SP rocket artillery capabilities must be developed, procured and deployed not only to provide agile, long-range capabilities, but also deep fires out to 300 km and potentially beyond using unitary munitions.

Deep fires, however, is something French artillery experts have recently expressed a lesser interest in, primarily due to the expense of unitary munitions. According to a leading military spokesperson, cost would mean they would only be able to procure sufficient unitary munitions to fire and deliver a token effect on target, after which "there would be little left for the artillery to do" without other ammunition. Their preference at this time would be to build an effective 150 km LRPF SP rocket artillery capability, one that could deliver a massed effect. Deep fires would be left to Alliance colleagues, though as part of a well-thought-out, cohesive strategy of mutual support. Whatever the choice, such systems must be self-propelled and able to operate autonomously, executing shoot-and-scoot tactics to be effective and survive.

Rocket Power

Lockheed Martin's TACMS is the Alliance's only 300 km-range unitary asset at this time, though military experts stress the need for more of these among Alliance member nations. The latest standard is the Army TACMS – ATACMS – unitary system, currently in the inventories of Finland, Greece and Turkey, as well, of course, as the US, had a seeker upgrade announced in 2016 enabling it to strike moving targets. A collaborative effort between Lockheed Martin, Boeing and Raytheon was also announced that year to develop a new missile to meet the US Army's LRPF requirement to replace the ATACMS with an advanced-propulsion missile and a range of 500 km. These munitions will be thinner and sleeker than ATACMS missiles enabling two to be carried per pod, thereby doubling the number that can be carried by M270A1 Guided MLRS (GMLRS) and M142 HIMARS (High Mobility Artillery Rocket System) launchers. Production is slated to begin in the 2021-

Photo: UK MoD



Increased automation of loading systems and new fire-control systems, amongst other developments, contribute to improved rates of fire and ensure the latest shoot-and-scoot tactics can be employed. Shown is an AS90 crew in action.

2022 timeframe. (GMLRS itself is currently undergoing a 36-month Extended Range Programme, and while there will still be six rockets per pod, each will have a larger, higher-performance motor. An alternative GMLRS warhead was fielded in 2016 offering wide area effects.)

The AMOD – ATACMS Modernisation Programme – relates to the new missile system launched from a High Mobility Artillery Rocket System (HIMARS) launcher. This is now fully qualified, in production and already with the US Army and is available for procurement by NATO allies. System performance and capabilities have been enhanced along with a new proximity sensor payload. August last year saw the first production contract for AMOD missiles for the US Army signed requiring the modernisation of 150 ATACMS Block 1 and 1A submunition warheads, a process which disassembles the munition and replaces it with new unitary warheads in order to comply with latest cluster munition policy.

In Q4 last year, flight tests at White Sands Missile Range, New Mexico, saw the missile fly some 140km with the proximity sensor demonstrated in an air burst above the target area and the interface with the SP tracked HIMARS launch vehicle fully vali-

dated, among other test objectives. AMOD missiles can be fired from any member of the MLRS family of launch vehicles. This was the seventh successful test in the AMOD programme.

Allied Rocket Moves

Back in August last year the US approved the sale of 54 HIMARS launchers to Romania together with a long list of associated equipment. The US\$218M contract for the first 18 HIMARS was announced this August. Additional equipment to the eventual full 54-launcher order includes: 162 GMLRS warheads (81 unitary and 81 alternative), 54 ATACMS unitary missiles, 30 Low Cost Reduced-Range Practice Rockets, and 24 Advanced Field Artillery Tactical Data Systems, as well as 30 HMMWVs and other logistics vehicles. The overall order for Romania will exceed US\$1Bn and is a clear effort to increase its defence budget and meet its NATO obligations. HIMARS is able to carry a pod of six rockets or one ATACMS missile on its five-ton truck. Operationally proven in Iraq, HIMARS fires the full MLRS range of munitions out to 40 km, with newer extended-range guided munitions able to

reach between 60 and 100 km. Poland is also looking to acquire HIMARS and the Polish Armaments Group, with approval from the Ministry of National Defence, will be working with Lockheed Martin to meet the requirement. Late last year the US approved sales of related munitions to Poland, including 25 GMLRS missiles, 61 ATACMS missiles together with additional ancillary equipment.

Vendor Innovations and Developments

Serbia's Yugoimport had an impressive display of SP tube and rocket systems on show at this year's Eurosatory and spokesperson Marco Stojanovic was able to tell ESD that it had begun firing trials of its ALEKSANDAR 155mm/52-cal SP wheeled system. Different to the existing NORA 6x6 system, he said that ALEKSANDAR may replace this at home, but it will also be available for export. Stojanovic said the most important component of the weapon module is its fully automatic loader attached to the barrel; with 12 projectiles and propellant charges ready, it offers the possibility of loading at all elevations and enabling a rate of fire of up to six rounds per minute.



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The 155mm autofrettaged barrel assembly has 23-litre and 25-litre versions and while the former is JBMOU-compliant the second enables significantly longer ranges. A further 12 rounds are stowed on the platform for automatic reloading, so the combat set comprises a total of 24 rounds without any crew engagement necessary. For stabilisation purposes, the weapon is fitted with four hydraulic outriggers enabling fire in both directions. The weapon can use all types of standard and special 155mm NATO standard ammunition and

tially to demonstrate the 105mm solution, the system can be integrated into any vehicle. So far AM General has demonstrated the concept using the L119 and L118; the M777 155mm is also being integrated onto a medium tactical vehicle and a BRUTUS prototype was expected on firing trials during August.

As for HAWKEYE's potential suitors, the US is looking seriously at it, according to McDonald, already having included it in their manoeuvre fires integration exercise, giving it a technology rating level 7-8 out

technology involved is the same. BRUTUS makes use of a 39-cal M777 tube, because it exists in the army now. The company says, however, that with the army currently testing 52- and 58-cal tubes these "can easily be integrated" into this system and may even be able to be put on the same vehicle as, according to McDonald, "weight is our friend due to the way the recoil operates". Even if a slightly bigger truck is required, it will still be mobile and manoeuvrable. "Mobility and survivability are the biggest selling points of this system. Towed artillery is just too slow today. What the near-peer threat can do to a battery if it stays in position too long... well, this solves that problem."

In a typical fire mission scenario, as HAWKEYE drives into position, outriggers deploy as the mission is being calculated, and ammo is prepared at the same time as mission calculations. In two minutes or less it can shoot the mission and, with the push of a button and a further two minutes or less can be out of position and moving to the next location.

"We are currently working on ammo carriage and expecting a rack to carry eight rounds, though hoping to keep resupply and ammo off the ground and just vehicle to vehicle. If we keep ammo flow 'down-hill' using gravity to our advantage that can happen with both the 105mm and 155mm systems. There is no autoloader on it right now, as such things start to weigh the system down, but by looking at different ammo handling methods we believe we can achieve a higher rate of fire." The aim according to McDonald is to achieve a maximum rate of 8 rounds per min for 3 mins, or a sustained rate of 3 rounds per min. The range using charge 7 is 11.6 km, or 19.5 km using a rocket-assisted projectile.

The Mandus Group are behind HAWKEYE's MG 9000 Digital Pointing and Aiming System, which has a Northrop Grumman INS LN-270 high-accuracy system core although the howitzer can be integrated with any digital fire control system on the market.

Within NATO – Wheeled SP on the Move

In mid-2017, the Danish Defence Acquisition and Logistics Organization (DALO) awarded NEXTER a contract for 15 8x8 CAESAR, 155mm wheeled self-propelled artillery systems for the Danish Army, with an option for an additional six systems. Since its entry into service in 2009, CAESAR, in its 6x6 configuration, has been deployed operationally by French Forces in

Photo: Tim Guest



Yugoimport's SUMADIJA SP LR multiple launch weapon at Eurosatory 2018

with extended range and advanced ammunition can achieve ranges between 40 and 62 km. Its crew of three is protected inside an armoured cabin.

Two other new SP innovations on tour in Europe during May and June and worthy of note at prototype stage are AM General's HAWKEYE 105mm and BRUTUS 155mm SP systems, which look set to move towed guns further into the back seat. AMG's Mark McDonald gave ESD an update on this L119 light gun cannon tube with a hybrid soft recoil system mounted on a regular M1152A1 HUMVEE prime mover. He explained that a millisecond or so before the gun fires the soft hydro-pneumatic recoil system moves the tube forward, reducing firing shock by 80%. And because of this advanced recoil system/reduced shock of firing the gun the system can be mounted on a regular truck, without modification. Outriggers add increased stability, but it can be fired without them. Its simplified design reduces the workload of a towed howitzer crew and associated logistics. While the HUMVEE has been chosen ini-

ally to demonstrate the 105mm solution, the system can be integrated into any vehicle. So far AM General has demonstrated the concept using the L119 and L118; the M777 155mm is also being integrated onto a medium tactical vehicle and a BRUTUS prototype was expected on firing trials during August.

As for HAWKEYE's potential suitors, the US is looking seriously at it, according to McDonald, already having included it in their manoeuvre fires integration exercise, giving it a technology rating level 7-8 out of 10, where 10 is applied to completely mature systems. It has also been certified so US Army soldiers can fire it safely. Three different crews had fired the howitzer as of that time. The solution is available to all NATO nations. HAWKEYE lethality corresponds with similar systems, though its accuracy is said to be better, because the recoil system makes it more stable. Its pointing and aiming/digital fire control system eliminates the need for manual laying. McDonald said HAWKEYE will also demonstrate an increased rate of fire even with a reduced crew, due to the way ammunition will be packaged. In the direct-fire mode HAWKEYE makes use of a camera under the cannon tube combined with a laser rangefinder, so previous direct-fire methods of sitting down the barrel, adjusting rounds and guesswork are gone. McDonald said that in its direct-fire mode the gun had fired at 2,700 m and hit a target with the second round. "We would never previously have attempted a target with direct fire at that range". Similar results are anticipated with BRUTUS as the

combat in the Lebanon, Afghanistan, Mali and Iraq. More than 300 CAESAR systems, 8x8 and 6x6, have now been ordered by five different countries.

The 8x8 configuration will help meet the current and future requirements of the Danish Army with an improved operational autonomy and a platform offering significant growth potential for further adaptation. Two systems have so far been delivered and are in evaluation with the Danes, who are forming a new artillery brigade and doctrine to go with the new system. With CAESAR's fully automatic loading system there is no need for crew intervention as long as the ammunition stored is what is requested for a fire mission. If, however, a fuse change is needed, then human intervention is required. Nevertheless, three rounds can be fired in 45 seconds and the gun can move immediately. CAESAR 8x8 has a four-man crew, a 52-cal gun, carries 36 rounds, has a range of 40 km(+) and an achievable arc of fire of +/- 300 mil. The Danes expect their systems will be fully operational during 2021.

A leading spokesperson for the Royal Danish Army said recently that having had SP systems in the early 2000s like MLRS disbanded in 2004 along with other brigade and divisional assets cuts and M109s taken out of service in 2005, new systems and approaches were well overdue. Hence the new defence agreement 2018-2023 sees the Danish focusing on new guns for a 3rd artillery brigade and possibly of a rocket system, although it is understood they don't want to 'put too much' into one system. However, they see the speed and mobility of self-propelled systems as essential if they want to beat 'the adversary'. The NEXTER contract is, therefore, a major part of their plans affording them fully autonomous capabilities and the ability to shoot and scoot, something the spokesperson saw as essential to survivability. As for long-range targeting capabilities, this is something, like the French, the Danes want NATO partners to deal with.

Other Developments within the Alliance

There are numerous upgrades, procurements and developments towards an SP-dominated future

within NATO, indeed too many to mention here, but below is just a glimpse of a few of the other projects and moves happening within NATO.

The Slovaks announced earlier this year its artillery would be procuring the domestic ZUZANA 2 155mm wheeled SP gun. Konstrukta-Defence is the company awarded the deal and first deliveries of the 25-system order are scheduled for this year and to be completed by end 2022. The decision supports their efforts to build a heavy mechanised brigade based on the country's NATO role and requirements and the new SP system will be an integral part of the country's

support as part of the Alliance. The new gun has a 52-calibre barrel compared with its earlier 45-calibre counterpart still in use, and greater automation throughout enables the crew to be reduced to three. The weapon turret has a 360-degree traverse and is mounted on a TATRA Defence 8x8 chassis with added ballistic and IED/anti-mine protection for the crew compartment.

In Finland, the first K9-THUNDER self-propelled artillery systems arrived earlier this year, the country joining Norway and Estonia among others having opted for the 'soldier-friendly' 155mm SP system. A total of 48 ex-Republic of Korea Army K9s were

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Photo: Tim Guest

Yugoimport's ALEKSANDAR 155mm system alongside its NORA-B52 155mm and SUMADIJA modular SP long range multiple launch weapon on display at Eurosatory 2018

ordered by the Finnish Defence Force (FDF) with an option for additional systems. All the K9s for the FDF will be overhauled and fitted with battle management system, GPS, as well as intercoms solutions and radios. One FDF spokesperson, speaking recently, said the tracked SP K9 THUNDER is seen as an ideal solution for defending Finland, with its mobility ideal for keeping pace with manoeuvre units and its ease of use a crucial need with the country's conscript army. The K9 will also be making use of the huge stockpile of legacy 155mm ammo and charge bags the artillery has. Nammo has re-

cently provided the FDF with new energetic/bagged charges for the K9. As for SP rocket artillery, it is understood the FDF is considering equipping all its truck-mounted BM-21 SP systems with smart munitions, although cost concerns may hinder this. It is currently working with the US on this and in future, the spokesperson said the FDF is looking at a potential 500 km rocket-launched capability. By 2050 the country may still be using MLRS for which it is looking to develop new capabilities. With an enemy choosing where to attack, the Finns see themselves needing the ca-

ability to engage different targets, point, massed armour, mass fires, but also a rapid shoot-and-scoot capability that can deploy in 30 seconds, engage and fire on a target in 30 seconds, and bug out and move in 30 seconds. That said, the FDF spokesperson said future precision fires need to be precise enough to kill a target, but the shoot-and-scoot tactics and increased manoeuvrability may increase the chance of missing targets, and that's on both sides. He added that cost sharing within NATO to ensure MLRS users have precision munitions like EXCALIBUR would go some way to boosting the effectiveness of the Alliance as a cohesive whole. The Czech Artillery is looking to procure 155mm SP guns in the 2020–2022 timeframe that will equip two artillery regiments – potentially six batteries of eight guns, though an overall total of 52 systems. These are likely to be 8x8 wheeled SP systems that have automatic or semi-automatic loading systems and that are able to carry 30+ round payload. The defence ministry is also considering multiple launch rocket systems beyond 2025.

Summary

While towed systems will certainly continue in use in scenarios such as amphibious and airborne assault, perhaps in low-intensity localised conflicts, they lack the mobility to keep up with mobile forces of today. It is the mobility and agility of latest and upcoming SP systems that will be required in bigger theatres of operations, as greater ranges and shoot-and-scoot tactics become the necessary order of the day, making SP tube and rocket systems essential to ensure the survivability of artillery assets in future conflicts. ■

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The Case for Biodefence

Dan Kaszeta

Biological defence is a multifaceted issue that has been neglected by governments to date and even lags far behind defence against chemical warfare. It is time for that to change.

An American biological warfare specialist, the late Bill Patrick, once told me that biological warfare is “public health in reverse”. By this logic, defence against biological warfare comprises the elements of public health – detection, diagnostics, prevention, treatment, decontamination, and protection.

As many biological warfare threats are genuine public health threats or veterinary threats, it can be legitimately difficult to differentiate between normal medical work and “biological defence”. In the early 1990s, when the Pentagon first started taking the problems and issues of biological defence

budget that is vastly inferior has tended to yield mediocre results in the last 25 years. Large pharmaceutical and biotechnology firms follow money. There is more money in treating cancer and diabetes than there is in treating obscure pathogens and toxins, even if biological warfare experts are worried about them.



Photo: Arthur Friedlander

The 2001 “Amerithrax” incidents caused by Anthrax spores were a watershed moment in the history of biodefence. Anthrax is a serious infectious disease caused by Gram-positive, rod-shaped bacteria known as *Bacillus anthracis* (yellow).

Biodefence can be taken to mean either defence of military forces from biological attack or civil protection of society as a whole, from biological attack, whether it be by means of terrorism or acts by nation states. Defences against bacteria, viruses, toxins, and parasites are a valid, if poorly understood, segment of the security and defence sector.

seriously for the first time in a few decades, bureaucrats could not believe that spending a few tens of millions of dollars here and there in biomedical areas was not enough to get noticed, until they realised the billions that were being spent on things like cancer and diabetes. A few million for work on an anthrax treatment was “decimal dust” compared to the serious work underway in the mainstream health care and pharmaceutical industries. For many sub-segments of the biological defence market, it is far more useful to look at deriving military and civil protection value from developments in the civilian sector. Trying to drive product and technology development with a military

Research

Acts of biological warfare and biological terrorism have been blessedly rare. There are a number of practical and political reasons why this has been the case. The major nation-states amassed biological arsenals during the Cold War. Various non-state actors have used or attempted to use biological warfare agents. Perhaps the most notable was the anthrax terrorism in 2001 in the USA. The “Amerithrax” incidents were a watershed moment in the history of biodefence programmes, as this one particular series of deaths and illnesses spawned a very large amount of expenditure in the USA. Indeed, biodefence is an area where American budget expenditures and requirements dominate the world market, even more so than in other segments. There is little doubt that many things simply would not be happening in biodefence if American defence and homeland security requirements and budgets were not a driving force. The “Biological Advanced Research and Development Authority” was set up by the US Government to spearhead research, and no rival organisation elsewhere in the world has been spending to a similar level on biological warfare defence.

Detect to Treat

As biological agents are invisible to human senses and easily dispersed by covert means, detection and warning are an important aspect of biodefence and one which has seen much expenditure over the last two decades. Instruments for the detection and identification of biological warfare agents have been discussed in previous issues of this magazine. The fundamental issue remains the same as in previous years – biolog-

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ical detection continues to lag many years behind chemical and radiological protection. The fundamental problem is that the natural background is awash in biological matter. The science and engineering simply does not exist for real time discrimination between natural and offensive bacteria. The techniques for doing so exist, but take time. "Detect to warn" is the standard that exists in chemical defence, that is, enough warning time to put on a protective mask, generally less than 10 seconds. While achievable in chemical warfare agent

and these assays do not tell the difference between living and dead microorganisms. However, they are the least costly detection technology and are improving over time. A number of US and European manufacturers now make these items.

The Biowatch Programme

Probably the biggest detection programme is a civil programme. It is the now venerable US Biowatch programme. It is a system of air sampling equipment backed up by laboratory analysis of the collected particulates. Although some of the details are classified,

Government Accountability Office report in October 2015 was particularly scathing in its criticism of Biowatch, and only the best of optimists can say that the programme's future is safe.

Major military biological detection programmes do exist, but are limited to only a handful of the major nations. These tend to be large suites of equipment, applying as many as a dozen technologies to the detection problem. A classic example is the US military's Joint Biological Point Detection System made by Battelle, a US firm with long history in this area. This is an integrated system with many different parts, and



Photo: FLIR Detection

Real time bio monitors like Proengin's MAB (right) or FLIR's IBAC 2 (left) allow for early warning without time-consuming lab analysis.



Photo: Proengin

detection, the "detect to warn" standard is simply unachievable in biodefence. With biological detection, the prevailing standard is "detect to treat" – detection and identification of threats in sufficient time to provide treatment or prevention. For example, if anthrax spores are disseminated, there is about a two-day period in time in which antibiotics can be administered to prevent an outbreak of illness.

Hand-Held Assays

A core capability in biological detection is the use of hand-held assays. These are small test kits, many of which are similar in appearance to home pregnancy test kits. Hand-held assays are single-use and they work by using specific antibodies to trigger a visible colour change in the presence of the particular microbe or biological toxin. These assays exist for the major biological threats, such as anthrax, tularaemia, or botulinum toxin. However, quality control and availability of antibodies plagued early versions of this technology. They are a post-dissemination diagnostic tool and require some clue or hint in order to use them, as well as a sample. Poorly collected or prepared samples can cause poor results,

it is operating in at least 30 major US cities. It was originally established after 9/11 to provide enough warning of an aerosolised biological attack to allow for treatment of the public. It has also been deployed in support of major public events, such as major sporting events. Allegedly, the major collection effort is part of air sampling infrastructure already set up by the US Environmental Protection Agency for air pollution monitoring. Air samples are analysed by the US Centers for Disease Control for the presence of major biological warfare agents, and any significant results are flagged up to the FBI and Department of Homeland Security. Several generations of equipment have now passed through this system, none of which have lived up to expectations. Manual collection of samples and laboratory analysis have significantly driven up the labour costs, which have historically comprised a high percentage of the programme's budget. Overall, the programme has been costly; the 2017 budget for it was over US\$80M. False alarms have occurred (two are known in the public domain) and the project routinely gets criticism, both within the government and in industry as poor value for money. Particularly early in the programme, the delay between sample collection and diagnosis was sometimes too long to have protective value. A US

replaces an older system that was quite troubled, the M31 Biological Integrated Detection System. A smaller system, the Joint Biological Tactical Detection System is in development, with Chemring (US) as the prime contractor. Very similar systems are in use or development in the UK and Japan. Of note, the French firm Bertin Technologies has a biological sample collection system, the CORIOLIS. This is a rare example of a military biological detector from outside the Anglosphere.

Vaccination

Prevention is as important as detection and surveillance. An important component of prevention is vaccination. This is clearly a segment with significant crossover from the traditional pharmaceutical industry. Vaccines have significant development timelines and face lengthy trials. Regulatory approval for vaccines against warfare agents that are not normally occurring in nature can be difficult to achieve as human safety and efficacy trials are problematic. Generally, it is easier to develop vaccines for use in military force protection, as many countries allow investigational vaccines to be used on restricted populations, like military personnel. Obtaining

approval for widespread civilian use is not impossible, but is lengthy and expensive. Without significant governmental backing, industry will not develop biowarfare vaccines on its own. A good example of a recently developed vaccine is the "Bio-thrax" improved anthrax vaccine, developed and marketed by Emergent Biosolutions (USA). Emergent is also making a smallpox vaccine. Although not generally considered a biological warfare threat, the rapid development of an Ebola vaccine in recent years shows what can be done if political will and resources are available. The phrase "medical countermeasures" gets used a lot in biological defence, but it generally means treatment. Work has been done to improve post-exposure treatments for many specific biological warfare threats. In particular, serious research and development has gone into development of anthrax antitoxins, which could, in principle, save many people who might die from inhalational anthrax. Glaxo-Smith-Kline (UK), Emergent, and Elusys (USA) have all developed anthrax antitoxins. US defence and homeland security budget money has also gone into development of more broad-spectrum antibiotics, antiviral drugs to treat smallpox, and improved antitoxin for botulism.

Stockpiling Efforts

Many drugs and vaccines are already in existence and approved. Therefore, stockpiling is a valid course of action. Often, the stockpiling efforts are bundled with chemical and/or radiological countermeasures. The US, UK, and various European nations have CBRN stockpiling efforts. Commonly, things like ciprofloxacin, an antibiotic effective against anthrax, is included in stockpiling efforts. For example, documents in the public domain show that the UK stockpiles ciprofloxacin, botulism antitoxin, gentamicin (for plague) and doxycycline (useful for several types of bacterial infection).

There is an economic aspect of medical stockpiling. Inclusion in a stockpiling effort means large repeated orders for a manufacturer, and it can thus be dangled as an incentive to manufacturers to develop a new product. Medicines and vaccines have shelf lives, so inclusion in a stockpiling programme is a reliable income stream for manufacturers. This also means that stockpiles for actual population protection are not cheap. As a result, interest in development of stockpiles appears to be stronger than actual expenditures in many parts of the world.

Decontamination

Decontamination is often overlooked in biodefence or gets lumped in with chemical decontamination. Particularly in a military perspective, chemical decontamination gets the attention. From a technical standpoint, biological warfare threats are generally easier to decontaminate than chemical warfare agents. With the exception of anthrax spores, most biological threats are not as persistent as chemical threats like VX or sulfur mustard. However, the experience of the anthrax attacks in 2001 in the USA demonstrated that decontamination can be a time-consuming and expensive task. The overall cost of decontamination from a relatively small number of anthrax spores was estimated to have exceeded US\$300M. Any improvement in efficiency and economy would be helpful.

Developments in decontamination have been discussed at length in previous issues of this magazine. However, the products launched in recent years by both Steris (USA) and Cristianini (Italy) have demonstrated significant improvements in the field. Both of them have developed products for fumigation of large and small spaces. Steris is well known for its hydrogen peroxide techniques,

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whereas Cristanini uses a hydroxyl radical to neutralise pathogens. Both techniques are less destructive and dangerous than older methods which involved fumigants like chlorine dioxide or ethylene oxide. These have the prospect of making major biological decontamination tasks less expensive and less damaging to property.

EU Efforts

European Union efforts in biodefence are worthy of mention. Numerous projects have been undertaken in recent years, both by European agencies and as part of research efforts under FP6, FP7, and Horizon 2020. Examples are numerous. The European Centres for Disease Prevention and Control are working on a bioterrorism handbook. The EU Agency for Law Enforcement Training is conducting courses on evidence collection. The European Defence Agency has been considering CBRN threats for years. In total, over two hundred CBRN-related European projects are listed in various databases and reports, many of which have biological components. These range from broad (and sometimes vaguely defined) coordination actions to highly focussed research efforts on specific aspects of the biological threat, such as toxins. The EU ENCIRCLE project website has an excellent summary of recent and ongoing work.

Capability Gaps

In the area of biodefence, the gaps are as important as the developments and capabilities. Some of these are quite significant. The state of the art in detection and identification of biological warfare threats is inadequate for protection purposes, even though governments have been spending money on it for decades. We are still at the point where the first warning of a biological attack may very well be sick people turning up at hospitals, as if it were 1950. The biological detection systems and technologies currently available are simply not enough. However, a reasonable way forward is still not in view and as an observer of biological defence since the early 1990s, this correspondent is at a loss to see where breakthroughs could be had. The other technology and product areas are progressing as well as can be expected, given the overall priorities that the health-care sector faces daily.

Not every gap is technical. One gap is diplomatic. The international arms control framework in this area exists, but is comparatively weak. The Biological and Toxin Weapons Convention (BTWC) treaty went into effect in 1975. However, when com-

Photo: U.S. Army



British military experts adjust their respirators inside the CBRN chamber of the US Army Training Support Center Benelux at Chièvres Air Base, Belgium.

pared with chemical weapons, there are some shortcomings. The Chemical Weapons Convention has far more details in it and is backed up by an entire international agency, the Organisation for the Prohibition of Chemical Weapons (OPCW). However, there is neither the level of enforceable detail in the BTWC treaty nor an apparatus equivalent to the OPCW to enforce its provisions. Efforts to remedy this deficit have been underway for decades. However the diverse and complex nature of biotechnology means that it is proving difficult to come up with definitions and regulations that protect intellectual property, make people safe, and keep both industry and governments happy. The nature of what may be considered “dual use” biological technology is turning out to be more complicated than the comparable discussions in nuclear and chemical technologies. Unless the international legal framework can be strengthened, it will be harder to pursue non-proliferation objectives.

Some of the gaps are gaps in threat perception. While focussing on threats that are directly lethal to people is, naturally, a policy priority, there are other aspects of biological warfare and biological terrorism that are often neglected.

An underemphasised aspect of biological warfare is economic warfare. The USA and UK were heavily involved in biological weapon development in the 1950s and 1960s before renouncing and demilitarising their biological agents. A large part of the West’s programmes were devoted to incapacitating agents and anti-agriculture agents. Perhaps the most effective anti-personnel agents in the US bio-arsenal in

the 1960s were agents like Q-Fever, brucellosis, and Venezuelan Equine Encephalitis. While they cannot be said to be non-lethal, their primary intent was to make people sick for weeks, on the basis that sick soldiers and sick workers do not win wars. A sick person is far more of a logistical drain than a dead person. Vast damage can be wrought by a small amount of microbial material by targeting the economy rather than the military.

Pestilence and famine are ancient threats. They can be caused by deliberate human acts. During the Second World War and the Cold War, much effort went into developing biological warfare agents that targeted agriculture, either by targeting crops or livestock. Anti-agricultural agents were designed to destroy the food supply and degrade an enemy’s economy. Things like wheat rust, rice blast, and Colorado potato beetles can ruthlessly destroy an economy and cause famine. Generally speaking, both the military and the civil protection programmes and products are not addressing the threat to food supplies and economies posed by anti-agricultural agents. One merely need witness the economic losses of the foot and mouth disease outbreak in the UK in 2001 to see the havoc that can be caused.

Biodefence is a complex field, and one that is very different to other segments of defence and security. It has often lagged behind even the equally exotic chemical warfare defence area. Unfortunately, the best time to discover that defence development efforts are inadequate is not in the immediate aftermath of a biological attack. One hopes that such a discovery is not made any time soon. ■

Coastal Defence Options

Doug Richardson

Until the second half of the 20th century, the most important coastal defence weapon was the long-range cannon, which was installed at fixed locations and protected by thick walls. But fighter planes armed with air-to-ground missiles made fixed installations useless, which is why coastal defence became mobile.

On the night of 12 June 1982, a team of Argentinean military personnel were ready to make naval history. A 10-day development programme using Aerospatiale MM38 EXOCET systems hastily removed from two Argentinean Navy destroyers had resulted in the creation of an improvised Lanzador Terrestre del Misil (Terrestrial Missile Launcher) which had been flown to what their country regarded as the newly-liberated Islas Malvinas earlier that month. By then, Britain (for whom the territory in question was the Falkland Islands) had moved a naval task force to the waters around the contested islands, landed its own forces, and was using naval gunfire to support its operations.

Having detected the British destroyer GLOUCESTER by radar, the missile team prepared an EXOCET missile for launch. An Argentine marine who had driven the truck used to tow this improvised weapon system into action pressed the firing button of a makeshift firing system partly based on telephone-switchboard hardware. The first ever engagement of a warship by a coastal-defence missile system had begun. Although GLOUCESTER survived the impact of the EXOCET, the attack opened a new era in coastal defence, and the land-based anti-ship missile now casts its shadow over naval operations conducted in littoral waters or in maritime choke points.

