THE TRUSTED SOURCE FOR DEFENCE TECHNOLOGY ANALYSIS

ARMADA INTERNATIONAL

SEPTEMBER 2019. Issue 04.

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PHOTO: SSgt Ezekiel R Kitandwe

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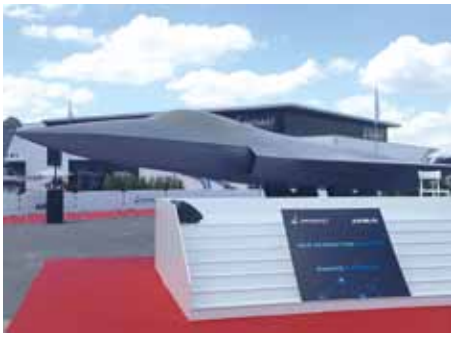

ON THE COVER:
The dual station wing can be fitted to both the Lockheed Martin/Sikorsky UH-60M or the PZL Mielec S-70i. A new single external weapons pylon station will be shown at the Polish defence expo, MSPO, in Sepember. (Sikorsky)

THE TRUSTED SOURCE FOR DEFENCE TECHNOLOGY ANALYSIS

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THIS MONTH ON ARMADAINTERNATIONAL.COM

RECORD-BREAKING YEAR FOR CANSEC

It was a record-breaking year for Canada's largest defence and security trade show, according to newly released data from the Canadian Association of Defence and Security Industries.

ELTA SYSTEMS JOINS FORCES WITH LOCKHEED MARTIN TO OFFER RADAR FOR LTAMDS SENSE OFF

Lockheed Martin and ELTA Systems, a subsidiary of Israel Aerospace Industries successfully completed a demonstration of their radar solution for the U.S. Army's Lower Tier Air and Missile Defense Sensor (LTAMDS). The demonstration was held during a Sense Off event at White Sands Missile Range, New Mexico.

ESTONIA HAS JOINED THE SPIKE MISSILE FAMILY

In a ceremony last week in Tallinn, Estonia, the Estonian MoD signed a 40M Euro Framework agreement with Eurospike (a European Joint Venture between Rafael Advanced Defence Systems, Diehl Defence and Rheinmettal Defence) for the supply of SPIKE LR ATGM's, launchers and associated maintenance and training.

GM-200 FOR DUTCH ARMY

Dr. Thomas Withington – The Dutch Army will receive new ground-based air surveillance radars in 2021, allowing the force to retire several legacy systems.

Editorial

RUSSIA AND CHINA
ROAMING THE GLOBE TOGETHER?

When any nation opens fire on aircraft from one of the superpower nations there is always cause for international concern. On Tuesday 23 July, the South Korean government stated that Republic of Korea Air Force (ROKAF) F-15 and F-16 fighters had fired around 360 warning shots towards a Russian Beriev A-50 (NATO - Mainstay) airborne early warning and control (AEW&C) aircraft which entered, on at least two occasions it is claimed, a South Korean air defence identification zone near to the disputed Dokdo islands (also known as the Liancourt Rocks and Takeshima) in the Sea of Japan. Japan also claims sovereignty of the islands.

Although the A-50 is the only aircraft to have been fired upon, it was not alone. Russian and Chinese air forces were conducting what they have described as a joint long range air patrol over the Sea of Japan. The mission reportedly comprised two Russian Tupolev Tu-95 (NATO - Bear) strategic bombers and two Chinese Xian H-6 (NATO - Badger) bombers, with additional support being provided by the Russian A-50 early warning aircraft and a similar Chinese aircraft, a Shaanxi KJ-2000 (NATO - Moth). Both of the bombers are capable of deploying nuclear weapons/cruise missiles.

While both Russian and Chinese forces have conducted exercises together in the past, this new joint air patrol is out of the ordinary and many observers believe it was designed to sow uncertainty among America's traditional allies in the region. President Trump's respect for North Korean leader Kim Jong-un and the cancellation of joint exercises for a while was not popular in South Korea. Japan too has a territorial island dispute over the Kuril Islands (Russia) or Northern Territories (Japan), just to the north of Japan. The Taiwanese government must also regard the increasing military cooperation of Russia and China with a sense of dread, as its independence is guaranteed by the strength of the US Navy's carrier capability.

This is another sign of the ramping up of global military cooperation and patrolling by these two superpowers - the governments of which are closer now in terms of military cooperation than they have been for many decades. The Chinese People's Liberation Army Navy (PLAN) is already in the Mediterranean Sea where, in 2017, it conducted live firing drills before heading to the Baltic Sea to join the Russian Navy in the first ever exercise there between the two countries, *Joint Sea* 2017 (*Joint Sea* 2019 was staged across the East China Sea and Yellow Sea).

Planners in Moscow and Beijing must be looking around the globe at areas where future military 'exercising' could take place. The PLAN now has an established naval support base (its first overseas) in Djibouti in the Horn of Africa. This offers a launchpad for joint exercises into the Arabian Sea and further into the Indian Ocean.

Russia's backing of Venezuela's past President Nicolás Maduro earlier this year, against his rival and declared new President Juan Guaidó, was also endorsed by China. With Russia having staged military air force exercises from Venezuelan airfields - two TU-160 bombers landed there in December 2018 - there is the potential that a future joint exercise could be staged through Venezuela, potentially going into the Caribbean Sea. Would this a red-line for the US (think the reasons behind the Cuban Missile Crisis of 1962)?

The concern to many western strategists will be how to counter this new global challenge. While the US and other nations, notably the United Kingdom with its legacy or Empire, have in decades gone by roamed the globe with their navies seemingly at will, there is now a push building up from two strategic opponents who want to be seen to compete on the world stage as equals - if not more.

ANDREW DRWIEGA,
Editor-in-Chief

MULTI-ROLE SINGLE SOLUTION

The world's first certifiable Remotely Piloted Air System

The RAF's Protector RG Mk1 is based on the new generation MQ-9B SkyGuardian. With a flight endurance of over 40 hours and a payload capacity (sensors and weapons) of 2,177 kg (4,800 lb) Protector provides a flexible multi-role capability.

Protector will be controlled remotely over satellite communications including taxiing and initiating automatic take-off and landing. This feature eliminates the need for deployed flight crews at forward operating bases, only requiring a light footprint of personnel and equipment to service the aircraft.

ga-asi.com

GENERAL ATOMICS AERONAUTICAL

Leading The Situational Awareness Revolution

BAE

BAE Systems CV90 Mark V infantry combat vehicle includes iFighting a system that utilises the power of data processing to continually collect, integrate and analyse data from the vehicle's various sensors.

BEEFING UP BATTLE WAGONS

Infantry combat vehicles have better situational awareness for the crew and the soldiers they carry. They are also becoming harder to detect and destroy.

Stephen W. Miller

Combat vehicle improvements have traditionally focused on armament (bigger guns), protection (generally armour), and mobility (better suspensions and more horsepower). By their nature this meant that substantial improvements to combat vehicles generally occur in a deliberate and often lengthy process. Although some up-armouring can be done in the field, engine and suspension upgrades require in-depth engineering which is usually performed during major overhauls or rebuilds. The result is that protection has often been increased at the expense of the vehicle's power-to-weight ratio and adding load to the suspension. These in turn often adversely impact on agility, mobility and overall performance. Major armament upgrades fall into a similar category requiring at least workshop capabilities. This process offers little help for forward units that will be the first committed to combat as they face increasingly capable threats.

The manner in which improvements are developed and fielded is further challenged by the rapid pace with which technologies are changing. There is a growing consensus in both military and industry circles that a process is needed whereby new capabilities can be readily inserted into combat systems with minimal time and effort. This is now being made possible by some technological advances that are overturning the traditional development cycle, to increase speed of application and fielding.

Infantry Combat Vehicles (ICV) are now benefiting from new approaches that enhance protection and lethality in what might be considered 'non-traditional' ways yet which may well reflect the direction to be taken in future ICVs.

NETWORKS

Dan Lindell, BAE Systems CV90 platform manager, one of the most widely fielded ICVs, explained: "the move to digital mediums, miniaturisation, and the availability of greater processing power offer the potential to provide new capabilities across many combat system elements." However, he continued, "taking advantage of these possibilities necessitates a redefinition of combat systems from a strictly hardware aspect to one that focuses on tasks to be executed and mission results sought." Another aspect of this is the potential for increasing cross-functionality. Whereas previously automotive, armament, communications and even survivability components of the vehicle were largely separate, these are now becoming tightly connected functions.

One new capability that has major implications for ICVs is networking, not only in how information can be distributed but how in can be controlled remotely. Any position within a vehicle now has the potential of assuming some or even all of the functions of the others. The traditional crew (commander, gunner, driver, etc) can share in the outputs provided by various sensors on the vehicle. This not only includes any surveillance sensors, but also monitoring of automotive and

Australian MOD

Panoramic sights offer the ability to view 360 degrees. They allow locating a target and passing it to the gunner or, with digital networking, others in the vehicle while continuing searching. They are becoming a standard feature on ICVs and CRVs such as the Rheinmetal Boxer shown.

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FAST. FORWARD.

The Remote Controlled Weapon Station design allow fitting of additional observation and firepower onto ICVs. In some cases such as the US Army Striker ICV it has provided a significant up-gunning from .50 to 30mm using Kongsberg's MCT-30.

weapon status, communications and both exchanging data within and external to the vehicle. One practical application of these possibilities is demonstrated in the Singapore Armed Forces Hunter fully digital armoured fighting vehicle. At its July 2019 debut William Peh, the programme director (Land Systems), DSTA, shared that each "soldier will åhave access to all combat functions at every crew station with the Hunter. Even if you have one crew station down, you have other redundancies to kick in". The configuration has all three crew positioned in the hull with the commander and gunner side-by-side. Using its drive-by-wire design the commander is even able to drive the vehicle if necessary.

The benefits of networking are particularly evident in the latest ICVs, particularly for the embarked infantry. Troop compartments, like in the Rheinmetall/Kraus-Maffei Wegmann PUMA, are equipped with video displays which provide images selected from one or multiple external cameras including the primary commander/gunner sights. This ability to exchange information also includes maps, graphics, photos and other imagery. This means that both vehicle, infantry and even higher echelon commanders can brief to all soldiers, even while on the move. Matt Pickett, US Army Soldier Lethality Cross Functional Team at Fort Benning, said: "As dismounted members are themselves equipped with wearable displays and individual wireless connection, networking can be extended to include a seamless exchange between the vehicle and section members in and outside the vehicle. This will go a long way to better assuring coordinated action between the combat vehicle and dismounted soldiers.

SITUATIONAL AWARENESS

Knowing what surrounds a combat vehicle is critical to its survival and effectiveness. Limited outside observation has been an 'Achilles heel' since the earliest tanks. A sound knowledge of the terrain, conditions, and potential threats offers protection by allowing anticipation of dangerous situations and quicker detection of enemies. It also enables rapid counter-action by fire and manoeuvre to retain the initiative.

Obtaining all around observation is particularly critical on a manoeuvre battlefield and in close quarter environments like urban areas and woodlands. Panoramic turret mounted sights are increasingly becoming standard for combat vehicles, both in manned and unmanned turrets. This configuration permits 'hunter – killer' targeting where the panoramic sight detects a target which is passed off to a primary gun sight to be engaged. The panoramic system then continues to seek new targets. Frederique Thomas at Safran Electronics and Defence, a leader in optronics and fire control, indicated "our Paeseo stabilised panoramic sight is used on a number of Czech Army combat vehicles in collaboration with Pramacom- HT. Its ability to detect and recognise targets allows rapid engagements even while moving."

Perimeter and rear view video cameras are increasingly being adopted for close-in observation. These can be compact, multiple camera mounts including thermal imagers and high definition colour CCD or panoramic cameras. Sekai-Electronics' RBC-180ER, offers colour CCD with 180 degree field of view in a ruggedised bolt-on module. The compact CCDs can include digital zoom allowing closer examination of specific views. Object image processing further simplifies observation through the integration of separate cameras images to present a seamless 360 degree picture or to assign a specific sector to a designated position in the vehicle. Another offering by Kappa, its multispectral Situational Awareness Solutions (SAS), use a scalable

A vehicle's ability to blend into it's surrounding complicates the opponent's ability to detect and effectively engage. Counter-detection including signature management and camouflage like the Saab Barracuda Mobile Multi-spectral Camouflage System (MMCS) offer a simple yet efficient way to enhance protection.

Automatic ammunition handling for extreme military environments

Around the globe, military system engineers have turned to Meggitt to help them meet their demanding lethality and reliability requirements for ammunition storage and handling systems in all manner of combat platforms – rotary and fixed-wing aircraft and ground combat vehicles.

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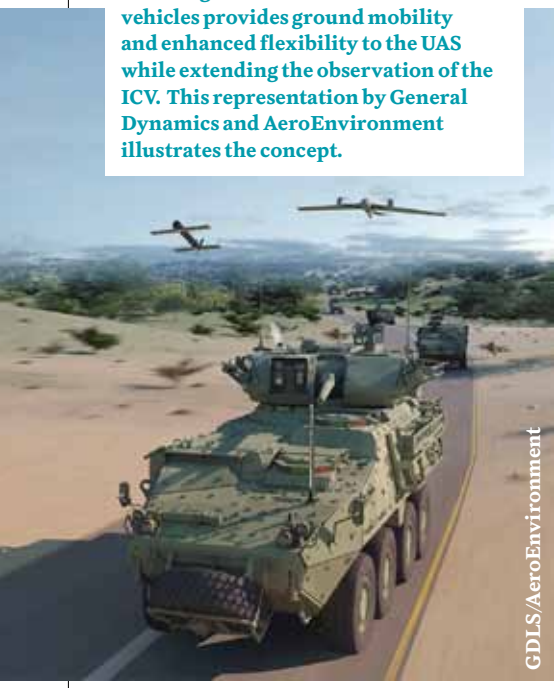

GDLS/AeroEnvironment

The integration of the UAS onto combat vehicles provides ground mobility and enhanced flexibility to the UAS while extending the observation of the ICV. This representation by General Dynamics and AeroEnvironment illustrates the concept.

modular architecture that can be retrofit. Its solutions include day/night sensor fusion, covert illumination, 4K eZoom, and object Detection-Recognition-Identification (DRI). The latter is a processing tool that can automatically detect, alert and highlight threats to the observer. The wider availability and lower cost of high definition cameras is also seeing the replacement of black and white sensors with high performance colour displays that significantly aid situational awareness.

Another technology gaining increased attention is Hostile Fire Detection. This has been successfully done using acoustic detection as in the ShotSpotter, Raytheon Boomerang III, and QinetiQ North America's EARS family. Radar, as being offered as part of Rafael's Trophy APS, or Laser Warning Receivers (LWR), such as Leonardo's RALMO2/V2, also offers this capability. These systems not only detect a gunshot or the targeting by a weapon's fire control, but identify the precise direction and range to the firer. This allows immediate counter-action including deploying obscurants and delivering suppressive fires. By also passing this information over the unit networking, other friendly elements can engage the threat.

