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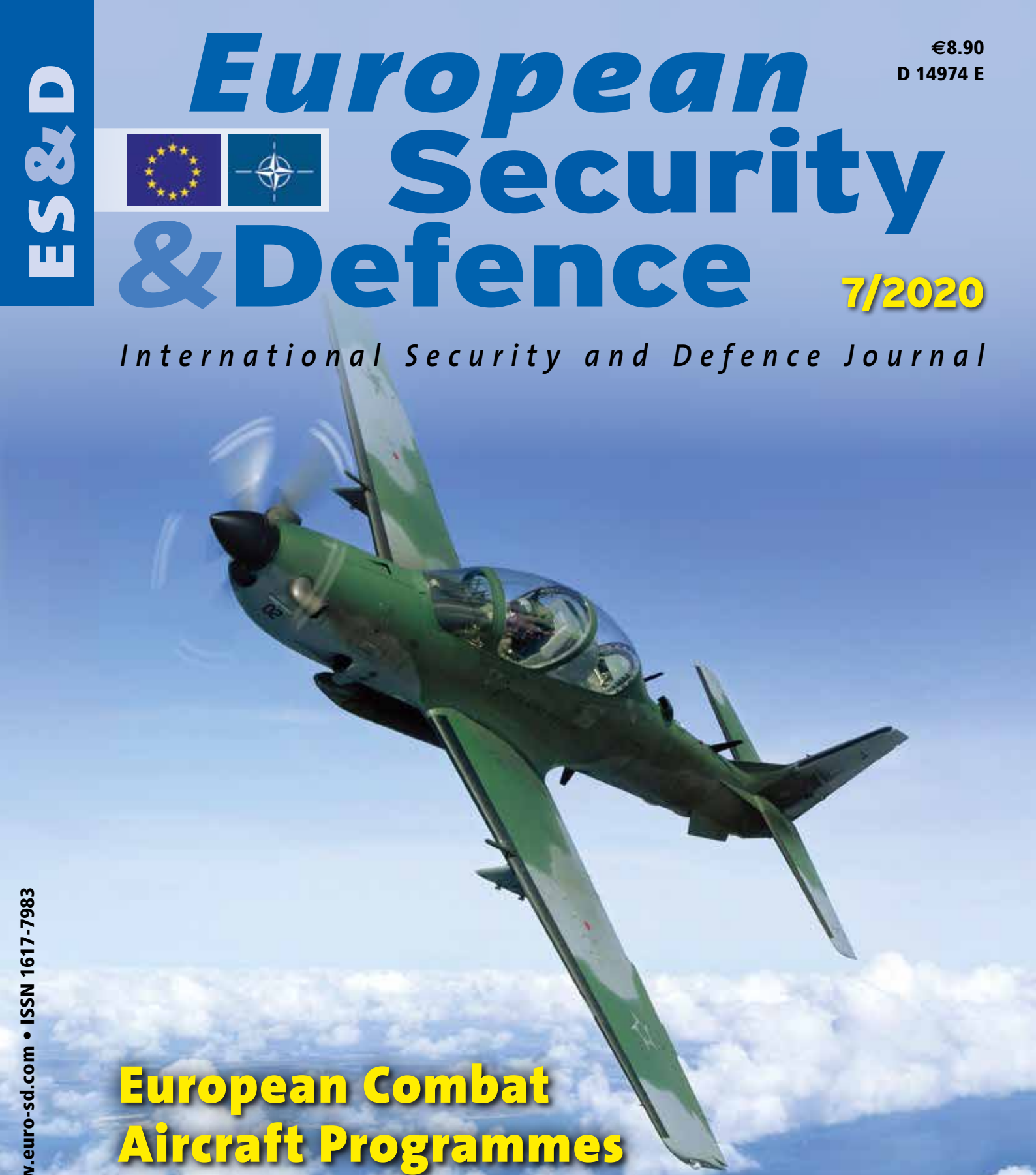

European Combat Aircraft Programmes

- European UAV/UAS Requirements
- Vertical Rotary Lift
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US Foreign Policy in a Time of Covid-19, Riots and Election Campaigns

Photo: MRV archive

When pain depresses people, they seek refuge in strong hope. Currently, many are suffering from the effects of the coronavirusa, from images of police violence and race riots in the US, and from the clumsy reactions of US President Donald Trump. They hope that after these events everything will be different: Covid-19 brings about a change in thinking, the mass protests against racism lead to police reform, and Trump is voted out of office for failure.

It may happen. But it might not happen. Experience with earlier dynamics, which at the time were perceived as major cataclysms, urge caution. Even if all three hopes were to be fulfilled, US policy towards Europe and the world would probably not change fundamentally.

Certainly, all three developments can bring about change. The Covid-19 ledger in the USA with its high numbers of infections and deaths, raises doubts about the efficiency of health care and disaster control. And the President's course. The USA is not getting a grip on the virus so quickly. The economic slump is deep. Some 40 million citizens have lost their jobs. However, new economic data is inspiring confidence that the worst is over and that things are now looking up again. But how quickly? And, are there any setbacks looming? The uncertainty is palpable. Even if the positive trend continues in the months leading up to Election Day on 3 November, it will not be easy to regain the belief that Trump is the guarantor of a good economy. So far, he has been his own most important election worker.

The political consequences of the death of George Floyd and other victims of police violence are less clear, together with the mass protests that they sparked. Similar incidents occurred in the run-up to the last presidential election in 2016, when "Black Lives Matter" became a powerful movement. But it radicalised. Some of the demonstrators went on a rampage. In the summer of 2016, extremists fired on police officers. The mood changed. This helped candidate Trump, who presented himself as a defender of "Law and Order", to win the election. This could repeat itself in 2020, especially since Trump appears to be intensifying the conflicts instead of reconciling them.

One thing is different, however. In 2016, Trump could attack as an opposition member. Obama led the country. Now Trump is in the White House and gives the impression that he is not ruling, but is permanently campaigning, solely with his voters in mind.

Trump has fallen behind in the polls in recent weeks. On average in the nationwide polls, Biden (49.8%) now leads with 8.1 points ahead of Trump (41.7%). Biden is also ahead in the presumably election-decisive swing States such as Arizona, Florida, Michigan, North Carolina, Pennsylvania and Wisconsin. Except for Ohio.

How will Trump react? He will intensify controversy, real and imagined, domestic and foreign. For those of us who are behind, the best defence is a good offence. There are plenty of opportunities: China, North Korea, withdrawal of troops from Germany, sanctions against Nord Stream, punitive tariffs and much more.

This is a look ahead. Which conflicts will disappear if Trump loses the election? Which ones will remain? And which ones can be expected to intensify if he wins?

Only one part is specific to Trump. A President Biden would threaten neither Germany nor Europe with troop withdrawals or automobile tariffs. On the other hand, the pressure for Europe to do more to defend themselves would remain, even under Biden. The same goes for the sanctions against pipelines and gas deals with Russia. They meet with non-partisan approval in Congress. This also applies to the expectation that the entire West must press China to be fairer in market access and tariffs.

All in all, yes, many things could change with the coronavirus, the protests against racism and an election victory for Biden. But many challenges remain. Things will not change in the USA if Trump loses the election.

Christoph von Marschall,
Diplomatic Correspondent in the main editorial office
of the German newspaper Tagesspiegel

The Publisher and Editor-in-Chief welcome submissions for the opening Editorial. Contact details are included in the Masthead (page 66).

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The EUROFIGHTER TYPHOON is the combat aircraft of choice of five European and four other countries. **Page 42**

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VIEWPOINT FROM ...

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WFEL Appoints New Ex-Military Director

Photo: WFEL

(ck) The Board of WFEL Ltd, a producer of rapidly deployable military bridging systems and a partner in the UK MoD's BOXER Mechanised Infantry Vehicle programme, has appointed Tom Winney to the position of Director of Business Development. This new Director role has been formed in order to address the large number of enquiries for WFEL's portfolio of world-class bridging products, which have already been supplied to more than 40 armed forces across the world. Winney served as an Infantry Officer in the British Army, with postings to Afghanistan, Kosovo and Northern Ireland. In his new position, Winney will oversee all Business Development activity for WFEL's range of products including the Dry Support Bridge (DSB) and Medium Girder Bridge (MGB). He has experience of military bridging, vehicles, ammunitions and service support with both the UK MoD and military organisations throughout the world. Prior to joining WFEL, Winney previously held senior Project Management and Business Development roles within BAE Systems and RBSL.

New President at SENER

Photo: Sener

(ck) Andrés Sendagorta, hitherto Vice-president of SENER, will be the Group's new President, taking over from Jorge Sendagorta, who will continue to be linked to the SENER Group as its Honorary President. Sendagorta holds a diploma in General Management from the Institute for Higher Business Studies IESE (Universidad de Navarra, Spain). He is a member of the Steering Committee of the Institute for Stock Market Studies, and the President of the Basque Family Business Association AEFAME and was formerly a Lieutenant Commander and HARRIER jet pilot on board aircraft carriers (US Navy and Spanish Navy). In 2009, he was awarded the Grand Cross of Naval Merit with white decoration by King Juan Carlos I. Sendagorta's relationship with SENER was forged, first, as a Director at the Board of Directors and ten years later, since 2000, as Vicepresident of the Group. In 2018, he was appointed President of the SENER Foundation.

Communications Systems for Canada's Joint Support Ships

(ck) Thales Canada has contracted Rohde & Schwarz to deliver secure communications systems for two new Joint Support Ships. Construction of the new Joint Support Ships is currently underway at Seaspan Vancouver Shipyards under the National Shipbuilding Strategy. Once constructed, the Joint Support Ships will be purpose-built, multi-role vessels that will provide an

Photo: Rohde & Schwarz

important auxiliary function to the Royal Canadian Navy. In addition to replenishment at sea, the vessels will support training and naval manoeuvres and humanitarian operations, ensuring Canada's continued safety and security at home and abroad. Some of the factors that resulted in Rohde & Schwarz being awarded this contract include the independent company's ability to engineer ship specific high frequency (HF) broadband antenna designs.

First Flight for PrecISR Radar

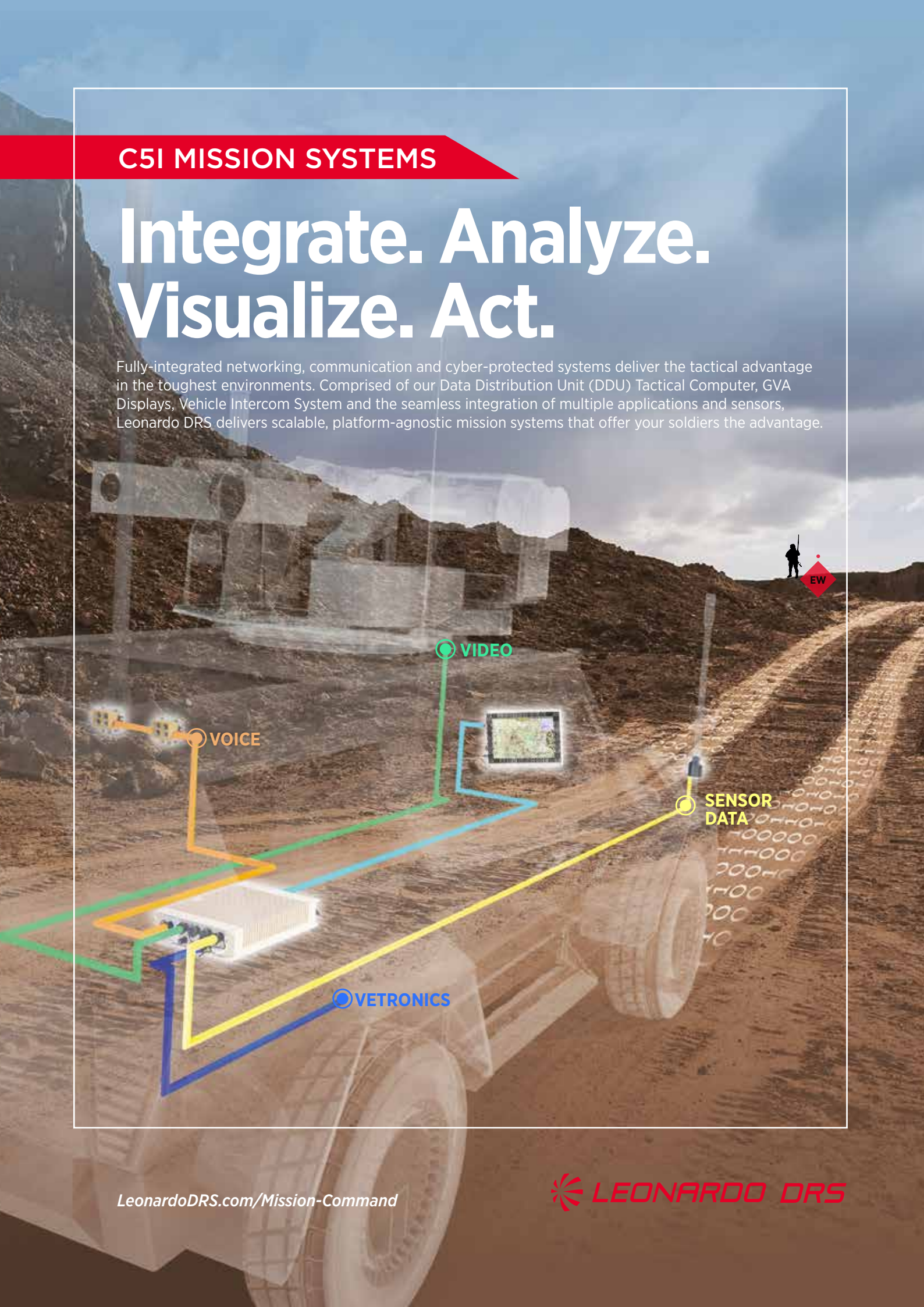
(ck) Hensoldt's new airborne multi-mission surveillance radar PrecISR 1000 has successfully completed its maiden flight. In a one-week flight campaign, the radar proved its value in terms of simple integration and performance. Thanks to its industry standard interfaces, the aircraft was modified and the radar was integrated, tested and flown within two months. PrecISR 1000 proved to be very stable and it generated a huge amount of high-quality reconnaissance data such as SAR pictures during its first operational flight. The radar translates latest achievements in active array and digital receiver technology into a scalable high-performance sensor which can be installed aboard helicopters, UAVs and fixed-wing mission aircraft. Due to its software-defined radar modes and electronic beam steering, PrecISR can fulfil different tasks at the same time. It is able to detect, track and classify more than a thousand objects simultaneously. Because of its compact design and the fact that all radar related components are located outside of the airframe, the airborne platform integration of PrecISR is simplified compared to other radars. Its superior precision and target accuracy make it the sensor of choice for surveillance of large maritime and coastal areas. PrecISR ground surveillance capabilities include reconnaissance and characterisation of fixed targets using Moving Target Indication (MTI) and Synthetic Aperture Radar (SAR) operating in Spot or Strip mode. For maritime surveillance it characterises the maritime targets through Maritime Inverse Synthetic Aperture Radar (ISAR) operation and Range Profiling. Air surveillance capabilities include detecting and intercepting low flying aircraft, gathering information on direction and speed of all kinds of targets for correlation with data from other sensors, e.g. ADS-B, AIS, EO/IR. Hensoldt has been awarded an order by a provider of airborne special missions operations to deliver PrecISR 1000 until year-end for installation underneath a PILATUS PC-12 special operations aircraft.

Photo: Hensoldt

New CEO of EXPAL Systems

Photo: MAXAM

(ck) MAXAM has announced the appointment of José Manuel Fernández Bosch as CEO of EXPAL Systems, MAXAM's business division specialising in defence and security. Fernández Bosch will join the MAXAM management team in his role as General Manager of the defence unit. Pedro Sallent, who has served as General Manager of EXPAL Systems for the past five years, is leaving the company. With more than 25 years of experience in listed companies and consulting firms, Fernández Bosch was, until joining EXPAL Systems, Partner at the international consulting firm Arthur D. Little. Prior to this, he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was General Manager of the non-regulated business of Aena, participating in the company's transformation process between 2012 and 2019 and its IPO in 2015. He has also been CEO of Aena International, as well as Partner of the Boston Consulting Group. He is a Telecommunications Engineer from the Polytechnic University of Madrid and has an MBA from IESE. Fernández Bosch joins EXPAL with the aim of piloting its strategic development and reinforcing its growth, advancing the transformation of the business from a company specialising in ammunition to a global defence firm.

Predictive Maintenance for Land Equipment

(ck) In December 2018, the French Army entrusted Arquus with the conduct of an experiment into predictive maintenance tools on land equipment entitled EVTA Vérité. The goal was to analyse the relevance of predictive maintenance-related technologies and their suitability for the management and use of military fleets. It also aimed at measuring the impact of these technologies on maintenance organisation, as well as defining the next development steps. As part of this evaluation, 20 VAB (Véhicule de l'Avant Blindé) armoured vehicles were equipped with various HUMS (Health and Usage Monitoring Systems) sensors and delivered in June 2019 to the CENTIAL (Centre d'Entraînement Interarmes et du soutien Logistique, Combined Training and Logistics Support Centre) in Mourmelon. During the collection phase at CENTIAL, the VABs were given a wide variety of missions, conducted under different conditions and on very different terrains. This experiment, carried out in partnership with LGM, was conducted across several thousand kilometres in numerous configurations, thus enabling the building and studying of a complete database on the spectrum of monitored functions. SIMMT's positive feedback on the use of this first data collection highlights the potential of the degradation models created through this study. The analysis of data collected by the sensors enables the construction of complete models to forecast maintenance needs, adapted to the environment and mission profile. Thanks to predictive maintenance, technical failures may be anticipated several days in advance, refining the planning and work of maintenance and logistics personnel. The generalisation of HUMS-based procedures within the land forces should therefore increase equipment's uptime.

Photo: CENTIAL

These new approaches should also offer field commanders the necessary tools to assess equipment's potential and maintenance needs. The use of HUMS is one of the solutions developed by ARQUUS to improve the maintenance of Army equipment in operational condition. These solutions include the use of 3D printing, as well as virtual and augmented reality.

Antycip Simulation Becomes ST Engineering Antycip

(ck) Antycip Simulation, a European provider of virtual reality, simulation and visual display solutions, has changed its legal name to ST Engineering Antycip, to reflect the overarching identity of its parent company, ST Engineering. To align with the name change, the company will also adopt the group corporate brand. ST Engineering Antycip is a subsidiary of the electronics arm of ST Engineering, a technology, defence and engineering group based in Singapore that specialises in the aerospace, electronics, land systems and marine sectors. While ST Engineering Antycip has been part of ST Engineering for over a decade, the incorporation of "ST Engineering" into its name and the adoption of the ST Engineering masterbrand will help to reinforce its identity and drive greater brand visibility for global growth.

Contract Awards for Hensoldt

(ck) With the release of the budget for the development, production and integration of a new AESA (Active Electronic Scanning Array) radar for the entire German EUROFIGHTER fleet, the Bundestag's Budget Committee has cleared the way for the modernisation of the Eurofighter in one crucial area, sensor technology. Thus far the development of the radar has been undertaken by a consortium under British leadership, but now radar system responsibility will pass into the hands of the German radar house Hensoldt. Hensoldt's share will be over €1.5Bn. The company has already been involved in the development and production of the EUROFIGHTER sensor technology currently in use. Hensoldt employs 2,000 people at its radar centre in Ulm. In the EUROFIGHTER radar departments alone the creation of 400 highly qualified jobs is expected over the duration of the programme. In radar development, the company works closely with the main contractor Airbus and the Spanish defence electronics group Indra. Hensoldt is also supplying four TRS-4D naval radars, also based on AESA technology, for the MKS 180 multi-purpose combat ship programme for the German Navy. Radars of this type are already deployed on several German Navy ships.

IAI to Collaborate with UAE on Covid-19 Research

Photo: IAI

(ck) Israel Aerospace Industries (IAI) entered a historic collaboration agreement with Group42, a company based in Abu-Dhabi, the capital of the United Arab Emirates. The collaboration between the two companies will cover research and development of solutions that may help fight the COVID-19 pandemic. The agreement was signed between IAI's ELTA Group via a video conference call between UAE and Israel. Representatives of both companies discussed ways to leverage AI and other technologies including lasers and sensors, to develop new COVID-19 focused systems. The solutions, as well as the joint medical and technological initiatives, are meant to help not only the populations of both countries but also aid in the global battle against the COVID-19 pandemic and improve the healthcare situation of the entire region. Yoav Turgeman, IAI Vice President, said, "We are now proud to join forces with Group42 from UAE and take the first step in what may become future joint work by the two countries."

Missile Tube Contract for Babcock

(ck) Babcock has been awarded a multi-million pound contract extension to manufacture a further 18 tactical Missile Tube Assemblies (MTAs) for General Dynamics Electric Boat (GDEB). It is part of the Common Missile Compartment (CMC) project for the UK DREADNOUGHT class and US COLUMBIA class submarine programmes, and will support more than 200 Advanced Manufacturing jobs at Babcock's Rosyth and Bristol facilities. This specialised, internationally significant work reinforces Babcock's position as a critical supplier of MTAs, utilising its digital manufacturing skills and expertise to support the future deterrent submarine programmes for both the UK and US Navies. Since 2014, Babcock has secured competitive contracts with GDEB to manufacture 57 MTAs. The latest of these contracts included an option to supply an additional 18 MTAs, resulting in the recent contract extension. This brings the total number of tactical MTAs that will be manufactured by Babcock for Electric Boat to 75, and will see Babcock's work transition from the UK DREADNOUGHT to the US COLUMBIA programme.

Photo: Babcock

Milestone Reached in Belgian-Dutch Mine Hunter Programme

(ck) One year after the notification of the contract in 2019, the Belgium Naval & Robotics teams have reached a new milestone within the framework of the Belgian-Dutch mine hunter programme, which provides for the delivery of 12 mine hunters equipped with drone systems (Toolbox) to the Belgian and Dutch navies. The milestone reached in May 2020, "Systems Functional Review", validates the functional and architectural studies of all the systems of mine action ships developed by Naval Group such as computer networks, electrical installations, propulsion or combat systems, as well as those of all drones developed by ECA Group, key elements of the ships. This review also focussed on the systems of systems that provide mission management, communications and cybersecurity, as well as on the integration of drone systems on the ship. The twelve ships will be equipped with a total of a hundred drones managed in a pool called Toolbox, shared by the two navies and supplied by ECA Group. The configuration of the Toolbox, used on board each ship or deployed from the shore, will vary depending on the typology of the missions. It will consist of surface drones USV INSPECTOR125, underwater drones AUV A18M and towed sonars T18 for mine detection and the MIDS system (Mine Identification and Disposal System) for mine identification and neutralisation. The contract for twelve mine hunters for the Belgian and Dutch navies will span over ten years. After a design period of three years, Belgium Naval & Robotics will move on to the production phase of the ships and drone systems, with an initial delivery scheduled for 2024. Six ships will be delivered to the Belgian navy and six to the Dutch navy; they will be equipped with a complete drones system (Toolbox) containing a total of more than a hundred underwater, surface and aerial drones entirely dedicated to mine hunting.


Image: Naval Group

BRADLEYs for the US Army

(ck) The US Army Contracting Command has contracted BAE Systems to supply another 159 BRADLEY A4 infantry fighting vehicles for around €238M until 31 March 2023. As recently as June 2018, a contract for 473 BRADLEY M2A4 and M7A4 had been awarded with an order value of around €310M. Since 2018, the US Army has been looking for a successor to 4,700 BRADLEY under the name Optionally Manned Fighting Vehicle (OMFV). A major improvement in the BRADLEY A4 is the increased power train with almost 500 kW (A3: 441 kW), which, despite the increase in combat weight to 36.3 tons (34.3), results in an increase in maximum speed to 66 km/h (61 km/h). Digital electronics have also been used to improve situational awareness and integration into command and control networks. Last but not least, improved fire suppression and IED jammers increased protection.


Photo: BAE Systems

India to Buy More MiG29s and Su-30MKIs from Russia

(jcm) With a depleting number of fleet, the Indian Air Force (IAF) is expediting a proposal to buy 33 new fighter aircraft, including 21 modernised MiG-29s and 12 Su-30MKIs, from Russia. India's MoD is expected to give a green light to the proposal as early as the end of this month, according to an MoD official. The IAF expects to get the latest versions of the MiG-29 fighters. It also wants the new aircraft to be equipped with indigenous weapons systems including the ASTRA missiles. The IAF has been in advance talks with Russia for an urgent procurement of MiG-29 fighters that are lying ready built in Russia. The plan is to acquire 21 additional aircraft at the earliest opportunity to make a new squadron of MiG-29 jets. The aircraft are expected to cost about INR60Bn. The MiG-29s, if procured, will cost significantly less than the RAFALE fighter jets, which India is acquiring from France. The proposal includes the acquisition of 12 Su-30 MKIs that would be required to replace the number of aircraft lost by the IAF in different accidents. The country's state-owned Hindustan Aeronautics Limited (HAL) will assemble the Sukhoi twin-jet multirole air superiority fighters from the kits at its Ozar plant in the western state of Maharashtra's Nashik, while the MiG-29 jets are expected to come in flyaway condition. The IAF already has a sanctioned strength of 272 Su-30 MKIs and operates 69 MiG-29 UPGs jets. The first Su-30 MKI aircraft entered service with the IAF on September 27 2002, and since then 259 more have joined the force. Russia has delivered all components and kits to HAL to assemble 222 Su-30 MKIs. Out of the 272 fighters, the first 50 Su-30 MKIs were manufactured in Russia and flown to India.


Photo: J. C. Menon

The IAF has barely 32 squadrons of fighter aircraft currently in its inventory, and aims to have a strength of 42 combat squadrons to be fully prepared for a two-front war. The additional Su-30 MKI frontline fighters and MiG-29 jets will add two more squadrons to the IAF fighter fleet.

ESCAN Radars for EUROFIGHTER

(ck) Following approval by the German and Spanish governments, Airbus has been contracted for the development, delivery and integration of 115 ESCAN radars for the German and Spanish EUROFIGHTER fleets. The contract provides for the delivery and integration of 110 CAPTOR-E radars for Germany and, initially, five radars for Spain from 2023. Development and construction of the radars will be subcontracted and awarded to the Euroradar consortium led by Hensoldt and Indra, with the involvement of other EUROFIGHTER partner companies. According to Airbus, the EUROFIGHTER CAPTOR-E radar is the world's most advanced fighter radar with electronic beam steering. The airframe is prepared for the installation of the largest possible electronic radar field, detection and tracking range, advanced air-to-ground capabilities and enhanced electronic self-protection measures. In particular, the size of the aircraft nose allows a higher field of view than any other combat aircraft. This increases the aircraft's performance and also guarantees the EUROFIGHTER's role as an important component of the Future Combat Air System (FCAS).

Negotiations for Germany's Heavy Transport Helicopter

(ck) In May 2020, the German procurement authority BAAINBw began negotiations for the Best and Final Offer (BAFO) for the German Bundeswehr's heavy transport helicopter (STH) programme. The two competitors, Lockheed Martin/Sikorsky and Boeing, submitted their bids in January. The negotiations were conducted via video conferencing because of restrictions imposed due to the coronavirus and, according to the parties involved, no significant delay has occurred so far. It is therefore expected that the negotiations will be concluded on schedule in August 2020. Procurement and service contracts are scheduled to be completed in March 2021 after the project has been approved by parliament. In June 2020, Lockheed Martin/Sikorsky and their German industrial partners provided information on selected aspects of the project. According to the companies, the CH-53K KING STALLION offered by Sikorsky has reached two important milestones this year: in April 2020, Lockheed Martin handed over the first flight simulator to the US Marine Corps, thereby enabling high quality training. Also in April, air-to-air refuelling was successfully performed with the C-130J transport aircraft – soon to be fielded by Germany – which was important for the helicopter's long-range capability. Sikorsky currently has 31 CH-53K helicopters in production. By 2025, when the first Bundeswehr aircraft are due to arrive, the USMC will have 70 KING STALLION in service. In the industrial team, Rheinmetall acts as coordinator for the various branches and as the contact point for the Bundeswehr. Support for training and logistics are key elements of the team's services. MTU Aero Engines is also a member of the CH-53K team, offering advantages in terms of maintenance and repair. Autoflug will contribute crash-resistant seats for troop transport, multibase pallets for freight transport and as functional pallets and auxiliary tanks for range extension. Hydro is to provide special tools for the CH-53K for use in stationary maintenance, in the field and in the aircraft, thereby continuing the existing cooperation with the German armed forces.

Spanish VCR 8x8 Programme on Track

(ck) The Spanish Defence Minister Ángel Olivares recently chaired a meeting at the GDELS-Santa Bárbara Sistemas factory in Alcalá de Guadaira (Seville) which assessed the progress of the VCR 8x8 demonstrator programme. The meeting was attended by senior representatives of the Spanish MoD, the Spanish procurement authority DGAM, the Spanish Army as well as the companies involved in managing the VCR programme; Santa Bárbara Sistemas, Indra Sistemas and Sapa Placencia. The delegation toured the assembly chain of the five VCR 8x8 prototypes, which is installed in one of the factory's workshops. The meeting included a dynamic demonstration of the 8x8 VCRs on the test track where the attendees checked the maturity of the designs and their mobility allowance and power performance. The first two demonstrators are scheduled to conduct test firing in early July 2020. The contract for the acquisition of 348 VCR 8x8 units is expected to be signed in August 2020. Once the MoD has signed the contract, the companies involved will set up a joint venture in charge of supplying the vehicles, providing maintenance and support throughout their life cycle and promoting international commercialisation. It is estimated that the vehicles will be delivered within a period of seven years from the signing of the Programme Agreement. The Spanish VCR 8x8 Programme is intended to be a driving force within the national industry; an ambitious national Industrial Plan has been developed, which facilitates the maintenance of the design authority in Spain and encourages a high participation of national industry of no less than 70%.

iMAST Alliance Formed to Support RN Training

(ck) The iMAST Alliance is a collaboration between three UK Maritime defence companies: Babcock, QinetiQ and Thales, together with technology partners Centerprise International, Learning Technologies Group and academic institutions, the University of Portsmouth and University of Strathclyde. The alliance has signed an Alliance Agreement to deliver a training solution that they believe will modernise Royal Navy training. A contract will be awarded following a competitive tendering process run by the MoD and will see the successful bidder partner with their customer to transform Royal Navy training. Down selected to bid in 2019, the iMAST team is finalising its approach with final tender submissions due in summer 2020. iMAST lead contractor, Babcock, is currently responsible for around 70% of the outsourced Royal Navy training programme. The winning bidder will also be responsible for designing, procuring and managing the maintenance and repair of all associated training equipment. This includes support for the delivery and procurement of the interior design, fit out and relocation to a new purpose built facility for submarine training based on the Clyde, helping to create a submarine centre of excellence.

Graphic: iMast

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IRIS-T Ready for Fielding in Sweden

(gh) The Swedish procurement agency FMV has announced that in November 2019, the new air defence system Robot System 98 (RBS 98) was tested successfully at Vidsel

Photo: FMV

Proving Ground. According to FMV, only minor software changes are necessary before the system can be introduced to the troops. Diehl Defence's IRIS-T missiles (Infra Red Imaging-Thrust Vector controlled) are at the heart of the air defence missile system. The missiles are used in the IRIS-T SLM/SLS (Surface launched medium range/Surface launched SHORAD) version. Sweden is the first nation to use the open system design of the newly developed Ground Based Air Defence (GBAD) family, which combines and integrates system elements (sensors/radars, command and control systems, communication systems) from different manufacturers into a single powerful weapon system. RBS 98 uses the BV 410 from BAE Systems/ Hägglunds as carrier. Aside from a minor software adjustment, RBS 98 is the same system used on the Jas 39 GRIPEN fighter jet. In the near future, the RBS 98 will be complemented by the PATRIOT medium-range air defence system.

Navigation System for Sweden's High-Speed Craft

(ck) The Swedish Defence Materiel Administration (FMV) has contracted the navigation company iXblue to deliver up to 172 FOG-based QUADRANS gyrocompasses. Delivered over the span of 4 years, the QUADRANS navigation systems will equip the Swedish Navy's fleet of high-speed craft which, in the main, comprise

Photo: iXblue

combat boats CB90. The FMV has been seeking new maintenance-free and high-performance gyrocompasses for the retrofit of their fleet of high-speed craft as the CB90 vessels are very fast boats and need reliable and accurate heading and attitude data to navigate safely. The Fibre-Optic Gyroscope (FOG) technology, having no moving parts and offering exceptional reliability, was identified as an ideal solution to keep maintenance costs down. The QUADRANS gyrocompasses already equip other surface boats in the Swedish Navy fleet. Built around iXblue's Fibre-Optic Gyroscope technology, the QUADRANS gyrocompasses are solid-state and strap-down systems, provide highly accurate heading and attitude data and are perfectly suited for high performance at high speeds and in challenging environments such as GNSS denied settings. Compact, lightweight and with low power consumption, the QUADRANS gyrocompasses are easy to install on small-sized craft, while their open architecture guarantees seamless interfacing with all major GNSS systems and third-party navigation software.

MBDA's MMP Missile Selected for PESCO

(ck) The European Commission has selected LynkEUs, an MBDA coordinated project, as part of the new European Defence Industrial Development Programme (EDIDP). LynkEUs is the first technological and industrial contribution to the objectives of the Permanent Structured Cooperation

Photo: MBDA

(PESCO) Beyond Line Of Sight (BLOS) capability project. The BLOS capability project was approved in November 2018 by the EU Defence Ministers. MBDA is joining with 13 partners and subcontractors from 5 countries to develop a new capability based on the MMP missile system that will be unique for mounted and dismounted forces. The LynkEUs project is managed in partnership with the French, Belgian and Cypriot armed forces. The project seeks to define an initial operational concept for a European BLOS capability. It will also provide an opportunity to identify and test emerging solutions of potential value for future upgrades to the capability, and will be validated by a test campaign. The concepts and tests completed for the PESCO BLOS project will contribute to the development of a family of man-on-the loop BLOS missile systems with back image, based on the MMP medium range missile, and under full control of Europe's defence industry.

Schiebel CAMCOPTER on Duty for European Maritime Safety Agency in Finland

The Finnish Border Guard will operate the CAMCOPTER® S-100 for maritime surveillance purposes. The Remotely Piloted Aircraft System (RPAS) service is offered by the European Maritime Safety Agency (EMSA) and will also extend to Estonia and Sweden. The

Photo: Schiebel

CAMCOPTER® S-100 will support the Finnish authorities in carrying out Coast Guard missions, such as search and rescue, monitoring and surveillance, ship and port security, vessel traffic, environmental protection and response, ship casualty assistance, as well as accident and disaster response. The S-100 will execute these tasks equipped with an L3 Wescam Electro-Optical / Infra-Red (EO/IR) camera gimbal, an Overwatch Imaging PT-8 Oceanwatch, a Becker Avionics BD406 Emergency Beacon Locator and an Automatic Identification System (AIS) receiver. EMSA awarded the multi-year maritime surveillance contract for a Vertical Takeoff and Landing (VTOL) RPAS to Schiebel in November 2018. In execution of this contract, Schiebel provides simultaneous maritime surveillance services to several EU member states and EU bodies. Currently, the CAMCOPTER® S-100 is also operational in the Republic of Croatia supporting the Maritime Safety Directorate of the Ministry of Sea, Transport and Infrastructure of the Republic of Croatia.

Lockheed Martin to Recapitalise More MLRS M270 Launchers

(jcm) Lockheed Martin has received a US$226M contract from the US Army to recapitalise an additional 44 Multiple Launch Rocket System (MLRS) M270 launchers. This award follows an initial contract, issued in 2019,

Photo: Lockheed Martin

calling for the refurbishment of 50 US Army MLRS launchers, a company official has stated. The US Army's MLRS recapitalisation effort will eventually upgrade its existing fleet of 225 MLRS M270A1 launchers and 160 decommissioned M270A0s to M270A2s. Lockheed Martin, in partnership with the Red River Army Depot, will overhaul and upgrade the M270s as "zero-time" launchers with brand new engines, improved armoured cabs and the new Common Fire Control System (CFCS) which will provide compatibility with future MLRS Family of Munitions (MFOM), according to Gaylia Campbell, vice president of Precision Fires and

Combat Maneuver Systems for Lockheed Martin Missiles and Fire Control. The launcher's improved armoured cab significantly expands the interior volume and incorporates new energy-absorbing seats that provide additional protection from mine blasts and improvised explosive devices. Lockheed Martin will also upgrade the fire control panel and fire control system. MLRS is a heavy tracked mobile launcher, transportable via C-17 and C-5 aircraft, that fires Guided MLRS rockets and Army Tactical Missile System missiles. MLRS will also be able to fire the Precision Strike Missile and Extended-Range GMLRS rockets, both currently in development.

Navigation Systems for GOWIND Class Vessels

(ck) Naval Group has selected iXblue to supply navigation systems for two GOWIND corvettes intended for the international market. These two future combat corvettes will be fitted with MARINS navigation systems and NETANS data distribution and processing units. This contract reinforces iXblue's long-standing collaboration with Naval Group. iXblue's navigation solutions have already been selected by the naval defence company for numerous French and export programmes. Based on fibre-optic gyroscope (FOG) technology, iXblue navigation solutions equip more than 650 surface ships and underwater platforms in 40 navy and coast guard settings, including major programmes such as the French Navy's future FDI , the new ASTUTE class nuclear attack submarines and the QUEEN ELIZABETH class aircraft carriers of the UK Royal Navy, the F122 (BREMEN class) and F123 frigates (BRANDENBURG class) of the German Navy, and the new OPV 87 of the Argentinian Navy.

Photo: iXblue

Communications Suite for Romania's CORSAR Vessels

(ck) NATO is continuing its High Readiness Patrol in the Black Sea, with the Romanian Navy providing the flag ship for Standing NATO Mine Countermeasures Group 2. Rohde & Schwarz has recently modernised communications on the Romanian Navy's minelayer CONSTANTIN BALESCU by providing modern R&S M3SR software defined radios and a message handling system. The communications systems installed on board the Romanian ship facilitate communications within the task group and with Allied Maritime Command. Rohde & Schwarz has provided more than 40 navies with communications technology. Earlier this year, production in the Rohde & Schwarz Memmingen manufacturing plant achieved a milestone: the delivery more than 10,000 R&S M3SR radios.

Photo: Rohde & Schwarz

Inflight Refuelling for CH-53K Helicopter

(ck) The CH-53K KING STALLION heavy transport helicopter has successfully completed several in-flight refuelling tests with the US Marine Corps' KC-130J SUPER HERCULES tanker. The test flight, which lasted several hours, took place in April off the east coast of the United States. Inflight refuelling has been identified as an essential capability for the Bundeswehr's new heavy transport helicopter, or STH. In response to the current Bundeswehr request for tenders, Lockheed Martin subsidiary Sikorsky and Rheinmetall joined forces to offer Germany the CH-53 K. The CH-53K's advanced fly-by-wire flight control reduces the strain on the crew during inflight refuelling operations as was confirmed during the recent flight tests. The ability to refuel in mid-air is essential for covering long distances without having to make intermediate stops, and substantially expands the CH-53K's operational flexibility. It means that it can be redeployed to distant areas of operation, for instance, and remain aloft for extended periods. The helicopter can carry more personnel and material for longer distances and under more challenging operational conditions than any other aircraft of its kind. Full-scale production of the CH-53K has begun at the Sikorsky plant in Connecticut, as planned. In all, 31 aircraft are currently at different stages of completion. The first USMC CH-53K squadron is expected to be operational by 2023/24.

A European Unmanned Ground System

(ck) Under the European Defence Industrial Development Programme (EDIDP), the European Commission has contracted a consortium of several defence, communications and cyber security companies to develop an integrated Modular Unmanned Ground System (iMUGS). At a total cost of €32.6M, the contract is being funded with €30.6M from the EDIDP. The project is managed by Estonia and technical requirements have been agreed with Finland, Latvia, Germany, Belgium, France and Spain. The countries plan to finance the remaining €2M of the project budget. As part of that programme, a modular and scalable architecture for hybrid manned and unmanned systems is being developed under the leadership of Milrem Robotics. The architecture is intended to become the basis for standardising a Europe-wide ecosystem for air and ground platforms, command, control and communication equipment, sensors, payloads and algorithms. The prototype system will use an existing unmanned ground vehicle – THeMIS from Milrem Robotics – and a specific list of payloads. The outcome of the project will be demonstrated during the participating member states' military exercises or on test sites under operational conditions. Throughout the project operational know-how will be gathered and concepts for the combined use of manned and unmanned means will be developed, taking into account the ethical aspects applicable to robotics, artificial intelligence and autonomous systems.

Photo: Milrem

TRITON for Australia

(ck) Australia will provide funding for an additional three of their planned six MQ-4C TRITONs and associated ground mission control stations. The MQ-4C TRITON is a cooperative development programme between the Royal Australian Air Force and the US Navy, and provides a round-the-clock maritime wide-area intelligence, surveillance and reconnaissance capability. Operating at altitudes exceeding 50,000 feet, TRITON can cover more than 2 million square miles of ocean and littorals in a single flight, thereby enhancing the operational commanders' common operating pictures. In addition to the aircraft, Australia has also committed funds for the main operating base at RAAF Edinburgh in South Australia and a forward operating base at RAAF Tindal in the Northern Territory. The main operating base allows for a permanent control station while the forward operating base enables de-

ployment of the TRITON system to support Australian national security requirements. The US Navy – with a programme of record for 68 aircraft – is planning five operational TRITON orbits around the globe. Australia, as one of the US key allies and a strategic partner in the Pacific, would be able to provide a sixth.

