MSD

MARITIME Security & Defence

From the Sea and Beyond

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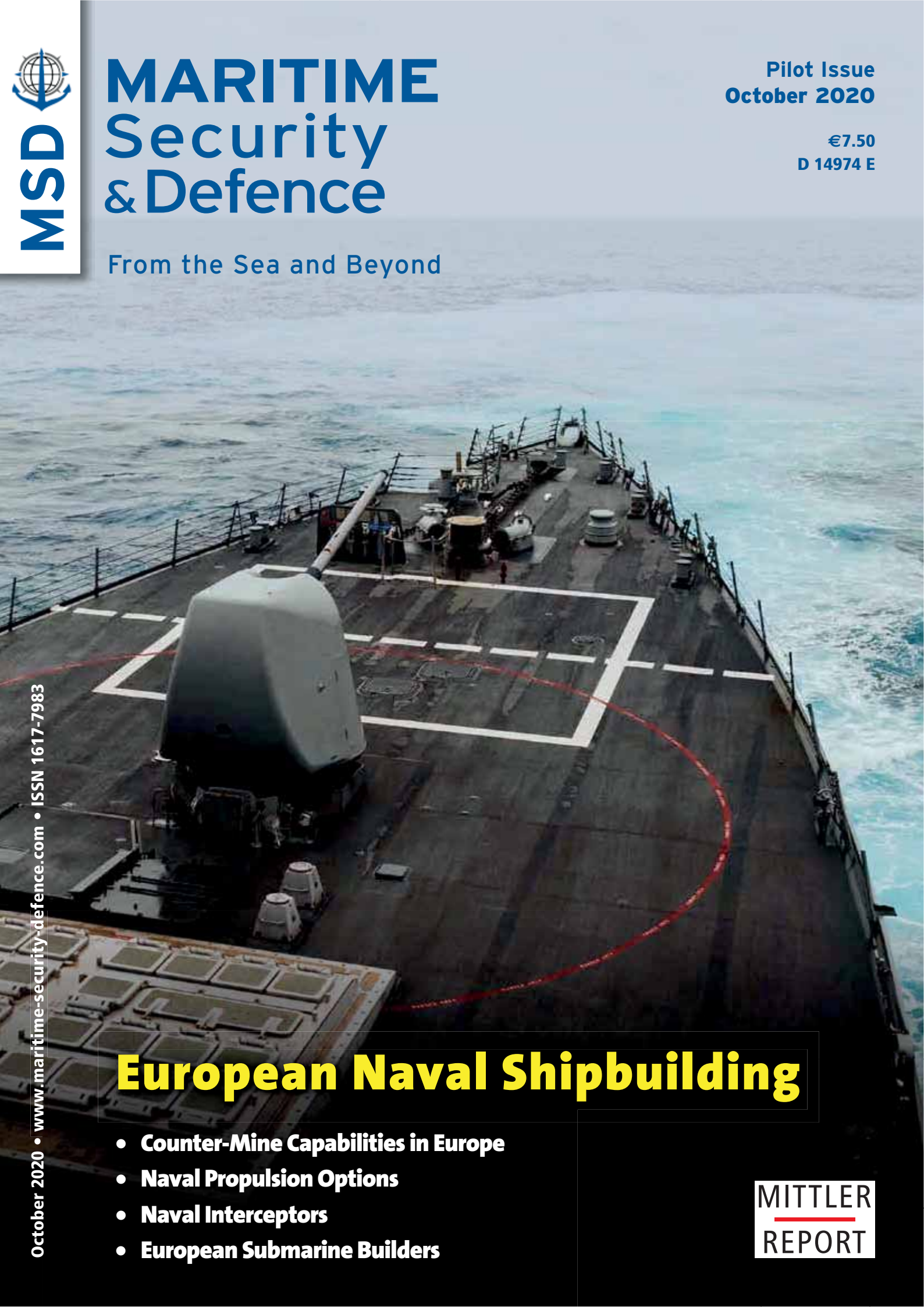

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LÜRSSEN

From the Sea and Beyond

You are holding a new magazine concept in your hands, and might already be asking: *"Security and Defence – again? Maritime? What for?"*

Water covers more than 70 per cent of the world's surface – including rivers and lakes of strategic importance. It is the means for defining national boundaries, outlining regions, conducting trade, feeding populations, energising the digital planet and relaxing safely on a beach holiday. Yet, there are many aspects about the sea that are ignored or misunderstood by the current – and shrinking pool – of defence titles focused on it. Maritime Security and Defence is dedicated to remedy the broader understanding of "the sea" in a unique way.

The question *"What is happening on the world's oceans?"* opens a complex array of different elements and considerations.

The main mission of Maritime Security & Defence (MSD) is to address matters of the sea and waterways by considering all aspects of this arena and how each aspect – economics, environment, humanity, politics, prosperity and regional and technical developments – impact or drive the maritime security and defence situation…beyond grey ships and battlespace developments. *Anyone can cover* those.

The MSD editorial team's intention is to include relevant maritime topics that influence - or are influenced by - maritime security and defence developments, directives and doctrine. As such, MSD's editorial has the capability of redefining "Power Projection".

MSD's content includes a greater understanding of the sea and its importance, while it also helps readers to meaningfully *engage with* the sea.

Increasing the reader's strategic awareness for the lakes, oceans, seas and waterways goes beyond the obvious other uses: communication, energy, food, leisure, transport and – sadly – waste disposal. These are watery arenas in which political and trade objectives, are articulated alongside regional stability, national boundaries and defences.

Maritime aspects of security and defence reach beyond grey ships. Land provides boundaries, while air and space influence and interact with the earth's bodies of water. Air, land and space are partners to "the sea" for naval communication, data collection, intelligence, navigational, repairs, surveillance, supply and understanding.

While security and defence politics in a globalised world is already a complex and confusing matter, it seems today even harder to grasp the interplay of world economics and geopolitics. Albeit sometimes subject to non-military disputes, one commonality persists: the seas can connect continents and serve as a platform for trade and mutual prosperity and understanding among nations *when all goes well*…and when it does not, there is MSD to define why and what is happening for the reader.

Photo: author

Conrad Waters is a contributor to Mittler Report Verlag publications, serves as editor of "Navies in the 21st Century" and is the editor of the "World Naval Review" since 2009 when it was founded.

Photo: author

CAPT (ret) Hans-Uwe Mergener had different international assignments during his naval career – both within NATO and Europe, and is serving as the Naval Editor of Mittler Report Verlag publications since his 2018 commission started there.

From environmental to political, from prosperity to security, all of these have one thing in common: they rely on a safe, secure and stable maritime situation. Deep analyses are required to understand these interdependencies vis-à-vis a competent naval perspective, MSD provides this.

Maritime Security and Defence is about, fostering a "maritime consciousness" that uniquely provides security and defence insights by inclusively covering actors and governments, catalysts, armaments, developments, equipment, industrial frameworks, procurements, sciences, situations and technologies that fuel maritime issues and support peace and prosperity from the Sea and Beyond.

MSD's quarterly availability provides it the luxury of properly analysing *"what is happening on the world's oceans?"* with calm objectivity and rationality that will support decision-makers at all levels in the MSD frame

As a new title with a unique focus, MSD will evolve in coming issues, struggling with the right balance between defence aspects of naval activity and concentration and the civilian aspects of maritime security and operations. We remain committed to integrate these different, interconnected elements to publish a resource dedicated to what interests you and impacts your understanding.

We invite you to join in our effort against *sea blindness* with feedback and suggestions.

Yours, aye,
Conrad Hans-Uwe

Contents

Photo: Luca Peruzzi

Maritime operations require multirole naval gun systems capable of dealing with multiple threats. **Page 34**

Image: Damen

MKS 180 constitutes the largest-ever naval procurement effort of the German Navy. **Page 49**

Index of Advertisers

MQ-9B SeaGuardian

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GENERAL ATOMICS AERONAUTICAL

NATO Forces Train with Algeria

(jr) Standing NATO Maritime Group Two (SNMG2) flagship, ESPS ALVARO DE BAZAN carried out a training programme with the Algerian ship EL MOUDAMIR in the Mediterranean on 14 September 2020. The exercise took place after a three-day visit to the capital Algiers, aimed at increasing cooperation between NATO Maritime Command and Algeria, a member of NATO's Mediterranean Dialogue Programme. Algeria has been part of this initiative since 2000 and Standing NATO Maritime Groups regularly visit Algiers to develop military dialogue and to improve mutual understanding and promote cooperation. The ALVARO DE BAZAN visited Algiers from 12 to 14 September to focus on strengthening links between Algeria and NATO, as well as reinforcing a partnership that faces the similar threats and challenges, including terrorism and a wide variety of illegal activities across the maritime domain. The visit was scaled down due to restrictions on movement of personnel, with COVID-19 measures in force to preserve the readiness of the force. After departing Algiers, the ALVARO DE BAZAN and EL MOUDAMIR proceeded to the exercise areas. The training programme included a passing exercise as well as communications and manoeuvre drills, which are key for working together at sea and supporting collective maritime security in the region.

Photo:NATO

Damen Shipyards Cape Town Lays Keel on Second BIRO IPV

Damen Shipyards Cape Town (DSCT) held a keel-laying ceremony for the second of three Multi-Mission Inshore Patrol Vessels (MMIPV) that DSCT is building for the South African Navy's Project BIRO. This event was held on 28 August and planned to ensure the well-being of delegates during the ongoing coronavirus pandemic. As well as stringent safety measures on location, physical attendance was reduced to a minimum, with the majority attending remotely with digital conference facilities. The South African Navy's Project BIRO aims to develop maritime security, ensuring the country's capabilities to respond effectively, rapidly, and cost-efficiently to maritime threats such as piracy and illegal fishing. The MMIPVs draw on proven technology from Damen's standardised range of patrol boats, which covers everything from 10-metre interceptors and 50-metre patrol vessels, to 140-metre frigates. The vessels for Project BIRO are tailored to the specific requirements of the South African Navy and feature the Damen SEA AXE bow – a vertical hull form that reduces slamming for safe, comfortable operations in rough seas. The MMIPVs are the first SEA AXE vessels to operate in South Africa.

Photo: Damen

Propulsor Contract for General Atomics

(jr) General Atomics Electromagnetic Systems (GA-EMS) announced yesterday that it has been awarded a developmental contract by the Naval Surface Warfare Centre Carderock Division (NSWCCD) to provide manufacturing design drawings, engineering, fabrication, inspection, and assembly of prototype propulsor, shafting and bearing components as well as the equipment needed to support propulsor research & development, testing and evaluation. GA-EMS will work with NSWCCD to develop new propulsor components for both surface ships and submarines. Design and analysis work will be done primarily at GA-EMS' facilities in San Diego, CA, and manufacturing engineering and fabrication will be done at the company's manufacturing facility in Tupelo, MS. This effort supports the NSWCCD Advanced Propulsor Management Office requirement for the design and development for prototype propulsors, shafting and bearing components, mechanical design specification, and manufacturing plans to support the COLUMBIA and VIRGINIA Class Submarine Programme Offices in addition to future R&D activities towards the next generation of propulsor and shafting systems.

iXblue INS for ARAFURA Class

(jr) iXblue's Inertial Navigation Systems (INSs) and gyrocompasses have recently been chosen to equip the Royal Australian Navy's (RAN) ARAFURA class Offshore Patrol Vessels (OPV). Based on fibre-optic gyroscope technology, iXblue's INS is to provide the 12 new ARAFURA class vessels with highly accurate and reliable navigation capabilities in all environments, including within GNSS-denied operational areas. Already equipping more than 650 surface ships and underwater platforms in 40 navies and coast guards worldwide, iXblue's recent success in SEA1180 continues 15 years of continuous service and support to the RAN. In addition to supplying equipment to Defence, iXblue also supplies specialist geospatial services and recently completed the first commercial hydrographic survey project under the SEA2400 Hydrographic Industry Partnership Programme (HIPP).

Photo: iX blue

BMT Reaches Patrol Boat Milestone

(jh) BMT has announced a partnership with Marine Specialised Technology (MST), the company selected by the UK Ministry of Defence (MoD) following a competitive tender process to provide two state-of-the-art high-speed fast patrol vessels. With an overall length of 19 metres, the new design, which is capable of 40 knots, has been selected by the MoD to be operated by the Royal Navy's Gibraltar Squadron. As part of this public procurement, BMT also announced that its team will be providing a comprehensive Integrated Logistics Support (ILS) package. This latest contract for a government customer is a significant milestone for the international design consultancy in the market for high performance patrol vessels. Built by Marine Specialised Technology (MST), the two boats will be delivered over the course of the next three years.

Photo: BMT

BLACK EAGLE 25E and 50E Unveiled

(jh) Israeli company Steadicopter, a developer of rotary unmanned aerial systems (RUAS), unveiled BLACK EAGLE 25E and BLACK EAGLE 50E - the newest models of its RUAV - now operated with electric motors, and designed for a wide range of law enforcement, maritime, civilian, and covert missions. Based on the company's BLACK EAGLE platform, the new systems enable high perfor-

mance and operational flexibility for security forces and civilian applications. Converting Steadicopter's BLACK EAGLE 50 system to an electrically powered engine has significantly reduced the weight of the air vehicle, thus providing additional payload capacity.


Photo: Steadycopter

With a platform weight of 18 kg, each model has the capacity to carry additional batteries for longer flights, heavier payloads and more. The BLACK EAGLE 25E is designed for weights of up to 25 kg, making it suitable for tactical-urban missions, while meeting the strictest weight and category regulations. The BLACK EAGLE 50E, weighing up to 35 kg, enables a wide range of mission payloads, giving the user versatility for covert operations. The small dimensions of the platforms allow for efficient and safe operation. From a wide variety of OPVs to the busiest offshore platforms, the BLACK EAGLE family of products offers a comprehensive solution for highly-demanding maritime applications. All BLACK EAGLE systems are certified for use in the harshest maritime operating scenarios, according to the IP67 environmental standards.

ASPIS RWS Unveiled

(jr) Escribano Mechanical & Engineering has developed ASPIS, its new Remote Weapon Station (RWS) for naval and land use. This RWS weighs less than 90 kg, making it the lightest RWS on the market. It is also equipped with a 7.62 mm M240 automatic gun and a Gatling M134D machine gun of similar calibre. ASPIS includes advanced features present in the Guardian and Sentinel RWSs, including two-axis stabilisation, a target tracking system and automatic tracking. Its electro-optical sensor has an uncooled thermal camera, a high-sensitivity visible camera and a laser range finder. The ASPIS RWS can be used on both unmanned land and naval surface platforms, allowing its integration with the VICTORIA unmanned vessel, developed by the Spanish company FERRI. This new collaboration agreement between the two companies represents an ideal solution to enhance the security in maritime missions since it allows the detection of standardised NATO targets over a distance up to 13 km.


Photo: Escribano

Diehl Delivers Precision Ammunition

(jh) In September, Diehl Defence was awarded a contract by the Federal German Office of Bundeswehr Equipment, Information Technology and In-Service Support (BAAINBw) to deliver GBU-54 weapon systems to the German Air Force. GBU-54 is an air-to-surface weapon, equipped with the "Laser JDAM" (Joint Direct Attack Munition) conversion kit developed by Boeing. Through the combination of INS/GPS navigation, laser seeker and target designation, stationary and mobile targets can be precisely engaged even in adverse weather conditions. First units are to be delivered from November 2021; the delivery will presumably cover 48 months. Diehl is cooperating with Rheinmetall Defence and JUNGHANS Defence as component suppliers for the procurement effort. The battle-tested GBU-54 was already procured in the past for the TORNADO multirole fighter aircraft. In the future, GBU-54 is also to be used with the EUROFIGHTER aircraft of the German Air Force. In 2018, Boeing and Diehl decided to cooperate for the procurements of GBU-54 weapons for the German armed forces. In


Photo: Diehl Defence

the scope of this cooperation, Diehl Defence offers the Bundeswehr the adaptation and quick introduction into service of a modern system established in the market, plus on-site support with experience in the integration of weapon systems on fighter aircraft, such as the EUROFIGHTER. In cooperation with the US partner Raytheon, Diehl already successfully provided the air force with GBU-24 and GBU-48 precision ammunition in the past.