COUNTER DETECTION

Reducing detectability can be a significant enhancement to combat vehicle survivability. With new observation technologies, counter-detection must deal with a wide range of sensors. Therefore, multi-spectral and even 3D systems must be considered. SAAB Barracuda, a well know developer of signature management system has continued to evolve its Multispectral Camouflage System (MCS) to defeat better visual, thermal, infrared and radar sensors using various special flexible fabric solutions. ArmourWorks takes another approach with hexagonal random 3D panel appliqué. These TactiCam panels can have infrared and radar absorbing coatings and filled with insulation that suppresses emissive frequencies and reduce the thermal gain. Their solution has been demonstrated on General Dynamics Land Systems Griffin ICV.

An often overlooked aspect is vehicle lighting both external and internal. Lighting is vital to safe operation, however, advances in night vision systems do not allow for the use of normal white or even red or blue-green lighting. In addition, these not only compromise your own night vision systems like night vision goggles (NVG0 but will standout like a beacon to enemy night vision sights offering a clear target. With especially personal night vision becoming widely used what are required are tactical lighting specifically designed for use with friendly and protection against opposing night vision devices. The company Blue Wolf Technologies specialises in such lighting for tactical and combat vehicles. These provide multiple illumination options in a single LED fixture that can be selected of each situation. There is white light for non-tactical use, plus setting compatible with image intensification (NVGS), and infrared that actually enhances NVG vision. Units are available for use inside vehicles as well as external ones that offer more discrete night driving with stop, turn, and marker lights that are visible only by night vision devices.

CLOSE-IN PROTECTION

Independent weapons systems are another feature being widely added to combat vehicles to provide supplemental firepower. The PUMA is being outfit with the TSWA (turret independent weapon system) that is mounted on the rear of the vehicle. This 40mm remote weapon is controlled from the rear compartment and can engage close quarters targets to 400 meters with lethal and non-lethal projectiles. A Rheinmetall representative shared that '"this outfitting is expected for 2023."

The CV90 Mark III has added the Kongsberg Protector remote weapon station positioned on top of the turret. This configuration has been fielded by the Norwegian army. In addition to an accurate .50 medium calibre weapon its high mounted optics allows discrete surveillance even with the vehicle entirely in defilade. In the past including more separate weapons might create a concern of over tasking the crew, however Lindell at BAE explained "networking changes this by allowing control to be exercised by more positions within the vehicle including in the embarked troop compartment. This permits others on board to take over duties, like manning of the RWS relieving primary crew members to focus on their tasks."

ONBOARD DECISION AIDS

The expansion of processing power and the growing maturity of computer programming, much of which is drawing from Video Gaming, is being capitaliSed on to provide crews with on-board decision aids. The objective is to take in and analySe


Raytheon

Active Protection Systems (APS) offer the ability to disrupt a rocket or missile in flight that is attacking the host vehicle. They complement other protection and can be fit to existing vehicles. The process of an APS intercept is illustrated in this sequence of Raytheon's QuickStrike.

The wide spread use of night vision devices requires a new category of tactical vehicle exterior and interior lighting that neither is detectable by the enemy or compromise friendly night vision. Such lights use LED technology and also use little power and have many times longer life. This flexible arm map light by BlueWolf provides several selectable types of light allowing use with night vision goggles or without.

a wide range of data from sensors and other sources and provide commander and crew recommended action options. BAE Systems is proposing such capabilities in its latest CV90 version as the iFighting. Liddell explained "it is an overreaching concept that seeks to reduce task load and includes fusing data from different vehicle systems to prioritise the most critical. It harnesses data to enable faster and more informed decision making in combat." Other combat vehicle developers including Raytheon, Rheinmetall, Nexter and General Dynamics Land Systems are introducing similar capabilities. Mike Peck Director of Business Development for the later shared that "our Griffin III technology demonstrator uses an open architecture that will accept new decision aid applications and even new sensors as "plus-and-play" as they come available."

ACTIVE PROTECTION

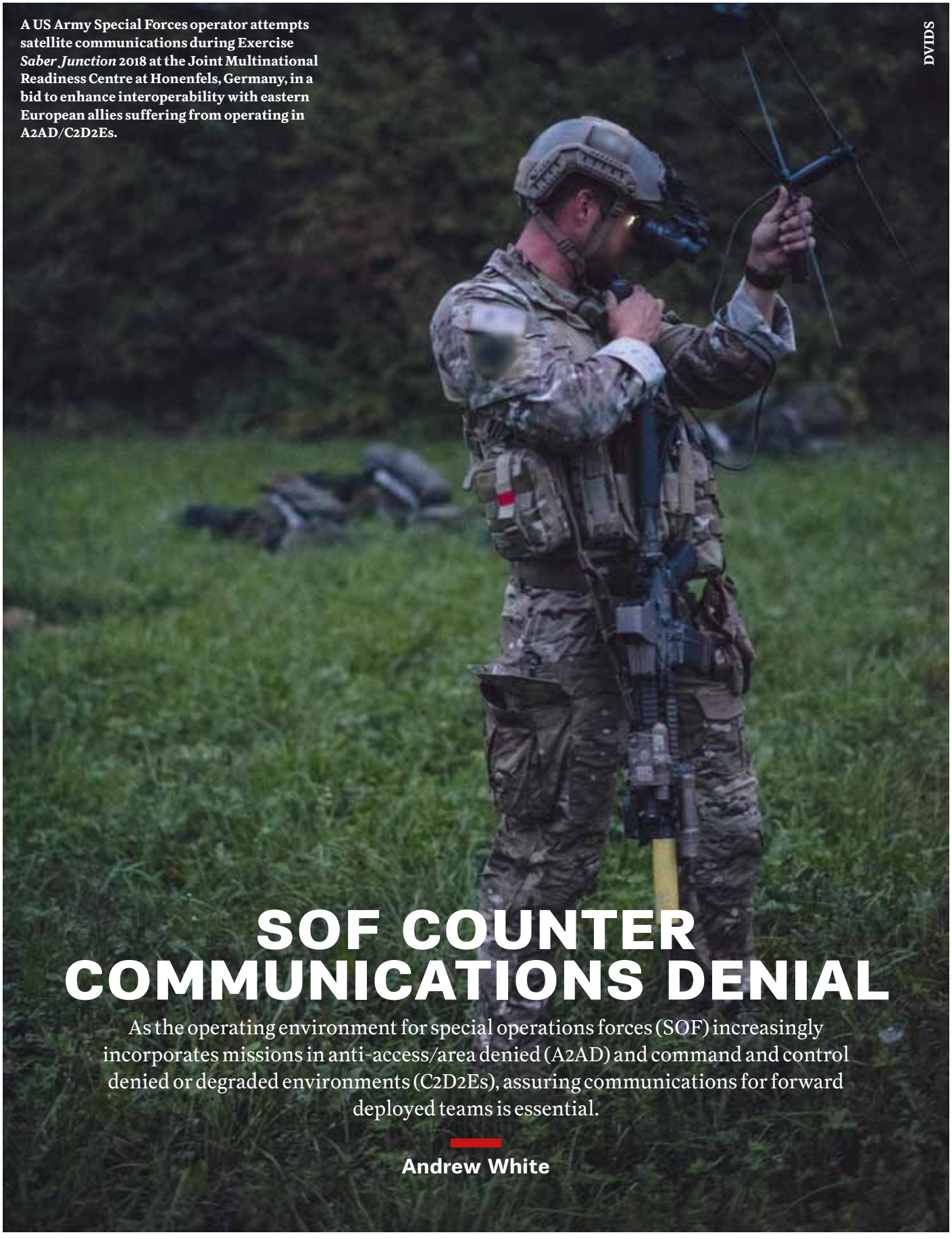
Systems that can actively counter an incoming rocket or missile are receiving a great deal of attention. Some view these as an alternative to adding traditional armour. An Active Protection Systems (APS) must detect, access, and respond to a projectile that has targeted the vehicle and neutralize it before it impacts. This sequence must occur in seconds as an entirely automatic process while not endangering either the crew or accompanying troops around the vehicle. All these conditions are difficult to achieve especially on lighter class combat vehicles, such as the ARTEC Boxer or US Army Stryker. "Hard Kill" systems like the Rafael Advanced Defense Systems Trophy have proved effective on heavier ICVs such as the M2 Bradley, but come with weight and tactical challenges. "Soft Kill" like Artis Corporation's Iron Curtain and Rheinmetall's Active Defense System are lighter, more easily fit, less expensive and lower potential for collateral damage. The benefits of having a counter-measure to an active engagement that can be added to existing vehicles is so attractive that it is certain to be more widely introduced once its challenges are addressed.

UAS

Incorporating Unmanned Aerial Systems (UAS) onto combat vehicles offers a mobile platform to carry and control the UAS while the aircraft itself extends the reach of the vehicle. The UAS can be launched from the vehicle and, depending on its configuration, provide far reaching reconnaissance or even strike targets. Industry is anticipating this capability with General Dynamics Land Systems, for example, teaming with AeroEnvironment to integrate Switchblade missile and the Shrike 2 onto Stryker and showing a UAS capability on its Griffin III. In a statement Don Kotchman, vice president and general manager reflected "This delivers a decisive advantage to ground combatants, to see first and strike first, across the tactical landscape. It expands situational awareness, survivability and over-the-next-obstacle lethality".

FUTURE DIRECTION

Larger armament, take for example the up-gunning of the US Army Stryker with Kongsberg's 30mm Medium Calibre Remote Weapon Station, more powerful engines, and new passive armour packages will continue to be pursued for future ICVs. However, increasing emphasis will be on technologies that can be applied more as modules. A Raytheon spokesperson spoke of "protecting against the future" by employing approaches that provide for the near seamless adding and integration of new capabilities and solutions. Potentially these needs and capabilities may not been even previously envisioned, yet provisions need to be provided in designs to allow them to be introduced as they may be needed and as they mature. In effect, the ICV's future may well be beyond what one can presently envision. A



A US Army Special Forces operator attempts satellite communications during Exercise *Saber Junction* 2018 at the Joint Multinational Readiness Centre at Honenfels, Germany, in a bid to enhance interoperability with eastern European allies suffering from operating in A2AD/C2D2Es.

DVIDS

SOF COUNTER COMMUNICATIONS DENIAL

As the operating environment for special operations forces (SOF) increasingly incorporates missions in anti-access/area denied (A2AD) and command and control denied or degraded environments (C2D2Es), assuring communications for forward deployed teams is essential.

Andrew White

Constrained operating environments continue to be witnessed in eastern Europe in particular where coalitions of special operations task groups working in Ukraine and Poland regularly suffer from disrupted satellite communications (SATCOM), defence sources informed *Armada International*.

These operating restrictions, enabled by Russian armed and proxy forces, have led to a rise in alternative communications types including mobile ad hoc networks (MANETs) which do not rely upon fixed or large-scale infrastructure via space or on the ground. However, the SOF community looks set to continue to rely upon SATCOM as commanders implement redundancy across complex communications plans to overcome these operational requirements.

Similar sentiments were highlighted at the SOF Industry Conference (SOFIC) in Tampa, Florida between 22-24 May where end users from the US and international SOF community shared ideas regarding the optimal employment of tactical communications in austere environments.

Speaking to AI, Lt Col Shelton Richards, programme manager for Tactical Communications, Program Executive Office C4, described a series of areas of interest currently facing the US Special Operations Command (USSOCOM) as it considers operating in A2AD and C2D2E areas of operation.

According to Richards, current and future requirements call for reductions in the size, weight and power specifications of handheld and manpack software defined radios (SDRs) in particular, as well as hardware commonality and reduced complexity of operation and maintenance in order to lessen logistical burdens.

Additional areas of interest include reduction in the size of antenna profiles for ground, airborne and maritime platforms in order to evade physical detection by enemy forces; enhancements in cyber security to ensure secure communications; the identification of wireless and tethered personal area networks; and the proliferation of 'cross-domain' solutions allowing the same SDRs to be used in multiple mission roles and environments.

USSOCOM, Richards added, is also interested in managing signature reduction and jam resistant waveforms of SDRs across A2AD and C2D2Es in terms of Line-of-Sight (LoS) and Beyond Line of Sight (BLoS) communications as well as demand for high bandwidth RF communications including ISR transmissions and wideband high frequency solutions. This requirement also applies to satellite communication (SATCOM) high-throughput in C-, X-, Ku- and Ka-bands.

NGTC SUITE

Of particular interest to the international SOF community is USSOCOM's Next Generation Tactical Communications (NGTC) suite of SDR technologies which currently includes handheld and manpack form factors.

As Shelton explained, the NGTC family

of solutions has been designed to provide SOF small unit teams with "real time, hostile and friendly force information, LoS and BLoS communications, and access to situation awareness in the form of intelligence inputs, broadcasts and networks".

L3 Harris Technologies is contracted to deliver the NGTC capability to USSOCOM in both handheld and manpack form factors with the addition of an ISR mission module, initially manufactured by L3 Technologies ahead of its merger with Harris Corporation in 2019.

Speaking to AI, L3 Harris's USSOCOM sales manager, Sandy Olejniczak explained: "The Harris NGTC handheld and manpack radios enable the insertion of additional capabilities into the tactical communications network via their common mission module interface.

"The first mission module is an ISR receiver that enables an ISR video feed to be received on the radio with the ISR MM and disseminated to other radio users, eliminating the need for multiple ISR receivers in a single formation," he explained before confirming how the company was also in the process of designing additional mission modules to support as yet undisclosed mission profiles.

"The rapid integration of emerging technology into the ecosystem of NGTC devices ensures that the SOF community will be able to react to emerging threats and maintain dominance in the current and future operating environments," Olejniczak suggested.

The AN/PRC-163 (formerly designated RF-335M-STC), comprises a two-channel SDR with 'double-height' screen to support ISR operations and the utility of the mission module.

Operating between 30 and 2,600MHz frequency ranges, the AN/PRC-163 is


Harris

L3 Harris continues to deliver undisclosed amounts of the AN/PRC-163 NGTC to the US Special Operations Command. International SOF partner forces will be keen to maintain the highest levels in interoperability, potentially through the procurement of the same SDR type.


Invisio

Invisio has designed its Intercom System to connect dismounted special operations users with platforms including air, ground and maritime assets.

The Viasat BAT-600 Multi-Mission Terminal (MMT) delivers IP-based voice, video, and data networking over X-, Ku-, commercial Ka-, and military Ka-bands.

NATO Secretary General Jens Stoltenberg stated ahead of the meetings of NATO Defence Ministers in Brussels that NATO was 'investing...in modern capabilities, which are able to deal with A2AD challenges."

capable of supporting multiple waveforms including Trellisware Technologies' TSM-X Mobile Ad Hoc Network (MANET) solution. The SDR can also support UHF SATCOM connectivity and wideband data rates up to 16MBPS, company officials confirmed to *Armada*.

Weighing a total of 1.13kg (inclusive of battery), the SDR has also been designed to survive immersion in water down to a depth of 20m. The radio is also capable of accommodating Suite A and Suite B encryption services, allowing levels of interoperability with partner nation forces around the World.

L3 Harris continues to deliver an undisclosed number of NGTC Handheld SDRs to USSOCOM force components under a 'high volume low rate of initial production' contract.

Referring to the NGTC Manpack solution for USSOCOM, Olejniczak confirmed it is still under development and "progressing extremely well".