ToxicShield for CBRN Protection

(gh) Autoflug has introduced a filter material called ToxicShield to protect against CBRN warfare agents. The material consists of activated carbon as an effective layer in the protection system; by combining the three layers of ToxicShield, Autoflug has developed a new protective clothing system for aircraft crews. The lowest layer is the undergarment, which lies directly on the body and provides protection against heat and cold. This layer can be dispensed with, as the second layer is also skin-friendly. The second layer consists of garments that provide protection with ToxicShield, comprising long socks, trousers, top, head protection (hoodie) and gloves. The pieces significantly overlap, so that they protect against warfare agents even without a fastener. Trousers and top are provided with special zips, so that they can be taken off quickly after contamination without any carry-over of the contamination. The third layer is the two-part flyer combination; the functional layer. This layer provides the necessary pockets and pen holders as well as camouflage colouring. The headset, the pilot's helmet and the NBC protective mask complete the protective equipment. The entire system is compatible with the aircraft crews' existing clothing and equipment and protective vests can be worn on top of the clothing if needed. After any mission, contaminated clothing can be removed with the help of trained personnel in such a way that nobody is contaminated.

Photo: Autoflug

US DoD Contract for WFEL

(ck) WFEL, leading supplier of rapidly deployable military bridging systems, has been awarded another contract by the US Department of Defense to upgrade a further tranche of DSB Dry Support Bridges already in-service with the US Army. This contract allows 20 more DSBs to be enhanced, increasing gap-crossing capabilities from 40 metres to 46 metres. The deal follows on from a previous US Army contract for the upgrading of 60 Dry Support Bridges. The US Army holds around 120 Dry Support Bridges in inventory and this upgrade package – developed with US Army Tank Automotive Command Centre (TACOM) – allows its original 40-metre DSBs to achieve the new standard capability. Since 2013, all WFEL Dry Support Bridges supplied have been 46 metre variants. Already adopted by Australia,

Photo: WFEL

Switzerland and Turkey, this military bridging solution has recently been evaluated under an Assessment Phase contract as a replacement for the UK MoD's ageing BR90 bridging systems. WFEL recently supplied a further four Dry Support Bridges to the US Army as part of the USA's US$4.8Bn European Deterrence Initiative to improve the USA's readiness and responsiveness of NATO forces in Europe.

Hensoldt to Lead New Radar Consortium

(ck) Airbus Defence and Space has contracted sensor system supplier Hensoldt to develop and produce a new AESA (Active Electronic Scanning Array) radar for the German and Spanish EUROFIGHTER fleets. The project is jointly financed by the EUROFIGHTER partner nations, Spain and Germany, who will also be the first users of the radar in their fleets. Following budget approval by the Spanish government and, most recently, by the German Bundestag in mid-June, contracts worth over €1.5Bn have now been signed. The contracts cover the new development of core components of the EUROFIGHTER radar, including a digital multichannel receiver and transmitter/receiver antenna modules, as well as the equipping of approximately 130 EUROFIGHTER aircraft. The development is being carried out by a Spanish-German industrial consortium under German leadership with the support of the EUROFIGHTER nations, Great Britain and Italy. Hensoldt has been involved in the development and production of the EUROFIGHTER sensor technology currently in use. At its radar centre in Ulm, Hensoldt currently employs 2,200 people, and in the EUROFIGHTER radar sector alone the company expects to create 400 qualified jobs over the programme period.

Contract Signed for Multirole Combat Ship 180

(jh) On 19 June 2020, Damen Schelde Naval Shipbuilding and the German procurement agency BAAINBw signed a contract for the construction of the multi-purpose combat vessel MKS 180. Initially the contract covers the delivery of four ships in the years 2027 to 2031 with an agreed option for a possible delivery of two more ships in the years after 2032. Construction of the ships is due to start in 2023. According to Damen, construction will take place at Blohm+Voss in Hamburg, with the involvement of other North German shipyards in Bremen, Kiel and Wolgast. The budget for the procurement of the four multipurpose combat ships 180 is €5.8Bn. In addition to the net construction costs for the ships, which amount to around €4.6Bn, the budget includes training facilities. The signing of the contract marks the end of the awarding procedure, which began as a European competition in 2015. The multipurpose combat ship 180 will be built through cooperation between the Dutch Damen Shipyards Group, Thales Group and the Lürssen shipyard with the involvement of German Naval Yards. Damen Shipyards intends to keep a high value-added share in Germany – more than 70% – and this will also

Photo: Damen

affect the German supply industry. In addition, it has been contractually agreed that around 30% of the volume will be outsourced to medium-sized companies. The command and control weapon deployment system of the future units will be supplied by Thales Group, the central sea and air surveillance sensor by Hensoldt (the Taufkirchen-based company will supply four TRS-4D ship radars based on AESA technology). Furthermore, the German MoD has announced that a large number of sensors and effectors will come from the USA, Germany, the Netherlands and Norway. Germany has secured extensive rights to the ship for the future. The Defence Ministry views the project as being the result of the successful Dutch-German cooperation which has seen the Netherlands integrate units into German structures and vice versa. Army units (parts of the Armoured Corps, Fast Forces Division) have already rolled out lighthouse projects and the Naval Battalion of the German Navy will gradually be integrated into the Royal Netherlands Navy. Since 2016, Damen has been working together with the Netherlands on entering into the capability building process for the secure and long-range sea transport of the Bundeswehr. The maritime cooperation also envisages that the German Navy will be able to use the Dutch Joint Support Ship to transport personnel and equipment.

The Challenges of Covid-19 Quarantine

Andreea Stoian Karadeli

Throughout history, quarantine has been a classic public health intervention to curb the spread of infectious diseases. Although an effective measure, quarantine has always been controversial because it raises political, ethical, and socioeconomic issues and requires a careful balance between public interest and individual rights. This article brings to debate some of the socio-psychological, economic, political, security and education challenges of the Covid-19 quarantine.

Quarantine is defined as the separation and/or restriction of movement of persons who are not ill but are believed to have been exposed to infection to prevent transmission of diseases. The practice dates back to the mid-14th century when officials in Venice forced ships that were arriving from infected ports to sit anchored for 40 days before landing in order to prevent the spread of plague. Since the 14th century, quarantine has been the cornerstone of a coordinated disease-control strategy, including isolation, sanitary cordons, bills of health issued to ships, fumigation, disinfection, and regulation of groups of persons who were believed to be responsible for spreading the infection.

Photo: Tomaskju

During the Covid-19 quarantine, many formerly bustling city centres remained largely empty, such as the centre of Turin, Italy.

Short History of 'Quarantine'

Healthcare officials have often turned to quarantine in the early days of an epidemic, when the infectious agent remains unknown, and when vaccines, antibiotics, and anti-viral drugs are either useless or of little-known utility. Even if prophylaxis or treatments were effective, they would likely be in short supply in the first stage of the disease's development. Because of these obstacles, which limit the effectiveness of modern medicine, quarantine is a fast and useful infection containment mechanism in the early days of an outbreak.

Author

Dr. Andreea Stoian Karadeli is an independent researcher based in Turkey, an Associate Fellow at the Geneva Centre for Security Policy and a Visiting Researcher at the University of South Wales. Her interdisciplinary research varies from cultural and intercultural studies to conflict resolution and focusses on national security and terrorism, with a specific expertise in the Middle East.

The Covid-19 Quarantine

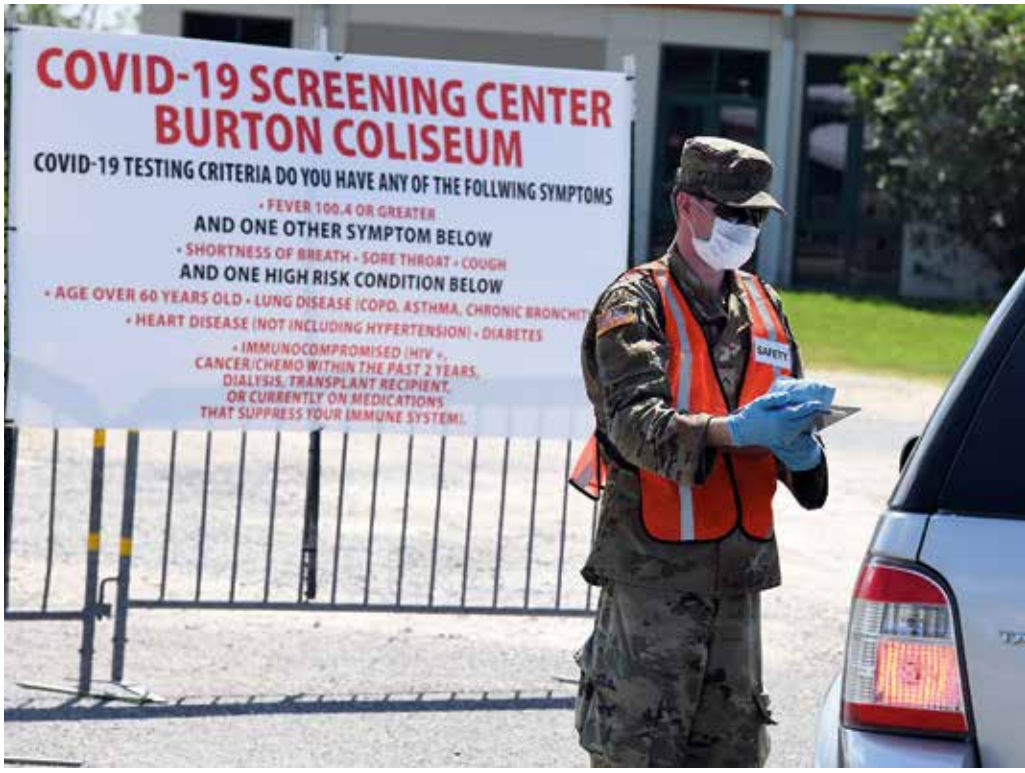
Beyond the short-term benefits of quarantine during epidemics, this restrictive measure also provides a great variety of challenges to modern society and to the daily life of people in affected areas. Although most of them have not been yet considered, the long-term effects of the Covid-19 quarantine period are much deeper and variated than the ability of any government to foresee at this moment.

Social and Psychological Challenges

There are many studies of the psychological impact of quarantine in scientific literature. Most of these demonstrated an increase in common mental disorders (such as anxiety, depression and confusion) compared to expected levels in the general population. Bearing in mind the average of 2.6 billion people quarantined until now around the world, we are currently undertaking the largest psychological experiment ever, that will probably result in a wide range of symptoms of psychological stress and disorder, including low mood, insomnia, stress, anxiety, anger, irritability, emotional exhaustion, depression and post-traumatic stress symptoms. Low mood and irritability specifically stand out as being among the most common side-effects of being locked down for a long period of time, stressing for reasons such as the fear of becoming sick or of losing loved ones, as well as the prospect of financial hardship. All these have been fuelled by a so-called "infodemic" spread via different platforms social media. Outbursts of racism, stigmatisation, and xenophobia against particular communities are also being widely reported. The COVID-19 outbreak may also give rise to stigmatising factors like fear of isolation, racism, dis-

crimination, and marginalisation with all its social and economic ramifications. Various radical groups have already started spreading their extremist messages, taking advantage of the opportunity presented by the pandemic through a large audience locked to their computers, easily exposed to propaganda. Another relevant aspect to be considered is societal rejection regarding the quarantined cordon in forms of discrimination, suspicion and avoidance by neighbourhood, insecurity regarding properties, workplace prejudice, and withdrawal from social events even after containment of epidemics. Such phenomena have already been witnessed in some European countries where communities of a certain ethnic origin and the health workers have been targeted. Moreover, the psychosocial aspects of older people, their caregivers, psychiatric patients and marginalised communities are affected by this pandemic in different ways and need special attention. Post quarantine psychological effects may include significant socioeconomic distress and psychological symptoms due to financial losses.

Photo: Louisiana National Guard



The Louisiana National Guard activated over 660 soldiers to assist with Covid-19 emergency response measures.

Economic and Political Challenges

The Covid-19 pandemic has triggered the most severe recession in nearly a century and is causing enormous damage to people's health, jobs and well-being, according to the OECD's latest Economic Outlook. The economic impact of strict and relatively lengthy lockdowns in Europe will be particularly harsh. Euro area GDP is expected to plunge by 11,5% this year if a second wave breaks out, and by over 9% even if a second hit is avoided, while GDP in the United States will take a hit of 8.5% and 7.3% respectively, and Japan 7.3% and 6%. Emerging economies such as Brazil, Russia and South Africa, meanwhile, face particular challenges of strained health systems, adding to the difficulties caused by a collapse in commodity prices, and their economies plunging by 9.1%, 10%, and 8.2% respectively in case of a double hit scenario, and 7.4%, 8% and 7.5% in case of a single hit. China's and India's GDPs will be relatively less affected, with a decrease of 3.7% and 7.3% respectively in case of a double hit and 2.6% and 3.7% in case of a single hit. In both scenarios, the recovery, after an initial, rapid resumption of activity, will take a long time to bring output back to pre-pandemic levels, and the crisis will leave long-lasting scars – a fall in living standards, high unemployment and weak investment. Job losses in the most affected sectors, such as tour-

ism, hospitality and entertainment, will particularly hit low-skilled, young, and informal workers.
The containment measures brought in by most governments were necessary to slow the spread of the virus and limit the death toll, but they have also closed down business activity in many sectors and caused widespread economic hardship. As restrictions begin to be eased, the path to economic recovery remains highly uncertain and vulnerable to a second wave of infections.
At the political level, an extended national and international strategy to strengthen healthcare systems and support people and businesses to help adapt to a post-Covid world needs to be developed based on a multidisciplinary assessment. Policymakers have used a vast array of exceptional measures to support healthcare systems and people's incomes, as well as to help businesses and stabilise financial markets. But there is still much to be done, while we all need to understand that decisions that are taken today, in the time of the pandemic, will have a great impact on our individual and common future.

Security Challenges

While the whole world has been focusing on the fight to contain the virus, many of the security issues faced at national, regional and international level have been left in the shadow of the Covid-19 crisis. In fact, whatever security challenges nations were facing before the pandemic have only been aggravated since the spread of the virus. For instance, terrorist groups have enlarged their online presence, reaching to a wide and vulnerable audience. Conflicts and power vacuums have been amplified by the spread of the disease taking advantage of weak sanitation and lack of local health infrastructure. Cybersecurity has gained more and more importance with most of the work being transferred to the online environment. In the same way, cyberattacks and terrorist activity over the internet have increased.

Education Challenges

The school closures are one of the most visible – and controversial – means by which Covid-19 is affecting young people. According to UNESCO, the education of nearly 1.6 billion pupils in 190 countries has so far been affected – that's 90% of the world's school-age children. And at the time of writing, there are still no definite plans for opening the schools of around half of these children. The school closures are one of the most visible – and controversial – means by which Covid-19 is affecting young people. If schools don't reopen until September, many children will have spent more than 20 weeks in a row away from school – an unprecedented amount of time away from education, meaning we can't simply extrapolate from the existing data. Given that time spent in education appears to shape adult IQ – this could result in serious, lifelong effects on their cognitive ability. For those in the most critical periods of adolescence, it may even increase the risk of mental illness, delaying their cognitive, emotional and social development. Moreover, bearing in mind that the poorest will be hardest hit by all of these effects, lockdowns are expected to widen the existing inequalities across the globe, with repercussions for years to come.

Recommendations

Covid-19 has hit our modern world harder than any terrorist attacks or natural disaster up to present. The effects of the virus are developing beyond the physical direct effects and the number of cases and deaths. In order to combat the long-term consequences of the pandemic, a national and international strategy should be developed accordingly, based on a multidisciplinary assessment of effects and policy recommendations. Psychological and social preparedness of this pandemic are now among the main assets to be developed on both short and long run. The government and stakeholders must appreciate the psychosocial morbidities of this pandemic and assess the burden, fatalities and associated consequences. Stigma and blame targeted at communities affected by the outbreak may hinder international trade, finance and relationships, instigating further unrest and providing opportunities for terrorist groups to spread hate and violence. Due care needs to be taken to erase the stigma associated with disease, racism, religious propaganda and psychosocial impact and needs to be implemented by regular discussion with trained and specialist health care personnel by making task force and execution teams who are directly engaged in health care delivery systems without creating any communication gaps between policy makers and ground level workers.
Although hard to recover in the short-term, the economy worldwide has to adapt to the new reality brought by the pandemic. As some argue that digitalisation is the future, many still hope to get back to the old-style work schedule, although it is still unclear when and how all the business that have been put on hold are to resume. It is important to underline that the keyword of the quarantine and post-quarantine period should be 'adaptability', meaning that the more people and businesses increase their adaptability to new contexts, the easier the transition will be.
Last, but not least, misinformation and disinformation have proved more dangerous than the virus per se and governments need to develop strict measures regarding fake news, propaganda and social media rumours. 'The internet of things' is today as dangerous as it is helpful in going on with our daily lives. Hard times need courageous decisions and we all have to agree that the strategies that we develop today during the Covid-19 crisis are framing our common future. ■

The EU as an International Security Actor

David McAllister

Today, the EU is facing numerous challenges and threats, with increased complexity and unpredictability in its security environment. Fragile states, the fight against terrorism, irregular migration flows, the crises in the Middle East – and of course the current COVID-19 pandemic – all represent challenges that require common solutions and collective action.

The basic values on which the EU is founded – democracy, respect for human rights, and the rule of law, as well as the rules-based international system – are being increasingly challenged in an era of geopolitical turbulence and degradation of the strategic environment. External crises have greatly expanded, they are closer to Europe, both at our eastern and southern borders, and are increasingly likely to have direct consequences for the EU and its citizens. To counter these threats, the EU must strive for a closer and more coherent community among its Member States, just as for a structured and coordinated partnership with other actors, such as NATO and OSCE.

The aim is to further strengthen security and defence mechanisms, as well as to establish tools for detection, prevention and defence against various threats in order to guarantee the security of our citizens. The EU has to be more united, effective, strong and strategic. EU Commission President Ursula von der Leyen's decision to transform the EU's executive branch into a 'Geopolitical Commission' is a further step in the right direction. The EU needs to become a credible and effective global actor so that it can take on a responsible, tangible, proactive and prominent leadership role on the international stage and can unlock its political potential to think and act like a geopolitical power with a meaningful impact.

The reinforced Common Foreign and Security Policy (CFSP) needed to be more coherent, including not only traditional "soft" power, but also a strong Common Security and Defence Policy (CSDP). In 2017 the Permanent Structured Cooperation on security and defence (PESCO) was therefore established to strengthen defence cooperation between Member States.

Twenty-five of the 27 EU Member States participate in PESCO, signatories to stronger, joint commitments to invest, plan, develop and operate defence capabilities better, together, within the EU framework. The objective is to arrive at a coherent set of defence capabilities available to Member States for national and multinational purposes, to enhance the EU's capability as an international security actor, to contribute to the protection of EU citizens and to maximise the effectiveness of EU defence spending.

Subsequent to the legally binding commitments, 47 PESCO projects have been

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launched, in three successive waves, since 2018. They cover areas such as training, land, maritime, air and cyber warfare. Each project is taken forward by a fluid group of project members, under one or more Coordinators. An absolute guarantee of seamless interaction between PESCO and NATO initiatives, at national and multinational levels, is essential.

Collective security and defence of EU Member States, and their crisis-intervention capability abroad, depends entirely on their ability to move allied troops, civilian crisis management personnel, material and equipment across each other's territory and outside the EU freely and rapidly. Military mobility is a concrete capability that is necessary to meet the EU's specific security and defence needs, and one which forms part of the CSDP.

Photo: European Parliament

David McAllister is a member of the Christian Democratic Union, part of the European People's Party, of which he is currently Vice President. He is Vice Chairman of the International Democrat Union, and is Chair of the European Parliament Foreign Affairs Committee. He has been described as a potential successor to Angela Merkel, and as a possible future European Commissioner.

As analyses have shown, the height and weight limits of many road bridges are insufficient for certain military vehicles, and there is insufficient load capacity to move oversized military equipment by rail.

A substantial number of obstacles – physical, legal and regulatory – hinder military movements by imposing significant delays. This is a risk, especially in crises. Military exercises in Europe carried out under the auspices of NATO in recent years have shown the huge importance of suitable transport infrastructure for the success of military missions. In this regard, it is a good sign that military mobility has gained a substantial level of attention from all the relevant actors.

In March 2018, the High Representative of the EU for Foreign Affairs and Security Policy presented a "Joint Communication to the Euro¬pean Parliament and the Council on the Action Plan on Military Mobility" (Action Plan), introducing a com-prehensive European approach to allow the swift movement of personnel and assets to where they are needed. It identifies tasks, responsibilities and time¬lines for improving military mobility in terms of legal aspects, customs and military requirements, and cross-bor¬der movement permission.

The European Parliament adopted a resolution on military mobility in December 2018, underlining "that military mobility is a central strategic tool enabling the EU to pursue its security and defence interests effectively and in a complementary manner". The Commission subsequently published a report on the implementation of the Action Plan, stating that tangible progress is being achieved.

Military Mobility is a PESCO project, aiming to address legal barriers and bureaucratic requirements, such as reducing the time to obtain diplomatic clearances. It is a binding commitment for PESCO members: Commitment No 12 requires the 25 Member States to simplify and standardise 'cross border military transport in Europe for enabling rapid deployment of military material and personnel'. Achieving an efficient military mobility policy will also strengthen the EU's CSDP missions, given their international dimension and their peace-keeping objectives, by increasing synergies between defence needs. It will increase the EU's capacity to respond to emergencies, and humanitarian missions and natural disaster responses within the EU will also benefit.

Effective military mobility requires the full involvement and commitment of all Member States and cooperation with NATO. Each Member State's available resources, needs and regional specificities, as well as any requirements identified by EU-NATO cooperation, must be taken into consideration: the aim is to establish Military Mobility that works for both the EU and NATO.

In mid-2020 we are at an important stage for this project, as negotiations over the next EU long-term budget have reached a crucial point. The aim should be to fund Military Mobility via the Connecting Europe Facility (CEF) in the next Multiannual Financial Framework (MFF), making it possible to fund projects that pertain to dual use (civil and military) of the transport infrastructure. In its initial proposal the Commission allocated €6.5Bn to Military Mobility projects in the next MFF, but throughout the negotiations this number has dropped significantly. If we want the EU to become a credible global actor, we have to invest in the necessary instruments to achieve that goal. And we need to ensure that our instruments have the financial resources they need in order to fulfil our policies. Given the EU's current security environment, the proposed cuts to the Military Mobility programme are not acceptable.

In the fields of defence, the fight against terrorism, and cybersecurity, the EU must be able to decide and act without depending on third parties. In building its own resilience and consolidating its strategic autonomy, Military Mobility is a cornerstone towards achieving a genuine European Defence Union.

We must develop our own strategic autonomy through an efficient foreign and defence policy, in order to maintain peace, prevent conflicts and reinforce international security – as the EU. The security of our citizens and of staff involved in CSDP missions must be guaranteed – particularly in light of the COVID-19 pandemic. Our global interests have to be protected; our founding values have to be defended. ■

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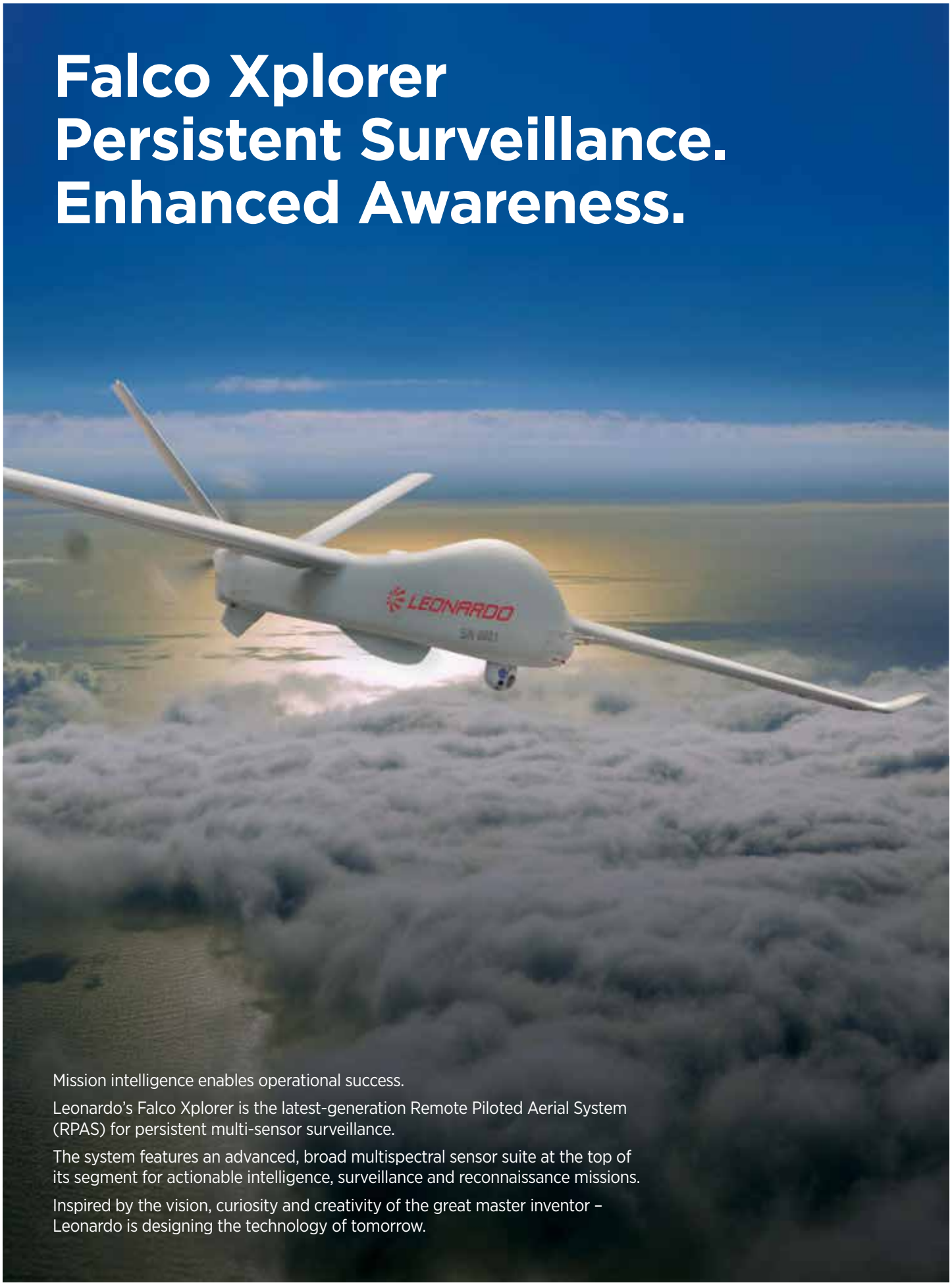

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The Danish Defence Industry in 2020

Bo Leimand

For a small country like Denmark, the Danish defence industry offers a considerable range of skills. Nevertheless, Denmark is dependent on cooperation with foreign partners in order to equip its armed forces appropriately.

It is a little uncomfortable to sit at your desk and write about the Danish defence industry in 2020, as there is no way of knowing what course the industry will take in mid-May 2020. There are two possibilities. I can try to give an estimate where I think everything will end up on the safe side of COVID-19. The other possibility is to describe the Danish defence industry as it was before 13 March 2020, before Denmark went into lockdown. I choose the latter option because this description is a more optimistic view into the future.

Photo: Weibel

Weibel's long-range radar technology, operating in the X-band frequency, is highly suitable for today's advanced ground-based ballistic missile defence systems. The Gap Filling Tracking Radar (pictured) is based on technology that has been used for more than two decades to track long range missiles, ballistic missiles and warheads.

FAD and CenSec

The Danish defence industry is organised in two entities: FAD and CenSec. The first entity, the Danish Defence and Security Industries Association (Forsvars- og Aerospaceindustrien i Danmark [FAD]) is the voice of the Danish defence, security and aerospace industry and the focal point concerning all matters related to the defence and aerospace industry, nationally and internationally. FAD acts on behalf of the Danish defence and aerospace industry as a whole and is the forum for networking, cooperation, and coordination of the defence and aerospace industry in Denmark. FAD represents approximately 100 member companies, all of them members of the Confederation of Danish Industry (DI).

The second entity, the Centre for Defence, Space and Security (CenSec) is the prime Danish cluster for companies specialising in high tech industries like defence, homeland security, space, aerospace, and cyber security. CenSec currently has 134 member companies – primarily SMEs – with leading edge skills in advanced manufacturing and production, electronic and software development and related niches. Among the partners are leading Danish universities and other knowledge institutions.

CenSec works with prime contractors, systems integrators, MoD procurement, logistic and repair agencies, and so forth, to identify, develop and recommend appropriate supplier and sub-contractor capabilities.

The reader might wonder why a small country like Denmark has two organisations representing the defence industry but it is not unusual to have one organisation handling the interests of bigger companies and another handling the interests of small and medium enterprises (SME). Canada, for example, has a similar set-up with CADSI (Canadian Association of Defence and Security Industries) and ACADA (Atlantic Canada Aerospace and Defence Association). For Denmark, this set-up works well as FAD and CenSec are cooperating on issues of common interest, and there are companies who are members of both organisations.

Typically, the Danish defence industry is producing components, subsystems, software, and accessories for major defence and security-related systems and equipment. There are only a few companies in Denmark that can assume total system responsibility and thereby total cost ownership. Danish defence companies fall into three different categories: system suppliers, traditional subcontractors, and component suppliers.

Denmark's Defence Industry Strategy

For a small nation like Denmark, it is impossible to own all important industrial competencies and capabilities. The National Defence Industry Strategy of 1 July 2014 outlined how Denmark can maintain and develop competitive industrial competencies and capabilities in defence, necessary for the protection of Denmark's security. These capabilities are of great strategic importance for the performance of tasks by the Danish Armed Forces. The strategy consists of six areas:

1. A competitive international defence market: In all relevant international fora, Denmark supports a targeted effort to ensure an international, competitive market for defence equipment that fosters innovation and competitiveness.

2. Good framework conditions for the defence industry: The Danish defence industry is supported by competitive framework conditions, including special conditions for the defence industry in terms of licences for production and exports and security certificates.
3. Cooperation between the MoD and Danish industry: There is close cooperation between the Danish Armed Forces and Danish industry providing Danish enterprises in the field of defence with the best conditions for building international competitiveness.
4. International cooperation: When Denmark takes part in international cooperation concerning the development and/or acquisition of defence equipment and defence services, the possible participation of Danish industry is evaluated to maintain and develop industrial competencies and capabilities.
5. Security of supply: In relation to invitations to tenders concerning strategically important defence equipment and defence services, the Danish Armed Forces includes relevant requirements for security of supply and security of information. The requirements will be made in accordance with EU law.
6. Industrial cooperation: If it is not possible to ensure the maintenance and development of the necessary defence industry capabilities in other ways, obligations for industrial cooperation with companies in Denmark can be imposed on foreign suppliers. Obligations for industrial cooperation will be laid down in accordance with EU law, especially Article 346 of the Treaty of the Functioning of the European Union.

Photo: Forsvarsgalleriet

The Naval Team Denmark concept of unique operational flexibility and cost savings resulted in the multi-company Standard Flex Concept as seen here with the IVER HUITFELD class. As a combination of standard platforms with exchangeable mission modules to match different missions and roles, it is a "plug and play" concept that allows unique flexibility and financial and logistical advantages. The Standard Flex Concept is available to friendly navies worldwide.

Although the strategy dates from 2014, I believe that it is still valid, even though the FAD has presented a proposal for a new strategy, the status of which is un-

Photo: Tacticall

Pictured is the TactiCall ICS screen (on a ship's bridge) with an intuitive, modern user interface to ensure reliable, secure activities for every deployment – i.e., international coalitions, joint operations, and maritime tasks.

known, as the Danish Government has not yet officially commented on this new proposal.

The Most Important Markets

The Danish, European and North American defence industries are of great importance for the protection of Denmark's security interests. Their competencies are crucial to whether Denmark can procure equipment necessary to achieve relevant strengths and operational advantages, whether Denmark can deliver high-quality responses flexibly, quickly and effectively in international operations, and whether Denmark has the necessary technological insight to understand and assess new threats, develop the necessary countermeasures and ensure Danish security.

Photo: Forsvarsgalleriet

A young soldier is equipped with the Invisio X5 head set to allow optimal hearing protection, communication and situational awareness. On patrol, this soldier is using the Invisio V-60 control unit as a tactical communications hub, taking advantage of its three multipurpose COM ports.

Barriers and Obstacles

In general, it is extremely difficult to enter the defence and security market. Market entry costs are high. This is because of the certification requirements, both in terms of quality, processing, maturity and safety.

Achieving the necessary certifications is the challenge, especially for small companies. It is often a time-consuming and cost-intensive process that represents a considerable investment for companies. The certificates must be in place before the company can expect to be awarded a defence-related contract or even be invited to bid. Meanwhile, the same applies to the US Department of Defense's cyber security and supply chain requirements. This is another set of requirements that requires certification by a third party and is by no means trivial.

This means that in order to be included on the bidding list, a company must have a certification of quality, security certificate and cyber security maturity model and be certified as an authorised Danish company. Finally, companies must comply with the Danish War Material Act in order to obtain export licences.

The Offset Issue

Since goods and services related to defence contracts are generally excluded from the provisions of international trade agreements for reasons of national security, many governments around the world seek to leverage their investments in defence-related goods and services to achieve broader economic benefits for their nations. This has been the case in Denmark over the last 50 years.

The Danish defence industry is fully aware of the "Rules of Engagement" in defence procurement. In addition to the economic benefits, there is also a political signal to taxpayers, as jobs are created. This makes it almost impossible for any political party to neglect this regulation.

A few years ago, Denmark decided to rename Offset to Industrial Cooperation. This new name was an attempt to direct the interests of the EU Commission to this phenomenon. In the good old days, when the F-16, the SEA SPARROW and the HARPOON were included in the Danish inventory, this was termed Offset, because the Danish Government demanded that Denmark should have a production of related defence equipment equal to, or exceeding the value of the respective procurement.

Whatever it is called, it is expensive for taxpayers, even if there are benefits, as in some cases this obligation could mean an increase of 10% or more in the price tag. However, it has been an accepted mechanism for many years, as politicians can tell voters that they are getting something in return when buying expensive defence equipment. The last example is the F35 procurement. Although the F-35 programme does not mention any requirement for industrial cooperation, it was an untold quid pro quo.

A further aspect is that the defence market is determined by political decisions, meaning that it can take years from an original idea to the actual awarding of the contract to the defence company. To cope with this, the defence industry needs easier market access.

The Danish Business Authority manages industrial cooperation in close collaboration with the MoD and with the Danish Defence Procurement and Logistics Organisation (DALO), which is responsible for tendering and procurement of defence equipment. Industrial cooperation is designed to ensure that Danish industry has the capabilities required for the protection of Denmark's security interests and to secure supplies during tension or war.

The European Defence Fund

Denmark wants to ensure that the European Defence Fund promotes market integration and increased competition in the European market. This will benefit Danish industry in the form of better access to European subcontracted products. The objective is to integrate Danish companies into the development, production and maintenance of defence equipment supported by the European Defence Fund, which member states will acquire in the future.

Participating within the Fund offers the opportunity of opening up significant business opportunities. However, Danish interests go beyond purely commercial interests, as the industry's positioning in European supplier networks contributes to the protection of Danish security interests. The promotion of Danish interests under the European Defence Fund is thus an extension of the National Defence Industrial Strategy; this stipulates that it is an important security interest for Denmark to have a competitive defence industry, integrated into international undertakings and one which supplies high-quality material to the armed forces and Denmark's allies.

Efforts are also being made to support non-traditional areas such as cybersecurity, energy efficient technology, including energy storage, and space and health technology, where Danish defence companies have strong competencies.

Denmark generally supports the participation of third-country actors in consortia as it can contribute to product development and innovation capacity of the European Defence Fund. Fair conditions for third-country participation in the Defence Fund are also of great commercial importance, given Danish export opportunities in the US market.

The Preparatory Action for Defence Research (PADR) and European Defence Industrial Development Programme (EDIDP) are test programmes for the European Defence Fund which will be rolled out from 2021 to 2027. In EDIDP, there is a special call for SMEs which targets innovative defence products, solutions, and technologies. The programmes are established in a bureaucratic way which is illustrated by the requirement for the action to be carried out by undertakings cooperating within a consortium of at least three eligible entities which are established in at least three different EU member states. If you are an SME, you really have to understand all the rules in order to be successful.

The so-called National Action Plan (NAP) was created to promote Danish interests in relation to the EU Defence Fund. Specifically, the NAP aims, inter alia, to ensure increased dialogue between the Armed Forces, companies, and research institutions, clarify the possibilities for Danish co-financing, and offer advice and guidance. The NAP is supported by several ministers and is a good starting point for the Danish defence industry taking into consideration Denmark's special situation in defence projects within the EU. This should also be seen in the context of having an attractive Danish defence industry for relevant partners. Right now, there is an ongoing discussion as to whether to cut the EU's defence budget and thereby, the funding for development.

EDA and the Danish Defence Industry

Denmark does not participate in the European Defence Agency (EDA); it is seen as being outside the current efforts to develop common military capabilities, where the concrete cooperation projects initiated at the 2013 Summit will be taken forward by the EDA and PESCO. Although these efforts are still at an early stage, they could gain momentum in the coming years. It is likely that the EDA will gain more influence in the future as the need for, and focus on capability development increases, as supported by the European Defence Fund.

One problem of non-participation in the EDA is that Denmark has placed itself "outside the circle" and therefore does not receive all the information regarding ongoing projects, although some information is available, but not all by any means. This means that it will be difficult for Denmark to have an overview of the ongoing efforts to develop skills. Non-participation in the EDA can also have economic consequences for military investments. The Danish defence industry is excluded from participation in new defence projects, as these are reserved for EDA member states. It is therefore difficult to estimate the economic consequences.

On 30 October 2018, upon invitation by the Danish authorities, EDA Chief Executive Jorge Domecq paid a visit to Denmark where he met with the Minister of Defence, Claus Hjort Frederiksen, as well as other government officials and industry representatives.

The discussions centred on the interaction between Denmark and EDA. Domecq commented, "I really appreciate Danish involvement in the Agency's activities in areas such as energy and Single European Sky. Though Denmark is not a member of EDA and while fully respecting its opt-out from the defence aspects of the EU's Common Foreign and Security Policy, I strongly believe that a certain level of interaction in the Agency's work directly related to wider EU policies and regulations, as well as activities that benefit from EU funding, can provide for mutual benefits." ■

Denmark: Executive Insights

For its size and population, Denmark leads the world in a few European security and defence categories: Advanced Hearing Technologies; Doppler Radars, Tracking and Velocity Measurement; End-to-End Data and Voice Encryption; and, Multi-Modal Communication – to name but a few of these disciplines wherein Denmark excels.
The following executive insights are excerpts from interviews with these companies' leadership.
The full-length interviews are at www.euro-sd.com

INVISIO – Lars Højgård Hansen, CEO

Photo: INVISIO

Lars Højgård Hansen

On unique expertise: INVISIO's solutions build on a deep understanding of sound and human hearing. Many of INVISIOs R&D staff have roots in "The Danish Sound" – a world-renowned industrial cluster of excellence in acoustics, hearing and mobile communications based on collaboration between industry and academic research. This cluster has a long tradition of producing high quality, innovative loudspeakers, hearing aids, test apparatus, audio systems, and other communications equipment.

On knowing customers: A close collaboration with customers – and an in-depth understanding of their needs – is an integrated and critical part of our innovation model. Many of our innovations are a direct result of interacting with end-users and understanding their needs. All of INVISIO's systems are developed and tested in close co-operation with some of the world's most demanding users.
It is a win-win situation. For the customers it means that their needs are met in the most effective way with new, advanced technologies. For INVISIO, it means that we constantly push ourselves in developing the most advanced solutions and – at the same time – engage customers in helping us.
That drives our growth and sets our solutions apart from other industry players. Customer knowledge and proximity are crucial factors in providing advanced communication systems that help professionals to work more safely and effectively in noisy, mission critical environments while protecting their hearing.

Saab DENMARK – Heino Lundgren, CEO

Photo: SAAB

Heino Lundgren

On Innovation partnerships: TactiCall was originally developed for the Royal Danish Navy's land-based centres and radio stations in 1983 with delivery in 1985. After this the system was implemented for the Royal Danish Navy's ships towards the end of the decade and since then TactiCall has been put into operation all over the world and in all possible domains. This means that different customized adaptations of TactiCall is in use on all continents aside from Antarctica both within the military and civilian domains.
TactiCall interconnects all communication subsystems into one single IP platform infrastructure, making it possible to control everything from one single interface thus making it possible for the operator to have a complete overview of all ongoing communication from a single system. This includes different classification levels with an assurance level of EAL 5+.
In the latest deliveries to Norway and Finland TactiCall has gone from being a system delivery to be only part of a full solution including Ship communications, external and internal communication, communication infrastructure, comms management, security and even services such as topside design, ILS and EMC/EME management etc.
Saab in Denmark is involved in running R&D projects and studies tied to communication and communication security run in both national and international scopes examples of these are:
The Mobile ComNode R&D project for providing naval mobility is a joint project

with the Danish MoD's Defence Acquisition and Logistics Organisation and partly funded by the Danish Defence; and, Participation in the future Generic Open Soldier System Reference Architecture (GOSSRA) study funded by the European Defence Agency.
In addition to this, every year, Saab actively works with local university students in developing thesis projects which, in time, can contribute to technological advances as part of our existing portfolio or even lay the foundation for future solutions to bring to market.