GA-ASI and SENER Aeroespacial Team to Develop New NATO Pod for MQ-9

(jr) Since General Atomics Aeronautical Systems, Inc. and engineering and technology firm SENER began collaborating in 2008, the international partnership has resulted in significant agreements regarding the MQ-9A Remotely Piloted Aircraft (RPA) for Spain and its adaptation to the requirements of the Spanish Armed Forces. The latest joint development effort is a NATO pod, designed and built by SENER Aeroespacial, part of the SENER Group. GA-ASI will integrate the NATO pod with the MQ-9 aircraft line to increase its configuration and payload options. NATO pod development is driven by GA-ASI's initiative to provide customers with a customisable pod for carriage of sovereign, cross-domain Intelligence, Surveillance and Reconnaissance


Photo: GA-ASI

(ISR) sensors that can be integrated with GA-ASI-built MQ-9A and MQ-9B RPA Systems. GA-ASI is working with European suppliers to add sensor capabilities to the new European-built payload pod that meets NATO airworthiness standards. The NATO pod is a flexible, scaleable, certifiable, aerodynamic and low-cost enclosure that enables customers to add sovereign sensor capabilities developed in their respective countries using a common set of interfaces to the aircraft system. This approach reduces integration time and cost.

Rohde & Schwarz Equipment for Philippine Vessels

(jr) Rohde & Schwarz has signed a contract with NTT Communications Co., Ltd. to provide a state-of-the-art IP-based, high quality and reliable maritime integrated communication system for the Philippine Coast Guard. The system, called NAVICS®, will be integrated into two 94 metre Multi-Role Response Vessels (MRRV) for the Philippine Coast Guard which will be constructed by Mitsubishi Shipbuilding Co., Ltd. with completion of work and delivery scheduled for 2022. The MRRVs will be financed by the Japanese Government, corresponding to Phase II of the Maritime Safety Capability Improvement Project. Rohde & Schwarz will enhance situation awareness and improve incident reporting with dedicated data communications capabilities, including R&S POSTMAN, a message handling solution, with MAP TRACK, a blue force tracking functionality. This will enable the ship's crew to effectively exchange information (voice and data) with the fleet, shore stations, other joint forces


Photo: Rohde & Schwarz

and governmental authorities. The system ensures a security architecture that allows secure, trusted and tamper-proof communications so third parties will not be able to interfere with information exchange. In addition to external Line-of-Sight (V/UHF) and Beyond-Line-of-Sight (HF) communications, the system will provide onboard communications with smartphone-like intuitive handling. The compact Wi-Fi based wireless voice terminals provide a unique benefit of uninterrupted, high-quality communication while on the move.

Greece Announces Major Arms Purchase

(jr) Greece has announced major arms purchases with "six emblematic decisions that multiply the power, functionality and effectiveness of Greek weapons," in the words of Prime Minister K.Mitsotakis. These decisions include: The Hellenic Air Force will immediately acquire a squadron of 18 RAFALE fighter jets that will replace older MIRAGE 2000 fighters. The Greek PM said these are fourth generation superior aircraft that "strengthen Greek deterrent power in combination

Photo: Greek MoD

with the modernised F-16." The Hellenic Navy is launching the process for the procurement of four new multi-role frigates, while at the same time, it will modernise and upgrade four existing MEKO combatants. As a result, several countries are looking at the tender for their own industry, while the new ships will also be accompanied by four MH-60R naval helicopters. The arsenal of the three branches is being enriched as a whole. New anti-tank weapons are being provided to the Army, new heavy-duty torpedoes for the Navy and new guided missiles for the Air Force. The doctrine is every weapon system will be active throughout its lifespan. Mr Mitsotakis also announced the recruitment of 15,000 men and women for an initial five-year period and at the same time, the whole framework of military service and training is being re-evaluated, so that recruits can acquire certified skills for free. The re-activation of the Greek defence industry was also announced. Already in the Elefsina shipyards, American funds are being invested in their modernisation and a strategic investor will soon enter the Scaramanga shipyards. Also, the privatisation of ELVO – Hellenic Vehicle Industry SA will be completed in the immediate future and the Hellenic Aerospace Industry has been reorganised into an aircraft maintenance centre for the wider area. The armed forces are enhancing their digital operations, as well as their protection against hybrid-type cyber-attacks. At each of their operational levels, modern systems are installed that ensure a secure flow of information and therefore timely mobilization. During high tides on geopolitical level in the broader MENA Region, discourse on security and defence has become much more intense. Greece itself is bouncing back from the Euro-crisis and after a full decade of fiscal stagnation is investing in defence and preparing a multi-year armament programme.

Egypt - Christening and Launch of the Fourth Class 209/1400 Submarine

(hum) On 29 September, Vice Admiral Ahmed Khaled Hassan Said, Commander-in-Chief of the Egyptian Navy, christened "S44", the fourth and last of the submarines of the 209/1400mod class ordered by the Arab Republic of Egypt, at the premises of thyssenkrupp Marine Systems (tkMS) in Kiel. The ceremony took place on a small scale, in compliance with strict COVID-19 preventive measures. "S44" follows its sisters "S41", "S42" and "S43" which were delivered in December 2016, August 2017 and April 2020 respectively. The submarines of this type have a length of 62 metres and a diameter of 6.2 metres with a surface displacement of 1,450 tonnes, and 1,600 tonnes submerged. Personnel: 30 crew members. Armament: six torpedo tubes. According to tkMS, the HDW class

Photo: Michael Nitz

209/1400mod is the latest version in the series of over 60 units built or contracted. Egypt has also ordered three MEKO A200 frigates from the Kiel-based company. According to a newspaper report from April 2019, the German Government has approved the delivery of the frigates to Egypt valued around 2.3 billion euros. The Budget Committee of the German Bundestag had also approved deliveries on 3 April 2019. According to reports from September 2019, Bremerhavener Stahlbau Nord is a subcontractor for steel sections for the construction of the Egyptian MEKOs. There is varying information on the actual scope of the contract. The German Government does not comment on this, citing a ruling of the Federal Constitutional Court of 21 October 2014 (BVerfGE 137, 185). In addition to the German submarines and frigates, Egypt in recent years purchased the French helicopter carriers of the MISTRAL class initially intended for Russia, and a multi-purpose frigate of the FREMM class. In France, Egypt also ordered four GOWIND class corvettes. From South Korea, the Egyptian Navy ordered a POHANG class corvette, from the USA four AMBASSADOR MKIII class patrol boats. In the summer of 2020, it became known that Italy would provide (at least) two FREMM-class frigates to Egypt. Between 2015 and 2019, Egypt was the world's third largest arms importer after Saudi Arabia and India (source: SIPRI). According to the Stockholm Institute, Russia, France and the USA are the major suppliers.

German Navy Orders Anti-Ship Missile from Saab

(jr) Saab has received an order from its German partner Diehl Defence for the RBS15 anti-ship missile to be supplied to the German Navy. The order value is approximately

Photo: Saab

1.7 BSEK with deliveries between 2022 and 2026. This is part of a framework agreement between Saab and Diehl Defence, which offers the possibility for additional procurement in the future, where Saab's share is up to approximately 1.5 BSEK (approx. €130 million). The agreement allows orders to be placed until the end of 2024, with the missiles and launcher systems to be integrated on the German Navy's BRAUNSCHWEIG class corvettes. In addition to the missile systems, the order includes associated equipment and services. The RBS15 missile provides naval operators with a long range all weather anti-ship and sea denial capability. Built for deployment on multiple platforms, the RBS15 missile system currently serves with the armed forces of several nations around the world and is jointly produced by Saab and Diehl Defence.

A Chronic or Acute Disease?

The Current Maritime Relationship in the Eastern Mediterranean

Korhan Özkilinc

On the Greek island of Rhodes, when ordering a cup of coffee, the locals simply ask the waiter for a "Turk". The word "Turk" in this context is as famous as the German designation of origin, "Made in Germany", so the Greek community decided to replace the word "Turk" with the Greek form instead. Of course, it is not important what the coffee is called, but how it tastes. It is unfortunate how both these great cultures share so many social and cultural values, yet lose sight of their real goals due to geopolitical differences in the Aegean and the eastern Mediterranean.

Oil and Gas

The current conflict between these two NATO allies is primarily due to the discovery of significant oil and gas deposits in their neighbourhood. According to a US geological publication from 2010, the reserves in the area amount to approximately 2 billion barrels of oil and 4 trillion cubic metres of natural gas. For the express purpose of extracting these deposits, a consortium, the Eastern Mediterranean Gas Forum (abbreviated EastMed Gas Forum) based in Cairo, was established on 16 January 2019. In the consortium, Greece, the Republic of Cyprus, Israel, Jordan, Egypt, Italy and representatives of the Palestinian authorities are all included, though Turkey and the Turkish Cypriots on the divided island of Cyprus are not. Of course, this decision understandably angered Turkey, which then dispatched its oil exploration and drilling vessel ORUÇ REIS to the area, duly escorted by the Turkish Navy. After the drilling vessel entered waters, which Greece claims as its own, tensions rapidly increased between the two countries in the summer with the Turkish move subsequently condemned by the European Union. Essentially, the intense disagreement over maritime borders and other geopolitical differences stem from unstable relations between these two states in the eastern Mediterranean and are fundamentally based on three conflict settings.

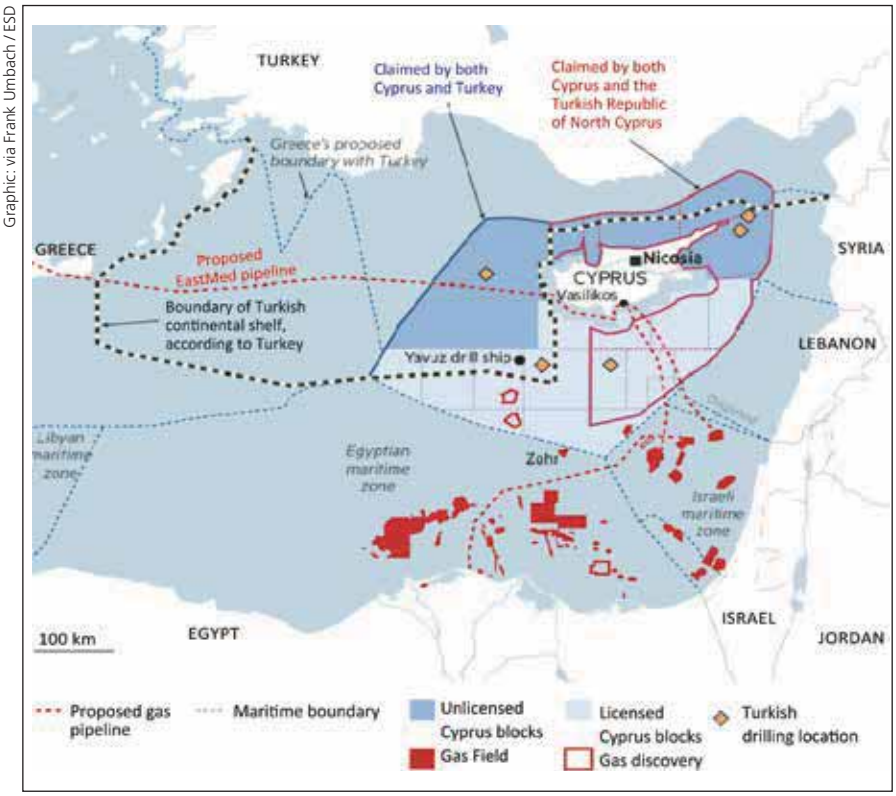
Photo: via author

Touareg secessionists pose with their guns. The civil war in Libya has been affecting a number of countries bordering the Mediterranean.

Maritime Disputes

Firstly, there have been international maritime disputes between Turkey, Greece and Cyprus for years, including over the status of the Dodecanese archipelago, the maritime borders in the Aegean Sea, and the major problem of Cyprus. Recently, Greek Prime Minister Kyriakos Mitsotakis has increased Greek territorial claims extending from the islands on the western side of Greece towards Italy from 6 to 12 nautical miles. The Turkish government reacted quickly and warned Athens not to make the same claims on the eastern side of the country warning that the consequence of such a decision would lead to war since many Greek islands in the eastern Mediterranean are in some locations merely a few kilometres from the Turkish mainland. This is also the reason why so many migrants choose the Greek islands as their last place of refuge, so they can swim to the EU from the Turkish coast in order to seek asylum. Moreover, from the Turkish point of view, Greece is violating a clause dealing with the demilitarisation of the islands as enshrined in the Treaty of Paris, in which Italy ceded Castellorizo and other islands of the Dodecanese to Greece in 1948. Actually, the key dilemma between these two countries is the Cyprus conflict, which after the war of 1974 resulted in the division of the island, based on ethnic lines. In 2004, with the admission of the Republic of Cyprus to the EU, the entire island was considered EU territory. Since the division, the self-declared Turkish Republic of Northern Cyprus has not been recognised under international law by any state other than Turkey. The Turkish population on the island was thus excluded from the EU, which caused the situation to escalate rather than improve. Of course, it would have made sense to first solve the problem and then admit Cyprus to the EU. In return, Turkey does not rec-

Graphic: via Frank Umbach / ESD



A map of the struggle for gas and oil in the eastern Mediterranean

ognise the Republic of Cyprus, meaning that its Exclusive Economic Zone is not recognised by Ankara.

The War in Libya

Secondly, in the Libyan civil war, Turkey supports the United Nation's recognised government in the capital, Tripoli. The opposing side, the rebel groups under General Khalifa Haftar, are supported by Russia, Egypt, the UAE and Saudi Arabia, and particularly by France. The warring parties are supported by all sides with the supply of weapons, mercenaries, military advisors and financial support, with the eastern Mediterranean becoming a transit zone for warships belonging to Turkey, Russia, and other countries. In June this year, an incident occurred between French and Turkish warships when they 'lit' each other with fire-control radars; it is unthinkable that this can happen between NATO allies.

France and Turkey

Thirdly, French President Emanuel Macron is not only competing with Turkey on the Libyan question, but also favours Greek and Cypriot positions on Turkey. There are of course good reasons why France is taking sides on the Greek question, since France has long been trying to establish a long-term partnership with the Greek maritime industry and is competing with the USA in this field. The fruits of this approach were recently harvested when Greek Prime Minister Mitsotakis said that his country will order 18 French RAFALE fighter jets (partly used), as well as frigates and helicopters. Furthermore, an additional 15,000 soldiers are to be recruited and the national defence industry will be further strengthened. In addition, the Cypriot Minister of Defence signed an agreement with his French counterpart in May 2019 for France to use the military section of Paphos airport and the naval base in Larnaca. More importantly, of Greece's debt to the EU of around €340Bn, around €40-50Bn is borne by France.

The current situation between Greece and Turkey has placed NATO in the eastern Mediterranean in a very difficult situation. It is a pity therefore that some NATO members seek to take advantage of the situation to fill their empty coffers with arms sales. The USA, as a long-time strategic partner of Turkey is trying to defuse the situation and at the same time lift the arms embargo against the Republic of Cyprus; it is also unclear whether Greece will buy F-35 JSF combat aircraft which Turkey is also legally entitled to, but do not receive. The real beneficiary of this discord is clearly Russia, which has not only slowly taken control of the Syrian coast along the Mediterranean Sea, but has also intensively expanded its reach in the Mediterranean. This also relates to the fact that the

Photo: via author

Civil war damage in Libya`s capital Tripoli

gradual withdrawal of the USA from the Middle East has changed the regional security dynamics on the ground and consequently Turkey feels less obliged to adjust its strategies in the Trump era. In the region, an alliance of Greece, Cyprus and Israel is not at all sufficient to maintain Western order; Turkey basically holds all the cards, but this will also have consequences.