Satellite communications helps to connect warfighters with instant access to video, voice and data.

"The Operational User Assessment will occur in 2019, and the SOF community is very excited to get their hands on the big-brother of the AN/PRC-163 handheld radio," he confirmed.

SATCOM

SATCOM remains a critical mission capability for SOF units operating at extended range and in austere environments, despite concerns regarding jamming and disruption in A2ADs and C2D2Es.

On 28 May 2019, USSOCOM awarded Leonardo DRS a $977 million contract to provide global SATCOM services to the Tampa-based headquarters as well as the organisation's Theatre Special Operations Commands (TSOCs) and Component Commands which include US Army, Air Force and Marine Special Operations Commands as well as Naval Special Warfare.

The contract sees Leonardo DRS supporting an eight year programme centred around USSOCOM's Global Access Network (GAN) system, which comprises an end-to-end commercial SATCOM solution.

According to a statement on the day of the contract award from Dave Fields, senior vice president and general manager of the Leonardo DRS Global Enterprise Solutions business unit, USSOCOM requires an "integrated satellite and terrestrial telecommunications system to support the dissemination of command, control, communications, computers and intelligence information between USSOCOM, its components, and their major subordinate units as well as selected US government agencies and activities directly associated with the special operations community".

"Network connectivity includes satellite transmission and terrestrial services, which connect communication hubs to deployed communication nodes located in the continental US and outside the continental US in support of deployed Special Operations Forces," the statement concluded.

Meanwhile, USSOCOM continues to be supported by Viasat in terms of research and development into next-generation 'multi-mode, multi-mission and multi-frequency satellite terminals', available in Ka-band.

Speaking to AI, Viasat's president for government systems, Ken Peterman, described how the company remains in the midst of delivering terminals to the Command which will be capable of supporting Ku-band communications in the future.

"We are demonstrating how to enhance mission effectiveness and enable new concepts of operation not possible before which allow end users to 'hide in plain sight' amongst commercial SATCOM traffic. This is a significant advantage when operating in A2ADs and C2D2Es," said Peterman.

Viasat is also working with Tampa Microwave Systems and L3 Harris, both companies of which are already contracted to support USSOCOM's Satellite Deployable Node (SDN) light, medium and heavy programmes.

"Viasat is working with those satellite terminal providers so they are able to operate across Viasat networks and other [satellite constelllations] in Geographic, Medium Earth and Low Earth Orbits in the future," Peterman continued.

"We are carefully looking at emerging technology in the private sector which is very revealing," Peterman concluded. "High capacity at Ka-band is effectively immune to ground based jamming, data collection and technologically game-changing. Many across government and defence communities don't have an appreciation for the enormous technology investment and rapid pace at which technology is evolving in the private sector."

END USER DEVICES

According to Olejniczak, the SOF market continues to witness the utility of additional end user devices including smart phones tethered to SDRs. Examples include USSOCOM's Tactical Assault Kit (TAK) which is also in operation with multiple SOF partner forces around the world.

Networked to Samsung or any technology agnostic end user device which is generally mounted on the chest, TAK software is designed to provide operators with 'precision targeting, intelligence on surrounding land formations, navigation and general situation awareness', according to the US Air Force Lab, Army Research Lab and Defense Advanced Research Projects Agency.

Also critical to the employment of any SDR are headsets and vehicle/platform intercommunication solutions, allowing SOF operators to benefit from seamless communications in both dismounted and mounted roles.

Seeking to overcome many of these operational requirements from the SOF community is Invisio which has designed an 'easy to use, portable and battery operated' intercom solution allowing end

Leonardo DRS, a provider of satellite communications services to the US Government, on 28 May 2019 won a $997 million award to supply USSOCOM with global SATCOM services.

users to establish 'intercom' environments anywhere and instantly when needed.

Invisio's senior vice president for research and development, Jan Larsen described how the design of the intercom had comprised a natural progression from the company's series of communication and hearing protection systems initially aimed at supporting dismounted end users.

"These different systems have generated great interest and are now sold to a wide range of customers within the global defence and public safety communities. With the intercom system, Invisio is bridging the gap between the dismounted and mounted soldier. The new intercom system is developed for use together with Invisio's personal communication equipment and it is small, lightweight, cost-effective and highly mobile to establish Intercom anywhere," Larsen explained.

Developed in collaboration with undisclosed end users in the SOF community, the Invisio Intercom System allows end users to quickly 'plug-into' any platform communications suite without requirement to change equipment. Examples, highlighted by Larsen, include tactical ground vehicles including the HMMWV and M-ATV; C-130 Hercules aircraft; UH-60 Black Hawk helicopters; as well as maritime surface vessels.

Comprising a single box, each Intercom System is capable of accommodating up to ten plug-in devices. However, Larsen warned how Invisio's solution is not a 'traditional intercom' system: "It's a lightweight portable system that can be carried and operated from a bag. It can be installed in vehicles for normal intercom operation, but its full strength is utilised in environments with a need for a portable, easy-to-use, plug-and-play system that can easily be set-up anywhere the users may go.

"The intercom system was developed for stand-alone use or together with Invisio's existing communication systems, permanently mounted in a vehicle or portably in a backpack," Larsen added before explaining how the solution features the company's own IntelliCable plug-n-play interface which operates with "most portable and installed radio systems".

"The system makes it possible for multiple users and radios to be connected simultaneously while using their existing soldier system. Seamless plug and play integration between control units, intercoms, headsets and interface cables are key to the versatility of the Invisio system, as it allows for deployment of new equipment without the need for updating existing Invisio systems," he continued.

According to Larsen, Invisio received its first Intercom System order at the end of 2018 although he was unable to confirm the customer with a 'European defence force'.

CONCLUSION

No matter the future direction of the contemporary operating environment, assured tactical communications will remain a critical pre-requisite to special operations task groups operating in A2AD/C2D2Es and other austere environments.

However, particular attention must be given by industry and commanders in terms of ease of use in order to not only reduce the cognitive load on end users but also optimise operational effectiveness. A

The propulsion system of the RN Type 26 (Global Combat Ship) 'city class' frigates will have a gas turbine and four high speed diesel generators driving two electric motors in a 'CODLOG' arrangement.

POWER HUNGRY WARSHIPS

Increased, power hungry electrical systems onboard warships has resulted in greater power generation from maritime propulsion systems.

By Tim Fish

Naval propulsion for both surface ships and submarines has advanced significantly over the past two decades. Deciding which kind of propulsion system to go on a warship depends on the range required in various modes of operation and the signature and endurance aspects for each mode, the need for survivability and redundancy, limitation in the total weight, space and location of the equipment and the total cost of ownership including crew operations and maintenance efforts.

Bad power selection for a warship is best exampled in the case of the selection by the UK Government of the Rolls-Royce WR-21 engine for the Royal Navy's Type 45 guided missile destroyer, an untried engine in this application, using Integrated Electric Propulsion (IEP) system. After it had been proven that the system was inadequate to provide the power required (particularly in hot operational environments such as the Persian Gulf, it was necessary to conduct a major overhaul centred around a a Power Improvement Plan (PIP). Upgraded diesel generators would be required to provide the required additional electrical generation capacity.

Apart from nuclear propulsion reserved for large aircraft carriers and submarines, most navies will find themselves selecting some kind of hybrid mechanical-electrical propulsion system typically employing gas turbines (GT), diesel engines and electric drives in various combinations for a range of surface combatants from destroyers and frigates to corvettes and patrol ships. Conventional submarines are another specialist area where electric propulsion using internal combustion engine gensets and fuel cells are used for the main source of electric power.

The key requirements for frontline surface warships is to achieve top high speeds of 27-30 knots. For those vessels that have an anti-submarine warfare (ASW) role there is also a requirement for quiet operations and that means an electric propulsion element is needed. Modern propulsion arrangement options include mechanical ones such as Combined Diesel Or Gas (CODOG), Combined Diesel And Gas (CODAG), which use both diesel engines and gas turbines to drive the propeller shaft. CODOG arrangements use the power from diesel for slow speeds and gas turbines providing power for high ship speeds separately, whilst CODAG achieves the high ship speeds by using the power from both types of engines running together. Hybrid electric arrangements like Combined Diesel Electric Or Gas (CODLOG) and Combined Diesel Electric And Gas (CODLAG) use diesel engines and gas turbines in the same way but instead send the power from the

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In addition to the Type 26 ships, the MT30 has been selected for the US Navy's Freedom-class Littoral Combat Ship and Zumwalt-class destroyer, the UK Royal Navy Queen Elizabeth-class carriers, the Italian Navy LHD Trieste, the Republic of Korea Navy FFX-II and the Japan Maritime Self-Defense Force 30FFM frigate.

engines to direct-drive shaft-mounted electric motors to drive the ship at low speeds. This separation of the mechanical elements allows the main reduction gear and gas turbines to be disconnected and shut down using a friction clutch or a SSS clutch between the motor and the gearbox. This removes the underwater radiated noise usually generated by these systems and allows for very quiet ASW operations running at 15kt on the electric motor.

Waldemar Herdt, head of Project Engineering Ship Propulsion at Renk, told *Armada International*: "Once the requirement for silent operation is posed, special attention is put on the selection of equipment with lower source noise and on application of various noise attenuation measures. The lower the power level the more effective and less complex such noise reduction measures are."

He added: "This circumstance is contradicting with the requirement for high propulsion power to achieve the max speed, however the requirements for high speed and low noise don't apply at the same time. Therefore, is it reasonable to look for distinguished means of propulsion and/or power transmission individually applicable in the silent mode and in the high-speed mode of operation."

Furthermore with the CODLOG and CODLAG hybrid systems, the installed electrical power generated by the engines is shared for all the ship's requirements more effectively utilising it, whereas in a mechanical system the power generated for propulsion is separate from that generated for the rest of the ship.

"One of the technological trends, which we observe, is the attempt of better use of the total power source as installed on board the vessel," Herdt said. "Whether the power is required for propulsive or non-propulsive load, the boundaries between the mechanical prime movers and electrical power generation systems become blurred. Once a bi-directional power link between the on-board power generation and the propulsion system is established, then the entirety of power 'resources' can be flexibly used for both propulsive and non-propulsive loads reducing the demand for total power to be installed on-board and improving the load levels and share of operation hours between the individual engines."

NEW WEAPONS, MORE POWER

The ability to more effectively manage the electrical load on a ship and ensure all the ship's systems have enough power at the right time is becoming more important as high energy laser weapon systems and more capable sensors are set to be added in the near future.

One recent development has been the introduction of the MT30 gas turbine system from Rolls-Royce, which offers

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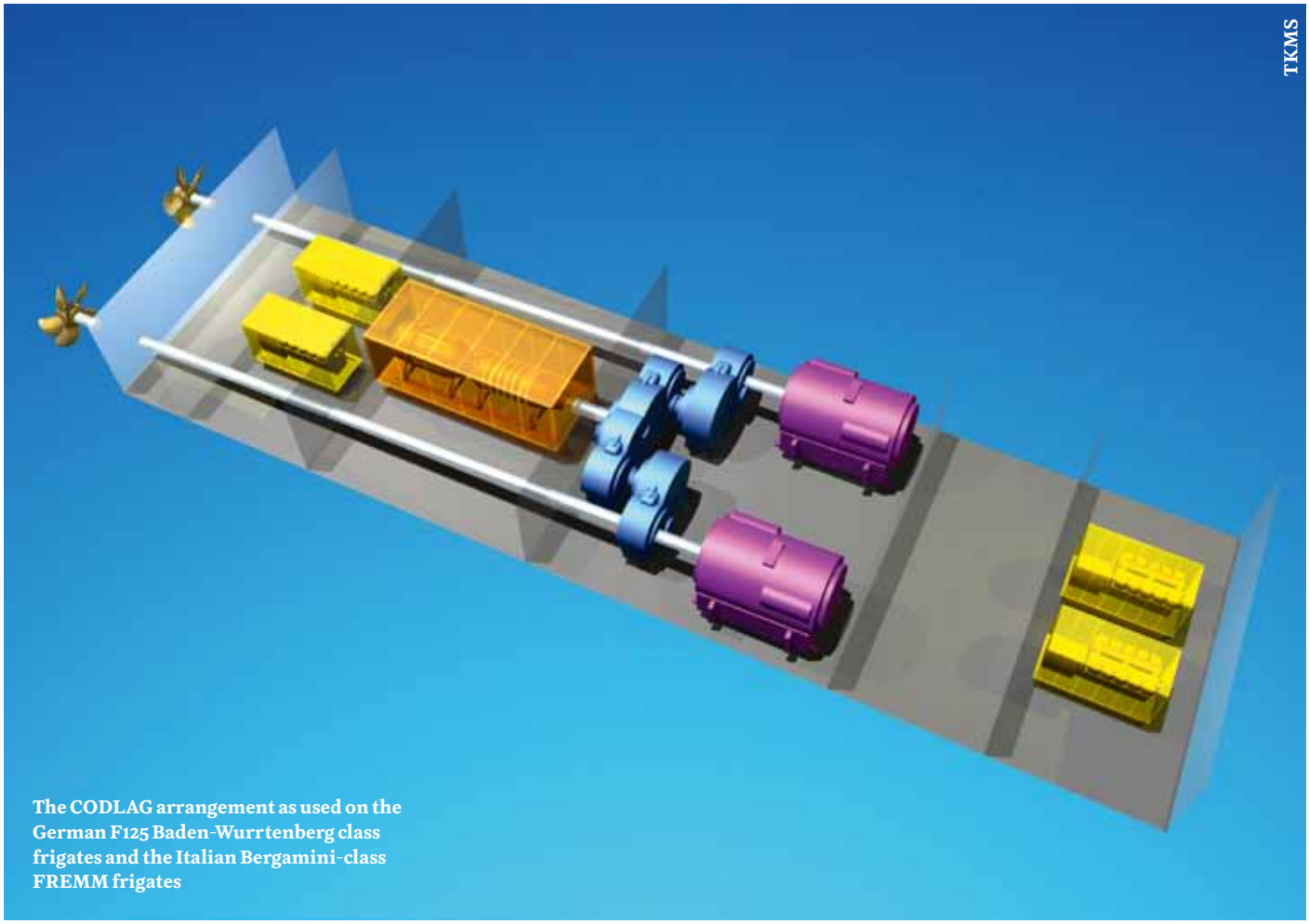

The CODLAG arrangement as used on the German F125 Baden-Wurrtenberg class frigates and the Italian Bergamini-class FREMM frigates

more power density than earlier gas turbines. This was the engine selected for the Royal Navy's *Queen Elizabeth* class aircraft carriers. With an output power of 36MW it can offer more than double the power of competitor gas turbines and makes the CODOG and CODLOG arrangements a more effective solution for ships' propulsion. It means a single MT30 gas turbine can be used instead of two in order to achieve the top ship speeds required in frontline warships.

Legacy CODOG/CODLOG arrangements previously used a twin-GT setup because this was the only way to get enough power for those top ship speeds. But with MT30 a single-GT option is available for 'Or' systems just like the 'And' arrangements it makes them an equally capable layout but with reduced complexity. The CODLOG arrangement has fewer power converter requirements than CODLAG and has the power to host additional systems.