WEIBEL – Peder R. Pedersen, PhD, CEO & President

Photo: Anders Ingvartsen

Peder R. Pedersen

On drone threats: In the past five years, there have been numerous examples all over the globe emphasizing that drones and UASs are major threats to the security of ground forces as well as military and civilian installations.
It does not require much effort from insurgents to acquire and adapt commercial assets to pose a threat. Government officials, refineries, and airports have been attacked or "under siege", and I think we have only seen the beginning. Furthermore, the emergence of 5G networks means that the threats become even more difficult to counter. We need to get inside the OODA-loop and speed up development, test, certification, and deployment to get that critical edge, as well as get better at using existing technologies in novel ways.
On Growth: We have just launched a new 2025 strategy for Weibel, a very ambitious growth strategy. We have managed to grow by nearly 100 percent over the past 5 years, so we are confident that we know what it takes. A key focus area for Weibel is the instrumentation market. We want to continue to be a key player in the global market, recognised for our best-in-class technology, quality, and user-friendly systems.
In the Ballistic Missile Defense market, our long-range tracking radars are already widely recognized and used by the US Navy and NASA. Weibel's unique technology increases the chances of early discrimination and enables very precise tracking at long ranges. This is optimal for closing gaps in Ballistic Missile Defense, both in Europe and around the world. Furthermore, we are investing significantly in building a position in infrastructure protection and SHORAD markets with our state-of-the-art technology.

MQ-9B SkyGuardian

The Next Generation of Remotely Piloted Aircraft

The MQ-9B Remotely Piloted Aircraft from General Atomics Aeronautical Systems, Inc. (GA-ASI) possesses a number of unique advantages not found in manned platforms: much longer endurance (40 hours or more based on payload), more affordable, require a fraction of the footprint, effectively operate at low and high altitude (500 to 40,000 feet), employable in high-risk environments without concern for loss of aircrew and, like manned platforms, they are built to be certified to fly in civil airspace. These attributes, which have been exploited in over-land and largely permissible environments, are now being tested for multi-domain missions, including maritime surveillance, Anti-Submarine Warfare (ASW) and broad-spectrum Electronic Warfare (EW), including in high-threat scenarios. Developments that network the RPA with other land, aerospace and maritime assets are enabling this role expansion and highlighting the MQ-9B as a true force multiplier.

Photos: GA ASI

The SkyGuardian

Operational roles for RPA are in transition in conjunction with changes to U.S. and Allied warfighting priorities. While support to land forces will remain a core role for these systems, employment focused on high-end and 'gray-zone' warfare (warfare below the threshold of armed conflict including asymmetric methods, and often involving militia and constabulary forces) in the maritime environment, are shaping current development priorities for GA-ASI and its customers.

The GA-ASI MQ-9 Medium-altitude, Long-endurance (MALE) series of RPA had their genesis in the 1990s, with an early version of the PREDATOR RPA with Intelligence, Surveillance and Reconnaissance (ISR) capability. PREDATOR operated over Bosnia in 1995, with more capable, armed versions commencing operations in the Middle East theatre in 2001. The more advanced USAF MQ-9A REAPER RPA variants followed, along with the US Army's MQ-1C GRAY EAGLE Unmanned Aircraft System. Today, the UK, France, Italy, and Spain operate the MQ-9 system with great success. The Netherlands have also procured the MQ-9 with deliveries to commence in the near term.

Less well known is the MQ-9's non-military utility. For example, the US Customs and Border Protection has effectively employed MQ-9 platforms for both overland and maritime surveillance activities since 2005. In the past two years, GA-ASI has conducted maritime and civil surveillance demonstrations in Japan and Europe, with further trials planned for later in 2020. Additionally, the California Air National Guard has used the MQ-9s with great success combatting forest fires by identifying hot spots, and providing critical environmental intelligence to allow more targeted and safer deployment of firefighters and equipment.

Now, production has commenced on GA-ASI's most advanced RPA variant – the MQ-9B SkyGuardian/SeaGuardian. The UK and Australia intend to acquire these systems, and the Government of Belgium has approved Belgian Defense to negotiate the acquisition of GA-ASI's MQ-9B. Significant customer interest is also expanding throughout the world. From a coalition perspective, the MQ-9B is well suited to be networked and interoperable during coalition operations due to its open system architecture and common communications protocols.

With the focus of US and Allied forces now turning to multi-domain, high-end warfare in the great power competition, including an increased focus on 'gray-zone' warfare, the traditional roles for MQ-9 series RPA are transitioning to multi-role and multi-domain applications, including maritime warfare. With this refocus comes an increased requirement for networking and synergies with other tactical and operational platforms. System testing of these new capabilities is ongoing in operational environments at various threat levels.

New, Innovative Capabilities

Capability development and the integration of systems for MQ-9 series platforms is proceeding at an unprecedented pace within GA-ASI to meet US and Allied requirements. The most prominent developments relate to ASW, EW, IR and EW Self-Protection systems, and advanced networking solutions, with flight trials on these configurations planned in 2020. Meanwhile, developments to the baseline MQ-9B SkyGuardian/SeaGuardian, including a Detect and Avoid System (DAAS) to aid in seamless operations in all classes of airspace, Portable Pre/Post-Flight Equipment (P3E) to enable austere expeditionary operations, and a range of automation and Artificial Intelligence (AI) applications for operations and processing, exploitation and dissemination (PED), are either operational or nearing completion.

The SeaGuardian

The MQ-9B is ideally suited to operate from a range of airfields throughout the world, including fields as short as 4,000 feet, by using an Automatic Takeoff and Landing Capability (ATLC). ATLC enhances the MQ-9B's versatility and employment options due to its small footprint and it only requires a handful of essential personnel for support. The capability to auto-land at un-surveyed airfields is also in development by GA-ASI (recently demonstrated by the US Air Force). With such capabilities, the MQ-9B could operate more flexibly and rapidly reposition between deployed operating sites, when compared to other strategic Intelligence, Surveillance, Reconnaissance and Electronic Warfare (ISREW) and Strike assets. With expanding multi-role capability options, the MQ-9B offers impressive future employment potential.

Many of GA-ASI's customers are acquiring a range of very capable ISREW platforms, including the E-7A WEDGETAIL, P-8A POSEIDON, and the MQ-9B SkyGuardian weapon systems. Operational roles for these systems overlap in some areas, with each providing an important contribution to the layered and networked aerospace force. This networked force creates a unique opportunity to maximize cross-domain capabilities for all. No longer can an Air or Defence Force afford to operate platforms within a narrow set of roles. With the need to focus more fully on multi-domain, high-end and gray-zone warfare, with reduced warning times and asymmetric challenges, the requirement for versatility and flexibility of weapon systems has become more acute.

The acquisition of the MQ-9B SkyGuardian/SeaGuardian enables a system of Multi-Domain Operations in direct support of Land, Maritime Surveillance, Anti-Submarine Warfare, Anti-Surface Warfare, Strike, EW roles and expeditionary roles. The MQ-9B's ability to network with other Air, Sea, Land and Space systems creates an exceptional opportunity to further expand force employment options.

Viewpoint from Taipei

Photo: via Author

First Flight of the BRAVE EAGLE

J.D. Kitsch

Photo: J.D. Kitsch

Taiwan's indigenously developed Advanced Jet Trainer (AJT) T-5 BRAVE EAGLE

Taiwan's indigenously developed Advanced Jet Trainer (AJT) T-5 BRAVE EAGLE conducted its official first flight on 22 June 2020. This marked Taiwan's first indigenously developed high-performance jet since the F-CK-1 CHING-KUO indigenous defence fighter made its first flight 31 years ago. The test flight was conducted in front of President Tsai Ing-wen.

The first prototype T-5A1, serial number 11001, took off from CCK AFB in Taichung at 09:20 for a 12-minute test flight with test pilots Lu Chih-Yuan and Kuan Yen-Nien. The entire flight was conducted above 5,000 feet. The Aerospace Industrial Developmental Corporation (AIDC) is slated to deliver a total of 66 airframes and 26 ground-based training systems (GTBS) before 2026. The programme cost is estimated to be around US$2.3Bn.

Development began in 2017 as a joint effort between the Air Force Aeronautical R&D Center, the Aeronautical Systems Research Division of the National Chung-Shan Institute of Science and Technology (NCSIST), and AIDC. The T-5 will replace the AT-3 and F-5E/Fs currently operated by the Taiwan Air Force in advanced trainer and Lead in fighter trainer (LIFT) roles respectively, and streamline pilot training from three types of aircraft into two.

The T-5 design was based on the F-CK-1, powered by the ITEC F124 with additional use of composite materials consisting of over 30% of its construction. The trainer's wing chord was thickened, fuel capacity increased, and equipped with a wider set landing gear, as well as digital anti-skid system in order to facilitate required performance and handling characteristics. Significant portion of the plane's software and hardware are of domestic design, including the flight control OFP software, Integrated Mission Computer, and flight control integrated servo actuators.

While the jet was not equipped with a fire-control radar, the onboard ZAH-1400A network communication radio would allow, for the first time, datalink capability for Taiwan's jet trainer. Developed by NCSIST and AIDC, the device is expected to allow the trainer to relay flight data such as position and altitude, as well as the emulation of frontline jets equipped with advanced radar and EW systems in conjunction with the Augmented Reality (AR) based GBTS on the ground. The GTBS will be capable of uploading a variety of battlefield scenarios to the trainer, including virtual threats and wingman. Currently however, the system has yet to undergo extensive testing and evaluation by the Air Force R&D Center.

Addressing concerns regarding insufficient height of the rear seating resulting in obstructed view for the instructor pilot, test pilot Kuen explained that the rear cockpit was equipped with a 4K visual display, duplicating the view and telemetry as seen by the cadet pilot in the front, and a standard set of duplicated flight controls were also provided for the IP.

The jet will undergo further development and testing for another 9-10 months, with additional static testing on the second prototype to verify a service life of 8000 flight hours, or 30 years. Other than the 4 prototypes so far, the first 6 production aircrafts are expected to be delivered by late 2021, entering low-rate initial production in 2022, and full-scale production between 2023-2025, with the last of the 66 airframes to be delivered in early 2026.

According to Air Force officials, since the T-5 is required to fulfil the role of both advanced jet trainer and LIFT roles, it is expected be capable of carrying ordinance and perform combat missions in the future.

Meteksan on the Growth Path

Meteksan Savunma is the one of the leading defence companies in Turkey. Established in 2006, Meteksan Savunma is known for providing sensor systems, communication systems, underwater acoustic systems and platform simulators. It is also part of Bilkent Holding, a large conglomerate funded by Bilkent University, which is Turkey's 15th largest industrial group, and privately held. The company is one of the main suppliers of the Turkish Armed Forces, and has been involved in various projects such as missile defence systems, attack helicopters, UAVs, corvettes and underwater weapons systems. ESD had the opportunity to talk to Selçuk Kerem Alparslan, President of Meteksan Savunma.

ESD: When and with what objectives was Meteksan founded? In which technology segments is the company active?

Alparslan: Meteksan Defence Industry Inc. was established in 2006 to develop and produce high technology products and subsystems for the Turkish and foreign armed forces. The systems and subsystems we produce are used for command and control, communications, reconnaissance, surveillance and intelligence purposes, and they apply to several different platforms, especially for surface and underwater platforms, helicopters, unmanned aerial vehicles (UAV) and missile systems. Our company operates in six fields: radar systems; perimeter surveillance systems; laser and electro-optic systems; communication systems; underwater acoustic systems; and platform simulators. Within these areas, we have completed various projects both in Turkey and in other countries, such as ground surveillance radars, missile data links, hull-mounted sonars, naval training simulators, which are all fulfilling the costs, schedules and performance expectations of our customers.

ESD: Meteksan develops several high technology systems for UAVs. Could you please provide us with information about your activities regarding UAV platforms?

Alparslan: As you have mentioned, Meteksan develops several mission critical subsystems for UAV platforms. All our products have been tested and readied in the field and each holds an assertive and competitive position in the global market. We believe that our solutions meet the needs of UAV platform manufacturers as they are high technology systems that also offer best value with low ownership costs compared to leading competitors. For example, one of our products is called the MILSAR UAV SAR/GMTI radar that allows UAVs to continue to provide high-resolution wide area images even in disadvantaged weather conditions where electro-optic sensors are ineffective. This high technology radar system has the same form-fit mechanical interfaces as the standard 15" EO/IR sensor turret to be readily replaced with an EO/IR sensor. In addition, operating MILSAR, together with an EO/IR sensor in a "slew-to-cue" fashion, improves the effectiveness of UAV-UCAV joint operations through maximizing wide area surveillance of the UAV and by increasing the UCAV's attack capability.

We are also working very closely with Turkish UAV manufacturers regarding data links. Our C-Band UAV data link is a LOS air-to-air and air-to-ground real time bi-directional communication system; it transmits manned/unmanned systems' command and control data and receives telemetry and high data rate, and real-time video data on a ground system with highly reliable electronic warfare (EW) protection. The system offers multi-platform support in a co-located fashion with hand-over capability. We are highly competitive on

Photos/Graphic: Meteksan Savunma

Meteksan`s RETINAR radar systems are high resolution radars with low power consumption and low probability of intercept

the international market in terms of data rate, electronic warfare protection, communication range, ease of integration and also cost.

As you may know, approximately 50% of all UAV losses are experienced during the take-off and landing phases. The OKIS automatic take-off and landing system we developed, based on cooperative radar technology, ensures the safe take-off and landing of UAVs within GPS denied conditions. The airborne unit of OKIS is small in size and weight and can be used in almost any kind of UAV without having any significant degradation on payload capacity. On the other hand, the OKIS ground unit provides for safe and precise take-off/landing by feeding accurate 3D position information (range, bearing, elevation) of the UAV to the Ground Control Station (GCS). Therefore, the GCS can communicate the precise location of the UAV with the autopilot via a communication link.

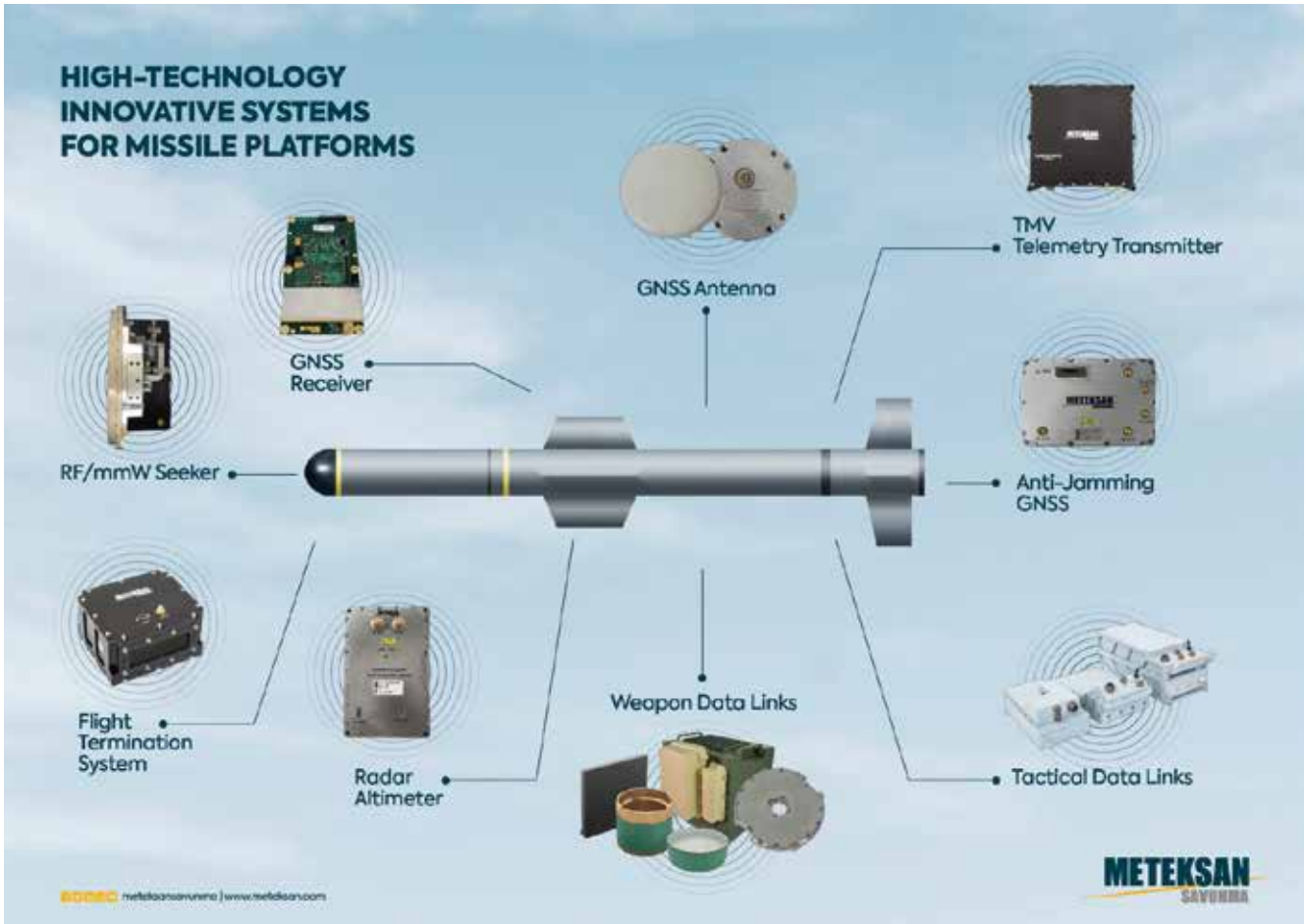
Today, most military platforms depend on Global Navigation Satellite Systems (GNSS). Jamming GNSS signals may cause many platforms to fail in their mission. For this reason, the development of GNSS anti-jamming systems and sustaining the performance of the military platforms in jamming environments is a crucial task. In that respect, we recently introduced a multi constellation, multi band anti-jamming GNSS which suppresses jammer signals targeting the Global Positioning Systems of the UAV and missile platforms. It is a very lightweight product that can be used in any kind of UAV platform.

The anti-jamming GNSS developed by Meteksan

Additionally, our company is the supplier of high precision 2,500 ft and 5,000 ft radar altimeters, telemetry transmitters and flight control computers according to the requirements of UAV companies. Some of these subsystems are already being used in Turkey's leading platforms and projects with great success, as well as by certain international users.

ESD: Meteksan also works very closely with Turkish missile manufacturers and is responsible mainly for the data links of missile platforms. What are your company's main products inside the missile systems?

Alparslan: Missile technologies are rapidly improving and becoming more sophisticated and complex with increasing requirements for greater reliability, accuracy and capability. While missile companies are trying to develop more complex systems, the technologies inside missile platforms must become more effective and conform to requirements related to low size, weight and power (SWaP). Meteksan Defence designs and produces missile specific high technology products that enhance the capabilities of platforms, which span RF/mmW seekers, GNSS receivers, GNSS antennas, telemetry transmitters, anti-jamming GNSS systems and CRPA antennas, tactical data links, weapon data links, radar altimeters and flight termination systems.



I can tell you proudly that Meteksan Defence is responsible for several subsystems of the main missile platforms in Turkey. For example, data links of the Long and Medium Range Anti-Tank Missile System programmes (UMTAS/OMTAS) and Low/Mid Altitude Air Defence Missile Systems are all Meteksan Defence products. We completed a product last year called KEMENT TDL which is a network-based, secured (crypto), jam-resistant, high-speed tactical data-link digital communication system with relay capability for near-real time transmission of complex data sets. KEMENT TDL enables NEC (network-enabled capability) and NEW (Network Enabled Weapon) among command and control (C2) systems, land, sea and air platforms, ammunition (cruise missiles, etc.), weapons and mission systems in the battlefield. With these innovative products and technologies, Meteksan Defence adds value by contributing to next generation missile systems that lead to more autonomy and complex battlefield capability and we are ready to supply our products to allied European nations' missile manufacturers.

ESD: Turkey signed an important contract last year to supply four corvettes to the Pakistan Navy and Meteksan is responsible for the hull mounted sonar systems in these vessels and also for the Turkish Navy's MILGEM class corvettes. Could you explain your projects for naval platforms?
Alparslan: Meteksan Defence was designated as Turkey's "Centre of Excellence in Underwater Acoustics" in the field of underwater acoustic systems, which adds significant value to the naval platforms with advanced technologies in underwater acoustic sonar systems. Our YAKAMOS Hull Mounted Sonar System is a medium frequency, surface ship anti-submarine warfare and obstacle avoidance sonar, which is designed for the surveillance of the underwater environment to automatically detect and track underwater targets such as submarines, surface ships and torpedoes. The system has been used in the MİLGEM class corvettes since 2011 and was selected as the sonar system of the Pakistan Navy's corvette programme in 2019.
We also delivered a system called PELIKAN RF Seeker Simulator to the Turkish Navy which provides realistic anti-ship missile (ASM) seeker radar simulations to evaluate the operation of RF chaffs/ decoys and other EW countermeasure systems in naval ships. It also provides a cost-effective in-house electronic warfare test, training, and validation capability.
Meteksan recently successfully delivered another project to the Turkish Navy named ALACA; this is used to measure the radar cross section (RCS) of surface ships. RCS is an important parameter in the protection of naval forces' command combat platforms from fire control radars and guided missile seeker radars that can be found in hostile platforms. ALACA performs high accuracy RCS measurements so that the relevant EW measures can be applied to improve the millimetre wave radar cross sectional areas of existing or newly designed platforms and to determine the operational scenario of electronic warfare counter measures such as chaff and decoys.
Our company also develops training simulators such as the Damage Control Simulator, Fire Training Simulator and Helicopter Escape Training Simulator for naval forces. Our Damage Control Simulator has been winning almost all open tenders in recent years around the world and has become the number one system in its class.

ESD: Turkey's unique geographical location has a strategic role between Europe and Asia but also serves as a transit country for migrants and refugees. Meteksan is instrumental in protecting Turkey's borders with advanced technologies. Can you tell us anything about that?
Alparslan: Borders are regions where measures should be taken within an absolutely integrated security solution regarding terrorist activities and also illegal crossings. Border security is achieved by bringing together as many different security components as possible, such as border fences, observation towers, mobile observation platforms, unmanned aerial vehicles, and balloons, but one of the most critical components is the radar systems being used. We are very proud of our Retinar Perimeter Surveillance Radar family, which are currently operational in the border areas of Turkey and other countries. For example, a large airport in Europe is using our radar system for its perimeter surveillance. Retinar radar systems are completely developed by our company and they are high resolution advanced technology radar systems with low power consumption and low probability of intercept, operating in millimetre wavelength and optimised for human detection and recognition. These radars are developed not only for border surveillance but also for perimeter security of critical facilities and security of patrolling mobile personnel. Retinar radars also generate the micro-doppler signature of the target and provide classification information whether it is vehicle, human or animal with spectrogram analysis which I believe is very important for users. I should add that we have important capabilities in the design and production of advanced and unique military radar solutions to our customers based on radio frequency (RF) technology. The abilities we have gained in millimetre wave radar technology since the foundation of our company, has allowed us to design and develop system components in this field and establish a design and test infrastructure as well. With the knowledge and experience we have gained in RF microwave and millimetre wave technologies, we are developing and producing different radar systems and are ready for cooperation with European companies for potential international opportunities.

ESD: Last but not least, the new drones are used not only for surveillance but also for air strikes. Technologies for drone defence still needs to be developed, so can you inform us about the latest developments?
Alparslan: The first step in acquiring counter-drone technology is the development of a sensor system that can detect, identify, locate, and track the converging drone. Relying on visual observation to detect drones is very ineffective; at a distance of several hundred feet, drones become invisible to the naked eye and very difficult to search with camera systems. Radar technology should be the main sensor of a counter-drone system as they can detect all types of drones, even non-communicating mini/micro UAV threats and non-GPS driven drones. Our Retinar FAR-AD, which is a perimeter surveillance radar especially developed to detect mini/micro UAV threats, is a new generation radar system with advanced drone detection, classification and tracking technologies. We are using Retinar FAR-AD Drone Detection Radar together with electro-optic sensors and drone jammers in our KAPAN Anti-Drone System. Different sensors and countermeasure components can be mounted on a vehicle or a mast, or it is also possible to integrate each component in different amounts according to the requirements of the area. In this way, effective solutions can be achieved both in terms of performance and cost. I believe the KAPAN Anti-Drone System is one of the best systems on the international market able to counter drone threats.

ESD: Thank you.

The interview was conducted by Korhan Özkilinc.

Viewpoint from Moscow

Si vis pacem, para bellum?

Yury Laskin

June 24th, 2020 saw Red Square hosting a military parade celebrating the 75th anniversary of the Allies' victory over fascism. The parade should normally have taken place on 9 May, but was rescheduled due to the COVID-19 pandemic.

On display were over 13,000 military personnel, 234 pieces of ground equipment, and 75 military planes and rotorcraft.

President Putin was accompanied by 10 foreign dignitaries: the heads of State from six CIS nations and Serbia, in addition to leaders of the internationally non-recognised Republics of Abkhazia and South Ossetia, and from the Republika Srpska entity of Bosnia and Herzegovina. Russian soldiers in the parade were joined by their military counterparts from the CIS nations, together with troops from Serbia with China, Mongolia and India. Perhaps more of a symbolic gesture bearing in mind the COVID-19 pandemic and the high number of infections worldwide plus recent Sino-Indian clashes in Ladakh.

The range of vehicles on display was indeed impressive, with 20 new machines making their public debut near the Kremlin walls.

Coincidentally, the same day saw President Trump hosting his Polish counterpart Andrzej Duda at the White House. The US leader repeated his plan to move troops from Germany to Eastern Europe - Poland in particular - while criticising Berlin at the same time for not following a NATO defence-spending plan and for acquiring natural gas from Russia.

"They will be paying for the deployment of additional troops, and we will probably be relocating them from Germany to Poland," Trump said during a press conference together with his Polish counterpart. He said that the US would be decreasing its armed forces' presence in Germany "very substantially." Some of these troops would be repatriated to the US, while others would be redeployed elsewhere. .

Needless to say, such a prospect is not enthusiastically welcomed in Moscow. The Russian capital lies 1,150 km from Warsaw and around 800 km from the Baltic states. The capital of Moscow's closest ally – Minsk, in the Republic of Belarus – is located about half way between Moscow and Warsaw, while Russia's westernmost enclave — Kaliningrad region — is bordered by Poland and Lithuania.

Russia well remembers the morning of 22 June 1941 when 5.5 million Nazi troops crossed the Soviet border.

The surprise airstrike that day involving thousands of aircraft heralded the first phase of a war whose aim was drive the USSR into extinction. Lasting 1,418 days and nights, the war resulted in the terrible loss of some 27 million people - one seventh of the total population - including 19 million non-combatants. The Belarussian Republic of USSR, which had been occupied for over three years, lost one quarter of its inhabitants. This could never be forgotten.

Not surprisingly, the lion's share of military vehicles displayed on Red Square showcased the country's air defence. Long range S-400 TRIUMF and S-300V4, both capable of intercepting all types of aerial targets up to distances of 400 km. The medium range belt was presented by the upgraded BUK-M3, and the latest S-350 VITYAZ mobile system, designed to engage targets at a range of 1.5 to 200 km. The close range is comprised of three versions of the PANTSIR missile weapon system, including the Arctic variant), TOR-2MU missile system and the 57-mm DERIVATSYA-PVO SP anti-aircraft gun system. The defensive branch also included the BAL anti-ship coastal mobile system employing a Kh-35 cruise missile with a range of 120 km at Mach 0.8.

Nothing had been heard ahead of the parade about the ISDM (Engineering System of Distance Minelaying) ZEMLEDELIYE (Husbandry) minelaying vehicles. The machine employs 50 122-mm launchers capable of firing a salvo to create a minefield at ranges of 5 to 15 km. The new generation mine employed in this system meets the Geneva Convention requirements. The vehicle is set to complete state trials before entering active service by the end of the year.

Eight types of APC and light wheeled armoured vehicles were also on display.

This Russian Army "iron feast" also displayed the new versions of the T-14/T-15 ARMATA family, as well as T-80/T-90 upgraded versions.

Additional strike power was displayed by the TOS-1A and TOS-2 heavy flamethrowers, 300-mm TORNADO MLRS (modernisation of the MLRS SMERCH) and ISKANDER missile complex with a reported range of 400 km.

The RS-24 YARS concluded the ground show; a battery of the three-stage solid propellant ICBM highlighted Russia's superpower capability. The missile has a range of 2,500-10,500 km, and is capable of carrying ten MIRV warheads.

With what happened 79 years ago in mind, Russia sent a clear message of its strong military power aimed at defending its independence and promoting self-confidence. Russia is the legal successor of the USSR but it is not the Soviet Union. It is driven by national interests and not by communist dreams and ideology. It has overcome the very worst pages of its history during the war and has stood firm for fifty years thereafter for the sake of its people.

Addressing war veterans and parade participants, Vladimir Putin said, "We understand how important it is to strengthen friendship and trust between peoples, and are open to dialogue and cooperation on the most pressing issues on the international agenda", including, "the creation of a common reliable security system." In the 1930s, a lack of a sense of common security, coupled with "irresponsible games" of the ruling elites, resulted in the most devastating war, which killed over 70 million people globally. The Earth will not have a second chance to survive if this lesson is forgotten and if another - now nuclear - catastrophe breaks out. Unfortunately, it appears that deterrence is the only way to maintain peace on the planet. Perhaps, the new generation will be wiser.

Collins Aerospace: Technologies for the New EUROFIGHTER and FCAS

Photos: Collins Aerospace

Interview with Mike Mohren,
Account Director EuMEA and Avionics at Collins Aerospace

Modernisation of the EUROFIGHTER and the FCAS relies on other industries and companies apart from the main actors (Dassault, Airbus DS, BAE Systems or Leonardo). This is the case of Collins Aerospace in Germany where it has been operating for more than 50 years. Avionics for fighters is one of its key capabilities. "Collins also provides integrated navigation and communication systems for a wide range of military applications", said Mike Mohren, Account Director EuMEA and Avionics at Collins Aerospace in an interview with ESD. They are involved in new technologies to provide the Long-Term Evolution (LTE) of the EUROFIGHTER. "We are a core supplier for EUROFIGHTER mission computers and we have a product line that uses a common core concept to cover a wide range of platforms and applications, from low cost up to high reliability", Mohren said. One of those technological examples Collins introduces in the new EUROFIGHTER is the MFD-4820 Large Area Display that can be used with bare hands, gloved fingers or a stylus. The System Prototyping Integration Demonstration Rig (SPIDR) with two MFD-4820 displays and three AFD-3200 or the Helmet Mounted Display System (HMDS) are other possibilities. "The HMDS provides pilots with intuitive access to vast quantities of flight, tactical, and sensor information for advanced situational awareness, precision and safety. It also enables the pilot to target weapons by looking at and designating targets, and target verification when receiving steering cues from on board sensors or via datalink".

For the SAAB GRIPEN aircraft, Collins in Heidelberg has been selected for the Next Generation upgrade programme, delivering three 6-by-8 inch smart head-down displays as well as a smart digital head-up display. Airbus Helicopters awarded Collins in Germany a contract to develop the German Avionics Management System (GAMS) for the life extension upgrade of the German Forces' CH-53 helicopter fleet.

ESD: What are you already providing?
Mohren: Collins Aerospace already provides various products and services from across our different business units to the EUROFIGHTER. Some examples are Mission Computers, MIDS-LVT, Lighting Systems, On-board Oxygen Generating System, various kinds of different sensors and more. Not to forget our local service support centres to keep the products in healthy condition and to guarantee short turnaround time if something breaks or needs overhaul. We also provide Performance-Based Logistics (PBL) services to our EUROFIGHTER customers.

ESD: How do you envision the future and modernisation of the EUROFIGHTER regarding your services?
Mohren: Considering that the EUROFIGHTER has been operational for some time now and and is planned to remain in operation until the 2060s, we are currently in obsolescence removal discussions with the EUROFIGHTER operators. But we also envision the EUROFIGHTER LTE (Long Term Evolution) mid-life update programme which is under discussion between the EUROFIGHTER core nations, Germany, the UK, Spain and Italy. We see a lot of potential to modernise the cockpit, for example, with a

The MFD-4820 Large Area Display can be used with bare hands, gloved fingers or a stylus.

large area display or state-of-the-art helmet system. To elevate the EUROFIGHTER to the next level and to stay competitive with its peers on the international market over the next decades we believe there will be a need for - but not limited to - a more robust and faster internal data management provided, for example, via a full digital backbone and more powerful computer processing. Whatever eventually will be decided concerning the EUROFIGHTER LTE programme, Collins Aerospace is well prepared to support our partners and the operators to make it a success in utilising our local capabilities.

ESD: How is Collins Aerospace getting prepared for the FCAS project?
Mohren: Collins Aerospace is closely monitoring the advancements of current 6th generation programmes as well as the 5th generation programmes. Part of this process is to collaborate closely with real life and experienced flight operators to feed their operational experience into our developments. We believe computing power and the respective digital backbone will be key for any future 5th and 6th generation programmes due to the increased processing demand. The key technology here is to provide assured multi core processing to the OEM which will also be flight certifiable – not to mention hardened against cyber threats. Collins Aerospace is already investing in technologies which enable pilots to reduce their operator workload such as higher autonomy to be ready for Manned-Unmanned Teaming (M-UMT) missions along with Remote Carriers, aka LOYAL WINGMEN. Based on our proven and unprecedented Collins Aerospace 5th Gen HMDS we are looking into advanced flight deck technologies to dramatically increase the situational awareness for the operator alongside reduced workload. One very recent example of this is our investment in our latest large area display, the MFD-4820. As it is very likely that those future 5th and 6th generation assets will be very costly and limited in availability, reliable pilot health monitoring systems will become more important.

ESD: What is next in military field of the aerospace?
Mohren: Upcoming airborne assets, manned or unmanned, will become more and more complex and must be prepared to operate in high dynamic A2/AD operations against technologically advanced adversaries. We at Collins Aerospace believe that more flight and mission execution automation as well as AI (Artificial Intelligence) to support the operator will be an important part of any 6th generation fighter programme. For this reason, Collins Aerospace is investing not only its own, but also third party funding in those areas. Collins Aerospace is one of a few major aerospace companies that is touching all current western 6th generation fighter programmes which have similarities in their operational requirements. This puts Collins Aerospace in a position where we are able to focus our efforts and strength to develop technologies applicable to those programmes.

ESD: What are the main challenges for the next few years?
Mohren: Today's certification and approval authorities rely pretty much on deterministic principles. However, self learning software or AI are not deterministic, which will lead to an enormous challenge to certification, verification and validation processes. We believe today's approval regulations are not fit for 6th generation demands and need to be reconsidered to become more adaptive to new technologies.

ESD: Thank you.

The interview was conducted by Esteban Villarejo.

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A Stimulus Package for India's Defence Industry

Suman Sharma

India's Ministry of Defence and the country's arms manufacturers are optimistic about Prime Minister Narendra Modi's announcement during the COVID-19 pandemic about the "Self-Reliance Initiative", albeit with some apprehension.

At a digital conference organised in May 2020 by the Society of Indian Defence Manufacturers (SIDM), Defence Minister Rajnath Singh applauded SIDM's efforts aimed at accelerating the manufacture of DRDO [Defence Research and Development Organisation] designed personal protective equipment (PPE) kits, masks, and ventilator parts within the defence industry, noting that it had done so in a period of less than two months. However, he cautioned that "the manufacturing sector has been affected the most by the lockdown, resulting in disruption to existing supply chains." Defence Minister Singh characterised MSMEs as the backbone of the Indian economy, able to accelerate GDP growth, earn valuable foreign exchange through exports, and can provide employment opportunities. He said, "There are more than 8,000 MSMEs, tiered partners of many of our organisations – ordnance factories, DPSUs (Defence Public Sector Units) and service organisations. They contribute more than 20% of the total production of these organisations."

Photos: via author

A Dassault RAFALE flying at Aero India 2017. RAFALE constitutes a major business case for Franco-Indian defence cooperation.

Though the lockdown has affected defence production, Prime Minister Modi has urged the defence sector to view it as an opportunity towards achieving self-reliance. Hence, under the "Atmanirbhar Bharat" initiative, an increasing number of projects are being converted under the Government's flagship 'Make in India' programme. In this regard, Defence Minister Singh stated that this will provide a fantastic opportunity for Indian industry to enter the defence sector and integrate into the supply chains of all arms of the MoD, including the Service Headquarters, ordnance factories, DPSUs, DRDO and OEMs (original equipment manufacturer), on both the domestic and global stage.

Measures Announced by the Ministry of Finance

Some measures announced by Finance Minister Nirmala Sitharaman under the Atmanirbhar Bharat scheme include: (a) collateral-free loans of US$45Bn for MSMEs which will help re-establish about 4.5 million units and save jobs; (b) subordinate debt provision of US$2.86Bn for 200,000 MSMEs, in order to help stressed MSMEs; (c) equity infusion of US$7.14Bn for needy MSMEs; (d) a US$1.43Bn 'Fund of Funds' to increase the capacity of these units and for marketing purposes; (e) the definition of MSME has been revised so that MSMEs can be expanded; at the same time, there will be no distinction between manufacturing and service sector MSMEs; (f) global tenders will not be allowed in government contracts (procurements) valued at US$2Bn or less; and (g) the Government and PSUs should ensure clearance of all outstanding payments within 45 days.

The defence sector reforms announced on 16 May 2020 form the basis of the Prime Minister's self-reliance pitch, and these include:

1. Measures to reduce dependence on defence imports:

a. The MoD will issue a list of weapons and platforms which will not be allowed for import. This list will include: (i) artillery equipment, including field guns, rockets and rocket launchers; (ii) missile systems, including missiles and missile launchers; (iii) combat engineering equipment, including military bridges, mine ploughs; (iv) warships of all types; (v) submarines of all types; (vi) all ship-borne subsystems; (vii) torpedo defence systems; (viii) all types of radars; (ix) unmanned aerial systems; (x) armoured fighting vehicles; (xi) mine protected vehicles; (xii) armoured personnel carriers; (xiii) all types of launchers; (xiv) all types of winches; and (xv) naval combat management systems.

Author

Suman Sharma is a Delhi-based journalist covering foreign policy and defence. Previously, she was an instructor at the Indian Military Academy.

b. Indigenisation of imported spares.
c. Separate budgetary support for domestic capital procurement with a recommended list of programmes to be fast tracked for indigenous capital procurement: (i) P75I submarines under the State Procurement model; (ii) naval utility helicopters (NUH) under the SP model; (iii) Pinaka MBRLs under para 72 of the Defence Procurement Procedure (DPP); (iv) Akash SAM systems under para 72 of the DPP; (v) MRSAM and QRSAM systems under para 72 of the DPP; (vi) ASTRA missile systems under para 72 of the DPP; (vii) modular Bbridging systems under para 72 of the DPP; (viii) future infantry combat vehicles (FICV) under the "Make-in-India" Initiative; (ix) tactical communication systems under Make-I; (x)landing platform docks; (xi) warships such as NGOPVs, NG corvettes, NG frigates; and (xii) a BMP-2 upgrade under the revenue route.

Other Recommendations

2. Corporatisation of the Ordnance Factory Board in order to improve its autonomy, accountability, transparency, and efficiency.
3. Establishing a Project Management Unit (PMU) to support contract management.
4. Limit in Foreign Direct Investment in defence manufacturing under the automatic route to be raised from 49% to 74%. The aim is to increase the transfer of technology (ToT). So far, the defence sector has seen investment of less than US$10M despite up to 100% FDI allowed on a case-by-case basis.

It is worth noting that in the MoD's document on procurement(Defence Procurement Procedure- 2020), it was proposed that private industry should achieve a turnover of approximately US$26Bn in defence goods and services by 2025, thereby creating employment for nearly two to three million Indians and to achieve exports of about US$5Bn in defence goods and services by 2025, thereby reducing dependence on imports and making progress in achieving self-reliance.

The Indian Army

During the COVID-19 pandemic, the Indian Army placed orders from Indian vendors, both government and private industries, for ventilators, PPE and other stores, worth US$2.46Bn.

From the abovementioned list regulating defence equipment imports, those exclusively foreseen for the Indian Army include

The Indian Defence Minister Shri Rajnath Singh in the K9 VAJRA at Hazira, Gujarat on 16 January 2020

artillery equipment, including field guns, rockets and rocket launchers, combat engineering equipment, including military bridges and mine ploughs, all types of radars, unmanned aerial systems, armoured fighting vehicles, mine protected vehicles, armoured personnel carriers, and all types of launchers, worth approximately US$30Bn.