The Role of Egypt

In January 2020, Greece and Cyprus signed an agreement with Israel to build an Eastmed pipeline to transport natural gas from the Israeli Leviathan gas field (estimated at more than 600 billion cubic metres) to Europe. The problem is that the Republic of Cyprus wants to feed natural gas from its own fields and this could lead to an escalation with Turkey, which is making claims even in this region. On the other hand, Egypt, which will also feed its natural gas reserves from the Zhor gas field into the country, is also interested. In other words, this gives the conflict an even greater dimension. There is already a fundamental conflict between Ankara and Cairo due to the closeness of the Turkish President to the Muslim Brotherhood and the even more intense confrontation between the two countries in Libya, with Cairo supporting General Haftar and Ankara supporting the regular government. Considering the fact that Egypt's relationship with the USA is not strong, this does not bode well because Cairo has been buying weapons from Russia for a long time and has already received new Russian fighter planes; Cairo is also interested in acquiring the S-400. Within the neighbourhood, the Egyptian power structures view Israel as a partner, but such an idea is far from attractive to the Egyptian population. From Israel's perspective, Turkey is of course the most interesting country in the eastern Mediterranean, as the two countries have maintained economic and cultural relations ever since 100,000 persecuted Jews were taken in by the Ottomans at the end of the 15th century and assimilated into the Ottoman population. Unfortunately, conflict resolution is always more difficult when placed in the context of complex and interwoven relationships; we are facing tense times indeed.

Conclusion

Greece would have been bankrupt a few years ago without EU assistance, but massive financial support and economic reforms have saved the country and Athens will only have to pay off most of its debt and interest from 2033 onwards. With the privatisation process in full swing, the airports are now owned by the Germans, the trains by the Italians, the ports by the Chinese, and the oil and gas reserves by the French and Americans. It is no different for Turkey, as much has also been privatised, and the Turkish Lira is in decline. However, it would be sensible and advantageous for these two NATO partners to address the current crisis and rid themselves of the hostility that has lasted for decades. The challenge they face is at the same time immensely important for NATO as well as for the EU. Otherwise, the conflict between Greece and Turkey would further burden the already heavily exploited traditional alliance structures such as NATO and the EU. The main goal is to satisfy the common interests of the Greek and Turkish peoples, and to ensure peace and stability in the Mediterranean. ■

Numerous Challenges for the Peruvian Navy's Cyber Command

Photo: Guy Toremans

Left: Captain Luis del Carpio, Deputy Cyber Defence Command and Rear Admiral Enrique Arnáez, Commander, Cyber Defence Command

Cyber defence is becoming a priority in all military domains, not least for the world's navies. In today's operational environment where navies are increasingly dependent on interconnectivity and Command, Control, Communications, Computers, Collaboration, and Intelligence (C5I) capabilities, cyber attacks pose a genuine threat. Well aware of the evolving risks in the cyber domain, the Peruvian Navy's General Command decided to establish a Cyber Defence Command to meet its operational requirements to counter cyber attacks. The Cyber Defence Command was established on 2 August 2018, and the Cyber Defence Command Operations Centre was officially inaugurated on 20 February 2019. MSD had the opportunity to talk to Rear Admiral Enrique Arnáez, Commander Cyber Defence Command of the Peruvian Navy.

MSD: RADM Arnáez, how did you prepare yourself for the appointment as Commander of the Cyber Defence Command?
RADM Arnáez: Being a qualified surface warfare officer, I had expertise in weapons and fire control systems, and knowledge of artificial intelligence. However, I was well aware that I needed to expand my knowledge in the area of networks, cyber threats, and offensive and defensive cyberspace operations, and also look at other countries' procedures, regulations and capabilities in cyberspace operations.

MSD: Can you provide some details about the organisation of your command?
RADM Arnáez: The Cyber Defence Command (COMCIBERDEF) is the Peruvian Navy's fourth operational command, at the same level as our Navy's three other major commands: the Pacific Operations General Command (COMOPERPAC), the Amazon Operations General Command (COMOPERAMA) and the Coast Guard General Directorate (DICAPI). Our command consists of three divisions:

- The Department of Defence Operations which monitors all networks;
- The Exploitation Department which looks for threats through 'open sources' in cyberspace worldwide;
- The Response Department which is responsible for counter-attacking real threats.

MSD: What are your command's missions and tasks?
RADM Arnáez: The establishment of the Naval Cyber Command is a milestone in preparing our Navy for possible cyber warfare risks. Our mission is to ensure that the naval cyberspace domain remains secure for use by our naval forces. Our tasks are to defend our assets, both ashore and afloat, constantly monitor the data flows for any attacks, assess and analyse risks, coordinate and execute counter-operations and detect them and respond at the earliest possible opportunity to ensure the unrestricted use of our cyberspace.

MSD: Has the Cyber Defence Command already reached its full operational capability (FOC)?
RADM Arnáez: In my opinion, one cannot reach 'full operational capability' in the cyber domain due to the permanent evolution of technology and cyber threats. Consequently, constant modifications, improvements and adjustments to our techniques, procedures and equipment are required. However, the XVIII PANAM Games of 2019 can be regarded as the 'certification' of our command. We had to be ready for the games less than a year after our establishment. This was quite challenging and I am proud to say that we achieved very good results indeed. During the PanAm Games, we identified about five million incidents and we were able to deal, block and control all of them. Our motto was "the games' cyberspace must never stop, nor be affected by any cyber attack."

MSD: What have been the major milestones since its establishment?
RADM Arnáez: Obviously, the real landmark was the decision to create the Cyber Defence Command by the Naval Staff, and another very important milestone was our support to the 2019 PanAm and Para-PanAm Games in Lima between 26 July and

1 September 2019. The PanAm Organising Committee selected us to collaborate with them on cyber security throughout the games.
Another noteworthy event took place in January 2020 where the PanAm Organisation hosted a press conference for both national and international press, to which all Military Defence Attaches here in Peru were also invited. They explained and presented the way in which we cooperated with the PanAm Games' organisers and how we succeeded in achieving such good results.

Photo: Guy Toremans

RADM Enrique Arnáes during a briefing at the Cyber Defence Command Operations Centre

MSD: What are the major dangers of cyber threats for the Peruvian Navy?
RADM Arnáez: Today, the dangers in cyberspace are many - the main ones being international organised crime trying to steal classified information, and common cybercriminals (hackers).
The major threat is a 'ransomware' attack, a form of malware that encrypts files in networks, designed to deny access to a computer system or data until a ransom is paid. Ransomware typically spreads through phishing emails or by unknowingly visiting an infected website and which are not yet recognised by the anti-virus walls. Other malicious software is a danger to the vulnerabilities of ship control systems from a cyber attack, for instance the spoofing ship-based anti-collision systems (AIS). Some destructive programmes are those that masquerade as a benign application ("Trojan Horses"). Unlike viruses, this form of malware does not replicate itself but can be just as destructive. One of the most insidious types are programmes that claim to rid your computer of viruses but instead introduce viruses to your computer. With new variants discovered each day, we must make sure their endpoints are secure by employing the right security controls.
However, by experience we know that people are the weakest and most vulnerable link. It is worthless to employ the best security tools and sensors if your personnel are unaware of the possible threats to which everyone is exposed, meaning the lack of consciousness and carelessness with regard to cyber defence and cyber security. But we have an ambitious programme to improve people's behaviour in this area. The shipboard environment will continue to increase in complexity and pose challenges to naval operations. We are well aware that these dangers will be more sophisticated and occur more often.

MSD: Can you elaborate on what systems and technologies you have at your disposal?
RADM Arnáez: I cannot specify the tools and technologies but our capabilities include the protection of different technological platforms and information systems from attacks, their recovery in the event of total or partial failure, threat detection, and blocking the use of cyberspace to adversaries. We use a number of commercial solutions and other 'open source' tools which we customise to meet our requirements; and we also develop some of our own software. These give us an advantage so that we can configure and customise this software to our specific needs, something that you cannot do with licensed software.

MSD: Are there any systems installed on board?
RADM Arnáez: Today we do not have any specific facilities on board our units, but our new generation of warships will feature a 'security operations centre' from which we will monitor and supervise every network inside the ship. They are permanently under our cyber 'scope'.

MSD: How do you protect the Peruvian Navy's networks in general and warships in particular?
RADM Arnáez: Obviously, I cannot go into detail regarding our systems, tactics, techniques, and procedures for defending our assets, but I can say that our network architecture consists of very secure and reliable systems, allowing the mitigation of computer incidents and discarding false positives that usually occur. Our systems allow us to obtain, process, filter, and interpret vast outputs of information, and then turn this into useful intelligence and share it with anyone who might need it, in order to neutralise any threats. We keep pace with the constantly evolving technologies that are designed to counter threats.
We also constantly monitor cyberspace for any emerging threats and frequently adjust our information infrastructure and cyber defences to ensure we remain resilient and operationally effective. We are able to detect everything attempting to gain access 'inside' our systems. We continuously test our own systems to ensure they remain robust against different threats, and in case of any doubt, we 'erase' everything and reboot the systems.

MSD: Do you feel that you have sufficient assets to implement your tasks?
RADM Arnáez: In order to fulfil the assigned tasks, we need to take into account two factors - the human aspect and the

Rear Admiral Enrique Luis Arnáez Braschi

Born in 1969, he entered the Navy in 1986 and graduated in 1990 as Alférez de Fragata. He then took the Basic Course of the General Staff, the Command and Staff Course and the Naval High Command Course at the Naval War College and completed courses at the Training Centre of the Atlantic Expeditionary Forces of the US Navy and the University of Defence of the United States. He holds a Master's degree in Control Engineering and Automation from the Pontificia Universidad Católica del Perú and a Master's degree in Maritime Policy from the Escuela Superior de Guerra Naval.
During his service at sea, he served on the BAP VILLAVICENCIO and the BAP ALMIRANTE GRAU. He was also Second-in-Command of BAP SANTILLANA and Commander of BAP LARREA and BAP QUINOÑES. He has served in the Naval School of Peru, in the General Command of Operations of the Pacific, in the General Staff of the Navy, as Assistant Secretary of the General Commander, and as a Liaison Officer to the Command of the Fleet Forces of the US Navy.
As of 2 August 2020, he assumed the position of Commander of Cyber Defence of the Peruvian Navy. In 2019, he was promoted to the rank of Rear Admiral.

technological aspect. We have qualified personnel, all capable of performing in any field of cyberspace operations. Staff numbers will definitely increase in the coming year and as far as the technological aspect is concerned, we are seeking new tools in order to keep up with the fast-paced evolution of cyber threats. We will continue to upgrade our existing systems and acquire specialised equipment, and also to look at the newest technological developments in order to allow our personnel to enhance and hone their knowledge and skills.

Photo: Guy Toremans

From left to right: Lt.Cdr. Franco Del Aguila (Forensics, Reversing, Research & Development Department), Commander José Otiniano and Capt. Luis del Carpio (Deputy Commander Cyber Defence Command) RADM Enrique Arnàez (Commander Cyber Defence Command)

MSD: According to the experience you have already gained, what more is needed to improve security in the cyber domain?
RADM Arnáez: We must improve our cyber situational awareness. Cooperation is imperative. One of the most important activities in the fight against online threats is joining efforts in cyberspace defence something that cannot be achieved through military means alone. Many actors are involved, such as governments, governmental organisations, public and private industries and academia, both national and international.
By exchanging information about warnings, threats, and vulnerabilities, to see how they work, about the problems they encounter, we can learn from each other.
In my opinion, this can best be done by increasing cooperation with other navies and both national and international organisations in order to share and exchange information and knowledge about procedures, lessons learned and experiences. Everybody should keep their partners informed about any possible dangers out there.

MSD: What programmes have you introduced already and which projects are being developed?
RADM Arnáez: We already launched a range of programmes aimed at protecting our networks and train our personnel to operate in the complex, rapidly evolving cyber domain. After the 'lessons-learned' from the PanAm Games, we adapted our 'concept of operations', and Cyber Wargame is being developed. Courses about cyber security – not cyber defence – are delivered in our naval schools aimed at making students aware about the cyber environment. We provide a course at the Naval Academy and at a number of our schools where we include courses in our personnel's military education.
All Navy personnel need cyber training but not everyone requires the same level of instruction. We have developed tailored cyber training for our cyberspace workforce, leaders, users and enhanced users. As part of this effort, the different commands identify personnel who require specialised cybersecurity training based on the roles they perform. For example, certain engineers receive cybersecurity training so they are able to build better-defended networks and systems.

MSD: What are your strategies to evaluate what are the best practices?
RADM Arnáez: It is difficult to determine a proportional and effective response if the actual source of the threat is unknown or uncertain. Therefore we must ensure that the new systems include appropriate cyber security controls, supporting the identification of risks on naval networks from their design all the way to fielding and, most importantly, throughout the systems' operating cycle.

MSD: Are there any investments you would like to make over the next years?
RADM Arnáez: We are improving our training capabilities for our cyber teams in order to improve their proficiency, and we are looking into the possibility to introduce and develop a secure cloud concept. The construction of a new headquarters building, where we can accommodate more personnel and equipment, and increase our data centre capabilities, is in the pipeline. We expect to see the approval of the budget in the coming months and subsequently start the construction by the end of the year.

MSD: As this is a very high technical demanding environment to work in, what skills must prospective candidates have? How do you select your personnel?
RADM Arnáez: It is important to attract candidates with diverse backgrounds who preferably have strong mathematical, analytical and technical knowledge in computer science, database or network management, programming languages, operative systems, forensic analysis, electronics, artificial intelligence and operational planning. Successful candidates then undergo some challenging tests to see if they have the necessary skills and motivation and, depending their results, we then determine which department and team in our command they will work.

MSD: In which ways do you train your officers, petty officers and enlisted personnel?
RADM Arnáez: We train our personnel 'in-house' and continuously seek ways to improve their skills through exercises, particularly with the use of our web-based virtual training platforms and apply new technologies which we have acquired or developed ourselves in the Research & Development (R&D) area. We continuously train our personnel in digital security and 'attack' our own network, challenging every part of our system and instruct our staff in how to cope with 'real' attacks. We developed training methods that allow our operators to hone their skills in a "realistic and challenging cyber environment." We also have virtual servers for training our personnel, using 'capture the flag' (CTF) servers for example.

MSD: Is it difficult to retain your highly qualified staff when jobs in the private sector pay significantly more?
RADM Arnáez: We are committed to serving our country and our Navy; our person-

Photo: PERUVIAN NAVY

The inauguration of the Cyber Defence Command Operations Centre on 20 February 2019.

nel is highly committed in this endeavour, and they appreciate the education and the training that the Navy has invested in them.

MSD: Do you attend national and international exercises, conferences or workshops?
RADM Arnáez: Since the establishment of our Command, we have participated in the Cyber Defence Symposium at the IADB 2018, the Peruvian Naval War College International Symposium in Defence 2018 and 2019 and in the Western Hemisphere Cyber Defence Conference 2019 in Bogotá. Our participation at these events allowed us to better understand and identify gaps between current capabilities and the requirements needed to execute full-spectrum cyber warfare.
In November 2019, I travelled to Washington D.C. to attend the Inter-American Defense College (IADC), Cyber Defence and Security Seminar D.C., which gathered the different cyber commands from the 35 Member States. The conference addressed the lessons learned in cyber security and cyber defence, in order to promote the development of cyber defence policies and strategies, as well as to strengthen cooperation mechanisms in cyber defence across the hemisphere. I delivered a presentation about how we cooperated in the organisation of the PanAm Games 2019 and how we operate in cyber defence in Peru in general, and in the Peruvian Navy in particular.
I also went to US Southern Command (SOUTHCOM) HQ in Miami to attend the course of the Combined Force Maritime Component Commander where we shared information on how we can support each other in the southern hemisphere. In May 2019, we had a VTC-meeting with the Organization of American States (OAS) Hemisphere Security Council about cyber security during the COVID-19 pandemic and in July 2020 we have begun with a new concept for a cyber war game with the US Naval War College.