The UK RN's new Type 26 anti-submarine warfare frigate is using a single gas turbine CODLOG arrangement and it will also be the same for Royal Australian (RAN) and Canadian Navies (RCN), which have selected the Type 26 design for their future frigate programmes.

Richard Partridge, chief of naval systems at Rolls-Royce told AI: "One of the critical aspects of the Type 26 is its adaptability/future proofing. In CODLOG that is fine, in gas turbine mode all of the installed power generation is available for not just today's but tomorrow's electrical load demand for mission systems. With CODLAG, you need to supplement the power from the GT with that of the electric motors paired of course with the diesel gensets, so it is less adaptable and less future-proofed for meeting tomorrow's load demands as well at any given level of ship performance.'

He added that high speed diesel engines have also developed since the 1970s from what were marinised locomotive sector engines using 10-20 year old technology and were inefficient and unreliable. Using modern computation tools such as Finite Element Analysis (FEA) and Computational Forensic Engineering (CFE), better designs have been coming onto the market that meet efficiency and emissions targets and are becoming relatively power dense with up to 10MW per unit available.

SUBMARINE PROPULSION

For conventional diesel-electric powered attack submarines (SSKs) a standard propulsion system is an electric motor, which drives the propeller. The electric motor is powered by lead acid batteries which get their charge from diesel generator sets. Burning diesel fuel requires oxygen, which means that an SSK will have to come to the surface to 'snort', a process to bring more air into the boat and allow it to continue to use its diesel engines and allow the crew to breathe. But coming to the surface puts the submarine at risk of detection and destruction therefore any technological developments that will allow it to stay underwater for longer are essential.

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Tim Fish

FC2G is qualified as ready to sail with over 6,000 hours of operational running and realistic submarine operational profile tests completed.

The main advances in propulsion have been the improvement of electrical systems, lithium-ion (li-ion) battery technology and the introduction of air independent propulsion (AIP) systems. For electrical systems the development of the synchronous permanent magnet motor with insulated gate bipolar transistor (IGBT) electronic power converters has meant that old DC motors have been replaced with AC and offer more reliability, simplicity and – key for submarine survivability – less noise. A reduction in the acoustic and electrical signature is achieved by eliminating fans and smoothing out mechanical power fluctuations.

The increasing use of li-ion batteries means that traditional lead acid batteries are to become a thing of the past. Li-ion batteries allow for greater optimisation of the battery pack with better use of the higher range of their capacity and provide better performance at higher speeds, eliminated the generation of hydrogen and are simpler to use leading to less maintenance.

French warship and submarine manufacturer Naval Group identifies the main challenge with using li-ion batteries as integration "with all considerations of both physical and electrical architecture of a submarine, as well as with all safety considerations both in its operational exploitation and in maintenance."

A spokesperson said li-ion batteries offer operational advantages to SSKs including "the reduction of its indiscretion rate with a better optimisation of its capacity, both in charge and in discharge, during the whole mission – something prohibitive for a lead battery – faster loading, better performance at high speeds even at low capacity level. And from the safety point of view the elimination of hydrogen production coupled with reduced and simple maintenance."

AIP is based on hydrogen fuel cell technology providing power by burning hydrogen and stored oxygen. Although it does not provide as much power as diesel engines powering the batteries using atmospheric oxygen it gives SSKs the ability to operate for longer periods of about two weeks submerged increasing its autonomy. However, this requires hydrogen to be taken and stored on the submarine and when it runs out the AIP system will no longer function.

A Naval Group spokesperson told AI that with AIP, the storage of hydrogen on board the submarine was always a problem, but the company has developed the Oceanic Conventional Reference (FC2G) AIP solution "whose main innovation is the diesel oil reforming process to produce hydrogen on demand, achieving an operational advantage of up to three weeks of autonomy, with a significant reduction of the indiscretion rate, so necessary for every submarine." This removes the need to store hydrogen on-board the boat and instead getting it on demand using the existing stores of diesel fuel and there are significant safety benefits as well.

"We must always have safety in mind during sub operations, and the recent events with the loss of the Argentinian TR-1700 submarine reminded everybody. This is why the storage of hydrogen on board is considered as a permanent risk for the submarine and its crew," the spokesperson said.

Developing the FC2G fuel cell system meant undertaking significant

development efforts. Naval Group said that the first generation of fuel cell AIP systems is based on metal hydride storage designed for small coastal submarines not ocean-going boats. The small size of these submarines meant hydride cylinders "were placed outside the submarine, representing a risky challenge in terms of submarine architecture and weight balance. To illustrate it simply out of the 130 to 160 tonnes of hydrides transported by an FC system, only a maximum of two percent represents hydrogen that can really be used in fuel cells, which is a rate completely inefficient and costly."

Furthermore, transporting pure hydrogen and oxygen on submarines requires a significant shore-side logistical support arrangement that also increases costs and restrictions. "It involves special facilities for the treatment of gas; trucks conditioned in compliance with the strict regulations for transporting hydrogen; qualifications and procedures to keep purity of hydrogen and the integrity of the submarine and its crew to be guaranteed: a complex and expensive logistical chain in itself, which, moreover, is not available in any ports."

To get around these problems an onboard hydrogen production system using fuel reforming was chosen by Naval Group. The challenge was to select a fuel that could be used for an operational requirement and was also safe for the crew. The company also looked at the whole logistical operation and support of an AIP system to make improvements in the on-board and shore-side provision and treatment of fuels throughout the submarine's service life.

Key considerations were removing constraints relating to sea water temperature and avoid the hydrides heating process and pollution; safer hydrogen management; reduce sub-systems across all parts of the submarines and keep them in a dedicated section; reduce logistics constraints of refuelling hydrogen. Furthermore hydrogen needs to be stored safely and the energy and density of the hydrogen in the selected fuel had to be adequate. The hydrogen production itself needed to be simple and make hydrogen available easily.

Naval Group said that after analysis, diesel oil was the most suitable as the least flammable, least toxic (compared to ethanol and methanol), best hydrogen density, easiest to load and unload, with crews proficient at using it and worldwide availability.

Meanwhile in May 2019, Siemens unveiled its new FLEX permanent magnet submarine propulsion motor that is a development of its earlier Permasyn system. The FLEX system aims to provide a power range from 1.5MW up to 8MW, which is more than the 2-4MW available with Permasyn that is fitted to the Federal German Navy's Type 212A and Type 214 SSKs. It is envisaged that three different sizes will be available and will also help reduce acoustic and magnetic signatures. Development work is ongoing.

US DOD

British Army troops deployed with NATO's Enhanced Forward Presence Battlegroup Poland perform exercises in the Suwalki Corridor in 2017.

SITREP: THE SUWALKI GAP

The US Army is overhauling its electronic warfare posture; enhancing traditional capabilities and embracing cyber operations. This should concentrate the minds of potential adversaries.

Dr. Thomas Withington

The Czarna Hańcza River meanders through the pretty town of Suwalki, northeast Poland. St. Alexander's church is a handsome 19th century structure while the nearby Suwalki Landscape Park offers verdant landscapes and a tranquil lake. Yet by reasons of geopolitics Suwalki, has given its name to an eponymous corridor. The Suwalki Corridor is the narrow passage linking Poland to Lithuania. At a mere 65 kilometres (40 miles) in width it is the narrowest land corridor in the North Atlantic Treaty Organisation (NATO). To its southeast is Belarus, and to the northwest the Russian enclave of Kaliningrad. Should the alliance descend into open conflict with Russia the corridor will be the 'filling' in the sandwich with Russian forces in Kaliningrad and Belarus, or Belarussian forces supporting Moscow being the bread. A swift Russian drive northwest and southeast could probably close the gap in a day or so unless NATO mounted a robust defence; one which would almost certainly require a counterattack into Kaliningrad and Belarus. Any attempt by Russia to close the corridor risks isolating the Baltic NATO members of Estomia, Latvia and Lithuania from the alliance. With the corridor closed, Russia would be free to drive northeast into the Baltics and southwest into Poland; a nightmare scenario.

ELECTORMAGNETIC MANOEUVRE

The so-called 'Second Cold War' of 1985 to 1991, characterised by the premierships of US President Ronald Reagan and General Secretary of the Communist Party of the

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The US Army's AN/PLT-5 and AN/PLQ-9 systems have been used to reduced the threat of RF-detonated IEDs to deployed squads and platoons.

US DOD

Soviet Union Mikhail Gorbachev, brought a new incarnation of US Army doctrine known as Air-Land Battle. This doctrine would have been applied to Soviet/Warsaw Pact (WARPAC) forces should the unthinkable have happened and the US and her NATO allies been forced to fight a land war in Central Europe. The US Army's 1982 Field Manual, FM-100-5, placed manoeuvre front and centre of the Air-Land Battle concept defining it as "the movement of forces in relation to the enemy to secure or retain positional advantage." The same doctrine warned that Soviet and WARPAC forces would attempt to exert control of the electromagnetic spectrum via an initial analysis of opposing communications to develop an electronic order-of-battle regarding radios, links and relays. The purpose of this being to then disrupt an opponent's Command and Control (C2) and Situational Awareness (SA) via electronic attack directed against these elements. The doctrine concluded that while Soviet battlefield EW systems were reckoned to be less sophisticated than contemporary US or NATO EW systems, their power and the sheer number of systems in Soviet/WARPAC formations posed a formidable threat.

Fast forward to 2019 and the US Army is once again thinking about EW. In January 2018 the force published its *Concept for Cyberspace and Electronic Warfare Operations: 2025-2040*. What is immediately instructive about this document is the collocation of cyber and EW efforts. This is not surprising. The revolution in computing witnessed since the end of the Cold War, best exemplified by the proliferation of the World Wide Web, has had an impact on military operations. When FM-100-5 was drafted Soviet/WARPAC forces would have attacked NATO's communications primarily to frustrate their use for voice and written communications. Today, battlefield communications remain essential for voice traffic, but their carriage of data to aid C2 and SA has increased exponentially. A communications network is just as important for the carriage of the zeros and ones that contain written information and imagery as it is for voice traffic. These changes are reflected in the US Army's January 2018 publication *Cyberspace and Electronic Warfare Operations*. Published by the force's Training and Doctrine Command this document "describes how the Army will operate in and through cyberspace and the electromagnetic spectrum and will fully integrate cyberspace, electronic warfare (EW), and electromagnetic spectrum operations as part of joint combined arms operations." On the battlefield EW is becoming the vector by which cyber attacks can be delivered into hostile C2 systems, alongside its traditional mission of jamming communications through electronic attack, and injecting hostile or misleading communications traffic into opposing networks. The electromagnetic spectrum is now as much of a manoeuvre space as the physical environment which the army must exploit to achieve an advantageous position relative to its adversaries.

EXISTING CAPABILITIES

The US Army fields several distinct capabilities contributing to the force's collection of Signals Intelligence (SIGINT) and its execution of electronic attack. The force's current posture illustrates how it is at the crossroads between its EW posture from 2001 onwards when one of the dominant threats that the army would encounter on the battlefield were Radio Frequency (RF) triggered Improvised Explosive Devices (IEDs), and the current paradigm which could see the force potentially having to confront near-peer adversaries such as Russia which increasingly uses sophisticated telecommunications to move C2 and SA around the battlefield.

A plethora of manpack electronic attack systems, primarily focused on jamming the RF links which can be used to activate IEDs, remain in US Army service. These include Sierra Nevada's AN/PLT-5 Thor-I and AN/PLQ-9 Thor-III systems. The former was developed to help protect IED disposal teams, with the latter equipping conventional forces. Both are used at the squadron/platoon level to provide a 'bubble' of protective jamming around these forces as they perform their missions. These systems almost certainly cover a 30 megahertz/MHz to three gigahertz

waveband. This would encapsulate the frequencies used by cellphones, garage door remote controls, civilian two-way radio and baby monitors, alongside other easily-available civilian RF technologies routinely used by insurgents in the Afghan and Iraq theatres to activate IEDs.

Since its entry into service in 1998 L3 Linkabit's AN/MLQ-40(V) Prophet has provided the US Army with a vehicle-mounted electronic support measure capable of gathering SIGINT at the regimental level and above. Open sources state that the AN/MLQ-40(V) collects SIGINT across a 20MHz to two gigahertz waveband. The original AN/MLQ-40(V) was based on an AM General High Mobility Multipurpose Wheeled Vehicle. The AN/MLQ-40 was later supplemented by General Dynamics' AN/MLQ-44(V) Prophet Enhanced which entered service in 2008. This transformed the original Prophet concept to develop a capability which could be used either stationary or on-the-move. Moreover, the AN/MLQ-44(V) included a manpack SIGINT collection system which would allow dismounted SIGINT collection. The AN/MLQ-44(V) equips US Army Brigade Combat Teams (BCTs) with three systems per BCT, and US Army Expeditionary Military Intelligence Brigades (EMIBs) with eight AN/MLQ-44(V)s equipping each EMIB.

The AN/MQL-44 Prophet Enhanced SIGINT system entered service in 2008 provide a means of collecting SIGINT on-the-move and in a dismounted capacity.

US DOD

GATOR

Above the AN/MLQ-44(V) is the AN/FLQ-15(V)3 Ground Auto-Targeting Observation/Reactive Jammer (GATOR) fixed site SIGINT collection and electronic attack system. This gathers SIGINT and performs selective electronic attack against hostile communications in a specific area, or on a specific waveband. This is to force enemy troops to move to another area where they may find better reception, but where they could also be more easily attacked kinetically or electronically. Although the US Army is believed to have acquired between eight and twelve AN/FLQ-15(V)3 systems, the force has no plans to replace this capability in the future.

EWTV

While the army arguably maintains robust SIGINT collecting assets, it arguably faces a shortfall in mobile systems which can perform electronic attack and cyber operations. Recent procurement activity shows that the force is taking these shortcomings seriously. At the doctrinal level, according to the US Army's *Cyberspace and Electronic Warfare Operations* pamphlet "the army conducts cyberspace and EW operations in a holistic, synchronised and integrated manner." At the core of these merged capabilities will be the Terrestrial Layered System (TLS). This will be examined in more detail below. To bridge the gap between current capabilities and the advent of the TLS, the US Army has embarked on the EWTV (Electronic Warfare Tactical Vehicle) programme. The EWTV provides the manoeuvre commander with mobile electronic attack and SIGINT collection. Based on a MaxxPro Dash mine-resistant/ambush protected four-wheel drive vehicle, it carries the Tactical EW System (TEWS) reportedly closely based on the SRC AN/VRC-12(V)5 Sabre Fury electronic warfare system. This is based

US Army

The EWTV is the US Army's latest electronic warfare vehicle, and is capable of both SIGINT collection and jamming on-the-move.

on the firm's AN/VLQ-12 series CREW (Counter Remote Controlled IED EW) Duke system. It is reasonable to assume that the AN/VRC-12(V)5 covers a 30 megahertz to three gigahertz waveband, much like the AN/VRC-12 series which was optimised to jam wireless devices capable of activating IEDs. Given that standard tactical radios inhabit similar wavebands, adapting the AN/VRC-12s capabilities to jam such devices makes sense.