Until the second half of the 20th century the main coastal-defence weapon was the long-range gun. These were normally installed at fixed sites, and they enjoyed the protection provided by thick walls or earth mounds. But given the accuracy of tactical strike aircraft, particularly when armed



Photo: US Navy

On 17 May 1987, two Iraqi EXOCET missiles hit the guided missile frigate USS STARK in the Persian Gulf, killing 37 sailors.

with air-to-surface missiles, military fixed-site installations became of declining usefulness in the second half of the 20th century. If they were going to survive in combat, coastal-defence assets would have to become mobile. Their most common form became coast-defence variants of existing anti-ship missiles such as EXOCET.

In recent years, the deployment of coastal-defence missile systems is sometimes the subject of newspaper headlines and of international concern, with these systems sometimes being used to make a political point. Sweden fielded RBS15M3 anti-ship missiles with its coastal defence artillery force in 1995, but only one of the planned

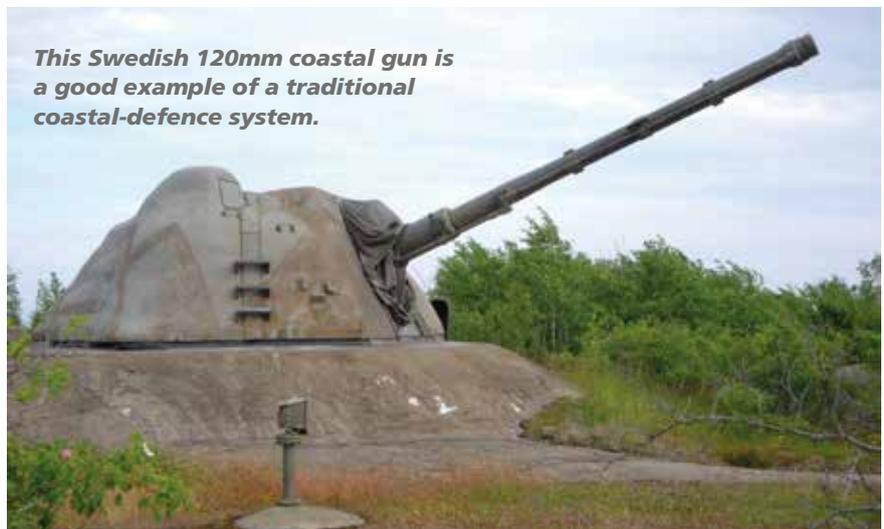


Photo: Holger Ellgaard

This Swedish 120mm coastal gun is a good example of a traditional coastal-defence system.

Author

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four batteries had entered service when the decision was taken in 2000 to phase out all the country's coastal defences. However, in November 2016, Sweden announced that the land-based RBS15 systems would be reactivated, and equipped with RBS15 Mk2 missiles in order to have commonality with the Swedish Navy's ship-based version.

Russia still maintains what it terms Coastal Missile-Artillery Troops. These are equipped with anti-ship guided missiles, as well as stationary and mobile artillery systems. Late in 2017, the Russian MoD announced that 3K60 BAL (SS-C-6 SENNIGHT) and 3K55 BASTION (SS-C-5 STOOGE) systems had been test-fired as part of a training exercise conducted in Crimea, the peninsula formerly part of Ukraine that had been incorporated into Russia as the Republic of Crimea following a takeover by pro-Russian separatists and Russian Armed Forces.

Late in the previous year, a BASTION coastal defence battalion had been deployed with the 520th Coastal Rocket and Artillery Brigade in the Yelizovsky region of Kamchatka in Russia's eastern frontier. It had replaced an obsolete SPU-35V REDUT (SSC-1 SEPAL) missile battery. BAL and BASTION systems have also been deployed in Russia's Kaliningrad enclave.

China is reported to have deployed anti-ship and surface-to-air missile systems on three of the outposts it controls on the disputed Spratly Islands in the South China Sea. In May 2018, Vietnam (which also claims ownership of the islands) demanded that China remove this military equipment, but China refused, with a foreign ministry spokesman claiming that his country has indisputable sovereignty over what China terms the Nansha Islands. Vietnam also sees its coastal defences as important, and has improved these with the mobile BASTION K-300P system, as well as anti-ship artillery batteries.

Japan plans to deploy its indigenously-developed Type 12 anti-ship missiles to three of its southwestern islands – Miyako-jima, Ishigaki-shima, and Anami-Oshima. It is reported to be considering installing Type 12 systems on Okinawa-jima. If these plans reach fruition, missile systems at these four locations could create problems for any attempt by the Chinese Navy to break out into the western Pacific in the event of a conflict.

The launch of a Kongsberg Naval Strike Missile (NSM) from a land-based truck launcher during the RIMPAC 2018 exercise in July is unlikely to have gone unnoticed by China, given that a US Army-sponsored report published by RAND in 2013 had ex-

Photo: MoD Russia



The Russian 3K55 BASTION coastal missile system

amined the possibility of using land-based anti-ship missiles to cut off Chinese sea routes outside of what China terms 'the first island chain' – a series of major archipelagos that includes the Kuril Islands, Japanese Archipelago, Ryukyu Islands, Taiwan, the northern Philippines, and Borneo. RAND had identified eight potential choke points that could be threatened by ASM deployments and pointed out that missile batteries would not have to be permanently stationed in the area, but they could be deployed in the event of China

conflict has seen repeated attacks mounted against shipping operating in the Bab al-Mandab strait, the waterway through which merchant ships travel between the Gulf of Aden and the Red Sea.

At first, these attacks were mounted using drifting naval mines, fast attack craft, and unmanned remote-control boats packed with explosives, but a significant escalation came on 1 October 2016 when the HSV-2 SWIFT, an experimental high-speed logistics catamaran that had originally been evaluated by the US Navy but was now

Photo: US Navy



While operating north of the Strait of Bab el-Mandab on 9 October 2016, the US Navy destroyer MASON was targeted by shore-based anti-ship missiles fired from the Yemeni shore. It successfully countered these by launching SM-2 Standard and RIM-162 Evolved SEASPARROW missiles.

using or threatening to use force against US allies or partners in the region.

Shore-based anti-ship missiles are playing a significant part in the Yemeni Civil War being fought between Houthi forces and those loyal to the Aden-based government of Abdrabbuh Mansur Hadi. This

leased to the United Arab Emirates was hit by a shore-based missile while operating near the Yemeni port of Mokha. The missile was probably a C-802 and caused a massive fire aboard the SWIFT. Despite this damage, the vessel remained afloat.

On 9 October 2016 the US Navy ARLEIGH



Photo: Rosoboronexport

Locating hostile coastal-defence batteries will be difficult if the enemy is using the NOVATOR KLUB-K system. Its launch tubes are mounted in a standard shipping container that is nearly indistinguishable from a normal commercial container.

BURKE class guided-missile destroyer MASON (DDG-87), which was operating in international waters north of the strait of Bab el-Mandab, launched surface-to-air missiles and countermeasures in response to two missiles fired from the Yemeni shore. According to unofficial reports, the ship launched two SM-2 Standard missiles, one RIM-162 EVOLVED SEASPARROW missile (ESSM), and a NULKA missile decoy. Both of the threat missiles crashed into the sea – one following an SM-2 interception, and the other probably as the result of some form of on-board failure.

Four days later, the US destroyer NITZE (DDG-94) launched three RGM-109 TOMAHAWK Land Attack Missiles (TLAMs) against Houthi-controlled radar sites in Yemen. This cruise-missile counterattack was intended to end Houthi radar surveil-

lance on the contested area, but having lost three radars the insurgents forced commercial ships in the Hodeida and Salif anchorage areas to allow their radars to be used to generate targeting data.

For countries planning to acquire coastal defence systems either for the first time or to replace existing but obsolete hardware, there are a number of options. Should the system be long-range, medium-range, or even short range? In general terms, the longer the range, the larger and heavier the hardware is likely to be. Increased size will probably affect ease of deployment, and make the deployed system harder to conceal.

Shore-based versions of many anti-ship missiles have a long range – in the case of EXOCET, the rocket-powered versions have a maximum range of more than 70 km, but around 180 km is available from the air-breathing variant. At the 2018 Farnborough Air Show Saab Dynamics announced the RBS15 Mk4, which will be used by the airborne, shipboard, and land versions of the RBS15 GUNGNIR (ODIN'S SPEAR) system. Externally near-identical to the earlier Mk3 missile, the Mk4 features a new composite airframe, an improved guidance system incorporating an improved target seeker and an anti-jam GPS subsystem. Maximum range is increased from the 200 km of the Mk3 to more than 300 km, and a data link has been added to allow in-flight retargeting.

Some manufacturers see a growing demand for shorter-ranged missiles. A new coastal defence system based on the MARTE missile family was announced by

MBDA in 2014. Intended to provide maritime coastal traffic surveillance and interdiction of hostile ships entering the user's territorial waters, the MARTE Coastal Defence System (MCDS) combines a shelter-based Command and Control (C2) module that uses data from its own radar and optionally from an upper level surveillance system, several four-round launcher modules that can be mounted on ISO standard trucks, a logistic and support vehicle, plus optional reloading vehicles. Two types of missile are available – the MARTE MK2/N and the longer-ranged MARTE ER.

MBDA is now marketing a combination of the land-based variants of the EXOCET MM40 Block 3 and MARTE-ER systems as the Multilayer Coastal Defence System. Ordered by Kuwait in 2016, this would typically consist of a tactical operations centre, a mobile sensor suite, two firing units based on high-mobility vehicles, and optional reloading vehicles. The MARTE-ER missile will be carried in a four-cell launcher. Although it weighs about 315 kg, its turbojet powerplant gives a maximum range of more than 100 km. The EXOCET MM40 will cover targets at ranges of up to 200 km.

Sweden operates the shore-based RBS 17 variant of the US anti-tank HELLFIRE as a coastal-defence weapon able to engage small warships such as landing craft and mine-countermeasures vessels operating within inshore waters. Extending coverage out to 10-20 km will require a larger missile such as the proposed medium-range coastal defence variant of MBDA's SEA VENOM/Anti-Navire Léger (ANL) air-launched anti-ship missile system. Developed to arm the UK's WILDCAT HMA2 naval helicopter and the French Navy examples of the Hélicoptère Interarmées Léger derivative of the Airbus H160 helicopter, this has a maximum range of more than 20 km.

Responding to an interest by the UAE armed forces in a new air coastal missile system, the Serbian company Yugoimport has developed the new ALAS-C version of its ALAS tactical missile. An ALAS-C battery would consist of a single command post vehicle and four launcher vehicles. All would use the NIMR 6x6 vehicle. The command post vehicle would be equipped with a shelter fitted out with radar, radio, and data communication systems, while each launcher vehicle would carry containerised ALS missiles arranged in two rows. After being launched by solid-propellant boosters, the missile would activate its turbojet engine and then begin its flight to a target that can be up to 25 km away. ALAS was originally developed as an anti-



Photo: MoD Russia

Russia's 3K60 BAL (SS-C-6 SENNIGHT) system uses the airbreathing Kh-35 missile.



Photo: Al Jazeera

The KALIBR (SS-N-27A SIZZLER) anti-ship missile was originally based on a two-stage (boost then cruise) configuration, but by the end of the 1990s the three-stage 3M-54 design had been fielded.

tank missile, and carries a nose-mounted EO camera. A trailing optical fibre passes target imagery back to the launch site, and sends guidance commands to the missile. Another decision to be faced when selecting a future anti-ship missile is whether the weapon should be subsonic or supersonic. Concepts for supersonic anti-ship missiles were investigated by French, German, and Italian companies during the 1980s and 1990s. The Franco-German Anti-Navires Supersonique and the French Anti-Navires Futur programmes had been intended to produce missiles cruising at Mach 2 or even Mach 3, while remaining similar in length and weight to missiles such as HARPOON and EXOCET, but none became a full-scale development programme. During the late 1980s, France and Italy studied a supersonic OTOMACH missile intended as a follow-on to the subsonic OTOMAT, but concluded that velocities approaching Mach 2 or Mach 3 would not be enough to defeat future defensive systems.

Customers looking for a supersonic missile will have to turn to suppliers such as Russia or China. But while the abandoned West European supersonic missiles were planned to be around 5.6 m long and 850 kg in weight, Russian and Chinese supersonic designs tend to be much larger and heavier. For example, the P-800 ONIKS is 8.9 m long and weighs 3,300 kg, and while the Russian version has a maximum range of 600 km, the YAKHONT export variant is restricted to 300 km. This level of size and weight could create deployment and concealment problems for land-based units.

Some reduction in weight is made possible by combining subsonic and supersonic phases of flight. Novator's KALIBR (SS-N-27A SIZZLER) was originally based on a two-stage (boost then cruise) configura-

tion, but by the end of the 1990s a three-stage 3M-54 design had been fielded. This incorporated a final stage that used a solid-propellant rocket motor to provide a supersonic attack phase with a maximum velocity of around Mach 2.9 while keeping the launch weight of the complete missile to around 1,500 kg. The maximum range is 600 km, but an export version designated KLUB has a range of less than 300 km in order to conform to MTCR rules. KLUB variants include the KLUB-M mobile coastal missile system, and the KLUB-K containerised versions intended for maritime, land vehicle and railway use. Both can use 3M-54KE and 3M-54KE1 missiles. Missiles approaching at hypersonic velocities are likely to pose problems for most current ship-defence systems. They will give the defences little time to react, while the kinetic energy released by a missile impact will have a devastating effect on the

Photo: Kongsberg



Kongsberg's Naval Strike Missile (NSM) could form the basis of an effective shore-based weapon.

target vessel. The first hypersonic anti-ship missile to enter service is likely to be Russia's 3M22 ZIRCON (SS-N-33). Developed by NPO Mashinostroyeniya and powered by a scramjet, this is reported to have a cruise speed of Mach 5 to Mach 6, and a maximum range of 500 km when following a low-level flight path.

As part of their refit programmes, the KIROV class battlecruisers ADMIRAL NAKHIMOV and PYOTR VELIKIY are expected to receive vertical launch systems capable of housing ZIRCON missiles. Plans for installation aboard other ship classes and submarines have been reported, as well as an air-launched variant, but it is not clear whether a coastal-defence version is planned.

Until recently, all anti-ship missiles were equipped with wings and control surfaces, and so flew aerodynamically, but artillery rockets are now being adopted as coastal-defence role ballistic missiles. Israel Military Industries has developed its Coast & Islands Defence System (CIDS) to protect coastlines, islands, and economic waters. The system combines 40 km range ACCULAR and 150 km range EXTRA (Extended Range Artillery) rockets with radars and drones able to identify enemy vessels. Both types of rocket can be fired from IMI's truck-mounted LYNX MRL multiple rocket launcher, or from a remotely controlled stationary launcher.

Iran's KHALIJ FARS is a specialised anti-ship version of the FATEH-110 guided artillery rocket, which in turn had been a development of the ZELZAL-2 unguided artillery rocket. FATEH-110 combines an inertial guidance system, with GPS satellite navigation, and is steered by four cruciform canard control surfaces located just of the



Photo: Saab

Intended for use in airborne, shipboard, and land versions, the Saab Dynamics RBS15 Mk4 will have a range of more than 300 km.

missile's nosecone. Flight tested in 2011 and 2013, the KHALIJ FARS can be recognised by the presence of a transparent dome at the front end of the nose cone. This is used by an electro-optical seeker that guides the weapon in the final approach to the target.

An upgrade similar to that which created the KHALIJ FARS could result in the US developing an anti-ship variant of the Lockheed Martin MGM-140 Army Tactical Missile System (ATACMS) tactical ballistic missile. In October 2016, then US Defence Secretary Ashton Carter announced that

ATACMS would be upgraded to give it the ability to strike moving targets on land or at sea.

While the shore-launched anti-ship missile remains the weapon of choice for most coastal-defence missions, the gun can still play a useful role. Russia still sees a viable future for the gun-based solution, and had developed new systems such as the A-222 BEREK 130mm self-propelled coastal artillery gun mounted on a MAZ-543 8x8 chassis. First shown to the public in 1993, it normally operates in a group of up to six guns, which are teamed with one command and

control vehicle (CPU) and one combat support vehicle (MOBD). BEREK is capable of engaging surface ships, fast attack craft, and ground targets, firing up to 12 shots per minute at targets up to 22 km distant. Although the system was promoted for export, the only known user is the Russian Navy Black Sea Fleet's 40th BRAP.

In 2015, Russia's Burevestnik Central Scientific Research Institute announced that it was developing a new self-propelled coastal defence gun. Based on the bureau's 2S35 KOALITSIYA SV self-propelled gun that featured during the 2015 Moscow Victory Day Parade, the new weapon would be 152mm calibre, and is likely to have a maximum range of 70 km.

Whether based on guns or missiles, coastal defences are likely to feature in future combat operations. But users need to be aware of the risk of opening fire against the warships of any major naval power. As the October 2016 incident involving the guided-missile destroyer MASON demonstrated, the response to such an attack could take the form of a salvo of cruise missiles. Radars, command posts, and missile launchers deployed for coastal defence will need to operate using "shoot and scoot" tactics. ■

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Energy Autonomy for Small Tactical Units

Tamir Eshel

The increasing demand for energy is driving an increase in the weight carried by dismounted warfighters. With no perfect solution in sight, military planners are seeking to optimise energy sources by reducing the number and types of batteries used in order to improve the energy autonomy of small combat forces.

The load carried by the warfighter into battle has increased dramatically in past decades, primarily due to the introduction of power-consuming electronic systems, such as radios, computers, observation and night vision systems. While electronic miniaturisation drives a reduction in equipment size and weight, such

person. As new capabilities are required, and advanced generations of equipment emerge, the demand for power increases beyond the human carrying capacity, thus requiring change in load and energy priorities. The principal challenge, therefore, is to reduce power/weight requirement for combat missions while preserving or even

sights. Team leaders and commanders consume even more energy, operating additional observation systems, data-communications links, a second radio, a portable computer and other specialised equipment.

This electronic ensemble requires a lot of energy. Each of the systems requires power and spare batteries to perform on extended missions, bringing battery weight carried by the individual soldier to 10 kg or more. This means over 100 kg of batteries of different sizes and types would be required to support an infantry squad on an average mission spanning 72 hours.

In an effort to lighten this load, the US Army provides team leaders the capability to better manage their energy resources and reduce their energy footprint. One of the first systems to provide such a capability was the Soldier Worn Integrated Power Equipment System (SWIPES), which used a wearable charger feeding from a central, conformal battery to trickle charge electronic devices through a cable harness embedded into the soldier's combat vest. An advanced version of the system added data connectivity over the power cabling, to enable monitoring and managing energy usage. A similar system now supports the US Army NETT WARRIOR integrated soldier system. The system relies on central or distributed power. For example, a typical Bren-Tronics battery developed to support NETT WARRIOR provides 212 Wh/kg at a weight of about one pound.

Other central batteries supporting such systems include the Soldier Conformal Wearable (SCW) batteries, a semi-flexible ergonomic lithium tactical battery pack. Available in a one-kilogramme unit high-density pack (200 Wh/kg) based on lithium-ion (or LiFePO4) technology for increased safety, this lightweight yet robust soft pack delivers 97 Wh/kg at a unit weight of 0.872 kg. Carried on the waist, close to the soldier's centre of gravity, the ergonomic design is optimised for wearab-



Photo: Tamir Eshel

Epsilon offers smaller batteries for the dismounted warfighter.

a reduction in energy sources is much slower, resulting in an increasing share of battery weight in the total warfighter's load. With missions potentially lasting for 72 hours without resupply, warfighters are often required to carry loads exceeding 50 kg per

improving the warfighter and tactical combat units' capabilities to sense, shoot, move, and communicate.

Soldier Power Solutions

Carrying a number of electronic devices, the modern warfighter becomes a platform that demands its own electronic and power architecture. Today's soldier often carries a personal radio, navigation and vision system devices and weapon

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le use. Battery recharging is done through a central connector, and a future enhancement will also have wireless recharging, enabling soldiers to top up their systems when seated in their combat vehicles.

Revision's SOLOPACK is a Li-ion battery the size of an M4 magazine, designed to fit into the soldier's vest. Weighing slightly more than one pound (0.55 kg), it delivers 178 Wh/kg, enough energy for an individual over a 12-hour mission. It has a standard GLENAIR connector supporting SMBUS V1.1 protocol.

Different data and power distribution har-

nesses are used to distribute power to the users. Similar capabilities are now used in wearable power and data hubs supporting multiple radio systems, such as the one used by Joint Tactical Air Controllers (JTAC). A typical port such as Glenair's STAR-PAN supports a 2- and 6-port high-speed USB hub configuration to provide power charging and conditioning, smart power monitoring and circuit protection for safe and optimal power consumption. Implementing the latest development in e-textile, BAE Systems' BROADSWORD SPINE harness is woven from conductive

yarns to create a patented fabric power-and-data distribution network offering a lighter, more flexible and robust wearable power and data distribution system. The system typically has eight connection ports arranged across a garment, capable of providing 180 watts of power and communicating over USB. An embedded computer provides automated power and data management that can be monitored and programmed from an app running on the soldier's phone or handheld information unit. The system conforms to the Generic Soldier Architecture Standard being developed by the UK MoD.

High-Capacity Vehicle Batteries

The benefit of high-capacity rechargeable batteries is not limited to dismounted operations, but has many advantages in vehicular applications and contingency operations. Different chemistries are available to deliver the required energy density to meet user demand.

Epsilor offers Li-ion batteries for combat vehicles configured in 6T format providing 4.3 kWh (176 Ah), claimed to have the highest energy density on the market. Epsilor also offers a super safe 2.0 kWh (80 Ah) battery that can be safely stored inside combat vehicles as a drop-in replacement for legacy batteries. These batteries employ LiFePO₄ chemistry, which quadruples the storage capacity of existing Lead-Zinc batteries of the same size. Designed to be form-fit with T6 batteries, LiFePO₄-based batteries extend the mission endurance of combat vehicles or dismounted sensors, to conduct 'Silent Watch' missions for many more – up to 12 – hours, enabling a tank or APC to sustain silent watch for a full night, without a single engine start.

Such batteries support over 3,000 charging cycles and up to a 10-year operational life. As a drop-in replacement for lead-acid batteries, they also provide self-balancing, self-charging and charge current management capabilities that support smooth operation of new vehicles as well as older-generation vehicles. Connected in a series or parallel configuration, they enable users to meet different operational requirements. For example, battery banks mounted on trailers can provide electricity to a small unit or command post.

When it comes to having sufficient electrical power for the equipment carried into combat, the dismounted warfighter is the most disadvantaged person on the battlefield. This is largely due to the dismounted warfighter having to carry all their equipment and the means to power that equipment for several days.

Revision offers a different approach to vehicle power with the 'Silent Watch Battery Pack' (SWBP) designed primarily for reconnaissance and command vehicles. Built in a super-high-density rig, SWBP cannot be stored inside the vehicle for safety reasons and is, therefore, placed in an external steel enclosure fitted into the winch bay. The gross weight of the unit is 575 kg. This unit uses proprietary Li-ion cells stacked to a module fitted into the winch bay of a Light Armoured Vehicle (LAV) or STRYKER. The SWBP contains 10 modules packing 1,600 Ah of storage at 28 volts, connected to the vehicle's power and communications bus to power onboard turret controls, communications and surveillance equipment for 10 hours. The kit is designed to support 6,500 recharging cycles and can support peak draw of 1,100 amps for engine start if required.



Photo: Epsilor

Epsilor's 6T vehicle battery is claimed to have the highest energy density on the market.

Sharing and Harvesting Energy

On routine operations, used (empty) batteries are replaced with fully charged ones, as the empty ones are sent to the depot for recharging and maintenance. However, many of these batteries returning from a mission still store a considerable amount of energy – a resource the unit wastes when sending them back to the depot.

Implemented at the platoon level, energy harvesting systems can utilise this lost resource to obtain energy from all available sources, including scavenging power to turn a 'dead weight' of used, empty batteries into usable energy, along with other energy sources available in the field, including renewable energy sources (solar, wind), vehicle power, and local grid.

Such a harvester is Revision's SQUAD POWER MANAGER, a kit that integrates and connects to 200 types of batteries and electronic devices. It can draw power from any source – vehicle or aircraft power outlet, solar blanket, primary and secondary batteries, and so on, and feed regulated power to the user device. Built-in power management software that matches different users is based on the specific data provided by each smart, device-specific cable, each embedded with the interface for the specific user.

Sharing power is another option to support soldiers' energy needs in dismounted operations. For this purpose, Revision has introduced the SHAREPACK power management system, an energy module that combines a high capacity battery pack and charger into a lightweight, conformal unit. Each unit displays its energy status, based on the remaining energy stored, device connection and energy draw. SHAREPACK can store, deliver, harvest and share power by eliminating the need for spare batteries. The system adapts to charge batte-

Bren-Tronics

Bren-Tronics, Inc., is a manufacturer of portable power systems for military applications used by the US, NATO and government forces around the world. The company was founded in 1973 and is based in Commack, New York. Its premier product is the only qualified US Department of Defense (DoD) BB-2590/U, 12V/24V Li-Ion rechargeable battery, which currently powers over 75% of all military applications in the world today. Bren-Tronics batteries come with enclosures constructed of impact-resistant metal or plastic materials which provide high durability meeting all relevant US DoD specifications. Bren-Tronics' devices feature smart circuitry in response to changing load conditions which keeps users and their smart devices informed of battery health status through onboard displays and SMBus protocols. Bren-Tronics also introduced a universal charging platform for the military, incorporating a software-based solution with a mechanical interface capable of recharging all dominant battery forms, voltages and chemistries using available AC / DC / renewable energy power sources. Another prominent product is Bren-Tronics' 6-PACK Portable Power System, used to deploy equipment requiring 1kW to 6kW to remote locations; it is a power source comprised of six BB-2590/U batteries packaged into a rugged, watertight container with an integrated power management system. Depending on the power requirements and the available input power sources (AC / DC / renewable), the 6-PACK can be sized to provide continuous power for missions over days and weeks, from extended remote patrols and operations centres by military, to border surveillance and emergency (FEMA) management where traditional power sources are not available.

ries powering electronic devices on board and can quickly recharge from available sources such as vehicle power or a solar blanket. Combining several SHAREPACKS can also support power-hungry equipment, when required. At a gross weight of 1.28 kg, SHAREPACK supplies an energy

density of 119 Wh/kg, feeding two users simultaneously.

Solar blankets are useful for energy harvesting, particularly for extended dismounted operations. Military-grade solar panels such as Bren-Tronics' FLEX CHARGER are provided as compact, foldable and light-

Lincad

The family-owned SME Lincad, which produces bespoke batteries, chargers and power management systems for a diverse range of applications, operates mainly in the defence sector. Set up in 1986, the UK-based company's main customer is the UK MoD, but it is also a supplier for some of the larger defence companies such as Leonardo, BAE Systems, Thales and Northrop Grumman. Lincad also supplies a range of smaller non-rechargeable battery products to the UK MoD and other customers. It has an annual turnover of between €5M and €10M and employs about 40 people. Lincad's products are mainly based on lithium-ion technology; they range from the extremely small – such as a battery recently produced for a Thales hand-held radio – to a power management system for Leonardo's LINAPS artillery pointing system. The majority of Lincad's work is for man-portable equipment and it has a core suite of batteries, the LIPS (lithium-ion power system) range, which were first produced in 2000. Lincad has sold battery solutions for the military to Poland, Denmark and Australia. In 2015, IATA (International Air Transport Association) issued new regulations prohibiting the air transport of lithium-ion batteries not contained in devices on passenger aircraft. They can only be transported by cargo aircraft – and only if the batteries have a charge level of 30% or less. With this, Lincad had found a market niche; in 2016, the company introduced a device capable of discharging batteries. The new CARAVEL Mk2 charger was developed, among other things, with a transport mode that allows lithium-ion batteries to be discharged to 30% or less in accordance with the new IATA rules. In 2018, Lincad won a multimillion-Euro contract with Team Leidos to supply a wide range of primary cells and batteries for the UK MoD.



Photo: Tamir Eshel

A portable Bren-Tronics battery charger

weight devices for expeditionary use. The FLEX uses a solid-state thin-film solar array on a flexible substrate that delivers up to 60 watts, at up to 21 volts of charging power. It comes with a foldable power manager that also supports AC (wall outlet) and DC (vehicle battery or solar) to charge various batteries.

Rechargeable Power Solutions

Modern rechargeable batteries based on lithium-ion (Li-ion) technology offer energy density levels similar to primary batteries using LiSO₂ chemistry. They offer the benefit of multiple recharging cycles, thus extending the useful life cycle of the battery beyond that of a single-use primary battery. However, unlike primary batteries, rechargeable batteries tend to lose power over time and must be recharged periodically to maintain top capacity. While rechargeable batteries are often more expensive than primary ones, rechargeable batteries become more cost effective as the use of batteries increases. Internally, most of the rechargeable batteries used by the military employ standard (Type 18650) cells. Besides the advantage of commercial availability, these cells are constantly improving, offering increased power density, as they address the growing demand for power from the commercial market. The military user benefits from this trend, as batteries that have expired are replaced by ever more powerful ones.

The Economy of Rechargeable Batteries

The advantages gained through the widespread use of rechargeable batteries brought the US forces to increase the procurement of these batteries over primary ones. Since 2010, the majority of batteries procured by the US Army have been rechargeable. Shifting the military deployable energy supplies to rechargeable batteries often yields a dramatic improvement in weight saving, logistics and energy economy. Although the introduction of rechargeable batteries requires significant non-recurring investment in chargers and maintenance, research has shown that a rechargeable battery supply chain would become cost effective with an operational supply sustaining 2-3 weeks of operation. Moreover, army studies have shown that rechargeable batteries would cost significantly less than primary ones, as all batteries are used through operational usage cycles. In contrast, only part of the primary battery stocks maintained for emergencies can be used during peacetime before their expiration time. Relying on rechargeable power sources enables combat units to trade one form of energy for another, supplying the energy to power the systems they use in the field. Therefore, recharging becomes an essential part of the field autonomy of combat units, just as ammunition, water, food, and fuel.