MSD: What impact has the COVID-19 pandemic had on your command?
RADM Arnáez: Peru was hit by the COVID 19 pandemic in March 2020. Obviously, this had an impact on our command and because a huge amount of military personnel was ordered by the government to patrol the streets during the lockdown measures, we were forced to re-schedule training courses for our new entries. As for the personnel of the Cyber Command, we introduced a rotation system during which 50 % of our personnel remained in the HQ, with the other 50 % off duty.
The day prior to commencing their two-week duty, they are required to take a COVID-19 test, and when this proves negative, they are granted access to the headquarters for the coming 15 days. The second group is also tested before relieving their colleagues.
During the COVID-19 pandemic, we witnessed a 40 % increase in Peruvian citizens using the internet and a 70 % increase in e-commerce, with a subsequent high increase in cyber-attacks. Prior to the pandemic, we had an average of 2,500 attacks per week (mainly occurring between Friday afternoon and early Monday morning – the so-called "weekend hackers"), but during the COVID-19 crisis it continued on an almost 24/7 basis, especially at the beginning of the pandemic.
We publish a daily newsletter with updates on the situation on cyber threats which we provide to the Armed Forces Joint Staff and the Secretaría de Gobierno Digital (the Government's Digital Secretariat). We work closely together with national organisations, and even private companies to provide up-to-date information on all the areas affected by the pandemic. Today, with our participation, the Government's Digital Secretariat is publishing a national daily news bulletin in which any news on cybersecurity is reported.

MSD: I suppose that "fighting" cyber threats is like fighting "the unknown"?
RADM Arnáez: It is a continuous challenge. The rapidly evolving nature of cyber threats means that complete security is impossible to achieve. Protecting the networks is a continuous challenge and the overarching concern is to try to detect the "unknown" and ensure that the right information reaches the right place at the right time and with the right level of protection. Rather than

Photo: PERUVIAN NAVY

RADM Enrique ARNÁEZ addressing his personnel during the COVID-19 pandemic

Masthead

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attempting to address every possible weakness in cyber defences, our aim is to execute a cyber-resilient strategy.

MSD: How do you see cyber defence evolving?
RADM Arnáez: The evolution in cyber defence will take place by employing different artificial intelligence tools, large-scale data analysis, and faster processors. To preserve the Navy's cyber warfighting advantage, we must continue to employ the latest technological advances. It is difficult to determine the origin and we have to cope with different types of attacks from around the globe on a daily basis. The most common are attacks that attempt to penetrate our networks, through the vulnerabilities of computer systems or through social methods, i.e. phishing and denial of services. Our President (Martín Alberto Vizcarra Cornejo) has already announced that Peru will further improve its cyber security capabilities and boost its national cyber organisation. In this regard, the headquarters of the Armed Forces Joint Command's Cyber Defence Operational Command was inaugurated in March 2020.
MSD: Where would you like to see improvements being made?
RADM Arnáez: There is certainly more work to be done to fully implement cyber security. The most important improvement is to change the mind-set of the users in order to achieve more secure and safer computer skills.. And with technology evolving ever faster, we must continuously search for better ways to improve our training capabilities.

MSD: What are the greatest challenges the Peruvian Navy will have to face with regard to cyber defence?
RADM Arnáez: At the heart of cyber challenges is the rapidly expanding nature of cyber threats. Attacks will continue to increase, become even harder to detect and even more difficult to counter. With digital technology and naval automation increasingly being applied in naval warfare - the growth in automated elements, software and artificial intelligence, and networked assets, components, electronics - the vulnerability of the ships and their systems will increase. The main challenge will be to design concrete strategies and action plans for cyber defence that take into account all these new applications. Another challenge is the legal/judicial aspect; because it is a fairly new area of warfare, laws, doctrines, procedures and manuals all need constant updating and we will also have to adapt our current concepts of operations (CONOPS).

MSD: As the Commander of the Cyber Defence Command, did you set yourself specific goals?
RADM Arnáez: I hope to establish a large 'network of friends' both national and international, because the most important factor in cyber security and cyber defence is to establish partnerships with both private and public organisations, national, as well as international, in order to collaborate and guarantee a more secure and safer cyber space. Another goal is to become the lead organisation in the region in the area of doctrines and operations in the cyber defence domain. Today, our goals focus mainly on a peacetime environment, but we also train to be ready for any wartime scenario. Our main role will then be to defend the sovereignty of our country. Therefore, we must be capable of supporting any cyber defence operation asked for by our government and support, as the naval component, the Cyber Defence Operational Command.

MSD: Thank you!

The interview was conducted by Guy Toremans.

The BONIFAZ Class Frigate (F-110) – the Future Backbone of the Spanish Armada

Esteban Villarejo

The state-owned shipbuilder Navantia is currently developing the new F-110 or BONIFAZ class frigate for the Armada Española with a projected budget of €4,317M. The Navantia shipyard in Ferrol (La Coruña) has the lead role in the building programme.

The state-owned shipbuilder Navantia is currently developing the new F-110 or BONIFAZ class frigate for the Armada Española. "The five F-110 frigates will be the first ships designed from the outset with a digital twin, which is a disruptive concept to respond not only to today's challenges but also the challenges of the future. Navantia is now fully immersed in the functional design phase, including the definition and implementation of a digital twin as a first step on the way to developing a digital fleet," Eduardo Dobarro, Navantia's Chief of the F-110 programme, told MSD.

According to the Spanish Ministry of Defence, the objective is to build five ships in the next ten years. These new frigates will replace the six SANTA MARÍA class (F-80) frigates which are already in the last third of their operational life cycle. Delivery of the first F-110 unit is scheduled for 2026, and the last vessel for 2031. The first cut of steel is expected in the first half of 2022.

The expected programme budget amounts to 4,317M and the shipyards of Navantia in Ferrol (La Coruña) will have the lead in building the frigates. Spanish company Indra will incorporate a new mast concept, where the various sensors of the combat system are integrated. This is one of the key aspects of the future backbone of the Spanish Navy.

Besides, the F-110 programme seeks to increase the participation of national industry in the ship with the share of national company participation on the entire ship estimated to be 65%. This is a key issue at this moment in time when the COVID crisis could force the Government to launch a programme of industrialisation in different fields, including defence.

But this military project, currently one of the most important for the Spanish MoD, will also have the support of the US company Lockheed Martin, as well as Indra.

Lockheed Martin will also collaborate with Indra to supply the main components of the AESA (Active Electronically scanned Arrays) S-band anti-air warfare radar antenna of the future F-110, one of the sensors that will make this frigate one of the most advanced of its class in the world. The total value of the contract amounts to over €150M over a period of seven years.

Photo: Navantia

Delivery of the first F-110 unit is scheduled for 2026.

The F-110 frigates have been conceived as a multi-purpose escort ship with capabilities in all the main areas of warfare, including anti-aircraft warfare (AAW) and anti-surface warfare (ASUW), but mainly it is the anti-submarine warfare (ASW) capability that will be enhanced. It will escort and protect the fleet, but it will also operate independently in highly hostile environments.

"The F-110 frigates are therefore essential to guaranteeing the maintenance of naval capabilities, in this case the role of escorts, which a nation so dependent on maritime traffic like ours requires, considering that approximately 80% of our trade enters or leaves Spain by sea," Fleet Commander Admiral Antonio Martorell told ESD.

"With a length of 145 metres, an 18-metre beam and displacement of 6,100 tonnes, the F110 is a vessel that best fits this new multi-purpose vessel concept with a high offensive and survival capability," the Spanish Armada official told ESD. In its interior, it will have 187 beds, including 150 for the crew and an extra 37 for additional personnel on board.

The propulsion plant will be the Codlag type (combined diesel electric and gas) with two shafts equipped with controllable-pitch propellers. The F-110 frigates - to be named in honour of five illustrious Spanish sailors - will have a multi-mission space located on the starboard side, almost symmetrical to the helicopter hangar located on the port side. This space can be used, for example, for embarking housing, toilet and office containers, as well as semi-rigid watercraft of up to nine metres in length, in addition to the two that are standard on the ship. It could also house ScanEagle UAVs, including its recovery pole and launcher.

The F110 is a new multi-purpose vessel concept with a high offensive and survival capability.

The Role of Indra

One of the most innovative design elements is the integrated mast that rises over the control bridge. According to the Naval Programmes Director at Indra, Carmela Barbero Arrabé, the mast "minimises the radar section so that the F110 operates with maximum stealth, making it difficult for the adversary to detect its presence."

But under the skin of this superstructure there is a complete range of state-of-the-art sensors designed to guarantee the F-110's superiority, the Indra Director explains further.

Aerial Surveillance

The primary S-band radar that Indra is developing with Lockheed Martin will provide the capability for aerial surveillance and support anti-aircraft combat at the highest level. It is a solid-state radar based on gallium nitride (GaN), the most advanced and efficient technology to generate the required power levels and highly reliable.

Completely digitalised and built with hundreds of small independent blocks, Barbero explains that "it will work as if the F-110 has multiple radars working in a coordinated way. This will provide the F-110 a powerful multi-function capability to combine tasks: it will operate as a long-range radar and integrate missile control, while setting the tracking on multiple targets, all simultaneously. "The possibilities offered by the new system will provide the frigate with capabilities far superior to other vessels in its class," Barbero said.

AESA Technology

In order to support surface combat and helicopter landing on deck, the frigate will have the Prisma 25X radar. Its four flat facets, which replace the old rotating radar antenna, contribute to its stealth. The solid state active electronically scanned array (AESA) technology, together with its incredible process ability, will allow the beam of each of its facets to be controlled with great agility and in an independent manner.

These features make it possible to explore a space with enormous freedom, precision and a high refresh rate. It is a multi-function radar, so operators "will be able to monitor the movements of surface targets and aircraft flying at low altitude while tracking the presence of submarine periscopes, support surface combat and support the helicopter landing on deck; there are no limitations."

IFF System

The IFF system will identify friendly and enemy aircraft to avoid the much-feared friendly fire.. This sensor will be based on state-of-the-art solid state active electronically scanned array (AESA) technology (GaN). It incorporates multiple military and civil identification modes and an additional passive identification system known as ADS-B.

Electronic Defence Systems

As for electronic defence systems, Indra technology will track the communications band and the radar band. "The system will detect and identify any nearby vessel, submarine or aerial or land platform and it will be prepared to counteract multiple threats simultaneously. It will prevent the enemy from detecting its position. It will make its communications difficult. It will blind the missile guidance systems," the Indra Director stressed.

It will use fully digitalised interferometry techniques, capable of combining the signals collected by different antennas and sensors to generate a much more precise situational awareness. Barbero explains that, in addition, "new algorithms based on artificial intelligence and additional hardware to collect raw data massively and identify the most complex signals" will be incorporated.

It will also use new super-resolution techniques and algorithms, capable of discovering enemy communications that attempt to go unnoticed by using the radio spectrum in an expanded way (Direct Sequence Spread Spectrum, DSS).

Protection

Finally, the system will provide an impressive protection capacity against sea-skimming missiles and swarms of vessels, which typically attempt to impact the waterline of vessels.

"The IRST i110, which is how we call this advanced system that we developed with

Photo: Navantia

The F110 will host the first-ever S-band variants of Lockheed Martin`s SPY-7 radar.

Tecnobit company, represents a technological leap of enormous magnitude. Through a fixed system, without moving parts, it offers simultaneous 360° surveillance, at all times, and covers the long and short- range visible and infrared spectrum. It also has telemetry capability. Its mission is to detect, recognise and identify any object likely to represent a threat."

The AEGIS Weapon System

Of course, the F-110 will host the Aegis Weapon System, which will be integrated with the ship's combat management system SCOMBA (the Spanish combat system developed by Navantia) when the first frigate deploys in 2026.

"The Aegis Weapon System is the most deployed combat system in the world, and its flexible system enables it to fulfil a variety of missions. Due in part to its unique open architecture design, the Aegis family continues to grow internationally as more nations around the world partner with Lockheed Martin," sources from the US company explain.

Spain's Ministry of Defence stated its preference for Lockheed Martin's technology for its five F-110 class frigates in 2017 and awarded the ship construction order to Navantia and Indra in 2019 (Protec 110 is called the Temporary Joint Venture).

As mentioned, these new frigates will host the first-ever S-band variants of the SPY-7 radar for the Spanish Navy. Production will be a collaboration between Lockheed Martin and Indra. "When the frigates deploy in 2026 our SPY-7 variant will be integrated as part of the Aegis Weapon System. The frigates will also incorporate the International Aegis Fire Control Loop (IAFCL) integrated with SCOMBA."

In the combat systems, imports have been reduced in both the AAW segment (anti-aircraft warfare) and sensors of the ASW segment (anti-submarine warfare). All other sensors and the command and control system are products of the Spanish companies Navantia, Indra, GMV, Tecnobit, Sainsel and Saes.

Spain's Ministry of Defence has also announced the selection of the Raytheon RIM-162 ESSM Block 2 as the primary anti-air self-defence weapon. Each frigate will also have two MK-99 illuminators for the final guidance of semi-active missiles. Regarding anti-surface warfare (ASUW) weapons, Harpoon Block II missiles will be part of the F-110's combat system in addition to a 5-inch Oto Melara 127mm and two 30mm automatic weapons.

In addition, it will also have a vertical launching system (VLS) of 16 cells, located on the bow, holding Standard SM2 medium-range, semi-active missiles and short-range missiles for Anti-Ship Missile Defence (ASMD).

Photo: via author

Under a contract signed by Thales and Navantia, Thales will transfer key underwater acoustics technology "more than €160M" to the Spanish industry.

Sonars of Thales

The French Thales will handle the sonars and acoustic systems: the key components of the integrated suite are the BlueMaster (UMS 4110) and CAPTAS 4 Compact sonars, the TUUM-6 underwater communication system, and the BlueScan digital acoustic system already in service with other European navies.

"The vessels' anti-submarine warfare capability, based on two world-class sonars, the Captas 4 Compact and the BlueMaster, and the BlueScan digital acoustic system, will be integrated through Navantia Combat Management System SCOMBA F-110 and will enable the naval service to conduct maritime surveillance, search and protection missions in any theatre of operations," the French company informed. Thales signed a contract with Navantia worth "more than €160M" and under this contract, key underwater acoustics technology will be transferred to Spanish industry, in particular for the supply of the TUUM-6 digital underwater communication system and acoustic arrays.

"After two years of talks with the Spanish Navy and Navantia about this contract to equip five F-110 frigates, we welcome Spain's decision to join other NATO countries (the United Kingdom, France, Italy, Norway) and Australia in placing their trust in Thales for their anti-submarine warfare (ASW) capabilities," Alexis Morel, Vice President of Thales stated.

The new BONIFAZ class frigate (BONIFAZ F-111; ROGER DE LAURIA F-112; MENÉNDEZ DE AVILÉS F-113; LUIS DE CORDOVA F-114; and BARCELÓ F-115) will have air capabilities using drones (ScanEagle) and the Airbus NH90 HSPN helicopter, foreseen to be in service in 2031. Until that date, the SH-60B is providing an interim solution.

Digital Twin of Navantia

The F-110 will be built from the beginning with a Digital Twin: "It is a key concept for the Shipyard 4.0. It consists of a 3D virtual reality replica of a physical product. As the data feeds the Twin, it evolves to reflect how the physical product has been used and altered showing the environmental conditions to which it has been exposed. As an avatar of the real product, its Digital Twin allows the company to visualise the status and condition of the product thousands of miles away. The Digital Twin can also provide new insights and perspectives on the design, manufacturing, operation and services associated with the real Twin," sources from Navantia explained.