Other capabilities being fielded rapidly within the US Army include Raytheon Raven Claw, a laptop-based early version of the army's Raytheon EW Planning and Management Tool (EWPMT) used for the C2 of army EW efforts. Raven Claw directly connects to the Versatile Radio Observation and Direction Finding Modular Adaptive Transmitter, better known by its VMAX acronym, and the TEWS. Whereas TEWS is vehicle-borne, the VMAX is a dismounted system providing soldiers with the capability to locate and jam threats. This trio of capabilities has been deployed by the US Army's 173rd Airborne Brigade, 2nd Armoured Cavalry Brigade and the 2nd Brigade of the 1st Infantry Division (2/1ID) and was put through its paces in 2018 during a Joint Warfighting Assessment by the 173rd and the 2/1ID in Hohensfels, southwest Germany. To summarise SIGINT is captured by the VMAX and TEWS, is fed upwards to the Raven Claw where the data is analysed. Instructions are then passed back regarding the action to be taken against specific emitters. These functions can encompass cyber actions and be performed from battalion to theatre levels. The EWPMT will eventually comprise server-client web-based applications and server-client laptop configurations for use at the command post, and by mounted and dismounted troops.

TLS

Over the longer term the US Army will overhaul its EW capabilities via the TLS initiative which will integrate army SIGINT, EW and cyber capabilities. The force is still defining the scope of the TLS but reports have noted that it will take a software-defined, open architecture approach. This will enable the TLS architecture to be easily upgraded with new capabilities, most probably in the form of electronic and cyber attack waveforms and techniques, when they become available, along with the easy update of threat information. The army has stated that it wants to adopt artificial intelligence within the TLS architecture. This is an important consideration. The past five years has seen the electronic warfare community awash with discussion of cognitive EW; the application of machine learning to electronic warfare. The 'holy grail' in this regard is to harness software let EW systems learn from their electromagnetic environment and apply lessons learned to future scenarios. For example, if a particular jamming waveform worked well against a particular communications network, the EW system will note this and perhaps autonomously apply similar jamming waveforms to similar networks in the future, subtly adjusting them to the unique attributes of that situation. Conversely if a particular EW technique was not successful, the software will learn from this and modify its behaviour for future, similar scenarios. The TLS initiative is expected to move into prototype stage in 2020. This will see the initial development of vehicle-mounted


US Army

The MFEW capability will furnish the US Army with an operational-level SIGINT collection asset, complementing current and future ground-based systems.

electronic/cyber attack and SIGINT platforms, each of which will use a common architecture tailored for their specific tasks. Both vehicles will form a single system working closely together, gathering SIGINT and then initiating the appropriate electronic/cyber attack response. Three systems, a total of six vehicles, are expected to be deployed with each BCT. Production vehicles could commence delivery in the 2023/24 timeframe. Beyond the TLS' vehicle element the army expects to procure either a fixed site or extended range capability, and a dismounted manpack element. At a stroke, both these latter initiatives could replace the AN/FLQ-15(V)3, and AN/PLT-5 and AN/PLQ-9 manpack systems the force currently uses.

MFEW

Complementing the TLS will be the army's MFEW (Multifunction Electronic Warfare) capability. Unlike the other systems surveyed in this article, this will be an airborne capability. This February, Lockheed Martin was awarded a contract to develop the (MFEW Air Large) dimension which will develop the Silent Crow podded EW payload to outfit the wing hardpoints of the US Army's General Atomics MQ-1C Grey Eagle unmanned aerial vehicle. According to reports the company will initially develop a prototype system in circa 18 months, with a second 18 month effort to deliver four systems by the first quarter of 2020. Given that the MQ-1C has a maximum altitude of 50,000 feet (15,240 metres) this could enable the detection of hostile emitters across a 500 kilometre (316 mile) range. Such a capability will provide a potent operational-level SIGINT asset to the ground commander.

CONCLUSIONS

It would be fair to say that the US Army has had to adjust to a new operational paradigm in which near-peer adversaries like Russia have realised the potential of EW and cyber warfare to challenge the force's pre-eminence on the battlefield. The army's initial investments into transitional capabilities such as the EWTV, and longer term initiatives such as the TLS underscore that the force is taking the challenge seriously. Such capabilities cannot on their own protect choke points such as the Suwalki Corridor from the nightmare scenarios discussed above. However they can help to slow the momentum of any future Russian operation to seal off the Baltic from the rest of NATO. Electromagnetically increasing the cost of any land operation against NATO is as much a deterrent effect as it is a combat capability during manoeuvre. By investing in these capabilities now the US Army has shown its determination to not only address shortfalls in its current EW posture, but also to achieve tactical and operational overmatch in the future. A

Photo: Sikorsky-Boeing

The Sikorsky-Boeing SB.1 Defiant rotorcraft achieved first flight on 21 March, 2019.

TARGETING THE FUTURE

Finding a quicker, more agile method of procuring capability is a central aim of Future Vertical Lift, but it is an ambition oft repeated down the years. FVL was conceived in 2009 but first aircraft in service is still optimistically a decade away.

By Andrew Drwiega

The United States Army (US Army) has been leading the search for a next generation type of military rotorcraft for over a decade now. The concept of Future Vertical Lift was launched in 2009 and in October 2011, the Deputy Secretary of Defense issued a FVL Strategic Plan which would be encapsulated by Joint Multi-Role Technology Demonstrator (JMR-TD) project for industry to present and demonstrate new designs in rotorcraft that could fly faster, higher and have better overall performance.

The ambition is to find attack/reconnaissance and utility next generation rotorcraft that will replace the 4,000 or so Boeing AH-64 Apaches and UH-60 Black Hawks.

Having gone through several processes and name changes, two Joint Multi-Role Technology Demonstrator (TD) aircraft have now flown; Bell's V-280 Valor - a tiltrotor, and the Sikorsky/Boeing SB.1 Defiant coaxial aircraft. But they are still not the only players in the game,

FARA AND FLRAA

There are now two identified projects for new rotorcraft, both of which are the responsibility of the US Army Futures Command and the US Army Combat Capabilities Development Command Aviation & Missile Center's Aviation Development Directorate. The first is the Future Attack Reconnaissance Aircraft-Competitive Prototype (FARA-CP), for which five development contracts have already been issued. The companies that have received Other Transaction Authority for Prototype Agreements are AVX Aircraft partnered with L-3; Bell Helicopter Textron; Boeing; Karem and Sikorsky. Each of the five is tasked to design and conceptualise its own FARA. The Army will make a decision in March 2020 that will see two companies selected for a "government-sponsored fly off" in 2023, according to Brigadier General Walter Rugen, director of the Future Vertical Lift cross-functional team. Once a selection has been made then FARA will become an official programme of record with the aim being for the first FARA aircraft to be fielded after in 2028.

In June, Federal Business Opportunities announced that it would be holding an industry "to provide industry day more insight into the FLRAA Project Manager's anticipated acquisition approach for FLRAA development. Again, the ambition is to award two vendors

Speaking at the Army Aviation Mission Solutions Summit (Quad-A) in mid-April, Jeffrey White, the Acting Assistant Secretary of the Army (Acquisition, Logistics, and Technology) And Army Acquisition Executive stated that in the Financial Years FY2020-2024, the Army planned to invest $24 billion in aviation. Of this, $6.6 billion would be into research, development, test and evaluation (RDT&E). The total set aside for procurement would be $17.5 billion.

The current plan, said White, was to 'Incrementally modernise the existing fleet while preparing for a competitive advantage with the next generation.' Illustrating the cost of new equipment, he shared that $4.7 billion buys 194 new UH-60M Black Hawks, while $1 billion converts 159 UH-60L to UH-60Vs (these have digital cockpits replacing analogue). He added that $4.7 billion would secure 210 AH-64E remanufactured Apaches complete with new airframes. This spending was still required to address obsolescence issues while the new FARA and FLRAA aircraft began to be fielded in the late 2020s.

White was quick to point out that there is another drive to change the way in which the government conducts its acquisition process. "We need to reduce the requirement development process. For too long, Army acquisition has stood aside from the requirements process - it was always somebody else's job to coordinate," he remarked.

Therefore there is a resurgence of need to get Program Executive Officers (PEOs) and Program Managers (PMs) to be involved with industry on a daily basis. He said that the way forward was rapid prototyping and technology demonstrations - 'test and learn'. Following this he added that a way had to be identified to "deploy technology

refreshers and upgrades faster and keep speed with the technology as it developed."

KEEPING FOCUS ON PRIORITIES

Another senior officer speaking at Quad-A in mid-April before he was officially sworn-in as the 40th chief of staff of the Army on 9 August, was General James McConville, an aviator who was qualified in the Bell OH-58 Kiowa Warrior, the Boeing AH-64D Longbow Apache, the Boeing AH-6, and the Bell AH-1 Cobra among other aircraft.

During a media briefing, he defended the recent decision to stop fielding new CH-47F Block II aircraft to the Army, although he did add a caveat: "the CH-47 is our newest fleet and the CH-47 Block II is coming along fine and that will go to Special Operations Regiment 160th SOAR (in the form of the CH-47G)." He stated that the DoD was looking at a variety of potential developments that would generally affect aviation acquisition , including how aircraft would be able to survive in an integrated air defence environment. He inferred that a further decision regarding the future of the CH-47F Block 11 could be made in a couple of years.

Echoing what Acting Assistant Secretary White had said regarding a better relationship with industry to invest in the right platforms, he stated: "We are putting out requests for information (RfI) taking a different approach with the way we are doing business with industry. We are moving away from the large requirement documents and seeing what industry can bring back so that we can develop in the future."

He stated the the Army remained focused on modernisation, but was balancing its main spend against the six modernisation priorities (2020-2024):
1) Long-Range Precision Fires (LRPF): artillery, and missiles with a range of over 1,000 miles — budget $5.7 billion.
2) Next-Generation Combat Vehicles (NGCV): both manned and robotic ($13.2 billion).
3) Future Vertical Lift (FVL): high-speed FARA and FLARA development ($4.7 billion)
4) The network: C2 ($12.5 billion).
5) Air & Missile Defence (AMD) ($8.8 billion).
6) Soldier Lethality (SL): better infantry equipment ($6.7 billion).

Gen. McConville stated that rapid acquisition should be one of the resultant goals, as a closer working relationship with industry leads to a more streamlined acquisition process.

General James McConville

One US manufacturer that has walked the 'rags to riches' path in the last decade is MD Helicopters. While not currently involved in either FARA or FLRAA, its proposal was turned down by the Government Accountability Office (GAO). Chief executive Lynn Tilton told Armada International that the GAO "did not read and evaluate MD's proposal properly." it is based on the further development of the company's twin-engined MD902 Explorer, with the new aircraft including wings and having been already named the MD 969 Swift. This will still used the NOTAR (no tail rotor) but would be a new composite structure ,have added power and speed.

"We have spent $150 million on research and development since 2014," said Tilton, who has taken the company from one near to collapse, back to an international manufacturer of new helicopters with a growing order book. Often shunned by the Department of Defense (DoD) in the past, a thawing of the relationship led by a significant order for the Afghan armed forces has allowed the company to re-enter the mainstream of the military helicopter market. "Will deliver 80 military aircraft between 2018-19. Some are for Afghanistan and the rest for international customers," stated Tilton.

Although the company is not considering the unmanned rotorcraft market at this point, Tilton believes that if a requirement was identified, they would look at it. She said that "going to unmanned would not be such a leap" because of her experience in the automotive industry which is already developing autonomous driving technology.

MD Helicopter is now compliant with the US Army-mandated Ground and Flight Risk Clause (GFRC) regulation, as the company had been informed that it wasn't compliant in delivering on its $1.4 billion indefinite delivery/indefinite quantity (IDIQ) award. In September 2017, a US Army / Partner Army Aviation Forces contract was placed through the Foreign Military Sales (FMS) process for 150 MD 530F Cayuse Warrior helicopter, the initial batch of 30 being for the Afghan Air Force. Deliveries of these helicopters are scheduled for completion by the end of September 2019.

Tilton praised the Defence Contract Management Agency and Multi-National Aviation Special Projects Office teams who worked with MDHI on the required documentation and process changes. "While this new level of USG oversight requires investment in both human and capital resources, the enhanced growth of our military sales assures that the effort to implement GFRC-compliant processes will be time and money well spent," said Tilton.

GERMAN CH-53 BID BACK ON

As an endnote to major procurement, this summer the German Army finally restarted its search for a replacement for its CH-53G/GS/GA helicopters (Schwerer Transporthubschrauber). Germany's defence minister Annegret Kramp-Karrenbauer has announced plans to increase the defence budget to the NATO target of two percent by 2024.

Replacing the old CH-53s is expected to cost over $4.5 billion - with the two contenders being Lockheed Martin/ Sikorsky's new CH-53K, and rival Boeing's CH-47F. The new CH-53K King Stallion will be the version that will be fielded by the US Marine Corps, although its development has been dogged by delays.

Boeing's CH-47F has less overall lift capacity, but it has been in service with the US Army for many years - so upgrades should be cheaper as they are rolled out to the US Army in the future. However, the DoD's decision to prioritise its budget spending will mean that only the US Army's 160th Special Operations Aviation Regiment (SOAR) will continue to receive CH-47Gs and new CH-47F Block IIs to the regular army will be halted as already discussed. A

MSPO

The new Single External Weapons Pylon Station will be shown by PZL Mielec at Poland's Defence Exhibition in early September.

SERIOUSLY ARMED BLACK HAWK

Central and eastern Europe has become a main target for Sikorsky's new weaponised kit for its S-70i Black Hawks

By Andrew Drwiega

The Sikorsky UH-60M/S-70i Black Hawk is the current iteration of the ubiquitous UH-60 which this year marks 40 years of continual military service. Sikorsky also has a further reason to celebrate, in that it has created a new role for the rotorcraft as a multi-mission aggressor. Following a six year development and qualification programme, the modern Black Hawk can now carry a powerful mix of pod mounted rockets, machine gun pods, and extra fuel tanks, transforming it substantially from its traditional role as a utility helicopter with crew-served machine guns for self-defence.

The US Army took delivery of its first UH-60A in 1979 as a direct replacement for the another legend of its time, the Bell UH-1 Iroquois. Since then it, it has been produced in a variety of versions for numerous different customers worldwide. The actual addition of weapons per se is not new. The AH-60L Apria was created for the Colombian Air Force and was armed with a variety of weapons - GAU-19 12.7mm machine guns, LAU-19 rocket launchers among others - which allowed Air Force pilots not only to fly troops in operations, but to support them on the ground in

counter-insurgency operations against FARC guerrilla fighters.

Sikorsky also offered a Battlehawk version of the AH-60L to the Australian Army for its Project Air 87 Armed Reconnaissance Helicopter requirement which was competed nearly 20 years ago, although this was ultimately won by Airbus' Tiger ARH.

FIRST ABH CUSTOMER

The United Arab Emirates Air Force and Air Defence (AF&AD) was the launch customer receiving the first weapons kits for its UH-60M Armed Black Hawks in January this year, marked by the presence of Sheikh Mohamed bin Zayed the Crown Prince of Abu Dhabi and Deputy Supreme Commander of the UAE Armed Forces. The first public showing of the newly weaponised helicopter was at the Abu Dhabi defence expo (IDEX) a month later.