SAFT

SAFT (Société des Accumulateurs Fixes et de Traction) is a manufacturer of advanced technology batteries for industrial and defence applications and has expanded its portfolio by a number of mergers and acquisitions of battery companies across the world. A wholly-owned subsidiary of the French oil and gas giant Total, SAFT was founded in France in 1918 and has been producing batteries since then. UK operations began during the 1940s, and by the 1980s the company had operations in the United States and Asia. SAFT employs 4,300 people at 14 production sites and has more than 3,000 customers in 18 countries. In 2017, the company invested €72M in R&D and reported €744M in sales. The company currently holds 158 patents. SAFT's products are essentially nickel-based batteries, primary lithium and new-generation lithium-based batteries and battery systems. They serve in a wide range of back-up or mission-critical applications in civil and military markets. In 2018, SAFT joined forces with a handful of European partners to form an R&D partnership focused on creating cutting-edge batteries. The primary focus of the initiative is on two specific technologies – advanced high-density lithium-ion and solid-state – and is aimed at several industries, including electrified vehicles, other forms of transportation such as rail and aviation, and energy storage. According to SAFT, these next-generation batteries will provide improved performance and safety as well as lower costs, compared to current Li-ion technology. What is more, they will create a new standard for integration into their overall system environments. They will also feature state-of-the-art digitalised functions and interfaces. SAFT says that it will meet the most stringent sustainability standards throughout this project. The new R&D alliance will include suppliers such as Solvay, a Belgian materials and chemical company; Manx, a German specialist in battery cell and module assembly; and Germany tech giant Siemens.

Photo: Tahir Esthel



A Soldier-Worn Integrated Power Equipment System (SWIPES) which can be linked to a Bren-Tronics battery charger

SFC Energy

Smart Fuel Cell (SFC) Energy is a listed manufacturer of fuel cells headquartered in Germany near Munich. The company develops solutions for grid-independent and stationary power generation and distribution. Another field of activity is electronic components such as voltage transformers and switching power supplies for industry, which they develop, produce and market internationally. The products are offered as system solutions for energy supply and are used in off-grid power supplies for industry and authorities as well as in the leisure sector. SFC has subsidiaries in Germany, the Netherlands, Romania and the US. In addition, SFC offers mobile energy solutions and energy management for the mobility, defence, oil and gas and industrial sectors.

The company was founded in 2002. Sales increased from €32 million in 2013 to €54 million in 2017, with the number of employees remaining virtually unchanged. By January 2016, the company had sold more than 34,000 fuel cells. SFC Energy's fuel cells are based on the Direct Methanol Fuel Cell (DMFC). A number of portable products based on proprietary DMFC technology are used in defence and security applications.

One of SFC's leading military products, the EMILY fuel cell, is designed to power sensors, radio, surveillance and defence systems integrated into military vehicles. The EMILY fuel cell charges the onboard battery automatically, quietly and without detection, ensuring the operation of all applications even when the engine is switched off or when starting a noisy generator. It is not necessary to operate an engine to charge the batteries. Therefore the camouflage remains intact. EMILY 3000 is capable of charging modern lithium-ion and lithium-polymer batteries as well as conventional lead-acid batteries. EMILY 3000 is virtually signature-free, noiseless and emission-free. It is also suitable as a mobile field charging station for batteries.



Photo: SFC

In 2018, the German armed forces contracted SFC to supply EMILY fuel cells for a total of €1.25M.

management systems, chargers that can tap new sources for renewable energy, wind generators and solar panels, or conduct energy scavenging from used batteries are all considered. Fuel cells converting consumable fuel into electrical energy could also be used for energy replenishment.

Application of Tactical Recharging

When implemented on a large scale, battery recharging becomes a major task for the unit, requiring significant logistical handling and transportation to and from the battlefield.

Supporting non-standard batteries further complicates sustainment and logistics operations, as specific types of batteries have to reach specific users at the front line. Users may have "energy" in stock, but it might be incompatible with their needs. Therefore, streamlining battery usage with fewer and more common types of batteries and matching devices using cable adapters could enable power managers to support non-conformal appliances.

Standard chargers designed for operation in the office are not suitable, nor optimised to sustain the military user in the field. When used in this role, they do so in an improvised and unreliable way. Ruggedised tactical chargers are designed for this purpose. Feeding from an AC generator (20–30 kVA) or a 24V vehicle power output, these ruggedised field systems are designed to recharge different types of batteries in the field.

Tactical charges are suitable to support small-scale operations, but they cannot sustain the full operational tempo of larger units in combat. Moreover, as the number and types of batteries vary, the small forward unit may not have all the equipment and charging capacity to process all the batteries it needs.

Traditionally, systems' original chargers are supporting specific batteries and are often designed to recharge a single battery at a time. These chargers may not be sufficient to support the needs of a combat unit returning from a mission, with 100-200 batteries that need to be recharged simultaneously, to enable the force to return to action.

An example of a technology capable of meeting this requirement is the High-Capacity Universal Charger, developed by Epsilon to provide military users with sustainable recharging capacity. Delivered in multiple 19" racks, these chargers are configured for integration in combat

Maintaining Tactical Energy Autonomy

Most users rely on the tactical grid, generators or vehicle power for battery charging. These sources suffice to process few dozens of batteries at a time, but to ensure continuous operational tempo for tactical units, dedicated equipment should be used. The ultimate goal for Small Unit Power (SUP) initiatives aims to reduce the dependency of combat units on supplied power, by pushing power generation and power management to the tactical edge. The goal is that small units would be able to provide part, if not all of their energy demand by organic resources, thus reaching the coveted state of "Power Autonomy". Another advantage of rechargeable smart batteries is the ability to track power

consumption in the field and match the energy resupply to the actual needs of the forces. Monitoring the power consumption of each device helps with determining where and when resupply is needed. It also allows units to assess the mission endurance of their teams, based on the remaining power available. It also enables logisticians to undertake efficient resupply planning, matching the types of batteries delivered to those that are actually needed the most by the warfighter. It also helps users to optimise the use of batteries, reducing consumption of power-hungry but less critical assets, without increasing combat loads. Modular chargers that support multiple charging of different batteries should be adapted to support a variety of batteries to address growing demand. Using smart chargers incorporating power

EnerSys

EnerSys is an American manufacturer of batteries for multiple applications such as motive power, reserve power, aerospace, and defence. EnerSys operates in over 100 countries worldwide, with 23% of the market share worldwide in 2012 with US\$2.6Bn in revenue. Founded in 1999 and headquartered in Reading, Pennsylvania, US, with regional headquarters in Europe and Asia, EnerSys employs over 9,000 people and operates 32 manufacturing and assembly facilities worldwide. EnerSys traces its corporate roots back to the formation of the Electric Storage Battery Company (ESB) in the late 19th century. The corporate predecessors of EnerSys came out of ESB's industrial battery business. In 2008, EnerSys launched its EcoSafe battery product line, which uses lead, nickel and lithium technologies. This line of batteries was developed for renewable energy storage applications, including solar power, wind power and other electricity-generation alternatives. EnerSys also offers fuel cells and is involved in specialty markets such as aerospace and defense, rail solutions, and the mining industry. More than 38 countries rely on EnerSys batteries for military applications. Additionally, EnerSys owns and operates a number of battery companies, such as Invensys or ENSER. The latter is a manufacturer of molten salt "thermal" batteries used in powering a multitude of electronics, guidance, and other electrical loads on many of today's advanced weapon systems. In 2002, EnerSys acquired Hawker Group, the world's largest lead-acid battery manufacturer.

updated. Monitoring the energy capacity of each battery enables logisticians to assess the entire unit's energy reservoir, as part of the unit's readiness. When the capacity level of specific batteries is no longer sufficient, they are automatically removed from the operational stock.

As chargers become networked, the unit logisticians and higher echelons can assess the energy level of entire combat units, predict replenishment trends and maintain the energy levels of the entire units for optimal energy availability.

Summary

Addressing the exponential increase in demand for electrical energy on the move, new approaches should be considered for the supply and consumption of power to help the military users regain tactical energy autonomy lost in recent years. High-capacity vehicle batteries supporting electric drive and extended silent watch, new sources for renewable and rechargeable energy, wearable power and energy distribution and innovative charging systems are some of the tools offering dramatic improvement in mission effectiveness. ■

vehicles or transportable shelters. Each rack simultaneously processes 400-500 batteries, enabling a complete four-rack assembly to refresh and recharge a full infantry battalion in 24 hours. A rack can be configured to support a specific type

of battery or several models, implementing different charging protocols with individual batteries.

Through the recharging process, battery health and state of charge are checked, and the batteries' operational data are

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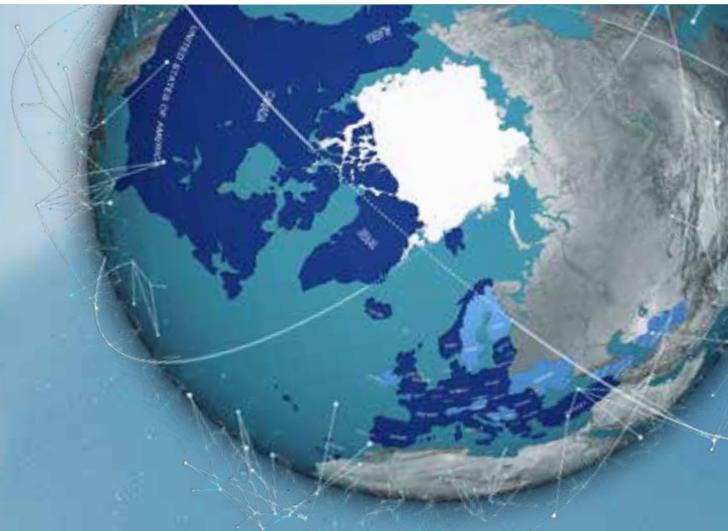
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Border Security: Trends, Technologies, and Markets

Dan Kaszeta

Border protection is a thriving market fuelled by a variety of factors.

A number of technical innovations promise more cost-effective border management.

Nations protect their borders on land, air, and sea. They do so with varying degrees of severity depending on a number of factors. Within the defence and security industry, border security is definitely a major segment. Two intertwined major factors drive major expenditures in the Border Security

market. One factor is perceived threats. Are there new things that are going to be crossing a ground, air, or sea border? Is there a new situation that brings about more traffic in illicit goods or more migrants, both legal and illegal? Has one side of the border become politically unstable, and there is now a flow of refugees? The other factor is change in the regulatory and legal environment, both at the border and inside the country's borders. Is there a new set of laws and regulations changing how things work

at the border, such as a new country acceding to the Schengen agreement in Europe or leaving a trade area? Has the political climate changed, with a new government promising stronger borders? Has a domestic law changed, such that there is more (or less) demand for an illicit good? Conversely, has

than a camera used at a border crossing, nor is an x-ray machine used at a port of entry fundamentally different from one used at the entrance of a courthouse or prison. Likewise, many components of border security such as walls, fencing, vehicle barriers, and the like are often generic and available from myriad vendors. This means that the potential list of suppliers and products in this space is vast and product differentiation may be difficult. A wall is often really just a wall, and the incremental differences between outdoor security cameras can be slight.

A full cross-section of the market, either on a horizontal or vertical basis would consume an entire issue of this magazine. Even then, it would likely be incomplete, as many products are not specifically border security products. However, certain technologies and products are indicative of the broader trends in the market.

Surveillance Technology

Electroptical (EO) surveillance is a complex word that generally just means cameras and lenses. The systems work not just in visible light, but also in "night vision" and thermal/infrared (IR) modes for situations where visible light is inadequate for the task. The broad trend in this area has been to migrate from analogue cameras to digital. Indeed, replacing older analogue camera systems with more modern digital hardware and software has been a boon for the industry, and some of the larger projects have been in the border segment. Border protection camera installations tend to be complex because they need to work in every conceivable weather and lighting condition, and have to be sufficiently rugged to survive abuse. Literally thousands of products are in this segment. One good example is L3 Technology's (USA) NIGHT-HAWK HP EO/IR camera system, which combines visible light, night vision, and thermal vision in a platform designed to survive very rugged environmental conditions.



Photo: Kelvin Hughes

For its SHARPEYE radar, Kelvin Hughes employs both X-band and S-band technology.

at the border, such as a new country acceding to the Schengen agreement in Europe or leaving a trade area? Has the political climate changed, with a new government promising stronger borders? Has a domestic law changed, such that there is more (or less) demand for an illicit good? Conversely, has

a trade agreement been enacted, which allows for much looser arrangements at the border or more border crossings. Many major border security purchases seem to stem from fundamental changes in perceptions of threat or from changes in regulatory and legal environments.

A major axiom of the border security market is that it truly is a segment of the marketplace where the major defence players and the vast industry of traditional physical security manufacturers rub up against each other. At the basic level, border security is actually a large, if specialised, market for traditional physical security products such as barriers, cameras, surveillance devices, access control devices. At the micro-level, a camera used for exterior security at a building is not fundamentally different

Author

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Unmanned Systems

The use of aircraft for border surveillance is not new, nor is the use of unmanned aerial platforms, both powered and static. UAVs can be vastly superior to manned assets for reasons of economy and endurance. Such respected systems as the Thales (France) WATCHKEEPER and the General Atomics (US) PREDATOR system have been used in border surveillance roles. They are certainly not the only players in this game.

Once again, a wide variety of systems designed for military roles have found traction in border patrol applications. Leonardo (Italy) has its FALCO family, which has seen use in North Africa. France's Safran teams with Stemme (Germany) to produce the PATROLLER, which is marketed for border surveillance missions. Not every aerial system is a traditional drone; aerostats (basically, tethered balloons) have long been used along the US-Mexico border as platforms for sensors. The US firm TCOM is a leader in this segment. Lockheed Martin (US) has also had some entries in this space. Unmanned ground vehicles (UGVs) have so far seen less use in this market, but are not unknown. Israeli firms have offered up products in this segment and rumours of Russian UGV systems in border protection have circulated for years. The European Union's FP7 programme evaluated UGVs for border roles in a project called TALOS, which was based in Poland and ran from 2008 to 2012. PIAP (Poland) has sold robotic systems to the Polish Border Guards, although their actual use appears to be more in the counter-IED arena.

Aerial platforms have taken much of the limelight in the sector, but waterborne drones are a growing segment for securing coasts and borders. The ASV division of L3 is one of the industry leaders in this segment, with numerous products with applications in border surveillance. Australia, with its lengthy sea frontiers, has long been mooted as a robust market for maritime drones. Given the sheer number of articles and white papers that are circulating on this subject, the smart money says that Australia is the market to watch in this growing segment.

Contraband Detection

An important component in any border protection scheme is the use of technology to detect illegal, dangerous, or unauthorised items at border crossings. The targets range from drugs and explosives, through illicit cigarettes and alcohol, to

Another manufacturer, Axis (Sweden), is a leader in commercial security cameras around the world. They provide numerous models of camera for this segment. Of potentially greater interest, they are an industry leader in video analytics, which is the art and science of processing and interpreting video images. Using video analytics to make informed decisions is an example of one of the technological fron-

eras into radar systems.

Acoustic and seismic sensors are important in border protection, particularly when tunnelling or breaching of walls is a concern. Sound waves and vibration, caused by activity or movement, can alert border patrols to activity. Such sen-

pushed in the border security sector.

Other forms of surveillance are prevalent in this field as well. Radar systems for air and sea surveillance are effectively identical to their military counterparts. Northern European firms like Kongsberg (Norway), Saab (Sweden), and Patria (Finland) are well established in the "hard" air defence business, which intersects with the border market. However, this market is best analysed in its own right as an air defence segment. Still, the majority of traffic is on the ground. Ground surveillance radar systems have existed for many years and are highly effective

The Thales WATCHKEEPER Remotely Piloted Air System (RPAS)

sors, usually termed "unattended ground sensors" can be planted along frontiers in areas of interest. Indra (Spain) and Quantum Technology Sciences (USA) are but two of a number of manufacturers in this segment.

Cable-based detection systems are not unusual in physical security applications to detect the presence of people, but a buried cable along a lengthy border can be prohibitively expensive to install and maintain. Animals can cause a lot of false alarms with traditional buried cable systems. However,



Photo: Safran

Safran's modular drone PATROLLER is designed to address multiple needs for surveillance and border protection

at detecting people and vehicles at reasonable distances. The UK firm Kelvin Hughes provides good examples of radar systems used in border security roles. Their SHARPEYE family of radars is a useful example of what can be done with ground surveillance radars as well as with integration of cam-

OptaSense, a branch of Qinetiq (UK-US), has an intriguing fibre-optic cable system that can either be buried or put along a wall or fence, and it can detect persons climbing over it. It can detect vehicles or animals, as well as digging or tunnelling efforts.

Photo: Safran



Safran's EUROFLIR 410 NG optronic system for border protection, human flow monitoring, ultra-long-range reconnaissance and sensitive area surveillance

human trafficking. There is a significant crossover in this market space with both the CBRN detection and transportation security markets, as much of the technology is similar. X-ray imaging of baggage and x-ray imaging of cargo containers and rail carriages differs in scale and expense, but not in the underlying technology. Trace detection of narcotics uses technologies not very different from detection of chemical warfare agents or explosives. Radiation detection is very important as well. However, CBRN detection issues have been heavily covered in other issues of this magazine.

Smiths Detection (UK) and Rapiscan (USA) are both market leaders in this complex market place. Smiths has the closest thing to horizontal integration in the detection market, with a product entry in practically every category of the contraband detection space. Rapiscan has similar entries in the x-ray and narcotics trace detection area.

For scanning high-volume cargo, such as cargo containers, Smith Detection's division in Vitry (France) makes high-power x-ray systems such as the HCVT, which are large enough to perform x-ray imaging of rail cars and cargo containers. Leidos (USA) has its VACIS range of products in this space as well. Dozens of

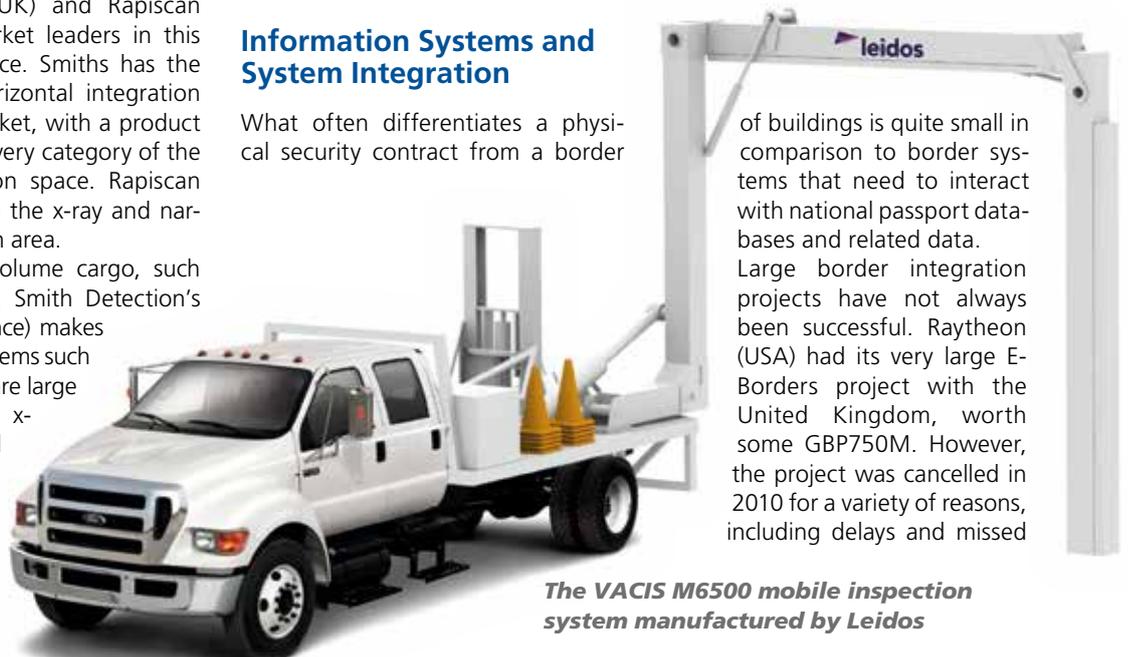
manufacturers make smaller x-ray systems. A similar technology is gamma radiography, which uses radioactive sources to conduct similar imaging. Decision Sciences (USA) approaches the contraband detection and cargo scanning problem with a new technology, Muon tomography. Although the physics are more complex and beyond the scope of this article, Muon tomography shows promise in the detection of hidden items without the use of dangerous x-ray or gamma radiation. The Decision Sciences units are quite expensive; so for now this technology is at the high end of affordability.

Information Systems and System Integration

What often differentiates a physical security contract from a border

protection project is often scale, both in terms of size and complexity. Project management and system integration becomes exponentially more important and difficult in, say, securing a 100 km swathe of Schengen-zone border in Eastern Europe than even the most complex physical security projects for individual buildings. The scope of such projects gives a natural advantage to larger, more sophisticated contractors, often ones who are comfortable operators in the major defence project space. As a practical matter, there is a lot of scope for profit margin in large system integration contracts. Names such as L-3, Lockheed Martin, Raytheon, Saab, and many other usual suspects from the traditional major defence contracting world come up again and again on lists and on press releases for contracts.

Information management is critical to border control projects. The various technologies and products used for border control only really work at their highest potential when they work together. For example, radar, cameras, and seismic sensors work with human patrols and conventional barrier systems to form a whole package of capability. However, such efforts require significant integration and data management. Hundreds or thousands of cameras and sensors must be managed in ways that are useful to the agencies guarding the border. Paperwork for both goods and people must be quickly processed. Border queues are bad for politics and commerce, yet customs duties must be collected, declarations processed, and identity documents scanned. Access control for a building or even a complex



The VACIS M6500 mobile inspection system manufactured by Leidos

Photo: Leidos

targets. Eventually, the UK racked up many millions in legal costs and paid Raytheon over GBP150M in compensation for the cancellation.

A Case Study: Israel and IAI

The nature of the border security market space is easier to understand when one looks at a specific case study. For widely understood geopolitical reasons, Israel is a country that punches above its weight in several different sectors of the defence and security market. For example, cybersecurity is full of Israeli experts, products, and companies. Border security is a sector where Israel has strong requirements, which in turn have driven the development of Israeli companies that produce products and technologies of high quality and great interest. Historically, many countries would not do business with Israel, so self-sufficiency in the defence and security sectors has been in Israel's national interest. Firms like IAI, Elbit, and Magal, among others, are known in the sector.

Israel Aerospace Industries (IAI) is clearly a good example in many ways. IAI exemplifies overall Israeli excellence in the security and defence industries. Additionally, it also shows how a serious defence manufacturer can bring its capabilities to bear in the border protection marketplace. Some of their products marketed towards border protection are representative of the types of activity in this sector. The "Intelligence, Surveillance, and Reconnaissance Vehicle" is a robust mobile surveillance platform, designed for patrolling border segments. It integrates a wide variety of sensors, including radar, electro-optical systems, acoustic gunshot detection, radio direction finding, and the ability to monitor unattended acoustic and seismic sensors. IAI's ELI-3370 is a lightweight electro-optical surveillance system, which a single user can install and operate. Battery operated, this system would be ideal for border sectors where additional coverage is needed during periods of heightened concern. The IAI product line includes a number of maritime products as well. The ELI-3315 is a "Vessel Traffic Management System" which monitors maritime traffic and integrate in with other surveillance systems.

Future Prospects

The world's geopolitics being what they are, there is large potential in this market segment. Large borders always have something in need of repair, replacement or upgrade, particularly as the demands of round-the-clock surveillance in all weather conditions mean that even the most rugged items gradually wear out. Incremental changes in technology can make countries invest in upgrades in existing border infrastructure. The overall switch from analogue to digital CCTV cameras has been a boon for the video surveillance industry, not just in the border segment. New border arrangements, such as those necessitated (although as yet undefined) by Brexit, also require a new security set-up. Large expenditure will be needed at ports in Britain, and something, nobody knows what yet, may be needed in Ireland. Across the ocean, the USA's borders, with Canada, Mexico, and two coasts, will continue to be large drivers of technology and products. This is due to the sheer volume of money expended by American authorities, regardless of the political rhetoric of the day. ■

Disclosure: This correspondent worked for Smiths Detection from 2008 to 2011.

Masthead

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From D to F: Spain to Upgrade its Fleet of 17 CHINOOK Helicopters

Esteban Villarejo

The Spanish Government has approved modernisation of the Spanish Army's key helicopter currently deployed in Iraq.

Spain will upgrade its fleet of 17 CH-47D CHINOOK multi-mission helicopters to the newest version "F" (Foxtrot). They entered service between 1973 and 1987 and have been in the so-called Famet Unit (Army Airmobile Forces) of the Spanish Army for 45 years.

Refurbished Systems

In addition, maintenance costs are to be reduced in the short, medium and long term. It is estimated that the new "F" version requires around 56% less maintenance hours per flight hour.

The agreement between the Spanish Army and Boeing was signed in the framework of a Foreign Military Sale (FMS), and it is expected that the Spanish Army will receive the new F-model CHINOOK between 2021 and 2025.

What is New in the F-Version?

Countries moving from a CH-47D to CH-47F configuration will notice several major advancements. The F-model is the first to feature a Common Avionics Architecture System (CAAS) digital glass cockpit that significantly enhances situational awareness and reduces crew workload.

The new Digital Automatic Flight Control System (DAFCS) is another technological leap forward compared to its predecessor. It provides enhanced stability, safety, and world-class flying qualities that enable aircrews to accomplish missions while taking less risk.

These capabilities include the ability to fly routes "hands off" and the ability to effortlessly hover over a precise spot on the ground even in difficult conditions. Each CH-47F also includes an upgraded, machined airframe that reduces the effects of vibrations and consequently reduces sustainment costs. Additionally, the F-model features the flexible Cargo On/Off Load System (COOLS) for more efficient cargo loading and unloading.

The CH-47F is a twin-engine, tandem rotor, heavy-lift helicopter. It can fly at speeds exceeding 175 mph and carry payloads greater than 21,000 lbs.

"There are two paths that can be taken to deliver these capabilities. One way is for a country to purchase new CH-47Fs which are comprised of all new parts. A country that already operates CH-47Ds can choose to modernise its current fleet, which is the case with Spain. In this process, the aircraft are disassembled and selected parts are recapitalised, cleaned, and inspected so that they achieve a "zero hour" standard.



The CH-47 CHINOOK in the latest "F" configuration

This investment, which has already been approved by the Spanish Government, is part of the new defence cycle launched by the Spanish authorities last year to renew some capabilities of the armed forces after years of budget cuts. A total of 10 new programmes have been approved, amounting to €12.9Bn over the next 15 years, including €819M for the "new CHINOOK".

"This action involves equipping the current helicopters with a new configuration, and it involves the acquisition, renewal and modernisation of the communications and information systems, the ground support equipment, the mission planning and simulation system, as well as training the pilots and mechanics and technical documentation", the Spanish MoD told ESD.

The Spanish Army will refurbish 39 systems of the current D version and deploy them in the new helicopters. For example, the two Honeywell T55-GA-714A engines of each CHINOOK, the gearboxes and the rotor blades are included in the "refurbishment" so as to reduce the price of the modernisation.

The main contractor will of course be Boeing Rotorcraft Systems, whose plant at Ridley Park (22 km from Philadelphia) will be responsible for the work. However, the Spanish technology company Indra will play a role in the production of some units' electronic combat systems, said the same military sources. Indra will also develop a new simulator for training a new generation of pilots of the Spanish Army.

That means, essentially, that the parts are as good as new. Those parts are combined with those elements of the aircraft unique to the F-model configuration, and reassembled", Chuck Dabundo, Boeing vice president of Cargo & Utility Programmes and H-47 CHINOOK programme manager told ES&D.

Each CHINOOK is subjected to the same stringent safety and flight tests, regardless of whether it is a new construction or a modernised CHINOOK. With this modernisation process, military personnel can purchase a standard CH-47F aircraft at reduced acquisition costs and minimised downtime.

Eight NATO Nations

"The CHINOOK is a versatile aircraft flown by eight NATO nations, including Spain," said Chuck Dabundo. "With this contract, Spain's CHINOOK crews will enjoy the platform's current technology and capability, while the country gets an affordable upgrade that builds on its existing CH-47 investment."

According to the US Defence Security Cooperation Agency, the Spanish contract of the 17 CHINOOKS will be completed with 21 Common Missile Warning Systems (CMWS) AN/AAR-57A(V)8 and 42 Embedded GPS Inertial Navigation Systems.

Also included are mission equipment, hardware and services required to implement customer-unique modifications, communication, Aircraft Survivability Equipment (ASE), and navigation equipment including AN/ARC-231 multi-mode radios, AN/ARC-201D SINCGARS radios, AN/ARC-220



Photo: US Army

For many years now, the CHINOOK has been a reliable workhorse.

High Frequency (HF) Radio, Identification – Friend or Foe (IFF), AN/AAR-57A(V)8, and the Radar Signal Detecting Set (RSDS), AN/APR-39A(V)1, special tools and test equipment, ground support equipment, airframe and engine spare parts, technical data, publications, MWO/ECPs, technical assistance, transportation of aircraft and training, and other logistics services and programme support.

So far, more than 450 CH-47Fs have been fielded by armed forces worldwide, including those of the US, Canada, the UK, Turkey, Australia, and the UAE. Spain, India, Singapore, Saudi Arabia, and The Netherlands will field the CH-47F within the next few years.

In 2017, Boeing and the US Army announced the development of a CH-47F

Block II, which will incorporate a new rotor blade, a redesigned fuel system, an improved drivetrain and structural improvements to the fuselage.

Why is the CHINOOK important for Spain?

Militarily, the Spanish Army CHINOOKS had their first mission outside Spain in the Kurdish areas of Iraq in a humanitarian mission aimed at alleviating the suffering of the civilian population gassed with chemical weapons by Saddam Hussein's regime in 1991.

Since then, many scenarios have required the presence of the Spanish CHINOOK unit, such as the mission in the Balkans in the 1990s. Another highlight was the deployment to Afghanistan from 2007 until the Spanish withdrawal in 2013, which posed quite a challenge to the pilots and crews of the Famet unit and maintenance personnel because of the risky environment.

The current presence of the Spanish CHINOOKS in Baghdad as part of the international coalition against Daesh terror shows how important this capability is for the Spanish armed forces. The three helicopters are integrated with the US Army CHINOOKS.

Another milestone has been the assistance to the civilian population affected by emergencies and disasters, which has been quite substantial, as demonstrated during the floods in the Basque Country and on the east coast in the 1980s and the intervention to clean up hard-to-reach areas on the Galician coast following the PRESTIGE oil spill. The list of assistance for such operations is long. ■



Photo: Boeing

The Spanish CHINOOK will be upgraded at Boeing Rotorcraft Systems' Ridley Park plant near Philadelphia.