Once the product is delivered, the virtual environment is delivered to the client, who will be able to exploit all the advantages it has to offer, such as the simulation of operational scenarios, artificial intelligence (combat, malfunction diagnostics…), and savings due to optimised maintenance. ■

SITREP: TAMANDARÉ Class Corvettes for Brazil

Jack Richardson

The Brazilian Navy's TAMANDARÉ class frigate programme is the result of a competition which includes industry from around the world and aims to provide the service with four new general purpose surface combatants.

The baseline platform will come from the MEKO family of modular combat ships produced by Thryssenkrupp Marine Systems (TKMS) of Germany, a model exported around the world for almost 40 years.

The Project

The resulting vessels, their sensors and armament, can be scaled up or down according to requirements, with examples including the HYDRA class operated by the Hellenic

Photo: ESuT

Brazil`s new corvettes are based on the proven concept MEKO A100 TKMS.

Navy and the ANZAC class, which forms the backbone of the Royal Australian and Royal New Zealand Navies. More modern MEKO designs have innovative features such as those used on the VALOUR class built for South Africa. One is a combined propulsion system using propellers and a pump jet to ensure high speed and low acoustic signature. These vessels also feature an 'X' shaped superstructure and mount their exhaust funnels at the stern in order to reduce radar signature. The TKMS led Águas Azuis consortium was named as the winner of Brazil's competition in March 2019 from a shortlist of offerings which included Naval Group of France, offering its GOWIND class corvette, Dutch Damen Group with its SIGMA corvette family, and a bid from Italy's Fincantieri based on the corvette design being supplied to Qatar (all of which had partnered with local industry). Up to 21 companies from around the world, including the UK and India, had made initial offerings. Despite delays over industrial relations and financing, President Jair Bolsonaro approved funding for the project in December 2019 and the contract was signed in March 2020.

Equipment

The four vessels will be 107 metres long, weigh 3,455 tons with a width of 15.95 metres and enter service between 2024 and 2028 at a total cost of US$2bn. Their main role will be the protection of the 'Blue Amazon', Brazil's 4.5 million square kilometre Exclusive Economic Zone which contains significant natural resources. Secondary roles for the ships will include Search and Rescue, Humanitarian Assistance and Disaster Relief in addition to peacekeeping. The ships will be fitted with equipment from a wide variety of countries. Propulsion will be provided by four MAN diesel engines (driving two propellor shafts for a top speed of 28 knots) with another four caterpillar generators providing the ships with electrical power. Each vessel will have 12 SEA CEPTOR missiles from the UK, coupled with the ARTISAN radar to provide an air defence capability. Each ship will also have four canister launched Block 3 EXOCET anti-ship missiles supplied by France and a Leonardo 76/62mm main gun to prosecute surface targets. Defensive systems include FN Herstal remotely operated guns, a Terma C-Guard decoy launcher and 40mm Bofors gun (the latter mounted above the hanger). In order to engage submerged targets, the ships will have a pair of triple torpedo launchers from SEA, an Atlas Elektronik hull mounted sonar and be able to deploy any helicopter in the Brazilian Navy's inventory. Currently, this refers to the Sikorsky SH-60 SEAHAWK, WESTLAND LYNX and EUROCOPTER EC275 COUGAR, though UAVs could potentially be deployed from the class in the future. Literature also states that the vessels will have modular space beneath the flight deck to carry out the wider range of roles listed above if necessary.

Contractors

As is the case in many procurement programmes today, the winning contractor has announced partnerships with local industry as part of their bid. Accordingly, TKMS do Brasil purchased the Oceana shipyard in Itajaí from Aliança S.A in May 2020. This is a company owned by Rio de Janerio based CBO Group which specialises in the production of offshore vessels and will be used to assemble the TAMANDARÉ class. The Águas Azuis consortium hopes that, at its peak, the programme will employ up to 800 people in Brazil, which is benefiting from a technology transfer by TKMS. As part of the consortium, Embraer will use subsidiary Atech to act as integrator for weapons and sensors into the combat system (some of which have been supplied by Atlas Electronik, a TKMS company). Under current plans, construction of the first ship will start in 2021 prior to delivery in 2024 and enter service in 2025, though exact timelines remain unclear. The Águas Azuis consortium plans to include a high percentage of local content in the supply chain, 30% in the first vessel rising to 40% in the other three whilst drawing on skills in the Brazilian work force. Despite economic difficulties facing the country in recent years, the Brazilian Navy has made major modernisation efforts. This includes the purchase of former UK helicopter carrier HMS OCEAN, new patrol vessels (also from the UK) and conventional submarines from France while starting work on a nuclear powered submarine. The service has also published a 20-year plan, which includes upgrades to weapons, ships and other systems, all of which are aimed at securing Brazil's maritime approaches, showing that the TAMANDARÉ class is only the start of a wider process. ■

Author

Jack Richardson is a professional UK based author and a regular contributor to our sister magazine European Security & Defence specialising in defence and security.

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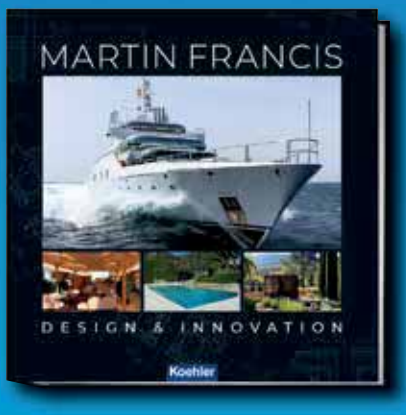

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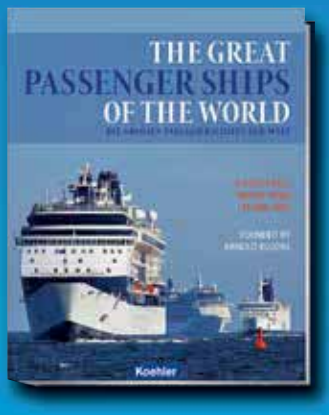

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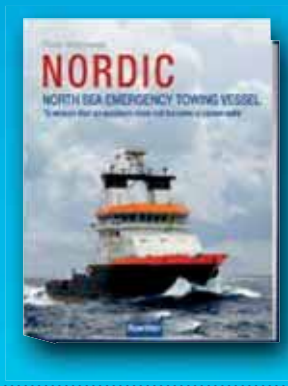

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Counter-Mine Capabilities in Europe

Jack Richardson

In recent years, counter-insurgency conflicts have seen non-state actors seek to gain an advantage over more sophisticated militaries through crude Improvised Explosive Devices (IEDs). This has resulted in force protection having to evolve fast, with vehicles needing to be more heavily protected and agile.

Concurrently, unmanned disposal robots have become more advanced to deal with this evolving threat. The tactic of crude devices to deny access has also been continually used at sea, with powers such as Saddam Hussein's Iraq using large numbers of sea mines to deny allied forces access to the Gulf. The extent of this threat today is demonstrated by regular Mine Counter Measures Vessels (MCMVs) carrying out exercises in the region.

Photo: via author

The joint project for a MCM mothership between Belgium and the Netherlands relies heavily upon unmanned systems.

Minesweepers and Minehunters

In recent years, navies around the world have been moving towards MCMVs that fulfil both traditional minesweeper (entering a minefield to search for and destroy multiple contacts) and minehunter (neutralising an individual mine that has already been detected). For instance, the UK has the SANDOWN class minehunter which is complemented by the older HUNT class minesweeper, though sweeper capability on the latter has been deleted. These two classes are built from Glass Reinforced Plastic (GPR) which reduces their acoustic signature, making them less vulnerable to magnetic mines. In addition to routine deployments in UK waters and the NATO area as part of Standing NATO Mine Countermeasures Groups, the two classes are an integral part of the Royal Navy's presence in the Gulf. Here, they operate from HMS JUFAIR, a recently re-opened facility in Bahrain where they are used to keep these key sea lanes clear of mines. Two MCMVs of each type are based in the region for up to three years (with crews rotating at regular intervals) alongside a BAY class support ship, which keeps them resupplied. The ships, which can also be used as Offshore Patrol Vessels (OPVs) have been upgraded in the last decade with new engines and more modern sonars to detect submerged threats. Once a contact has been identified, the MCMV (or an embarked boat) can deploy a recoverable SeaFox Unmanned Underwater Vehicle (UUV) which follows predesignated waypoints to visually identify the contact (using four electric thrusters). Once this is done, the UUV is recovered and an expendable version of SeaFox is deployed, and uses its shaped charge to neutralise the threat. SeaFox is in service with several navies including those of the US, Germany and Finland, with whom it can be used to neutralise historic ordinance and modern mines. The UK leased examples in 2001 for use in the Gulf and in 2011, SANDOWN class MCMV HMS BANGOR, destroyed a mine off the coast of Libya using the SeaFox system. Similar systems are produced by other manufacturers including Saab, who have sold the DOUBLE EAGLE UUV which can be deployed from the Swedish Navy's distinctive VISBY class corvettes (and its dedicated MCMVs) to search for mines before a SeaFox destroys them.

Graphic: Babcock

As MCM systems become more modular, scope grows for them to be deployed from alternative platforms, such as the Royal Navy's Type 31e General Purpose Frigate.

Author

Jack Richardson is a professional UK based author and a regular contributor to our sister magazine European Security & Defence specialising in defence and security.

Off Board Systems

As the next stage on from this innovation, MCMVs continue to evolve with more sophisticated off board systems, as shown by the fact the UK's ECHO class survey ships have a secondary function of commanding MCM operations. In order to learn more about how unmanned systems can aid naval operations more widely, the Royal Navy has run a series of 'Unmanned Warrior' exercises around the UK coast. In 2018, the service received the first ATLAS Remote Combined Influence Minesweeping System (ARCIMS) from Atlas Elektronik UK. Procured by the Maritime Autonomous Systems Trials Team (MASTT), this 11m, 10 tonne vessels are powered by pump jets and tow Coil Auxiliary Boats which emit sonic signals to classify and if necessary detonate mines, including advanced stealthy models. The USV can also be fitted with different modules including a launch and recovery system for the SeaFox and other Remotely Operated Vehicles (ROVs). Four of these USVs, which can be transported by land, sea and air, were handed over to the UK MoD in 2018 after the then First Sea Lord announced at DSEI 2017 that new mine warfare systems would be delivered within two years. The USVs can be deployed from either land bases or at sea and restore the minesweeping capability to the HUNT class through being deployed from the stern in order to navigate minefields, covering wide areas and if necessary detonating mines. This has been a UK only project but the principles of off board systems being deployed from around the world as needed are being fed into a larger Anglo-French project.

Anglo-French Cooperation

This is part of the increase in defence cooperation between the two countries that has run for almost a decade with both nations to receive a new MCM system by 2020. Each will consist of a USV provided by ASV Ltd (carrying a Thales towed sonar), an ROV supplied by Saab (to identify and neutralise mines), UUVs from ECA Group, communications systems from Wood Douglas and a Thales operator station fitted to a Portable Operations Centre. Both countries will evaluate these systems once delivered before deciding how to proceed in meeting their future requirements. The USV has been named the HALCYON and depending on the outcome of the trials, ASV Ltd (an L3 Harris company) offers an enhanced HALCYON 2 version.

Although work is continuing around Europe toward new MCMVs, existing models have similar characteristics with the HUNT class. Alongside a GPR hull, sonar and unmanned systems compatibility, several have more traditional facilities including a decompression chamber. This can be used to treat mine disposal divers operating from the ship who may be suffering from decompression sickness, commonly known as 'the bends'. This is where nitrogen dissolved in blood comes out of solution, forming bubbles in the bloodstream, a potentially fatal condition. The presence of this capability shows the continuing value of manual skills in disposing of mines.

On the other side of the English Channel, France currently operates 11 TRIPARTITE class MCMVs, jointly developed in the 1980s with the Netherlands and Belgium. France, where they are known as the ERIDAN class, supplied the equipment, Belgium the electronic systems and the Netherlands contributed the propulsion systems, though each nation built its own ships. These ships are built from composites to reduce their acoustic signature and their equipment varies among the operators. As these ships have aged, several examples have been sold to allied navies including Pakistan, Indonesia and Bulgaria. Additionally, France operates several smaller ships to deploy MCM divers around its coast.

Under the 2019-25 military planning law, France intends to replace these ageing MCMVs with four motherships (and potentially another two for the hydrography mission) which will cover both home waters and commitments overseas. Although little is known publicly, the vessels will operate on the principle of deploying unmanned systems to hunt mines and have a facilities from which to operate a medium helicopter with surplus mission space to enable them to carry out constabulary roles beyond MCM. It has been suggested that both monohull and catamaran designs are under consideration.

The Dutch-Belgian Approach

Compared to France, Belgium and the Netherlands appear to be taking a more orthodox approach to replacing the TRIPARTITE class MCMV. This has taken the form of a joint requirement for 12 new vessels (to be split 50/50) for which a design by France's Naval Group was selected in early 2019. This is an 82m vessel with a low calibre gun mounted on the bow for self defence, though towards the stern, there is a mission bay from which USVs and UUVs can be deployed (up to Sea State 5) as part of the MCM 'toolbox'. This was developed by Belgium's ECA group and takes advantage of the trend in MCM towards deploying off board systems to reduce the threat to crews. It consists of the

Photo: Belgium Naval and Robotics

The 12 m-long INSPECTOR-125 USV can operate with up to six drones in the mine danger area.

INSPECTOR USV which can be deployed to locate mines using a towed sonar. If a mine is detected, the second component of the toolbox, the A18 UUV is deployed from the mothership to inspect the contact, after which the third component, the Mine Identification and Disposal System is launched from the USV to neutralise the threat. Also part of this is a UAV launched from a heli-pad situated above the mission bay. In June 2020, it was announced that the UMS SKELDAR rotary wing UAV had been chosen to provide these new MCMVs with greater situational awareness. Similarly, the MQ-8B FIRESCOUT operated by the US Navy has the option of a mine sensor for littoral operations.

Aside from the high profile Belgian/Dutch programme, which could led to further sales of the Naval Group solution, little is known about how different nations plan to replace their MCMV fleets. At the moment, other existing European MCMVs include the Spanish Navy's six SEGURA class vessels while Italy operates the LERICI Class MCMV (and its derivative the GAETA class) which has been exported, including to Australia where four vessels (plus two in reserve) are active as the HUON class. A similar version was also operated by the United States as the OSPREY class. In Eastern Europe, several navies have acquired second hand MCMVs from Western European navies, Lithuania and Bulgaria having acquired vessels from the UK and France respectively. Recently however, one example of a ship in counter-mine operations has stood out. The Romanian Navy (which has a small flotilla of MCMVs) recently took command of Standing NATO Mine Countermeasures Group 2, operating in the Black Sea and Mediterranean. From July 2020, they have commanded the operation from the minelayer Vice-Amiral Constantin Bălescu. At almost 40 years old, this vessel is one of the few of this type left in Europe and according to the s website, can deploy three different types of mine in addition to anti-submarine bombs. It has also recently been equipped with new Rohde and Schwarz radios in order to fulfil this command role.

Photo: via author

Older vessels such as the Romanian Navy minelayer VICE ADMIRAL CONSTANTIN BALESCU 274 have been used to command NATO's Mine Countermeasures Groups.