The Indian Army's requirement for 100 K-9 THUNDER VAJRA self-propelled artillery guns signed with South Korean Hanwha Defence worth US$22.5Bn, 145 M-777 from BAE Systems worth US$25Bn are just some of the orders with foreign vendors, but there is also Indian participation; under the 'Make in India' programme, the Ordnance Factory Board has an order for 114 long range artillery guns named DHANUSH. The FICV programme worth US$300M was initiated under the 'Make in India' programme and will see 2,610 combat vehicles built to replace the 1980s' vintage BMP-2 with 49 mechanised infantry battalions foreseen for the Indian Army. Foreign vendors who have shown interest in this project include General Dynamics, BAE Systems, Krauss-Maffei Wegmann, Rosoboronexport, Nexter, Ukrain Export of Ukraine, Polski Holding Obronny and Hyundai Rotem. Indian defence manufacturers also interested includeTATA Power SED, TATA Motors, Mahindra Group, Titagarh Wagons, Tractors India, Bharat Forge, Punj Lloyd, Reliance Defence and Engineering Limited.

The Indian Army's projection has been for 1,500 light bulletproof vehicles, 4,000 light armoured vehicles, 4,500 light specialist vehicles, 600 light specialty strike vehicles, 230 light strike vehicles (LSVs), totalling over 10,000 vehicles, intended for reconnaissance and internal security roles for the mechanised, armoured and NBC units.

While the Indian private defence manufacturing sector has made considerable progress in the light strike, combat and mine-protected vehicle arena, the most visible 8×8 wheeled armoured fighting vehicle on the Indian defence scene is the KESTREL, a platform developed jointly by the Tata Group and DRDO. The Kestrel is often compared to the US STRYKER.

Light armoured vehicles require integration of various other functions including communications for command and control, weapons consoles, and multi-function activities such as recce operations, border patrolling, and quick reaction.

"Make in India"

In 2017, the Government initiated a Green Channel policy to facilitate the "Make in India" initiative. This policy is expected to institute a mechanism to award Green Channel status to firms with pre-defined financial and quality credentials. In 2019, with the intention of improving its ease of doing business, the Government devised a self-certification policy.

Self-certification is the process adopted to delegate the responsibility of certifying the quality of products to the manufacturer on behalf of the purchaser, after first ensuring the demonstration of the manufacturer's capability of consistently producing defect-free products over a certain period of time.

Lieutenant General Vinod Bhatia (retired) said, "Indian defence manufacturers have the potential to meaningfully and optimally contribute to self-reliance. The recent defence reforms will facilitate the indigenisation and growth of India's defence industry. The policy reforms are good; however, these need to be backed by relevant changes in procedures and processes, which continue to be lengthy and lethargic, adding to apprehensions in the industry."

Clearly, India can make a quantum leap in its defence capabilities and capacities if the MSMEs are incentivised and encouraged by the Government and the Indian Armed Forces. ■

A Wide Portfolio of Defence Solutions

Photo: Embraer

Embraer Defense & Security is the leading aerospace and defence company in Latin America. ESD had the opportunity to talk to Jackson Schneider, President and CEO Embraer Defense & Security.

ESD: The coronavirus pandemic has severely and negatively affected the global aviation industry. Military aviation activities are often a smaller part of bigger, civil-aviation-focused companies. To what extent has Embraer's military aviation business been affected in 2020?
Schneider: We are living in unprecedented times in the world with the COVID-19 outbreak this year that has brought meaningful impacts to our industry, but so far, the Defense & Security business remains resilient. We continue with active sales campaigns in several countries and with new business prospects, such as the investment we recently announced in cybersecurity.

ESD: What is the strategy behind this investment in cybersecurity?
Schneider: This investment is totally in line with Embraer's future strategy as it represents an important business diversification and it adds relevant technological capabilities in order to expand our presence as the Brazilian defence house in supporting Brazil´s Armed Forces in the area of cyber defence. Also, it represents new opportunities to export defence solutions as well as a potential expansion in the B2B market.
We did a capital investment in Tempest Security Intelligence, resulting in a majority interest in the company, and we did another investment in a company called Kryptus through the Brazilian Aerospace Investment Fund. Tempest is the largest cybersecurity company in Brazil, a provider of complete solutions for business protection in the digital world. And Kryptus has a recognised expertise in critical defence technologies such as cryptography and information security. Both companies already have a good international footprint with clients in Brazil, Latin America, and Europe.

ESD: Embraer recently delivered the third C-390 MILLENIUM to the Brazilian Air Force. What can you say about the entry into service of the aircraft?
Schneider: The feedback from the Brazilian Air Force (FAB) couldn´t be better. We are proud to see the C-390 MILLENIUM in service and to witness our customer's satisfaction with the proven execution of the combination of requirements, as defined by FAB, and demonstrated by the aircraft, as developed by Embraer. The C-390 MILLENIUM has been successfully used in FAB humanitarian missions to combat COVID-19, demonstrating, in practise, its operational abilities and its importance for the country. Among other points highlighted by FAB in the use of the KC-390 MILLENIUM, the aircraft has been helpful in its ability to carry massive amounts of cargo, quickly, over long distances. As an example, the aircraft flew 2,690 kilometres, from São Paulo to Manaus, in less than four hours. The other important conclusion is the confirmation of the high reliability and maintainability of all aircraft systems in operational scenarios, contributing to an unprecedented high aircraft dispatchability and fleet availability. This is, we believe, one of the most important and tangible operational outcomes of the C-390 MILLENIUM, especially when we are talking about smaller fleets.

ESD: What are the potential markets for the C-390 MILLENIUM? Where in the world do you see a higher demand for this aircraft?
Schneider: Clearly, there is a persistent global demand for medium lift aircraft, including countries seeking to replace existing, older technology aircraft. The addressable market for the C-390 includes all countries that have a need for medium-lift aircraft and air mobility and are not subject to embargoes. I can tell you that there is continued interest around the C-390 MILLENIUM in the international market and this includes several potential customers.

ESD: What would you say are the hallmarks of a successful programme such as the C-390 MILLENIUM?
Schneider: The C-390 MILLENIUM is the result of a combination of two very important items: solid and consistent requirements issued by the FAB that was able to translate its operational expertise into technical, logistic and industrial requirements; and Embraer's excellence in design and development of aircraft.
Embraer has been one of the most prolific aircraft designers in the world in the last two decades. The E-Jets family, the PHENOM and the PRAETOR jets, and the C-390 are first class examples of success in the aerospace industry. At the same time, we sold and produced hundreds of those aircraft. Such a level of activity keeps all professionals involved (design, manufacture, flight test, management, etc) in the highest possible readiness, proficiency and energy. The C-390 is the

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Photo: EMBRAER

The KC390 Container Delivery System

result of decades of constant improvement, lessons learned and entrepreneurship culture.

ESD: You have secured a contract with the Portuguese government – congratulations! – but what are the next steps in Europe for the C-390?
Schneider: We are proud to have been selected by the government of Portugal and we are certain that the C-390 MILLENIUM will meet Portugal's operational needs, ensuring the ability to integrate with allied nations for decades to come. The entry into service of the aircraft with the Brazilian Air Force is a great opportunity to show to all other 43 European countries, as well as to many other prospects around the world, that we have a superb tactical airlifter. The existence of an MRO certified for C-390 MILLENIUM in Europe and the NATO compatible and secure communications/avionics that will be delivered to Portugal are also important steps for our potential customers in Europe.

ESD: The SUPER TUCANO already has a superb success record worldwide. What are the key attributes of this aircraft?
Schneider: The A-29 SUPER TUCANO is the gold standard and the international reference for light attack with great ability to perform Close Air Support missions and also a great advanced turboprop trainer, covering phases II and III of the standard international pilot training syllabus. It has been selected by 15 air forces worldwide with over 230 aircraft delivered and more than 250 sold. The A-29 is a versatile and powerful turboprop known for rugged and durable design that can operate from unimproved runways at forward operating bases in austere environments. It is able to employ the most modern smart weapons and surveillance sensors. Also, the A-29 is a combat proven aircraft with a strong operational track record in conflict zones around the world.

ESD: In terms of light fighter aircraft Europe is one of the most competitive markets in the world, as well as encompassing the widest range of competitive airframes. How do you address that, both in terms of processes and technology? And what particular characteristic(s) lead to the SUPER TUCANO's success?
Schneider: We understand that the A-29 SUPER TUCANO can add an important capability of light attack, close air support and JTAC (Joint Terminal Attack Controller) missions since the aircraft has been performing these missions with an excellent track record over the last decade. It was selected by the US Air Force for its Light Air Support programme and, more recently, the selection of the A-29 for the US Air Force Special Operations Command (AFSOC) Combat Aviation Advisor (CAA) mission set reaffirms the aircraft's capabilities. Also, it is important to highlight the multi-role aspect of the A-29 since it can perform the ISR mission as well as advanced trainer. The A-29 offers the proper balance of technology, robustness, survivability, performance and simplicity. Those ingredients make the SUPER TUCANO a great contender in the European market.

ESD: Do you have any plans regarding future partnerships in the Defence area?
Schneider: There is nothing defined yet, but we remain open to discuss partnerships aimed at specific projects, whether around products or engineering.

ESD: In the last few years, Embraer has diversified its Defence portfolio. What can you tell us about that?
Schneider: Aside from a great portfolio of aircraft we can also provide a full line of integrated solutions and applications for defence in air, sea, land, space and cyberspace. This includes Command and Control Centres (C4I), radars, ISR (Intelligence, Surveillance & Reconnaissance), integrated systems for information, communications, border monitoring and surveillance as well as air traffic management and satellite systems. Our products and solutions are present in more than 60 countries.

ESD: Any plans for the development of new products in the near future?
Schneider: We are always evaluating the market as well as new business opportunities. We have very interesting projects in several areas, but I can't say anything at this time.

ESD: Thank you.

The interview was conducted by Stephen Barnard.

Photo: EMBRAER

Airborne forces perform a parachute out of a KC390

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Are Small Tactical UAS Disrupting Manoeuvre Warfare?

Photos: Aeronautics

The world of Unmanned Aerial Systems (UAS) has evolved for more than a century. But it was only in the early 1970s that UAS assumed a significant military role, with the evolution of computing, inertial navigation, electro-optics, and communications systems suitable for such platforms. With the dramatic miniaturisation of electronics and optronics and commercialisation of drone technology, UAS have become smaller and smarter, introducing disrupting capabilities for military, commercial, and personal users. In a recent interview with Matan Perry, VP Marketing and Business Development at Aeronautics, we had the opportunity to uncover some of these disruptive influences and trends that Small Tactical UAS (STUAS) may have on the future battlefield.

ESD: What are the main trends you see in the UAS world?
Perry: When you look at the general picture, a clear trend stands out – the market is booming. From predominantly tactical systems such as our AEROSTAR UAS, we see the introduction of much larger, heavier unmanned systems operating at a higher altitude, on extended missions, over unlimited ranges, as they rely on satellite communications for operations. Aeronautics offers the DOMINATOR for this category. It is operated on strategic missions, deploying from permanent airfields as part of national reconnaissance or naval surveillance activity. On the other hand, we see UAVs becoming smaller and more versatile. The ORBITER UAS family from Aeronautics is a leader in this category. These are small tactical systems that leverage new, more advanced electronics and optics to deliver the same missions, with better performance, more flexibly and affordably.

ESD: What technologies enable this trend?
Perry: The large drones leverage platform capabilities to operate in extreme conditions – high altitude, long-range, and long endurance. STUAS, on the other hand, are designed for extreme efficiency in all those aspects. They use miniaturised payloads to minimise space, weight and power consumption with efficient propulsion, launch, and recovery techniques that enable such UAVs to extend their missions and deploy with minimal logistics and support footprint. While Small Tactical UAS are not dependent on SATCOM for mission operation, using tactical SATCOM can help operations in extended range and beyond line of site areas.

ESD: Is VTOL part of this trend?
Perry: There are different VTOL technologies, suitable for various applications but all impose significant intrinsic weight on the platform, thus reducing endurance and payload capacity. Therefore, developers and users must assess VTOL carefully for the value it provides. At Aeronautics, we currently employ catapult launch with parachute and airbag retrieval for our tactical drones. We are considering using a vertical landing electrical multirotor system, which imposes the minimal penalty on the platform, retaining the catapult launch, while retaining higher energy efficiency.
We also employ multirotor technology in another product family – the PEGASUS 120. This is an octocopter – a load carrier powered by eight electrically-powered rotors. It operates in a fully autonomous flight and lifts up to a 45 kg load packed in a standard container, carrying ammunition, food, water, fuel, energy, and medical supplies. Flying for up to 30 minutes, PEGASUS can support dispersed units over 15km and deliver their cargo where it is needed. By sustaining combat units in their forward positions, the PEGASUS enable Brigades, Battalions, and Companies to move fast, cover large areas and minimise logistic concentrations, thus becoming more dominant, survivable, and effective.
Such drone formations can be operated at the tactical level as an organic asset of the Brigade, or deploy to a forward location, controlled remotely from an operating centre under a different authority or as a joint asset.

ESD: Can the fixed-wing platforms offer similar efficiencies?
Perry: Of course, our ORBITER 4 is a leader in the world's STUAS category – with mission endurance of 24 hours, a payload capacity of 12 kg and multi-payload capability. It delivers a performance that of a MALE UAS can offer today, but in a smaller platform. Our ORBITER family of UAS includes several performance levels, from the electrically operated Mini-UAS ORBITER 2, which allows a 4-hour operation at a distance of up to 100 km, to the larger electrically operated STUAS ORBITER 3 and ORBITER 4, which allows 24-hour operations at a distance of up to 150 km (LOS) or beyond LOS by SATCOM. All of them offer mission flexibility, as they can operate covertly, below cloud base, day and night and in almost any weather. Runway independence is a key feature of all ORBITERs, as it enables forces at the tactical level, from the Brigade up, to use drones to collect organic information and target for surveillance, reconnaissance (ISR) or special missions and

operated and maintained by smaller forces and by fewer men power.

ESD: What drove Aeronautics to offer these innovations?

Perry: As a vertically integrated company, Aeronautics Group possesses all the know-how and capabilities necessary for the STUAS mission – from platform design and flight control to propulsion, datalink security, and the development of mission payloads. Each area is covered by a member of the Aeronautics Group that is an expert in its field.

For example, Controp develops and produces EO/IR payloads, Commtact produces datalinks and communications security. Zanzottera manufactures propulsion systems, while our newly completed integration with Rafael opens new horizons for further integration of Rafael's exceptional capabilities in payload design and mission support. Aeronautics is the platform manufacturer and developer of flight and mission control systems.

While each company maintains its operations, as a group we share and synchronise development roadmaps with the entire group to position our solutions and products at the forefront of technology and meet customer requirements with the most suitable solution.

The evolution of the ORBITER family demonstrates this approach, as we were able to integrate Controp's STAMP family on the ORBITER 2 as soon as it was released, and in doing so, we were prepared in time to debut the larger T-STAMP payload on our ORBITER 3. Specialised mission payloads such as Rafael's MICROLITE Persistent Wide-area System (PWAS) combined with a compact version of the IMILITE automated mission processing system add new capabilities. Both systems were developed by Rafael and make ORBITER 4 a unique ISR enabler for persistent monitoring.

ESD: Where do you see the future of STUAS?

The electrically powered ORBITER 3 UAS

Perry: Autonomy and workload reductions are essential features for current and future UAS since users want to minimise their footprint at the tactical level. When operating the drone in a fully autonomous flight, mission operators can focus on the sensors and mission and let the computer fly the drone. These are features we provide today. All flight operations and procedures are maintained by the system, ensuring safe operation and airspace integration even with a single operator.

Future applications will see more missions conducted by UAS. So far, most users are using UAS to replace the traditional binoculars because UAS provide an elevated view of the battlefield. Soon, however, such drones will be able to deliver intelligence in more complex forms. By using artificial intelligence and machine learning (AI/ML), surveillance and target missions will be able to process much more data and process it largely automatically. By combining multi-sensor systems on single or multiple platforms, users will merge EO/IR, radar, cellular interception, and electronic surveillance to support tactical missions, develop clear situational maps and act upon it more efficiently. Until now, these capabilities were reserved only for the strategic and national operators and could not be employed at the tactical level.

With fixed-wing and multirotor UAS becoming part of the ground manoeuvre formation, drones have the potential to evolve into a disrupting element in modern warfare.

ESD: Thank you.

The interview was conducted by Tamir Eshel.

The ORBITER 4 can fly 24 hour missions at up to 150km range and beyond.

A Changed Setting

An Update on European Combat and Light Attack Aircraft

Georg Mader

When looking at the status and prospects of the numerous fixed-wing Combat and Light-Attack programmes of European manufacturers, one has to consider the uncertainty surrounding the funds available in the coming years for the defence sector given the impact of the various multi-billion post-COVID-19 economy stimulus packages. For most western governments, acquiring new or modernised combat aircraft will now assume a much lower priority. Western reluctance to spend more is in stark contrast to the recent 6.6% increase in defence funding in China, where COVID-19 originated.

While China may appear far away, other threats are in fact much closer. Until a few months ago, with Russia having emerged as a major threat to geopolitical stability, most NATO countries were on the right path to spend more on the Alliance's defence. This included seeking replacements for ageing fighter aircraft, reflecting the need to replace MiG-29s, earlier F-16s and F/A-18s or TORNADOs which have been in service for nearly 30 years. Manufacturers have been reacting to the air forces' demands for modern, multi-role combat platforms that can operate in complex aircraft packages, where ISR data is loaded onto computing clouds.

Before the resurgence of Russian power and assertiveness, most European air forces experienced drastic budget cuts. If there were any investments at all in this sector, most air arms concentrated their efforts on small deployments for close air support and urban operations, such as fighting the protracted wars in Iraq or Afghanistan. Subsequently, when conducting air operations over Libya, several shortcomings were noted, such as the fact that tactical recce no longer existed, except with the Swedish Flygvpanet, or that there were insufficient air-to-air refuelling capabilities.

At the same time, when it comes to competition on the global markets, the conditions for European manufacturers have once again darkened. This is contrasted by an increasing US dominance in the market, materialising by the ever growing Lockheed Martin F-35 aircraft and by the most recent versions of earlier designs such as the F-16 Block-70, the SUPER HORNET ADVANCED-III or the EA-18G GROWLER. Some time ago, European managers of defence agencies and companies had expected that the F-35 project might fail – which once nearly happened, while it is still plagued by drawn-out budget deficits. Last year, however, Steve Over, Lockheed Martin's F-35 international business director stated, "We have won every competition that we entered." That statement is justified. Most customers cite interoperability with the US as the main reason for choosing the F-35. Today, F-35 operators include Belgium (34), Denmark (27), Italy (90), the Netherlands (46), Norway (52), Poland (32) and the UK (138). Before being excluded from the F-35 programme in July 2019 after acquiring the Russian S-400 TRIUMF system, Turkey had a requirement for 120 F-35 aircraft, and may now choose to procure Russian fighter jets. Steve Over, however, is confident: "By 2030 we expect more than 500 F-35s to be operating in Europe, including 48 USAF examples based at RAF Lakenheath by 2030". And Lockheed Martin's John Neilson told the author at the last ILA Air Show, "We still see more markets in Europe emerging in addition to Switzerland or Finland. In the longer term that could include Greece, Spain or Romania".

Photo: AERO

The AERO L-259 light-attack aircraft project

Author

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

The Eurocanards

Three European solutions are competing against this considerable US footprint, namely the Eurofighter TYPHOON, Dassault RAFALE and Saab GRIPEN JAS 39E/F (and to some extent still JAS 39C/D). While they are each excellent in their own right, there are still limiting factors resulting from their par-

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Photo: AERO

The maiden flight of the AERO L-39NG in December 2018

allel development since they are, or were, competing against each other, often only for moderate contract numbers. This drawback has meanwhile been addressed by politics and industry and is one of the drivers for the 6th generation FCAS project. While the FCAS is not the focus here, two such projects have since taken off and are in the long-term pipeline with a time horizon of 2040 – one undertaken by the UK, Italy and Sweden and one by France, Germany and Spain. Several aerospace industry captains are calling for, or predicting, that sometime in the mid-term future, these will (have to) merge due to budgetary constraints.

The EUROFIGHTER

No matter how one refers to it, the EF-2000, EFA or TYPHOON, the 4-nation-built EUROFIGHTER is not only the most powerful of the three Eurocanards, but also the most widespread and successful western fighter aircraft programme of the fourth generation. When it comes to its operational use, whether in a distant conflict or airspace protection, its equipment limitations or spare-part problems, the EUROFIGHTER is sometimes configured in a significantly different way within the consortium, as well as to export-user countries.

A little more than 17 years after the first flights of the initial (two seat) T1 production aircraft, the last two series-platforms from the 1990s' basic framework agreement were rolled out at the end of 2019 – one each for the Spanish and Italian Air Forces. The British RAF and the German Luftwaffe took their last T3s into service in September and December 2019. 160 units went to the RAF, 143 to the Luftwaffe, 96 to the Aeronautica Militare Italiano (AMI) and 73 to the Spanish Ejército del Aire. In addition to these 472, there were six newly built out of 15 cannibalised T1s for first export customer, Austria in 2007, in addition to 72 for Saudi Arabia, 12 for Oman, 28 for Kuwait and 24 for Qatar. The aircraft from these two latest orders will be delivered between 2020 and 2023/24. Production continues in Warton, Manching, Caselle and Getafe and final assembly takes place in Caselle (Kuwait) and Warton (Qatar). In total, there are 623 aircraft – a number that no modern fighter aircraft (4th and 5th generation together) has achieved, even if the original framework contract was for 707 units. Regarding the US rivals, the F-35 currently stands at 500 deliveries (354 F-35A, 108 F-35B and 38 F-35C), but will outmatch the EUROFIGHTER some time soon.

While Airbus Defence and Space has placed the TYPHOON in competitions in Switzerland, Finland, India and Colombia, as of last year, it was never anticipated that Germany alone would offer the type's largest growth potential. There seems to be a consensus in Berlin that a replacement for the 85 ageing TORNADOs should be on the aprons by 2030. Time will tell whether it will be a split-buy between 60 to 90 additional TYPHOONs and/or – as recently officially announced – 30 Boeing SUPER-HORNETS for the shared nuclear capability and 15 EA-18G GROWLERS. While the latter represents an operational combat platform, and with the ALQ-218 receivers and new ALQ-249 jammers, it would take over SEAD/DEAD escort/standoff-jamming (electronic attack) role from the TORNADO-ECR – a role that Airbus recently claimed to be able to fulfil when they presented an artist's impression of a two-seat T4. Since then, we are also familiar with the type's LTE or Long-Term-Evolution. This includes Project Quadriga which covers 38 newly built T4 (26 single, seven twin-seaters, plus five options) to replace the Luftwaffe's early T1s – and as a synergy effect possibly also the Swiss legacy HORNETS. In the end, there should be about 110 true multi-role German EF-2000s of only T2 and T3 types. All these aircraft would receive provision for conformal fuel tanks, improved aerodynamics and HUD and the AESA radar. Regarding this new main sensor, the four partner nations paid over €1Bn to develop it but no orders have been placed yet.

Flight-testing of the new moveable E-scan radar which allows a 50% wider field than conventional fixed plate antenna systems is currently proceeding on LEONARDO's ISPA 6 (Instrumented Series Production Aircraft) for Kuwait and Qatar, based on their purchase orders.

Originally, the TYPHOON was developed as an air-superiority fighter to counter the MiG-29 and Su-27, with little emphasis placed on weapons integration for the air-to-ground role. For this reason, the above-mentioned EW version was not a trivial development as it required substantial modification, including modifications to switch inboard wet pylons to mounts for external fuel tanks for the standoff jamming-pods. For that reason, in November 2019, the consortium pre-

Photo: Eurofighter

The modernised EUROFIGHTER will replace Germany`s obsolete TORNADOs.

sented both a dedicated EW/attack version and a simpler SEAD variant requiring fewer modifications. To add to the challenge, the type would require certification for the B61 tactical nuclear weapons that are stored in Büchel, as was the case with the TORNADO. That task could take some time to complete and would require the European defence industry to forward potentially sensitive coding information to US agencies and companies. Should the EUROFIGHTER consortium refuse to share relevant data on the aircraft's weapon control system, the type may see itself restricted in B61 mod 12 use, comparable to how legacy platforms deploy the weapon, with locked tailkits in a non-guided mode, which is mandated by the non-digital nature of the current F-16 and TORNADO fleets.

Photo: Georg Mader

The EUROFIGHTER offers a number of integrated weapons options.

RAFALE

This other excellent European fighter has never been faced with similar discussions and restrictions as it has been nuclear wired for the French Force de Frappe from its inception. The RAFALE was created when France abandoned the early EFA project which ultimately led to the TYPHOON. Not surprisingly, their replacement for the venerable MIRAGE turned out to be very similar. While many other European countries have opted, or are opting for a US solution for their future fighter needs, France remains loyal to its domestic aerospace industry, just like Sweden. The French military has a standing requirement for 286 Dassault RAFALEs, consisting of 118 single-seat C-models and 110 dual-seat B-models for the French Air Force, plus 58 single-seat carrier-borne M-variants for the French Navy. When it comes to exports, RAFALE made a late but very French take-off when it only accrued orders from abroad two decades after being introduced. Deliveries of these exports have consequently caused interruption or have resulted in shifted production for the French forces.

According to Dassault's FY 2019 figures, Qatar has exercised an option for 12 addi-

Photo: Georg Mader

A GRIPEN-D parked at Satenas Airfield

tional RAFALE fighters, adding to a previous commitment for an earlier 24 aircraft (18 + 6). Egypt has meanwhile received the first 24 of a total 36-strong fleet, while deliveries to Ambala of the first four or five out of 36 (30 + 6) jets for India are imminent, unhampered by COVID-19. In FY 2018, the company delivered 12 fighters (9 export and 3 for France), a figure that more than doubled to 26 in 2019. In December 2019, the backlog for the RAFALE stood at 75 aircraft (47 exports and 28 for France, that will be handed over from 2022 due to the export commitments). A year earlier, the backlog was 101 jets (73 exports and 24 for France). All these aircraft are being assembled at a relatively small facility which has an output rate of 11 aircraft per year.

But there might be more orders coming in soon. Next to the Swiss market, and with 36 jets under production for India, Dassault is in a strong position to implement the largest fighter order in the industry, namely an Indian contract for 114 multi-role jets. While this has been going on and off with contradictory statements for two years, the Indian Navy – unhappy with the power/payload-weight ratio of the Naval TEJAS – issued an RFP of its own in May 2017, for 57 carrier-capable fighter aircraft. This could only mean F-18F or RAFALE (and MiG-29K), but while not much has since been heard about this project, the author spoke to the Indian DRDO and the Indian Navy is still eager to replace its unreliable MiG-29Ks. To replace these MiG-29s, Dassault was also very active in Malaysia in 2017, but this has failed, just as it did in the UAE, where in late 2019, a €1Bn modernisation contract for the MIRAGE-2000/9s was signed instead.

In terms of the type's subsystems development work, Dassault is now working to develop the F4 standard of the RAFALE under a €1.9Bn contract awarded in January 2019. Once development is complete, its retrofit to the 152 jets already delivered to the French Air Force and Navy will generate additional revenue. F4 means implementing innovative connectivity solutions to optimise the effectiveness in networked combat (new satellite and intra-patrol links, communication server, software-defined radio) and new functions to be developed to improve the aircraft's capabilities (upgrades to the radar and front sector optronics sensors, helmet-mounted display capabilities). Also covered are new weapons to be integrated (MICA NG air-to-air missile and 1,000 kg AASM Air-to-Ground Modular Weapon). Validation of the F4 standard is scheduled for 2024, with some functions becoming available as of 2022. Qatar's aircraft differ in detail from those delivered to France and Egypt, as they incorporate a Lockheed Martin SNIPER laser designator pod, instead of the French Thales DAMOCLES or the new Thales TALIOS pod now under development. QEAF RAFALEs also have provision for an Elbit Systems TARGO-II helmet-mounted target designation system.

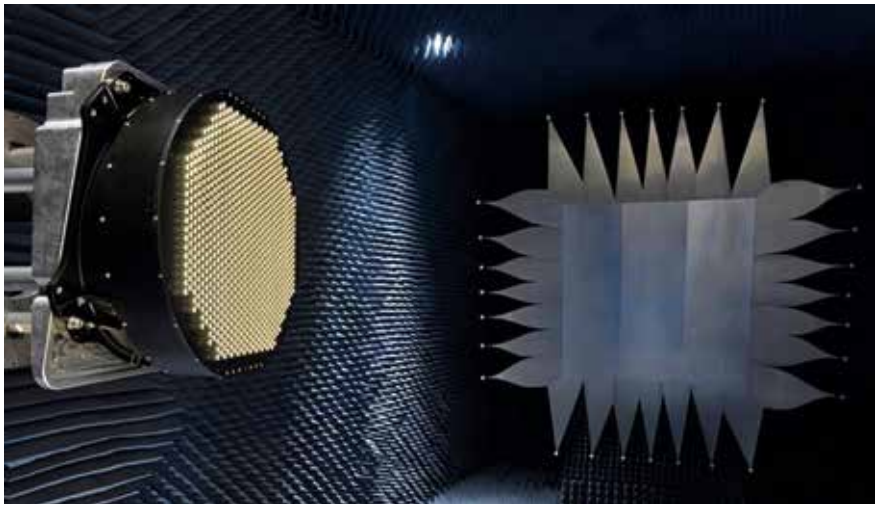
GRIPEN

The original Saab GRIPEN was once purpose-built for Sweden's national defence and datalinks, but its quick reaction alert (QRA) missions, and later added defensive/offensive counter-air or offensive recce roles during NATO's "Operation Unified Protector" over Libya in 2011 for example, have succeeded in convincing other air chiefs.

Currently, the GRIPEN programme has been split into two parts. The main effort in Linköping (Sweden) and Dos Santos (Brazil) has been transferred to the latest – and fifth – version of the JAS-39, the GRIPEN-E. The Swedish Air Force (SwAF) has signed a deal for 60 single-seat GRIPEN-Es (+ maybe 10 more), but no two-seater GRIPEN-F. The latter are so far an issue only for the E-model's first export customer (Brazil), with eight to be designed and largely built there together with the majority of the total of 36 airframes. Due to the introduction of new Russian weapon systems in Sweden's vicinity, it is essential for the SwAF to bring the GRIPEN-E into service in order to remain a relevant player in the Baltic region, capable of defending the nation as well as supporting its partners. In April 2020, the test programme surpassed 300 flight hours and meanwhile, it includes six aircraft and will be expanding to two sites in 2020 involving SAAB test pilots, the Swedish defence materiel administration (FMV) and SwAF. SAAB is preparing to deliver three initial-production aircraft in 2020. Current plans are to have an Initial Operational Capability (IOC) in 2023 and a Full Operational Capability (FOC) in 2026/7.

During the roll-out in May 2016, the new model was described to the author as a giant smartphone with two separate software systems designed not to allow future capability apps to interfere with the flight-control software and other basic systems. SAAB

Photo: SAAB



AESA antenna testing for GRIPEN PS-05A radar

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

From Left-Field...

Although not a European product, EMBRAER's A-29 SUPER TUCANO has significant potential in Europe. The aircraft combines its intrinsic Light Attack & COIN characteristics with embedded synthetic training that can simulate threats, targets and other aircraft, making this one of the best advanced turboprop trainers in the market. It is highly manoeuvrable, has a low heat signature and incorporates 4th generation avionics. It carries a wide variety of weapons, including precision-guided munitions incorporating the latest EO/IR pods with Laser Designation. It is also NVG compatible and has the option of carrying Chaff/Flare dispensers. Its design incorporates ruggedised fuselage and landing gear, and low maintenance requirements were "built in", making it ideal for operations in extreme conditions in places like Afghanistan, Lebanon, Mali and Mauritania, where it has already proven its qualities. From concept onwards, the A-29 design focussed on low operating cost, creating a low-cost system operating in low-threat environments. In addition to manufacturing in Brazil, EMBRAER has set up a production line in the US in conjunction with Sierra Nevada Corporation, to manufacture A-29s for many export customers. At present, 230 SUPER TUCANOs have been delivered, of more than 250 sold to 15 nations. In August 2019 a Ukrainian military delegation led by Col. Gen. Sergey Drozdov visited EMBRAER's military division in São Paulo. An Su-25 pilot flew the SUPER TUCANO, and interest emerged in purchasing the aircraft through a US government FMS. In October 2019, Ukrainian President Volodymyr Zelensky, in a meeting with Brazilian President Jair Bolsonaro, stated that his country would buy the A-29. That deal could have been announced during Zelensky's visit to Brazil in the first half of 2020, but looks to have been delayed due to Covid-19 travel restrictions. There were also discussions with Sweden to replace their Sk60s, when Brazil chose GRIPEN-E. The same applies to Portugal, which is a manufacturing partner of EMBRAER for the C-390 transport.

Photo: Derember Studios LLC

A Nigerian A-29 in Desert Paint

enhanced the GRIPEN-Es fused sensor-suite and decision-support capabilities. So far, the AESA-radar, passive infrared search and track (IRST) sensor, tailored datalink and multi-function electronic warfare (EW) system "are performing better than expected", according to a SAAB spokesman. Testing has also included an electronic jammer pod to complement the EW system, flights with the long-range MBDA METEOR BVR AtA missile and firing of the short-range infrared-guided IRIS-T.

In 2019, SAAB suffered a setback in Switzerland when a public referendum rejected the GRIPEN-E which had been selected in 2014 and which had to be withdrawn due to Swiss requirements to reflect an operational or fielded status, which could not be demonstrated during the flight-test programme. And then there is Finland, where SAAB is sweetening the selection of the E-model for 60+ aircraft by offering to add its unique GlobalEye multirole AEW&C platform.

Photo: Georg Mader

A Serbian UTVA KOBAC aircraft at Batajnica in 2019. Successor to the LASTA 95, the KOBAC is designed for full combat operations.

Regarding the minor part of GRIPEN activities, these are related to the earlier GRIPEN-C/D. The 2019 "Swedish Defence White Paper" called for the earlier GRIPEN C/Ds to remain operational during the 2020s with 60 of them past 2030, with the D-models the last to be retired. The SwAF has introduced its latest edition, MS20, adding many capabilities, especially when it comes to air defence. The SwAF was the first air force operating the METEOR missile, once regarded as a game changer due to its long endurance and agility.

The latest add-on to the 'C/D' was announced in April 2020 – an AESA antenna for its PS-05/A fighter radar offered as an upgrade option for current C/D-operators (and other legacy types). This might well attract users such as the Czech Republic (their GRIPEN leasing runs until 2027), Hungary, Thailand and South Africa. With regard to Saab's other lengthy export campaigns in Europe, it experienced considerable frustration because, although already selected, after changes of governments, Slovakia, Bulgaria and Croatia reversed their earlier decisions and opted instead for F-16 solutions. Meanwhile, Croatia has again changed its mind and has invited renewed bids for 12 jets.

Light Attack Aircraft

Since 2001, in operational scenarios, especially in those with a low-medium threat level, modern and expensive 20 to 30 tonne-class fighters are often used with high operating costs. Generally, these are Close Air Support (CAS) missions in urban areas and battlefield air interdiction, as well as Homeland Security and air policing, tactical recce and support for combat SAR operations, where the use of low-cost aircraft equipped with on-board radar, a state-of-the-art target-designator pod, advanced self-protection systems, datalink and air-to-air refuelling capability would be enough.

Not surprisingly, this segment is increasingly prominent internationally but not truly reflected by efforts of the main European manufacturers – with three notable exceptions. Italian giant Leonardo presented the M346FA in Dubai 2017 as the latest iteration of their successful M346 MASTER advanced trainer (AJT) – or an evolution of the dual role fighter-trainer version, designed to meet air forces' growing and diversified operational requirements. The -FA is advertised as an extremely effective and low-cost seven-hardpoint tactical solution for the modern battlefield, as it offers the most effectiveness with all the AJT-features, including their advanced and virtual training capabilities. GRIFO X-band radar equipped

Natural Role Equipment Partner for FCAS

ACMA Can Supply Substantial Sub-Systems for the Future Combat Air System (FCAS)

ACMA has been responsible for the development and management of advanced role equipment for the EUROFIGHTER TYPHOON since 1989. Together with our shareholder AEREA, ACMA provides almost all of the role equipment of the EUROFIGHTER weapon system.

ACMA is "a typical child" of the EUROFIGHTER TYPHOON programme. During the development phase of the EUROFIGHTER, the so-called role equipment, which is required as an additional device for the respective aircraft mission, was developed and manufactured by numerous companies. To optimise industrial processes, ACMA was founded as a joint company for four nations. ACMA's task is to coordinate the work of the various companies that develop and manufacture the components, and to offer the products on the world market. ACMA was founded in 1989 by AEREA (Italy), CASA (Spain), MBB (Germany) and MEL Aviation (United Kingdom). Today, the company based in Ottobrunn is a 50:50 joint venture between Airbus Defence & Space and AEREA SpA.

With more than 30 years of experience and the industrial skills and technological capabilities of our industrial cooperation partners and shareholders, we are one of the most competent role equipment providers worldwide.

As a management company, ACMA brings together the capabilities of six European suppliers to provide the MFRL and the TEU as fully integrated and highly complex sub-systems for carrying and firing all common air-to-air missiles and to carry and drop the 1,000 litre tank. This is how we ensure that the EUROFIGHTER can fulfill its missions and operations.

The Multi-Function Rail Launcher (MFRL) is part of the Armament Control System (ACS) of the EUROFIGHTER. The MFRL is used to carry and fire air-to-air guided missiles such as AIM9-L, ASRAAM, AMRAAM and IRIS-T. The MFRL is the only widespread rail system in service in the world that can handle all currently available air-to-air guided missiles from NATO.

The Tank Ejecting Unit (TEU) is a sub-assembly of the Supersonic Fuel Tank (SFT). It is built into the pylon structure of the tank. The function of the TEU is to hold the fuel tank with a capacity of 1,000 litres on the aircraft. A pyrotechnic dropping system is integrated into the TEU to enable safe dropping of the tank on the pilot's orders. The advantage over the pylon and bomb rack-based tank discharge system that is normally used is that the aircraft remains "clean" after the tank discharge without aerodynamically disruptive structures.

ACMA has delivered the MFRL and TEU systems as fully integrated, highly complex and easily interchangeable subsystems now for 30 years to cost, quality and time in line with the contract for development, series production and service support. Based on our years of experience and our technological know-how, we can ensure that the mission performance of the combat aircraft that use these devices can be fulfilled.

Graphic: ACMA

ACMA's Future Business: Partner for FCAS

In addition to our daily core business, we are currently preparing to develop weapon carrying and release equipment for the Next Generation Weapon System (NGWS), which is at the core of the Future Combat Air System (FCAS). As a long-standing and highly qualified supplier for the EUROFIGHTER, ACMA is natural partner for the FCAS. Since we enable EUROFIGHTER to fulfill its operational capability, it is a straightforward step for ACMA and its shareholders to give the NGWS their experience and know-how within the FCAS framework for carrying and firing guided missiles.

Based on the FCAS specifications, ACMA has developed a completely new concept for carrying and firing air-to-air and air-to-surface weapon systems. ACMA integrates this in close cooperation with the weapon developer and the platform carrier. In accordance with the requirement that the new aircraft has a low-visibility profile (stealth) and fires weapons at very high speeds, ACMA has developed a special rail concept. This makes it possible to carry the weapons in the aircraft and to fire the weapons without opening bomb bay doors.

In addition to the fulfilment of the demand to fire weapons from a closed bomb bay at high speed, the concept offers – with sufficient space in the aircraft – a combination of reloading functions with additional weapons and fuel. This allows the NGWS all air-to-air, air-to-surface or air-to-sea missions in the various ranges in stealth mode.

The integration in the layout of the avionics systems is just as important as the physical integration of the weapons with the platform. The weapon carrying and firing system should be able to manage the weapons after target allocation independent of the platform's avionics. This essentially offers the opportunity to meet NATO's demands for standardisation of weapons regardless of the platform on which the weapon is carried.

and advertised as a modern, affordable Red Air (aggressor), it was demonstrated to several Gulf and Central Asian states. Reportedly, Azerbaijan selected it, but as of yet, no contract has been announced. In 2019, Leonardo CEO Alessandro Profumo announced the sale of six -FAs but did not mention the customer.

COVID-19 restrictions have slowed efforts to sign a G2G deal with Austria to replace their obsolete Saab-105s. While favoured by Austrian AF officers, it seems that there is little political will in Vienna to go ahead with the deal.