Completion was carried out by Abu Dhabi-based Advanced Military Maintenance, Repair and Overhaul Center (AMMROC), a joint venture between Emirates Defense Industries and Lockheed Martin/Sikorsky (Sikorsky is owned by Lockheed Martin). AMMROC is also the only approved Lockheed Martin C-130 service centre in the Middle East.

The UAE Armed Black Hawk (ABH) can mount Lockheed Martin AGM-114 Hellfire laser guided missiles, Hydra 70mm laser guided rockets, as well as .50 cal guns on the two stub wings which have two hard points on each wing. Up to 200 US gallons of fuel can be carried on each station, either side, which can potentially be increased to 400 gallons in extreme circumstances. The stub wings can be taken off in around three hours to transform the helicopter back into its regular utility role. The UAE's S-70i ABHs have passed through Initial Operational Capability (IOC) and have already been involved in combat operations with UAE armed forces in Yemen.

Qualifying weapons for the ABH took around two years of live firing trials conducted at the Yuma Proving Ground in Arizona. The weapons kit is only suitable for the 'third generation UH-60M or S-70i, due to the fact that both have an integrated digital cockpit.

The weapons suite is integrated into the digital cockpit and an electro-optic/infrared sensor (EO/IR) turret with added laser designator allows both aircrew to target and fire weapons through information fed to helmet-mounted displays.

Without the capability of the UH-60M, the weapons suite cannot be retrofit into older UH-60 models. "We have been building UH-60M aircraft since 2003 so sustaining older UH-60s is not really economical for users," said Joe Palumbo, director of Aircraft Programs at Sikorsky Global Military Systems & Services. The US Army has a sustainment programme

A weaponised S-70i Armed Black Hawk at Sikorsky's PZL Mielec subsidiary in Poland.

centred around a UH-60V, although this is an interim solution to address obsolesense issues in the cockpit, with the main aim of transforming the avionics from analogue to digital. It does not feature the new developments incorporated into the UH-60M/S-70i.

SINGLE STATION

An new single external weapons pylon station will be shown by PZL Mielec at Poland's Defence Exhibition in early September (MSPO). This single station addition can mount missile or gun pods, and is a cheaper alternative to the full weaponised ABH with twin stub wings.

"We are looking at the same weapons management system, or an alternate / locally designed weapons management system. On the new pod here will be Rafael's Spike missiles, locally assembled in Poland, and an FN Belgian-made gun pod, as well as anything else the local industry would like to add to their helicopter. Poland will customise the Armed Black Hawk to a customer's requirement," said Palumbo.

"This single station pylon has been conceived and made in Poland. It is the first of a kind, demonstrating that there is a more simple alternative to a dual station if that is what eastern European countries in particular are looking for, although it obviously doesn't have same capability as dual," said Palumbo. "But it offers something more affordable with the same weapons management system - or even possibly with a locally designed system." However, the the single station pylon is also compatible with the UAE weapon kit.

Janusz Zakrecki, PZL Mielec president and general director illustrated the current opportunity for the ABH: "Due to increasing military threats in central and eastern Europe and the sustainment of current helicopter inventory, there is a growing demand for anti-tank capabilities to replace Russian made aircraft."

He added that the PZL/Sikorsky S-70i ABH was "not an alternative to typical narrow body attack helicopters but a supplement to them. We believe S-70i Armed Black Hawk with guided missiles capability will meet the immediate needs of Poland and other countries of central Europe in term of anti-tank capabilities." Zakrecki underlined the affordability of the S-70i when pitched against more complex, dedicated attack helicopters.

"PZL Mielec's Polish engineers are qualified to the same standard as those in the US and can adapt the S-70i to the customer's particular needs," said Palumbo. At the start of the year Poland bought four S-70i Black Hawks for special forces use, with an option for a further four. "We strongly believe that the ABH could meet the needs of Poland and other eastern European countries for battlefield anti-tank support, which they don't have right now," he said.

Black Hawks (UH-60s) are built at Sikorsky's main plant in Stratford,

Janusz Zakrecki, PZL Mielec's president and general director stands in front of an Armed Black Hawk.

Connecticut and at PZL Mielic in Poland (S-70i) and are basically the same aircraft with components sourced from all over the world. PZL Mielec has been part of Sikorsky since March 2007. "We can ship the aircraft from either the US, Poland, or from the UAE or even as a kit if a customer wishes to off-set an acquisition," concluded Palumbo.

When buying through the Foreign Military Sales (FMS) process an international customer will receive an aircraft approved by the US Army Engineering Directorate (AED) with an Air Worthiness Release (AWR) for a customised Black Hawk. Direct sales still meet the same military standard as the baseline Black Hawk.

Palumbo challenged potential buyers to talk to PZL's pilots, who formerly flew Russian MI- 8, MI-17 and MI-24 Hind helicopters - to compare both helicopter types. "Believe me, they are the best sales people in the world," he added. A

Opener, a pioneer of aero vehicles for consumer travel, has developed BlackFly, an ultralight all-electric fixed-wing vertical take-off and landing (VTOL) aircraft.

A TRANSFORMATIVE TIME FOR VERTICAL LIFT

Just how close to mainstream adoption is electric Vertical Take-Off and Landing and what will it offer military users?

Robert Torgerson

A quiet revolution is taking place in the vertical lift industry. It is the merging of multiple technologies to bring forth a new type of aircraft powered by electronic batteries and known as eVTOL (electric Vertical Take-Off and Landing). This has been made possible by quantum leaps in battery and computer technology, 3D printing, composite materials and soft tooling.

While there is no precise count of how many such advanced aircraft there are, the Vertical Flight Society (VFS) has put together one of the most advanced data bases of eVTOL aircraft.

In an interview with *Armada International*, Michael Hirschberg, the executive director of the VFS stated that this is the most transformative time since the development of the turbo-shaft engine. While acknowledging that today's batteries are not as effective as needed and will require significant future development, he stated that there is huge investment in this new technology, which up to this point has been strictly commercial in nature. The military's interest is sparked by factors including low noise emissions and lower cost of ownership of electric technology compared to fossil fuel aircraft.

Mike Hirschberg is an aerospace engineer by training working in industry prior to joining DARPA (the Defense Advanced Research Projects Agency) and then onto the Office of Naval Research (ONR) where he was involved with the Joint Strike Fighter (JSF) programme. He holds an aerospace engineering degree and a Masters in Mechanical Engineering and an MBA.

RT: *The biggest new thing in rotorcraft is the emergence of eVTOL with hundreds of emerging new players located worldwide. What has caused this trend to emerge and do you its growth continuing?*

MH: On our website eVTOL.news there are more than 130 different aircraft catalogued. We're tracking all of these and we don't make judgments as to which are viable or not, as we are all-inclusive.
In the beginning, there were a lot of criticisms of eVTOL and why it would never work, but now people are flying in them. One way to look at it is "based on everything

Launched in December 2018, LIFT Aircraft has developed an electric, vertical takeoff and landing (eVTOL) aircraft for one person to use.

you know about rotorcraft, these configurations may seem impossible, but based on everything that you don't know eVTOL is possible," and we expect they will have a major impact in aviation and society.

You have a variety of different technologies that have all come together in a confluence including electric motors, improving batteries, composites and manufacturing, 3D printing, and the benefits enabled by soft tooling. With these technologies you can now put together eVTOL prototypes. You can even build production aircraft, particularly due to the new improvements in manufacturing and computer modelling and simulation. So you have a democratisation of aircraft design. In the past it was only the big OEMs that had the sophisticated tools to design aircraft, particularly vertical flight aircraft. Vertical flight aircraft are so complex and challenging but now with sophisticated software packages available, they enable more advanced capabilities to be in the hands of small-scale innovators and start-ups.

There was a change to performance regulations, Part 23, where regulations are not now as prescriptive as they once were. This is coupled with a general disposition now in industry and among society as a whole which makes people much more expectant and desirous of advances and innovative solutions - leaps ahead in technology coupled with revolutionary change. Secondly more money is now available. A trillion dollars has been made in the App economy, producing things like Apple products and advances in hardware and software — this has given us Google, Microsoft, Amazon, Facebook, etc. Elon Musk invented PayPal and then took that money and developed electric cars, plus a space programme where he launched his car into space. These are transformative capabilities so people such

as Elon Musk, Larry Page (Google) and Jeff Bezos (Amazon) have used their money to improve and transform society. Well over a billion dollars has gone into eVTOL. Billionaires can now apply their money generated from innovative activities outside aerospace into eVTOL projects, where before this was money from governments or from the aerospace companies themselves.

RT: *How will eVTOL's emergence impact the conventional fossil-fuelled rotorcraft marketplace?*

MH: In the near-term not much, but in the long-term significantly. Batteries today are not good enough for electric VTOL except in limited cases and so depending on which measures you use, energy density of batteries is only between 2-5 percent that of liquid fuel. Basically, today's batteries are terrible for eVTOL. They are good only for single small passenger aircraft that can be flown under the FAA's Part 103 rules. These are not really certifiable. They have to weigh 115kg (254lb) - not counting floats or safety equipment - to be flown as a Part 103 ultralight. Only four companies actually have aircraft that are approved for use under the FAA's ultralight category. These four one-seat aircraft are approved to carry a single passenger.

When you compare battery capabilities to fuel you realise it becomes a ridiculous comparison. For example, if you are using lithium ion batteries, the aircraft regulations require containment - exampled by the problems experienced by overheating and melting of batteries on Boeing's 787 in 2013. While the overall gross weight of the lithium battery is small on an airliner, regulations add weight for containment so batteries on an eVTOL aircraft become a significant certification hurdle due to this additional weight. In comparison to use of fossil fuels, if you are using batteries on an eVTOL aircraft, they can be a third or even half the weight of the aircraft and that can become a significant hurdle. Batteries are much heavier and have less energy density than fossil fuel. However, with unconventional configurations, you could cruise on the wing and be very efficient in cruise. In the ultra-light category, or multi-rotor configuration, they are not efficient but if you can get off the ground and transition to the wing - for a great lift to drag ratio - that will mitigate the low energy density issue you have compared to a helicopter.

Now to the second part of the question: If you have to hover a long time - as a lot of missions for helicopters require - there will have to be two or three huge leaps in generations of battery capability. Lithium ion is state-of-the art today, but there are a lot of interesting battery types being studied that should have leap-ahead capability; so maybe in ten to twenty years battery power density will be good enough to replace more missions than helicopters today are performing. For the foreseeable future, however, anytime you need longer endurance or higher performance, you will need fossil fuel. Some configurations are looking at hybrid capability as well, as an interim possibility.

With today's state-of-the-art, you can have a one-person ultra-light with 30 minutes endurance and in five years maybe a multi-passenger fully electric aircraft with 30-minute endurance. But really in today's time frame if you need to carry more people and require endurance for range, you most likely will need a hybrid configuration with a turbine generating electricity for the batteries and motors to meet the high-power requirements of vertical takeoff and long-endurance. Fossil fuel will still be required to develop energy.

RT: *Do you believe the eVTOL market will ultimately end up replacing all fossil fuelled aircraft?*

MH: The short answer is no. Over time it will replace more and more and maybe in 100 years we may have eVTOL. But I think there will always be a place for fossil fuel aircraft - at least for 50 years. There are even helicopters today that are still operating that were built in the 1950s (for instance Bell 47s). From the military perspective, Boeing Chinooks are expected to have a 100 year history of operations which will take them past 2050 - and they are fossil fuelled aircraft.

RT: *Do you see the rotorcraft market heading to an interim phase where hybrids will take over?*

MH: Yeah, I think so. Only way I see eVTOL as viable for the foreseeable future for most missions currently conducted by helicopters is as a hybrid, since batteries are not competitive with fossil fuels. So you have to have an interim hybrid solution. The only way in my opinion that I see eVTOL as viable near term is if you have an aircraft with wing to transition it to forward flight. Batteries enable unconventional configurations but they need more capability than today's batteries can give.

However, if your requirement is to generate no tailpipe emissions or if you need to fly downtown in highly populated areas where there are noise concerns, eVTOL should be hugely quieter than helicopters. So if there are requirements for noise reduction or aircraft with no emissions, then eVTOL is sensible. There are three different factors forcing things to eVTOL—emissions, noise control and unconventional configurations. Uber is driving requirements. If you have a requirement for no emissions then eVTOL can be the answer or if you want very low noise then it is viable, but if you have helicopter-related requirements then a helicopter is probably the best answer at least for the foreseeable future.

SureFly is an eVTOL personal helicopter designed for safe and easy flight. It features eight independent motors, each driving a single carbon fibre propeller, a backup battery power system, and a ballistic parachute to safely land in the event of emergency.

Russian developed Hoversurf eVTOL flying motorbike.

RT: *The eVTOL market is filled with many significant new players - both wealthy individuals and large corporations with the wealth to make risky bets. Do you foresee governmental interest in developing eVTOLs or will this remain a risk-oriented, capital-intensive commercial market development?*

MH: NASA and the FAA are helping to facilitate and support but they don't fund development. Traditionally the military has funded development. I was at DARPA for ten years and when they develop aircraft it is when others won't. I see no compelling reason for government to invest in eVTOL. Military or government generally don't do technology development but once technology has been proven and is available the military will want it. Currently it offers shorter range, but potentially higher speed and lower noise levels.

RT: *What is the principal benefit that eVTOL offers conventional rotorcraft users? Is it performance through unconventional configurations, lower noise with less emissions or long-term ownership costs?*

MH: What I haven't mentioned so far with unconventional configurations - is you can really get higher speeds as you don't have retreating blade stall and the other shortcomings of conventional rotorcraft. A slowed-rotor compound for example is one of those where you can achieve higher speeds. If you can transition to a wing or other high-lift-to-drag configuration, you can achieve much higher speeds. In the second part of the question you mentioned this comment about cost. There is some data that indicates eVTOL will have much less maintenance than conventional combustion engine rotorcraft. I believe that electric cars have demonstrated this. Data has shown if you have an electric aircraft, particularly a fully electric aircraft, there is much less that can go wrong. Electric motors have much less that can go wrong with them compared with combustion engines. There are fewer moving parts. Helicopters also have a tremendous issue with vibration that impacts rotorcraft avionics which have to be more hardened than on an eVTOL.

RT: *How certifiable are the current crop of eVTOL designs? Some of them are quite interesting featuring literally dozens of unguarded moving rotor blades. That would seem to make them a challenge for certification from a safety standpoint?*

MH: One of the things with eVTOL is that it has a totally different design due to power distribution - no shafts, transmissions and gearboxes - plus all helicopters now have two rotors (either tandem or main and tail); now with eVTOL and power by wire, there are no longer such constraints. Multiple propellers have thrown out the conventional aircraft design rules; however, more moving parts cause concerns. The certification basis is not in-place for eVTOL yet. The vast majority I believe will be done under the FAA's Part 23 (for small airplanes) as a consensus performance standard. ASTM is developing standards that will include all the vertical requirements to be certified under Part 23. Certification though is everything. You won't make money if you don't get it certified as it must meet minimum standards for safety. So it has a public opinion aspect. People will sue if there are accidents.

RT: *Thank you.* A

On 10 June, the head of the Ministry of National Defense Mariusz Blaszczak visited Eglin air force base in the United States where he was updated on the development programme of the F-35.