Future Solutions

Given existing ships as old as these can assume wider roles, and as unmanned systems proliferate, questions have been raised over whether dedicated MCMVs will be needed in the future. For example, the ACRMIS USV could be deployed from the mission bays that have been designed into the Royal Navy's next generation Type 26 and 31 frigates, Batch 2 RIVER class Offshore Patrol Vessels and potentially from shore establishments. With this in mind, industry has been consistently producing concepts such as the VENARI 85 from BMT. This 85 metre vessel is designed around the deployment of off board systems with a mission bay at the stern featuring gantries to deploy and recover unmanned vehicles, in addition to a flight deck for UAVs and manned helicopters (to temporarily land on). Marketing material suggests the vessel is well suited to detecting and neutralising mines in both littoral and open sea settings through 'route survey' to ensure safe passage for other vessels. The company also suggests the vessels will have wider roles including patrol, humanitarian assistance and low-end anti-submarine warfare. It has been reported that countries beyond the UK have been approached as possible operators for this class. On this theme, the UK MoD also commissioned an off board systems study which looked at the BLACK SWAN class sloop of war, where up to 40 small ships would rely on mission modules and tailored crew compositions to fulfil a wide variety of roles such as MCM and sea denial. Similarly, Norwegian contractor Kongsberg offers the VANGUARD concept for a small vessel which can be used to carry out MCM in addition to civilian duties including subsea survey and harbour protection. These builds on the modular philosophy (in this case fitting ISO containers and unmanned systems into a mission bay) pioneered by the troubled US Littoral Combat Ship Programme with its MCM module.

Modular Designs

These proposed vessels however are small, but existing designs are considerably larger and alter traditional warship definitions. The Royal Danish Navy is notable for operating the ABSALON class support ship, which is unique for combining the features of a frigate and Landing Platform Dock (LPD). The two vessels have a flexible deck-space running beneath the hanger and much of the superstructure which can be configured for many different roles. The space has been shown to be able to support the weight of a LEOPARD 2 MBT and carries equipment to launch and recover long-range boats. As a result, the area could be configured for mine hunting, or mine laying, operations. On a similar theme, Dutch shipbuilder Damen has produced the CROSSOVER concept for a vessel with frigate like characteristics and and LPD area at the stern which can be reconfigured in a similar way while Italy's THAON DI REVEL class also feature considerable mission space.

With this ongoing innovation, the realm of MCMV operations also has its fair share of failures. For example, towards the end of the Cold War, the Royal Navy looked at operating hovercraft for MCM operations. Other experiments however have proved more successful. In Germany, one company that has pedigree in this area is Abeking & Rasmussen. This firm constructed the FRANKENTHAL class MCMV for the German Navy, one of the first in the world to have a non-steel hull, which today has been upgraded with UUVs including the SeaFox in addition to the PENGUIN UUV, housed in a hanger. These ships have STINGER anti-aircraft missiles for self-defence and have been sold to the navies of Turkey and the UAE. While Abeking & Rassmusen also built the ENSDORF class MCMV for the German Navy, the company continues to innovate in this sector. This comes in the form of the PROTECTOR class MCMV, a futuristic looking vessels with its bow partially swept forward in addition to a mission area at the stern. The company markets this solution as being able to benefit from the reduced costs of a steel hull while ensuring survivability with a non-magnetic steel hull. The design is also offered as the PREDATOR, which can be optimised for ASW and ASuW solutions. At the smaller scale, Abeking & Rasmussen has delivered five 25 metre Small Waterplane Area Twin Hull (SWATH, a technology the company has 21 years experience in) patrol boats to the Latvian Navy. Mainly intended for patrol missions, an ISO container fitted between the two hulls can be deploy equipment for a wider variety of roles including MCM. Similarly, the Royal Norwegian Navy, deploys its OKSOY and ALTA classes which also utilise a catamaran hull.

Rotary Wing Solutions

One noticeable absence from Europe's diverse and evolving MCMV capabilities is rotary wing solutions, no navy in the region uses helicopters to tow MCM arrays similar to MH-53E SEA DRAGON and AW101 MCM variant used by the U.S. Navy and the Japanese Maritime Self Defence Force respectively. However, at time of writing, a possible way ahead was shown at an event hosted on HMS PRINCE OF WALES, the Royal Navy's second aircraft carrier of the QUEEN ELIZABETH class. In July 2020, the ship was used to showcase how UAVs could help the service carry out its roles in the future under the 'NavyX' initiative. On the vast flight deck, several quadcopter UAVs were displayed with one model carrying three payloads. One was general cargo, for vertical replenishment between ships, the second was shown with a life raft (for delivery to downed aircrew) whereas the third had a Hydroid REMUS UUV suspended underneath it. MCM forces around the world use this electrically powered submersible. Currently, it can be deployed from either a mothership or a RHIB to investigate suspicious objects, while it also has general underwater reconnaissance functions, a notable example being its use in the search for the missing Air France Flight 447. The company states that the UUV can be used to search harbours, rivers, lakes and inland waterways. It is available in REMUS 100 (100m depth and 12 hour endurance), REMUS 600 (endurance of between 600 and 1500m with 24-hour endurance) and the REMUS 6000. This variant can go as deep as 6000 metres for up to 22 hours and features an automatic stern recovery system on selected deployment vessel. The RN operates these vehicles from its existing MCMVs and other European navies have deployed it, including the Royal Netherlands Navy.

As in many areas of modern naval warfare, the threat of undersea mines (both historic and modern) continues to evolve with mines becoming smarter and more dangerous. Similarly, the techniques of countries in Europe and around the world to meet this threat are evolving in tandem with new technology. As with any part of the defence industry however, requirements have to be balanced with wider needs, costs and technological considerations. ■

Forcit Defence – New Wave of Underwater Mine Disposal Operations

Forcit Defence is one of the forerunners in Insensitive Munitions (IM) technology, manufacturing IM defence products with its Plastic Bonded Explosives (PBX) product family.

Explosive Pedigree

OY FORCIT AB is a Finland-based privately owned company that has almost 130 years of explosive expertise. Forcit Defence, a part of OY FORCIT AB, was developing and manufacturing innovative defence systems for Armed Forces globally as early as the 1920s, shortly after the First World War. Since the early 1980's Forcit Defence has been serving western Defence Forces as well as International Defence product manufacturers with world class IM PBX products. The product range covers a wide variety ranging from special forces to combat engineering charges to underwater systems.

Forcit utilises a technology called cast cured Plastic Bonded Explosives (PBX). This technology enables Forcit to create products that are safer to use, transport and store. Currently Forcit has a capability to manufacture a wide range of core load charges, from extremely small boosters to several hundreds of kilo's large core loads.

In 2006, Forcit was awarded for its technological achievements in the area of Insensitive Munitions from NATO's Munitions Safety Information Analysis Centre (MSIAC) as the first organisation from a non-NATO country to develop an extremely potent underwater explosive called FOXIT with an unprecedented safety level for users.

An Undefeated BOXER

Today, Forcit Defence offers the BOXER - a Multi-Purpose Underwater Mine Disposal System. The BOXER is an Insensitive Munitions system and it can be used by a diver or ROV (Remote Operated Vehicle), providing versatility in different scenarios. Command and control of BOXER system is executed with a wireless acoustic communication.

BOXER has a low magnetic signature improving safety aspects even further. The system requires very low maintenance and comes with a rechargeable battery. These features combined with the versatility and ease of use, makes BOXER a unique, effective and affordable system during the life cycle of 25 years.

The BOXER´s underwaterweight is approximately 1 kg, while the dry weight is 18 kg.

Why the BOXER Underwater Mine Disposal Charge is advantageous for mine clearance;

- Fast deployment and versatility in operations. The preparation time is minimal compared to conventional Mine Disposal Charge's.
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- It is ROV compatible and it´s convenient for diver placement
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- The BOXER has Coded Wireless acoustic communication (arm, disarm, range and fire) up to 1 km > No initiation cables needed
- Enables initiation up to 120 meters of depth
- No need to be in contact with the UXO (Unexploded Ordnance) which reduces the time needed for the diver to be next to the UXO. This is a big user safety aspect
- No extra tools required during placement

As a product solution, BOXER places the highest priorities on operational efficiency and safety.

BOXER requires less preparation time and it can easily be safely recovered back to the vessel if the operation would be cancelled.

Foto: Forcit Defence

The BOXER is operational in environments between -34°C and +63°C and has a shelf life of 25 years.

Next Steps

The Baltic Sea and surrounding waterways are not the only places to have a significant population of sea mines; however, it was one of the most intensely mined areas. The number of these silent killers is in excess of tens of thousands of units in the Baltic Sea alone.Also, northern European waterways are polluted with a vast number of sea mines – many of which are old and unstable.

Forcit Defence looks upon the BOXER to be a solution to neutralise deadly, destructive sea mines around the world.

BOXER:

– UNDERWATER MINE DISPOSAL

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Naval Interceptors

Arie Egozi

The Israeli exclusive economic zone (EEZ) is threatened from two sides – from Lebanon where the Hezbollah has acquired maritime systems, and from Gaza, where the Hamas is increasing its maritime capabilities.

In the past, the two organisations have tried to use the sea to penetrate Israel's borders to carry out terror attacks. Since Israel has discovered huge reservoirs of gas in the Mediterranean, the gas pumping rigs have become a potential target for these two organisations.

An exclusive economic zone (EEZ) is a sea zone prescribed by the United Nations Convention on the Law of the Sea (UNCLOS) over which a state has special rights regarding the exploration and use of marine resources, including energy production from water and wind. It stretches a distance of 200 nautical miles (nmi) out from the baseline of the coastal state. To protect the natural resources in the EEZ, countries need an almost constant presence in the open seas. This threat has accelerated the development of advanced unmanned surface vehicle (USV) by some Israeli defence industries.

Photo: Elbit

The Elbit HERMES-900 capable of lengthy monitoring of vast swathes of sea and long coastlines and effective identification of suspicious activities and potential hazards.

The PROTECTOR

Rafael was the first to develop a USV system. The company's PROTECTOR is now operational and in 2019 it proved its capability to launch missiles. During the test, Rafael fired a number of Spike-ER missiles which are precise, electro-optical missiles that can be launched from aerial, land and naval platforms. According to Rafael, this new capability enables pinpoint attacks of land or naval targets, allowing for safe vessel operations from a remote-controlled vessel, with no risk to the operating force, from a remote command and control room, or from aboard other naval platforms.

The PROTECTOR USV has been in use since 2004, allowing its developers and engineers to accumulate vast experience to continue its spiral development. Rafael has recently supplied a significant number of PROTECTOR USVs to a number of fleets and civilian bodies around the world, in accordance with the growing need for a remotely operated vessel with modular payload carrying capabilities, based on mission needs.

The recent test brings to an end the operational integration process of PROTECTOR's suite of mission components, including a stabilised weapon station called MINI-TYPHOON, a water cannon, non-lethal means, EW systems for protection and escort of naval vessels, MCM, electro-optical long-range detection and tracking systems, and now the Rafael's SPIKE-ER missiles, all remotely-operated.

Rafael does not release client data, but a company source mentioned the situation in Bab al-Mandab strait that separates the Arabian Peninsula from East Africa and links the Red Sea with the Gulf of Aden and the Indian Ocean, as an example. "The Houthi rebels in Yemen control the strait and have caused heavy damage to navy and civilian ships mainly by launching missiles and rockets," an Israeli source said. Intelligence sources added that the Houthis have been building capabilities to perform "swarm attacks" using a number of high-speed boats.

According to a Rafael official, company developers came to the conclusion that the existing defence methods against such attacks were ineffective. "We decided to use an unmanned vessel as the platform for such a protection system. The PROTECTOR was designed from the start as an unmanned platform and therefore is the ideal platform for such a mission."

Author

Arie Egozi served in the Israeli Defense Forces (IDF). After completing his service , he studied political science and journalism at Tel Aviv University. Egozi worked as aerospace and defence correspondent for Israel's largest daily "Yedioth Ahronot". He writes about the IDF and the Israeli defence industry from a wider perspective. He is currently the Editor in Chief of the Israel Homeland Security website (I-HLS).

To equip an unmanned boat with advanced missiles, the Israeli company had to prove that the maritime platform was a solid basis for using the missiles at sea under different and sometimes harsh conditions. "The PROTECTOR can launch missiles in sea state 3." Under these conditions, the waves are 0.5 to 1.5 metres high. According to the Israeli company, the PROTECTOR has proved itself so far, mainly in performing Intelligence, Surveillance, Target Acquisition and Reconnaissance (ISTAR). It is fitted with a comprehensive sensor suite and can accommodate a variety of mission modules. A very important one is the Rafael's TOPLITE electro-optical system (EOS). The MINI-TYPHOON is part of the basic configuration of the PROTECTOR; it is a stabilised gun mount that is highly accurate and includes fire control capabilities, yielding excellent shooting accuracy. The water cannon system provides non-lethal engagement at close range, as well as firefighting capabilities. The PROTECTOR is operated from a control station which includes two control consoles, one for the USV commander and one for the payload systems operator. The control station receives, via communications links, all the system data, video imagery and audio required to effectively build a situational awareness picture and operate the system. The system can easily be incorporated into a wider defence array via a standard interface to an external C4I system.

According to Rafael, the PROTECTOR, has excellent manoeuvring capabilities. The platform has water jet propulsion systems powered by diesel engines. The platform systems include control over propulsion, manoeuvring, and navigation.

The SEAGULL

Elbit systems, another Israeli major defence company has developed the SEAGULL USV. This is a 12-metre long USV that can be operated from a mothership or from shore stations. It provides multi-mission capabilities including anti-submarine warfare (ASW), mine countermeasures (MCM), electronic warfare (EW), maritime security and underwater commercial missions. Earlier this year in a Sea Acceptance Test (SAT) performed by the Israeli Navy, a Helicopter Long-Range Active Sonar (HELRAS) dipping sonar was successfully converted for operation on board the SEAGULL.

Operating a dipping sonar on board a USV significantly increases the operational working time and substantially enhances detection capabilities and the effectiveness of its ASW operations. The SEAGULL autonomous multi-mission USV features switchable, modular mission payload suites and can perform, in addition to ASW, MCM missions, EW, maritime security (MS), hydrography and other missions using the same vessel, mission control system and data links. SEAGULL offers navies a true force multiplier delivering enhanced performance to naval operations, reducing risk to human life and dramatically cutting procurement and operating costs.

UAVs are rapidly replacing manned aircraft in maritime patrol missions. Israel, a super power in the development of UAVs, has some years ago decreased the use of manned aircraft for maritime missions and most of them are now performed by different UAVs. This capability is being exported, when in parallel more platforms are being developed, as well as more advanced sensors. In 2017, the Israeli Air Force (IAF) took a strategic decision to consolidate the capabilities of its manned and unmanned intelligence gathering aerial platforms. The aim is to allow the IAF's B-200 KING AIR intelligence gathering aircraft to operate with UAVs of all types in a certain area to supply the most complete set of real time visual and other intelligence.

Shortly after the decision was made, the B-200 squadron and the UAV squadrons

Photo: Elbit / Galina Kantor

An Elbit Systems SEAGULL USV charts a secure path for the HMS OCEAN in a joint Navies drill.

Photo: Elbit / Galina Kantor

The maritime HERON-1 has a maximum speed of roughly 120 km.

operating from Tel-Nof and Palmachim air bases participated in an exercise during which they began to build a "common language" that will allow them to use all the aerial sensors in order to build a complete and real time operational picture. According to the IAF, the B-200's speed, together with the long endurance of the HERON-1, HERMES-450 and HERON TP UAVs, enable the supply of desired intelligence to all echelons of the armed forces. The exercise focused on using a large number of manned and unmanned platforms simultaneously to supply intelligence in fast evolving scenarios, such as massive rocket launching or small enemy units that manage to cross the border.