Another manufacturer with a long tradition is Aero Vodochody in the Czech Republic. In the footsteps of the thousands of L-29 DELFIN and L-39 ALBATROS jet trainers built at Odolena Voda to the north of Prague, in October 2018, AERO rolled out the prototype of the latest version of the L-39NG (Next Generation). It conducted its maiden flight on 22 December 2018 and is also marketed for light-attack. The type will complete its flight test programme in mid-2021 and receive Light Attack type certification in Q3 2021. It was a considerable boost, when Senegal's President Macky Sall in April 2018 announced a contract for four of these aircraft. Other prospects are Red Air companies in the US and Portugal or the above-mentioned Austrian Saab-105 replacement. Another more distant project presented in 2018 by Aero and IAI (Lahav Division) is introducing the multirole light-fighter F/A-259, then oriented towards the USAF OA-X requirements

Photo: QEAF

A RAFALE in Qatar's camouflage colours

Photo: Dassault Aviation

Probable Rafale production 2019-2023

Year / Customer	2019	2020	2021	2022	2023	TOTAL
Egypt	1	0	0	0	0	1
Qatar	13	12	11	?	?	36
India	12	12	12	?	?	36
France	0	0	0	>12	>12	>24
TOTAL	26	24	23	>12	>12	>97

(Source: Dassault Aviation)

The Turboprop Segment

When it comes to turboprops, Serbia's Pančevo UTVA factory surprisingly presented a light-attack version of the Serbian LASTA trainer dubbed KOBAC. Marketed since 2019 by the state-run Yugoimport agency, KOBAC is a two-seat training/light-combat or COIN (counter-insurgency) aircraft, but now with a turbo-prop engine instead of a piston engine. It comes with five hardpoints under the wings and one under the belly, providing a total ordnance weight of 500 kg. This could be pods with 7.62mm and 12.7mm MGs and 20mm MCs, multiple rocket launchers, bombs and guided missiles. Equipment includes an advanced nav/attack-system, optoelectronics with a day camera and thermal imager, and a laser range finder. Not much has been heard of KOBAC, but Yugoimport states the aircraft is oriented towards customers such as Iraq, Algeria, Angola, Kenya and Uganda.

Photo: Georg Mader

A fully armed M346FA

There will be only one

In summary, it seems that European fighter programmes will struggle to survive as they are no longer financially viable in the post COVID-19 era. Looking to the future, most countries' industries are being offered a chance to support one of the two mentioned European 6th-Gen. fighter options. And both will also have to compete with a US FA-XX solution and whatever players such as China might bring to the table. Therefore, we leave the last words to Dirk Hoke, CEO of Airbus Defence and Space: "We need to get our act together for a common European approach, not a national approach. I believe both FCAS sides in Europe need to make compromises. We will all benefit if we find a collective solution on how we approach defence. If we prolong with two competing major defence projects, competing for our nations' involvement and supply chains, we will go under in fighting each other for small sales again. It is unacceptable that such a prohibitive situation should occur again". ■


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EUROFIGHTER Ready for a Leap Into the Future

Esteban Villarejo

The future of the EUROFIGHTER TYPHOON rests on four pillars: modernisation of the aircraft; expected contracts from two core nations in the programme (Germany and Spain); deliveries to Qatar and Kuwait which will keep the production lines open at least until 2024; and the ongoing export campaigns with Switzerland and Finland as main targets.

"Our core nations have acknowledged the advantages of an integrated fleet concept by developing the EUROFIGHTER in line with the evolving threats as well as future newly introduced systems. From industry side we are supporting this effort by ensuring the latest technology makes its way into the EUROFIGHTER, and that in turn will allow it to maintain its superior position vs today's and tomorrow's threats", an Airbus Defence and Space source told ESD.

Graphics: AIRBUS DS

The integration of the Mk1 E-Scan radar is a bi-national programme involving Spain and Germany

Upgrading the EUROFIGHTER fleet

The goal of the phased enhancements is to ensure the superiority of the EUROFIGHTER by addressing four different yet complementary aspects:

- Ensuring superiority in the current roles
- Introducing new capabilities to fulfil new roles
- Obsolescence removal
- Modernising the weapon system

The Phase 2 Enhancements are entering into service which include capabilities like the fully digital integration of the air-to-air METEOR or the air-to-ground STORM SHADOW missiles. The engineering departments are currently working on the Phase 3 Enhancements which as a highlight features the integration of the air-to-ground BRIMSTONE 2 precision missile and the new E-Scan Radar, which brings in a new era when it comes to sensor capability.

Airbus DS wants to introduce the E-Scan Radar Mk1 in part of the T2 and the entire T3 fleets of Germany and Spain starting in 2022. This adaptation will imply improvements in: multiple and simultaneous air-to-air and air-to-ground threat detection, attack and identification; Synthetic Aperture Radar (SAR) modes; transmission of images; electromagnetic defensive measures; and integration of smart weapons.

The integration of the Mk1 E-Scan radar is a bi-national programme involving Spain and Germany to start in 2022 in the Luftwaffe fleet. It will bring a significant improvement in fast searching and tracking (longer range and wider field of regard) of multiple air and ground threats and will include electronic warfare functions.

Airbus DS and its industrial partners Leonardo and BAE Systems will also introduce significant enhancements to the DASS (Defensive Aids Sub-System) and the most modern Targeting Pods LITENING IV and SNIPER.

"The E-SCAN Mk1 programme provides Germany & Spain full national radar sovereignty in system and equipment", said Kurt Rossner, Head of Combat Aircraft Systems, during a media event in 2019. "Our mission is to enable the retrofit and upgrade of up to: 110 Tranche 2/3 German aircraft starting in the second quarter of 2022, and 19 Tranche 3 Spanish aircraft starting in the third quarter of 2022", he added.

Regarding the E-Scan radar, on 25 June 2020, Airbus was awarded a contract for the development, supply and integration of 115 EUROFIGHTER E-Scan radars for the German and Spanish EUROFIGHTER fleets. This marks the largest order to date for the world's most modern electronically scanned array radar, CAPTOR-E. The contract signature followed the approval by both governments in recent weeks.

The contract foresees the delivery and integration of 110 CAPTOR-E radars for Germany and an initial batch of five radars for Spain to be delivered by 2023. The new sensor will equip Tranche 2 and Tranche 3 EUROFIGHTERs, as well as new aircraft. Whereas the Airbus sites in Manching, Germany and Getafe, Spain, will act as overall integration hubs, the development and building of the

radar will be subcontracted to a consortium under the leadership of Hensoldt and Indra with participation of further EUROFIGHTER partner companies.

"The contract for the CAPTOR-E radar is a main achievement to equip the EUROFIGHTER with sensors that ensure today's dominance of the aircraft, also taking into account the threat scenarios of tomorrow," said Dirk Hoke, CEO of Airbus Defence and Space. "With the EUROFIGHTER, Germany and Spain are investing in a strong backbone of European air defence and in the leading project of the European defence industry."

This retrofit programme will pave the way for the Long Term Evolution (LTE) until the arrival of the Future Combat Air System and Electronic Warfare capabilities. This is one of the key questions why it is so important for Airbus DS and the partner companies. In May 2019, EUROFIGHTER, Eurojet Turbo and NETMA (NATO EUROFIGHTER and Tornado Management Agency) signed contracts worth a total of €53.7M to initiate the studies and risk reduction phase of the LTE for the EUROFIGHTER.

Part of this upgrade is the "Quadriga" project that will replace the German Tranche 1 Fleet. This initiative of the German MoD will produce 38 new EUROFIGHTERs (7 Twin Seater / 26 Single Seater + 5 Single Seater optional). The aircraft standard shall include the Mk1 E-SCAN Radar including a new multichannel receiver.

"With the introduction and embodiment of the E-Scan Mk I (and Mk II) TYPHOON AESA Radar systems the sensor and task management requirements of future battle space connected operations are one significant step closer to being met. To keep up with the pace of change it is paramount to introduce operational changes quicker and independent from safety related system modifications that are bound by regulatory rules. Application and software-based capability insertion will enhance speed and ease of upgrades. A task-based mission system architecture will facilitate this further", an Airbus DS spokesperson explained.

As part of this roadmap, "we are already looking at the next enhancement packages, with Phase 4 Enhancements (P4E) being currently in definition, aiming to expand the spectrum for the current operational roles as well as enabling new ones, such as SEAD/DEAD missions (Suppression/Destruction of Enemy Air Defence).

P4E will, however, probably be the last traditional enhancement package prior to LTE: "We are likely to see a paradigm shift in order to ensure compatibility with FCAS". This requires different aspects: Wider waveband and more secure communication links, new missions/roles, increased range and persistence, higher survivability, and a higher speed of technology/capability introduction thanks to an open SW/modular Avionics Architecture.

"Likewise, without the possibility of leveraging mature LTE capabilities in EUROFIGHTER first, the Next Generation Weapon System (NGWS) development challenge will be greater in terms of technology maturation and certification with higher costs and the possible risk of obtaining a weapon system in 2040 that is less capable than desired".

With the electromagnetic spectrum gaining more relevance, the ECR (Electronic Combat Role) will be an essential contribution to the future battlefield. This is part of a collaborative German industry approach under study. It will have the possibility to combine Escort and Stand-in Jammer roles.

With this P4E package to be complemented and augmented with LTE the EUROFIGHTER TYPHOON will be ready to seamlessly interoperate within the FCAS with the New Generation Fighter. Besides, the EUROFIGHTER TYPHOON LTE will be at first a test bed, maturing futuristic capabilities and finally will be a fundamental pillar in the future FCAS architecture.

On the British side, having delivered enhanced weapons capability as part of the Project CENTURION upgrade, BAE Systems is now looking at the next step in the TYPHOON's capability evolution. "This will include investments in radar, communications, data management and connectivity which will ensure TYPHOON is future-proofed well in to the 2060s. Through its evolution, TYPHOON will be

A Core Supplier

The modernisation of the EUROFIGHTER relies on other industries and companies apart from the main actors (Airbus DS, BAE Systems or Leonardo). This is the case of Collins Aerospace, a unit of Raytheon Technologies Corp that has been operating in Germany for more than 50 years. Avionics for fighters is one of its key capabilities. "Collins Aerospace in Germany also provides integrated navigation and communication systems for a wide range of military applications", Axel Schumann, managing director of Collins Aerospace in Germany, explained to ESD.

Photo: Collins

A Collins Aerospace Helmet Mounted Display System (HMDS)

They are involved now in the new technologies to provide the Long Term Evolution of the EUROFIGHTER. "We are a core supplier for EUROFIGHTER mission computers and we have a product line that uses a common core concept to cover a wide range of platforms and applications, from low cost up to high reliability", Schumann said.

at the heart of developing and deploying technologies which will become part of a future combat air system, making it the perfect interoperable partner for Future Combat Air Systems".

Expected Contracts in Germany and Spain

Apart from the Quadriga project to replace the German Tranche 1 Fleet of EUROFIGHTERs with 38 new aircraft, the German MoD seeks to replace its ageing TORNADO fleet by 2030.

The German Minister of Defence, Annegret Kramp-Karrenbauer, has just proposed the purchase not only of 93 European EUROFIGHTER aircraft but also 45 American Boeing F/A-18E/F SUPER HORNETs/EA-18G GROWLERs, intended in particular to keep the NATO/DCA role of part of the German TORNADO fleet which can carry B-61 nuclear bombs. Neither EUROFIGHTERs nor F/A-18 E/F SH were originally designed for this strategic capability. However, there is an arguable belief at the German MoD that such a new integration would be faster with the American fighter bomber than on EUROFIGHTER.

On the Spanish side, the Ejército del Aire will progressively replace 85 F-18 HORNET between 2025-2035. "The EUROFIGHTER is a solid candidate for the replacement of the F-18 deployed in Zaragoza, Madrid and Canary Islands", a Spanish Air Force spokesperson said.

The final decision is also linked to the possibility of reinforcing the industrial capabilities of Airbus DS in Spain, starting with a first batch of 20 aircraft under the programme name of Halcon, replacing the ageing squadron of F-18 HORNETs in Gando Air Base (Canary Islands). Of course, for the subsequent batches there could be two other US-made candidates, the F-18 SUPER HORNET by Boeing and F-35 LIGHTNING II by Lockheed Martin.

Therefore, these two core nations of the programme have emerged as the next great opportunity for the EUROFIGHTER and for the enhancement of their current fleet: Germany (141) and Spain (70). Both countries have received their last T3 aircraft from the factories.

Deliveries to Qatar and Kuwait

In total, 623 EUROFIGHTER TYPHOON have been ordered: 160 aircraft for the UK, 143 for Germany, 96 for Italy, and 73 for Spain. Added to these are export orders amounting to 15 aircraft for Austria, 28 for Kuwait, 12 for Oman, 72 for Saudi Arabia, and 24 for Qatar. The deliveries for Kuwait and Qatar are especially important because they will allow the factories lines to remain open at least until 2024. This is essential to bridge the production until the new German and Spanish EUROFIGHTERs can be produced.

Under the deal, Kuwait will receive 22 single-seat and 6 twin-seat aircraft, which will be assembled in Italy by Leonardo. Kuwait is set to receive its first batch of EUROFIGHTER TYPHOON fighter jets in the fourth quarter of this year. This batch will include the CAPTOR E-Scan radar (part of P3Eb), the most advanced EUROFIGHTER ever delivered. The contract is worth US$8.7Bn.

On the other hand, Qatar signed with BAE Systems a US$6.8Bn deal for 24 EUROFIGHTER TYPHOON. The Qatar deal includes the supply of a weapons package covering MBDA-built BRIMSTONE 2 ground-to-air and METEOR beyond-visual-range air-to-air missiles as well as Raytheon's PAVEWAY IV precision-guided bombs. The first of the 24 aircraft are expected to be delivered to Qatar in late 2022.

New Opportunities: Switzerland and Finland

For Switzerland, Airbus Defence and Space proposed up to 40 EUROFIGHTER as replacements for the F/A-18 HORNET and F5 TIGER. The selection by the Federal Council is awaited for early 2021.

According to Kurt Rossner, Head of Combat Aircraft Systems, these 40 EUROFIGHTER for Switzerland would have identical configuration as German Quadriga project: "The joint procurement ensures economic benefits for Switzerland, too. EUROFIGHTER offers full autonomy in mission data and technology access for Switzerland. The EUROFIGHTER is an ideal platform for air policing requirements in challenging Swiss topography and airspace". This is an export campaign led by Germany with Airbus DS.

As for Finland, in January 2020, the Finnish Air Force began the flight test evaluation of the EUROFIGHTER TYPHOON as part of the programme to replace the 55 Boeing F-18 HORNETs whose service life ends by 2030. This is an export campaign led by the UK with BAE Systems. Contenders to replace the F-18 fleet include Lockheed Martin F-35, Boeing F/A-18 SUPER HORNET, EUROFIGHTER TYPHOON, Dassault RAFALE and Saab GRIPEN. A final decision is expected in 2021 with a contract valued at €10Bn.

And then there is Colombia. The Colombian Air Force needs to replace its 23 Israeli-built KFIR C-10/C-12/TC-12 multirole combat aircraft, in service since 1989. Bogotá has studied different options, including the GRIPEN NG and the F-16 Block 50. The EUROFIGHTER TYPHOON consortium has also offered to sell 15 EUROFIGHTER Tranche 3 fighters (12 one-seat and 3 twin-seat) to Colombia. This is an export campaign led by Spain with Airbus DS.

There is another option: the sale of 17 second-hand EUROFIGHTER Tranche 1 fighters from the Spanish Air Force that would later be modernised (to Tranche 2) by Airbus DS in Getafe (Madrid) factory to be used later by the Colombian Air Force. ■

One-Stop Information and Communication

The availability of information across all subsystems and the deployed battlegroup is crucial when it comes to obtaining the optimal overview of the situation. This is where IT company ATM and its system solutions come in. ATM networks communication participants and tactical applications as well as sensors and subsystems.

Photos: ATM

ATM develops display and panel PC systems as well as system control units in sizes from 7" to 17", which also comply with SILs in accordance with DIN EN 61508.

Central Information Node

Within vehicles, the ATM CENTURION i7 vehicle server takes on this task. As the central node in the network, the CENTURION i7 receives, uses and disseminates information from various sources. Bringing all the information together on a standardised software interface and displaying it on the ATM VistaMaster or the PALLADION panel PC increases situational awareness.

As the VistaMaster and the PALLADION can be adapted to a particular workstation, it is suitable for use in a whole host of tasks:

- As a display, slave display and rear display only
- As a display with terminal function
- As a central control and display unit

Resistive single-touch or capacitive multitouch technology helps soldiers to operate the touchscreen. If potentially safety-critical equipment is involved, ATM applies functional safety in accordance with DIN EN 61508 and meets the requisite safety integrity level (SIL).

The CENTURION i7 is a powerful computer for land combat vehicles.

Central Communication Node

To gain information superiority, the ATM KommServer connects all units and command stations in a communication network. In its central intelligence role, the KommServer links both existing and future heterogeneous, narrowband and broadband radio and wired networks. The KommServer is therefore what makes the communication technology infrastructure available in the first place. In network-centric warfare, the Tactical Service Provider proves to be the backbone of tactical communication.

The Tactical Service Provider from ATM handles the interoperable exchange of information from user to user. As the central element in the communication network, it creates a self-organising, mobile ad-hoc network, which it uses to integrate all transmission resources into a homogeneous and fundamentally IP-compatible network.

The Tactical Service Provider and the hardware basis provided by the KommServer can also adapt to meet the needs of future communication media and software functions.

The ATM communication server safeguards communication for the armed forces.

Maintenance of Functions

With its life cycle software solutions, ATM is helping to keep maintenance work in check both during operations and once they are complete. Simple and intuitive tools provide assistance with diagnosis and maintenance in the following areas:

- Function monitoring during operations
- Installation, configuration and backup by administrators
- Maintenance, fault localisation and function testing by repairers

System Solutions for Unrestricted Operability

As an IT interface between the vehicle, operator and external communication participants, ATM's IT systems and life cycle solutions guarantee unrestricted operability in all situations.

European UAV/UAS Requirements

Giulia Tilenni

Military operations over the last decade have highlighted how important it is to have Unmanned Aerial Vehicles (UAV) in the inventories of armed forces. Although UAVs are still one of the major requirements of European armed forces, the need to fill capability gaps resulting from years of low defence spending has somehow slowed down the procurement and development of UAVs in a field where Europe was already lagging behind.

Recent high and low intensity global conflicts have once again demonstrated the added value that UAVs offer armed forces. Compared with manned aircraft, UAVs are cheaper in terms of acquisition and operating costs, and safer due to the lack of personnel on board. UAVs are also a useful means of collecting huge amounts of information in 4D scenarios (Dull, Deep, Dirty and Dangerous). They have already demonstrated their remarkable capabilities for ISTAR (Intelligence, Surveillance, Target Acquisition and Reconnaissance) and armed ISTAR missions. The improved situational awareness they bring has a positive impact on both mission planning (commanders gather more information) and the military operations themselves (as UAVs provide immediate air support to ground forces), making them an important force multiplier. The existence of three UAV classes (less than 150 kg, between 150 kg and 600 kg, over 600 kg) allows users to choose the most cost-effective solution for their operational requirements and budget. However, weight and size also tend to determine the technical features – such as maximum service ceiling and range – and are decisive for the choice of payloads on board. As a result, each class typically provides a different type of user support – operational, tactical and strategic. Compared with manned aircraft, MALE (Medium Altitude, Long Endurance) vehicles are the most powerful and cost-effective. Taking all this into account, most countries and the most powerful terrorist groups have decided to expand the use of these means, both armed and unarmed.

European countries follow this general procurement trend, with France, Italy, Germany and the UK being the main users and trendsetters in terms of operational requirements and development of cooperative technologies. European countries have gained relevant first-hand experience of UAVs in combat operations during the operations in Afghanistan, Iraq and Libya. UAVs operated by the US in the two Middle Eastern countries have allowed for acquiring relevant information and neutralising threats without putting troops on the ground at risk, a significant advantage due to the high number of IEDs (Improvised Explosive Devices) used in these operations. The military mission in Libya in 2011 confirmed the importance of UAV-carried ISR missions, and suggested that unmanned technologies would have been the best solution to fill the long-lasting capability gap in this domain, which first emerged in the 1990s during operations in the Balkans. It is important to recall here that the redeployment of US unmanned assets was necessary in Libya to support the missions led by European countries due to the lack of relevant ISR assets.

European countries have drawn two main lessons from these experiences: the advantages that UAVs bring, especially in operations carried in non-contested airspace, and the need to acquire their own UAV fleets to increase their independence from Washington.

Photo: Airbus

A full-size mock-up of the Airbus EuroMALE unveiled at the ILA Berlin Air Show in 2018

Which UAV to Go for?

Almost a decade later, most European countries have UAVs in their inventory. Ideally, technologically advanced armed forces should have a diverse fleet of UAVs in their inventory, so that they are able to select those that best suit their operational scenarios on a case-by-case basis. However, UAVs weighing more than 150 kg are still a rather costly commodity, which limits their purchase in times of budgetary constraints. As a result, the lightest models are most common among European armies, navies and special units, while tactical and strategic vehicles (on which we will focus because of their greater operational effectiveness) are only used in a limited number of countries, particularly in armed versions. Now that the number of European users has increased, a divisive issue remains: the choice between domestic and Israeli and/or

Author

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Photo: SAFRAN

The PATROLLER UAS is currently entering service with the French Army's reconnaissance forces.

Photo: German MoD

HERON UAS are used by defence and security agencies of ten nations.

US off-the-shelf products. Most countries have opted for mixed solutions, which may even include leasing options (as is the case for France, Germany and Greece).

The issue of off-the-shelf procurement encompasses strategic, political and industrial considerations that are even more relevant in the case of armed UAVs (also known as UCAVs). For about a decade, the US has been the main exporter of these technologies and has imposed strong policy constraints on the procurement of military equipment. On the one hand, European countries are still the main users of the MALE drones produced by the US. For example, France, Italy, the Netherlands, Belgium (SKYGUARDIAN version), Spain and the UK are currently the only foreign users of MQ-9 REAPERs, with India being the first non-European buyer. Other allies of the US, such as Saudi Arabia and (perhaps) Turkey, were not allowed to buy it despite their formal requests.

However, flying American equipment can be a major obstacle for European countries. After Washington approved the sale of UCAVs in 2015 (in fact the possibility of arming MQ-9 REAPERs with AGM-114 HELLFIRE missiles), the UK and Italy were the only MQ-9 REAPER users to receive approval from the US Congress to arm their systems, with France following in 2017, several years later.In short, their military capabilities on the battlefield have been affected by political considerations abroad.

In other words, in order to become more independent from the US in terms of ISR capabilities, European countries procured products from the US, somehow increasing their dependence on Washington. As will be further analysed, it is difficult to find a balance between "buy European" and "buy American".

Tactical UAVs

According to estimates, tactical UAVs – those weighing between 150 kg and 600 kg – account for 20% of the global UAV market today. More affordable and easier to operate than MALE UAVs, they represent a cost-efficient compromise for armed forces with limited participation in external operations and/or with budget constraints. But they are also a valid alternative in low-intensity operations for countries operating strategic UAVs as well. When compared with larger models, tactical UAVs are easier to deploy in terms of logistics and can be operated by a land forces' member rather than piloted by an air force operator. Their ability to gather relevant information in areas far from the battlefield is enabled by the array of available sensors – for example, electro optic/infrared (EO/IR) balls, laser designators, radars with Synthetic-Aperture Radar (SAR)/Ground Moving Target Indicator (GMTI) functions, and SIGnal INTelligence (SIGINT) sensors.

Between 2019 and 2020, France, Italy, the UK and Germany updated their tactical UAV fleets with the Safran PATROLLER, the Textron SHADOW V2, the Thales WATCHKEEPER, and the EMT LUNA NG, respectively. Future trends on tactical UAV requirements concern the procurement of unmanned helicopters (considered tactical UAVs according to their operational use) and the possibility to arm tactical UAVs.

VTOL Tactical UAVs

Growing numbers of European states have expressed their interest in acquiring VTOL (Vertical Take-Off and Landing) tactical UAVs despite their limited reliability in harsh conditions. Unmanned helicopters fit well on naval vessels thanks to their capabilities and their size. They are able to gather information across the maritime operational environment and are valuable alternatives to manned ISR missions, but are also deployed for manned SAR (Search and Rescue) and ASW (Anti-Submarine Warfare) operations, depending on their payload. Germany and France have launched dedicated procurement programmes in this field. The OCEAN 2020 programme (Open Cooperation for European mAritime awareNess) demonstrates that the willingness to further develop drones for naval use is in fact pan-European. Launched in 2019, the biggest EU-funded defence programme focusses on promoting joint aspects of maritime operations, including cooperation among different types of manned and unmanned assets, coordinated by command and control systems. A first exercise held in November 2019 involved Leonardo AWHERO and SW-4 SOLO. Unveiled in 2018, AWHERO is a 200 kg class rotary wing UAS with an 85 kg payload, which can be used for both maritime and land operations, and can fly 6 hour-long missions. Leonardo has been able to acquire highly relevant skills in this segment thanks to the purchase, in 2017, of IDS Sistemi Dinamici, an Italian company specialised in VTOL technologies. AWHERO is a *sine qua non* for the Italian Navy for integration on its vessels, but no official procurement procedure has yet been launched.

The SW-4 SOLO is an Optionally Piloted Helicopter (OPH) produced by Leonardo in Poland. It weighs 1,800 kg, with a 450 kg payload, and can fly 6-hour long missions. The maiden flight, with no safety pilot, was concluded in February 2018. This model has been tested with the British Ministry of Defence as part of the Rotary Wing Unmanned Aerial System (RWAUS) Capability Concept Demonstration (CCD) since 2013. Since 2018, the SW-4 SOLO has been involved along with QinetiQ and Thales in the Royal Navy's Maritime Autonomous Platform Exploitation (MAPLE) programme that aims to create an information architecture required to integrate a diverse mix of live unmanned systems into a common operating picture.

Leonardo's UAVs are not the only European products available on the market. CAMCOPTER S-100, produced by the Austrian company Schiebel, is probably the model that has raised most interest among European countries. The Belgian, Norwegian, German, Italian and French navies have all tested this system, which has a 6-hour flight endurance, weighs 200 kg, and can carry a 34 kg payload. Italy was the first European country to operate this system. After a first test campaign in 2012, the Marina Militare and Schiebel signed a contract in 2014 for a one-year lease of one system (consisting of two UAVs) to better evaluate its performance. CAMCOPTER S-100s have been used on board LPD San Giusto to support humanitarian interventions within Operation Mare Nostrum (the Italian operation in place in the Mediterranean before the EU-led operations Triton and Eunavfor Med/Sophia).

In November 2019, the French Armament Procurement Agency (DGA) qualified the integration of the Schiebel CAMCOPTER S-100 UAV on board the Dixmude amphibious helicopter carrier (PHA), marking the first time in Europe that a rotary-wing UAV became fully operational and connected to the combat system of a warship. The Deutsche Marine, which carried out tests in 2008, was expected to buy six CAMCOPTER S-100s to be operated from K-130 class corvettes, but finally abandoned the procurement procedure in 2013. Berlin finally preferred the purchase of the V-200, produced by Saab's subsidiary UMS Skeldar, in 2018. This modular UAV, with a 40 kg payload, can be equipped with VIDAR (Visual Detection and Ranging), which provides enhanced coverage compared with EO/IR systems. These UAVs have been operated by the Spanish Navy in anti-piracy operations since 2013 under a service provision agreement with the company.

Photo: UMS SKELDAR

Germany is acquiring the SKELDAR V-200 for deployment on the K130 class corvette.

As part of its drone system for the navy (Système de Drone Aérien pour la Marine, SDAM), the French Marine Nationale (MN) is seeking a tactical UAV to be deployed onboard the future FDI/AMIRAUX class frigates, with deliveries starting in 2025. MN requires an all-weather, 24/7 system, able to provide tactical situational awareness to the vessel on which it is embarked in any type of maritime operation. The desired features are a maximum 700 kg take-off weight with a 100 kg payload capacity, a 185 km operational range, with a speed of 186 km/h and a 15,000 ft. service ceiling. In summer 2019, MN conducted trials with an optionally piloted demonstrator of Airbus VSR700 rotary-wing tactical UAVs. VSR700 has a 10-hour flight endurance and weighs 760 kg, with a 100 kg payload. The first prototype completed its first flight in November 2019 and trials of the first demonstrator are expected in 2021. Future trials will be made in collaboration with Naval Group, which participated in the design and development of the warship-integrated VTOL system, as well as in the UAV mission system.

Arming or Broadening Fleets

In addition to expanding existing fleets, the impact that tactical UAVs have on the battlefield will probably improve thanks to weaponry. Conflicts in Syria and Yemen have proven that armed tactical UAVs can be a significant force multiplier, even when equipped with improvised bombs. Therefore, for European countries, the main requirement (and technical challenge) is weapon miniaturisation, which would result in an optimal balance between lethality and weight.

In October 2019, during an audition at the Senate, the French Army Chief of Staff, General Thierry Burkhard, officially

Photo: Matthias Kabel

The Schiebel CAMCOPTER S-100 at the ILA Airshow in 2010

confirmed that Safran PATROLLERs will be armed. The French armed forces finally chose the Thales 68mm laser-guided rocket, which already equips the TIGER helicopter, over the air-launched version of MBDA's MMP (Medium Range Missile). Cheaper and lighter than MMP, laser-guided rockets are well-suited for UAVs against targets of opportunity (pick-up trucks, snipers, and so forth) while on-

Photo: Oliver Cabaret

The Leonardo FALCO XPLORER being unveiled for the first time at the Paris Air Show 2019 in Le Bourget.

station. The choice enhances French strategic independence in this segment, as the PATROLLER is mainly produced domestically (90% of components are French made).
Although Italy and UK have not considered this option, both the Textron SHADOW V2 and the Thales WATCHKEEPER can be armed. The first platform can carry Textron FURY lightweight guided weapons, while weapons for WATCHKEEPER have not yet been disclosed.

Providing an EU Response to MALE Requirements

European states have rapidly understood the benefits that pooling and sharing might bring to the development of future European MALE. Working on different national products to respond to similar operational requirements is not a cost-effective solution. Moreover, the limited number of assets each country is expected to buy does not allow for economies of scale. After a decade of R&D on technological demonstrators (for example, nEUROn), two joint programmes could succeed in the next decade. The MALE RPAS programme (previously known as MALE2020) is expected to provide Italy, Germany, France and Spain with armed ISTAR capabilities by 2025 – if a deal on the next phase is reached shortly. Also, France and the UK agreed on developing a joint Future Combat Air System (FCAS) in 2016, but the programme stalled due to Brexit-related issues.
Above all, it is the issue of common requirements that endangers the MALE RPAS programme. According to the full-size mock-up unveiled at the ILA Berlin Air Show 2018, the MALE RPAS would be much larger than the MQ-9 REAPER and would feature a twin-pusher propulsion and a single electro-optical/infrared (EO/IR) sensor. These features seem closer to German requirements, which are mainly focussed on the need to fly in non-segregated air space, also considering the country's posture towards international operations, than to French ones. Indeed, Paris' requirement is a jet-powered model with EW pods and some stealth features, a sort of light UCAV that can fully replace the MQ-9 REAPER. Two main questions are affecting the programme, which is not advancing at the desired pace. On the one hand, the issue of combat capabilities, still debated in Germany, influences both operational capabilities and export opportunities, which would be of utmost importance due to limited intra-European procurement. On the other hand, MALE's ambitions in terms of size are likely to increase the initial cost of the programme by 30% (from the €7bn target set by governments to the €9.8bn estimated by companies), as well as operating costs – a scenario that has already provoked criticism in Paris.
The lack of electronic countermeasures (ECM) is one of the most relevant weaknesses of MALE vehicles, which has limited their use in asymmetric conflicts so far. The increased likelihood of conventional conflicts and the increased military capacities of terrorist groups – as demonstrated by the number of UAVs shot down in Syria or in Libya – makes finding effective countermeasures fundamental. Non-kinetic countermeasures as part of mission payloads are probably the easiest solution to adopt. For instance, the Leonardo FALCO XPLORER, the largest evolution of the existing FALCO and FALCO EVO, is equipped with SAGE, a 20 kg scaleable and modular system able to map the source of active emissions. The system locates emitters and provides electronic situational awareness, advance warning of threats and the ability to activate other sensors.

Final Remarks

Despite its willingness to acquire relevant skills in UAV production in order to achieve strategic independence from Washington while filling ISR capability gaps and relaunching its defence industry, Europe is still lagging behind in class III models. Worse still, the need to recover from decades of poor spending and the preference for cooperation are widening the gap to other countries, particularly China and Turkey, which have started to produce effective UAV models in all segments and at limited cost. For them, export has no strings attached, so Chinese and Turkish products are easily conquering the African and Asian markets. So far, several European countries fly domestically developed, or at least European produced, tactical UAVs, and this trend seems to be confirmed for VTOL tactical UAVs and the development of miniaturised weapons. Consequently, European countries will probably be able to pick EU solutions to respond to their requirements. However, the future is more uncertain when it comes to class III assets. As with the A400 ATLAS, European cooperation can slow down rather than promote joint solutions. The problems outlined for the MALE RPAS programme have already forced Germany to find gap-fillers, and launch a new lease of IAI HERON UAVs, to be redeployed in Afghanistan and Mali in the coming years. Greece, which was already using leased HERON models, made the same choice in May 2020.
As new REAPER systems are delivered to France, the main European countries are again looking abroad for their UAVs, despite the fact that the interest in these technologies has been reaffirmed by their inclusion in EU-funded programmes. Per these considerations, it is hard to envisage that Europe's dependency on foreign MALEs and UCAVs will end soon. ■

The Oncoming Swarm

David Saw

You are looking to attack a high value target or targets. The target in question is well defended and to get to the target you will have to traverse hostile territory. The obvious way to conduct such a mission would be to use airpower, but this approach has risks, you have to penetrate enemy air defences which requires air defence suppression both inbound to and outbound from the target, plus the ability to accurately engage the target to achieve the desired effects. All things considered, you have to devote a significant number of high value assets to this mission, added to which conducting such a mission into the territory of a foreign power is without doubt an act of war. Or, is there another way of solving this conundrum?

Actually, the answer to that question has already been delivered, via the use of swarming Unmanned Aircraft Systems (UAS) by Iran to attack high value oil targets in Saudi Arabia in September 2019. The attacks happened; it quickly became pretty clear who was responsible for the attacks, despite efforts to hide the source of the attacks, and yet in spite of the fact that this was an obvious act of war, the conflict did not escalate. What we therefore appear to have is arguably, the first successful, if limited in scope, swarming UAS attack. This is just the beginning, though. Inevitably, the combat capabilities of swarming UAS are going to increase and they will become far more of a threat than they currently are. Our starting point though, is an analysis of the September 2019 swarming attacks on Saudi Arabia which will provide the foundation for a discussion of future swarming UAS developments. It should also be noted that although the September 2019 attacks are generally credited as the first true swarming UAS attacks, this might not actually be the case.

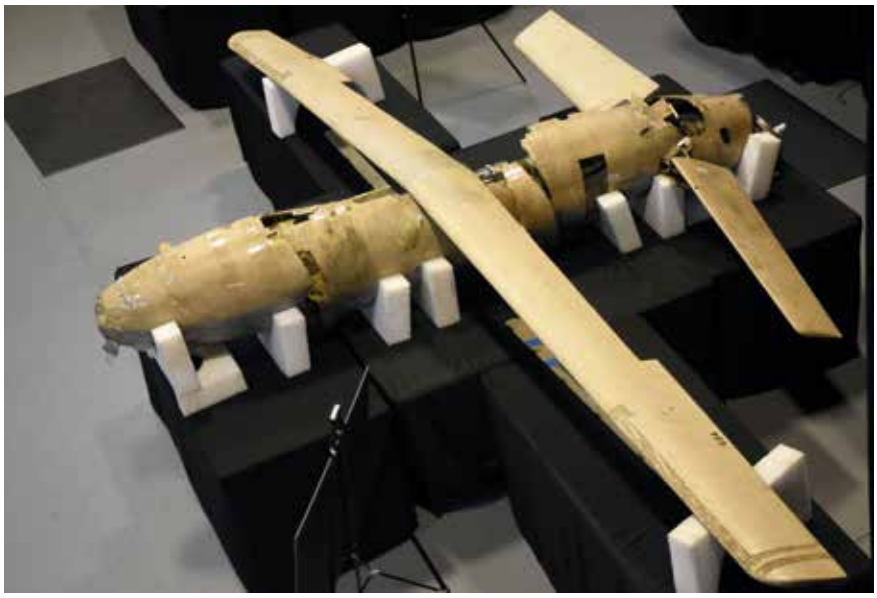


Photo: DoD by Lisa Ferdinando

The wreckage of an Iranian SHAHED-123 UAS system, part of the Iranian Materiel Display at Joint Base Anacostia-Bolling, Washington, D.C. UAS of this type are said to be responsible for swarming attacks on Saudi oil and infrastructure targets.

The Overture

To provide some context, Saudi Arabia and Iran have developed into regional competitors; both seek to be the dominant power in the Middle East. Normally, the conflict between Saudi Arabia and Iraq is conducted via surrogates, however in the Yemen the situation is more complicated. Since 2015, there has been a civil war in the Yemen, with the Houthi movement, backed by Iran on one side, and the Saudi-backed Yemeni government on the other. Saudi Arabia, along with some other Gulf Cooperation Council countries and other Arab states, have intervened militarily in the Yemeni civil war with varying degrees of success.

The Yemeni civil war is not confined to Yemen. In fact, Houthi forces have been attacking Saudi Arabia for quite some time. The Houthi arsenal at the lower end of the spectrum consists of mortars, artillery and anti-tank missiles, all of which have been used against Saudi territory. They have also employed anti-ship missiles against targets in the waters off Yemen and have used BUKHAN-2H Tactical Ballistic Missiles (TBM) against Saudi targets. Although this TBM is claimed to be developed by the Houthi, it is actually an Iranian SCUD modification. The Houthi have also modified SA-2 surface-to-air missiles into a TBM configuration. In addition, Yemen had acquired significant numbers of the OTR-21 TOCHKA TBM prior to the war and the Houthi have used these to attack Saudi targets. More recently, they have used 210mm artillery rockets and there are some indications that they have access to guided variants of these rockets.

In 2019, there was a change in Houthi tactics in their attacks on Saudi targets. They were now attacking oil and natural gas infrastructure and they were using UAS systems to achieve their objectives. On 14 May 2019, there was a Houthi UAS attack against the Saudi East-West Pipeline, also known as the Petroline, a 1,200 km long crude oil pipeline from the Abqaiq oil field in the Eastern Province of Saudi Arabia to the port of Yanbu on the Red Sea, with a capacity of five mil-

Photo: Saudi Aramco

Abqaiq is the biggest oil processing plant in the world and is responsible for half of Saudi Arabia's oil processing capability. The Abqaiq oil plant was hit by a UAS swarm attack on 14 September 2019 and was out of commission for nearly three weeks.

lion barrels of oil per day. The Petroline means that Saudi can still export oil without the risk of Iranian interdiction in the Gulf or the Strait of Hormuz. As such it is a key target for Iran, and although the Houthi claimed that they had used their QASEF UAS for the attack, these were actually Iranian ABABIL-2 UAS. It was also a sophisticated attack, as two small point targets, both pumping stations, were hit. Petroline is important to Saudi and work is now underway to increase its carrying capacity to seven million barrels per day.

The next UAS attack came on 17 August, with the target being the Shaybah oil and gas field. Shaybah is in the Rub al Khali on the border with Abu Dhabi in the UAE. It is some 1,000 km away from the nearest Houthi controlled territory. The field came on line in 1998 and contains high value Arabian Extra Light oil with production capacity of one million barrels per day and substantial gas deposits. In the attack, a total of 10 UAS struck the Shaybah Natural Gas Liquids (NGL) facility, causing a limited fire; according to the Saudi's that was subsequently extinguished. Shaybah was described at the time as a 'vital facility' by the Saudi government. The key finding here is that 10 UAS attacked a single point critical facility. In many ways this was a swarming attack.

Photo: Zhuhai Ziyan

The Zhuhai Ziyan UAV Company BLOWFISH A2 UAS is designed for swarming applications. The system has a max take-off weight of 38 kg, a payload of 10 kg and endurance of 60 minutes. Up to 10 of these systems can be used in a swarming attack according to the company.

This then brings us to the early morning of 14 September 2019. A total of 18 UAS and what were described later as three "low flying missiles," or to be more precise, cruise missiles, had earlier been launched from Ahvaz air base in Southwestern Iran, and at 04:00 Saudi time they reached their targets of Abqaiq in Eastern Saudi Arabia and 177 km southwest of Abqaiq. The second target was Khurais. Abqaiq is the biggest oil processing and crude stabilisation plant in the world. It is responsible for processing 50% of Saudi oil processing capability, especially in Arabian Extra Light and Arabian Light blends, and it is said to account for 7% of global oil supply. Khurais is the second largest oil field in Saudi Arabia and produces 1.5 million barrels of oil per day.

Being an oil producer themselves, the Iranians knew precisely what to target, and in the aftermath of the attack Saudi oil production had been cut by 50%, which pushed up oil prices by 20% initially, because the attacks had taken five percent of global oil production offline. It took until early October until full production was restored at Abqaiq and Khurais. These attacks had an obvious economic impact on Saudi Arabia. This was increased by the fact that they are also alleged to have delayed the privatisation of Saudi Aramco, the state oil company, which would have been worth a vast amount of money to the Saudi government.

Investigation of wreckage and other analysis indicates that the UAS were launched from Ahvaz and utilised different routes to the two targets in Saudi Arabia. This was done to mask Iranian involvement in the operation (after the attack the Houthi claimed responsibility). Another positive was that using different ingress paths limited the chances of discovery and interception. The US classified the systems used in the attack as the Iranian IRN-05 UAS, also known as the SHAHED-123. As of early June, the UN confirmed that the Abqaiq/Khurais attacks were carried out by Iran.