POLAND LOOKS TO SHED ROBES OF THE PAST

Poland is on the defence acquisition trail to replace its old Soviet-era equipment, even if the new budget and strategy looks optimistic.

By Andrew Drwiega

Poland has undoubtably come a long way since it emerged from behind the Iron Curtain to become a member of the North Atlantic Treaty Organisation (NATO) on 12 March, 1999. It has stood firmly behind its western allies not only the Iraq War, where it committed troops and special forces (SOF), but as a NATO member, Poland contributed forces into NATO's International Security Assistance Force (ISAF) in Afghanistan up to withdrawal of the majority of forces in 2014.

Poland's Task Force White Eagle brigade took responsibility for the province of Ghazni. It deployed a variety supporting vehicles and helicopters including 70 Kołowy Transporter Opancerzony (KTO) Rosomak wheeled armoured vehicles and four Mil Mi-24 and up to five Mil Mi-17 helicopters for aerial firepower and utility lift. It also sent SOF to operate in the province.

As Russian foreign policy continues to be perceived as looking for expansionist opportunities, following on from the seizure of the Crimea and part of the Ukraine, the US and NATO view is that Poland is a state on the edge of NATO's eastern border that must be bolstered and strengthened. Its common border with Lithuania in the northeast of the country links the Balkan states (Lithuania, Latvia and Estonia) with the main NATO land mass in the West.

In keeping with so many ex-Warsaw Pact countries, its main military strength comprises Russian made equipment which it is eager to replace with more modern, western designed equipment. This would also have the advantage of integrating more easily with all of the defence based networks of its allies in addition to operating common equipment.

MODERNISATION PLAN

On 28 February Polish Defence Minister Mariusz Blaszczak signed the Armed Forces Technological Modernisation Plan (TMP) 2017-2026. The initiative plans to secure the investment of around $48.5 billion on defence acquisition by 2026. There is some concern about the accuracy of this figure. Currently Poland spends just over two percent of its Gross Domestic Product (GDP) on defence but the Plan makes the assumption that this will increase and will allow defence spending to raise to around 2.4 percent GDP.

However, the acquisition of two systems has already been agreed. One is the purchase of an initial 20 M142 High Mobility Artillery Rocket System (HIMARS) launchers - 18 combat and two for training. Each mobile launcher can fire six guided rockets over 70km (37 miles) or one MGM-140 ATACMS missile up to 300km from the five-ton truck; the chassis being produced by BAE Systems while the rocket launching system is from Lockheed Martin Missiles & Fire Control. It is a small MLRS variant with the ability to 'shoot-and-scoot'.

Raytheon's Patriot air and missile defence system was also on the Polish MoD'S shopping list and the largest contract for arms ever committed to by Poland, $4.75 billion, was signed in March 2018. The first deal will see the delivery of two batteries together with fire control by 2022.

F-35 CLUB

Modernising doesn't get any further towards the 'tip of the spear' than 5th Generation Fighters. During a speech on 29 April Defence Minister laszczak stated that the Polish government was looking to acquire Lockheed Martin F-35 fighters to replace its ageing Soviet era Sukhoi Su-22 and Mikoyan MiG-29 jets. This was followed in May by a letter of request sent by the Polish Government for 32 F-35 aircraft.

In 10 June, during a visit to the United States the Minister visited Eglin Air Force Base, where he was further briefed on the F-35 development programme. Talking of the prospect of owning F-35s he stated that it would be "a big breakthrough in the combat capabilities of Polish Air Force."

According to Blaszczak, "the purchase of F-35 fighters fits into the creation of the entire system that deters a potential enemy." He added: "Earlier, I signed contracts for the purchase of Patriot and Himars systems."

Also during the visit to the US, a Declaration on Defence Cooperation was signed which, in essence, is designed to bring more US forces into Poland. The declaration aims to see the establishment in Poland of the following: "a Forward US Division Headquarters; a Combat Training Centre; a base for US Special Forces capabilities; a base for a US Air Force unmanned aerial vehicles MQ-9 squadron;

Prime Minister Mateusz Morawiecki and the head of the Ministry of Defense Mariusz Blaszczak visiting the 1st Warsaw Armoured Brigade and telling them of the confirmation of the HIMARS rocket acquisition.

Polish MoD

as well as a loading and unloading air base and support groups to secure current and future US Armed Forces in Poland. An infrastructure will also be created to support the presence of an armoured brigade combat group, an air combat brigade and a battalion of logistic support."

On 21 June, the Department of Defense (DoD) approved the sale set of Insitu RQ-21A Blackjack UAS to Poland. The contract was conducted through FMS and was valued around $11.3 million. The usual package of this nature comprises five airframes and two ground control stations. The RQ-21A sensor suite would include an daytime/night camera, laser rangefinder, infra-red target designator and communications package. It has an endurance of around 16 hours up to an altitude of around 6,000 metre.

According to Blaszczak, the Polish MoD is also looking to modernise most of the Army's equipment including motors, tanks, guns and even submarines.

HOME INDUSTRY

One of the most successful defence companies in Poland is the WB Group, well known for its UAV systems (FLYEYE), loitering munitions (WARMATE) and personal communications systems.

On 22 July the company announced that it had signed a supplemental agreement with the NATO Support and Procurement Agency (NSPA) "for upgraded versions of the in-service FLYEYE UAS fleet." The upgrades will serve to "increase the interoperability of the Polish Army by standardising configuration'.

The FLYEYE UAS is operated by the Polish armed forces, is infantry portable and hand launched and used to provide ground troops with intelligence, reconnaissance, surveillance and target acquisition (ISTAR) from over the battlefield. The enhanced version delivers increased system performance and offers longer endurance, up to 2.5 hours. According to the company, further features include tactical and maritime antennae and an FT-LoC2 GPS based long range emergency location and recovery device. The final delivery is due by the end of 2020.

Aircraft manufacturer PZL Mielic (a Sikorsky company) has recently received orders from the Polish Government for four S-70i Black Hawks with an option for a further four. The company has also designed a single weapons station with it will reveal of the Polish defence show in September (MSPO). The company now not only builds UH-60M helicopters, but is also qualified to maintain them as well giving European customers a closer maintenance and repair facility.

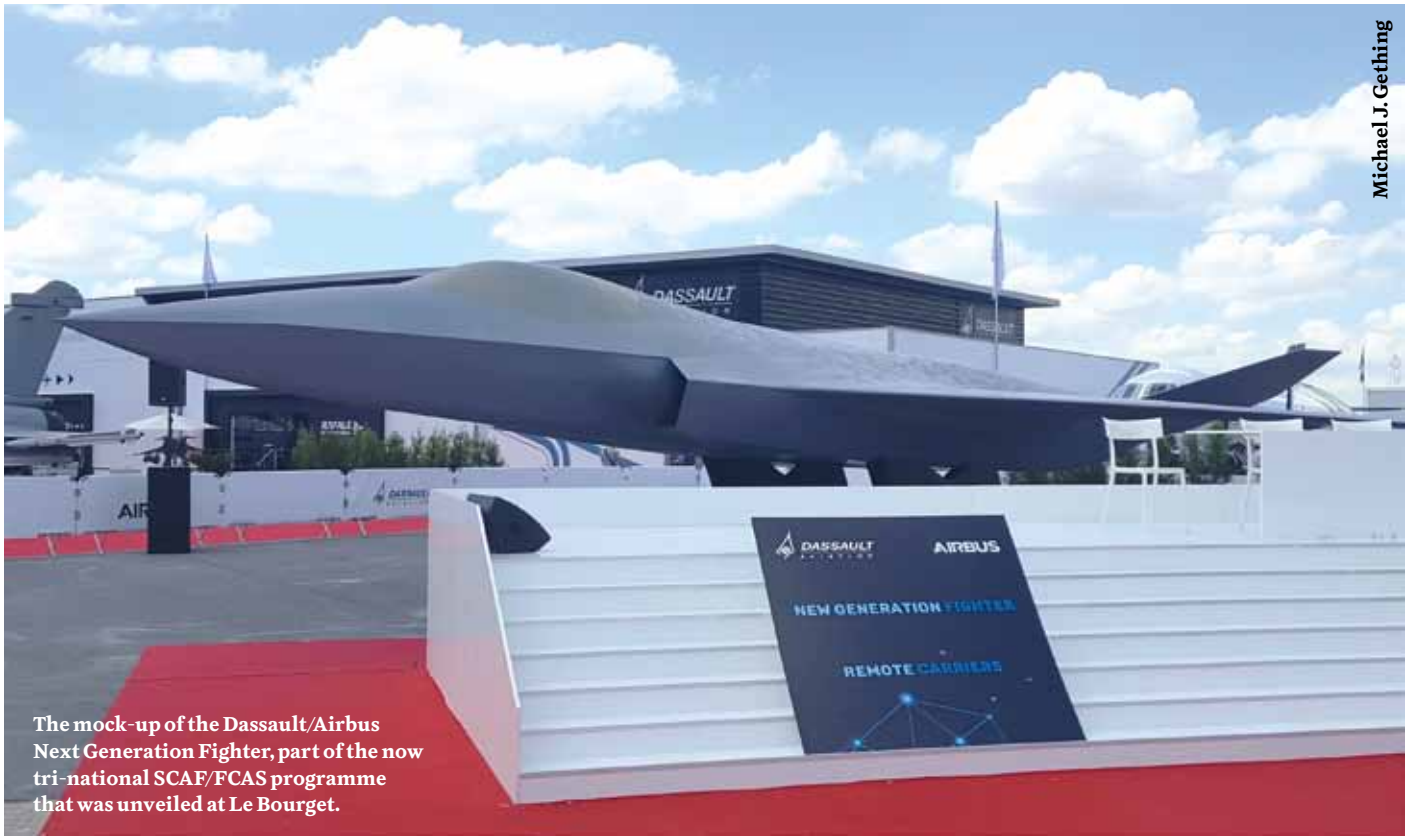
In March, PZL Mielic confirmed an $18.9 million contract from the US DoD to supply two M28 short take-off and landing (STOL) aircraft to the Nepalese Army Air Wing which had already operated one of the type before it crashed heavily. Mielic is well known for its design and manufacture of fixed wing aircraft that stretches back to the 1930s.

The Polish Army is also still looking for a dedicated 'narrow cockpit' attach helicopter to replaced the Mi-24 while the Polish Navy agreed an acquisition of four AW101 helicopters from Leonardo. These will serve both as anti-submarine warfare platforms and for combat search and rescue (CSAR). The $430 million deal will see the AW101 eventually replace the old Mil-14s. Like Sikorsky, Leonardo also has its own Polish factory, PZL-Świdnik's in eastern Poland.

The Polish Government is also preparing to defend the country against cyber attack. The Government has launched its own CYBER.MIL programme. On 7 May an agreement was signed with NATO to cooperate in cyber security and mutual support. According to a Government statement, "Poland will participate in the development of early warning systems for threats in cyberspace and will be able to count on the advice of NATO experts and cooperation with the defence industry in this area. The Government is also looking to establish its own military Cyberspace Defense Forces. A

WB Group has just signed an agreement with NATO's Support and Procurement Agency (NSPA) for upgrades to the FLYEYE UAS fleet.

WB Group



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The mock-up of the Dassault/Airbus Next Generation Fighter, part of the now tri-national SCAF/FCAS programme that was unveiled at Le Bourget.

PARIS AIRSHOW OVERVIEW

There was excitement at this year's gathering of the aviation industry at Le Bourget airfield in Paris this summer, largely generated by mock-ups of new fighter aircraft.

By Mickael J. Gething

The opening day of the Paris Air Show at Le Bourget airfield on the outskirts of Paris (17-24 June) saw a full-scale mock-up of the Dassault/Airbus New Generation Fighter (NGF), revealed with due ceremony in the presence of French President Emmanuel Macron. The NGF is the manned element of Système de Combat Aerien du Futur (SCAF) [or Future Combat Air System (FCAS)].

Initially a Franco-German initiative (agreed in July 2017), Spain announced its intention to join the project in February 2019. The formal signature of documents by the Defence Ministers of France (Florence Parly), Germany (Ursula von der Leyen) and Spain (Margarita Robles) confirmed Spain entry into the programme followed the unveiling.

The SCAF programme is intended to develop a sixth-generation air combat capability to replace the current Rafale and Typhoon in the three mainland European countries from around 2040. In addition to the manned NGF element (which includes a naval carrier-capable variant for France), the programme includes unmanned air vehicles, described as remote carrier platforms, operating alongside, or in concert with, the NGF as force-multipliers, plus an air combat cloud network.

A joint industry proposal for SCAF's first demonstration phase, covering the period out to mid-2021 was submitted by Dassault and Airbus. A contract is expected by the year's end and demonstrators are expected to fly by 2026. The French Direction Générale de l'Armament will be the contracting agency.

Details of the work share are, at present, scarce but it is known Dassault will act as design lead for NGF with Airbus directing the work on the remote carrier and air combat cloud elements. A parallel teaming between Safran and MTU will cover development of a new power-plant, likely to feature thrust-vectoring. Input from other elements of industry, notably MBDA and Thales, will make key contributions. The former is known to be considering a range of weapons and small remote carriers suitable for SCAF.

TURKEY'S TF-X

The second airshow reveal focused on another new concept aircraft, the Turkish Aerospace Industries (TAI) TF-X fighter mock-up. The TF-X, bearing a similarity to the Lockheed Martin F-35 Lightning II,

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Turkey's TF-X fighter was the second new design to be unveiled at Le Bourget.

albeit with a twin-engine configuration, is intended to replace the Turkish Air Force F-16 fleet, and a prototype is expected to fly around 2023.

Speaking at the unveiling, TAI's CEO, Temel Kotil, stated that "TF-X will be a fifth-generation fighter" adding that "once we develop the TF-X, we will become the world's fourth country to have this type of aircraft."

TAI is currently considering partners to join the project. Following the signing of a Memorandum of Understanding (MoU) with the United Kingdom during the visit of Turkey's President, Recep Tayyip Erdoğan, in May 2018, it is expected that BAE Systems and Rolls-Royce will join the TF-X programme.

According to Turkish government sources in 2018, an initial investment of nearly $1.2 billion (4.817 billion liras) has been allocated to the conceptual design phase of the TF-X programme.

Part of the incentive behind the TF-X project is an ongoing dispute between Turkey and the United States over the former's procurement of the Russian S-400 air defence missile system, which has placed Turkey's buy of 100 F-35 aircraft in deep jeopardy. A US ultimatum which called on Turkey to cancel the S-400 deal by 31 July 2019 has passed with the forfeit its acquisition of the F-35 now seemingly unavoidable.

LEONARDO'S LATEST RPAS

In the presence of Italian Prime Minister Giuseppe Conte, Leonardo unveiled a mock-up of its latest - and largest - member of its Falco Remotely-Piloted Air System (RPAS) family, the Falco Xplorer.

The first prototype Xplorer is complete and was expected to make its maiden flight later during the summer from Trapani, Sicily, Fabrizio Boggiani, Leonardo's senior vice-president of airborne sensor and mission systems, said at the ceremony. This will be followed by a flight test programme, to include validation of the fully-integrated on-board sensor suite. Certification is expected by the end of the year, he added. A second prototype is also under construction.