“There is nothing better than the CHINOOK”



Photo: FAMET

General Juan Carlos González Díez

Interview with Juan Carlos González Díez, General of the Army Airmobile Forces of the Spanish Army, FAMET

intensity war operations to less demanding ones. In military terms, it is particularly useful in counter-insurgency operations and when it is integrated into special operations by specially trained crews.

ESD: What kind of missions have the Spanish CHINOOK helicopters been employed in?

Díez: Due to its versatility and load carrying capacity (10 tonnes), this helicopter is well suited not only for purely military missions but also for use in catastrophes when all civilian helicopters have exhausted their ability to provide assistance in extreme situations (fires, floods or extreme nuclear or biological emergencies). And we discover new possibilities every day: For example, after the last Ebola crackdown, CHINOOK helicopters, together with the medical services of the Army's Health Brigade, developed a medical air-conditioning procedure under biosafety conditions. The procedure is the only one of its kind in Spain and it considerably minimizes the risk of infection.

ESD: Why is its modernisation necessary?

Díez: As I mentioned earlier, our fleet entered service in 1973. Gradually we were able to field 17 aircraft. All of them were modernised in the 1990s and converted to the Delta version and standardised. Right now this helicopter must be upgraded in order to extend its service life for some decades in line with the new military standard (the Foxtrot version compliant with our NATO allies).

On the other hand, if we wouldn't do the upgrade, certain critical elements of our model CH-47D would become obsolete, which would mean that we would have to adopt alternative, much more expensive solutions very soon.

ESD: What will this modernisation consist of?

Díez: In short, it is about saving costs by integrating new, very expensive elements of the current fleet such as engines, dynamic

elements and a long list of main components into the new helicopters.

The new helicopter will be virtually indistinguishable from the current one, but will have a new composite cell and a new avionics system. The CH-47F version will be able to operate more safely and efficiently in any operating theatre and will also have an optimised maintenance system, which we expect to deliver significant savings over the entire life cycle.

ESD: When is the helicopter scheduled for delivery?

Díez: We are planning to receive the first of the CH-47F helicopters at the end of 2021 and then receive all 17 helicopters in four consecutive years.

ESD: What about the training period of the pilots?

Díez: It should be based on the experience we gained during the commissioning of TIGER and NH-90 helicopters. The initial aim is to qualify our prospective trainers in the US — a small and select group of pilots and maintenance specialists, capable of assuming critical roles such as pilot instructors, test pilots and technical inspectors. After this first group has been trained, the remaining pilots and mechanics will be trained in Spain, which would be the most cost-effective solution.

ESD: Is a modernisation of the simulators also necessary?

Díez: Yes, we want that as soon as possible, because we have to fly helicopters of both versions for four years. In addition, the cabin of the new "Foxtrot" model is fully digitalized, so a flight simulator will be a great help.

ESD: How long will the CH-47F CHINOOK operational life be?

Díez: We estimate that the useful life extends between 2040 and 2050. Considering that the Chinook CH-47A entered service in 1962, this could be the first example of a military aircraft whose revolutionary design and reliability has been in service for as long as 100 years. For the moment, there is simply nothing better than the CHINOOK.

The interview was conducted by Esteban Villarejos.



Photo: EJERCITO DE TIERRA

The Spanish Army's Health Brigade developed a medical air-conditioning procedure under biosafety conditions for the CHINOOK.

Tactical Navigation

Tamir Eshel

Determining one's own position and that of the enemy has always been a complex process reserved for experts. The information age revolutionised the world of navigation by introducing global satellite navigation.

The technologies that have connected our lives and shrunk our world into a 'global village' also revolutionise our military. Our world is dependent on Global Navigation Satellite Systems (GNSS) for localisation, navigation and essential timing for wireless communications, information synchronisation, and encryption, man-to-machine and machine-to-machine connectivity.

Defined by cutting edge technology, spectrum dominance and cyber warfare, PNT remains a critical aspect of command and control, and failure could determine victory or defeat in battle.

Determination of your own position and the location of the enemy has always been a complex procedure reserved for experts. Surveyors charting faraway lands provided strategic geographic insight and mapping

The introduction of radio communications in the 20th century enabled users equipped with mobile receivers to use known radio signals as lighthouses or beacons, charting their way at sea or in the sky. Similar techniques were also used to determine your own position based on angle measurement to celestial objects. While those position location systems were used to establish the point of origin, inertial navigation systems (INS) were used to keep the vehicle moving at a straight line or plot a set of manoeuvres to get to a destination. Heavy, complex and expensive, these systems were suitable mostly for large platforms such as battleships or large aircraft. Inertial navigation made possible many of the great spaceflight achievements such as the APOLLO programme. Land navigation had to deal with the map and compass for few more decades.

The information age, particularly the introduction of global navigation satellite systems (GNSS), such as the Global Positioning System (GPS) in the mid-1980s revolutionised the world of navigation as it enabled the military user to localise the own position at high accuracy.

Inertial Navigation

Inertial Measurement Units (IMU) consist of different sensor assemblies comprised of three gyros and three accelerometers. Such an apparatus can use a setup of mechanical gyros, close-loop ring-laser gyro or fibre-optical gyro assemblies (FOG) as sensors. An Inertial Navigation System (INS) relies on such IMUs to track the position, velocity, and orientation of an object relative to a starting point. Measurement errors are accumulated over time reflected in the system's position error of "drift".

Inertial systems with the lowest drift, referred to as "navigation grade", deliver position accuracy with an average error rate of 1.6 km/h. Navigation precision can be improved by position updates from complementary sensors, such as celestial measurement or radio navigation. Future navigation systems could also employ quantum



Photo: US Army

Position, Navigation and Timing (PNT) are essential for military command and control.

The military establishment sees "Position, Navigation and Timing" (PNT) as essential for military command and control as it includes the ability to know where you are and where your target is (position), plot and follow a path that will take you to your destination (navigate) and synchronise actions to achieve the desired effect (Timing). Although today's PNT is far removed from the military drills and disciplines of the past, it still has the same effect on the battlefield.

for battle planning. Recruited from local elements, scouts often provided essential insight for commanders, in planning manoeuvres or exploiting seasonal changes and terrain features. Knowledge of the land also enabled leaders to select the most advantageous time and location for a battle. Despite the importance of geographic orientation, the means of localisation remained unchanged through the years, relying on pedometric distance measurement (step counting), celestial observation, lighthouses, or sun dials for navigation and timekeeping. The modern age introduced the sextant, magnetic compass and chronograph — sophisticated navigation aids that were the 'gadgets' of their time.

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technology that promises to dramatically minimise drift and increase accuracy. Due to their high costs, inertial sensing technology was reserved for high-end aerospace applications. Compact IMUs employ FOG that often come in small pucks, optimised for integration in missiles, drones and combat vehicles, providing extended operation in GPS-denied area.

In recent years IMUs were miniaturised through the use of Micro Electro-Mechanical Systems technology (MEMS). These elements enable the creation of low-cost, chip level inertial sensors that have gradually improved in accuracy to become an alternative to mechanical inertial sensors. MEMS often provide Tactical grade navigation, with drifts of 19 km/h, (or 5.3 metres per minute); therefore they are useful in short range applications, where integration with reference sensors, such as GPS, frequently updates their location, thus minimising drift over a long travel.

Combined with other sensors, or enhanced by accuracy augmenting filters and algorithms, miniaturised IMUs provide the core for navigation systems that are embedded in weapons, guided munitions, observation systems or combat vehicles. They provide effective positioning, weapon orientation, and, when coupled with laser rangefinders, deliver precise location of enemy targets.

Global Navigation Satellites Systems (GNSS)

GPS is provided as a service managed by the US Government since the 1980s. Officially, the accuracy of the system measured by User Location Error (URE) is equal to or better than 7.8. However, as performance exceeds the system spec, the average measured URE was a tenth of that level (0.715 m) in 2016. During the 1990s, GPS employed a feature called Selective Availability that intentionally degraded civilian accuracy on a global basis.



Photo: Lockheed Martin

In December 2018, the US Air Force and Lockheed Martin launched the first GPS III satellite, which delivers three times better accuracy than earlier systems.

Since the year 2000 selective availability was cancelled in order to make GPS more responsive to civil and commercial users. Today, both civilian and military users get the same accuracy, but military GPS receivers often use two satellite frequencies P(Y) code to gain a stable and reliable signal.

Other constellations offering GNSS are the Russian GLONASS, the Chinese BEIDOU and the European GALILEO. The GALILEO constellation has been deployed since 2011 and currently counts 26 satellites, with a goal of 30. By 2020 the GALILEO is expected to become fully operational with 24 satellites orbiting in space, delivering

one-metre accuracy on its public (free) access and up to centimetre level navigational accuracy with encrypted service. The GLO-NASS network is comprised of 24 satellites orbiting in medium earth orbit (MEO), providing an accuracy level of 2.8 – 7.8 metres. The Russian system also has an encrypted channel that supports higher accuracy, but its accuracy level has not been disclosed. The Chinese BEIDOU constellation is growing and expected to reach 30 satellites by 2020, extending coverage beyond Southeast Asia. The new satellites support a signal in space accuracy of 0.5 metre, compared to 2.5 - 5 metres provided by the BEIDOU-2 satellites. US intelligence sources claim the Chinese network also supports an encrypted mode enabling much higher precision in the 10-centimetre range.

Sensor's STIM300 is an ITAR-free IMU and features three gyros, three accelerometers and three inclinometers. It is suited for a variety of applications, including UAVs, man and vehicle portable target acquisition systems, land navigations systems, turret stabilisation, missile stability and navigation, and mortar aiming systems.

Photo: Sensor

Dealing with Navigation Warfare

Despite its great advantage GNSS has serious weaknesses, particularly to the military user. Primarily, the signals received by users on earth are extremely weak – the strength of an average GPS signal is about 1/10,000 of a cellphone signal. As such, it is vulnerable to natural interference such as sunspots, and unintentional or deliberate man-made interference. A simple jammer that transmits a signal at a strength of 1

watt can jam and disable GNSS receivers within a radius of 40 km. Beside jamming and interference, GNSS is also vulnerable to deception. Misleading the targeted receiver to develop a navigational error without the user's awareness is a method also known as 'spoofing'.

ding to NovAtel, GAJT offers an interference suppression of 40 dB which enables users to overcome jammers 100 times closer to a jammer than without protection. Raytheon was selected by the US Air Force Research Lab (AFRL) to develop an affordable, small, anti-jam GPS receiver using frequency spatial time adaptive processing (FSTAP). The system dubbed Advanced GPS Inertial Navigation Technology (AGINT) has a multi-element RF front end, digital adaptive A/J filter, and SAASM GPS receiver. The study demonstrated the capability to suppress a jamming signal by 120 dB, engaging multiple broadband and narrowband jammers, using beam steering to receive four separate GPS satellites.

IAI and Honeywell also offer GPS-AJ capabilities based on IAI's ADA system. Under a teaming agreement with IAI, Honeywell intends to integrate ADA in its navigation products, including Honeywell's Global Positioning System/Inertial Navigation System (EGI), providing the system with a robust countermeasure against GPS interruption. GSTAR is another GPS-AJ system developed by Lockheed Martin. In addition to maintaining 'Deep Nulls' to mitigate the jamming signal, GSTAR also uses beamforming to improve antenna gain at the satellite's directions.

New generations of hardware are employed to bolster the GPS space segment. On 23 December 2018, the US Air Force and Lockheed Martin launched the first GPS III satellite, which delivers three times better accuracy and up to eight times improved anti-jamming capabilities. Lockheed Martin is on contract to build 10 such satellites.

The first experimental Timing & Inertial Measurement Unit (TIMU) chip had a size of 10 millimetres.

Various measures are used to counter navigation warfare threats and to protect the space segment (satellite, payload and signal) and the ground segment, for example to prevent unwanted interference and to protect the receiver and receiving antennas. Since most jammers are employed at ground level or at lower angles, such a method enables continued reception of satellite signals, while nulling the jamming signal.

Raytheon's LANDSHIELD is one such countermeasure offering GPS Anti-Jam (AJ) capability. LANDSHIELD uses a multi-element antenna and an anti-jam processing unit that replaces existing unprotected GPS antennas. The system works against a full range of hostile jammers, including narrowband, broadband, continuous wave pulse, swept and spectrally matched, and it can protect L1 and L2 GPS frequencies simultaneously.

Another solution dealing with GPS jamming are Controlled Reception Pattern Antennas (CRPA) – dynamic anti-jam antennae assemblies, such as the GAJT from NovAtel and QinetiQ, Lockheed Martin's GSTAR, or ADA from IAI. These systems dynamically change the antenna gain pattern to create nulls in the direction of the interfering signals. Accord-

The spacecraft life will extend to 15 years, 25% longer than the newest GPS satellites on-orbit today.

A major component of the GPS modernisation is the introduction of a new military signal called Military Code (M-code). It is designed to further improve anti-jamming

and secure access of military GPS signals. The latest generation GPS Block III satellites have added an M-code to their service. With energy spread in multiple lobes away from the centre, M-code receivers better handle interference and jamming, even in instances where C/A code is jammed by friendly or adversary action. Such 'blue on blue jamming' is not possible with the current P(Y) code receivers. The new code also enables GPS operators to increase the signal intensity in a specific region, using powerful 'spot beams', delivering signal power increase of up to 20dB. This means that, in each conflict region, military GPS receivers should be able to benefit from a large increase in jamming resistance.

Lack of GNSS coverage is also evident in complex terrain, where signals are disrupted or unavailable, such as inside buildings, underground, in forests, or in 'urban canyons', where signals from satellites may be obscured or reflected from nearby buildings, providing false readings on navigation systems (multipath effect). Advanced receivers are designed to overcome some of these limitations by tapping multiple satellites and multiple frequencies and using advanced algorithms to mitigate position errors.

Platform-Based PNT

GPS data is not only used to provide location and mapping information; they also deliver critical timing information used for mission synchronisation, encryption and digital interfaces. Lack of timing signals will result in multiple system failures. Some systems incorporate integral GPS to ensure timing and synchronisation for

uninterrupted service, but such service is jeopardised by hostile jamming, regardless of the alternative position location or navigation systems available on board. To compensate for the loss of GPS data system designers offer centralised PNT data generated on board. Such devices include Ground-Based GPS Receiver Application Module (GB-GRAM), INS, Chip Scale Atomic Clock

(CSAC), and other PNT services that provide assured PNT to the warfighter regardless of the availability of GNSS. Such systems are offered as dedicated assets or applications that run on COTS vetronic units that may already be installed on the platform. The US vehicle electronic architecture (VICTORY)

Photo: DARPA



Photo: Curtiss Wright

According to Curtiss Wright, the DBH 672 BEACHHEAD is an Assured Position, Navigation & Timing (A-PNT) solution.

supports such applications that enable multiple users on board to share central PNT resources over the vehicular network.

Dismounted Navigation Aids

Personal navigation aids developed for combat use are providing soldiers the navigation services they have grown accustomed to in daily life, sustaining navigation and position inside buildings, underground or in GPS-denied environment. These solutions are similar to those implemented on missiles, aircraft or tanks, but are miniaturised to fit the soldiers' needs.

The sensor made by Raytheon UK uses a boot strapped puck that contains a GNSS location engine combined with IMU and a barometer to provide location information even in GPS-denied environments.

A more versatile system called DCCS developed by Roke Manor and QinetiQ adds visual navigation sensors to the kit. Taking the last known GPS location as a reference it integrates information from visually tracked features captured by a helmet mounted camera and inertial sensors to track the location of an individual inside a building or in a tunnel. The integrated visual navigation system uses algorithms that continuously processes GPS location data and understand when such information can or cannot be trusted. When a bogus GPS is detected the system smoothly transitions to other navigation sources. Additional sensors such as a laser weapon orientation indicator, acoustic gunshot detection, or health monitoring sensors (heartbeat, temperature etc.) can be integrated to turn such soldier systems' navigation into wearable information suits.

Adaptable Navigation Systems

Due to its susceptible nature, relying only on GPS for location and navigation is considered too risky for military use. In fact, some services regard it impractical for precision guidance of weaponry, and always require a supporting sensor to determine position data. However, at present there is no substitute to this navigation technology. Searching for an alternative the US military explored Adaptable Navigation Systems (ANS) to provide GPS-quality PNT, regardless of the operational environment. Under this research the Defense Advanced Research Agency (DARPA) pursued several options for future navigation systems. One of the new concepts include Precision Inertial Navigation Systems (PINS) that require fewer position fixes, to generate high accuracy navigation, thus overcome GPS jamming,

errors and deception. PINS implement innovative inertial sensors that include cold-atom interferometry – a method measuring the relative acceleration and rotation of a cloud of atoms within a sensor case, potentially offering far greater accuracy than today's state-of-the-art IMUs.

Along with the miniaturisation process IMUs also integrate timing functions under the Timing & Inertial Measurement Unit (TIMU) initiative, to deliver a complete navigation unit on a chip. The first experimental TIMU chip developed under this DARPA

An example for an ASPN is the Navigation Fusion Module designed by Rockwell Collins and Integrated Solutions for Systems (IS4S). By blending selectable sets of complementary sensors, the system provides accurate navigation across a wide range of threat environments. According to the developers, the system was designed with ASPN interface to enable future integration with new sensors.

ASPN technologies can also integrate sensors from different disciplines, for example, couple inertial and vision systems to provide

Photo: US Army



GPS data is used to provide location and mapping information.

research in 2013 came in a 10 cubic millimetre package. Other improvements in the chip level use Chip-Scale Self-Calibrating MEMS as a method to conduct periodic error corrections, reducing drift and temperature variations in MEMS based devices. A different approach to navigation in GPS denied environment is the utilisation of advanced waveforms that defeat adversary strategies to detect and disrupt friendly signals. Such a method was recently demonstrated by CTSi and L3 Technologies as part of the Enhanced Link Navigation System (ELNS) as means to navigate all types of unmanned aircraft in GPS-denied airspace.

Vision-Aided PNT

Future navigation systems could be very different from the systems used today. In fact, PNT will use as many sources of information as possible to tap the necessary information. To acquiring position fix the 'All Source Positioning and Navigation' (ASPN) approach is evolving, a method that correlates data from signals of opportunity, such as broadcast TV, radio and satellite signals to obtain a position fix, when GPS is unavailable or suspected to deliver an error.

accurate navigation. One of the advantages of Vision-Aided PNT is the ability to harness sensors and processing power available on the platform. Leidos has recently demonstrated such a solution that took live sensor images from a drone camera and processed it on board. The process compared live images to a database of satellite images to provide INS-compatible position location in the absence of GPS signals.

This method combines visual interpretation of the camera view with motion sensing from the IMU to deliver navigational information. By correlating the IMU against a flow of visual images anchored to specific points such as corners, patterns and landscape features, the system can determine orientation and position to minimise MEMS' IMU drift. In a recent experiment, such a vision-aided PNT was developed for the Office of the Secretary of Defense using the SCORPION fusion software.

Through this article we highlighted some of the trends and technologies associated with Position, Navigation and Timing. These technological means automated PNT and have revolutionised warfare in the recent decades. That revolution continues today at an ever-faster pace. ■

Air-Delivered Munitions Become Smaller and Smarter

Doug Richardson

On 1 November 1911, an Italian aircraft dropped four hand grenades on a Turkish Army position. This incident during the 1911-12 Tripolitan War fought between Italy and Turkey has no recorded effect on that long-forgotten conflict, but it was the first time that an aircraft had bombed a ground target. A century later, 31 October 2011 was the final day of operation “Unified Protector” against regime forces in Libya, the first bombing campaign to have been fought entirely using Precision-Guided Munitions (PGMs).

Total reliance on PGMs was a logical development given the growing use of “smart” weapons in recent conflicts. For example, although PGMs made up only 6% of the munitions that the US services expended during operation “Desert Storm” against Iraq in 1991, by the time of operation “Allied Force” against former Yugoslavia in 1999, this portion had risen to 29%. During operation “Enduring Freedom” against Al Qaeda and Taliban forces in Afghanistan between 2001 and 2014, 57% of the munitions expended were PGMs.

Today, a wide range of PGMs is available, and the number of countries and manufacturers who offer these weapons has never been larger. But many are weapons that use a single guidance mode to deliver an explosive payload weighing 250 kg or more, and so show little advance over earlier designs. However, a study of currently available products will show two interesting technological trends that are creating more tactically useful weapons. The first is the use of smaller explosive payloads in order to reduce collateral damage. The second is the growing use of multimode guidance systems that offer greater tactical flexibility.

As the demand for lighter-weight PGMs increases, some manufacturers are offering suitable designs as variants of their existing product range. For example, Boeing's Joint Direct Attack Munition (JDAM)

series of PGMs includes the GBU-38 and JDAM-ER, which weigh 254 kg and 226 kg, respectively, and are based on the MK 82 bomb. Greece's Ordtech Military Industries' SEIRINA PGM family includes an SGM 500 variant with a total weight of only 269 kg. While JDAM uses an inertial navigation system (INS) aided by a GPS satnav receiver,

electronic safety and arming device (ESAD), a height of burst (HOB) sensor, impact sensor, plus control and power subsystems. Launch weight is a mere 4.9 kg, and after a flight of up to 4 km, the weapon is expected to reach its target with a CEP of 10 m. First shown in 2013, Roketsan's MAM-L reuses much of the hardware from the com-



Photo: Doug Richardson

Roketsan created the unpowered MAM-L PGM (seen here alongside the MAM-C guided rocket) by reusing major subassemblies from its L-UMTAS (L-MIZAK-U) anti-tank missile.

some manufacturers such as Ordtech offer satnav subsystems that can operate with the Russian GLONASS satellites.

General Dynamics Ordnance and Tactical Systems (GDOTS) developed its Air-Dropped Guided Mortar (ADM) as a lightweight PGM for use from UAVs. As its name suggests, the weapon is based on the hardware of the standard 81mm mortar bomb, but adds a nose-mounted guidance system and a custom-designed tail section. The guidance system screws into the projectile's nose in place of the normal fuse. It contains a GPS-based Guidance Navigation and Control (GNC) system, an

pany's L-UMTAS (L-MIZAK-U) anti-tank missile, but omits the solid-propellant rocket motor of the latter weapon. It weighs 22 kg at launch and uses SAL guidance to deliver a blast-fragmentation, penetration, or tandem shaped-charge warhead to a range of up to 8 km. Tubitak SAGE's BOZOK semi-active laser (SAL)-guided munition is similar in concept to the MAM-L, but weighs only 16 kg. Intended for use from helicopters or UAVs, it has a maximum range of 9 km.

Russia has been slow to develop and field lighter PGMs. The smallest PGM offered by a Russian manufacturer is probably the

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Region JSC's KAB-250, which weighs 256 kg. Two versions are being offered for export: the SAL-guided KAB-250LG-E and the satnav-guided KAB-250S-E.

Early members of China's FEI TENG (FT) series of PGMs used GPS-aided inertial guidance to deliver 450 kg-class warheads, but these have now been supplemented by lighter weapons. The FT-3, -3A, and -6 are based on 200-225 kg warheads. Development of the 20 km-range FT-3 seems to have been protracted, with several changes in design between the first (shown in 2006) and what was probably the definitive version (shown in 2012). While the FT-3 used GPS-aided inertial guidance and had a CEP of about 20 m, the follow-on FT-3A uses a TV and imaging infrared (IIR) seeker that gives a CEP of less than 3 m. The FT-6 is based on the FT-3, but has a wing kit that extends its range to as much as 80 km, while the FT-3A has both the wing kit and a passive anti-radiation seeker. While the GPS/INS-guided FT-5 was originally planned as a 500 kg-class weapon, by 2010 it had been redesigned to become a 75 kg-class system with a 35 kg warhead.

During the 1999 Kosovo campaign, bad weather and heavy cloud created problems for SAL-guided weapons, and spurred the development of dual-mode weapons which combined SAL with GPS guidance. Given clear weather, these would rely on SAL guidance for maximum accuracy, but they could revert to GPS guidance in poor weather conditions.

Photo: UK Royal Air Force



Test drop of Raytheon's PAVEWAY IV from a Royal Air Force Lockheed Martin F-35B

In August 2000, the UK Ministry of Defence selected Raytheon's Enhanced PAVEWAY bomb to meet an Urgent Operational Requirement (UOR) for an Interim Precision-Guided Bomb (IPGB) capable of carrying out all-weather day/night attacks. The weapon used a combination of GPS, INS and SAL guidance, and it demonstrated a miss distance of 6 ft (roughly 1.8 m) during Royal Air Force trials.

In the summer of 2003, the UK selected Raytheon's PAVEWAY IV to meet a follow-on Precision-Guided Bomb (PGB) requirement. As originally ordered, the weapon

would have used second-generation GPS-aided inertial navigation incorporating anti-spoofing and anti-jamming technology, but the company was quick to point out that the addition of SAL guidance would add only some 10-15% to the unit cost of the weapon. By 2005, Raytheon was able to offer the additional SAL guidance mode at no additional cost to the original contract price, and this was accepted by the UK.

In some cases, dual-mode guidance is offered as an option for a weapon initially fielded with a single guidance system. The standard version of the GRIFFIN 3 Next-Generation Laser-Guided Bomb (NGLGB) developed by IAI uses SAL guidance, but can be provided in a version fitted with dual-mode guidance in which the normal seeker is supplemented by a GPS guidance subsystem.

Inevitably, dual-mode weapons are following the same trend towards lightness that we have seen with single-mode designs. In 2010, US Special Operations Command (USSOCOM) and Raytheon revealed the GRIFFIN, a lightweight INS/GPS-guided weapon incorporating SAL terminal homing. This had drawn on Raytheon's earlier ARCHER project, which had combined the rear section and rocket motor of the JAVELIN missile with the INS/GPS guidance from Raytheon's Extended Range Guided Munition (ERGM) 5-inch naval shell and anSAL seeker.

Four variants of GRIFFIN had been developed – the AGM-176 GRIFFIN A designed for aft-eject launch by aircraft like the MC-130W, the AGM-176B GRIFFIN B tube-launched forward-firing missile intended for use by UAVs, helicopters or ground vehicles, the AGM-176C GRIFFIN C, and the AGM-176C-ER GRIFFIN C-ER. The A and B version use INS

Photo: Doug Richardson



GBU-44IB VIPER STRIKE weighs 20 kg and can be released from UAVs or from fixed-wing aircraft such as the US Marine Corps' KC-130J HARVEST HAWK. It combines GPS midcourse guidance and SAL terminal homing.

+ SAL guidance, but the C and C-ER models introduced a dual-mode IR/SAL seeker and a data link. All versions carry a 5.9 kg blast-fragmentation warhead and are powered by a solid-propellant rocket motor. For the A, B and C versions, this gives the weapon a maximum range of 6 km, but the C-ER version has a motor of increased size, which boosts the range to a maximum of 23 km. Originally developed by Northrop Grumman, but now an MBDA product, the GBU-44/B VIPER STRIKE and GBU-44/E VIPER-E are classic lightweight PGMs. They weigh 20 kg and 19 kg, respectively, and are suitable for use from UAVs or from the Derringer Door launcher developed for the USMC's KC-130J HARVEST HAWK. This modified version of the aircraft's rear paradrop door allows munitions such as VIPER STRIKE to be released without having to depressurise the aircraft and open the rear ramp.

After release, the weapon is able to glide for ranges of up to 10 km, then use its GPS-aided INS and SAL seeker to attack targets with its shaped charge warhead (in the case of the -44/B) or with the 1.05 kg tandem shaped-charge warhead carried by the -44/E version. A follow-on VIPER-E II optimised for use against moving land and sea-based threats has been reported. Textron Systems' Guided Clean Area Weapon (G-CLAW) has been reported in versions weighing 23 kg and 34 kg respectively. A small solid-propellant rocket motor gives a maximum range of 19 km. Guidance is by means of GPS-aided INS and a Selex ES SAL seeker giving a CEP of 5 m. Intended for use against urban targets, Lockheed Martin's Small Container Area Laser Precision Energetic Load (SCALPEL) is based on the company's Enhanced Laser Guided Training Round (E-LGTR). The lat-



The Armement Air-Sol Modulaire (AASM) 250 HAMMER is one of the lighter-weight versions of this Safran Electronics & Defense modular PGM.

ter has no warhead, but the SCALPEL configuration adds a small blast-fragmentation or kinetic warhead and a higher-accuracy version of the SAL guidance system used in the PAVEWAY II laser-guided bomb. An alternative SCALPEL+ variant uses GPS guidance. Both weigh 45 kg and have a maximum range of 9 km. Lockheed Martin's SCORPION is a small winged glide weapon with a launch weight of 10 kg and a range of more than 18 km. Terminal guidance is by SAL, but the use of GPS, IIR, and millimetre-wave subsystems has also been reported.

Lockheed Martin is currently developing the PARAGON Dual-Mode Plus in versions based on MK 82, MK 83, and MK 84 bombs. These combine the SAL seeker from the PAVEWAY II Plus with an INS/GPS guidance package. For all-weather operations, the bomb can work in INS/GPS mode, but

dual-mode INS/GPS+SAL operation is available for attacks mounted against moving targets, while the SAL-only mode can be used in GPS-denied environments. In 2013, Thales UK teamed with Textron to offer the FURY, an unpowered 5.8 kg munition that is based on the UK company's Lightweight Multirole Missile (LMM). Thales UK saw the potential need for what it called the FREEFALL LMM (FFLMM) derivative of the LMM, and joined forces with Textron to jointly offer a weapon of this type for the US and export markets. The resulting weapon is 0.7 m long and retains the 76 mm diameter of the LMM. It weighs 5.8 kg and carries a 2 kg payload that combines a shaped-charge penetrator and pre-fragmented blast warhead with a proximity fuse. A custom-designed INS is teamed with GPS, with an uncooled SAL seeker being used for terminal homing. After release from a UAV, FURY and its derivatives are expected to have a maximum range of 4.5 km, and a CEP of 1 m.