Next Steps

Evaluation of captured Iranian equipment and wreckage of downed systems has demonstrated that Iran is, to be fair, not using state-of-the-art systems and components in their UAS programmes. Some of these systems are built locally. Other components are either commercial off-the-shelf or military grade sourced from China, amongst other places. In short,

these Iranian UAS are not at the top end of the sophistication scale.
And yet, the attack on Shaybah in August 2019 and the Abqaiq/Khurais attacks in September 2019 indicated that the Iranian systems had extended range capabilities; Ahvaz to Abqaiq/Khurais is over 800 km for example. These attacks also demonstrated effective navigation capabilities and in the endgame effective targeting capabilities. These attacks show that Iran can get up to 10 UAS systems to accurately attack a high value target, and this is being achieved with technology that is far from world beating.
When we look at these attacks, it is important to understand that they are calibrated. Houthi/Iranian-inspired attacks on oil infrastructure and other high value targets are intended to demonstrate that the costs of intervention in the Yemeni civil war could become too high for Saudi Arabia. The Abqaiq/Khurais attack continues that strategy, but it is also designed to send a message to the US government to take account of Iran's military capabilities, the economic vulnerabilities of US allies in the region and the ability of Iran to manipulate the oil price. Also notable is the Iranian calculation that Saudi Arabia would not retaliate and that the US would not exercise any military options at that point. As things turned out, the Iranian thinking on this matter was correct at least until January 2020 when the US took active measures against Iran.
One immediate issue raised by the Iranian attacks is that, at this point, they appear to be unable to attack a target with more than 10 UAS, as demonstrated at Shaybah. When you envision a swarming attack you are thinking about a significantly greater number of UAS attacking a high value target. When you look at the importance of Abqaiq, the largest oil processing plant in the world and responsible for half of Saudi oil processing capability, this facility was offline for almost three weeks after what was in reality a limited attack. Increase the numbers of UAS in the attack, thereby maximising the effects on the target, and the possibility to knock out a facility of the significance of Abqaiq for a considerable period of time is very real. The same logic applies to Khurais; remember this is the second largest oil field in Saudi Arabia. The more UAS used in the attack the greater the damage and the longer it takes to repair.
If one was just to target oil and gas infrastructure in Saudi Arabia, the biggest problem would be the vast number of targets that were worthy of attack although it should be stressed that Abqaiq and Khurais would certainly be near the top of any targeting list. Another targeting option explored by the Houthi/Iranian nexus in both Saudi Arabia and the UAE is airports. Interrupting the operations of a major international airport is a rather attractive targeting option. It causes extreme disruption and because it has international implications it cannot be hidden and/or minimised. Targeting data is easy to come by and it is not difficult to imagine the consequence if an airport fuel tank farm were struck.
Another possibility comes from just having a number of UAS systems in the vicinity of a major airport. You do not have to do anything kinetic; you just have to be there. An example of what can occur in these circumstances comes from Gatwick Airport, the second London airport, between 19 and 21 December 2018. UAS sightings in the vicinity of the airport led to hundreds of flights being cancelled, in total 1,000 flights were said to be impacted and the travel plans of 140,000 people were disrupted.

Complications

The growing importance of UAS systems as reconnaissance, surveillance and targeting assets, amongst other missions, and their increasing direct combat role have obviously led to the development of countermeasures. Ongoing military operations in the Middle East have seen UAS systems successfully engaged by combat aircraft and conventional ground-based air defences. However, more directly focussed counter-UAS systems are in service or development, utilising soft kill methods such as jamming and high-power microwaves, with hard kill systems also coming into play.
Putting the Iranian utilisation of UAS swarms to one side for the moment, it is noticeable that elsewhere swarming UAS developments focus on much smaller air vehicles, with explosive payloads of between two and ten or so kilogrammes and tactical ranges. The number of UAS in such swarms will be substantial, but that creates issues that have to be overcome such as control, collision avoidance with in the swarm and localisation of the swarm in terms of the target and the path to the target.
What will be the real difference maker for the future swarming UAS will be increasing their autonomy, thus reducing their vulnerability to external countermeasures, add artificial intelligence to their capabilities and all of sudden defending against UAS swarms becomes even more difficult. What is increasingly clear is that the swarming UAS will become a feature of conflict at the tactical, operational and strategic level. All of which means that air defence mission has broadened in both scope and complexity. ■

Photo: via author

The Chengdu Aircraft Industry WING LOONG UAS system is in service with China and has been widely exported in the Middle East to Egypt, Saudi Arabia and the UAE amongst others. This is a combat proven armed UAS, illustrating Chinese capabilities in all aspects of the UAS field from the conventional to swarming.

Euphoria Evaporated

Norwegian-German Submarine Cooperation

Hans-Uwe Mergener

In September 2018, when a programme agreement was signed between the German procurement authority BAAINBw and the Norwegian procurement agency Forsvarsmateriell, there was confidence that a supply contract could be concluded before the end of 2019.

Photo: Forsvaret

Wanted: A successor to the ULA class. Depicted is HNoMS UTSIRA

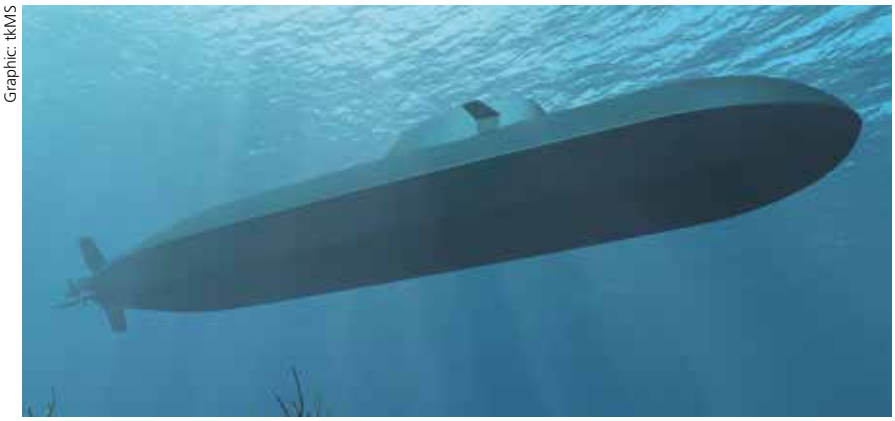
However, this expectation has not been realised. A year earlier, in August 2017, Norway and Germany had signed a landmark intergovernmental agreement. In October 2017, the German industrial partner thyssenkrupp Marine Systems assumed that the contract would be in place by the end of 2019.

From the limited amount of information available, it can be concluded that the effort and time required to reach agreement on the operational requirements for the duration of the programme had been underestimated – or in other words, being able to adapt to the threat and technological developments in order to enable the necessary capability adjustments over the next 30 years. However, there were already different views on this.

In an interview with our sister journal "MarineForum", RADM Nils Andreas Stensønes, Inspector of the Royal Norwegian Navy, put it like this: "Joint procurement means harmonising requirements to meet both German and Norwegian needs." Put another way, with the signing of the intergovernmental and programme agreements, both navies faced roughly the same situation as newly-weds do before moving into a new home, namely being confronted with making sustainable decisions against the backdrop of previous social and living habits. It is a matter of systemic decisions (e.g. energy and furnishings) all the way to the supplier (e.g. the kitchen), which prolong the process and test the partnership. Any fundamental differences in opinion seem to have been resolved over time – a compromise between signature reduction (stealth) and payload has been found, as has been the case with the application of certification agreements; according to reports from British defence analysts Shephard, the Naval Submarine Code will be applied. Compromises have also been found on other features, such as rescue equipment, the one versus two-chamber system, the command and weapon deployment system, armament, sensors, but details of these have not yet been made public, for good reasons. However, despite progress made so far, the programme is currently at a standstill.

According to Norwegian media reports in October 2019, thyssenkrupp Marine Systems is responsible for the delay: "The offer from the German supplier was simply not good enough," the Norwegian online newspaper "Aldrimer.no" reported on 7 October. Other Norwegian reports quoted the price. These reports are partly based on information from the procurement authority, according to which the supplier was to submit an updated offer by the end of July 2019. Due to the upcoming budget discussions in the Norwegian Parliament, the issue has become highly contentious.

Graphic: tkMS



An artist's impression of U212CD

Numbers Games

The Norwegian Procurement Authority foresees a cost ceiling of slightly more than €3.6Bn for the four Norwegian submarines, which includes VAT, a risk margin and implementation costs. In an earlier document (the 2017 issue of "Future Procurements in the Norwegian Defence Sector 2017 – 2025"), slightly under €1.3Bn was earmarked for the 6346 project "New Norwegian Submarine Capability" over the period 2018 to 2025.

The procurement, according to Forsvarsmateriell, is expected to take more than ten

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Masthead

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Cover Photo:The SUPER TUCANO, from Brazilian manfacturer EMBRAER, has established itself as one of the key contenders, including in the European market, for fighter aircraft in the Light Attack, COIN and Close Air Support roles.
Photo: EMBRAER

Annual subscription rate: €82,50 incl. postage

Photo: tkMS

The ORCCA Combat System was, developed by kta Naval Systems, the joint venture between ATLAS ELEKTRONIK (part of tkMS) and Kongsberg Defence & Aerospace

years, with the first submarine expected about seven years after the order has been placed with the remaining submarines to follow at annual intervals. When the Memorandum of Understanding was signed in February 2017, this was planned from 2025 – and was published as such. Germany is taking submarines number three and number six in the series, which is to be completed by 2032, according to a statement Forsvarsmateriell made at the time.

Given that the contract has still not been signed, a delay is inevitable. Norwegian media outlets report, citing the Norwegian MoD: "Delivery of the first submarine was planned for the end of 2026. This schedule is likely to be affected by the current situation and a new schedule will be determined by the upcoming contract negotiations." In an interview with T2, a Norwegian television station, a staff officer familiar with the submarine project admitted that the contract would not be signed until later in 2020. T2 mentioned delays of several years compared to the original plan.

Oslo is already considering keeping the ULA class submarines in service for a longer period. In any case, the budget for 2017 – 2025 had already provided up to €130M for decommissioning measures. As life-extending measures for the four remaining ULA submarines, the projects P6345 (updating the ULA class), and P6370 (the interim solution ULA class), will be launched for an additional €51M.

In Norway, submarines are considered a strategic defence capability. In the medium-term planning 2021 – 2024 (roughly corresponding to the capability profile of the German Armed Forces), which was presented to parliament by the Inspector General of the Norwegian Armed Forces in October 2019 and presented to the public, at least four submarines are accommodated in each of the four options examined, while the two more demanding scenarios, which are very costly in terms of defence policy, involve five submarines each.

Comprehensive Norwegian Partnership

According to the Norwegian journal "Teknisk Ukeblad", the Norwegian Parliament has set a balanced industrial cooperation and market access for the Norwegian defence industry as conditions to be met prior to the signing of contracts.

Some of this has already been carried out in advance on the German side. It was agreed to establish maintenance and repair capacities in Bergen, Norway. There are plans by the two navies for joint training, personnel deployment and life cycle management of the future U212CD project (common design, i.e. everything – with the exception of encryption technology

– is largely identical). The Norwegian company, Kongsberg is to become the supplier of a naval strike missile (NSM) to be used by both navies. The Norwegian company is also involved in the development of IDAS (Interactive Defence and Attack System for Submarines) – a missile system designed primarily for the self-defence of submarines against airborne threats.

In addition, Kongsberg, thyssenkrupp Marine Systems and its subsidiary ATLAS ELEKTRONIK have established the joint venture kta Naval Systems in October 2017. This joint venture will be responsible for the development, production and maintenance of command and weapon deployment systems (Combat Systems). The company is based in Kongsberg, Norway, with a branch office in Bremen. Kongsberg and ATLAS ELEKTRONIK are each contributing 50% of the joint venture's equity.

Hopefully, this joint project, which was launched with great enthusiasm, will not founder at this stage. For thyssenkrupp Marine Systems, U212CD was intended to set new standards in submarine construction with which the company wanted to profile itself as a leading systems house for conventional submarines, ready to develop the standards for the future, a company representative told an international audience at SUBCON 2019. After tkMS failed to secure a deal in Australia, U212CD is a lifeline for thyssenkrupp Marine Systems.

Photo: Forsvaret

The German U36 tied alongside in Bergen in 2016

However, there is more than just the reputation of the company at stake. For the past 60 years, Norwegian submarines have exclusively been made in Germany. It is no coincidence that Norway has chosen Germany as its partner for a joint submarine project, despite negative experiences in the past. In this respect, it also needs political impetus. In 2017, the German MoD commented on the Norwegian decision on the "comprehensive strategic partnership" with Germany: "The Norwegian decision will also help to secure a future-oriented key technology for the next decades in Germany and to further develop it in close cooperation with our Norwegian partner." In this respect, it is time for the "Berlin in-laws" to play their part. ■

Quo Vadis, FELON?

Yury Laskin

The fifth-generation Russian fighter is a result of Sukhoi Design Bureau's experimental work on the front-line aviation complex PAK FA. As a prototype, the plane had been designated as T-50 until August 2017. Once the programme entered the production stage, the aircraft received its current designation as the Su-57. Perhaps, the number "5" stands for fifth generation, while the number "7" came from the Su-27 – one of the most famous products of the Sukhoi family. The NATO designation is the undesirable nickname FELON, meaning criminal.

The fifth-generation Russian fighter has been designed to effectively destroy all types of air, ground and surface targets. The combination of powerful weapons, advanced enemy detection systems, supersonic cruising speed, high manoeuvrability and low visibility have been key objectives in the Su-57's design to gain absolute air superiority.

Photos: via author

The Su-57 programme is a strictly classified project.

The Maiden Flight

The Su-57's first prototype, T-50-1, made its maiden flight on 29 January 2010. Nine more flying prototypes were constructed in order to make their first flights between 3 March 2011 and 23 December 2017.

On 22 August 2018, an initial contract with the Russian MoD was signed at the Army Forum trade show, with delivery of the first two serial Su-57s scheduled in 2019 and 2020. A far larger contract for the Russian Aerospace Forces (VKS) of 76 Su-57 fighters was signed on 27 June 2019. Under the terms of the contract, the VKS were supposed to establish three full-force regiments in the period 2020-2027.

In November 2019, a picture of a Su-57 with a blue tail number "01" in the assembly shop of the Gagarin Aviation Plant at Komsomolsk-on-Amur (KnAAP) appeared in Russian media.

Just a few weeks later, on 24 December, the "01" aircraft crashed during a test flight. The pilot successfully ejected. The media then published possible causes of the incident, but the results of the official investigation remain unknown. It was announced that the investigation's results "would be taken into account" to improve the aircraft.

Currently, several serial Su-57s are already at the KnAAP workshops in different stages of readiness, among them the second aircraft of the 2018 contract, as well as the first aircraft of the second order. These aircraft are expected to be handed over to the VKS before the end of this year. The next batch is supposed to be delivered to the armed forces in 2021, and to finalise the works in 2027. Bearing in mind the total amount of aircraft in question, the KnAAP needs to build 10+ fighters annually in order to meet the schedule.

The Aircraft's Features

The Su-57 is a strictly classified project, but from open sources, it is known that the fighter's length is 19.4 m, the wingspan is 14 m, and weight is 18.5 tonnes.

The scale of weapons includes over 50 types of various means with different principles of guidance, including short, medium, long-range missiles, as well as a 9-A1-4071K 30-mm cannon from the

Shipunov KBP Design Bureau. The combat load of 1.3 – 10 tonnes is located in the internal fuselage compartments. There have been reports of the possible installation of the shortened version of the KINZHAL (DAGGER) hypersonic attack weapon.
The aircraft is equipped with the latest onboard equipment, as well as a radio-absorbing coating employing stealth technology. The small area of the reflecting surface (0.4 square metres) allows the Su-57 to remain virtually invisible to enemy radar thanks to the high-tech composite construction materials (70% of the surface and 25% of the weight of the aircraft).
The antennas of the H036 BELKA radar station are located not only in the machine's front, but also over the entire surface in order to provide a circular view of hundreds of kilometres. The main radar and four other active and passive radar and optical-radar stations, as well as a single combat and control information system, are integrated with the data exchange subsystem for joint operations with other aircraft, command posts and reconnaissance systems of the air force, army and navy units.

The Engines

Two turbojet engines allow the Su-57 to reach speeds of up to 2,600 km/h and a climb speed of 21 km/min. The fighter switches to supersonic speed with no use of afterburner, while a three-dimensional engine thrust vector deflection system provides the aircraft with super-manoeuvrability, which is extremely effective not only for dog-fight scenarios, but also for anti-missile manoeuvres.
Deliveries of Su-57 fighters to the VKS are planned in two stages: until the mid-2020s with a fourth-generation engine, after which, with a fifth-generation engine, according to Deputy Minister of Defence Alexei Krivoruchko. He added that the second-stage engine will have improved efficiency and lower life cycle costs. The expected number of aircraft in the first and second stages remains unknown.
So far, the Su-57 is equipped with an AL-41F1 dual-circuit engine which was developed by the Lyulka Design Bureau and was previously known as "Product 117". According to the media, the AL-41F1 engine is 4+ generation, and is structurally similar to AL-31F and AL-41F1S, though with some serious differences. In particular, the power plant is equipped with a plasma ignition system and a thrust vector control in a vertical plane. The plasma ignition system is built into the fuel nozzles of the engine, so the ignition of the plasma arc occurs simultaneously with the fuel supply. Among other things, this technical solution avoids flaring, i.e. ejection of a column of fire from the engine due to an excess of fuel in the combustion chamber at start-up.
The AL-41F1 has two sisters: the AL-41F ("Product 20") and AL-41F1S ("Product 117C"). The first was due to be installed on a Soviet prototype of the fifth-generation fighter Mig-1.44 MFI. Due to the collapse of the USSR, it never entered production. The AL-41F1S is slightly bigger in size than the AL-31F (Su-27/30 power plant). This engine is mass-produced and installed on the Su-35S. The AL-41F1S has more than 70% of new parts in comparison with its predecessor, resulting in a significantly improved performance. It has been reported that the AL-41F1 has over 80% new parts compared to the AL-31F.

A Su-57 taking off at the MAKS Air Show in 2019

"Product 30"

From the mid-2020s, the Su-57 will receive fifth-generation engines known as "Product 30". The future power plant will differ from the AL-41F1 with even higher fuel efficiency and lower life cycle costs. It is believed that, in terms of specific fuel consumption, "Product 30" corre-

Russian President Putin and Turkish President Erdoğan inspect a Su-57. Turkey is considering procurement of the Su-57 after being banned from the US F-35 programme because of purchasing the Russian S-400 system.

sponds to the AL-31F dual-circuit engine (670 grammes per kilogramme-force per hour in cruising mode), but surpasses it in terms of specific thrust.

According to the media, the new engine will additionally employ the possibility of cruising supersonically. For this to happen the engine must have a variable degree of bypass. This requirement has added another parameter – reduced fuel consumption. Furthermore, the engine should have significantly less reflection in the infrared and radio bands. This could be achieved by the special design of the nozzle and air intake. An important feature of the new engine is a reduction in life cycle costs with the requirement for less maintenance and more overhaul resource.

"Product 30" is a completely new power plant which has introduced numerous technological innovations. For example, in 2013, NPO Saturn disclosed a promising blade design for a high pressure compressor made of titanium aluminide. There were reports of the possible introduction of such material into the turbine design. The exact characteristics of the new engine are not yet available to the general public. It is known, however, that they should enable the aircraft to accelerate to 1.5 Mach numbers without turning on the afterburner. In addition, the new engine employs an original electronic-digital control system designed to receive data from many different sensors and monitors. The smart engine management simplifies the work of the pilot, as well as facilitates the configuration of the power plant.

According to open source data, the maximum thrust of the "Product 30" engine reaches 11,000 kgf and the afterburner – 18,000 kgf. For comparison, the first stage AL-41F1 engine has a thrust of 9,500 and 15,000 kgf, respectively.

New "Product 30" engines will also provide an increase in the thrust-to-weight ratio. The Su-57 which employs the "117" product engines maintain this parameter in a range of 0.85-0.9. The installation of the "Product 30" allows the aircraft to exceed a thrust-to-weight ratio of 1. With normal take-off weight, the thrust-to-weight ratio is expected to increase from 1-1.15 to 1.2-1.35. Accordingly, all the main take-off and landing and flight characteristics, carrying capacity, etc. will increase. The first Su-57 prototype with a "Product 30" engine undertook its maiden flight in late 2017.

Deputy Prime Minister Yury Borisov, in charge of the defence industry, said in an interview with RIA Novosti on 21 May: "During the tests, the Su-57 confirmed almost all the requirements of the tactical and technical specifications in full. The state contract for the supply of 76 aircraft to equip three aviation regiments of the Aerospace Forces is being implemented according to the delivery schedule." Yury Borisov believes that, despite the COVID-19 situation, the first batch of Su-57 fighters will be transferred to the VKS this year.

Official Russian sources have repeatedly stated that the Su-57 was successfully tested under combat conditions in Syria. According to the Minister of Defence, Army General Sergei Shoigu, two Su-57 passed the test programme in Syria. Within two days, the planes had successfully completed their tasks, including combat ones. It was later reported that four aircraft underwent similar tests. In all, six Su-57 flying prototypes from the total of ten have seen combat in Syrian skies.

Three Su-57 air regiments represent a quantum leap in the development of the combat capabilities of the Russian Air Force. The latest fighter is capable of detecting air and ground targets at ranges of up to 400 kilometres, escorting up to 62 objects (and transmit targeting to other planes or attack drones).

One can only imagine how much the combat capabilities of 76 Su-57 will increase if they carry out tasks in an integrated role together with the HUNTER UAV. The Russian-made vehicle is similar in size to the Su-54, employs a "flying wing" design and stealth technology. When interacting with a fifth-generation fighter, an "invisible" drone can be a breakthrough in the field of combat use of fighter aircraft. Here, a huge scope opens up for the effective interaction of the pilot and the combat robot. A joint flight of the Su-57 and HUNTER took place in the fall of 2019 and lasted longer than 30 minutes. In May 2020, an unmanned regime was tested aboard the T-50 flying laboratory. The half hour flight was carried out with a pilot in the cockpit who monitored the aircraft's performance. The official report claimed that all systems were tested successfully, as well as the fifth-generation engine operating mode.

Procurement

It appears that the current contracts for 78 aircraft will not be the last, and after 2027 the construction of the Su-57 will not be terminated. Thus, no later than 2028, we should expect the beginning of the supply of equipment; apparently, they will be in the configuration of the "second stage". The initial batches of Su-57 aircraft could be upgraded with the "Product 30" engine and, perhaps, other innovations.

The Su-57 may also receive a naval version. Recently, the Zaliv shipyard in Kerch received an order from the Russian MoD for the construction of two universal landing ships for the country's Navy. The proposed vessels are set to exceed the French MISTRALs in dimensions and displacement, and as such, raises the question about the possibility of using the vessels not only for helicopters.

Export Options

The Su-57's export prospects remain unclear. In April 2018, India left the FGFA 5th generation fighter programme which it had run together with Russia on the basis of the Su-57 project. Perhaps, New Delhi may become a FELON customer if it finds the terms of acquisition attractive within the "Make in India" programme.

Last year, Turkey was expelled from the F-35 programme due to its sensational purchase of the S-400 Triumph ADS. During MAKS 2019, President Erdoğan was accompanied by Vladimir Putin himself, and became acquainted with the Su-57. Rumours followed about the possibility of Ankara's participation, but the level of interest remains uncertain. According to sources available publicly, Algeria had already concluded a contract with Russia on the 14 Su-57E export version but there is no evidence thus far of such a deal.

To conclude, the Su-57 today remains in prototype mode. Needless to say, the FELON's comparison with the American F-35 is in the realm of "virtual reality": 500+ copies of the LIGHTNING II have already concluded over 240,000 flight hours with 975 pilots and 8,585 ground personnel properly trained within the U.S Air Force and Marine Corps, the UK's Royal Air Force and the Israeli Air Force. The Su-57 programme is, however, behind the Chinese J-20 programme. Both programmes started almost simultaneously, and for more than two years now, the Chinese Air Force has been operating nearly three dozen J-20s.

The current delay, however, should help the Su-57 programme learn the lessons from the F-35 and J-20 operations and improve the FELON's design, establish a steady product line and reach a desirable goal – namely, to create a combat aviation system to be reckoned with by any rival. ■

The Bahraini Air Force in Substantial Renewal

Photo: Georg Mader

RBAF Hamad bin Abdullah Al Khalifah

Weeks before the Covid-19 travel restrictions, at DIAC-2019 ESD spoke to the long-time commander of the Royal Bahraini Air Force (RBAF), AVM Hamad bin Abdullah al Khalifah. The RBAF is currently renewing two critical platforms. Nevertheless, the small service is combat-proven.

ESD: Bahrain's Shaikh Isa AB has experienced many coalition activities, including the Operations "Southern Watch", "Desert Fox" and "Iraqi Freedom". While the RBAF stayed out of these operations, its F-16s have flown more than 3,500 missions in the Saudi-led coalition against the Houthis in Yemen since March 2015. What are your main commitments now?

AVM al Khalifah: I would like to recall the RBAF's involvement in the liberation of Kuwait only one year after the introduction of the F-16. And yes, we provided close support along Saudi Arabia's southern border with Yemen. But that does not mean that we have nothing to do today, because we have obligations as a member of the Gulf Cooperation Council (GCC). In this regional alliance, our squadron has the responsibility to be on QRA alert for a region called Sector B. This includes Bahrain, and parts of Saudi Arabian and Qatari airspace. We share the mission with Dhahran AB's RSAF F-15Cs. Our forces are fully prepared to defend the Kingdom's land, air and sea borders and be the bulwark against anyone who attempts to obstruct its security and stability.

ESD: In December 2019, Lockheed-Martin started production of the first new 16 F-16V Block 70/72 FIGHTING FALCON, for which RBAF became the launch customer for 12 single and four double-seaters. How are you preparing for this technical renewal? Will HAWK or F-5 pilots fly the new platforms?

AVM al Khalifah: The new F-16s will complement our current capabilities and will be integrated with those of other Allied air forces. Of course, we have begun preparations. Some of our pilots are already in training in the US for the new VIPERs, and pilots of the HAWK and F-5E are also involved. And the infrastructure is being built or renovated to be ready for the time after 2022.

ESD: Lockheed Martin hoped that your 20 Block 40 F-16C/D would also be upgraded to this latest standard, so that you would have a fleet of 36 F-16Vs in total. But this has not been aimed for until today. Why?

AVM al Khalifah: Our priorities are clearly the 16 new Block 70s, as our current fleet has been modernised to a high standard and will be extremely efficient until the Block 70s arrive and are fully implemented and integrated. We do not yet know what happens after that. We also have to think about the budget, as we are also purchasing new AH-1Z COBRA VIPER attack helicopters.

ESD: What about the RBAF's 30-year-old F-5Es: Will they be used together with the HAWK Mk129 for training purposes? In the USA the F-5s are highly regarded as aggressors. You could offer a similar service within the GCC. How is your training currently structured? How many pilots are trained per year in total?

AVM al Khalifah: The 12 F-5E/Fs will be in service for a while longer. They will be used as a multipurpose platform. One of their tasks is to provide Lead-in-Fighter Training (LIFT) for the F-16s, since they are supersonic aircraft. However, they will continue to be used in the air-to-ground mission role. As far as our training is concerned, students generally go to EgyptAF Academy, King Faisal Air Academy in Saudi Arabia [flying the PC-9 and PC-21] and the United Arab Emirates [on the PC-7 and PC-21 at Sheikh Khalifa bin Zayad Air College]. Returning pilots from Egypt go directly to the F-5s. If they have been in the KSA and the UAE, they start with the HAWK Mk129 and then with the F-5s. In total, about 20 pilots are trained per year.

ESD: You just signed a contract to purchase 12 AH-1Zs for US$912M. You are already one of the few operators of the previous COBRA series. At BIDEC-2019, an RBAF-coloured model AIM-9 carried ATA missiles. Would that be a desired configuration?

AVM al Khalifah: Well, the 12 new aircraft are currently under construction and deliveries will start at the end of 2022 and be completed in 2023. A fully assembled Flight Training Device (FTD) will also be delivered in 2020. As for a specific configuration for Bahrain, this is being discussed with our officers in the US. Any ammunition would be part of separate contracts.

Photo: Lockheed Martin

The F-16 Block-70 destined for Bahrain

ESD: What will happen to the 22 senior AH-1E/F and eight TAH-1P instructors stationed in Riffa? Were they retrofitted by Turkish Aerospace in 2015? TAI claimed in 2017 that the ASELFLIR-300T EO/IR tower and glass cockpit and avionics systems from their T129 would be included.

AVM al Khalifah: Let me just say that a large part of our current COBRA fleet will be significantly improved, which will help us to continue our contribution to the security of our Kingdom and the Gulf region.

ESD: Thank you.

The interview was conducted by Georg Mader.

US Army Selects GM Design for Infantry Squad Vehicle

Sidney E. Dean

On 26 June, the US Army announced that GM Defense LLC would receive the contract to produce, field and sustain the new Infantry Squad Vehicle (ISV). General Motors beat out two other contenders in the final phase of the ISV competition, Oshkosh Defense and SAIC.

Photo: US Army

US Army paratroopers evaluating the GM ISV prototype in forest terrain.

Prototypes from all three firms had been evaluated from November 2019 through January 2020, including operational and static testing at Fort Bragg, North Carolina by units of the 82nd Airborne Division.

The ISV will be supplied to airborne and airmobile Infantry Brigade Combat Teams (IBCTs). According to an Army statement, the unarmoured lightweight vehicle will enhance mobility and flexibility by moving soldiers and their equipment quickly over complex, difficult or restrictive cross-country terrain. This will allow soldiers to approach their operational targets with less fatigue and greater readiness while enhancing survivability, the statement stressed. Procurement of the ISV is also largely a response to the dense air defence networks US forces can expect to encounter in future wars. The vehicle will permit C-17 or C-130 aircraft to drop paratroops further from their objective, in sufficient distance from enemy air defences and perhaps even undetected by enemy sensors.

- The basic performance profile of the ISV, as required by the Army going into the competition, includes:
- Nine-man squad carrying capability, to ensure operational unit cohesion;
- Payload of 3,200 pounds (1,455 kg);
- External sling load by a UH-60 BLACK HAWK helicopter;
- Internal load/external lift by CH-47 CHINOOK helicopter;
- Low-velocity air drop by fixed-wing C-130 or C-17 transport aircraft;
- Exceptional mobility over all terrains.

General Motors Design

GM's design for the ISV is based on the commercial Chevrolet COLORADO ZR2. Although a mid-sized civilian pickup truck, the ZR2 has proven itself in near-military-quality off-road racing and rock crawling events. GM has emphasised its performance in the Best of the Desert race series, where the COLORADO is one of only four vehicles (out of 434 competitors) to complete eleven consecutive races. According to GM, ZR2 vehicles have completed, in total, more than 10,000 miles of highly-challenging off-road and desert racing.

The ISV will draw 90% of its components from commercial-off-the-shelf Chevrolet Performance brand parts used on the COLORADO and BISON variants of the ZR2. These include: long-travel rear leaf springs; the nitrogen-charged, hydraulic front jounce shock system; high-angle upper control arms; a steel driveshaft; locking front and rear differentials; ball-spline half shafts. Many of these components were specifically designed for the needs of high-performance off-road vehicles. Major vehicle systems including the engine, transmission, and steering are electronically controlled.

Particularly important elements of the General Motors ISV design include:

Roll-Over Protection System (ROPS): The open-topped passenger and cargo section is protected by a roll-bar framework made of lightweight but high-strength 4130 chromoly alloy. This ROPS cage can be collapsed and stored when the ISV is internally carried via CH-47. The protective framework can also be customised to accommodate specific passenger or cargo payload requirements.

Propulsion: The ISV will be powered by a 186-horsepower, 2.8L DURAMAX turbo-diesel engine, electronically assisted power steering and six-speed automatic transmission. According to GM's ISV product sheet, the performance tune of the DURAMAX 2.8L engine will produce significantly more power than the ZR2's engine, which itself delivers 186 horsepower and 369 pound-foot of torque.

Dynamic Suspension: Long-travel Multimatic Dynamic Suspensions Spool Valve (DSSV) dampers are designed to minimise stress on passengers and to maximise driver control over the vehicle. The precision spool valve technology enhances performance during both on-road and off-road operations. As described by GM, when wheel travel moves outside normal road operating range, a third spool valve specifically tuned to provide extra damping comes into play, helping to maintain control during high-displacement wheel movement and high-impact compression cycles.

Underbody Protection: Several underbody skid plates are in place to protect critical components including the engine, suspension, drive train and fuel tank.

The final design for the ISV incorporates soldier feedback from infantry personnel who evaluated the competing prototypes in static and operational testing, as well as real-world lessons from recent overseas missions. Every effort was made to maximise not only performance but also simplify operation. The lack of doors or side panels permits near-instantaneous boarding and egress by armed soldiers. The ISV's sloping hood optimises the driver's forward visibility up to within five meters of the vehicle's front. The single-piece hood and fender design was chosen to ease access to the engine and facilitate maintenance.

Dimensions and performance characteristics include: Overall length, width and height of 5.26 metres by 2.08 metres by 1.88 metres. Curb weight is below the Army's maximum threshold of 2,272 kg. Mounting 89 centimetre diameter tires, the ISV has a minimum ground clearance of 35 centimetres. Approach, breakover and departure angles as cited by GM are 46.1, 26.4 and 42 degrees, respectively.

Vehicle design, development and construction rest in the hands of General Motors Defense. In January 2020, GM Defense teamed with the British engineering firm Ricardo plc to provide support with product logistics and fielding requirements. Ricardo is expected to develop and provide integrated logistics solutions and life cycle sustainment for operational vehicles, areas in which the firm enjoys considerable experience. This is likely to include development of technical and training manuals for operators and maintenance personnel.

Photo: Chevrolet

The Chevrolet COLORADO 2017 model during off-road/desert trials

Photo: GM Defense

The General Motors ISV prototype submitted for evaluation by the US Army in 2019

Operational in 2021

The procurement programme and competition are managed by the US Army's Maneuver Capabilities Development and Integration Directorate (CDID) at Fort Benning, Georgia. Due to the perceived urgency of the capability set, the Army opted for an accelerated testing and procurement procedure. "Using an innovative acquisition approach through an Other Transaction Authority – a flexible, collaborative tool designed to speed acquisition and modernisation – the ISV team awarded the production contract for this capability in 16 months. Using normal acquisition processes, it could have taken as many as 36 months," said Timothy G. Goddette, the Army's programme executive officer for Combat Support and Combat Service Support, or PEO CS&CSS.

The initial phase of the procurement contract calls for GM to deliver eight ISVs for extensive testing at Aberdeen Proving Grounds, Maryland by October. Steve Herrick, the Army's product lead for Ground Mobility Vehicles at PEO CS&CSS, stated that the production qualification testing will address the vehicles' ability to meet the performance specifications in areas not previously tested, while simultaneously enhancing confidence in areas already tested. He continued to explain that the ISV will also undergo transportability certification, including low-velocity air drop and helicopter sling loading. The Army will conduct initial operational test and evaluation in Summer and Autumn of 2021.

The 1st Brigade, 82nd Airborne Division will be the first unit operationally equipped with the ISV; according to Steve Herrick, deliveries are expected to begin approximately eight months after contract award, which would be circa February 2021. The current contract covers acquisition of 649 vehicles, at an overall programme cost of US$214.3M; this figure includes installation kits, ancillary hardware and logistical support. Completion of deliveries under this contract is expected by June 2028. The Army has announced a comprehensive acquisition objective of 2,065 vehicles. No date for award of a follow-on procurement contract has been determined. ■

Vertical Rotary Lift

Current and Near Future Developments

Sidney E. Dean

Vertical rotary lift aircraft are indispensable for any military force and every service branch, fulfilling such vital functions as logistic support, personnel transport (including aerial assault), search and rescue (SAR), medical/casualty evacuation (Medevac/Casevac), and installation/area surveillance and security missions.

Often the same aircraft – sometimes with modified avionics suites – can provide the same services to both the armed forces and to civilian law enforcement, public safety, and humanitarian agencies.

Numerous armed forces worldwide are currently upgrading their helicopter fleets with improved variants of existing models. Many armed forces also pursuing innovative new concepts to satisfy future rotary lift needs. Some significant developments are being promised, both in the short and longer term. Traditionally, the term vertical rotary lift has been synonymous with helicopters. Today, however, a broader definition can be applied to include tiltrotor aircraft as well as ducted fan aircraft.

Photo: Lockheed Martin

Concept of the FLRAA based on the Sikorsky SB>1 DEFIANT.

Photo: Lockheed Martin

The Sikorsky/Boeing SB>1 DEFIANT technology demonstrator.

Transport and Utility Helicopters

The US armed forces are currently developing a new family of helicopters under the Future Vertical Lift (FVL) programme. One FVL sub-programme is dedicated to procuring a Future Long-Range Assault Aircraft (FLRAA) to carry infantry squads into battle. The aircraft will also perform other missions such as S&R, medevac and logistic support.

Future Vertical Lift

The current objective is fielding FLRAA in fiscal year 2030 as a replacement for the UH-60 BLACK HAWK and H-1 HUEY utility helicopters. Core requirements for the FLRAA are: capacity to carry 12 combat equipped soldiers; a threshold cruising speed of 460 kilometres per hour (kph) and an objective of 515 kph cruise speed (the USMC sets higher demands, 500 kph threshold and 542 kph objective); an unrefueled combat radius of 368 kilometres threshold and 552 kilometres objective (USMC: 672 km / 829 km), and the capability of deploying with without a human pilot.

While the aircraft are likely to be procured by the Army, USMC, and joint Special Operations Command (SOCOM), the Army is managing the FVL programme. In March 2020, two competing offers were selected for the two-year Competitive Demonstration and Risk Reduction (CD/RR) phase of the programme. According to the Army, this CD/RR phase will "include initial conceptual designs, requirements feasibility, and trade studies using model based systems engineering" with the goal of

reducing technical risk before awarding the full development and production contract in 2022. Insights gained during CD/RR will enable the Army to formulate realistic expectations regarding operational requirements, conceptual designs and the ultimate acquisition strategy, said Program Executive Officer Mr. Patrick Mason. The winning firm is expected to present the first prototype in early 2025, with testing to run through the end of FY 2029.

The competing CD/RR contracts were awarded to Bell Textron and to a joint venture by Sikorsky and Boeing. Both firms had presented technology demonstrators on which their ultimate FLRAA designs will be based. Neither aircraft is a classic helicopter. Bell Textron's twin-motor V-280 VALOR technology demonstrator utilises tilt rotor technology which has been made "mainstream" by the firm's V-22 OSPREY. The V-280 is smaller than the V-22, includes integrated cabin armour, and has a v-shaped tail which enhances manoeuvrability, especially at high speed.

At first glance Sikorsky's SB>1 DEFIANT has a more conventional appearance, but its propulsion system differs from current helicopters. The twin-engine SB>1 is classified as a compound helicopter. It has two counter-rotating coaxial rotors and a rear-mounted pusher propeller. The former provide enhanced lift and stability compared to conventional rotor designs; the latter provides considerable forward thrust without tilting the axis of the main rotors.

BLACK HAWK Family

Both FLRAA concepts guarantee significant boosts in speed, climb and agility when compared to the Sikorsky UH-60. However, replacing the 2,000 BLACK HAWK helicopters currently in US service will not be completed before the 2040s. Moreover, FVL is a purely US programme, while the BLACK HAWK family is in service in nearly 30 nations. For this reason, Sikorsky is currently upgrading and modernising the 41-year-old UH-60 line (which consists of dozens of general purpose and specialised variants, including export models designated as UH-70).

The UH-60M or MIKE multi-mission variant introduced in 2006 remains the current production model. Older variants can be upgraded to the new standard, and are designated as UH-60Vs or VICTORs.

Performance, maintenance and survivability have all been enhanced vis-a-vis previous iterations of the UH-60. The MIKE variant has a four-person crew and accommodates 11 combat-equipped passengers. In addition, 4,090 kg can be sling-loaded. Cruising

Photo: US Army

The Bell-Textron V-280 VALOR tiltrotor aircraft technology demonstrator

Photo: US DoD

A UH-60M BLACK HAWK helicopter lifts off with a High Mobility Multipurpose Wheeled Vehicle during Exercise Uhlan Fury at the Gen. Silvestras Zlikaliskas Training Area, Pabrade, Lithuania.

Photo: US Army

The UH-60V upgrade package outfits older model BLACK HAWK helicopters with a digital cockpit.

Photo: Lockheed Martin

Lockheed Martin / Sikorsky offers a specialised fire-fighting variant of the S-70i called the FIREHAWK. It includes a 3,785-litre water tank and can be configured for casualty evacuation, SAR, or firefighter insertion.

speed is 151 knots, while the vertical rate of climb when carrying 11 combat troops is 478 metres per minute. Major performance enhancing components include: the two 2,000 shaft horsepower (shp) T700-GE-701D turboshaft engines producing up to 2,974 kW power each; the wide chord main rotor blades which enhance lift and manoeuvrability; an active vibration control system; and the advanced digital cockpit which reduces pilot workload and enhances situational awareness. Cockpit elements include four night-vision compatible Rockwell-Collins multi-function displays, a four-axis fully coupled flight director, digital map, a Honeywell dual embedded GPS/INS navigation system, a Joint Variable Message Format (JVMF) messaging system, the STORMSCOPE lighting detection system, and two Marconi digital flight control computers. The UH-60M's profile encompasses almost everything short of attack-helicopter missions (although the UH-60M and S-70i can be outfitted with the Armed BLACK HAWK kit which enables the aircraft to deploy various air-to-ground munitions including up to 16 HELLFIRE anti-armour missiles).