The Xplora, powered by a Rotax engine driving a three-blade propeller, has a wingspan of 18.5m and is 9m long, with a retractable undercarriage, with an endurance in excess of 24 hours. It has maximum take-off weight of 1,300kg (2,866lb), with a payload capacity of 350kg (770lb), and a maximum altitude of 30,000ft (9144m), Boggiani said.

The baseline sensor suite comprises the LEOSS electro-optic/infrared (EO/IR) sensor turret, a Gabbiano T-80UL multimode synthetic aperture radar (SAR) that can undertake mapping and ground moving target indication, and a SAGE signals intelligence (SIGINT) suite. In addition, there is a satellite communications (SATCOM) capability allowing control beyond radio-line-of-sight.

In addition to controlling the aircraft and its sensors, the Ground Control Station (GCS) incorporates data exploitation tools, enabling the dissemination of useful information, as well as providing mission data analysis, mission planning, training and simulation capabilities.

At this stage, there are no plans to arm the Xplorer, Boggiani added. It is designed as an ISR (intelligence, surveillance and reconnaissance) platform and weaponisation is not part of the system's overall design roadmap, he stated.

As yet, Leonardo does not have a launch customer, but Boggiani said the company

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The mock-up of the Leonardo Falco Xplorer RPAS was unveiled on the first day.

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The second of two ATR 72 airliners converted to Sea Eagle MPA configuration for the Pakistan Navy on display at the Paris air show.

is "talking to customers around the world", some 50 examples (of all models) having being built and operated by five nations.

ATR72 MPA TO PAKISTAN

Adapting airliners to the maritime patrol role is not new and the latest iteration of the genre - an ATR 72 for the Pakistan Navy - was also on display. The aircraft, dubbed the Sea Eagle MPA (maritime patrol aircraft), has been converted by Rheinland Air Service (RAS).

Conversion of the former passenger aircraft (supplied by the customer) into a multi-role MPA with anti-submarine warfare (ASW) capabilities was conducted by the Special Mission Aircraft Division of RAS of Mönchengladbach in cooperation with Braunschweig-based Aerodata.

The aircraft's sensor suite comprises Leonardo's Osprey AESA (active electronically-scanned array) X-band surveillance radar, a high-resolution FLIR Systems Star SAFIRE III EO/IR (electro-optical/infrared) sensor turret, an Elettronica ESM/ELINT (electronic support measures/electronic intelligence) system, an acoustic processing system from Sonartech Atlas of Australia, and Aerodata's AeroMission mission management system (MMS).

In addition, there are two weapons hard-points beneath the forward fuselage, capable of carrying ASW torpedoes; rear-fuselage chaff/flare dispensers, four pressurised sonobuoy dispensers in the rear cabin and a stores management system from Alkan. There are also two custom observation windows, broadband satellite communications and a 'glass-cockpit' AIS (integrated with the MMS), plus IFF and DF capabilities.

Depending on configuration and weights, an endurance of 10 hours is claimed by RAS. The first of two aircraft was delivered to Pakistan in mid-2018 and the aircraft on display will be delivered after the show. Speaking with Pakistan Navy aircrew at the show, it is apparent that they are very happy with the aircraft and its capabilities. The potential exists for procurement of a further two aircraft.

Speaking to *Armada International* at the show, Nikolaos Mavrikis, director of RAS's Special Mission Aircraft Division said: "with its long endurance and low operating costs, along with excellent parts and maintenance availability, the ATR 72 series was the ideal platform to fulfil our client's most demanding operational needs for maritime patrol and anti-submarine warfare missions".

MUSICAL INROADS

The J-Music (MUlti Spectral Infrared Countermeasure) DIRCM (directed infrared countermeasures) system from Israel's Elbit Systems is making inroads into the European large-aircraft market. On the first day of the airshow the company, together with NATO and Airbus, announced the successful integration of the system onboard the Airbus A330 Multi-Role Tanker Transport (MRTT) aircraft of NATO Multinational Multi Role Tanker Transport Fleet (MMF). This was followed, two days later, by the announcement of a contract award from Diehl Defence to provide J-MUSIC DIRCM systems for A400M Atlas cargo transport aircraft of the German Air Force.

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The integration of the J-MUSIC DIRCM self-protection system onboard the NATO A330 MRTT was completed after three days of integration flight tests performed in late May at the Madrid-Getafe airfield. The tests were led by an Airbus team, supported by Elbit Systems engineers and monitored by representatives of NATO Support and Procurement Agency (NSPA) and the Organization for Joint Armament Co-operation (OCCAR).

During these flight tests the system demonstrated what the company describes as "flawless functionality" and "showed the [system's] ability to defeat multiple threat types" simulated at the A330 MRTT aircraft while conducting a series of flight manoeuvres. The integration flight tests also established that J-MUSIC can handle simultaneous threat scenarios and overcome head-on, tail-on and side-on threats, from several ranges and at different altitudes.

The MMF programme is a multinational pooling and sharing initiative in which five nations (Belgium, Germany, Luxembourg, the Netherlands and Norway) are jointly acquiring, managing, operating and supporting a fleet of eight A330 MRTT aircraft from Eindhoven and Cologne. The aircraft, procured by OCCAR from Airbus and outfitted with the Elbit J-MUSIC DIRCM system, are owned by NATO and managed by the NATO Support and Procurement Agency (NSPA).

Elbit Systems

This artist's concept show an A400M equipped with J-MUSIC defeating a gound-launched SAM

The contract award from Diehl Defence, valued around $73 million, will see J-MUSIC fitted to German Air Force' Airbus A400M aircraft over a four-year period. Elbit Systems will work closely with Diehl Defence and Airbus Defence and Space on the integration of J-MUSIC DIRCM systems into the A400M Defence Aid Support Systems (DASS) protection suite. The German Air Force currently has 53 A400M aircraft on order, of which over 25 have been delivered.

While not presenting any radical new products, FLIR Systems' focus during the airshow was on the presence on its UltraForce range of EO/IR (electro-optic/infrared) sensor turrets, which are free of ITAR (International Traffic in Arms Regulations) restrictions.

Roelof van der Spuy, vice president Europe & Africa Surveillance BD & Sales, told *Armada International* that its UltraForce 275 EO/IR sensor turret had been re-packaged for use on footprint-constrained platforms. "We've shrunk the components," he said, "at the same time upgrading to HD [high definition] configuration". He added that some customers preferred to acquire a non-US product (from its UltraForce range), accepting that some areas of performance may not match those of US-produced systems.

That said, he noted that the 275mm-diameter UltraForce 275-HD turret (with a 378.5mm depth and weighing 15kg (33lb) had been re-packaged and given improved sensors: a Gen3 640x512 MCT focal plane array thermal imager, operating in the 3-5 micron (MWIR) range, with a continuous zoom (28 to 1.83DEG) lens; and an HD 1,080x720 CMOS daylight camera, with a continuous zoom (45 to 2.2DEG) lens. The video output is delivered with embedded metadata fully compliant with STANAG and MISB standards.

The slightly larger UltraForce 350-HD (with a 350mm diameter and 485mm depth, weighing 28kg (62lb) features the same MWI thermal imager as the 275-HD but with a triple field-of-view lens and x2 electronic zoom; while the daylight imager is an HD charge-coupled device (CCD) with a continuous zoom (60 to 2.2DEG) lens. A spotter scope option uses a 1 lux colour CCD with a continuous zoom (25.4 to 0.75DEG) lens.

Optional sensors available for both the 275-HD and 350-HD include a 10km-range laser rangefinder, a covert laser pointer (narrow-angle beam), an eye-safe visible laser pointer and a laser illuminator (wide-angle beam). Other features include an auto-tracker and an improved inertial measurement unit (IMU). A

Michael J. Gething

The UltraForce 275-HD EO/IR sensor turret is ITAR-free and repackaged for footprint-constrained platforms.

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ILL WIND BLOWING THROUGH DEFENCE TRADE

Andrew Hunter

Trade has always been a tool of statecraft, but its prominence here has risen markedly in recent years and the connection to national security has become quite explicit. The Trump Administration has cast its tariffs on Chinese imports as part of confronting a strategic competitor. It has also justified tariffs on aluminium and steel on a range of countries, including bizarrely several allies, as being required on national security grounds. After decades of effort on the trade front to reduce or eliminate tariffs and non-tariff trade barriers, tariffs as a tool of state competition are, quite suddenly, back.

In contrast to commercial trade, defence trade has always been seen primarily as a tool of national security, with arms transfers used to solidify alliances as well as reward and strengthen security partners while supporting domestic industries on both sides. On the other hand, countries that are security competitors usually have little to no reciprocal defence trade. While the trade trend overall is towards greater focus on and influence of national security concerns, more closely mirroring traditional defence trade, defence trade is undergoing its own shift.

The exemplar, as it is in so many things defence, is the Lockheed Martin F-35. The US and Turkey have come to a stunning rupture in the F-35 programme. Turkey, an early and critical partner which was on the verge of receiving its first aircraft, has been effectively expelled from the programme. Complicating the situation is the fact that Turkish companies have been suppliers of parts for the F-35, relationships that must now be quickly unwound. The rupture happened over the Turkish Government's decision to acquire the Russian S-400 air defence system, just a few short years after shooting down a Russian aircraft that it believed had violated its airspace. In the process, Turkey declined to procure a western air defence system in lieu of the S-400. While Turkey's reasons for choosing the S-400, and deciding at the same time to pay a steep price on the F-35 programme, are not entirely clear. It is a stark demonstration that the usual rules of the international defence trade are shifting in unpredictable ways. Something that would have been inconceivable just five years ago.

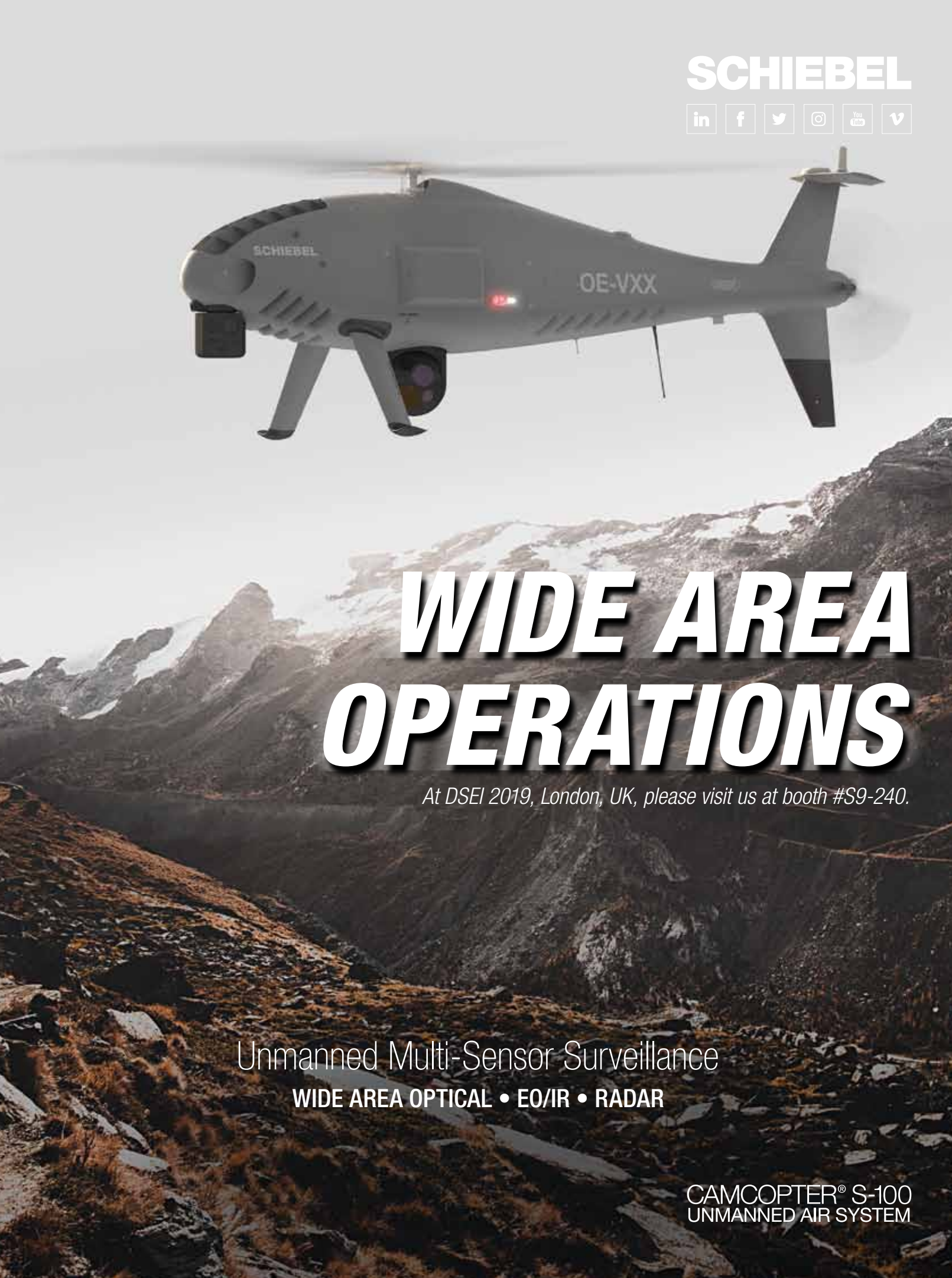
A less dramatic, but perhaps no less important F-35 development is in the works in Asia, where Japan appears to be on the verge of requesting full partner status on the F-35 programme. While Japan for years sought to purchase Lockheed Martin F-22s to provide it with an air superiority fighter, Japan was persuaded to purchase the F-35 instead. Japan now seeks to join the original nine partner nations (at least temporarily down to eight with Turkey's departure) as a core participant. It is rumoured that Washington may be reluctant to grant Japan this on the basis that partnership status must be limited to the original partner nations who contributed to the programme's development years ago. But the ramifications of denying Japan full partner status could be even more significant than Turkey's withdrawal. The likely effect would be to spur the development of indigenous fighter aircraft in both nations. While neither of these indigenous aircraft efforts are likely to become competitors at the top end of the international fighter markets, a further splintering of the fighter market only reduces the strategic national security benefits that the F-35, and other western defence trade strategies, are designed to foster.

Given that the Cold War has been over for approximately 30 years, it is perhaps not surprising that East/West alliance structure, which has largely persisted in defence trade over this time, may break down.

Will some countries decide to refocus their defence trade around authoritarian regimes that are unlikely to demand concessions on human rights and may be more willing to share technology? Will countries redouble their efforts to develop indigenous systems that provide less capability at higher cost, straining already strained western defence budgets? Will new poles of industrial cooperation develop between Asia and the Middle East reducing US or European involvement? These questions mirror the larger uncertainty about whether the global security system is evolving toward a multipolar or a new bipolar orientation.

Defence trade relationships have long lives, which suggests that they will be a lagging indicator of the development of a new global security structure. However, the evidence is already pretty clear that the winds of defence trade relationships are already swirling and the path ahead is becoming unclear. Arms exporting nations are well advised to revisit all of their assumptions about what is motivating their security partners and how those motivations may change with long lasting implications. A

SCHIEBEL



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