Developed by SAGEM (now Safran Electronics & Defense), the Armement Air-Sol Modulaire (AASM) – now being marketed as the HAMMER – is available in a range of configurations that incorporate 125, 250, 500 or 1,000 kg bomb bodies, and with single-mode or dual-mode guidance. All are powered by a solid-propellant rocket that gives a maximum range of more than 50 km. A range of guidance kits are offered – INS/GPS, INS/GPS + IR, and INS/GPS + SAL, and the designation of the complete weapon indicates the type of guidance used. Weighing only 115 kg at launch, IAI's Medium-Weight Laser Guided Bomb (MLGB) uses a combination of SAL and GPS guidance to deliver a 92 kg warhead. When initially flying under GPS guidance, then transition-



IAI's Medium-Weight Laser Guided Bomb (MLGB) can initially fly under GPS guidance, then transition to SAL mode for the final attack.

ing to SAL mode, it has a maximum range of 20 km or more, but if the laser designation is being done by the launch aircraft, the resulting SAL-mode attack has a maximum range of 10 km. The CEP produced by the SAL seeker is only 1 m.

China's LEI SHI-6 (LS-6) series offers a range of configurations, with the final suffix of the designation indicating the weight (in kilogrammes) of the explosive payload. The LS-6-500 and -250 have a maximum range of 60 km when released at high altitude, and are based on GPS/INS guidance, while

the USAF awarded Small Diameter Bomb (SDB) Increment II risk-reduction contracts each worth more than US\$145M to a team consisting of Boeing and Lockheed Martin, and a team headed by Raytheon. While the GBU-39 SDB weighs more than 600 kg and carries a warhead with a 93 kg explosive filling, the GBU-53/B SDB II (later to be formally designated as STORMBREAKER) was intended to deal with classes of target that would not be hardened, so could make do with a smaller and lighter warhead with a 43 kg explosive fill.

names suggest, these are based on 2,000 lb-class and 1,000 lb-class explosive payloads, respectively. Both were designed to attack fixed targets, but the lightweight SPICE 250 can also be used against mobile land-based threats and maritime targets.

According to Rafael, the on-board INS/GPS subsystem is accurate enough to get the weapon to the target zone, even if GPS is being jammed. Once closer to the target, imagery from its seeker is compared with mission reference data stored in the weapon's computer memory. The use of a dual-mode (IIR and CCD) seeker gives the weapon a day and night capability, and Rafael estimates that the probability of target acquisition is 95%. SPICE 250 then homes autonomously to its target, arriving from the pre-planned direction and striking at the desired impact angle with a circular error probable that the company claims is less than 3 m. The warhead accounts for 80% of the total munition weight, and penetration, general-purpose, and multi-effect payloads are planned. The company is known to have considered adding yet another guidance mode. This would probably add a semi-active laser mode rather than a STORMBREAKER-style millimetre-wave radar.

Russia's military intervention in Syria in support of the Assad regime started in September 2015, but it has seen only a small-scale use of PGMs. Although Russian officials have boasted that the Syrian campaign has involved combat tests of over 200 new types of weapon, including satnav-guided munitions, most attacks still seem to be made using free-fall unguided bombs. In practice, only around 5% of the expended munitions are thought to be PGMs.

Some Russian commentators have suggested that the latest generation of C4ISR systems have raised the effectiveness of unguided munitions to a level comparable to that of PGMs. Claims have also been made that the SVP-24 GEFEST digital navigation and weapon-aiming system installed on the modernised Su-24s and Su-25s being used in Syria gives unguided bombs an accuracy comparable to that of PGMs. The SVP-24 uses a military-grade GLONASS satnav to measure aircraft position and velocity, then uses this information to automatically release weapons against ground targets whose ground coordinates were accurately known. Claims in the Russian press that the SVP-24 delivers unguided ordnance with an accuracy similar to that obtained from PGMs must be viewed with scepticism. There is no easy or inexpensive route to high accuracy – if you want to land warheads accurately on target, there is no substitute for a PGM. ■



Photo: Raytheon

To date, Raytheon's GBU-53B STORMBREAKER is the most sophisticated PGM on the market, combining imaging infrared (IIR), millimetre-wave (MMW) and SAL guidance sensors in order to allow all-weather attacks against moving targets.

the LS-6-100 and -50 are 20 km-range designs with dual-mode guidance that combines GPS/INS with a terminal seeker. Two models of seeker have been displayed – one of the SAL type, and the other based on IR technology.

Luoyang Optoelectro Technology Development Centre (LOEC) offers the LT-3, a second-generation PGM that uses dual-mode guidance. The weapon's INS can be aided by a receiver using either the GPS, GLONASS, or BEIDOU satnav constellation, while terminal homing is done using a SAL seeker. Maximum range is 24 km; the explosive fill of the penetration accounts for all but 70 kg of the munition's total weight of 570 kg.

The Boeing GBU-39 SDB, which entered low-rate initial production in April 2005 was intended for use against fixed targets, and used GPS-aided inertial guidance. In order to create a newer weapon able to attack mobile or relocatable targets in adverse weather, in the summer of 2006

Raytheon engineers devised a tri-mode design incorporating imaging infrared (IIR), millimetre-wave (MMW) and SAL sensors, a combination that they regarded as the only practical way of meeting the design requirement in full. The MMW capability would allow targets to be acquired from above clouds, while the IIR channel would allow classification of the target once the latter had become visible. The mission requirement could be met by an uncooled seeker, which would be less expensive than a cooled sensor, but would still meet the mission requirements. Eliminating the need for a pre-release seeker cooldown would make the weapon easier to use in direct-attack mode. All three sensors share a single gimbal. To date no other manufacturer has adopted triple-mode guidance for its PGMs, but this is likely to change.

Rafael Advanced Defense Systems' SPICE 250 is the latest member of a family of glide weapons that includes the original SPICE 2000 and follow-on SPICE 1000. As their

Surface Ship Combat Management Systems

Stefan Nitschke

Shipboard Combat Management Systems (CMS) are one aspect of the increasing digitisation of the maritime battlespace. They provide an integrated picture of the tactical situation to the ship's crew and every command level by receiving, combining, and processing sensor data obtained from the variety of shipboard and external sensors.

CMS or combat direction systems are inherently important as they integrate and coordinate all existing sensors and weapons systems to ensure a quick-reaction combat capability against incoming threats by accelerating the detect-through-engage sequence.

Interoperability is a Prerequisite

In 2019 a number of critical decisions may be taken. Under a number of programmes, navies are continuing to increase interoperability at sea by integrating or updating hardware and software components to address deficiencies arising from the use of different communication and C4I means, operating procedures, protocols and standards, and tactics, all of which can lead to interoperability deficiencies, making it difficult to fully realise information superiority at sea and beyond the traditional limits of the sea/shore air war. NATO's standing naval forces, integrated into the NATO Response Force (NRF), show how the nature of information exchange and language barriers can affect naval operations. This shows that surface combatants of different modernity and sophistication depend on shared CMS procedures.

New-construction warship programmes in France, Germany, Italy, Spain, and the United Kingdom (UK) also testify to this requirement. Marc Steffens, Head of the F125 Project at the German BAAINBw procurement agency, stated that the four new Type F125 frigates will feature the ATLAS Naval Combat System (ANCS), which is an advanced open-architecture and distributed-architecture computer system designed to provide a clear and automated tactical picture from all ship sensors, while coordinating both defen-

sive and offensive responses. The latter can include the ships' 127/64 LW (Light-weight) naval gun from Leonardo, providing a real Naval Surface Fire Support (NSFS) capability. Developed by the Joint Einsatzsystem Team (JET) F125 industrial

Programmes undertaken by non-NATO countries like Australia, Japan, and New Zealand suggest that the modernisation of shipboard combat direction systems can result in significant improvements in information superiority. To overcome exist-

Photo: Starpoint



The DREADNOUGHT 2050 is a glimpse of the future. Engineers have unveiled a series of images of the ground-breaking warship that could be controlled by only five sailors sitting at screens, much like game consoles. Data fusion systems convert the information feed into a coherent operational picture.

consortium consisting of thyssenkrupp Marine Systems and ATLAS Elektronik GmbH, ANCS integrates an onshore tactical picture and artillery weapons control system. This will allow the F125 frigates to conduct more sophisticated on-shore surveillance and engage land-based targets in coordination with Army units. ANCS will join the ATLAS Tactical Data Link System (ADLIS) aboard the F125. ADLIS allows the ship to use a variety of data links to share what "it sees with German and allied forces", according to ATLAS Elektronik. It includes the key NATO standards Link 11, Link 16, and Link 22.

ing deficiencies, the Royal Australian Navy (RAN) selected Saab's 9LV Combat Management System to upgrade existing frigates or equip future warships that aim to maximising capability. There are indications heard from Australian defence officials that the 9LV/CEAFAR radar-equipped ANZAC class frigates may currently possess the "world's best air defence on surface ships" over short to medium distances. However, with the American AEGIS combat system fitted to the RAN's HOBART class Air Warfare Destroyers (AWDs), there will be a mix of combat direction systems in the service's future order of battle.

Author

Stefan Nitschke, Ph.D., is Editor-in-Chief of WEHRTECHNIK.



Photo: Terma

HDMS ABSALON's CIC equipped with the C-FLEX combat information system

CMS Evolution Accelerates

At Euronaval 2018 in Le Bourget, Italian manufacturer Leonardo, through its Land & Naval Defence Electronics Division, confirmed that the new generation of net-centric CMS architectures will play an increasingly important role when it comes to cooperation between surface ship, aircraft, submarine, and land-based assets. As a consequence, new-generation warships like the Italian Navy's upcoming multipurpose Offshore Patrol Ships (PPA; Pattugliatori Polivalenti d'Alta), will be platforms with full-scale C4I/C4ISR/C4ISTAR architectures. Digital systems will play an inherently vital role since many leading navies do have a number of shipbuilding programmes coming on stream, which will see large-scale changes to the ships' CMS and data system infrastructures. According to the French shipbuilder Naval Group, completely new command information centres (CICs) and control rooms are seen as a major drive to allow for the integration of improved subsystems into shipboard combat systems. Such considerations will play a major part in the design of the French Navy's upcoming 4,000-tonne FTI (Frégate de Taille Intermédiaire) medium-size frigate that will be equipped with a highly sophisticated CIC and Thales' SEA FIRE four-flat antenna radar. Listed as a major objective of the French Navy's strategy is the ability of the new frigates to operate seamlessly with other allied partners.

Dutch shipbuilder Damen Schelde Naval Shipbuilding (DSNS) developed the CROSSOVER platform concept that can be labelled as a "hybrid development" of the HOLLAND class offshore patrol vessel (OPV), SIGMA type corvette, and EN-

FORCER landing platform dock (LPD) ship. The CROSSOVER series benefits from a very high level of automation, reduced manning, and optimised operation room and bridge layouts derived from the HOLLAND class, as well as a flexible arrangement of deck spaces and internal infrastructure to accommodate the necessary pre-selected command, control, communications, and combat systems.

Looking over the pond, Lockheed Martin is continuing to enhance the performance characteristics of its AEGIS combat system. In 2017, according to the US Missile Defense Agency (MDA), the ARLEIGH BURKE class destroyer USS JOHN PAUL JONES (DDG 53), supported by Lockheed Martin, used the latest evolution of its AEGIS combat system to detect, track, engage, and launch

a missile to intercept a medium-range ballistic missile target. This exercise marked the first shipboard demonstration of the AEGIS Baseline 9.2 (BMD 5.1) BMD (Ballistic Missile Defense) tracking and engagement capabilities against more complex threats with increased battlespace in support of the US Phased Adaptive Approach to protect Europe from ballistic missile attack. The test, which was called Standard Missile-3 Block IIA Cooperative Development Flight Test Maritime-1 (SFTM-1), demonstrated the integrated capabilities of the AEGIS Weapon System and how it has continually evolved to counter advanced threats.

Over the past two decades, the AEGIS system has also been chosen by Australia. Lockheed Martin's Integrated Test Team continued AEGIS combat system integration and testing aboard the RAN's first AEGIS-equipped AWD, HMAS HOBART (DDGH 39) in 2017 and 2018.

"HMAS HOBART marks the 21st international ship and the sixth allied nation [Australia, Japan, Spain, Norway, Republic of Korea and the US] to benefit from these capabilities," said Jim Sheridan, Lockheed Martin's Vice President and General Manager of Naval Combat and Missile Defence Systems.

As to the Spanish Navy, Indra and Lockheed Martin are collaborating on the integration of new a solid state S-band radar system being developed for the future F-110 frigate. The F-110 will be the Spanish Navy's next generation of multi-mission surface vessels, due to see operation in the next decade. Concept work for the successor of the ageing SANTA MARIA class (F-80) frigates, which began in 2004, addresses a new evolution of the SCOMBA Combat Management System. It

Photo: Royal Danish Navy; Terma



The Maritime Boarding System (MBS) delivered for fitting aboard the Royal Danish Navy's flexible support ship (L16, shown here), utilises Systematic's SITAWARE situational awareness software, the Command and Control Information Exchange Data Model (C2IEDM), and the IRIS data replication mechanism.

will enable the ship to operate in all the main warfare areas, according to NAVANTIA, encompassing both symmetric and asymmetric threat environments. The SCOMBA Combat Management System will support a variety of weapons, including a 16-cell Mk41 VLS module for SM-2, and/or EVOLVED SEA SPARROW MISSILE (ESSM) Blk2, or SEA CEPTOR missiles from MBDA; eight surface-to-surface missiles; one 127mm Mk45 Mod4 naval gun; two 25mm cannons; four 12.7mm remotely operated heavy machine guns; and light-weight torpedoes.

Keeping Procurement on Schedule

For the Turkish Naval Forces (TNF), modern combat direction systems are high on the agenda; local industry is developing mission-specific solutions for several new-construction programmes, including the MİLGEM project consisting of eight multipurpose corvettes and four slightly enlarged TF-100 frigates equipped with Mk41 VL modules for SM, ESSM, and VL ASROC missiles. For the MİLGEM project, Aselsan, Havelsan, and Yaltes were selected to deliver critical systems, including the G-MSYS (Genesis MİLGEM Savaş Yönetim Sistemi) CMS, the EPKIS (Entegre Platform Kontrol ve İzleme Sistemi) integrated platform man-



Photo: TNF

The TNF's MİLGEM project incorporates local content, including sensors, armament, and electronics such as a modified version of Havelsan's G-MSYS Combat Management System.

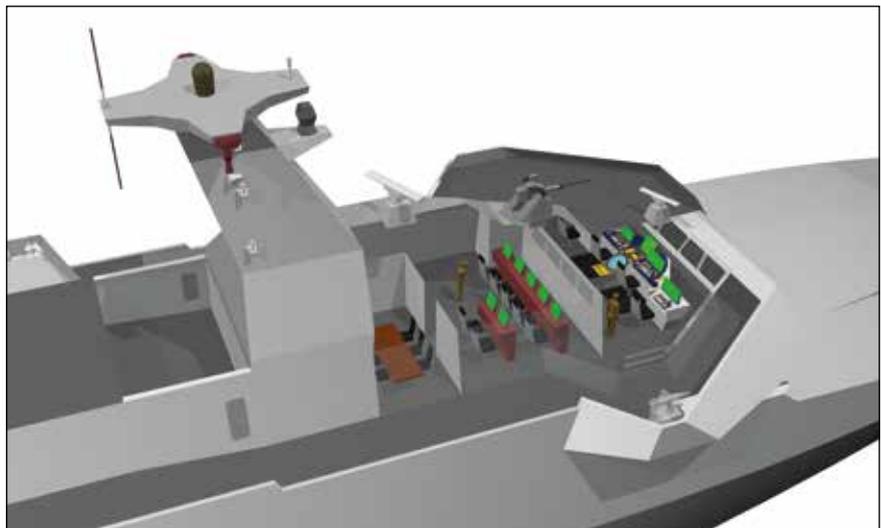


Photo: DSMS

The spacious CIC of the CROSSOVER platform concept incorporates two main rows of multifunction consoles and large flat-screens, eventually supplemented by a third row providing space for platform management functions and weapon-specific stations, all laid out for optimal operational flexibility and internal communication.



Photo: German Navy

The operational programme of the CIC on board the German Navy's SACHSEN class (Type F124) frigates is broken down into four functions: sensor data fusion, tactical situation analysis, action plan synthesis, and automatic kill assessment functions.

agement system, and the ALPER low probability intercept radar. The Finnish Defence Forces took a similar approach. They initiated the LAIVUE 2000 (Squadron 2020) programme to build a new class (POHJANMAA class) of four multipurpose corvettes equipped with a modern combat direction system. Although not a frigate-type warship, the new vessels will replace the service's four RAUMA class fast attack craft (FAC) and two of its HÄMEENMAA class minelayers around 2022/2024. According to the Finnish MoD, the naval service needs a platform capable to "monitor maritime

areas above and under the water surface", using "capable weapons and a modern combat information system" to counter potential threats. The project planning phase was to be completed in 2018, with the construction phase estimated to be initiated later this year. As to in-service assets, Patria was selected in early 2018 for a mid-life upgrade (MLU) and overhaul of the HAMINA class, a four-strong class of FAC or "missile boats", with Saab undertaking "a good deal of work" devoted to their CMS, integrated communications systems, and optronic sensors. Saab will deliver its 9LV CMS, replacing the ANCS

2000 suite from ATLAS Elektronik. This effort is part of the Naval Capability Development Programme that will ensure continued naval defence capabilities until the commissioning of the Squadron 2020 corvettes in the 2020s.

Conclusion

The Finnish HAMINA class MLU shows how an existing, sophisticated combat management system (ANCS 2000) is to be replaced with another advanced system, instead of simply upgrading it, to extend the operational life of a “legacy” surface combatant. At the heart of the MLU is the 9LV CMS from Saab, an open architecture system that allows integration of different subsystems, sensors, and

Photo: Saab



The 9LV Mk 4 Combat Management System from Saab on board the ANZAC class (MEKO200ANZ) frigate HMAS PERTH (FFH 157)

weapons into a single integrated package. Saab noted, however, that different building blocks can be integrated into the CMS system from other manufacturers, or other manufacturers’ subsystems can be easily integrated into the 9LV CMS. Within this scheme, modern CMS like Saab’s 9LV are testament to improved interoperability at sea. The range of modern CMS from Saab and other European manufacturers – among them ATLAS Elektronik, BAE Systems, Kongsberg Defence & Aerospace, Leonardo, Naval Group, and Saab – are designed and adapted to the requirements of three-dimensional warfare, with both Anti-Submarine Warfare (ASW) and local area defence gaining increasing attention following two decades of declining commitment. This situation also affects smaller surface combatants like OPVs. A recent non-NATO example is the Mexican Navy, which is about to receive its first Ocean Patrol Vessel (Patrullera Oceanica de Largo Alcance; POLA) fitted with Thales’ TACTICOS Combat Management System consisting of ten operator consoles and a large collaboration wall. Thales noted that the contract includes transfer of technology for CMS development, thus supporting the Mexican Navy’s vision to utilise digital technologies for big data analysis, cybersecurity, and significantly enhanced connectivity. The UK Government, which is committed to eight Type 26 Global Combat Ships

(GCS) in its 2015 Strategic Defence and Security Review (SDSR), declared that the ships’ “ultra-modern” CMS suites may represent an urgent requirement, to provide the critical ASW protection to the continuous-at-sea-deterrent, thus protecting the new QUEEN ELIZABETH class aircraft carriers in high-intensity warfare. Major shipbuilders like Fr. Lürsen noted that lighter, simpler, “smarter”, and less expensive surface combatants – frigates and corvettes – equipped with fully integrated combat systems can have effects on growing opportunities for export. This was clearly expressed by the UK and French governments when they announced their Type 26 GCS and FTI programmes, offering sufficient potential for export. The latter will be France’s new 4,000-tonne ‘digital’ front-line frigate replacing the five LA FAYETTE class frigates. According to Naval Group, the new class will have the “most advanced combat direction system to comply with the spectrum of operational scenarios in the future digitised maritime battlespace.” In sum, the idea of introducing fast and highly secure data links into modern warfare is to enable surface warships to collect intelligence for rapid processing, analysis, and interpretation, and to provide for superiority in weapons systems efficacy and long-range precision strike through the rapid sharing of large volumes of timely battlespace information between individual surface assets. ■



Photo: MDA

A February 2017 test from the Pacific Missile Test Range demonstrated the first shipboard tracking and engagement of a ballistic missile target by the Baseline 9.2 (BMD 5.1) AEGIS Weapon System

Mine Warfare: Programmes, Platforms, Vulnerabilities

Bob Nugent

In the last ten years, there has been an increasing trend from purpose-built Mine Countermeasures Vessels (MCMVs) to mine warfare modules and multi-capability ships. Will global navies continue to shift from single-mission mine warships to multi-mission and modular mine defence capabilities?

The recent announcement that steel has been cut on the first of 12 Australian ARAFURA class (SEA 1180) OPVs marks another significant development in the evolution of the mine warfare vessel market. The ARAFURA class will replace the RAN's purpose-built HUON class MCM vessels, while also performing patrol and survey missions.

This shift away from purpose-built MCMVs to mine warfare modules and multi-capability ships is a trend that has accelerated over the past decade. The use of the Mine Warfare mission package for the multi-mission US LCS is another example of this approach to mine warfare. The LCS configured for mine countermeasures will entirely replace the USN's current OSPREY class mine warfare ships. The UK, France and other European countries are also investing in a new mine warfare capability that relies heavily on unmanned platforms.

Will navies continue to shift away from single-mission mine warfare vessels toward multimission and modular mine countermeasures capabilities? This article draws on AMI's proprietary naval market data on ships in service and forecast to be built over the next 20 years to answer that question.

It first assesses the general naval mine warfare vessel market—current and future. Next it looks in detail at the mine warfare ships forecast to be built through 2039, including subsegments, numbers, tonnage, and assessed expenditures on these ships. Lastly, it reviews recent developments in the most significant mine warfare ship and capability programmes.

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Current and Future Mine Warfare Fleets

AMI tracks 490 mine warfare ships and craft in service today. That represents less than 5% of the world's inventory of commissioned ships and craft in service with navies, coast guards and other maritime government agencies and departments. AMI's future market projections forecast the number of dedicated mine warfare ships is set to decline significantly in the

life, both OPV and frigate fleets will drop off much less rapidly than mine warfare ships by 2040.

The projected investment in new dedicated mine warfare ships is just short of US\$22Bn over twenty years. This represents about half of projected spending on new OPVs and a mere 12% of the projected expenditure on new construction frigates (acknowledging that the cost of the weapons and sensor systems on frigates are significantly higher on a per-hull basis).

Existing Naval Market (Ships currently in Navy or Coast Guard service)	MCMV	Forecasted New Builds Estimated Ships to be Procured by Navy or Coast Guard)	MCMV
Asia & Australia	168	Asia & Australia	74
Caribbean & Latin America	6	Caribbean & Latin America	6
Middle East & North Africa	29	Middle East & North Africa	21
NATO	191	NATO	54
Non-NATO Europe	35	Non-NATO Europe	9
Russia	45	Russia	29
Sub-Saharan Africa	5	Sub-Saharan Africa	0
USA	11	USA	0
Totals	490	Totals	193

Graphics: via author

next 20 years, with fewer than 200 MCMVs expected to come into service through 2038. This is well short of a one-to-one replacement rate for today's MCMV fleet, many of which are near or at the end of their service lives now.

Mine warfare ship projected build rates contrast sharply with forecast OPV and frigate acquisitions. Today mine warfare, OPV and frigate current fleets each number about 500 ships in service globally. New build projections for OPVs and frigates are each about 300 new ships over 20 years, compared to 200 for mine warfare platforms. Using a projected 30-year hull

Viewed by region, mine warfare capabilities are concentrated in NATO countries, in Asia-Pacific and in Russia. Forecasted Russian investment in mine warfare ships remains robust, and the Asia-Pacific region is funding mine warfare ship replacements at about 44% of current inventory. However, the fall-off in NATO spending on these ship types is marked, with replacement ships representing only 28% of the current fleet.

While the MENA region's mine warfare fleet is much smaller than that of comparable NATO or Asia-Pacific regions, new ship build rates are over 70% of the



Photo: Brian Burnell / George Hutchinson

A classic MCMV: Royal Navy minehunter HMS CHIDDINGFOLD entering Portsmouth Naval Base, UK

current fleet. This reflects the maritime geography of the region, with multiple critical chokepoints (straits, narrow seas) especially vulnerable to closure with mines.

The large majority (about 90%) of mine warfare ships in service and projected to be built are defensive — employed to detect, sweep, and otherwise neutralise the mine threat to enable other naval operations. However, a few select navies are building offensive capabilities in the form of mine laying ships. On the smaller end of the size spectrum, Taiwan is expected to acquire up to 20 250-tonne fast minelayers — an asymmetric sea denial option against China’s naval numerical advantage. Similarly, the Republic of Korea is forecast to build what are the largest ships in AMI’s mine warfare category — 4,000-tonne FLD mine-laying ships.

Segment Analysis: Mine Warfare Ships

The future mine warfare market ranges from USVs and small craft of 25 tonnes to the previously mentioned 4,000-tonne minelayer planned by the ROK. The table below breaks the sector into sub-segments of below 500 tonnes FLD; 500–1,000 tonnes; and above 1,000 tonnes.

The sector is heavily concentrated in ships of 500–1,000 tonnes, representing 70% of total market value, 64% of total tonnes and 74% of total value (acquisition costs of ships and systems). Large ships

make up the next largest subsegment, and small platforms and craft make up only 5% of the total market, measured by tonnes or acquisition cost.

Significant Mine Warfare Ship Programmes and Platforms

Measured by cost and numbers of hulls forecast to be built, significant mine warfare programmes are found in Germany, Belgium and The Netherlands, Russia, Poland, and India. Sweden, Australia and Singapore are among the navies investing significantly in unmanned, modular and reconfigurable mine warfare systems.

Germany

The German Navy’s current mine hunting force consists of FRANKENTHAL (Type 332), KULMBACH (Type 333) and ENSDORF (Type 352) class coastal mine hunters (MHCs) commissioned from 1989 through 1998. Based on a 35-year service cycle, these ships will require replacement beginning in 2020.

MCMV	Hulls	%	Tons	%	Value	%
500-1000	135	70%	94,140	64%	16,276	74%
MCMV <500	33	17%	6,645	4%	975	4%
MCMV >1000	25	13%	47,400	32%	4,700	21%
All	193		148,185		21,951	

Most of Germany’s mine warfare vessels were built at Abeking & Rasmussen, Lürsen Werft and Kröger Werft (Lürssen). Future mine hunting procurements are expected to go to these yards, possibly involving a work-share agreement.

The German Navy appears committed to maintaining a force of purpose-built ships for mine related missions. This does not preclude development and deployment of USV and modular mine warfare systems such as those offered by ATLAS ELEKTRONIK. The large MKS-180 Multi-Purpose Surface Combatant could operate as a host platform in this approach to mine warfare. AMI anticipates that Germany could issue a Request for Proposals (RfP) for new mine warfare platforms in 2021, followed by a construction contract in 2022. This will allow the first unit of the class to commission by 2025.

Belgium and The Netherlands

In January 2018 the Belgian Government approved the acquisition of six Mine Countermeasures Vessels (MCMV), with procurements to begin in 2020. This approval enables a joint Dutch/Belgian MCMV programme. The Belgian share of the programme is expected to cost around US\$1.36B for the six vessels, which includes off-board systems. The Royal Netherlands Navy (RNIN) will also procure six hulls under the joint effort.

The programme began in 2014 and was a three-year plan to work on common operational concepts and a set of common requirements for the future MCMV forces. The RNIN and BN are currently planning for this joint effort that will primarily use off-board Unmanned Maritime Systems (UMS) to provide an MCM capability that will allow the host platform to remain out of the minefield during clearing operations.

The Request for Proposal is expected to be out in time to provide for a preferred builder and construction contract to be awarded in 2020. This timeline would allow the Belgians to receive the first hull in 2023 according to schedule. The Royal Netherlands Navy (RNIN) would receive its first hull by 2025.



In June 2018, the Belgian and Dutch defence ministers signed two Memorandums of Understanding (MoUs) ratifying the plan to jointly procure the MCMV as part of a 16 ship programme. The 16 ships will also include four frigates. Belgium and the Netherlands will each receive two frigates and six MCMVs. The entire project is worth an estimated US\$4.7Bn.

STX France and Socarenam have publicly acknowledged the formation of a consortium with Belgium's EDR in order to bid for the MCMV programme. The consortium is known as Sea Naval Solutions and will offer the design for the 12-hull programme following the release of the RfP. Saab (MCMV 80 design), BMT Group (Venari 85 design) and Sea Naval Solutions are leading

contenders for the programme award. Belgium will manage the 12-MCMV programme. The new MCMVs will be larger than the traditional platforms as they will need a large storage and operating area for Unmanned Maritime Systems (UMS). All MCMV activities will be conducted by UMS. Search and identification of mines will be conducted through the use of Autonomous Underwater Vehicles (AUVs), Remotely Operated Vehicles (ROVs), USVs and mine destruction through the use of one-shot Unmanned Underwater Vehicles (UUVs). Each MCMV will also have one organic mine hunting sonar. The ships will be large enough to embark equipment and staff sufficient for any of the hulls to act as an MCM command ship.

Poland

In September 2018, steel was cut for the Polish Navy's (Marynarka Wojenna – MW) second KORMORAN II class Mine Countermeasures Vessel (MCMV), ORP ALBATROS (602), at Remontowa Shipbuilding. It will be delivered in 2020.

Russia

In July 2018, the Russian Navy laid the keel for the sixth ALEKSANDRIT (Project 12700) class MCMV, RFS PETER ILYICHEV, at the Sredne-Nevsky Shipyard in St Petersburg.

India

In January 2018, the Indian Navy (IN) cancelled its 12-ship US\$3.4Bn Mine



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Countermeasures Vessel (MCMV) programme with Kangnam Corporation of South Korea and its Indian partner Goa Shipyard Ltd (GSL).

Kangnam Corporation had been selected on a single vendor basis to provide design and technology transfer assistance to India's GSL. It appears that disputes between the Indian Government and Kangnam over the design and technical transfer fees contributed to the programme's cancellation.

The Indian MoD has ordered GSL to develop and release a new global Expression of Interest (EoI) in order to restart the MCMV programme that has languished since 2005. The technology transfer terms of the new EoI will probably

Netherlands); Naval Group and Thales (France); Intermarine and Selex (Italy); Navantia (Spain); Istanbul Naval Shipyard (Turkey); Kangnam (South Korea); Saab Kockums (Sweden); Sredne-Nevsy (Russia); and Lockheed Martin, Raytheon and Northrop Grumman (US).