The results of the exercise also allowed the IAF to build the combined capability that currently operates the maritime patrols off the Israeli coast. The manned aircraft were retained in the operation, mainly for their speed. This preference is changing as the speed of new UAVs is increasing; speed is a crucial factor and Israeli manufacturers, such as Israeli Aerospace Industries (IAI), are in the middle of development efforts to increase the speed of UAVs that conduct maritime missions. As the Israeli Navy, like other navies, constantly transfers these missions from manned aircraft to UAVs, the need for speed becomes ever more crucial. "When a UAV is on a maritime patrol mission, speed is essential. Something suspicious is detected some distance from the shore or crucial installation and you want to be able to investigate it as soon as possible, at least in the speed offered by manned maritime mission aircraft," said Avi Bleser, VP Marketing and Sales of IAI Military Aircraft Group. "We are developing ways of increasing the speed of UAVs used for maritime missions."

UAV's are currently operating more than 80 % of the total flight hours performed by the IAF and this number will increase as new capabilities are added to currently operated systems. New UAVs are now in the development phases and will enter service in the coming years.

The maximum speed of the HERON-1 is roughly 120 km and about 200 km for the Heron-TP. "In order to cover huge sections of sea, the UAV equipped with the maritime patrol sensors must have more speed," Bleser added.

IAI is in the midst of its speed increase efforts but no details are available. The speed increase will mainly involve two factors – using engines with higher thrust and decreasing the UAV drag.

The latest result of this effort is the IAI's HERON Mk2, which is powered by a Rotax 915 IF engine. According to Bleser, this engine has been adapted specifically by Rotax to the operational needs of the new UAV. "This upgraded engine is used only by us." It allows the HERON Mk2 to reach a ceiling of 35,000 feet and a maximum speed of 140 km/h. Bleser added that the MK2 has a wider and longer fuselage than the HERON-1 which allows for the installation of additional payloads. Maximum Take-Off Weight is 1,350 kg and maximum payload weight is 470 kg. The new design and especially the new improved engine give the Mk2 a climb rate that is 50% greater than the HERON-1.

According to the IAI official, the Mk2 has an endurance of 45 flying hours; endurance is essential in maritime missions. The new version is equipped with a line-of-sight communications system and with a satellite communication system. "The improved communications links enable the Mk2 to use a large number of payloads in parallel and transmit the data to the different customers," Bleser noted. The Mk2 is offered with a variety of dedicated payloads for ground, air and maritime missions, including anti-submarine operations.

Elbit Systems is the second largest Israeli manufacturer of UAVs. The company's HERMES 450 and HERMES 900 are operational in the IAF and they perform a long list of missions including maritime patrols. In late 2018, Elbit Systems won a contract to supply maritime patrol services to the European Union. The services are performed by the Israeli company's HERMES 900 UAV. Elbit says that the HERMES 900 was adapted to the maritime patrol mission by adding the relevant payloads to the platforms. These include maritime radar, an electro optic payload, satellite communications, an automatic identification system (AIS) receiver and an emergency position-indicating radio beacon (EPIRB) receiver.

According to Elbit, in this configuration the HERMES 900 is capable of lengthy and intensive monitoring of vast swathes of sea and long coastlines and effective identification of suspicious activities and potential hazards. The particular HERMES 900 Maritime Patrol used by the EU was adapted to withstand the strong winds and icy conditions common to the North Atlantic. The Israeli company also states that the HERMES 900 in the maritime patrol configuration enables frequent changes in flight profiles, enabling visual identification of vessels at sea, in addition to the ISAR capability provided by the radar. Satellite communications enables it to fly to mission areas at extended ranges as far as 1,000 nautical miles from shore.

A unique capability supported by Elbit Systems command and control systems is the ability to control two UAVs simultaneously from a single ground control

station, using the two redundant datalinks. This has a significant impact on the assets, manpower and operating costs, as well as for the efficient utilisation of UAVs that are now able to cover a greater area or run denser surveillance over a given area. The maritime command and control system employed at the ground control station is optimised for maritime missions, supporting specific mission planning applications such as maritime search, Search and Rescue, etc. The entire command and control is located in a single shelter which can be operated onshore in a mobile shelter or in indoor configurations, at sea, or even co-located in several locations.

As mentioned above, over 80 % of the operational flight hours performed by the IAF are carried by UAVs. Maritime patrol missions constitute a large part of this amazing figure. According to experts, this number is expected to grow in the coming years as more advanced UAVs with advanced payloads enter service.

VTOL UAVs

The growing demand for vertical take-off and landing (VTOL) UAVs is driving Israeli companies to develop this platform and convert existing types for the new role. The demand has triggered Israeli UAV manufacturer BlueBird to use its successful tactical ThunderB UAV for the development of a highly advanced VTOL system. According to the company, the new dual-hybrid ThunderB VTOL is capable of taking off vertically from a very small ground clearing or a small marine vessel by using its quad vertical electrical motors, transition to level flight while powered by its long endurance horizontal fuel-injection engine, and transitioning back to a precise, vertical landing after completing its mission; according to the company, this all requires a much smaller logistical footprint than needed when using a standard launch and recovery system.

BlueBird says that this VTOL capability is achieved by adding a VTOL kit comprising of two booms, with four vertical electrical motors, connected under the ThunderB's wings, similar to the way in which the ThunderB carries its releasable cargo capsules.

Ronen Nadir, BlueBird's CEO stated that with the VTOL capabilities, and its unprecedented long range capability (150 km), long endurance (12 hours in VTOL configuration), advanced full-HD real-time video image and its ability to operate in Com-Jam and GPS denied environments, the ThunderB VTOL can take the lead in tactical land and maritime operations, where take-off/landing areas are limited, such as on a ship far from shore, on an oil rig or a small forest clearing, for military use, HLS, protecting exclusive economic zones (EEZ), as well as in civilian applications.

BlueBird states that the catapult-launched ThunderB is already operational in the maritime arena and besides maritime surveillance, it can carry and release cargo capsules containing small intelligence sensors and life saving devices.

The company has also developed a smaller version, the WanderB VTOL, a mini electrical UAV capable of operating from small confined areas such as patrol boats. This small system has an operational communications range of 50 km.

Consequently, Israeli defence companies, in order to answer urgent operational requirements, have developed systems aimed at intercepting seaborne threats. It should be noted, however, that some of these maritime interceptors are classified but also serve the mission. So, UAVs are taking over an increasing amount of maritime patrol missions in the Israeli Navy. The frequent visits of representatives from foreign navies to Israel and their wish to observe these unmanned platforms in action prove that they are attracting considerable interest in other maritime forces. ■

Photo: Elbit / Galina Kantor

The maritime HERON-1 has a maximum speed of roughly 120 km.

Powering the Modern Warship

Doug Richardson

Although a slowly dwindling number of warships and naval auxiliary vessels are still powered by steam turbines, most modern warships use powerplants based on gas turbines, diesel engines, or a combination of the two.

Gas turbines first saw use on a significant scale as part of combined steam and gas propulsion systems. These first-generation applications used a combination of steam turbines and gas turbines, with a system of gearboxes and clutches that allowed either or both engines to drive a shaft. While the steam section offered cruising efficiency and reliability, the gas turbines allowed a fast startup time and rapid acceleration.

This concept of dual powerplants used in configurations based on gas turbines, diesels, or a combination of the two has spawned a range of solutions. An entire article would be needed to discuss the relative merits of these different arrangements, but this text will focus instead on the gas turbine, all-diesel installations, and the relatively recent concept of integrated electric propulsion (IEP).

Photo: US Navy

The Chinese destroyer SHENZHEN was the last steam-turbine powered major warship to be built. Launched in 1977, it was fitted with two turbines delivering a total of more than 70MW.

Author

Following an earlier career in engineering, **Doug Richardson** is a defence journalist specialising in topics such as aircraft, missiles, and military electronics.

Three companies dominate the marine gas turbine market – General Electric (GE), Rolls-Royce, and Zorya-Mashproekt. GE is by far the main supplier, followed by Rolls-Royce.

Gas Turbines

GE's marine gas turbines are based on existing jet engines. Its best-known example is the LM2500, which is based on the General Electric CF6 series of high-bypass-ratio turbofan engine, and has been used in warships ranging in size from aircraft carriers down to fast-attack patrol boats. The LM2500+ and LM2500+G4 follow-on versions have been shortened by 0.36 m to match the length of the basic LM2500. This would allow these higher-powered options to be used within the same length and volume.

First naval applications for the LM2500 included the SPRUANCE class and KIDD classes of destroyers, OLIVER HAZARD PERRY class frigates, and TICONDEROGA class cruisers. More than 300 LM2500 gas turbines have been supplied for the USN's fleet of ARLEIGH BURKE class destroyers, and in 2018 GE announced that it was to provide engines for next-generation DDG 51 destroyers. Ten vessels are already on order, with options for additional ships.

Since 2014, GE has been working with the US Navy and General Dynamics Bath Iron Works to introduce a lightweight composite enclosure for its engines instead of the traditional steel enclosures. Goals of this work included reducing the weight by 2,500 kg, and increasing the size and number of access doors in order to reduce maintenance time. Following a successful shock test, this lighter-weight installation received USN approval in 2019. It will first be used on the – 78th ARLEIGH BURKE class destroyer TED STEVENS (DDG 128), and then on the Littoral Combat Ship SANTA BARBARA.

The LM2500 powers warships operated by Australia, Brazil, China, Denmark, Germany, Greece, India, Israel, Italy, Japan, New Zealand, South Korea, Spain, Taiwan, Thailand, Turkey, Morocco, Norway, Philippines, Portugal, and South Africa.

As with many items of military technology, the availability of the LM2500 has been affected by political factors. Two LM2500 turbines were teamed with an MTU Friedrichshafen 12V 1163TB83 6.5MW diesel on both of the two Type 052 LUHU class missile destroyers, but an later US embargo prevented the GE engine being used in subsequent Chinese warships. The follow-on Type 051B LUHAI class destroyer SHENZHEN used steam turbines, but the two subsequent Type 052B GUANGZHOU class destroyers were both fitted with two Zorya-Mashproekt DN80 gas turbines, and two MTU Friedrichshafen 12V 1163TB83 diesels.

Over the last 60 years, Rolls-Royce has developed a long series of marine turbines

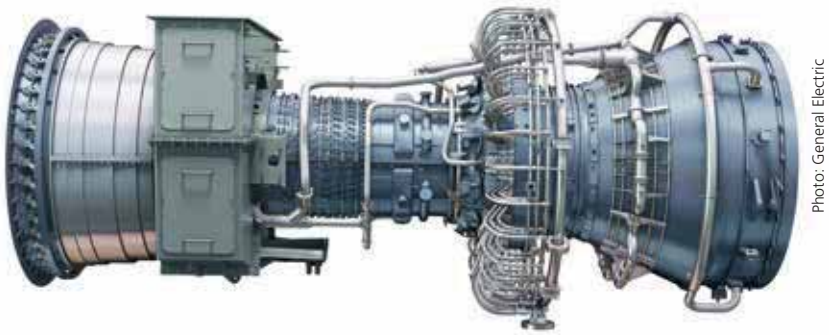

Photo: General Electric

General Electric's LM2500 series is the most widely-used naval gas turbine.

based on the company's aero engines. Vintage designs such as the Tyne RM1A, RM1C and RM3C were used in the UK Royal Navy's Type 42 destroyers and Type 22 frigates, some of which are still is service with other navies. The Type 42 and Type 22 used a configuration in which two Tynes were teamed with two examples of the company's Marine Olympus. The 17.3-21MW rating of the latter engine complemented the circa 4.5MW available from the Tyne.

The MT30 (Marine Turbine) is based on Rolls-Royce Trent 800 aero engine used by the Boeing 777, and has 80% commonality with the latter. First run in 2002, it was selected to power the Royal Navy's QUEEN ELIZABETH class aircraft carriers. This 40MW-class engine has since been repackaged to make it compatible with smaller ships, a move that resulted in an order from South Korea for use on their DAEGU class frigates. Other known applications for the MT30 include the Type 26 frigate (UK), the HUNTER class frigate (Australia), the 30DX frigate (Japan), the USN's ZUMWALT class destroyer and FREEDOM class littoral combat ship, and Italy's TRIESTE landing helicopter dock (LHD).

Zorya-Mashproekt is based in Ukraine, and is part of the Ukrainian Defense Industries (Ukroboronprom) state corporation. A major Soviet centre for the development and production of maritime gas turbines, it had maintained this position following the breakup of the former Soviet Union. The first three Project 11356 ADMIRAL GRIGOROVICH class frigates were equipped with M7N1 COGAG propulsion plants whose two DS71 (UGT6000R) and DT59 (UGT16000R) gas turbines and R058, R063 and R1063 gear reducers, were supplied by Zorya-Mashproekt. The first and second Project 22350 frigates – ADMIRAL GORSHKOV and ADMIRAL KASATONOV – were equipped with M55R propulsion plants made up of two Ukrainian-made DA91(UTG15000+) gas turbines, two Russian 10D49 diesel engines, and a Ukrainian-made P055 reduction gear assembly.

Following the Russian seizure of Crimea, which had been part of Ukraine, the latter country imposed an arms embargo against Russia. This included naval gas turbines. For more than a decade Russia has followed a policy of reducing its dependence on imported military hardware, so even before the 2014 crisis with

Photo: Rolls Royce

A WR-21 undergoes tests at a dedicated Rolls-Royce facility in Bristol, UK.

Photo: Rolls Royce

First run in 2002, the Rolls-Royce MT30 has a maximum power rating of 40 MW.

Electric Propulsion

Integrated electric propulsion (IEP) schemes – also known as full electric propulsion (FEP) or integrated full electric propulsion (IFEP) – use diesel engines and/or gas turbines to generate electricity for electric motors that drive the propellers, and for the ship's propulsion, combat, and service systems. This eliminates the need for long propellor shafts that need to penetrate watertight compartments and bulkheads, and the ability to run engines and propellers are their optimum speeds without the use of complex reduction gearboxes.

All-electric propulsion for ships has proved successful in the commercial field, but its initial use in combat vessels such as the US Navy's ZUMWALT class (DDG-1000/DD(X)) destroyer and the Royal Navy's Type 45 destroyer produced a series of problems.

Although the electrical propulsion system of the ZUMWALT had been tested at the General Dynamics Bath Iron Works shipyard, it was only once the ship was under way at sea that problems emerged. During ZUMWALT's transit from the Bath Iron Works Shipyard to its homeport of San Diego, seawater contamination was found in two propulsion motor bearing lubricating oil sumps was discovered. This was initially solved by replacing the lubrication oil coolers and flushing of the affected lubrication oil. The seawater had got into the motor bearings via a faulty lubrication oil chiller, a unit that uses water drawn in from outside the ship, so the problem was solved by modifying the coolers to use fresh water rather than sea water.

Ukraine, it had begun the development of an indigenous gas turbine for the Project 22350 frigates. The NPO Saturn company was ordered to begin work on what would become the M70FRU and M90FR turbines. These are intended to replace the Ukrainian DS71 and D090. During the official opening of NPO Saturn's new gas-turbine engine production facility in April 2017, the company demonstrated its M70FRU and M70FRU-2, and during the formal opening ceremony for the new facility Russian president Vladimir Putin claimed that the new engines were more efficient than their Ukrainian counterparts.

In June 2015, Russian shipbuilder United Shipbuilding Corporation announced that Russia's Saturn engine company would supply the gas turbines for the ADMIRAL GRIGOROVICH class and ADMIRAL GORSHKOV class guided missile frigates that were under construction.

Photo: via author

Zorya-Mashproekt's UGT 2500 combines a two-spool gas generator and free power turbine.

Photo: Babcock Group

Like several recent frigate designs, the Type 31 being developed by the Babcock Group for the UK's Royal Navy uses a a combined diesel and diesel powerplant. The first of class is expected to enter service in 2027.

A turbine developed by Rolls Royce forms the basis of the WR-21. This was created by an internationally-funded programme in which the UK company provided the turbine, while Northrop Grumman provided the intercooler and recuperator, and also acted as prime contractor. As its name suggests, the intercooler cools the air from the intermediate-pressure compressor before it enters the high-pressure compressor, while the recuperator recovers and transfers heat energy from the hot exhaust, so that it can be used to preheat the combustion air. These features were intended to reduce fuel consumption and minimise the ship's infrared signature. The WR-21 has a power output of 25.2MW.