Sikorsky also produces a dedicated maritime variant designated as the MH-60R SEAHAWK, which the US Navy describes as the world's most modern maritime helicopter. The mission profile ranges from logistic support, personnel transport and SAR, to over-the-horizon (OTH) reconnaissance, target designation, and armed anti-ship/anti-submarine operations. While the aircraft shares most components with the UH-60M, it has been optimised for shipboard operations. This includes addition of the AN/APS-153 maritime surveillance radar, Link 16 and the HAWKLINK AN/SRQ-4 Common Data Link for communications with the ship, the AN/ALQ-248 Advanced Offboard Electronic Warfare (AOEW) capable of integrating with the shipboard EW systems, and the Thales/Raytheon AN/AQS-22 ALFS (Airborne Low-Frequency Sonar) for underwater reconnaissance. Carrying the specialised equipment reduces the transport capacity of the MH-60R to only five passengers.

Photo: Airbus

In September 2019 the Airbus H145 set a new altitude record, landing on the 6,962-meter-high Mount Aconcagua in the Andes of Argentina. This is the first time a twin-engine helicopter has landed at this altitude.

Airbus Light Utility Helicopters

The UH-60 and the FLRAA are classified as medium-lift aircraft. There is also high demand for light utility helicopters. Being smaller, they can land in less accessible areas, and are normally more economical to operate while remaining capable of the same spectrum of operations performed by medium utility aircraft. Noise signature tends to be reduced compared to larger aircraft, delaying detection by opposing forces and minimising disturbance to civilian communities. Representative of this class is the light helicopter line produced by Airbus. Utility variants include the H135 and H145, also known as the EC135 and EC145. The twin-engine H135 can be operated by a crew of one or two, and carries up to six passengers. Alternately, it can take one litter patient and two medical attendants, leaving sufficient space to perform emergency medical services. Early this year, Airbus announced a 120 kg increase to the H135's alternate gross weight (AGW). This increases maximum range and endurance to 770 kilometres and four hours and 16 minutes, respectively. Maximum speed (259 kph) and hover ceiling (2,195 metres) remain unchanged. The H135 is well suited for operations at high altitudes and in all climate zones, and is frequently employed for mountain SAR and Medevac missions. The operational profile also includes military and civilian flight training (including for attack helicopter and heavy-lift helicopter pilots), police surveillance, and technical/logistic support for offshore installations. Sensors and communications equipment can be configured to operator requirements.

The largest of the Airbus light utility helicopters is the twin engine H145. The militarised variant, designated the H145M, is operated by the armed forces of 11 nations. Mission-specific kits can be installed within minutes to optimise the aircraft for a wide range of missions. Configuration options include light attack, transport and utility, intelligence/surveillance/reconnaissance (ISR), and maritime security. In the transport/utility configuration, the H145 carries up to ten combat-equipped soldiers (in addition to the two-person crew) and a sling

capacity of 1,600 kg. Passengers can egress quickly via two sliding side doors and the rear clamshell hatch. A fast rope system, hoists, cargo hooks and machine-gun mounts are available, enabling the H145 to be utilised for assault, special operations, and SAR as well as conventional personnel and supply transport. When optimised for medevac, it can accommodate two litters plus medical personnel.

Safety factors and aircraft survival systems include a ballistically protected cockpit, cabin and engine; defensive electronic warfare suite; self-sealing fuel tanks; infrared signature suppression; a high-set rotorhead which enables crew to safely egress or load the aircraft despite turning rotorblades; and the Fenestron shrouded tail rotor which not only prevents the risk of injury, but also improves aircraft handling. Performance characteristics include a fast cruise speed of 240 kph, a range of 638 kilometres and a mission endurance of three hours and 32 minutes with conventional fuel tanks. The H145 is considered a rugged and reliable aircraft. The US Army, which operates it as the UH-72A LAKOTA light utility helicopter, reports a 90% mission availability rate. In September 2019, an Airbus-operated H145 set a new altitude record by landing above 6,900 metres in the Andes.

Photo: Airbus

The German special operations forces received the first of fifteen Airbus H145 helicopters in 2015.

Heavy Lift

At the other end of the spectrum are high performance heavy-lift helicopters such as the Leonardo AW101 which entered service in 1999 and serves with the armed forces of six NATO nations and Japan. The aircraft is powered by three General Electric CT7-8E turbines which enable a top cruising speed of 277 kph, a maximum range of 1,500 kilometres, flight endurance of six hours and 50 minutes (extendable through aerial refuelling), and 9.5 metres per second rate of climb. Solid design and regularly upgraded equipment maximises occupant and aircraft safety while ensuring that the AW101 remains one of the best performing helicopters of its class; mission system modularity enables customisation to meet customer preferences.

The digital cockpit, mission management computer and other avionic and sensor systems are fully integrated. This provides the crew with real-time situational awareness and enables rapid tactical assessment. Ballistic protection, optional pintle-mounted machine guns and an integrated defensive electronic warfare suite can counter hostile fire and missiles. Additional safety elements include a 20G crashworthy airframe and crashworthy fuel tanks, 30-minute run-dry transmission, and a high-degree of redundancy for all critical systems. The SAR variant features some additional systems such as Synthetic Vision, an Obstacle Proximity Warning System, AESA radar and high-definition electro-optical sensors.

The AW101 can be configured as a multi-role aircraft, as a dedicated SAR helicopter, or as a maritime variant. Crew size varies between two and four depending on mission requirements. The multi-role configuration permits carriage of an additional 25 seated soldiers in the 6.5 x 2.5 metre cabin; up to 50 persons can be taken aboard during emergency evacuation/rescue missions. The rear ramp also permits drive-on/drive-off of special operations force vehicles. The dedicated SAR/Combat SAR variant benefits from the aircraft's range and endurance as well as the superior carriage capacity. Up to 20 wounded can be airlifted off the field at one time; this leaves space for specialised medical equipment to provide emergency trauma care to the most critical patients.

Photo: USMC

The first CH-53K KING STALLION taxis across the flight line at Marine Corps Air Station New River, North Carolina, in May 2018.

The largest heavy-lift helicopter manufactured outside of Russia is the Sikorsky CH-53 SEA STALLION. The CH-53 line dates to the 1960s, but new variants have been steadily introduced. The newest iteration is the CH-53K KING STALLION which is currently entering service with the US Marine Corps; several other nations are also evaluating the KING STALLION.

While the CH-53K resembles the previous variants, it utilises so much new technology that many observers consider it a de facto new aircraft rather than an upgrade. A digital or "glass" cockpit (with triple-redundant fly-by-wire systems) reduces crew workload, improves situational awareness, and enhances the capability to operate under all weather conditions including severely de-

Photo: USMC

Test flight of a CH-53K in 2015

Photo: Tactical Robotics

Tactical Robotics' CORMORANT is an unmanned VTOL aircraft which can be used for Casevac and for logistical support missions.

Photo: Bell-Textron

Bell Helicopter is developing various configurations of the NEXUS EX as an "air taxi" concept. The US military is considering it as an option for short range tactical airlift (Agility Prime programme).

graded visual environment. Cabin volume is 12% larger than on legacy aircraft; widening the cabin by 30 centimetres permits internal carriage of HUMVEE-sized vehicles. Fuel efficiency is improved by 18%. Maintenance requirements have been reduced by 35% through use of corrosion-resistant fuselage and rotor materials, introduction of an electronic aircraft health monitoring system, and configuration to ease access to components requiring repair or replacement. The aircraft configuration accommodates regular mission system upgrades (hardware and software).

This redesign results in significant performance enhancement over previous models. The three T408-GE-MTU engines enable top speeds of 315 kph, with a service ceiling of 5,540 metres. The maximum external lift capacity of 16,300 kg is nearly three times the capacity of previous CH-53 variants; the presence of three cargo hooks provides the option of carrying one heavy load or three smaller loads which can be delivered to separate destinations. Internal transportation capacity is flexible, with options ranging from 32 removable crashworthy seats to carriage of 463L cargo pallets and/or tactical vehicles; deck-embedded rollers facilitate on- and off-loading via the rear ramp. Combination payloads are possible, such as external carriage of a howitzer, and internal carriage of munitions and weapons crew. In medevac configuration the CH-53K can load 24 litter patients.

Ducted Fans and "Flying Cars"

While helicopters are more flexible than fixed wing aircraft, and can access a wide range of landing sites, they are still constrained by such factors as rotor diameter and susceptibility to wind effects. Ducted fan technology has been proposed as one way to overcome these drawbacks. This concept places the rotor or propeller inside a shallow tubular cylinder or "duct", which is open at the top and bottom. Rotor blades are normally much shorter than helicopter blades; this is compensated by using a larger number of blades or "vanes" per duct – in some designs up to 200. Sets of louvers at the top and bottom of the ducts are adjusted to dictate the force and direction of thrust necessary for vertical, lateral or forward motion. The configuration channels and intensifies the lift created by the rotor, enabling flight performance equivalent to that of a helicopter. Proponents of ducted fans point to various advantages: reduced noise signature; reduced physical footprint due to the smaller rotor diameter; decreased vulnerability compared to helicopter rotorblades, which must maintain sufficient distance from obstacles. Taken together, this means ducted fan aircraft could land in spaces too small or dangerous for even light helicopters. Military and civilian applications include medevac, rescue, tactical or humanitarian supply, law enforcement or special operations transport.

The Israeli firm Urban Aeronautics has been touting its trademarked FANCRAFT technology for two decades, demonstrating its HUMVEE-sized CORMORANT prototype flying directly up to the windows of

tall buildings to conduct insertions or rescues. The firm's designs place the lift fans directly within the body of the craft, with crew, passenger or cargo sections along the outer edge. This configuration gives the craft a footprint no larger than an average 4x4 tactical vehicle. While the firm has so far failed to market the CORMORANT, the technology has now gained the interest of Boeing. In January 2020, the aerospace giant signed an agreement with Urban Aeronautics subsidiary Tactical Robotics to explore opportunities for developing, producing and marketing FANCRAFT-based VTOL aircraft including the CORMORANT.

The US Air Force (USAF) is taking a separate approach in its effort to acquire electric-powered vertical take-off and landing (eVTOL) aircraft informally referred to as "flying cars". USAF's Agility Prime programme is committing US$25M in 2021 to support eVTOL and Urban/Advanced Air Mobility technology; additional funding is planned in follow-on years. Will Roper, Air Force Assistant Secretary for Acquisition, Technology and Logistics, has stated a goal of achieving operational capability for this technology by 2023, and acquisition of 30 aircraft by 2030. Rather than pursue a dedicated military prototype, the USAF will support further development and testing of civilian eVTOL with a potential for military applications. The military's goal is procurement of an aircraft capable of carrying three to eight people. Initial performance criteria remain modest: flight speed of 160 kph, a minimum flight endurance of one hour, and a range in excess of 160 kilometres. Potential applications include short range cargo transport, SAR, medevac, and installation security. However, some prototypes being evaluated by USAF already boast much higher performance. The Bell NEXUS family being developed as civilian air taxis are considered prime candidates for the Air Force programme; the largest variant employs six tiltrotor ducted fans, and can carry a pilot plus six passengers at 288 kph. The RHAEGAL-B cargo UAV, which employs four tilting ducted fans, will have a 2,450 kg payload capacity, a range of 1,850 kilometres and a top speed of 370 kph. In addition to battlefield resupply, the Pentagon is considering its suitability for casevac. Overall, up to fifty firms have shown interest in the Agility Prime programme.

Is this a watershed moment for rotary lift? Will future aircraft still resemble helicopters, or will they be closer to the aerial vehicles of today's science fiction films? The answer will likely be: "Both." Conventional rotory lift configurations, tiltrotor designs, and ducted fans all have their distinct advantages and drawbacks. Military and civilian public safety missions will remain multifaceted, precluding any "one-size-fits-all" approach. Diversity will be the key to maximising options. ■

Photo: Sabrewing

The RHAEGAL Cargo UAV uses a turboelectric powertrain.

Exhibition Update – July 2020

As at 6 July 2020, of those that are relevant to the ESD 2020 schedule, to the best of our knowledge, the following exhibitions have been affected by the COVID-19 coronavirus:

IDEB	Postponed to Oct 28-30 2020
BSDA	Postponed to 14-16 Oct 2020
NITEC	Postponed to "Spring 2021"
UDT	Postponed to 8-10 December
HEMUS	Postponed to 30 Sep-3 Oct 2020
KADEX	Postponed to 10-13 Jun **2021**
SEDEC	Postponed to 15-17 Sep 2020
EW Europe	Postponed to 16-18 Nov 2020
ADM Seville	Postponed to 2-4 Feb **2021**
DEFEA	Postponed to 11-13 May **2021**
Balt Military Expo	Postponed to 20-22 Apr **2021**
Close Combat Shrivenham	postponed to 20-22 Oct 2020
SMDC	virtual only, from 4 Aug 2020
Land Forces Australia	Postponed to 1-3 Jun **2021**
MSPO	NO CHANGE as at 6 Jul 2020
SMM	NO CHANGE as at 6 Jul 2020

ADEX	NO CHANGE as at 6 Jul 2020
DVD	Postponed to 4-5 Nov 2020
AAD	NO CHANGE as at 6 Jul 2020
Modern Day Marine	NO CHANGE as at 6 Jul 2020
NCT Rome	NO CHANGE as at 6 Jul 2020
ADAS	Postponed to 5-7 May **2021**
SOBRA	NO CHANGE as at 6 Jul 2020
AIREX	NO CHANGE as at 6 Jul 2020
itsa	NO CHANGE as at 6 Jul 2020
AUSA	NO CHANGE as at 6 Jul 2020
Arms & Security	NO CHANGE as at 6 Jul 2020
MILSIM CEE	No information
Euronaval	NO CHANGE as at 6 Jul 2020
Future Forces Forum	NO CHANGE as at 6 Jul 2020
Milipol Qatar	NO CHANGE as at 6 Jul 2020

Notes:

1. This list covers relevant events originally scheduled between 13 May and 31 Oct 2020.
2.

MITTLER REPORT

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The Most Advanced Military Transport Plane

A400M Situation Report

Jack Richardson

With seven partner nations, the UK, France, Germany, Spain, Belgium, Luxembourg and Turkey involved, few collaborative defence projects have had a history as turbulent as that of the A400M.

With a crew of three (two pilots and a loadmaster alongside the option of a third person on the flight deck) who operate it with an advanced glass cockpit derived from A380 super jumbo (with the addition of a head-up display), the A400M has significant potential. With a top speed of Mach 0.72 at 40,000 feet and payload of 37 tonnes which it can carry 2000 nm, Airbus have marketed this aircraft as performing 'delivery to the point of need'. By this, the company claims the A400M is able to deliver large loads to improvised and remote airstrips into potentially hostile environments, thanks to defensive aids, thus being able to act as both a tactical and strategic transporter for military payloads in addition to civilian cargo in Humanitarian and Disaster Relief (HADR) efforts. Various loadout options are available, from paratroopers with cargo/equipment pallets to Casualty Evacuation (CASEVAC) in addition to the ability to carry large Protected Mobility Vehicles (PMVs) and helicopters (including the CH-47 CHINOOK or multiple AH-64 APACHEs and various medium types). To make loading easier, the rear of the fuselage can be lowered into a 'squatting' position and a mechanical winch inside the cargo hold can be utilised to help load and off-load cargo. The aircraft is also equipped with two underwing air-to-air refuelling hoses to extend the range of fighter aircraft, while a hose and drum system can be fitted in the cargo hold the refuel larger aircraft. The A400M also has its own air-to-air refuelling probe mounted above the cockpit to receive fuel from other tanker aircraft.

Photo: via author

The A400M is able to deliver large loads to improvised and remote airstrips.

The Origins

The A400M has its origins in the 1982 Future International Military Airlifter (FIMA) project which sought to replace the C130 HERCULES and C160 TRANSALL used by different European Air Forces at the end of the Cold War. This became the Future Large Airlifter (FLA) in 1991, involving British Aerospace, Aerospatiale, Deutsche Aerospace, Alenia and CASA as US company Lockheed had pulled out in 1989 to focus on developing what became the C130J SUPER HERCULES. The FLA programme soon evolved to be taken on by Airbus Military, when the latter was created in 1995, with the programme also being joined by Belgian and Turkish industry in 1998. However, the complexity of the programme, differing requirements and internal restructuring within the company led to significant delay. One such cause of this was disagreement on the powerplant for the aircraft, with some partners favouring an off-the-shelf engine from Pratt and Whitney Canada, whereas others preferred (the ultimately selected) solution developed by the EUROPROP consortium (which has the unusual feature of the two propellers on each wing counter rotating). Italy withdraw from the programme and Germany considered a Westernised Antonov 70 as an alternative, with the UK leasing four C17A GLOBEMASTER IIIs as an interim measure in 2001. These aircraft were later purchased outright and joined by a further four within the following decade. The A400M design proposal was delivered in July 1999 then accepted in July 2000, though the first prototype didn't fly until December 2009, the year in which cost overruns put the aircraft €11Bn over budget. This led Airbus to suggest the aircraft could be cancelled,

forcing the partner countries to provide a €1.5Bn loan and reduce the combined order to 170 aircraft (down from the original 212). The aircraft finally made its operational debut in December 2013 when it transported supplies to French forces in Mali under Operation SERVAL. However, more difficulty was to follow on 9 May 2015, when an aircraft destined for the Turkish Air Force crashed shortly after taking off from the final assembly plant in Seville, Spain. The incident, caused by a software failure, led to an overhaul in Airbus's management structure and blunted the momentum of the programme.

Despite this, however, the aircraft has enjoyed a renaissance in Turkish service, with it reportedly being used in March 2017 to support President Erdoğan's visit to Russia for a summit with President Putin. Difficulty has continued after this fatal incident, however, as the aircraft has suffered from flaws in its air-to-air refuelling capabilities, which all of the partners, except the UK due to contractual obligations with its leased A330 Multirole Tanker Transport (MRTT) fleet, intend to utilise. Tests found that the wash created by the propellers made it unsafe for the aircraft to refuel helicopters, a key capability for the French Air Force, in order to refuel its CARACAL Combat Search and Rescue (CSAR) helicopters. As a result of this and wider delays to the programme, France and Germany are to establish a joint C130J squadron at Evreux Air Base in France's Normandy Region. France will operate four aircraft, two each in the C-130J transport and KC-130J tanker configuration with Germany buying three of each type to prevent any transport or aerial refuelling capability gaps arising from A400M delays. Final certification for helicopter air-to-air refuelling is expected by 2021, with 'dry' contacts between the A400M and a helicopter carried out in September 2019.

Successful Operations

Despite the need for this C130J purchase, the A400M has enjoyed some success in French service during ongoing operations in sub-Saharan Africa. It was reported in September 2018 that French Foreign Legion paratroopers conducted a parachute jump in cooperation with mechanised forces in order to improve mobility over Jihadi fighters in the region. The assault involved 120 paratroopers with 80 deployed from two C-160 TRANSALL legacy transport aircraft and 40 from an A400M. The following September, a French Air Force A400M airdropped supplies to Kidal Air Base in the Sahara as part of Operation BARKHANE, with France as one of the leading partner nations in refining the A400M's capabilities. In July 2019, a French A400M successfully deployed 58 paratroopers from one of its side doors and in May 2020, France's procurement agency, the DGA, announced successful trials towards maximum paratrooper deployment of 116 simultaneously (58 from each side door), paving way for this capability to become available in 2021.

Size comparison of military transport aircraft. Top down: Transall C-160; Lockheed Martin C-130J SUPER HERCULES, C-130J-30 SUPER HERCULES (extended), Airbus A400M ATLAS, Boeing C-17 GLOBEMASTER III

Humanitarian Aid

Another important role envisaged for the A400M is the Humanitarian Aid and Disaster Relief (HADR) mission, where it proved its value during the 2017 Hurricane season in the Caribbean. In response to this, the Royal Air Force deployed two A400Ms (alongside a C130J and multiple C17As) under Operation RUMAN to deliver key humanitarian equipment to the region. It was reported that the aircraft proved invaluable by being able to reach the Caribbean by flying over the Atlantic via the Azores compared to the C130J, which had to transit via the US and Canada. Once in theatre, the A400M also demonstrated its ability to carry oversized aid cargo, such as a mechanical digger, around the area. The French Air Force also deployed an A400M to transport cargo which included a PUMA tactical helicopter. Airbus has also reported that the A400M's only export customer to date, Malaysia, used their four examples to deploy HADR to Indonesia after an earthquake in October 2018 which affected the island of Palu. The manufacturer also said that the aircraft was the only one in theatre able to carry a 22-tonnes excavator and fuel truck needed in the area. This capability is becoming a key marketing point for Airbus when trying to sell the A400M overseas (in March 2019, A400Ms from the UK, Spain and Turkey delivered HADR to Mozambique following Cyclone Ida) to nations including Indonesia. With neighbouring Malaysia having already used the type to deliver large loads to remote areas (alongside providing air-to-air refuelling to its fast jets), Indonesia's Ministry of Defence approved the purchase of five A400Ms in January 2017. This was followed in March by a Letter of Intent with Pelita Air Services, a consortium of Indonesian Aerospace firms, though little has been heard of the deal since.

Air-to-Air Refuelling

As the A400M continues to be utilised more for air-to-air refuelling (Germany deployed it for this function with combat aircraft over the Middle East in July 2019, despite reports in November 2019 it refused to accept two examples due to reliability issues), the only partner not

Photo: via author

An A400M refuelling two TORNADO jets

deploying the aircraft for this function, the UK, is however using it in more specialist roles. The RAF has been using the A400M to support its operation against the so-called Islamic State in Iraq and Syria since 2015 and also deployed it to Exercise Mobility Guardian in 2017 to test the type's ability to carry specialist loads, including the US Army's STRYKER 8x8 wheeled vehicle.

These were followed in 2018 by t206 Squadron, RAF, charged with operational evaluation for transport types, testing the aircraft's beach landing capabilities in West Wales. The aircraft has still attracted controversy, however, after reports surfaced in the UK press during July 2019, that only two of the RAF's 20 A400Ms were available due to reliability issues. With a maximum range of 4800nm, the A400M has also been used by the RAF for one of its longest running operational commitments. Ever since the 1982 war, the UK Armed Forces have had a significant presence on the Falkland Islands of which the air element includes four EUROFIGHTER TYPHOON fast jets, a A330 Multi-Role Tanker Transport (MRTT) and since April 2018, an A400M. Having replaced the C130 HERCULES previously stationed at Mount Pleasant airfield, this aircraft provides British forces in the area with a tactical airlift capability. It can also be used for maritime reconnaissance in this theatre (despite lacking specialist equipment) in addition to Search and Rescue (SAR). Indeed, for the latter, the aircraft played a part in the search for a Chilean Air Force C130 which went missing near Antarctica in December 2019. In addition to the RAF supplying specialist personnel, the Falkland Islands based A400M carried out 'specialist reconnaissance flights' to find the missing aircraft.

COVID 19 Missions

In addition to taking on more routine missions including the support of a Spanish Air Force deployment of EUROFIGHTER TYPHOONs to Latvia as part of NATO operations in March 2018, in recent months, the aircraft has been at the forefront of efforts across Europe to counter the worst effects of the COVID 19 pandemic. In Spain, it has been used to transport urgently needed Personnel Protective Equipment (PPE) around the country and images appeared of a German example transporting COVID patients from France to Germany for treatment. The aircraft has also been utilised by the UK to transport COVID positive patients from Scotland's remote islands to the mainland for treatment while it had particular exposure in April 2020 when, at the height of the outbreak, the UK government ordered a shipment of PPE from Turkey and dispatched an A400M (with two more on standby) to Istanbul to collect it. Accounts differ as to the cause, but the consignment was delayed by several days, leading to pictures which circulated widely in the media of the aircraft sitting idle on the Istanbul runway while PPE shortages continued. Following this episode, in May 2020, the Turkish Air Force used its A400Ms to transport key COVID 19 aid, including ventilators, to the Somali capital Mogadishu.

Deliveries

Of the 174 number of aircraft on order, 90 have been delivered at time of writing, including the sole example ordered by Luxembourg, which first flew in April 2020 with delivery thought to be imminent, after which it will be operated as part of a joint fleet with the seven examples ordered by Belgium. A notable trait of the A400M programme, possibly due to its long delays, is the lack of exports. South Africa signed up to purchase eight

Photo: US Air Force / Erin McClellan

The load compartment of an A400M ATLAS

aircraft in April 2005 but the order was cancelled in November 2009. During 2005, the Chilean Air Force planned to acquire the A400M to replace the C130 and the country's government attempted to negotiate industrial involvement in the programme. However, this also fell through. Since, sales to states in the Middle East including to Algeria, Saudi Arabia, Egypt and the UAE have been suggested but have yet to materialise while in Oceania, the C17 was selected by Australia over the A400M to supply a large airlifter in the early noughties. More recently, in New Zealand's competition to find a new airlifter to replace its ageing first generation C130s, the C130J SUPER HERCULES was selected over more modern types including the A400M.

Exports

Despite these setbacks, there are continued reports of opportunities Airbus is pursuing to export the type but another consequence of the delays is the fact that several partner nations have reduced their planned A400M purchases. The UK originally planned to purchase 25, a figure reduced to 22 (with 21 delivered to date). Germany's original requirement was for 60, later reduced to 53, though 13 of these will not enter service. As a result, it has been reported these surplus aircraft could be sold to another country. Another option, proposed in February 2017, was these aircraft being purchased jointly by Switzerland and the Czech Republic in a joint pool to replace their ageing transport fleets, though little of this plan has been heard since. However, there have also been reports Germany will base its surplus aircraft at Lechberg Airbase near Augsberg and crew them on a multinational basis. This plan, if it comes to fruition, would not be without precedent as the NATO Strategic Airlift Capability operates a joint C17 fleet from Hungary and Germany is joining not only the combined C130J fleet with France, but also the Multinational Multirole Tanker Fleet with the Netherlands, Belgium and Norway, in order to increase European air-to-air refuelling capacity with a pooled A330 MRTT fleet. Spain also decided to defer 13 of its 27 planned airframes to later in this decade (with reports A330 MRTTs could be built instead) and there have been reports that the country is in negotiations South Korea to purchase at least some of these aircraft. It has been suggested that in exchange, Spain would purchase

Photo: US Air Force / Erin McClellan

The A400M's TP400-D6 turboprop engine in the workshop of MTU Aero Engines in Munich, Germany

a number of KAI GOLDEN EAGLE Advanced Jet Trainers to replace its legacy F5E TIGERs used in this role. This comes after South Korea failed to purchase the C17 before its production ended in 2015. As a result of this competitor aircraft no longer being available (the final surplus example was purchased by India), analysts have proposed another possible market for the A400M. The US currently operates a large number of C130Js (and other specialist derivatives) C17s and C5M SUPER GALAXY'S but lacks a medium 'strategical' airlifter between the C130J and C17 that can reach unprepared airstrips with large payloads. IHS Janes' proposed in 2018 that as these aircraft age, the A400M could serve as a replacement, with the C130J and C17 having maximum payloads of 21,772kg and 76,655 kg respectively, the A400M could fill this gap. However, any such acquisition (which could potentially extend to triple figures) would be subject to political considerations such as domestic manufacture and the US Air Force's experience with Airbus's MRTT proposal.

The Way Ahead

The A400M has had a long and troubled entry to service, at various times coming close to cancellation, missing several valuable opportunities along the way. Now that it has begun to pass key milestones in developing its full potential and started to be proven on different types of operations all over the world, attention has been drawn to it for more positive reasons. At time of writing in late May 2020, it was announced that the aircraft was also certified to fly at low level on autopilot. However, the prolonged road to this point has meant that many high-profile races to supply replacements for legacy airlifters to air forces around the world have been won by competitors, an issue compounded by customer nations scaling back commitments leaving surplus examples which can be sold without extending production. This situation is only going to get harder, as international defence budgets are likely to contract in the light of COVID 19 and more competitor airlifters (such as the C-390 MILLENIUM from Embraer and the Kawasaki C2) become available. On the positive side, however, its large size gives the A400M a degree of future proofing as military hardware payloads (such as aircraft and PMVs become larger) and volumes of HADR supplies become larger. Overall, though, it is too early to know the full nature of the way ahead for the A400M. ■

Project JIGSAW

Seeking Out Solutions for Operational User Problems

NATO ACT

Today's security environment is increasingly ambiguous and complex. Recent decades have seen an unprecedented acceleration of technological development especially in the digital domain. Widely available new technologies offer state and non-state adversaries new opportunities to disrupt NATO operations. This has created an environment of strategic urgency for NATO to embrace agile innovation. As the warfighting development command for NATO, Allied Command Transformation, under General André Lanata, recently launched an Innovation Branch to focus work in this area. SACT's effort in the area of innovation is focussed on increasing the warfighting capability of Allied Command Operations (ACO) as well as facilitating national member interoperability. One of the lead initiatives is a project called JIGSAW which is a US Air Force developed software tool, which will be rapidly adapted to the NATO environment.

Photo: NATO

Project JIGSAW's Tanker Flow Board

The Innovation Branch employs agile methodologies to actively seek out solutions for operational user problems and leverage technology to make the NATO warfighters' mission easier, safer and more effective. In a DevSecOps environment, Developers are matched with Operational users in conjunction with Security considerations to solve problems. The team defines the problem and rapidly develops a Minimum Viable Product (MVP) based on direct user input layered with security considerations at the initiation stage. Once the MVP is created the tool is spiral developed, improved, based on user feedback thus empowering the warfighter in solving their problem. This process continues until the team arrives at a final product and a satisfied user.

Allied Command Transformation innovators travelled to NATO Allied Air Command in October 2019 and gathered user problems in a Dragon's Den format. One of the challenges presented by Allied Air Command was Tanker planning. The methodologies employed to service airborne refuelling requirements during operations were personnel intensive and required hours of planning. The Allied Command Transformation Innovation team investigated and determined that there was an existing software tool specifically created to handle this task. It is called JIGSAW and was designed by the United States Department of Defence to complete this task in the Air Operations Centres environment.

Only two weeks after the initial discussion with Allied Air Command, Allied Command Transformation Innovators demonstrated JIGSAW during NATO Exercise TRIDENT JUPITER 19-1 in Fall 2019. The capability proved to be a tremendous improvement over existing methodologies and was subsequently tested by NATO personnel during the NATO Specialised Heavy Air Refuelling Course in February 2020.

During the Specialised Heavy Air Refuelling Course, a team of four students took three hours (a total of 12 person hours), to plan a series of 108 air refuelling requests, in a notional 24-hour mission day, as part of their course culmination activity. In contrast, using JIGSAW, a single test subject planned the same series of missions in only 1.5 hours with no knowledge of air-to-air refuelling planning and only 30 minutes of JIGSAW familiarisation training. In addition, JIGSAW planned the refuelling requests with only 25 tanker sorties vice the 28 used by the students. This test proved the efficiency of JIGSAW in reducing planning time and resources, as well as increasing operational flexibility during the mission execution phase. JIGSAW provides NATO the opportunity to continue streamlining its processes resulting in a more agile and effective force.

Lieutenant Colonel Jonathan Clow is the Allied Command Transformation Innovation lead for the JIGSAW project. "To keep our nations safe in such an unpredictable environment, we need to keep our Alliance strong. Innovation and experimentation are critical components of NATO's future defence, security, and deterrence," said Clow. "A culture of experimentation at Allied Command Transformation allows us to consistently revamp and develop our capabilities and embrace new concepts to make our Alliance more successful."

As a result of this success, NATO is engaged in a Foreign Military Sales process with the United States Department of Defence to secure the use of JIGSAW for NATO Air Operations Centres by the end of this year. While this process is proceeding, Allied Command Transformation Innovation is actively engaged in several other agile methodology software projects to increase NATOs warfighting capability and interoperability in all environments. ■

The Cartographic War between India and Nepal

Suman Sharma

On 13 June 2020, Nepal, a generally peaceful neighbour of India in the Himalayan region, passed an amendment in its House of Commons to include in the Constitution a map of the country that included three areas that had previously not been part of the country. These are the Lipulekh, Kalapani and Limpiyadhura areas, all part of the mountainous Indian state of Uttarakhand. This action came after Indian Defence Minister Rajnath Singh inaugurated an 80-kilometre road from Dharchula to Lipulekh on the Mansarovar Yatra Trail on 8 May 2020, which led to protests throughout Nepal. These protests were further fuelled after the Indian Army chief, General M.M. Naravane, declared that the protests in Nepal were directed by a third party, by which he meant China.
According to the Nepalese with the publication of the new map, an additional 335 square kilometres of land have been added to Nepal's geographic area, increasing the total area from 147,181 square kilometres to 147,516 square kilometres. Earlier treaties between India and Nepal, such as the Treaty of Sugauli of 1816, and a treaty of friendship between the two countries of 1950, contain no reference to an apparent border dispute.

A Pilgrimage Route

The Darchula-Lipulekh link road is known as the Kailash-Mansarovar-Yatra route. It is an extension of the Pithoragarh-Tawaghat-Ghatiabagarh road. It originates in Ghatiabagarhand and ends at the Lipulekh Pass, the gateway to the Kailash-Mansarovar. India's idea in building the road was to shorten the Mansarovar pilgrimage route for Indian pilgrims by six days. It is an arduous pilgrimage, undertaken by thousands of Indians every year in the hilly terrain and lasts about a month.
New Delhi immediately reacted to Kathmandu's cartographic aggression, calling it untenable and not based on historical facts, and urged the Nepalese leadership to create a "positive atmosphere for a diplomatic dialogue to solve the open border issues." Meanwhile, Indian Defence Minister Rajnath Singh said at a virtual rally of BJP supporters in Uttarakhand that "if there is any misunderstanding among the Nepalese people about the road built from Dharchula to Lipulekh, we can find a solution by sitting down together."

Kalapani Valley and two other regions have become contested territory between India and Nepal.

Once the new map card is approved in the Nepalese House of Commons, it must be approved in the House of Lords before it reaches President KP Sharma Oli for final signing. What New Delhi presumably meant by creating a "positive atmosphere of discussion" was to hold talks before the map is presented in the House of Lords.
There are reports of visits by Nepalese military leaders to the border and also of an apparent military deployment at the Indo-Nepalese border, such as a helicopter landing pad and the deployment of further Nepalese troops.

Skirmishes with China

The actions of communist Nepal must be understood in the context of the recent Chinese skirmishes over territory on the Indo-Chinese border. President K.P. Sharma Oli of the Communist Party of Nepal came to power in February 2018 and is said to be close to Beijing.
In view of the historical ties between India and Nepal, the open borders and the fact that India is the largest investor in the small country of 28 million inhabitants, 80% of whom are Hindus, the Nepalese action has not been well received by New Delhi.
Emboldened by the backing of Beijing, Kathmandu has shown inconsistency in its claims for disputed territories. The former diplomat Professor S.D. Muni commented, "former Nepal[ese] Kings and governments accepted Lipulekh as the point of contact between India and China, after both countries signed the Tibet Treaty in 1954, but now Nepal refuses to accept [it]. Nepal did not attach this new map in 2015 when it came up with its new Constitution, then why now?"
And Nihar Nayak of the Institute of Defence Analyses and Studies said, "In 2007, the Joint Boundary Commission completed its study and Nepal refused to sign it in 2008." In 2008, during the visit to Nepal by India's former External Affairs Minister Pranab Mukherjee, the Joint Statement mentioned Lipulekh, which was again rejected by Nepal.
Nepal's trade with India has grown exponentially over the years and accounts for more than two-thirds of Nepal's external trade of around US$12Bn annually. Interestingly, it may be noted that presently there are 39 Gurkha battalions serving in seven Gurkha regiments in the Indian Army. The Gurkhas are originally Nepali natives.

Photo: via author

Where Am I?

Thomas Withington

Satellite navigation has subtly changed our world. How can it be improved for civilian and military users alike?

The US Global Positioning System (GPS) space-based navigation apparatus is over 40 years old. It is far from having a mid-life crisis. Thoughts of engineers are turning towards how they can make GPS even better. The US Department of Defence (DOD) commenced development of GPS back in 1973 under the banner of the Defence Navigation Satellite System (DNSS). GPS was envisaged as a means of overcoming the limitations of traditional radio and cartographical navigation methods. It would take 22 years until the system entered military service. At the core of the DNSS were ten Rockwell International Navstar-1 Block-1 satellites. There were launched from 1978 and intended as prototype, proof-of-concept spacecraft. They used an elegantly simple technique to help those on Earth realise where they are; a process which remains at the core of all GNSSs (Global Navigation Satellite Systems).

In the case of Navstar-1, each satellite transmitted two L-band signals at frequencies of 1.57542 gigahertz/GHz and 1.22760GHz. These two signals, known as L1 and L2 respectively, continue to be used by the US GPS constellation today. In the usual alphabet soup of military acronyms, GNSSs provide PNT (Position, Navigation and Timing) services. All GNSSs rely on several satellites orbiting the Earth, transmitting a signal which is modulated to contain information regarding the satellite's position and the time it transmitted the signal. These signals travel at the speed of light; 161,987 nautical miles per second (300,000 kilometres-per-second). At least four satellites need to be in a line-of-sight range from the GNSS receiver on Earth. The receiver will computer your position relative to the four GNSS satellites in range of the receiver by calculating the tiny differences between the time of arrival of the signal from each of the four satellites.

Despite its unarguable utility, one of the shortcomings of GPS is that its transmission frequencies are rather weak, in the region of 44.8 watts. This is the result of several factors including the distance that the signal has to travel; typically in the region of 11,879 nautical miles/nm (22,000 kilometres) and the fact that transmitters have to be fitted to the satellites which are small enough to equip the spacecraft and allow

Photo: US Naval Research Laboratory

The NTS-2 was the first demonstration satellite which comprised part of the NAVSTAR GPS constellation. The spacecraft was designed and built by the US Naval Research Laboratory and launched from Vandenburg airbase, California on 23rd June 1977.

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it be a reasonable launch weight while still ensuring that the transmissions can reach Earth. As a result, these weak GPS signals can be relatively easy to jam. This has resulted in GNSS jammers which can be easily purchased on the internet and may have effective ranges of 40 metres (131.2 feet) and above.

M-Code

Military users can offset this weakness by using M-Code GPS transmissions encrypted using the Modernised Navstar Security Algorithm (MNSA). This became available in 2000. The M-Code approach has now received a further enhancement as a result of the GPS Block-III initiative. GPS-III got underway in 2000 following the project's authorisation by the US Congress. It represents a wholesale modernisation of the GPS architecture with new spacecraft, ground stations and GNSS waveforms. The first GPS Block-III satellite was launched on 23 December 2018. Since then, Lockheed Martin, which is leading the initiative, has launched a second satellite on 22 August 2019. A further eight satellites are planned with the spacecraft having an expected lifespan of 15 years. The M-Code transmitted by the GPS Block-III satellites will use the same L1 and L2 frequencies. This will supersede the P-Code used by the military for the legacy GPS constellation. To understand M-Code one needs to understand P-Code, and to understand P-Code one must understand CA-Code. Confused? Bear with us. Things will fall into place.

As noted above, GPS uses two signals; L1 and L2. These signals transmit two types of code CA-Code (Course Acquisition Code) and P-Code. CA-Code is used by the civilian world. It is a long list of zeros and ones transmitted at a rate of 1,023,000 million bits-per-second and is repeated every millisecond. Each CA-Code is unique to each satellite. By calculating the difference between the time each unique code was sent from each one of the four satellites a GPS receiver needs to compute one's location, and the time that each unique code arrives, the receiver will calculate its position. P-Code is used by the military and is known as P(Y)-Code when the signal is encrypted. In a nutshell, P(Y)-Code offers greatly improved resistance to jamming while providing better accuracy than CA-Code. However, it has a major drawback. P(Y)-Code is located in the same electromagnetic neighbourhood as the CA-Code. This is because the CA-Code is carried using a central frequency of 1.57542GHz and spreads five megahertz either side of this central frequency. P(Y)-Code is also centred on 1.57542GHz and spreads just shy of 20MHz either side of this central frequency. This means that if the CA-Code experiences interference or deliberate jamming there is a change that the P(Y)-Code is at the very least degraded. For its time the encryption used by P(Y)-Code was considered adequate but advances in hacking now render it less secure. M-Code improves things significantly. First of all, M-Code transmissions are moved well away from the central frequencies of the CA-Code. Jam the CA-Code and there is a chance that the M-Code is left alone. This is because the M-Code uses frequencies five megahertz either side of the central 1.57542GHz signal; but also has two additional beams between -5MHz and -15MHz and +5MHz to +15MHz either side of the 1.57542GHz transmission. Therefore, the civilian frequencies may get jammed while the military frequencies are left alone. Even if the military transmissions are targeted, simple noise spot or barrage jamming across these frequencies may make little difference unless the attacker is able to disrupt the M-Code encryption. As noted below, like civilian GNSS receivers their military counterparts maybe increasingly able to recognising when they are being jammed and then recommend that the user relies on other forms of navigation. Alternatively, the receivers may be capable of recognising and isolating the jamming signal, while continuing to receive the M-Code transmissions. Conversely, the architecture of M-Code and its interaction with the CA-Code will let an attacker jam the CA-Code while leaving their own use of the M-Code unaffected. This is important as the US is getting into the business of jamming GNSS. The sole offensive asset believed to be deployed by the new US Space Command, activated on 20th December 2019, is the L3Harris Counter Communications Jammer (CCS) Block-10.2 system. It is known that the CCS Block-10.2 can perform GNSS jamming and maybe able to disrupt such signals at the theatre/operational levels.