India's historical ties with Israel as a naval supplier makes USVs from Rafael or Elbit leading contenders to provide unmanned mine warfare capability.

Sweden

Saab MCMV 80: First displayed at the Undersea Defence Technology (UDT) exhibition and conference in May 2017, Saab Kockums continues to offer the

and many of the features of previous designs find their way into the MCMV 80.

The MCMV is equipped with two stern ramps and a launching crane for the deployment of various sized USVs, UUVs and AUVs as well as small craft. Optionally, it can have a flight deck and UAV hangar for the operation and storage of vertical take-off and landing (VTOL) unmanned aerial vehicles.

The MCMV 80 has been proposed for the joint Belgium/Netherlands MCM replacement programme that will see a total of 12 units built, six for each country, and is anticipated to have a contract in place by 2020. Additionally, Sweden will need to replace the five KOSTER and two STYRSO class MCMVs beginning about 2025, meaning a construction contract will have to be in place by 2023. The Kockums design should be considered a front-runner for the programme.

Australia

In March 2018, Steber International of Australia was identified as the winner of the contract awarded in late 2017 worth AUS\$6M (US\$4.7M) for the delivery of five USVs for the Royal Australian Navy (RAN) as part of the Deployable Mine Countermeasures programme (SEA 1778 Phase 1).

The five USVs will each measure 11.6 m (38 ft) in length and will be capable of a top speed of 25 knots. They are to carry a payload of three tonnes that will include a towed sonar and an ROV for mine classification and disposal.

Steber International is working with Thales Australia who is the prime contractor for the project that includes a 15-year contract to deliver and support a deployable MCM capability as well as conduct a service life extension of the HUON class MCMVs.

Singapore

In March 2018, the Republic of Singapore Navy (RSN) revealed that it is in the process of introducing USVs to patrol the nation's waters and to detect and neutralise mines. The USVs will be operated from shore-based facilities or from mother ships and controlled by a team of two personnel. The vessels will be either equipped with sensors and a gun for the maritime patrol mission or with mine countermeasures (MCM) equipment to detect, classify and neutralise sea mines. Although no specific



Photo: US Navy

The US Navy littoral combat ships USS INDEPENDENCE (LCS-2), rear, and USS CORONADO (LCS-4) under way in the Pacific Ocean: the use of mine warfare mission packages for the multi-mission US LCS is evidence of a new approach to mine warfare.

be the same as with Kangnam, except now issued on a global scale rather than a single vendor basis. The new EoI is expected to specify a programme of 12 hulls, with an additional 12 hulls expected to be acquired later. The Indian builder is expected to release an RfP sometime in 2020.

The programme is expected to attract interest from the shipbuilders and systems companies with particular strengths in naval mine warfare, including Lürssen Werft, Abeking & Rasmussen, ATLAS ELEKTRONIK (Germany); BAE Systems (UK); Damen (The

MCMV 80 design as a "next generation" MCM platform. Containerised modules enable the system to meet a wide array of different missions both in the minefield as a hunter/sweeper or outside of the minefield as a mothership for ROVs or autonomous underwater vehicles (AUVs).

The MCMV 80 is 80 m (262.5 ft) in length and has a displacement of 1,250 tonnes. It has a top speed of 15 knots and is manned by a crew of 40–60 sailors. Kockums has extensive experience in the production of both MCMVs as well as other composite-hull vessels



Saab Kockums is offering the MCMV 80 design as a "next generation" MCM platform. Containerised modules enable the system to conduct a wide array of missions both in the minefield as a hunter/sweeper or outside of the minefield as a mothership for remotely operated vehicles (ROVs) or autonomous underwater vehicles (AUVs).

timeline has been stated by the RSN, Navy officials have stated that the new capability will be introduced in the "near future". AMI believes that this means the new USVs could enter service as early as 2022, following testing and evaluation of existing systems.

Conclusion

This review of the naval mine market offers several conclusions. First, mine warfare continues to be a relatively low priority for new platform investment compared to other mission areas such

as anti-air or anti-submarine warfare. Mine warfare ships are not being built at rates sufficient to replace inventories in service now. Technology is influencing this shift away from purpose-built mine warfare ships. Navies are applying unmanned

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underwater and surface vessels to mine warfare missions. This is understandable as unmanned platforms are especially suitable in mine warfare, with operations typically being isolated from other shipping, and labour and platform intensive.

Changes in key mine warfare sensors and technology, notably sonar sensors, have also supported this trend away from dedicated single-mission mine warfare ships. As key mine warfare sensors become smaller and more precise, navies have been able to shift to mo-

dular configurations and USV-mounted systems able to deploy as needed from a wide variety of ships or shore-based infrastructure.

While technologies have enabled a shift away from purpose-built mine warfare ships, the last quarter century has also been marked by declining budgets among NATO navies and most other fleets worldwide. This has added pressure to the continuous naval challenge of allocating scarce resources to achieve an optimum balance of capability in many mission areas.

A shift away from purpose-built mine warfare ships to multi-mission platforms gives navies a chance to make a virtue of the necessity of retaining some mine warfare capability, if not on mine warfare ships with lower budgets. In an era of relative maritime peace, which has generally marked the post-Cold War era, this short spend on mine warfare ships has been a calculated, and evidently acceptable, risk. Nevertheless, the market for mine warships remains active and dynamic. The nearly 200 new mine warfare ships forecast to

be built in the coming two decades, representing almost US\$200bn in new hull and systems spending, indicates many navies are not shifting to the modular and multi-mission approach.

Multi-mission platforms represent an operational risk. They have to be ready and available for mine warfare missions when that call comes. The short-notice onset of a major naval contingency requiring mine warfare capability may find multi-mission ships committed elsewhere and therefore unavailable.

So navies are likely to continue to hedge their mine warfare requirements with MCMVs. The naval portfolio manager will balance investments in modular and multi-mission MCM with continued MCMV new construction programmes and modernisation.

This "hedge" strategy for mine warfare makes sense, as the next quarter-century promises to bring about a different operational environment than the 25 years since the end of the Cold War. It looks to be a naval era marked by near-peer rivalries and increased likelihood of major navy-on-navy conflicts. In this setting, shortfalls in counter-mine capability and platforms are likely to give planners and commanders pause, while encouraging advocates for purpose-built and dedicated MCM ships and personnel trained to operate them.



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The South African Defence Industry

Helmoed Römer Heitman

The South African defence industry has scaled down considerably since the 1990s, a result of dramatically reduced defence funding. It has, however, partly made up for that with increased exports that now make up more than half of the industry's turnover.

Exports are, however, now much lower than during the boom in sales of mine-protected and mine-detection vehicles and artillery ammunition triggered by the conflicts in Afghanistan and Iraq. The challenge today is to bring new equipment into production with which to compete internationally despite the cuts to the capital budget of the South African National Defence Force, which limit its ability to acquire equipment or fund R&D.

supportive of international engagement in the form of joint ventures and perhaps foreign equity partners for the industry.

The state-owned Denel group that had just begun to show good returns is currently in a truly parlous situation, having slipped into loss and expecting to make yet another loss in 2019, lacking working capital and having had to ask the government for funds to pay salaries. While it is not yet clear exactly what caused this fall from grace, the Min-

ation or the impact it may have on the industry as a whole. Denel's ostensible lack of interest in the US\$1Bn proposal put forward by Saudi Arabia Military Industries at the end of 2018, especially for guided weapon projects, was an unpleasant surprise and cast doubt on Denel's strategy and plans.

Despite Denel's difficulties and the apparent lack of a sense of urgency, there is some optimism that the group can be turned around, based on the fact that several of the divisions have performed well in the export market and have a useful product line-up as well as development projects that have real export potential. Both Denel Dynamics and Denel Land Systems, in particular, have useful product line-ups and interesting projects lacking only either government development funding or a development partner. While some senior officers and some senior officials in the Department of Defence have a jaundiced view of any foreign partnerships, the need to move swiftly to turn the group around may see government overriding their objections, and there are interested suitors ready to talk. One challenge will be that the forthcoming parliamentary elections will distract the government from defence and defence industry issues, despite their urgency if capabilities are not to be lost. More positively, the hiatus in relations with India has ended following talks in India during President Ramaphosa's visit to that country.

Arms Exports

Denel Dynamics has been particularly successful in the export market with its guided weapons and the SEEKER UAV system. The latter has been exported to Algeria and the United Arab Emirates, the latter having employed the SEEKER to good effect in Afghanistan and having placed several follow-up orders reportedly for the SEEKER 400 system. In the missile field Dynamics has exported UMKHONTO surface-to-air missiles to Finland and Algeria for their navies, the INGWE beam-riding anti-tank missile to Algeria (to arm the upgraded SUPER HIND) and to Malaysia (for the tank destroyer ver-



Photo: Paramount

The Aerosud Paramount MWARI light reconnaissance and attack aircraft is being brought to production standard.

The Department of Defence has established a National Defence Industry Council to support the industry and approved a new defence industry strategy in April 2018 of this year, for which a master implementation plan is now being developed. The strategy hinges on a new acquisition strategy for the Defence Force and 'all of government' support for the industry, particularly in respect of exports and in tying it into the wider industrialisation programme. It also seems likely that government will become more

ister of Public Enterprises has appointed a new board that has a useful mix of relevant experience and includes a former chairman of Denel and a former CEO who was previously also the CFO of the group. A new CEO with previous experience in the Saab group in South Africa and Germany has also been appointed. While the group and its constituent companies are struggling, Denel does have very considerable potential and the intention is to turn the group around. That will also be to the benefit of much of the rest of South Africa's defence industry, as many companies depend on Denel for a portion – in some cases a substantial portion – of their turnover. However, there is concern in the MoD and in industry that neither the Denel Board nor the Ministry of Public Enterprise fully understand the urgency of Denel's situ-

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sion of their new infantry combat vehicle) and the MOKOPA 10,000 m range laser-homing missile to Algeria to arm the navy's SUPER LYNX helicopters. The RAPTOR 2 stand-off weapon has been exported to at least two countries, and the AL TARIQ smart bomb system is being manufactured in the United Arab Emirates by Tawazun Dynamics, a 51/49% joint venture between Tawazun and Denel Dynamics. In addition, Dynamics has developed a complete guided bomb system for a European country and produces auto-trackers for other companies. Development work in hand includes the A-DARTER fifth-generation air-to-air missile that is being developed together with Brazil and is close to first deliveries of live rounds, the MARLIN radar-guided beyond-visual-range air-to-air missile that is being developed with technology funding from the South African Department of Defence, and radar-guided and extended-range variants of the UMKHONTO SAM, as well as a ground launcher for that missile.

Missiles

A new project is the development of a counter rocket, artillery and mortar (C-RAM) defence system comprising two complementary missiles, the CHEETAH Mach 3.5, 20 km range missile and the transonic 2 km range MONGOOSE 3. The missiles can be quad-packed in the place of an UMKHONTO SAM in shipboard or ground launchers or be launched from ISO-standard 6 m (60 missiles) or 3 m box launchers that also contain the uplink. Both missiles obtain their initial target designation from a standard air defence radar, and the CHEETAH has an active radar seeker for the actual intercept. The MONGOOSE 3 is also intended as an APFSDS interceptor for the Saab GRINTEK Defence Land Electronic Defence System (LEDS-150) and as a self-defence weapon for helicopters.

Other projects include the IMPI, a small missile developed using building blocks from the INGWE and MOKOPA and intended to arm UAVs or light attack aircraft, and the Future Infantry Support Missile, a small, man-pack top-attack missile. There is also work being done on a course-correcting fuse for artillery

The SEEKER 200 has been joined by the larger SEEKER 400, which can take two payloads, for instance an optronic turret and SAR radar, and which has been ordered by South African Defence Intelligence. Dynamics also has the smaller HUNGWE launcher intended for use at the unit and sub-unit level. Finally, Denel Dynamics is also the parent company for Spacetek, which will develop satellite related systems and equipment.

Guns and Cannons

Denel Land Systems developed the turret system for the BADGER infantry combat vehicle that is to replace a part of the present RATEL fleet. The turret system has been developed as a family of turrets to meet almost the full requirement of a mechanised infantry unit with standard turrets that differ only in their weapons modules and the fire-direction and communications systems. The section and mortar variants are armed with Denel Land System's 30mm CAMGUN cannon, and its 60mm long-range (6,000 m)

also developed the add-on armour package, a new rear door and the interior fittings, which include a large chilled water tank. The other major current project is the T5 truck-mounted 155mm gun on an 8x8 Tatra truck with a protected cab. This gun apparently performed very well during trials in Pakistan and has also drawn the attention of other armies, including that of India. Both the towed G5 and the self-propelled G6 are also still offered, and six upgraded G5s were recently exported. Unfunded is the long-range (30 km) 105mm gun, which has been developed in both towed and turreted

Photo: DLS



Denel Land Systems developed the turret system for the BADGER infantry combat vehicle.

Photo: Denel Dynamics



The CHEETAH and MONGOOSE 3 are complementary C-RAM missiles developed by Denel Dynamics.

breech-loading, water-cooled mortar; the anti-tank variant with the Denel Dynamics 5,000 m range INGWE missile, and the command variant with just a 12.7mm heavy machine gun for self-defence. The turret is also being exported to Malaysia in two variants for their new ICV, one with the CAMGUN and the other with the CAMGUN and four INGWE launchers. The vehicles, developed from the PATRIA AMV, will be built by Denel Vehicle Systems (DVS), incorporating flat-bottom mine protection developed by Land Mobility Technologies systems, which

versions, the latter having been successfully man-rated and demonstrated married to a US Army LAV. Its advantage lies primarily in the much lighter ammunition compared to 'light' 155mm guns, while the projectiles developed by Rheinmetall Denel Munition offer better fragmentation spread than current 155mm shells.

DLS also have upgrade packages for the G5 and the self-propelled G6 as well as for the turrets used on the RATEL and on PANHARD AML armoured cars. Smaller weaponry includes long-range 60mm and 81mm mor-



Photo: RRS

Reutech has exported several of its low-probability-of-intercept STEALTHRAD systems to the Middle East and Far East.

tars, an automatic 40mm grenade-launcher, light machine guns and the NTW multi-calibre anti-materiel rifle.

Denel Vehicle Systems – previously BAE Land Systems – has enjoyed considerable export success with mine-protected vehicles such as the RG31 and RG32, and it has sold its RG35 design to NIMR in the United Arab Emirates, for whom it is completing development and building the first batches of 4x4 and 6x6 vehicles. DVS also has the 8x8 RG41 in its lineup and will now manufacture the BADGER platform. Its range also includes the RG12 protected vehicle for police applications.

Land Mobility Technologies is a special vehicles design house that was part-acquired by Denel. It has developed a range of paramilitary protected vehicles and ballistic and mine-protection kits for vehicles such as the HMMWV, as well as ballistic and mine-protected cabs for Mercedes ACTROS and ZETROS trucks and a ballistic and mine-protected personnel transport container for Mercedes. Another company in the Denel stable is Mechem, which specialises in de-mining but also supplies the CASSPIR armoured personnel carrier family and operates bases for peacekeeping forces.

Denel Aeronautics supports various aircraft of the SAAF and is a licensed MRO company for the C-130 HERCULES and various Eurocopter helicopters. The company also manufactures parts for the A400M, including the wing/fuselage fairing and top shells, as well as components for a number of civilian aircraft. It recently completed the mid-life avionics upgrade of the ORYX transport helicopter and is the design authority for that aircraft and the ROOIVALK attack helicopter. A project still in its early stages is a light turboprop aircraft intended for the civilian market, the South African Regional Aircraft. Denel's PMP division is a small calibre ammunition house, manufacturing small-arms and cannon ammunition, including the 30x173mm ammunition for the CAMGUN

and 30mm ADEN ammunition for the air force's HAWKS, as well as 35mm ammunition for the army and the navy. The company has also developed a new personal assault weapon and a belt-fed weapon in 20x42mm calibre and has won the first export orders for the former. The latter, which fits any mounting that can take a 7.62mm LMG was shown in its production form at AAD 2018.

Two former Denel divisions currently have majority foreign ownership, Rheinmetall Denel Munition (RDM) and Hensoldt Optronics. RDM – 51% Rheinmetall – focuses on artillery, medium calibre gun (76mm, 105mm), mortar ammunition, 40mm grenades, aerial bombs and motors and warheads for guided missiles, as well as military explosives. The company has been extremely successful in the international market and has also established turn-key ammunition plants in several countries.

Hensoldt Optronics is the former Denel Optronics (Eloptro) in which Zeiss took a 70% stake that later passed to Airbus/Cassidian and now Hensoldt. It develops and manufactures a range of optronic and optical equipment, including submarine periscopes and sensor turrets for helicopters, UAVs and light aircraft, as well as the head position sensor system for the helmet sights used in the GRIPEN and the TYPHOON. Hensoldt also has a majority stake in GEW Systems, a communications and signals intelligence company that has been very successful in the export market and which today also manufactures IED jamming systems.

Reutech

The largest defence group after Denel is Reutech, part of the Reunert group. It has divisions active in several fields, mainly secure tactical communications, radar, fuses (Fuchs Electronics) and military electronics. Reutech Communications has been successful inter-

nationally with radios for ground forces and aircraft applications and is currently delivering a new generation of tactical radios and related equipment to the SANDF. Initially focused on the V/UHF range, the company acquired the HF radio business of the former Grintek Communications and more recently the cryptographic technologies company Nanoteq.

Reutech Radar Systems developed the RTS6400 trackers fitted to the SA Navy frigates and the ESR220 THUTLWA radar used by the SA Army's air defence units. A particular success was the development of the RSR210N radar to meet a requirement of the Royal Norwegian Navy, which is now fitted to the five FRIDTJOF NANSEN class frigates that are the primary combatants of that navy. The company has also developed a family of low-signature radars (RSR900 StealthRad) several of which have been exported to the Middle and Far East, a navigation radar intercept system, an FMCW optronic radar tracker (FORT) that has been trialled aboard one of the SA Navy's frigates, a dual-band 3D radar (DBRXL) for air defence units, and the RSR150 staring radar that forms part of the Saab Grintek Defence active protection system for armoured vehicles. Other military work has included the development and export of stabilised platforms and rotator systems for naval radars and the development of a perimeter intrusion monitoring system.

Other Defence Companies

Fuchs Electronics develops and manufactures electronic time, point detonating and proximity fuses and the associated fuse setting devices, as well as pre-fragmented aerial bombs and the related fuses. Among the company's exports have been low-yield (for reduced collateral damage) Mk 82 bombs for the Royal Danish Air Force. The other company in the group, Reutech Solutions, is focused on gun and turret drives and supporting equipment for communications and electronic systems. It also developed and has exported the Rogue remotely-operated weapons station in both its vehicle and naval variants.

Saab Grintek Defence is the former Grintek group now owned by Saab. Its speciality lies in the Integrated Defensive Aids Suite (IDAS) electronic self-protection system for aircraft, which centres on its multi-sensor warning system. It has been widely exported for integration with GRIPEN, HAWK, Su-30 and TORNADO combat aircraft, a range of helicopters and the Saab 2000 ERIEYE. The company has also developed a variant for civil aircraft (CAMPS). Electronic self-protection systems have also been developed for armoured vehicles – the LEDS system that is in service on Netherlands Army CV90s –

and ships. The latter include a miniaturised radar warning receiver to fit onto submarine periscopes that has been adopted by several navies, and warning systems adopted by the German Navy for its mine-countermeasures vessels and the UAE Navy for the BAYNU-NAH class corvettes. The company is also active in command and control systems and simulators, having successfully exported the BATTLETEK C2 simulator, but is in the process of selling this part of the business to a local company.

The industry also includes some smaller joint venture companies. Cybicom Atlas Defence, in which local software house Cybicom holds 60% and Atlas Elektronik 40%. CAD was established to support the ISUS-90 combat system of the SA Navy's submarines, but has branched out to develop periscope, bridge, flight deck officer and KING AIR simulators among other equipment. Another foreign-owned company is Aselsan South Africa, active mainly in the optronics field.

A designer for armoured vehicles financed by Saudi Arabia - SAKSA Technologies - has established itself in Egypt under the brand name IMUT and introduced a new vehicle family based on the designs developed in South Africa.

The Paramount Group's most visible current project is the MWARI light reconnaissance/attack aircraft that was originally developed by Aerosud and is now being brought to production standard as a joint venture. Previously, the group was active mainly in armoured vehicles, manufacturing its MARAUDER and MATADOR mine-protected vehicles in several countries, and having developed the MBOMBE family of 4x4, 6x6 and 8x8 vehicles, the original 4x4 MBOMBE having been developed by IAD before it was acquired by Paramount. The company has also developed protected police vehicles. In the maritime sphere, Paramount acquired Nautic and VeeCraft, both of which have been successful in exporting a range of small craft and patrol vessels into Africa. Paramount Advanced Technologies is the former Advanced Technologies and Engineering, which developed the SUPER HIND upgrade for Algeria. PAT has meanwhile been working on several small UAV systems. The group recently experienced financial difficulties and it is not yet clear in what form it will continue.

Milkor, previously known for its six-shot and single-tube 40mm grenade launchers, which continue in production and further development, has branched out into other fields: armoured vehicles (initially a 4x4 mine-protected patrol vehicle), naval inshore craft (the 12 m hydrofoil-assisted stepped hull catamaran CENTURION interceptor) and UAVs. In the latter field it is develop-

ing the 2,000 km range 20-hour endurance MA380 and the 240 km 24-hour endurance MA80. The company is also entering the cyber security field.

DCD Protected Mobility has enjoyed outstanding export success with its HUSKY mine-detection vehicle system, with more than 1,300 exported, 1,000 of them to the United States where it is type-qualified in the US Army. The company is currently also exporting the SPRINGBUCK mine-protected APC and patrol vehicle in several protection levels, which is also being manufactured in Nigeria under licence, and has developed a new MRAP vehicle with four-wheel steering, the MOUNTAIN LION. Other successful exporters of mine-protected and patrol vehicles are REVA, which has exported to the Middle East and Thailand among others, and OTT, whose PUMA is in service with the Kenyan Army and which has also exported SAMIL-20 based patrol/fast attack vehicles for special forces units. It is assumed that a newer company, ADG Mobility, intends to present an 8x8 armoured vehicle at IDEX 2019.

sights, including the IGS-4S video sight for armoured vehicles. Truvelo Armoury develops and produces a range of sniper and anti-materiel rifles, including one in the new 20x42mm calibre that combines very compact dimensions with the ability to deliver a range of 20mm projectiles out to 1,000 m in a flat trajectory that cannot be achieved with 40mm grenades. The company also produces barrels for other manufacturers, including 40mm grenade launcher barrels.

In the naval field, Southern African Shipyards in Durban carried out the refit of the frigate SAS AMATOLA and has been contracted to build the new survey ship for the navy, while Damen Shipyards Cape Town has built several patrol vessels for export and has the contract to build three inshore patrol vessels for the SA Navy. Both Nautic and VeeCraft, part of the Paramount group, have been successful in the export market.

A quite different company is Twiga, which focuses on providing a range of services to armed forces, including sourcing equipment and arranging for local assembly and

Photo: RRS



The DBRXL radar has been developed by Reutech to operate with the ground-based UMKHONTO SAM.

Among the smaller companies in the defence electronics fields are ETION (formerly ANSYS), which develops a range of electronic equipment and has produced smart weapons pylons for export; Protoclea, which has particular expertise in image processing and has developed a close-in surveillance system for naval vessels, and electronic warfare specialist Sysdel.

In the field of lighter weapons, Rippel Effect continues the development and production of its single- and six-shot 40mm grenade launchers, including an extended-range variant, as well as weapon mounts. The company has also entered the field of weapons

support. The industry also comprises several companies active in producing body armour, load-bearing equipment, camp equipment – Relocatable Camp Systems has been a successful exporter – and uniforms. The state-owned defence acquisition agency Armscor is also still active in the development of armour systems and biological/chemical protective equipment, the latter by its Hazmat and Protechnik companies. The Council for Scientific and Industrial Research (CSIR) has a Defence, Peace, Security and Safety (DPSS) division that conducts research in a wide range of fields, including cyber defence. ■

EDIC – The Emirates Defense Industries Company at IDEX and Beyond



Photo: Stephen Barnard

Fahad Mohammed Saeed Al Mheiri (left) and Stephen Barnard at the 2019 IAV Conference in Twickenham

Interview with Fahad Mohammed Saeed Al Mheiri, Executive Director, Business Development, Emirates Defense Industries Company (EDIC)

ESD: To put us into perspective, please, can you tell us about the latest developments within EDIC and the subsidiary companies since IDEX 2017?

EDIC: IDEX 2017 was 2 years ago, I had just been in the company, I guess for about 8 months. Since that time we have now fully consolidated all the companies that were planned to come under EDIC. At that time, few companies were still to be integrated. Today we have NIMR and GAL as part of the group, in line with having Land and Air MRO capabilities in place with EDIC Land MRO and AM-MROC, we are now also proud to have ADSB with their capabilities as part of the group. So, there has been a lot that has been happening on that aspect. Our focus over the last years has been to unify the group under a single Quality Management System from within, as you know, when you start with 16 assets, each and every one of them were running their own way, their own style and had their different cultures, having to pull that aspect all under one roof has required quite a lot of work from the whole team over at EDIC to ensure our policies, processes are aligned, it's not easy as we have a broad spectrum of activities to cover, for example going back to the MRO side, everything from land, sea and air. We have four companies that produce physical products, Barij Dynamics, previously known as Tawazun Dynamics,

so there has been a name change since the last IDEX, produce the Al Tariq and the P3 that was launched last year, we hope to have some exciting news to share at IDEX 2019 from them. During IDEX 2017 we launched Barij Munitions, we pulled together previously known companies Burkan and CLA, Barij Munitions covers the spectrum of munitions. A lot of changes and efforts in really making sure we align with the end-user, letting them understand where we stand today, how we work and the fact that we are really there as a strategic partner. A lot of proposals have gone out, and a lot of contracts signed and ongoing between EDIC throughout its assets and the UAE Armed Forces, thus they have seen that trend: prices coming down, stricter KPIs, the performance aspect all there driving forwards and all at a better value and a higher efficiency at the end of the day. It took some convincing, needed a lot of work. We had to prove it on paper, not just nice presentations and talk, so when proposals came round, contracts came to get renewed, and they see the difference. A clear history and a clear new path to show the EDIC effect.

ESD: So you have achieved what you wanted to within the country, to date. What about EDICs impact on the global stage, and as far as ESD is concerned, specifically within Europe?

EDIC: One of the other aspects as well was that we made sure we go back to our end-users and customers and let them understand how we stand as strategic partners and that we are there to listen, we are there to receive feedback. The great thing was, they did sit down with us, they did give us the feedback and because of that we have been able to in all that we produce, in all the assets that produce products, we have some new developments and new products that are going to be coming out

So from EDIC Caracal we got some new products that will be showcased at IDEX. NIMR will have some new products that will be showcased, Barij Dynamics' new products will be showcased, and Barij Munitions will have a new product to showcase. There has been a lot of internal movement to cater to our end-users' requirements.

ESD: Education of the workforce in particular, has that been a challenge? Where is your workforce from? Within the UAE?

EDIC: The workforce in the UAE is extremely cosmopolitan as you know, we always focus on the nationalization aspect, wanting to make sure that we retain the knowledge and the capabilities within the UAE... we are a minority in our own country, this is the same usually in any business or any work force that is out there. We have been really pushing to

maintain a high level of UAE nationals... On average I would say between 25-30% nationals. Not just in the administration offices, this is where we really pushed to have what we call touch Engineers, those who are physically involved, guys out in the field who gain real capabilities, both men and women.

ESD: And the training that you do for your workforce is all in house?

EDIC: The training aspect has been limited to be honest, over the last 2 years. There has been a lot restructuring, there has been a lot that has changed because we have not just brought in all the companies and consolidated under EDIC and let them just move forward with the way

thing is he understands the necessity to transfer that knowledge to those ready. This is part of the mission at the end of the day to ensure and empower UAE nationals in management. This is the ethos of what EDIC is doing. I come from outside the defense world, experience in the private, international, local government and federal government levels. He has really helped me gain the knowledge and understanding of the industry and helped me drive things forward.

ESD: What does EDIC bring to the European market, and vice versa, and what partnerships can be created?

EDIC: It has always been a vision to be able to export products from this indus-

and to ensure that you are as feasible as you can be. Your capacity is usually over your requirements and so it is quite difficult to be competitive in the global market. I think now, with the introduction of EDIC and everything that we have done to cut cost, to restructure, to re-look at all these aspects. On the supply chain there has been a lot of work that has happened there, where we are looking at group supply chain, categorised supply chain, and we are looking at where 2 assets could or do share the same supply chain. So now we have an economy of scale when it comes to the supply chain aspect, which has been a lot of work in the process and a lot of background work that the team has been doing to make sure it is happening. It is now coming together. They are understanding as well, we are not just going to accept - yes, ok thanks for that price, and we take it. Now bargaining happens. We look at it when we do have the bargaining power and there are a lot of people that know EDIC today and they understand where we are going, and they do want to partner up with us. This is where, on the European side, it is something where they see that we do have the capacity, we do have the capability, we are strategically placed to support local production. I think this is where, from the international market, we can really support as industry to work together as partners like we have seen throughout this whole conference in terms of working together to drive things forward. Not everybody can do everything anymore. It does not make sense, and this is something that EDIC understands. Before EDIC everyone was trying to do everything themselves and now with the synergies, we have there is a lot more organization on that and it has been working for us. Now in terms of what our outlook is forward regarding the international market, again our challenge was always our price point. Now things have changed. We do have some cutting-edge technology and capabilities. I would just like to highlight here Barij Dynamics. We have the Al-Tariq a precision guidance kit which is extremely competitive, and being able to supply this to our air force today at these rates will open up the ability for us to export these products. We have also been developing something a lot lighter and cost competitive and this is something we already started production in the beginning of 2018. We have already provided a vast number to our end user today. This is really the new product that could really take the world in terms of the price point



Photos: EDIC

EDIC subsidiary Abu Dhabi Shipbuilding contributes significantly to naval power projection and coastal defence of the UAE.

they were. So you have shared services from the finance, Human Capital, on the legal perspective, in the supply chain, the quality, so there was a lot of redundancy when you looked into it all. For us it was really about making sure we are keeping the right people. We were selecting the people who had the experience but also looking at people who maybe don't but have great potential and being able to move that forward, so we have a chain or ladder there built for the future and this is where training has not really been something that we have gone out to look for but it is more happening inside by people following mentors. Like me, for example, I report directly to our CEO, a man like himself with the experience he has in the industry is vital and the great

try. This has always been a challenge when it comes to commercial aspects the UAE exports plenty of products, not just services but physical products. In the military domain it has been extremely limited. We are a new player but definitely one to consider now, one to watch. UAE has always been one of those countries that when they are taking something seriously, they drive it forward and the military industry is really something we are looking out for. I believe previously the concern was always the price point. We have always been looking at catering to our end user, the UAE Armed Forces, and when you do that you are limiting yourself to certain quantities. And when you limit yourself to that demand volume, it becomes difficult to cover your NRE costs



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and in terms of the capability. You will definitely see this at IDEX 2019. There was a soft launch which was the P3 during the Dubai Air Show, but we will have a more prominent show of this product at this years' IDEX. We have done the testing, we have industrialized it and we have been delivering it to our end user. We do have a couple of new projects that are moving forward, and we will see that as well at IDEX, we have become recognized as a player in that position when we talk about air-to-ground capability. We also have a lot of interest from international parties for the product.

ESD: It is also a question of "Do you need to reinvent the wheel?"

EDIC: We are coming into a very niche market there and we are very proud of that product in terms of quality, capability and price point that we are able to obtain. Another product that we are really pushing forward is of course EDIC Caracal with our capabilities over there. There is a huge growth spurt on that aspect. We have been doing a lot in working together with our partners in Caracal Algeria. Focus has been placed on growing our US office, and of course supporting Merkel GMBH over in Germany. There has been a lot of work par-

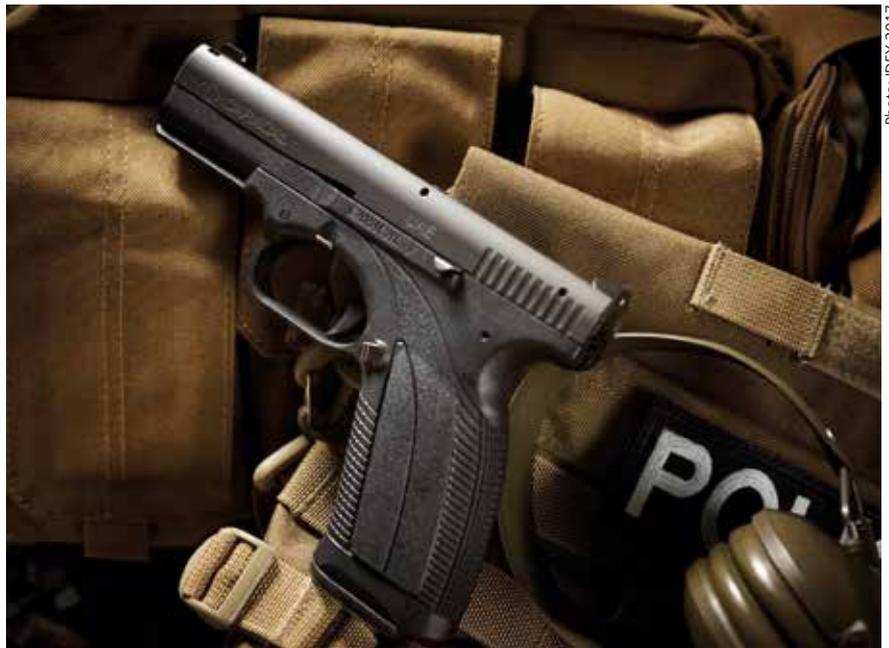


Photo: IDEX 2017

Police and military products from Caracal, an EDIC subsidiary, have achieved international recognition.

tender. We went through very rigorous technical testing, accuracy testing, all sorts of different requirements that came through from the Indian Army there and it is great to have found our product to be technically qualified, but even better that we were L1, meaning the lowest priced

were very pleased with the way that it has moved forward with the clarity and transparency they have shown thus far. Going into the ammunition side, Barij Munitions have really been focusing on certain capabilities inside and we are reducing our costs there and we will be coming out with a new product at IDEX. It is not new in the sense of a new sort of ammunition, but it is something that we now have under our belt as a certified and qualified medium calibre that we will be launching and that we are very proud of as well.

NIMR, of course, is one of the biggest in terms of moving out across the globe, if we talk about the different testing that has been done. We have done some more trials here, in 2018 we had things moving forward in Kuwait with tests and trials, in Algeria test trials have been going on, in Morocco, in Turkmenistan. We had tests all over Eastern Europe, from Romania to Lithuania, the Czech Republic, so there has been a lot happening on that. We have been part of a trial in Malaysia just after DSA last year. It was a very successful event; we had reports coming out of that with very positive results, so we are very happy with the capabilities. I think the vehicle speaks for itself and the capability and quality and hopefully at price point as well, we start to shine out on the international market.

ESD: Thank you.

The interview was conducted by Stephen Barnard.

Photo: NIMR



The HAFEET 640A 6x6 in Armoured Military Patrol Vehicle configuration

ticipating in a lot of international tenders where we have access to all the different capabilities in these locations to support us. You may have heard of the Indian project where they tendered for a 5.56mm CQB rifle there. It is a large number of weapons they are looking for in a very short period of time, so Caracal is L1 for

bidder. We have proposals and RFPs and tenders that we are looking at even in Germany coming out of Merkel under the brand Haenel in Germany, so that is a big tender as well for over 120,000 assault rifles. It is just us and H&K who qualified technically. We were very excited working towards the Indian contract and

Amidst Warfighting Exhibitors: The Bahrain Airshow 2018

Georg Mader

As everything in the Gulf region is measured in terms of growth and increase, so too is the fifth edition of the Bahrain International Airshow (BIAS), the largest to date. The event, dubbed the "fastest growing airshow" in the Middle East, recorded a 70% increase in exhibitor numbers in 2018.

Its timing was postponed to mid-November so as not to conflict with the Dubai Airshow. Kicked off by the 2nd Manama Airpower Symposium, the Bahrain Air Show had the theme of increased cooperation against regional and supra-regional opponents, including a commitment in the Yemen war, with Iran as the main enemy. Georg Mader has summarised some of the Air Show's highlights for ESD.

The island state of Bahrain is the smallest member of the Gulf Cooperation Council (GCC). Together with Kuwait, Oman, Qatar, Saudi Arabia and the UAE, it has signed a NATO-like defence pact to regard an attack on one of them as an attack on all. Nearly 20 airchiefs attended the high-profile "Manama Airpower Symposium" at Sofitel Manama. Besides the hosting Royal Bahrain Air Force Commander, the Air Chiefs or their deputies from Algeria, Jordan, Lebanon, Pakistan, Sudan, Iraq, Kuwait, the UAE, and Saudi Arabia, as well as the regional heads of the USAF and the RAF, gave presentations and shared insights.

A Threat from across the Gulf

Most speakers called for more regional cooperation and less "jealous" overclassification of information and data during multinational operations – not hard to guess against whom such operations are expected or planned. The main theme of this regional air force conference was to work better together to stop the Iranians on several fronts. Almost every keynote speaker referred to the Iranian threat and to real or perceived threats by various maritime and asymmetric capabilities of Iran true or Tehran-backed forces, such as the Triple-H Houthis, Hamas and Hezbollah. Another threat that all Gulf states are afraid of was Tehran's repeated announcement to block the important Strait of Hormuz, which would have a negative impact on the GCC states and the world economy. Several key figures with whom ESD spoke recalled that some Gulf states are involved in the proxy war against Iran in Yemen and other theatres of war. The head of the Royal Bahraini Air

Photo: RBAF



A Bahraini F16 Block 70

Force (RBAF), Maj.Gen. Hamad bin Abdullah Al Khalifah, said that the latest threat in Yemen – as in Syria – is small, conventional drones carrying explosives. He admitted that while the allies were coping well with Iranian large ballistic missiles fired by the Houthis, their drones with small explosives were obviously a real problem for them.

Another topic that is also perceived as urgent is the sophisticated electronic warfare (EW) conducted by Russia in Syria. In particular, Algeria, Egypt, Syria, Turkey and Iran could soon set up a kind of airspace control network that would report to Moscow using the long-range radar systems of various S-300 and S-400 air defence systems supplied or ordered. That is why the Gulf states are calling for EW counter technology as well as stronger regional networking and fewer national barriers to sensitive airspace data.

Interesting Statements

For the first time, the RBAF Air Chief has openly stated that the small fleet of F-16s has flown 10,000 hours in 3,500 combat operations from Saudi Air Force bases since 2015 in Operation "Decisive Storm" over Yemen. These 20 older F-16C/Ds – two have crashed – will double their performance from 2021, with Bahrain being the first customer of 16

of the latest F-16 Block-70 for US\$3.5Bn. The Obama administration has stopped the deal because of human rights issues related to Sunnis and Shiites, but the Trump government has approved it. Lockheed Martin's Vice President Gary North commented that Bahrain gave them three years to move F-16 production from Fort Worth to Greenville, SC; the Slovak Block-70 will also come from there. Cdr. Lt.Gen. Joseph Guastella of USAF AF-CENT Middle East recalled that through the joint effort of all allies, 'Daesh' was reduced to 2% of the area they had claimed a few years ago. He also confirmed that the US is no longer supporting the Saudi Arabia-led coalition over Yemen with refuelling and AWACS missions. Lebanese AF Chief Brig. Gen. pilot Ziad Haikal gave an overview on dumb bombs and rockets from the decommissioned HAWKER HUNTER which were mounted on the helicopter IAR330SM PUMA for air strikes against Daesh in 2014 and 2017, as well as on the successful deployment of the Cessna CARAVAN and SCANEAGLE UAVs. Brig. Gen. pilot Adham Belal Asendar, as Assistant Commander of the Royal Jordanian Air Force, complained that he was not very satisfied with his Chinese CH-4B armed UAVs. The RJAF wanted to retire them, but he did not give any reasons. Pakistani AVM Ahsan Rafiq spoke about the benefits of good

ISR and explained how the Pakistan Air Force has developed ISR and interdepartmental cooperation in domestic (air) warfare against Islamists in Pakistan's FATA tribal areas. As the first Pakistani pilot to fly the Pakistani-Chinese aircraft JF-17, he confirmed that the type's Block III AESA radar choices are now narrowed down to two Chinese sets.

Between the Dubai Air Show and IDEX Abu Dhabi

The aforementioned 70% increase in attendance at Bahrain Airshow at Sakhir Airbase meant 187 companies were present, including 11 of the world's top 15. Doubling the exhibition space since 2010 has made the event an important part in the annual aerospace calendar, said Amanda Stainer, Commercial Director of Farnborough International Ltd. and co-organiser of BIAS. While in 2018 five new international pavilions were added for the UAE, USA, Russia, Romania and Kuwait, most of the more than US\$5bn in orders and procurements signed at the show for aerospace were civil (mainly AIRBUS) orders. The largest military contract signed on the second day of the show was signed by Maj. Gen. Al Khalifah, Bell's CEO Bill Snyder and FMS Chief Lt. Gen. Hooper and concerned what had been approved by the Foreign Ministry by the end of April last year: 12 AH-1Z VIPER two-seater combat helicopters for the RBAF for US\$912M. Its predecessor, the Vietnamese AH-1 COBRA, is well established in Bahrain, which may have been the deciding factor. These older combat helicopters are not to be replaced or decommissioned because of the VIPERs, but are already being upgraded by Turkish Aerospace and Aselsan. Unfortunately, it was still too early for the RBAF to dispatch a VIPER to Shakir AB. The expansion of the fleet should be completed by the end of 2019. Several journalists asked whether the USA would now deliver the AH-1Zs ordered by Pakistan to Bahrain. DSCA and FMS chief Lt. Gen. Hooper explicitly denied this, pointing out that the equipment of both AH-1Z versions is very different and that the Pakistani aircraft are currently stored in Davis-Monthan (AZ) until the current US Government decides how to proceed with regard to relations with Islamabad. A Pakistani journalist was convinced that once the current US war on terror subsides, the helicopters for the Pakistani Army would probably be delivered without further ado. At the show, the first of two former RAF C-130Js was also presented; these were sold to Bahrain and overhauled by Marshall Aerospace and Defence Group in Cambridge. The crew was also trained there. Six BAE HAWK-129s, which were delivered from



Photo: Georg Mader

Air Chiefs Symposium

2006 onwards, also come from the UK. However, there is a lack of basic aviation training in Bahrain. Since the Slingsby T67 FIREFLY aircraft are no longer operational, young Bahrainian pilots are sent to Egypt, Saudi Arabia, the UAE and Great Britain for aviation training.

Colourful Air Displays

The daily displays saw the participation of 110 military and civilian aircraft. The UAE display team "Al Fursan" made its debut at the show and was complemented by its Italian MB-339 role models "Frecce Tricolori". Despite warnings of Russia's military presence in the region, Bahrain experienced a rare visit of the "Russian Knights" display team to show their impressive new Su-30SMs. Since the rift between Russia and the West in 2014, one has to travel to Malaysia or Bahrain to see these large machines, which thanks to their 3D TVC nozzles can violate the very laws of aerodynamics. Surprisingly, these first-class Russian pilots were on average about ten years older than their Western counterparts. Another highlight at the show was the many US military aircraft, such as the F-16C, the MV-22, the B-1B, a USMC F-35B and F-15E, the CH-53, MH-60S and the AV-8B HARRIER. In 2016, the Indian agencies DRDO and ADA sent two indigenous HAL TEJAS to BIAS, which were presented here for the first time by DRDO CEO Dr. Christopher. Bahrain officials hoped this year India would again send a large delegation and some aircraft to BIAS, considering India's intention to establish a defence department at the Indian Embassy in Manama. As a result of the 2+2 dialogue between the defence and foreign ministers of India and the USA, India's proposal to send a naval captain to Bahrain was accepted in September 2018. The Indians, however, did not attend the BIAS, but promised to participate by 2020. Kuwait's Deputy Chief of Air Force Cdr. Brig. Gen. Almutairi remarked in a conversation about the Eurofighter TYPHOON that "a country as rich as Austria should give up this first series and buy new Tranche 3 just like we did". Kuwait expects the first of 28 TYPHOONs by the end of 2019. Oman re-

ceived all its 12 T3 Eurofighters assembled in the UK in mid 2018, and Qatar will receive 24 Eurofighter TYPHOONs starting in 2022. Interestingly, the Sudanese Air Chief said he also wanted the Eurofighter if there were no sanctions, even though his government is discussing with Moscow the delivery of Su-30 and Su-35. Commenting on the Austrian dispute over the TYPHOON, he said: "I would immediately take your 15 TYPHOONs as they are. This aircraft is the finest out there!"

"Leave the moon and outer space alone..."

An interesting moment of the BIAS flight show was the appearance of an American astronaut who is one of only 24 people - only 12 of them are still among us - who have flown to the moon: Alfred Worden (86), West Point graduate, USAF veteran and astronaut of the APOLLO 15 mission in 1971. As a guest of the Air Force and the University of Bahrain, his most important message to the assembled high-ranking military community was to spare moon and space with military considerations: "Space is a risky realm. There will be problems, there will be accidents. It is so difficult, complex and expensive to get there. We flew to the moon with 6.5 million pounds take-off weight and had a payload capacity of 261,000 pounds in Earth orbit. We returned with 3,350 pounds! It does not make any sense militarise the moon or space with our current technological means, despite all the computing power and automation. Look, we are now falling back on tiny capsules at the tip of giant rockets. Moreover, today everyone is so safety-conscious that we are not getting anywhere. I think the ORION is just a copy of APOLLO, but a little bigger. The SOS is another SATURN-V with some solid boosters strapped to it. It's a kind of regeneration of old technology, and much of it is due to the bureaucracy we see today. And that would be much worse if military thinking and secrecy were added. No, while the use of military in Earth orbit makes sense for the security of the nations, it doesn't make sense further out there." ■

Bren-Tronics Battery Developments: Power with Control



Photos: Bren-Tronics

**Interview with Sylvain Lhuissier,
Vice President International Operations,
Bren-Tronics**



ESD: What are the major engineering and technical challenges being faced at the moment by the military power-generation industry? What are the imminent challenges?

Lhuissier: For more than 20 years now the challenges remain the same; a safe power solution that is low in weight, has a high capacity and is robust, to face all the operational requirements. The trend over the past 10 years of higher capacity has more or less doubled the capacity of standard lithium-ion cells - what we call 18-650 type cells. Capacity is the storing capability of a cell and is expressed by amp-hours and is directly related to the autonomy, the running time of the device. Charge/discharge cycles - cycle life - is the duration of a product expressed as its maximum number of cycles, and the challenge for lithium-ion batteries is to combine the capacity, the running time of the system; the life of the battery, how many cycles a battery can accept; and the power, so that means how much power/current we can drain instantaneously. Over the past years we faced different challenges in terms of applications, power demands. For instance, lithium batteries were used 15 years ago mostly in radio communication and optronic systems with quite low, constant power consumption. Today, we are also powering robots and robot engines, meaning high power-peaks: For weapon systems or electronic warfare, jammers we do not need a high-inrush current, rather a constant high power, so that's another

challenge. The same batteries should have the longest running time - capacity - but also be able to provide more power. The third part of the challenge is the thermal environment, from -30°C up to $+60^{\circ}\text{C}$. And when you drain current you generate heat. So, the challenge is to design the appropriate electronic control and overall battery pack to be able to provide power under high-temperature conditions and still operate in a safe manner.

ESD: Safe delivery of power and thermal management: what happens if a cell or battery gets physically damaged?

Lhuissier: By offering more capacity in the same, size, volume and weight of a standard cell, obviously we provide a more reactive element, so if something happens, it is a bigger reaction. That needs to be controlled and a way to control it is to monitor, in real-time, the flows of current and voltage of each element inside a battery pack. A cell or battery pack going into short-circuit, leading to an incident, is the risk in terms of safety and is always by outside abuse. It can be electrical abuse - a mismatch of the charging solution, when you connect a charger incorrectly, for example, or have a current or voltage impulse that is too high. The batteries and chargers must be qualified together and in each there must be some control to monitor what is going in, what is going out. In the battery in discharge mode there are normally no problems, and if a battery is short-circuited outside there are internal safety protections

that cut any ionic reactions, so it does not provide any more electricity. The second danger is from overheating. Obviously, if you throw a battery into a fire, you put the battery into a very hot environment and there is no way to suppress any internal thermal runaway, because of the environment. There we just specify that it should not be used outside of the qualified thermal range, which, as I said before, is from -30°C to $+60^{\circ}\text{C}$. So, first stoppage is at the PCB (protection circuit board) level and the electronic control - we stop any usage of the battery. The PCB is an electronic protection for the battery pack. That is around $75-80^{\circ}\text{C}$. That is resettable, but this becomes permanent protection when we reach between $95-100^{\circ}\text{C}$, depending on the design, at which point the battery is damaged; we cannot use it anymore, but it is safe. If the temperature continues to rise inside the cells then there is a mechanical breaker, a poly-switch, which physically isolates the electrode and then avoids any more ionic, chemical flows. That is around 120°C , which is a standard for the lithium-ion cells industry. There are some internal protections inside the battery as well, electronics that cut the operations and also inside the cells and in each chemical element there are poly-switches that can cut above 120°C and isolate each cell to avoid any ionic reaction. If one cell goes into default for whatever reason, it can self-isolate and protect thanks to this poly-switch feature. The state-of-the-art designers and serious providers are incorporating these protec-

tions - actually, the state of the art is to design safe, reliable lithium-ion battery packs. Some manufacturers are putting together simple combinations of four to eight cells which in terms of reactivity is not so critical, and have a very basic BMS - Battery Management Systems. But for some of our designs in Bren-Tronics we are managing up to 300 cells, and there you'd better have thermal sensors around the battery, and inside, monitoring the differences in temperature elevation in each area of the battery!

The third potential threat is mechanical. If you crush a battery or shoot it, as in the ballistic test, which is key in our industry, it creates a short-circuit inside the pack which can cause the cells to react. There is actually no way to avoid an incident or reaction for lithium-ion batteries subjected to the ballistic test. There are different lithium-based chemistries that are more or less reactive, and we can observe the specific energy, in watt-hours per kilogramme (Wh/kg). If we are above 200 Wh/kg, like an NCA lithium formulation, there is heightened reactivity, but if we go for a lithium-ion phosphate formulation, we are in the range of 100/150 Wh/kg or lower, and there is less reactivity.

Our core business is the design of lithium-ion batteries for tactical man-portable applications. A key element for us has always been safety, to make sure the battery will not overreact. But on the other hand, we are following what lithium chemistry technology offers us from mass production, from the worldwide portable application market and so we have now to deal with a higher capacity, higher energy storage, which is good to resolve the request for low-weight and longer running time, but it has to be integrated and accepted with a certain level of risk. And now, how to mitigate this risk — that is what we are working on now for the very near future.

ESD: How much of your business is the smaller batteries for portable and unmanned systems, for example, and batteries for vehicles?

Lhuissier: The portable lithium-ion battery market started 20 years ago and at the time Bren-Tronics won the standardisation programme from the US Army, and so we had a chance to lead the design and this market, specifically for the US. We opened international operations in around 2005, and now we are also very

active on the European and international market. Today, that represents a yearly production of more than 100,000 battery packs per year, a battery pack being a pack that is used for a portable military application. The most famous battery is the BB2590, used in more than 90



One of Bren-Tronics' rechargeable lithium-ion military batteries

different military applications, qualified worldwide, initially from the US but also at NATO level. For instance, the French Army just qualified it for the new MMP weapon system. It is used for robotics, radio communications, jammers, and so on. That is our core business. I mentioned we have a yearly production in the range of 100,000 units which for a military industry is huge production and that gives us a competitive advantage because we use standard elements, standard pack, so we can improve the manufacturing cost and always keep a cutting-edge technology performance approach in the design.

ESD: And the cutting edge that you have comes from, primarily, your electronic capabilities in terms of the control?

Lhuissier: The cutting edge is not only our chemical cells performance - because of our position and volume and the very specific environmental constraints we are facing, we have access to tier-one suppliers worldwide, access to the latest technologies and formulations and so on. Also cutting edge is the challenge to integrate those cells into a safe design to respond to the mission of the application. Over the past 20 years Bren-Tronics developed the

electronic control, the BMS and the software which are now embedded into every single battery pack to provide the level of safety and performance required by military standards. To put it simply, a modern battery pack is one-third chemical, one-third electronic design, OCBs, control and one-third software, plus of course the mechanical integration. Software is key, because all the systems are smart and there is a permanent communication between the application, the device, the system and the environment. So that means that the battery also needs to communicate its status information, providing alarms, alerts, and so on, so that the overall system can be consumption-optimised to last longer, be safer and help to fulfil the mission for the soldier.

We are in a leading position for tactical military power systems. We noticed a few years ago that what is happening on the soldier is also happening on the vehicle at a platform level: each platform - soldier or vehicle - requires more sensors, electronics, to communicate, to protect itself and to detect. Every element on the battlefield becomes a sensor, which is connected to a bigger network, and each sensor requires power. The vehicle becomes a key element in this network, not only driving, carrying the troops but also providing information about the environment. All the latest vehicle upgrade programmes in the US and Europe demand more electronic warfare capabilities, electronic capabilities, communications, and so on, on top of the previous mission equipment. That requires more power, so we introduced lithium-ion technology into the military vehicle battery standard. We are not alone; it is a market trend. This is a demand now from the customers, like Ministries of Defence but also the military vehicle industry and the defence electronic systems integrators. The challenge remains exactly the same as for portable power solutions: compact, lightweight, the highest capacity, high power, temperature, safety, all these things. Except that instead of dealing with a few cells, now we are managing several hundred lithium-ion cells, so the electronics become more and more critical and also the mechanical integration. If we shoot into a single cell, it can catch fire, but it remains a pack of a few cells and it is portable, light, and can be removed. Now, vehicle batteries are embedded so as not to become a weak point. With such high power, high energy stored inside a vehicle - we are talking about 2.5 kWh in a single battery pack - that requires proper integration, which we are addressing in two ways.

The first is the battery itself: we are changing the design, not optimising weight but rather using metal cases to contain fire or to protect in an incident. Recent integration work with key partners has shown the value of putting batteries into special compartments: not armoured, but protected; separated from the crew and cabin.

The challenge now for industry is to convince not the operators, nor the fighters, but the engineering and safety authorities of the different Ministries of Defence to authorise and approve this technology on board the vehicles. This approval is being discussed. Every Ministry of Defence is conducting its own studies and analysis to define the risk and then make a decision knowing what the risk is. On the other

hand, they need this technology in the vehicles of the 21st century. And there is a parallel to what is going on in the automotive industry. It will happen, it is happening, it is a matter of a few months or a year to get it really integrated and fully in use and deployed in military vehicles.

ESD: Looking ahead, where will current and future markets and current and future technologies take us?

Lhuissier: Regarding the markets, the power demand from any platform is giving us great challenges, but it's also a much bigger market than in the past. In five years we expect to make as much in the man-portable domain as with vehicles. Right now, it is 90% man-portable, 10% vehicle but because of the demand and the technology involved we can achieve 50/50. That means, it will grow for our company and it gives us a way to grow the activity with more and more complex technical solutions, so it is very challenging, but actually at Bren-Tronics we have 20% of our resources now being engineering-oriented, so that is the way we want to follow and to address more challenging engineering markets and demands.

We still have three types of markets. One is Soldier Modernisation Programmes. There were some significant programmes

that occurred and that are now being deployed and delivered, but only five countries really went through with their plans. In the US, in Europe, in Asia, but only five, I would say. It is still a hot topic, but the vision, the architecture of each system changed over the years, adapting to the lessons learned from conflicts in Afghanistan, Iraq, in Northern Africa or the Sahelian stripe. This remains a big potential market for us, because this is what we are good at: lightweight, portable power solutions. The second, booming market remains man-portable systems used, for example, in electronic warfare. That will continue. Ten years ago, there were no jammers; now it is a jammer per section.



A Bren-Tronics Soldier Portable Charger (SPC) for military-grade lithium-ion batteries

There will always be a huge demand for radio communications and so on, so that remains a core area of business. The third: vehicles. This means not only land vehicles but also all the robotics - ground solutions, but also underwater, and surface robots, and UAVs. We are starting on some significant programmes in the US but also in France to design specific, very smart, high-capacity, high-performance batteries for those applications. The challenge is not only to provide the amount of energy and power required but again, to provide complete interaction software

exchange between the battery, the power solution, the system and the information to assist users to make the right decision.

ESD: You mentioned robotics: where does that fit in with the company's own priorities? What are your priorities looking forward?

Lhuissier: Robotics for us means high-power. Managing burst current to power an engine, that is what it means. It can be in any condition: flying, swimming, rolling, driving. That is the challenge. We have adapted our engineering staff now to be more power, rather than energy, oriented. That means having the right engineering resources to design some high-power stuff, not only in terms of batteries but also in terms of power conversion, power distribution — and the challenge is to integrate into a complex system including the vehicle alternator, if we are considering a ground vehicle, the different engines, and different components around. We are also now looking at this higher level; I mean system integration for power distribution. In terms of robotics, there is another big challenge in here that is related to UAVs or drones.

A battery is a storage system; it is a way to store energy. For the future we are looking at a complete integrated system, for example, on a stand-alone solar system, which is a top priority in terms of energy/power generation that we then store in lithium-ion batteries and then deliver smartly according to the need. This concept is now widely integrated into our engineering teams.

Design kits or very small systems at the level of a soldier modernisation programme, for instance, up to a complete container for camp, hybrid container where we can connect together solar inputs, diesel generator, need some storage and distribute some high power to a camp. I am talking about 60 kW or more, whereas for a soldier we are talking about 12 or 15 watts. We are really mastering the energy and power requirements for military applications from a few watts to some 100 kilowatts. Solar is key; also, that corresponds to some priorities, for instance, given by the French MoD. Part of their Top Three innovation technologies, there is robotics, soldier protection and solar energy. How to integrate more solar energy on the field? That is really one of our top priorities. Lithium is not well accepted yet for anything flying, and safety remains a challenge. We see a large potential market in the aviation industry and the opportunities widely to introduce lithium-ion technology for aviation. We are already working on some chemical improvements in lithium-ion cell technology, with key developers in the US of "safe



A Bren-Tronics 4 Bay and 2 Bay FLEX CHARGER for military batteries

core cells". It involves a special process to create short-circuit isolation in the cells at the electrode level – and it's not only for our market and military applications. Naval applications are also an area of interest, just at the start of introducing some lithium technology into submarines. We are too far from this world, coming from ground systems, land forces and so on, but we are keeping this as a potential growth area. Clearly

the top priority is to make sure that lithium is adopted, qualified first for vehicle land systems and then, after demonstrating safety in land systems, we could introduce it also to submarines and naval applications. In our market you have two steps. The first one is delivering power for a new programme, a new system, where there are specifications and they want a qualified solution. But 5 to 10 years after, there is the

replacement, the follow-on business, which is just a maintenance and replacement programme run by administrative buyers, and there they are just comparing part numbers. If the process is not appropriately controlled and managed, some low-cost supplier could present an equivalent product, wearing the same numbers but not having passed the full qualification - and of course, being less expensive. In the best case, the customer needs to replace the batteries every year, instead of 4 to 5 years, but the worst case could lead to a serious incident because of lack of qualification. It is important that the buying community be aware that batteries are a hazardous product, strictly classified, and if two products wear the same NSN, it does not mean that they are of identical technical quality and performance. The original designer - and Bren-Tronics is the original designer for many lithium-ion military batteries - will not only provide a good product, but also all the services, and additional work behind the scenes to make sure the product is state of the art.

The interview was conducted by Stephen Barnard.



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The Latest in Military Training and Simulation

William Carter

The annual I/ITSEC is the world's largest annual training and simulation event by a wide margin. ESD attended the event.

The 2018 International and Inter-Service Training, Simulation and Education Conference (I/ITSEC) and exhibition was held at the Orange County Exhibition Centre in Orlando, Florida, over four days in November. It had a throughput of over 16,000 people over the four days; there were presentations by Generals and Admirals, and the exhibition covered several hectares with 315 different exhibitors from 14 countries. Most of the exhibitors were from the US, followed by the UK, Canada, Germany, Israel, France, and others. In the conference sessions, 142 papers were presented and there were 34 tutorials, 32 special events and 25 workshops.