Photo: CIU Ltd

GNSS jammers are freely available and can be procured for often as little as a few hundred dollars. They take advantage of the weakness of GNSS transmissions to jam the signals.

Photo: Lockheed Martin

The new GPS Block-III constellation will include important enhancements to the overall performance of the Global Positioning System not least of which will be the introduction of the M-Code protocol for the military.

Hard Immunity

GNSS jamming does not just affect the military. Given that military signals are encoded, electronic attack against military-level GNSSs may have a more serious effect on civilian users. This has already been observed in the Syrian theatre. In June 2019, it was reported

Photo: US Space Force

The Counter Communications System shown here is the only offensive asset owned by the US Space Force. As well as jamming hostile communications it is also thought to be capable of attacking GNSS transmissions.

that GNSS jamming had affected aircraft traversing Israeli airspace. The source of the jamming was determined to be Khmeimim airbase in western Syria. This is where Russia has a sizeable military deployment assisting its ongoing operations in support of President Bashir al-Assad's government. The Russian Army's Protek R-330Zh ZHITEL jamming system, believed to be capable of electronic attack across frequencies of 1.1GHz to 1.6GHz was suspected to have been the culprit. It was not thought that Russian forces were deliberately targeting the civilian use of GNSSs, but instead that jamming was being used to protect this facility from attack or reconnaissance by hostile Unmanned Aerial Vehicles (UAVs) using GNSS for navigation. The R-330Zh is deployed at the brigade level to provide operational/theatre jamming. As well as being deployed to Syria, the R-330Zh has been deployed to support Russia's intervention in the Ukrainian civil war. In 2015, it was reported as being effective in jamming the GNSS transmissions used by Schiebel S-100 CAMCOPTER UAVs which were supporting the monitoring efforts in theatre of the Organisation for Security and Cooperation in Europe. More recently in November 2018, the Russian military was accused of GNSS jamming during NATO North Atlantic Treaty Organisation exercises in Scandinavia prompting complaints to Moscow from the Norwegian and Finnish governments.

While the military has taken important steps to hardening the transmission security of its GPS signals through the adoption of M-Code, the civilian world can still be vulnerable to jamming, whether performed by a state actor or criminals. Guy Buesnel, positioning, navigation and timing security technologist at Spirent, says that there is an improvement in the awareness of GNSS jamming in the non-military sector but that "people don't appreciate the problem unless something goes wrong." He says that the commercial aviation domain has taken an important stance regarding its use of GNSS via its method of employment. It uses GNSS alongside several other navigation systems like Very High Frequency Omnidirectional Range systems and Non-Directional Beacons, both forms of radio navigation. This builds in redundancy: If one of these systems is lost a pilot can still navigate. Yet shortcomings can be observed in other areas. Timing is integral to GNSS constellations providing reliable information. The accuracy of the timing provided by GPS is now integral for a range of services, Buesnel notes, from governing high frequency trading in the financial world to ensuring automated industrial processes can be completed. The risk is that an organisation or company "might not realise that they get precise timing information from GNSS." This reliance is only likely to increase: "Autonomous vehicles will be hugely reliant on precise timing, you will need to synchronise information with other sensors, and that implies you need accurate timing information inside and outside the vehicle."

It seems inevitable that civilian users of GNSSs adjacent to conflict zones, or areas of tension, will have to be aware of the dangers of jamming. One way to ensure that disruption is kept to a minimum is to independently verify the quality of the GNSS data in a specific area, says Logan Scott, a GNSS expert and president of LS Consulting. He proposes having national organisations which would independently verify the integrity of the data from the multitude of constellations now used. In such a scenario this national organisation would be responsible for checking the integrity of the signals by continually testing the GNS data being transmitted into a country's territory, for example. The organisation could then send out alerts across wireless networks warning users that the GNSS data from certain constellations has been compromised, and that other forms of navigation should be used for the time being.

Scott says that improvements should also occur on the receiver side so that GNSS receivers would realise when they are being jammed. One way of achieving this could be through software updates. These could be downloaded into existing GNSS receivers helping them recognise when something is amiss. As the GPS signal is relatively weak "the receiver could measure the power that it is receiving," says Scott: "If the received GNSS power suddenly increases by a factor of 100, then this probably means that the receiver is being jammed. This is one measure that you can take to ensure the quality of the data." He says that it may be possible to use software which not only determines that jamming is occurring, but which can identify its source. This has the added benefit of potentially unmasking the perpetrator. In the civilian world "most jamming can be an indication of criminal activity," Scott remarks. As we saw with the

Photo: Denis Abramov

The deployment of military GNSS jammers like the Russian Army's R-330Zh Zhitel system to the Syrian theatre of operations has caused headaches for civilian satellite navigation system users in the Mediterranean.

GNSS jamming Israel suffered last June, the source of this interference was determined to be the Russian deployment to Khmeimim airbase. Thus in the civilian and the military context, GNSS jamming can be a double-edged sword as it can betray the jammer's location.

Enhancing GNSS receivers may be helped greatly by advances in artificial intelligence and machine learning. In such cases the receiver's software can draw on previous occasions when the it suffered interference determined to be jamming. This will help the receiver identify jamming in the future and outflank it by determining that the signal is false and discounting it while continuing to receive the true GNSS signals. Alternatively, the system could recommend that the user rely on other navigation systems until the jamming subsides. Scott says that this approach, known as "hard immunity". It borrows from the medical domain where mass vaccination stops the virulence of diseases. This is because they struggle to take hold and spread when most of a population is immunised. Having a majority of GNSS receivers containing hard immunity algorithms, coupled with sovereign assurance that GNSS data is accurate, or otherwise, could greatly reduce the potency of GNSS jamming in the civilian domain.

Use the MAP

Reducing GNSS vulnerabilities cannot be achieved by a single method. Instead Buesnel says that "the multi-layered approach" is paramount. This focuses on what Bradford Parkinson, a pioneer of GNSS who was instrumental in helping to realise GPS, called the 'protect, toughen and augment approach.' The focus is on the use of legislation to protect GNSS and its users, to improve the resilience of hardware and software against interference and congestion and to complement GNSS with other technologies. In the military domain, this is focusing on using satellite navigation systems in conjunction with other equipment such as Inertial Navigation Systems (INS).

Photo: US Army

US Army M-1126 STRYKER series armoured vehicles are receiving the MAPS upgrade to improve their resilience to the GNSS jamming; a prudent measure given recent Russian investments into satellite navigation system jamming.

This is already done in the civilian and military aviation domains, but this approach is now migrating to land forces. For instance, the US Army's MAPS (Mounted, Assured Positioning, Navigation and Timing Systems) programme is outfitting vehicles with a jam-resistant GPS antenna and pairing this with a vehicle's GPS receiver. Initially, the MAPS architecture is outfitting the force's General Dynamics M-1126 STRYKER family of wheeled armoured fighting vehicles. Reports state that the architecture also includes alternative PNT sources such as on-board atomic clocks to allow a vehicle to outflank disruption to the timing signal when an adversary is attempting to jam GNSSs. GPS anti-jam antennas use a number of antennas clustered together. They can sense when uncharacteristically powerful GNSS transmissions are being received which could indicate jamming. By triangulating the microscopic differences in time that the signal arrives at each individual antenna, the receiver can determine that powerful signals coming from a particular direction are in fact jamming signals, and 'blank out' the signals from this particular direction while continuing to receive normal GNSS transmissions. Put simply, you are barring the signals arriving from one direction, while letting in those arriving from another. MAPS will also include software allowing the GPS receiver to recognise unusual characteristics in signals which may indicate jamming and to either ignore these or to increase reliance on a vehicle's other navigation systems like its atomic clock.

As of mid-2019, the first MAPS systems were installed on M-1126 series vehicles used by the US Army's 2nd Cavalry Regiment headquartered in Vilseck, southern Germany. In addition, the army is examining the installation of an INS on-board these vehicles in the future. For the uninitiated, an INS employs accelerometers to sense motion, and gyroscopes to sense rotation to calculate a platform's speed and bearing via the process of dead reckoning. The useful aspect of an INS is that even though it needs a time input to perform dead reckoning as all navigation, satellite or otherwise, depends on accurate timing, it can use the Stryker's internal atomic clock thus removing the need for the GPS time signal.

"There is not one silver bullet out there which will solve everyone's problems," remarks Buesnel. Instead organisations, governments and companies should follow the approach advocated by Mr. Parkinson: "In the commercial domain, it can be quite difficult to convince someone to protect their GNSS equipment, particularly if they have only ever experienced sporadic GNSS disruption," says Buesnel, "but if you don't protect yourself against the threats, the impact could be significant." The bad news is that the GNSS jamming threat is real and tangible for civilians and militaries alike. The good news is that there are processes and systems out there that can mitigate its impact. ■

Next-Gen Overhead Persistent Infrared Subsystem

Northrop Grumman Corporation and Ball Aerospace have completed the preliminary design review (PDR) for the Next-Generation Overhead Persistent Infrared (Next Gen OPIR) Geosynchronous (GEO) Block 0 mission payload. Next-Gen OPIR is a satellite system that will provide improved missile warning capabilities that are more resilient against emerging threats. As the successor to the Space Based Infrared System (SBIRS), Next-Gen OPIR's first block of satellites will include five space vehicles, three in geosynchronous earth orbit and two in polar orbit. Following the successful completion of the PDR, Northrop Grumman will continue maturing the subsystem and payload of the next generation OPIR. Northrop Grumman and Ball Aerospace plan to complete the Critical Design Review of the payload in May 2021.

Airborne Radars and the Electronically-Scanned Revolution

Doug Richardson

For many decades, one of the main characteristics of most land, sea, and airborne radars was the use of a moving antenna. Mechanical movement was needed either to survey an area of terrain, sea or sky, or to direct the radar to a specific target.

In the case of airborne radars, this moving antenna was housed either in a radome, or in a slowly-turning rotodome. Although many modern airborne radars still retain this type of antenna, designs that represent the state of the art use electronically-scanned arrays able to form and steer their radar beams.

The high-power transmitter and receiver sections of a mechanically-scanned radar are connected to the antenna via waveguides or a similar feed systems that incorporate some form of flexible section in order to allow for antenna movement. This technique imposes signal losses as the transmitter output travels to the antenna, and further losses as the received signal travels from the antenna to the radar's receiver.

Building an antenna in the form of an array of modules allows the beam to be steered electronically. At first, this was done by creating a passively-scanned array that was connected to traditional transmitter and receiver subsystems. But radars using passive electronically-scanned array (PESA) technology still suffered from signal losses, and faced the reliability problems traditionally associated with high-power transmitters.

In a PESA array, the primary function of the modules is to generate the phase delays needed to create the beam. In an active electronically-scanned array (AESA), each transmit/receive (TR) module handles its share of the energy-generating and receive functions, eliminating the signal losses caused by the signals' journey to and from the antenna.

In some cases, an AESA radar is designed 'from scratch' as a totally-new item, but an alternative route is to replace the antenna, transmit and receive sections of an existing radar with new AESA hardware, but to retain the 'back end' subsystems that process the received signals.

One potential problem with electronically-scanned antennas is that they may act as a reflective surface that will increase the fighter's radar cross-section. One solution is to position the array with a tilt, but since electronically-scanned arrays have a lower performance against off-boresight targets, the radar's performance against targets approaching from directly ahead will be degraded. Some radars such as CAPTOR-E (on the Eurofighter TYPHOON) and ES-05 Mk 5 (on the JAS 39 GRIPEN E/F) are mounted on a repositioning mechanism that can steer the array towards an area of interest, including high angles away from the aircraft centreline.

Graphic: Saab

This diagram shows the advantages that an electronically-scanned radar such as the ES-05 Mk 5 of the GRIPEN JAS-39 E/F has over traditional mechanically-scanned radars.

AN/APG Radars

The first operational fighters to have an AESA radar were a batch of 16 F-15C deployed at Elmendorf Air Force Base late in 1999. They were fitted with the Raytheon AN/APG-63(V)2, a radar whose antenna had more than 1,000 T/R modules, and offered a performance better matched to the capabilities of the AIM-120 medium-range air-to-air missile. It also provided a non-co-operative target recognition (NCTR) function.

By using an improved T/R module developed for the AN/APG-79, plus a new array power supply, the follow-on AN/APG-63(V)3 radar could be made lighter than the (V)2. System development started in 2008, and the (V)3 is now in service on some USAF and Air National Guard (ANG) F-15s. Other users include Saudi Arabia and Singapore. The (V)3 will also be used on the F-15QA fighters that Qatar has ordered for delivery in 2022.

Author

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Based on an antenna array with 1,500 T/R modules, the Northrop Grumman/Raytheon AN/APG-77 carried by the Lockheed Martin F-22 uses the host aircraft's computer hardware rather than dedicated radar-mounted LRUs for its signal and data processing functions. The radar entered service having only air-to-air modes, but SAR and MTI air-to-ground modes are were introduced by the AN/AGP-77(V)1 radar on Lot 5 aircraft.

Initial deliveries of the F/A-18E/F SUPER HORNET were with the mechanically-scanned Raytheon AN/APG-73 multimode radar, but the Block 2 version of the aircraft introduced an Enhanced Forward Fuselage (EFF) designed to house Raytheon's AN/APG-79, which uses an AESA array made up of 1,100 T/R modules. Operating over a wider bandwidth than the AN/APG-73, the -79 has a high level of frequency agility. The AN/APG-79(V)X version announced in 2005 was designed to be compatible with the F-18C and -18D, and can be used to upgrade these older aircraft. It has a greater air-to-air range that is available from the aircraft's original AN/APG-65, and can handle simultaneous air-to-air and air-to-ground missions.

In 2014, Raytheon announced the AN/APG-79(V)4. a version whose smaller-diameter AESA array is compatible with the nose of older-model F-18s, but which retains the proven 'back end' of the full-specification radar. Flight testing was concluded in 2015, and in 2019 the company was awarded a contract to install the (V)4 on the F/A-18C/D fighters of the US Marine Corps.

Developed for the United Arab Emirates, the F-16E (single-seat) and F-16F (two-seat) DESERT FALCON versions of the aircraft are equipped with the Northrop Grumman AN/APG-80 AESA radar. According to Northrop Grumman, this has a much greater detection range and a two-fold increase in reliability compared to mechanically scanned radars.

The Northrop Grumman AN/APG-81 dual-mode radar for the F-35 forms part of an integrated sensor suite that includes the Northrop/Lockheed Electro-Optic Targeting System (EOTS). Its integrated RF system/multifunction nose array has 1,200 T/R modules, and acts as a multi-function aperture (MFA) that handles traditional air-to-air and air-to-surface radar functions, plus a full suite of electronic warfare functions. The latter was probably the first example of a fighter-mounted radar being given an electronic-attack function.

A drastic modernisation of the AN/APG-63 resulted in a AESA-based configuration originally known as the AN/APG-63(V)4, but subsequently redesignated as the AN/APG-82. Expected to replace the existing AN/APG-70 radar of the USAF's F-15E, it combines the antenna and power supply of the AN/APG-63(V)3 with a radar receiver/exciter and Common Integrated Sensor Processor based on similar hardware used by the AN/APG-79. New radar frequency tunable filters are intended to allow the aircraft to operate its radar and EW systems simultaneously, and the radar should permit the near-simultaneous interleaving of some air-to-air and air-to-ground radar modes.

The Scaleable Beam Radar

Launched with an eye to the F-16 retrofit market, Northrop Grumman's AN/APG-83 Scaleable Agile Beam Radar (SABR) was designed to be compatible with the existing electrical and physical interfaces of the F-16, as well as the aircraft's existing levels of power and cooling capacity.

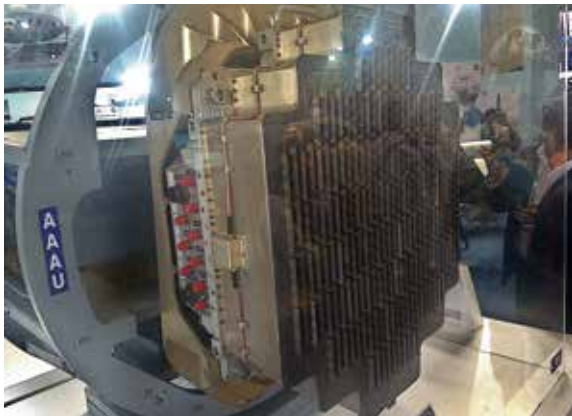
In 2013, the radar was selected for retrofit to USAF and Taiwanese F-16s, and in 2015 it was chosen by Singapore for its planned F-16 upgrade. 2017 saw the radar chosen as part of Greece's F-16 upgrade to the Block V configuration, and Bahrain announced that the AN/APG-83 would be retrofitted to its F-16 fleet as part of the Block V upgrade, and fitted to a batch of new-build Block V aircraft also being procured. A US$244M contract to retrofit the AN/APG-83 to 72 US ANG F-16s was awarded in May 2017

The Raytheon AN/APG-84 Advanced Combat Radar (RACR) was designed to be a drop-in upgrade for the F-16 and F/A-18. To make the set compatible with existing onboard power supplies and cooling systems, its antenna T/R modules are cooled by a liquid-to-air heat exchanger rather than a conventional liquid-cooling system. In 2013, the AN/APG-84 was selected by South Korea as a retrofit for its F-16 fleet, but the resulting order was cancelled in the following year due to rising cost.

The CAPTOR-E Radar

Having explored AESA technology under the European AMSAR (Airborne Multi-Role Solid State Active Array Radar) programme, the Euroradar consortium developed the CAPTOR-E radar, which combines an AESA antenna and front end with the back-end of the earlier ECR-90 CAPTOR-M mechanically-scanned radar that had been developed for the Eurofighter TYPHOON. An antenna with a diameter of about 600mm is populated by around 1,400 liquid-cooled T/R modules. This is mounted on a gimbal repositioning system able to point the array in wide off-boresight angles. A contract for the final development and integration phase of the CAPTOR-E was awarded in 2014. The new radar will be introduced during the aircraft's Tranche 3 production phase.

Photo: via author



The Active Antenna Array Unit (AAAU) of UTTAM radar being developed for India's TEJAS aircraft was displayed for the first time at Aero India 2019.

Germany and Spain have agreed to finance the development of an improved AESA radar for use on their respective Typhoon fleets. This will involve new hardware, including a digital multi-channel receiver and redesignedT/R modules for the antenna. The project will be carried out by a Spanish-German industrial consortium led by Hensoldt.

When the Dassault RAFALE entered service in 2001, it was equipped with the Thales RBE2 (Radar à Bayalage Electronique deux plans). This uses a passive electronically-scanned array, but R&D work on an AESA began in 2002. Flight testing of the resulting RBE2-AA initially used T/R modules of US manufacture until Thales-developed hardware became available.

The basic version of the RBE2 AESA entered service in 2013, and in the following year, France's procurement authority DGA placed a contract for what would become the F3R standard of RAFALE. This version would have an improved variant of the radar for aircraft destined for France, Egypt, India, and Qatar. Production of the RBE2 was expected to run until 2020, and could be extended in the event of further orders being placed for RAFALE.

Leonardo's GRIFO-E is a relative newcomer. Announced in 2018, the radar is currently in a development phase due to end by 2021. It consists of an AESA-based antenna with around 600 T/R modules based on gallium nitride technology rather than the more common gallium arsenide, and two subassemblies – a receiver/exciter/processor, and a power supply.

The current PS-05 Mk 4 radar of the Saab JAS39 GRIPEN uses a mechanically-scanned antenna, but Saab Electronic Defence Systems has developed the ES-05 Mk 5 AESA

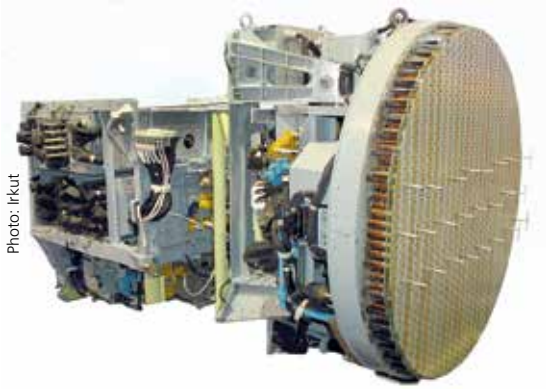


Photo: Irkut

The N011 BARS radar originally used a mechanically-scanned antenna, but this follow-on versions uses PESA technology.

radar for the GRIPEN JAS-39 E/F as well as future GRIPEN upgrades. Based on gallium nitride technology, this also draws on experience gained from the earlier Not Only a RAdar (NORA) demonstrator programme.

The IAI / Elta Systems EL/M-2052 is the first Israeli-developed AESA radar for fighters. Flight trials started in 2006 aboard a Boeing 737 testbed. The T/R modules in the antenna array are packaged into 'bricks' each made up of 24 modules. This configuration allows the creation of antenna arrays consisting to the maximum number of 'bricks' that can be housed in an aircraft's nose. This makes it relatively easy to reconfigure the radar for new-build or retrofit applications.

In 2015, Elta and Hindustan Aeronautics Limited (HAL) signed an agreement to develop an improved version of the EL/M-2052 for use on HAL's TEJAS lightweight fighter. By 2017, an EL/M-2052 was flying on an Indian Air Force Jaguar strike fighter as part of a plan to retrofit the radar to around half of India's JAGUAR fleet. In the following year, a contract to supply imported and locally-built radars for the TEJAS 1A was reported.

For the planned HAL TEJAS Mk2 fighter, LRDE India is developing the UTTAM multi-mode AESA radar. This will be teamed with other sensors including an infrared search and track unit and a missile approach warning system, in order to create a data-fused system.

Russian Developments

Early Russian electronically scanned radars for fighters such as the V Tikhomirov Scientific-Research Institute of Instrument Design (NIIP) N007 ZASLON PESA radar for the MiG-31 FOXHOUND used PESA technology. Experience gained from the development of the ZASLON allowed the organisation to use a PESA array for the N011M Bars adopted for India's Su-30MKI. The first Russian radar to use an AESA antenna was probably the Phazotron Zhuk-AE first displayed in 2005.

Russia's most advanced AESA radar is the Sh-121 being developed by NIIP for the Sukhoi Su-57 PAK FA fighter. The main forward-looking array is the N038 X-band antenna based of gallium arsenide T/R modules. Flank-mounted secondary arrays are used to extend the angular coverage in the azimuth plane, while at least one more array provides rearward coverage that may allow 'over-the-shoulder' missile engagements. The function of L-band arrays built into the wing leading edges of the aircraft remains unclear. They may have an IFF function, or could be intended to provide a limited capability against low-observable aircraft.

Sometimes referred to as the Type 1478, the Nanjing Research Institute of Electronic Technology (NRIET) KLJ-7 uses a mechanically-steered planar array antenna, and was developed for use on the JF-17 fighter, while the KLJ-7V2 is a higher-powered model reported to be carried by the JF-17 Block 2. The follow-on KLJ-7A uses either a single mechanically-steered AESA (a version thought to be intended for the JF-17 Block-3) or one frontal antenna and 2 lateral arrays. Both models of KLJ-7A have a track-while-scan capability.

The US Air Force and Navy pioneered the concept of airborne early warning (AEW) aircraft, and as a result, the Boeing E-3 and Northrop Grumman E-2 Hawkeye entered service with mechanically-scanned radars. However, the E-2D Advanced Hawkeye introduced the AN/APY-9 radar, whose antenna is electronically scanned in elevation, and uses a combination of mechanical and passive electronic scanning for azimuth coverage.

When Australia issued a requirement in 1995 for a next-generation AEW aircraft, Boeing responded with its 737 AEW&C twin-engine airborne early warning and control aircraft. Selected to enter Australian service as the E-7A WEDGETAIL, this carries the Northrop Grumman Electronic Systems L-band Multi-role Electronically Scanned Array (MESA) radar. This uses a 7.3m x 2.7m AESA array mounted in a dorsal fin on top of the fuselage to provide 120 degree coverage on both sides of the aircraft, while a 'top hat' supporting array covers 60 degree sectors facing fore and aft. In addition to serving as a radar sensor, these arrays can also be used in the passive elint role.

Technical problems delayed the aircraft's debut by three years. Deliveries started in 2009, and initial operational capability was achieved in November 2012. Turkey was the first export customer, receiving the last of a batch of four at the end of 2015. South Korea ordered four, and received these in 2011-12. The UK ordered five in 2019, and deliveries are due to end in 2026.

Russia's equivalent to the E-3 SENTRY is the BERIEV A-50 AEW aircraft. This uses a pulse-Doppler SHMEL radar operating in S-band. The antenna is housed in a dorsally-mounted rotodome, and uses mechanical scanning in azimuth, and electronic scanning in elevation. An upgraded SHMEL-M was subsequently developed as part of the A-50U upgrade. A SHMEL-2 version developed for a second-generation A-50 variant is reported to match the performance of the US APY-1/2 radar system. A new AESA-based version of the SHMEL radar is under development for the Ilyushin A-100, an AEW variant of the PS-90 engined Il-476 transport aircraft.

A dual-face flat panel AESA array operating in S-band forms the basic of the Saab Electronic Defence Systems Erieye PS890 dorsally-mounted radar carried Swedish Air Force Saab S-100B AEW aircraft.

Photo: Boeing

These WEDGETAIL airborne early-warning and control aircraft were delivered to Australia, but the type is now in service with Turkey and South Korea, and has been ordered by the UK.

Photo: UK MoD

Only a year after taking delivery of its final SENTINEL R1 ASTOR aircraft, the UK announced that the type would be withdrawn from service. Its premature retirement was later postponed until 2021, but a shortage of defence funds means that the UK would not be able to pay the running costs of a longer service life, let alone a mid-life upgrade.

Data from the aircraft is downlinked to Sweden's air-defence system. The ERIEYE radar is also carried by Brazil's EMB-145SA AEW aircraft. An extended-range ERIEYE ER radar has been developed for the Saab GlobalEye Bombardier Global 6000 business jet-based ISR platform. This is reported to offer a 70% increase over the 250 km range of the earlier version.

Elta Systems has created a series of AEW radars based on flat-panel arrays. At least three variants are known to exist. The EL/M-2075 is a first-generation system used by Chile on its Boeing 707-385C CONDOR. It has three L-band AESA arrays – one in the aircraft's nose, and one on other side of the forward fuselage. Working together, the three provide a total of 280 degrees of azimuth coverage.

For the EL/M-2085, Elta opted for a lighter-weight configuration based on nose and tail-mounted radomes with L-band antennas for long-range detection, and dual side-fuselage S-band antennas for higher accuracy. Fitted on GULFSTREAM G550 platforms operated by Israel and Singapore, the system includes a processing-intensive 'track-before-detect' mode intended for use against stealthy low-observable air targets. When developing the EL/M-2090 for use on Indian Air Force BERIEV A-50EhI aircraft, the company adopted three arrays mounted in a triangular configuration within a dorsal rotodome above the aircraft's rear fuselage.

The USAF's E-8 Joint STARS ground-surveillance aircraft uses an AN/APY-7 X-band radar, whose antenna is mounted in a canoe fairing beneath the aircraft's forward fuselage. The beam is electronically steered in azimuth, and mechanically in elevation. While still under development, the aircraft was used operationally during Operation Desert Storm in 1991 and Operation Joint Endeavor in 1995. Deliveries of production aircraft started in 1996, and the type has been used in support of the Kosovo War in 1999, then in Operation Enduring Freedom, Operation Iraqi Freedom, and Operation New Dawn. The E-8s had been built using ex-airline Boeing 707 aircraft (plus one military 707). A study completed in 2012 looked at potential replacements, but the USAF was unable to provide the required funding.

The Raytheon Systems Limited (RSL) SENTINEL R1 ASTOR system currently operational with the UK Royal Air Force is based on a fleet of five modified Bombardier GLOBAL EXPRESS aircraft fitted with an AESA SAR/MTI radar. The latter uses a 4.6m antenna array mounted in a canoe-shaped structure under the fuselage. The radar is operated by a team of three mission specialists, and the data it generates is transmitted to dedicated ground stations for full analysis.

The system entered service in 2008, and the final aircraft was delivered in 2009. Although the system had been successfully deployed in support of combat operations in Afghanistan, in 2010 the UK Government announced that despite being near-new, SENTINEL would be withdrawn from service. In practice, the aircraft was needed to support combat operations in the Middle East and Libya, so its premature retirement has been postponed until 2021. ■

Graphic: Saab

The Saab GlobalEye Bombardier Global 6000 uses an improved ERIEYE ER radar.

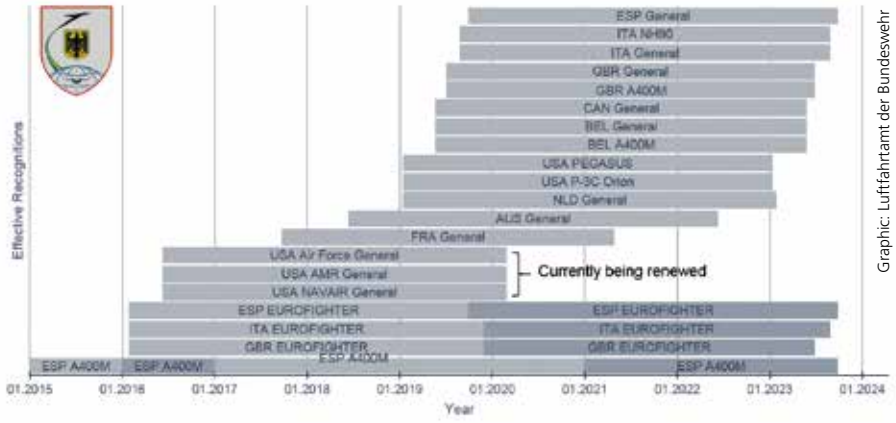
Recognition of Foreign Authorities

Enabling Efficient International Cooperation in the Combined Operation of Aircraft

Henning zur Nieden and Björn Oeltjen

The German Federal Government aims not only to intensify the combined planning, development and procurement of military capabilities but also to operate these capabilities increasingly together with other nations.

Interoperability is, therefore, becoming more and more important for the Bundeswehr. Examples include the Permanent Structured Cooperation (PESCO) as part of the European Union's (EU) security and defence policy, the European Medium Altitude Long Endurance (EuroMALE) remotely piloted aircraft system and combined Baltic air policing as well as the combined operation of the Multinational Multi-Role Transport Tanker Fleet (MMF) and, in particular, French and German C 130J aircraft. This article provides an insight into how mutual recognition of aviation authorities and their services, particularly for the technical and logistic support of aircraft, enables an unprecedented intensity of cooperation between allied air forces.



Recognition processes undertaken to date – there has been a considerable increase in demand.

The Need for Recognition

Before an aircraft is allowed to participate in air traffic, the competent aviation authority must make various sovereign decisions: For example, the aircraft needs a type certificate and an airworthiness certificate, the design, production, maintenance and training organisations need approval, and the technician who releases the aircraft to service, for example after repair, needs a license. The certificates, approvals and licenses required for military aviation in Germany are issued by the Luftfahrtamt der Bundeswehr (LufABw), the German military aviation authority.

However, under applicable air law, is a French technician with a French license also allowed to maintain a German A400M aircraft? Is he or she permitted to do so only in a French organisation under French law or also in support of a German organisation? Would it even be possible, within a joint French-German A400M contingent, to maintain each other's aircraft and release them to service?

In a single regulatory area, as existing in civil aviation with the European Union Aviation Safety Agency (EASA), this question would not arise. In military aviation, however, national regulations differ as each nation can allow exceptions to ensure fulfilment of its sovereign responsibilities. Rather than having a single authority – like the EASA – that performs regulatory and supervisory functions based on a binding joint legal framework horizontally for several nations, each nation has established an independent military aviation authority. In Germany, deviations from civil standards are based on section 30 of the Civil Aviation Act. However, although there are national differences and national military aviation authorities, it is still possible to use each other's services. The means to achieve this is — to put it briefly — recognition of foreign aviation authorities.

What is Recognition?

While not specifically referring to the recognition of aviation authorities, Andreas Voßkuhle, President of the Federal Constitutional Court, once explained that, "in many areas, the European legal system is based on the principle of mutual trust, i.e. the recognition of legislation of other member states without a profound legal assessment". Thus, basic trust between authorities is a crucial condition for mutual recognition. The trust needed to use a foreign authority's services is based on an objectively accountable evaluation both of the overall dependability of the foreign authority and of the scope of the assessment performed by the latter with regard to the specific service concerned. After all, a partner authority will only be recognised

Author

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if its services lead to the same level of safety as required under national rules.
In order to be able to perform such an evaluation, the LufABw needs to have sufficient knowledge of the facts. For this purpose, it assesses the processes, procedures and standards of the partner authority. Thus, a mutual understanding — and trust in a positive sense — is established, formalised and made measurable in the area of airworthiness. The entire process is carried out in accordance with the standardised guidelines for undertaking a recognition set out in the "European Military Airworthiness Document – Recognition (EMAD R)" coordinated between the European nations and issued by the European Defence Agency (EDA).
What is of particular interest is the ability to use foreign aviation authorities' services to meet the mandatory requirements mentioned at the beginning of the article which must be fulfilled before an aircraft enters service: certification of aircraft, approval of organisations such as maintenance or training organisations and licensing of technical personnel. Through the instrument of recognition, a partner authority is recognised for the services it provides within the framework of its regulatory and supervisory functions. Recognition thus increases an authority's efficiency, as services provided by another authority do not need to be duplicated in the own area of responsibility and consequently own inspection efforts can be reduced.
Besides the efficiency gain, increased interoperability also plays an important role. While the instrument of recognition was initially employed to use a partner organisation's services for the certification of aircraft, the LufABw is now extending this focus to the wide area of combined operation of aircraft and thus to the interoperability of allied air forces.

Graphic: Luftfahrtamt der Bundeswehr

Increasing maintenance and spare parts capacities for A400M aircraft through recognition

Tangible Benefits for Interoperability

Generally, interoperability refers to the ability of different systems, capabilities or organisations to work together. Besides providing a means to establish new opportunities, for example close cooperation aimed at alternating and combined employment of forces, interoperability is also clearly linked to efficiency, as resources are saved on both sides. This is particularly evident in the A400M and C-130J projects, where the instrument of recognition has been used with unprecedented intensity.
As regards the A400M project, recognition has been an established means of access to foreign services from the outset. Initially, the idea was to use services in the area of certification, more specifically, a Spanish Certificate of Airworthiness issued for the aircraft. The possible applications have since clearly been extended to the operation and continuing airworthiness of A400M aircraft. The current users include the Federal Office of Bundeswehr Equipment, Information Technology and In-Service Support (BAAINBw) and the German Air Force.
At present, the project focusses on spare parts supply. The stated aim is to make available and exchange capacities in the area of spare parts supply between the A400M user nations. In terms of air law, organisations (especially production and maintenance organisations) need to be approved by the respective national military aviation authority. If spare parts are to be exchanged between the A400M user nations, it is more efficient to ensure that the organisation approvals issued by a foreign authority can be used in one's own area by way of recognition than to obtain new approvals from the own national authority. The recognition processes for the partner authorities in the UK, Belgium and Spain have already been successfully concluded.
In the German Air Force, the focus is on creating new capacities for maintaining A400M aircraft, primarily in the other European user nations, which is also in the interest of the BAAINBw. The aim is not only to use own resources efficiently but also to achieve a higher level of flexibility. Thus, recognition has been applied as a tool for using foreign organisation approvals: German A400M aircraft can now be maintained or, in case of damage, repaired in Spain without Germany

Foto: Armée de l'Air

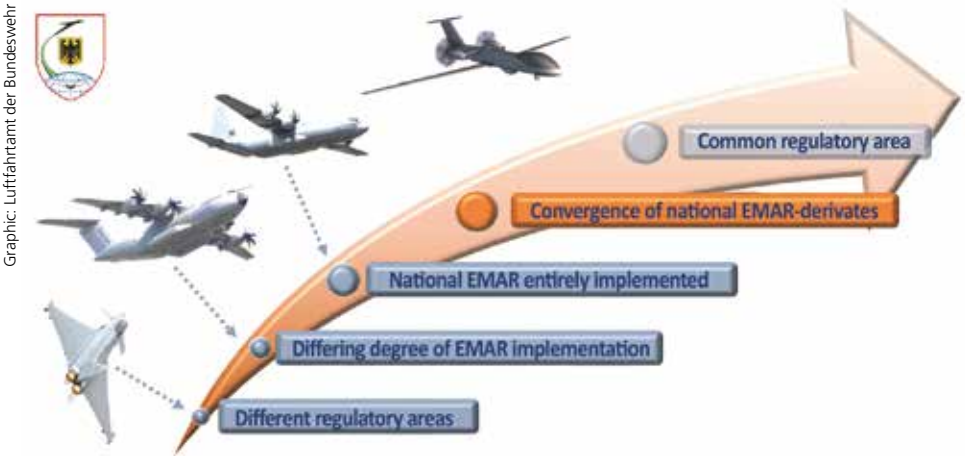
The first French C-130 J for the combined squadron

having to send an own repair crew; this will also be possible in Belgium in the near future.
Apart from additional maintenance capacities, a smooth exchange of licensed personnel is required for mutual support: foreign personnel who have already obtained a military aircraft maintenance license with the relevant type entry must be able to work in one's own area without having to undergo another licensing. This requirement and the method developed for implementation are in line with a wish frequently expressed by the users, namely that recognition results be directly usable. Essential strategic decisions have already been made in this regard, and recognition is currently being applied for this purpose for the first time. The approach used for licenses is based on the same "principle of territoriality" applied for the use of foreign organisation approvals: the authority of the nation where the organisation and/or technical personnel are based is responsible for the approval, licensing and monitoring of the organisation or technical personnel. By way of recognition, those services can also be used in other countries.

A New Dimension in the Case of C-130J Aircraft

While, in the A400M project, cooperation in the operation of the aircraft and in the use of individual services is being supported through recognition, a much more intensive cooperation between France and Germany is emerging in the C-130J project. The project envisages the combined operation of French and German C-130J aircraft within a joint French-German squadron at a French base in Évreux. From an air law perspective, German aircraft will be maintained in French organizations and the relevant tasks for continuing airworthiness will be performed entirely by a French Continuing Airworthiness Management Organization (CAMO). This CAMO and the French maintenance organisation employ both French and German personnel. The technicians receive their type-specific training together at a French training organisation. All organisations (the CAMO as well as the maintenance and training organizations) and the entire operation of German and French aircraft are regulated and supervised by the Direction de la Sécurité Aéronautique d'État (DSAÉ), the French military aviation authority, in accordance with French standards.
In short, German aircraft are de facto operated in a foreign regulatory area and under the supervision of a foreign authority while the original German responsibility is maintained. This example shows that harmonised Airworthiness requirements and the corresponding instrument of recognition hold great potential. Without recognition of foreign authorities, it would not be possible to enable such an extensive reliance on foreign services and the use of foreign regulatory and supervisory functions with reasonable effort.
The application of recognition in the C-130J and A400M projects shows how interoperability and cooperation in the operation of aircraft can be streamlined or, indeed, made possible in the first place. The lessons learned from the projects thus constitute valuable input for even closer future cooperation in the area of airworthiness. Recognition helps to provide additional maintenance capacities and, most importantly, meet air law requirements for combined squadrons in mission areas.

Graphic: Luftfahrtamt der Bundeswehr



Lessons learned from recognition – convergence of national regulations derived from the EMAR increases interoperability

Six Years of Recognition – Lessons Learned

After recognition has been applied for almost six years, there is a great deal of interest in this instrument, but often little awareness of the possibilities and limits associated with it. Therefore, the military services that operate aircraft and the BAAINBw are regularly informed on the increasing number of recognition processes through presentations and reports. However, it is still indispensable for potential users to contact the LufABw, as no recognition result is sufficiently general to be immediately applicable when a specific new idea emerges. Rather than being undertaken globally, recognition is normally limited to the specifically defined services required in each individual case.
An essential requirement for intensive and ultimately efficient cooperation and thus for recognition is a common standard which is understood in the same way by each party. Both recognition partners, the foreign and the national party, need to transpose the national EMAR (European Military Airworthiness Requirements) regulations derived from EU standards into national law as comprehensibly and with as few changes as possible — an important lesson learned from past recognition processes.
When comparing the recognition processes for the UK, Belgium, Spain and Italy undertaken in rapid succession in 2019 and the initiated process for France, it becomes obvious that the possible use of foreign services mainly depends on the scope and level of national EMAR implementation. For example, recognition of the partner authorities in Spain and Belgium has created the conditions required under air law for having an A400M aircraft maintained in those countries. However, it is not possible to have this service performed in military maintenance organisations in the United Kingdom, as parts of the EMAR have not been implemented there or are not applied to the United Kingdom's military organisations. From the point of recognition, the nations involved must strive for a convergence of the national EMAR regulations if interoperability is to be increased.
So far, the lessons learned from recognition support all those who promote convergence of regulatory areas as well as implementation and application of the EMAR at a national level and throughout Europe. What is more, the results achieved thus far demonstrate that day-to-day operations truly benefit from international cooperation achieved through the recognition of foreign aviation authorities. Cooperation is not just a value in itself, but also enables interoperability while at the same time saving resources. ■

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