Keynote Addresses

The first speaker was Admiral Chris Grady, Commander of US Navy Fleet Forces Command. He said that the nature of weapons is changing and we need to push the leading-edge of training, so that we can "out-innovate" our competitors. He challenged manufacturers in the audience to produce the technologies that we need. In live training, he admitted, realistic combat cannot be completely replicated. Therefore, the missing areas should be simulated so that, if conflict comes, people can say "we have been there before". Limitations in live training include how to model the potential enemy, and it is also important during live training not to give away potential future actions to people who may spy on military exercises. Simulation, he said, gives us more repetitions and sets of repetitions than live training, particularly in critical areas – this is often abbreviated to the current buzzword "Reps-and-Sets". Now it is possible to rehearse the fight using virtual technology, he said, and current Navy exercises use both live and virtual. Exercises include ships at sea, land-based simulators for ships and their weapons, and "pierside training" where moored ships can have their operational systems sTimulated (note the extra letter "T") with

exercise material, and so participate in a realistic exercise even though they are in port. He suggested that no-notice training could be held for scenarios that are not possible in live on-range exercises. He concluded by saying that we need a seamless mix of live and virtual - we are not there yet - so "we need your help and we need it now".

Aviation Administration (FAA). Aircraft producers like Boeing, he said, had enormous amounts of "Big Data" that should be used for not only for analysis but also for Virtual Reality-based training applications. He concluded by saying that industry is highly adaptable and this should be utilised by the military, particularly in the simulation and training area.



Photo: William Carter

An FS1 Open Plan PILATUS Flight Simulator at IITSEC

Admiral Grady was followed by Stan Deal of Boeing Global Systems. A key military feature is "readiness" which needs good training systems to prepare for it. Modern training technology must be made available to the military quickly, he continued. Turning to civil/military interaction, the military must take advantage of progress in civil simulation and there are military aircraft based on civil designs such as the Boeing P-8 POSEIDON maritime patrol aircraft for which its simulators are derived from highly capable Full Flight Simulators (FFS) designed to the standards of the US Federal

Fred Drummond is Deputy Assistant Secretary of Defence for Force Education and Training in the Pentagon. He mentioned the strategy of Defence Secretary Mattis, a retired US Marine General who gave an impressive keynote address to the I/ITSEC conference back in 2009, in which he emphasised the need for cooperation with allied nations (Mattis has since resigned from the Trump administration due to the President's decision to withdraw from Syria). Drummond said that "we must break the stovepipes", that is, systems that are unique to one equip-

ment and cannot be transferred to others. A blended approach was needed, taking into account land, sea, air, cyber and space, using a Secure LVC Advanced Training Environment (SLATE), and he

mon interests irrespective of the colour of their uniform. In conclusion, he suggested that the business case for future M&S systems should include their potential for tri-service and international use.

(AFC) headquartered at Austin, Texas. "Please bring us your ideas" he said, on subjects such as simulator acquisition strategy and how to streamline documentation.

Photo: William Carter



gave the example of Combined Operations (ConOps) training at the National Training Center at Fort Irwin. He also mentioned multinational Coalition Warrior training. More innovation is coming, he said, with stovepipes replaced by common systems including transferrable databases. He concluded by saying that in the future "we must be joint, we must be coalition."

Major General Michael Fantini is Director of Global Power Programmes at HQ US Air Force in Washington, responsible for 159 Air Force, joint service and international programmes with a US\$10Bn annual budget. He emphasised the need to leverage Modelling and Simulation and said that we should discard stovepipe systems and introduce open, secure architectures with common standards that can also be used by coalition nations. He mentioned multi-level security which, using modern IT systems, can now be achieved without the time-consuming manual security filters of the past. Young servicemen, he said, know how modern IT works and "can advise us Generals", so that the old guard can "let go" of old systems. Modern flight simulators are now really good and crews say that they give great training. Another example is the Nellis ranges in Nevada which are now complemented by a Virtual Test and Training Range (VTTR) system that uses modern simulation technology and does not require deployments of aircraft to Nellis. The future of training includes open-and-common standards, he said, across all three services and friendly nations. Tri-service cooperation is sometimes not easy, he continued, although at the working level there is less difficulty because specialists share com-

Major General William Mullen, US Marine Corps, commands the Air Ground Combat Centre at Marine Base Twentynine Palms in California, and said that our training environments should be difficult, even "disruptive" in the sense of deliberately doing things differently. Our big training challenge is "time", he continued, and synthetic training saves time. Self-paced learning should be used rather than classroom lectures, and fortunately "our young folks are digital natives". People need to make mistakes in training, he said, because that is the way to learn. After individual training at home bases, people can then get together for combined training. All training ranges should be instrumented for After Action Review (AAR), including for "mega city" training for urban combat.

Brigadier Michael Sloane is the Programme Executive Officer (PEO) for Simulation, Training and Instrumentation (STRI), based in Orlando, in charge of an annual US\$3Bn programme with eight main functional teams in which projects are run at colonel level. Modern synthetic training means that a unit can have 25 simulated fights before a real one, he said. All three services are represented in Orlando, he said, at which a multifunctional facility has just been established. The three services work together better than 10 years ago, he continued, and the Army is working with the Marines in common task areas. A monthly Industry Day is held by the STRI organisation, and inputs are made to the Defence Acquisition University (DAU) at Fort Belvoir, Virginia, and to Army Futures Command

In sum, the I/ITSEC keynotes were forward-looking and recognised the power of modern simulation. However, due to the large size of the US Services, although top-level motivation is there, it may take a few more years to retire old training systems and put state-of-the-art new ones in place.

US Navy Briefing

Rear Admiral Ronald Boxall, Director of Surface Warfare, referred to the Immersive Ship Virtual Environment (ISVE) system for future training. We need upgradable training systems, he said, both in land-based training and also on-board.

Rear Admiral Gregory Harris, Chief of Naval Air Training (CNATRA), is in charge of five wings consisting of 18 squadrons. "We already have Warfare Development Centres (WDC) for sea, air and underwater training, and look forward to introducing VR and Augmented Reality (AR) systems," he said, and continued that there is a need to make mistakes in training so that they are not made in real combat.

Captain Tim Hill, head of Training Systems Division, Naval Air Warfare Centre (NAWC TSD), said that "our acquisition rules sometimes slowed up procurement in some areas, and perhaps for small items a system similar to credit card acquisition could be considered. We need to beat the end of year log jam where funds have either to be spent by the end of the Financial Year, or are lost."

US Marine Briefing

Major General William Mullen commands the Air Ground Combat Centre at Marine Base Twentynine Palms in California and

said that classroom-based training should be replaced by online self-paced training. On exercises, all elements should be instrumented so that After Action Review (AAR) can be used to "do it again, and again –

about 3,000 are waiting for their next course – the waiting number needs reducing and digitisation of training material will help. The intention is to buy high-end simulation systems and update

The Exhibition

The exhibition catalogue listed 315 exhibitors from 14 countries. The US delivered 265 of those exhibitors, followed by 11 from the UK, 7 each from Canada and Germany, 5 from Israel, 4 from France, 3 each from the Netherlands, Sweden, Switzerland, and others from Australia, Denmark, Poland, Singapore, and South Korea. Such a huge exhibition is difficult to summarise; suffice it to say that all areas of modern training and simulation were represented: land, sea, air, cyber, electronic warfare, and so forth. The only qualification is that physically large devices such as aircraft Full Flight and Full Mission Simulators (FFS/FMS) are not seen on the exhibition floor, because they are simply too big and complex to transport to an exhibition for only a few days.

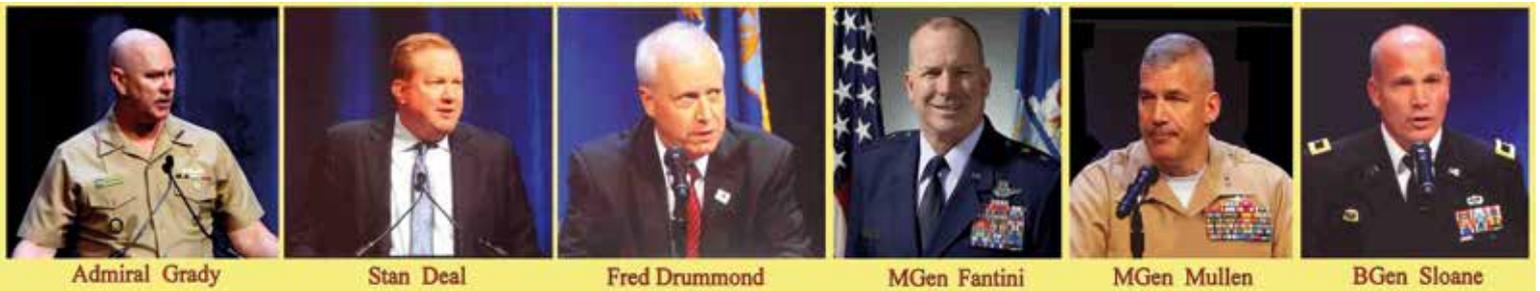
Conference Sessions

With 134 papers plus 91 special events, tutorials and workshops – a total of 225 items – it is difficult to summarise except to say that this is the most comprehensive annual set of training and simulation papers and events in the world. Just picking a few subjects to illustrate the breadth, these included Cloud-Based Systems, Decision-Making Training, Distributed Mission Training for the Land, Sea, Air and Cyber Domains, Medical Simu-



Army is doing it and the Brits are doing it", he said. "How do we do this except through simulation?" he continued. "We need to think flexibly and get out of the groove." Brigadier Eric Austin, Deputy Commander of USMC Forces Command, said that many pilots get 13 simulator rides before they fly the jet. Simulation, he said, does

facilities such as schoolhouses and other training buildings. Future classrooms will have computer-based training bays for students, monitored by state-of-the-art instructor stations, and they will be extensively used before students first transition to the real equipment. In addition, future big exercises will exploit Live, Vir-



The Keynote Speakers

not have the limitations that apply to aircraft and use of live weapons, and it has been particularly effective in training for flying with Night Vision Goggles (NVGs). The Marine Corps Aviation Master Plan (MCAMP) started 4 years ago and includes linking all simulators for combined training. In addition, deployable simulators are to be available for training away from home bases. The Marine Air-Ground Task Force (MAGTF) system includes the ability to connect simulators and other training devices for ground and air training. Brigadier Calvert Worth is in charge of USMC Training Command, headquartered in Quantico, Virginia. Some 100,000 trainees per year are currently processed, although at any one time

tual and Constructive (LVC) technology. The youth of today are digital natives, he said, and expect good training systems. Colonel Luis Lara is Programme Manager for Marine Training Systems and said that much progress has been made on the aviation side of training, but the ground side has some way to go. There is a need for distributed and blended training, and live training frequently cannot respond in time and is costly. Using synthetics, improvements of between 20% and 50% have been seen in some areas. A so-called Live Virtual Constructive Training Environment (LVC-TE) system is based at the Twentynine Palms Marine Base. He suggested that repeats and sets of repeats (Reps and Sets) is the answer to effective training.

lation, Variable Security for Multinational Training, Virtual and Augmented Reality, and many more subjects.

Summary

IITSEC is the largest annual world event devoted to Training and Simulation (T&S), and is held every November/December at the Orange County Convention Centre on the south side of Orlando. This is in contrast to the much smaller European ITEC event each June that moves from place to place every year, and this year is in Stockholm from 14-16 May. Anyone with an interest in T&S should think seriously of attending the larger and longer IITSEC event for a couple of days. For your diary, IITSEC 2019 is from 2-6 December with the Keynotes on 3 December. ■

Photo: William Carter

Czech IFV Competition

(gwh) The Czech Ministry of Defence has announced that it will invite four bidders to submit a bid for a new Infantry Fighting Vehicle (IFV). BAE Systems will be competing with the CV90 Mk IV, General Dynamics European Land Systems (GDELS) with the ASCOD, PSM with the PUMA and Rheinmetall Landsysteme with the LYNX KF 41. These four IFVs had already been tested by the Czech armed forces in advance. On the basis of the offers, a development

Artwork: Gerhard Heirning



and supply contract is to be concluded in August 2019, under which the delivery of 210 vehicles in the period 2020 to 2025 is to be agreed. The service life is estimated to be thirty years.

JLTV Joins the Troops

(gwh) Since 2015, Oshkosh has been responsible for the production of the Joint Light Tactical Vehicle. Following the tenth partial order worth €1.4 billion for 6,107 vehicles, the final series order for a total of almost 50,000 vehicles is now expected. Oshkosh has delivered more than 2,600 JLTVs to date. After the final testing and final delivery of the vehicles by the US Army, the 1st Brigade Combat Team (3rd Infantry Division) is currently the first unit to be equipped with the

Photo: Oshkosh



JLTV. By the end of March 2019, around 500 vehicles are to be handed over. The delivery of further units will follow. The JLTV vehicle family was developed to restore the payload/performance ratio and improve crew protection. The JLTV programme is on schedule and on budget. To date, two variants and four mission package configurations have been produced: General Purpose Vehicle, Close Combat Weapon Carrier, Heavy Weapon Carrier and Transport Vehicle.

Minehunters for Indonesia

(ck) The Indonesian MoD has commissioned Abeking & Rasmussen to design

Photo: Abeking & Rasmussen



and build two mine hunting vehicles for the Indonesian Navy. The 62 m long design was developed in recent years by ABEKING & RASMUSSEN using state-of-the-art design and production techniques and goes back to the FRANKENTHAL class of the German Navy. The MCM suite includes a modern minehunting sonar and unmanned vehicles.

New Head of Military Aircraft at Airbus DS

(ck) Airbus SE has appointed Alberto Gutiérrez (56) Head of Military Aircraft. He will report to Airbus DS CEO Dirk Hoke and become Member of the division's

Photo: Airbus DS



Executive Committee. He succeeds Fernando Alonso, 62, who will retire after 37 years at Airbus. Gutiérrez has an extensive background in Military Aircraft; currently Deputy Head of Military Aircraft within Airbus DS since July 2017, he was CEO of Eurofighter GmbH based in Germany from 2013 to 2016. He held many senior management positions in Airbus DS as Head of Operations for Airbus Military and Head of Eurofighter Production for Germany and Spain. He has an engineering degree from Universidad Politécnica of Madrid.

Airbus and Hungary Announce Long-Term Industrial Partnership

(ck) As part of the 'ZRINYI 2026' armed forces development programme, which aims at establishing independent Hungarian defence capabilities, Airbus Helicopters will set up a production facility for high precision mechanical parts for helicopter dynamic systems in Hungary that

will then be delivered to the major component assembly centre for dynamic parts to be fitted on to the various helicopters of the Airbus family. The agreement will also rely on a local supply chain being qualified to perform certain tasks such as surface treatment. Hungary has been a long-standing customer of Airbus civil and military products: the Hungarian MoD has recently purchased 36 helicopters, 20 H145Ms and 16 H225Ms, and it also operates two A319 aircraft.

Emiratization in Abu Dhabi

(ck) Al Seer Marine, the Abu Dhabi based boat builder and manufacturer of Unmanned Surface Vessels (USV), will launch

Photo: Al Seer Marine



a training programme for Emirati engineering graduates to boost Abu Dhabi's nationalisation efforts in maritime defence. The programme will focus on "upskilling" UAE nationals pursuing a career in the marine robotics industry. Robotics, networking, communications and autonomy will be cornerstones of the programme, giving the engineers the ability to augment their knowledge with real world applications. Seven Emirati engineers have already been earmarked for the programme, five being women. Al Seer Marine intends to increase the number of Emirati engineers within the company.

New Babcock Facility

(ck) The engineering services company Babcock International has opened a new office in Portsmouth in support of its five year Marine Systems Support Partner (MSSP) contract with the UK MoD. Under the MSSP contract, Babcock is responsible for engineering and inventory manage-

Photo: Babcock International



ment services for the Royal Navy and a wide range of support for the UK's new aircraft carrier and fleet of T45 destroyers. Located close to the home of the Royal Navy's surface fleet, the Babcock office opening coincided with MSSP's first anniversary and the successful passing of an important milestone - the completion of HMS QUEEN ELIZABETH's fixed wing flying trials conducted in the US with the new F-35 Joint Strike Fighter LIGHTNING II aircraft.

BIRD and Hensoldt to Cooperate

(ck) The sensor developer Hensoldt and BIRD Aerosystems, a developer of Airborne Missile Protection Systems (AMPS) and Airborne Surveillance, Information and Observation (ASIO) solutions, will cooperate on the integration of Hensoldt's new PRECISR multi-mode radar with BIRD's Radar Control and



Photo: BIRD

Display (RCD) system and BIRD's Mission Management System (MSIS). BIRD will also adapt their RCD to control and manage Hensoldt's PRECISR 1000 radar. Data from the radar will be collected and processed by BIRD's MSIS, which will automatically classify, prioritise and display the information gathered from the radar along with additional information from other onboard sensors.

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New Partners for Damen Saab Consortium

(ck) A consortium led by Damen Shipyards Group and Saab intends to bid for building the Brazilian Navy's four TAMAN-DARÉ class corvettes. Damen and Saab will offer a proven ship design (SIGMA 10514), a modern Combat Management System and partnerships with Brazilian companies for the construction and life cycle support of the corvettes. In December 2018, Brazilian company WEG Electric Equipment, and Dutch company Praxis Automation Technology joined the consortium. The two companies already have a track record of cooperation in Brazil; they jointly installed equipment on board more than 40 vessels built by Wilson Sons Estaleiros and designed by Damen, including the first diesel-electric PSV in Brazil. Praxis develops and delivers automation and navigation equipment, while WEG is a Brazilian technology company active in industrial automation.



Photo: Damen

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FLIR Acquires Aeryon Labs

(ck) FLIR Systems has acquired Aeryon Labs Inc., a developer of unmanned aerial systems (UAS) for the military, public safety, and critical infrastructure markets for US\$200M. Aeryon's vertical takeoff and landing (VTOL) quad-copter

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airframes integrate multiple sensors, including FLIR thermal technology, to provide users with immediate high-resolution intelligence, surveillance, and reconnaissance (ISR) capability. Aeryon

Photo: Flir



Labs was founded in 2007 and is a manufacturer of mission-focused Group 1 UAS solutions built around aircraft under 20 lbs. Aeryon's UAS are deployed by 20 militaries in over 30 countries, including the US. Aeryon's UAS solutions include hardware, embedded software, ground control stations, sensors, software for flight operations, and customer support. The most prominent product is the rugged, rucksack-portable SKYRANGER UAS which can be deployed in minutes by a single operator. SKYRANGER UAS can operate in demanding environments and inclement weather, including at high altitudes, in gusting winds, and in rain and snow. The SKYRANGER comes with a modular, open architecture, allowing end users and third party developers to create integrated payloads and software systems.

Cyber Situation Awareness Project Launched

(ck) The implementation of EU missions is dependent on access to a secure cyberspace, which makes cyberspace the fifth domain of operations, alongside the



Photo: EDA

domains of land, sea, air, and space. The EU Capability Development Plan (CDP), endorsed by EDA, confirmed cyber defence as a priority for capability development in the EU. The CDP recognises the need for defensive cyber operations in any operational context, based on current and predictive cyberspace situational awareness. For this purpose, three EU member

states agreed to set up a Cyber Defence Situation Awareness Package Rapid Research Prototype (CySAP-RRP): Spain as the lead country, and Germany and Italy. The project is a first step for establishing a full Cyber Situation Awareness (CySA) capability. The CySAP-RRP will be built upon previous work done by EDA to develop a Target Architecture and System Requirements for an enhanced Cyber Defence Situation Awareness Capability. The project includes research to assist military decision-makers in cyberspace and to set the basis of a Command and Control (C2) system for cyber operations. Results will be delivered over the next 18 months.

GA-ASI's Team SKYGUARDIAN Belgium

(ck) Belgium recently selected the MQ-9B SKYGUARDIAN TM to meet the Remotely Piloted Aircraft (RPA) requirements of the Belgian army. The MQ-9B SKYGUARDIAN is being produced by General Atomics Aeronautical Systems (GA-ASI), a manufacturer of RPA, radars, electro-optics and related mission systems. As part of the contract, GA-ASI has teamed with five Belgian businesses as part of an industrial collaboration effort with the Belgian aerospace and defence industry. Team SKYGUARDIAN includes GA-ASI, SABCA, Thales Belgium, Esterline, DronePort, and satellite communication technology company Newtec. SABCA will be in charge of Maintenance Repair Operations (MRO). Thales will cooperate on RPA surveillance sensor data processing, exploitation, and dissemination (PED) solutions; and Esterline will deliver the Ground Control Station displays. The total economic value of Team SKYGUARDIAN's efforts to Belgian industry is estimated to be in excess of €100M over the life of the programme. GA-ASI's MQ-9B has also been selected by the Royal Air Force for its PROTECTOR RG Mk1 programme.

GA-ASI Looking for Teammates

(ck) The UK Royal Air Force (RAF) has selected GA-ASI's MQ-9B SKYGUARDIAN to fulfil an RPA requirement. The RAF's MQ-9B variant is called PROTECTOR RG Mk1 and is the result of a five-year effort to deliver an unmanned aircraft that is safe to fly in non-segregated airspace due to its compliance with the stringent airworthiness requirements of NATO STANAG 4671. The RPA features endurance of more than 40 hours, rapid integration of new payloads, nine wing hardpoints, and all-weather capability. In July 2018,

Photo: GA-ASI



SKYGUARDIAN became the first Medium-Altitude, Long-endurance (MALE) RPA to fly non-stop across the Atlantic Ocean. For the UK's RPA programme, GA-ASI hosted an Industry Showcase to recognise UK companies that might contribute. Among the participants were BAE Systems, CAE, Cobham, Cosworth, Leonardo and others. The showcase featured contract signings with MBDA and Raytheon UK.

New President at Glomex Military Supplies

(ck) Josef Bečvář, retired General and former Chief of the General Staff of the Czech



Photo: Glomex

Armed Forces, became President of Glomex Military Supplies – a system integrator and services provider for armed forces. Glomex cooperates on projects in the

Czech Republic and abroad, in particular with US manufacturers of high-tech products for which it serves as a system integrator, as well as the marketing, training and service centre for Central and Eastern Europe. Bečvář will be responsible for Glomex's strategy and relations with key partners and customers. He also served as Deputy Chief of Staff of the Czech Armed Forces, Chief of the Military Police, as well as the Defence Attaché to France. In combat units, he served in command and staff positions with specialisation in artillery and rocket artillery.

New IAI Production Line for F-35 Wing Skins

(ck) Israel Aerospace Industries (IAI) has launched a new production line for skins for the F-35 wings. The line was established following Lockheed Martin's decision to expand the skins' production and its selection of IAI as the subcontractor responsible for the manufacturing. The 20-year programme is expected to yield revenues of hundreds of millions of dollars, with shipments expected from the beginning of 2019. The first



Photo: IAG

shipments will be of some 700 kits with potential for additional orders at later stage. The skins will be manufactured by means of innovative technology called Automatic Fiber Placement (AFP) that comprises layers of composite materials. The layers consist of 3-mm threads that become a cohesive unit, thus forming the special wing skin that provides them with a stealth capability.

New CTO at Marshall Aerospace

(ck) Marshall Aerospace and Defence Group has appointed Patrick Wood as



Photo: Marshall ADG

new Chief Technical Officer (CTO) and Programme Management Director. The appointment to this newly created role is to underpin Marshall ADG's growth strategy. Prior

to joining Marshall, Wood was the Director International Advanced Programmes and UK Country Executive for Lockheed Martin Space. Before this he had a number of technical and programme management roles at Airbus and its subsidiaries. Wood graduated from the University of Sheffield with a BSc in Electrical Engineering. He is a Fellow of the Institute of Engineering and Technology and of the Royal Aeronautical Society.

New MRO Vice President at MTU

(ck) MTU Aero Engines has appointed Martin Friis-Petersen (45) as Senior Vice President MRO Programmes, heading the sales and marketing organisation for MTU Maintenance. He takes over from Leo Koppers (60), who is retiring after 16 years with MTU.



Photo: MTU

Friis-Petersen has been the Managing Director of MTU Maintenance Lease Services B.V. since 2014. He joined MTU in 1999 and has held various leadership roles throughout the company, including as Chief Financial Officer and SVP MRO Operations at MTU Maintenance Hannover.

New Group CEO at Oxley

The Board of Oxley Group has appointed Darren Cavan as Oxley Group Chief Executive Officer.



Photo: Oxley

Cavan has had a long career with Oxley, including time spent with both Oxley Developments in the UK and Oxley Inc. in the US. He has a mechanical engineering back-

ground and experience across programme management, engineering, operations, commercial and technical functions, and he has over 25 years' experience within the aerospace and military sector, specifically in the LED lighting and electronics arena.

New Market Leader in Military Vehicles

(ck) Rheinmetall and BAE Systems will set up a UK-based military vehicle joint ven-



Photo: RBSL

ture called Rheinmetall BAE Systems Land (RBSL), headquartered at BAE Systems' facility in Telford, England. Rheinmetall will have a 55% stake in the existing BAE Systems UK based combat vehicles business, with BAE Systems retaining 45%. The purpose of RBSL is to sustain over 400 jobs in the UK, and to play a role in the delivery of the British Army's new Mechanised Infantry Vehicle (MIV) and other combat vehicle programmes. While initially focussed on major UK procurement programmes, RBSL will be part of Rheinmetall's Vehicle Systems Division and will contribute to various global military vehicle pursuits and contracts. By combining Rheinmetall's military vehicles technology with the capabilities and

products brought to the joint venture by BAE Systems, such as TROJAN, TERRIER, and WARRIOR, the joint venture is poised to create a European market leader in the military vehicles sector.

Changes at Naval Group Executive Committee

(ck) Naval Group has appointed Olivier de la Bourdonnaye (left) as new Executive Vice President, Programmes, for which the



Photos: Naval Group



main challenges are to ensure schedule, economic and technical performance, and compliance with commitments for the construction of surface ships and submarines. In 2015, Olivier de la Bourdonnaye joined Naval Group to supervise the newly-created Industry Department. At the same time, Naval Group appointed Laurent Espinasse (right) as Executive Vice President, Industry. His role is to ensure the coherence and effectiveness of the actions of the Engineering and Design Department, the production teams and the Supply Chain. Laurent Espinasse is a new member of the Executive Committee. He has pursued most of his career at Naval Group since joining the company in 1992.

New CEO of Rohde & Schwarz Cybersecurity

(ck) Falk Herrmann has been appointed as new CEO of Rohde & Schwarz Cybersecu-



Photo: Rohde & Schwarz

urity. In his new role, he will be in charge of growing the company's IT security business, and will report directly to Ralf Koenzen, Executive Vice President of Rohde & Schwarz Net-

works and Cybersecurity Division. Prior to this appointment Herrmann was CTO of the Security global business unit of Bosch Sicherheitssysteme. He holds a degree in mechanical engineering.

Maintenance for Spain's RG-31 MPV

(ck) The Spanish MoD has commissioned Star Defence Logistics & Engineering (SDLE) to repair and maintain the Army's RG-31 armoured mine-protected vehicle (MPV). SDLE will provide maintenance and technical support for the RG-31. The contract has a value of €260,000. Repair and maintenance work on the RG-31 fleet will be carried out at the SDLE sites near Madrid and Córdoba. Ten years ago, 60 vehicles of the 100-strong RG-31 fleet of the Spanish Army were deployed in Afghanistan. They replaced the BMR vehicles because the latter's armour against Improvised Explosive Devices (IED) proved inadequate. SDLE has also received two follow-up orders for the supply of spare parts for the Spanish Army's LINCE LMV (Light Multi-Purpose Vehicle) and Iveco ASTRA trucks. The contracts have a total value of €4.5M. SDLE will supply spare parts for the LMV LINCE.

tkMS Reaches Finals for Type 31e Frigate

(ck) In the tender for a new frigate for the UK Royal Navy, thyssenkrupp Marine Systems (tkMS) has reached the final round. tkMS is the leading partner in the consortium with ATLAS ELEKTRONIK UK and the British shipyards Harland & Wolff and Ferguson Marine. For the introduction of the new Type 31e frigate, the consortium is offering the multi-

purpose MEKO A-200 frigate - a modular vessel already in service with 2 navies. Should tkMS win the final design and tender phase, the ships would be built with the support of tkMS by Harland & Wolff in Belfast and Ferguson Marine Engineering in Glasgow. The Type 31e programme is the most important in the Royal Navy's comprehensive modernisation programme. The first of a total of five ships is to be handed over in 2023.

WesCom at IDEX

(ck) At IDEX, WesCom Defence, a specialist in pyrotechnic products for signalling, illumination, minefield breaching and training and simulation, will exhibit its key products, including the MANPAD Simulator, the MERS Illumination Rocket and the first fragment-free impact simulator, MECOST Simulator. This MANPAD Simulator replicates the launch and flightpath of a ground-to-air missile. Upon ignition, it provides a blast and a white smoke trail that lasts about 10 seconds to create an exact indication of a missile's flight path, allowing the direction a threat comes from to be visible. In contrast, the MERS Illumination Rocket has a minimal signature at initiation, with no visible signature throughout flight. This smokeless rocket provides concealment from detection of the launch and is suited to carry various payloads which could be parachute-suspended for large area illumination or free-falling flares for signalling

purposes. The MECOST Simulator creates a fragment and debris free simulation of a grenade impact and features an un-cocked striker mechanism.

Romania – Decision on Corvette Construction Suspended

(hum) The decision to award a contract to build four corvettes for the Romanian Navy, expected on 12 January 2019, was suspended the previous day, to the surprise of the three bidders, France's Naval Group, the Dutch company, Damen, and Fincantieri of Italy. The reasons were speculated upon differently in English and French media. The latter assess an intended disadvantage of Naval Group, whose Romanian partner, "Santierul Naval Constanta", had already initiated legal proceedings against the tender procedure. Damen holds 49% of "Damen Shipyards Galati", and 51% are held by the Romanian state. Observers assumed that the French offer, based on the GOWIND 2500 design, could have been the cheapest, with a slight advantage over Damen SIGMA design. According to the official, 11th January 2019 press release of the Ministry of Defence (only available in Romanian as ESD went to press), the State Secretary responsible for armaments has now brought in the (military) jurisdiction to clarify the facts, but the postponement certainly complicates the overdue renewal of the Romanian Navy.

Preview

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