The only class of warship to use the WR-21 is the Royal Navy's Type 45 DARING class destroyer, which used integrated electric propulsion (IEP) system based on two WR-21s and two Wartsila 2-MW diesel generators. Early operational experience with the Type 45 showed that during peak summer conditions in the Red Sea and the Persian Gulf, the sea and air temperatures occasionally exceeded the operating limits of the propulsion system. When this happened, the result would not be the gracefully degradation that had been anticipated, but a catastrophic failure. The solution was to make improvements to the WR-21, and to install additional diesel generators capable of carrying more of the ship's electrical load, and reducing the amount of time when the WR-21s will be needed.

Diesel Power

Until recently, all-diesel power was used largely for small ships, but there were exceptions such as the French 4,500t CASSARD class anti-air warfare destroyers, which used four SEMT Pielstick 18PA6-V280 BTC diesels. The specific fuel consumption of a diesel engine is at its best when the engine is running at a high power level, so a combined diesel and diesel (CODAD) installation takes advantage of this by using a gearbox and clutches to allow either or both of two diesel engines running at a high power level to drive a single propeller shaft. CODAD powerplants have been selected for several new frigates, including the Royal Navy's planned Type 31 frigate, and France's Frégates de Taille Intermédiaire.

Nuclear-powered submarines have a major advantage over their contemporary diesel-electric boats, since they can remain underwater indefinitely, while the diesel-electric boats must recharge their batteries at regular intervals. This recharging requires the boat either to surface, or to use a snort mast while running at periscope depth – conditions that make it vulnerable to detection.

For decades, nuclear submarines were operated only by the US, Russia, China, France, and the UK, but the debut of the India's missile-armed ARIHANT showed that other nations could be expected to join the list of nuclear-submarine constructors. The cost of membership in

Photo: via author

Developed to power conventional submarines, the MAN PA4 12-cyinder diesel engine was designed to have a high tolerance for variations or deterioration in snorkelling conditions. It has been installed on nearly 100 boats.

this still rather exclusive club is high – fiscal reality forced the Netherlands to abandon its SSN plans more than half a century ago, while the in-service date for Brazil's planned ÁLVARO ALBERTO nuclear submarine has slipped to late in the current decade.

But nuclear power is not the only route to making submarines independent of atmospheric air. Several types of air-independent propulsion (AIP) schemes have been devised.

Photo: Bundeswehr

U-34 was the fourth Type 212A submarine to enter service with the German Navy. This class uses a fuel cell based AIP.

In the early 1940s, Germany developed submarine powerplants that used high-strength hydrogen peroxide (HTP), but these saw only limited use. Post-war experience in several countries showed the dangers of using HTP, so the concept was abandoned as a method of submarine propulsion.

AIP Systems

Modern AIP systems first went to sea operationally aboard the Swedish GOTLAND class submarines. This three-boat class used a Stirling engine for underwater propulsion – a system that relies on a cyclic compression and expansion of air or other gaseous working fluid that is permanently contained within the system.

In 2004, Sweden signed an agreement with the US Navy under which the lead boat Gotland and its Swedish crew would be temporarily based in the USA in order to participate in US ASW exercises. According to unconfirmed reports, the submarine successfully conducted mock attacks against the USN SSNs and the aircraft carrier Ronald Reagan.

In 2015, the Swedish government ordered two BLEKINGE class submarines from SAAB Kockums. These will be fitted with a modified Stirling AIP system.

2009 saw the entry into service of the Japan Maritime Self-Defense Force's first SŌRYŪ class submarine. The first ten boats of this class used Stirling engines developed by Kockums and license-built by Kawasaki Heavy Industries. ŌRYŪ and TŌRYŪ (the 11th and 12th boats of this class) were the first to use lithium-ion batteries. Widely used in today's mobile phones, tablet devices, and portable computers, these have a much higher energy density than the lead-acid batteries traditionally used in diesel-electric submarines.

China's Type 039A (YUAN class) submarine – also referred to as the Type 041 – is reported to use an AIP system developed by the 711th Research Institute of the China Shipbuilding Heavy Industry Group Corp. This is reported to use a Stirling engine. The first example entered service on 2006. Although Thailand and Pakistan have both ordered versions of the YUAN class, it is not clear whether these boats will incorporate AIP systems.

Fuel Cells

Fuel cells allow another form of AIP. Like batteries, these convert chemical energy into electricity. But while a battery already contains the chemicals needed, and will only delivery electricity until these chemicals ate expended, a fuel cell uses an external supply of fuel and oxidiser, so can produce electricity for as long as these inputs are available.

Developed by Howaldtswerke-Deutsche Werft AG (HDW) for the German and Italian navies, the Type 212 class (known to Italy as the TODARO class) uses an AIP system based on Siemens proton exchange membrane (PEM) compressed hydrogen fuel cells. The fuel and oxidiser is stored in tanks located between the pressure hull and the outer hull. The first German boat was commissioned in 2006, and the first Italian example in the following year.

The HDW Type 214 is an export variant derived from the Type 212. Its air-independent propulsion (AIP) system uses Siemens polymer electrolyte membrane (PEM) hydrogen fuel cells. In 2005, Portugal awarded a contract to HDW for two Type 214 submarines, which were delivered in 2010. HDW built the first of the Type 214 submarines ordered by Greece, but the next three were built by Hellenic Shipyards. Turkey has ordered six Type 214 boats, which are being locally built in the Gölcük Naval Shipyard. The first was launched in December 2019. South Korea is the largest operator of the Type 214. Production has been split between Hyundai Heavy Industries and Daewoo Shipbuilding & Marine Engineering, which have delivered six and three respectively, with the latest being commissioned in January 2020.

The MESMA (Module d'Energie Sous-Marine Autonome) developed by France is a closed-cycle system that uses ethanol and oxygen to generate steam, which is then used to drive turbines. Since the system operates at high pressure, the resulting exhaust can be expelled from the submarine without the use of compressors. DCNS offers its SCORPÈNE class submarine in a MESMA-equipped AM-2000 variant, but reports that the third of Pakistan's three AGOSTA 90B submarines was delivered with MEMSA and that the system was later retrofitted to the first two have never been officially confirmed.

India is developing a fuel-cell AIP, which is expected to be retrofitted to the six locally-built KALVARI class submarines, a version of the SCORPÈNE class.

In 2018, the Dutch maritime engineering firm Nevesbu has proposed a novel form of submarine propulsion in which diesel engines would be eliminated, and the sole powerplant would be electric motors powered by lithium-ion batteries. The agency has proposed an all-electric variant of its Moray 1800 design. Elimination of the engine room, hardware such as the snorting mast, fuel tanks, and fuel pipes, and the personnel needed to operate and maintain these, has made space for a massive set of lithium-ion batteries. According to Nevesbu, this vessel could remain submerged for 25 to 30 days, travelling up to 2,500 nautical miles underwater. ■

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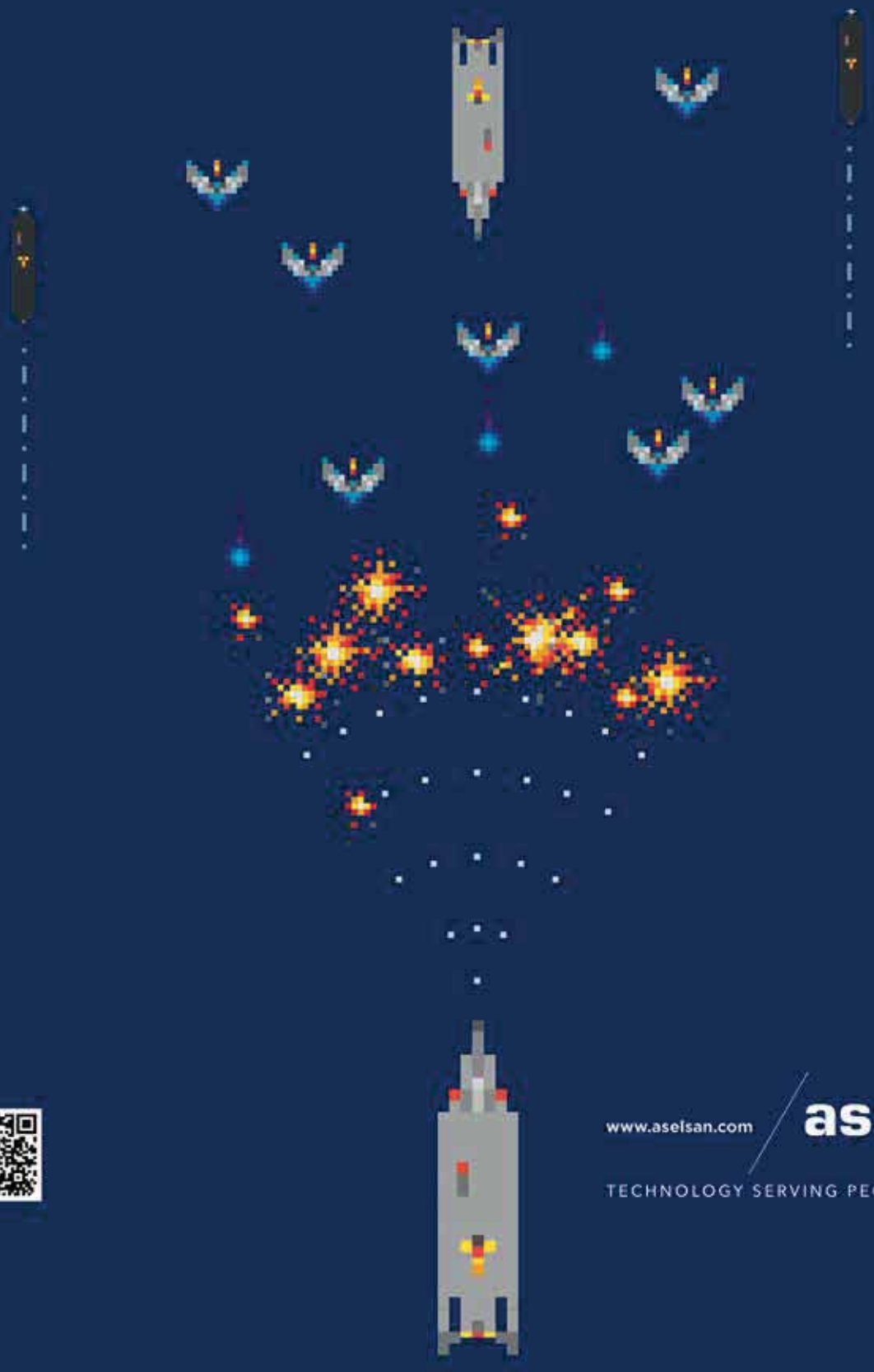

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Naval Gun Systems from Europe

Luca Peruzzi

Present and future maritime operations require multirole naval gun systems capable of dealing with multiple threats in a wide range of theatres. The European industry is the leader in both the gun and ammunition sectors, especially at the high-end of the market.

This analysis provides a non-exhaustive overview of the broad offer of gun systems offered in the 30mm to 127mm calibre range, to which both European and navies from around the world look to equip their latest generation of larger combat vessels.

Photo: Leonardo

The single 30mm ATK Mk 44 gun-equipped OTO Modular Advanced Remotely controlled Lightweight Naval Weapon Station (MARLIN-WS) adopts a full digital architecture and is proposed in three control and targeting configurations.

Aselsan

Based on the successful and well-proven 12.7/25mm equipped STAMP/STOP products, Turkey's Aselsan has developed and is currently producing the MUHAFIZ/SMASH 30mm remote-controlled stabilised naval gun system. Fed via two separate ammunition lines selected by the operator, the 200 rounds per minute (rpm), 30mm Mk44 BUSHMASTER-II gun is integrated with an independent EO/IR sight which can accommodate thermal and TV cameras, a laser rangefinder and gyroscope, and can operate in surveillance mode without aiming the gun. Weighing 1,250 kg, which includes 150 rounds, the SMASH/MUHAFIZ does not require deck penetration and provides automatic target detection and tracking, automatic ballistic calculation and can be slaved to external sensors and command and control systems. MUHAFIZ/SMASH equips the Turkish ARES Shipyard's 34 m and 48 m fast patrol vessels under delivery to the Qatari Coast Guard, the Croatian Coast Guard's 43.5 m coastal patrol vessel, the Malaysian Maritime Enforcement Agency (MMEA) OPVs, Azerbaijani Navy patrol vessels and the Philippines Navy on the new JOSE RIZAL class frigates.

Escribano Mechanical and Engineering

The Spanish group is proposing its new family of SENTINEL remotely-controlled weapon systems for both 20/25mm and 30/40mm guns. While development and qualification activities have concentrated on the smaller calibre SENTINEL 20 gun mounting, the EM&E group is also working on the SENTINEL 30 model for the larger 30/40mm calibres. The proposed gyro-stabilised remote-controlled gun mounting features a 30mm ATK BUSHMASTER II fed by two separate ammunition lines for a total of 200 rounds and an independent pan and tilt EO/IR director.

Leonardo

By leveraging the product families of HITROLE smaller calibre gun mountings, Leonardo developed the single 30mm OTO Modular Advanced Remotely controlled Lightweight Naval Weapon Station (MARLIN-WS) to meet emerging naval requirements. Adopting fully digital architecture, the modular, non-penetrating and lightweight mounting is offered with the ATK Mk 44 BUSHMASTER II 30mm cannon with 160 rounds on-mount stowage and a dual ammunition feed system with a total weight of 1,170-to-1,430 kg (without ammunition). The MARLIN-WS has enjoyed success in the Middle East, where the latest customer is the Qatar Emiri Naval Forces, in addition to UAE and Iraq, and the Royal Netherlands and Portuguese navies in Europe. The MARLIN 30 is available in three different versions: RC - remote controlled - in case an external FCS to drive the turret is available; COAX, with the turret equipped with a day/night camera with laser range finder with coaxial line of sight and has the capability for ballistic computation; and ILOS, with the turret equipped with a panoramic sight suite and ballistic computer.

MSI-Defence Systems

The UK-based MSI-Defence Systems offers a complete family of 20/25/30mm naval gun systems, which use a standard range of mountings and control system configurations, customisable with a weapon options range including the ATK Mk44/M242, Oerlikon KCB, Rheinmetall Mk 30-2 and 40mm in dual or single feed configurations. The SEAHAWK product portfolio builds on the SEAHAWK Lightweight and the SEAHAWK DS for larger guns. The latter comes in three different configurations including

Photo: Aselsan

Aselsan is offering its MUHAFIZ/SMASH 30mm remote controlled stabilised naval gun system, equipped with a 30mm Mk44 BUSHMASTER-II gun and integrated with an independent but co-mounted EO/IR sight, which can operate in a surveillance mode without aiming the gun.

the DS A2 with associated EO/IR director, the DS A1 with coaxial mounted sensors and the DS Remote which is managed from the CMS. The SEAHAWK DS A2, with a 30mm Mk 44 BUSHMASTER II gun, forms the basis of the Automated Small-Calibre Gun (ASCG) (DS30M Mk 2) mounting in service with the UK's Royal Navy, including its Type 23 frigate class, the QUEEN ELIZABETH class aircraft carriers, the second batch of RIVER class OPVs and the under-construction Type 26 Global Combat ship frigates. MSI-Defence Systems has sold or delivered SEAHAWK DS naval gun systems to at least 16 navies including Algeria, Malaysia, New Zealand, Oman, the Philippines, Saudi Arabia, Thailand and Iraq with repeated orders, seen more recently with the Royal Thai Navy.

Rheinmetall

Rheinmetall Defence currently markets the new family of SeaSnake remote-controlled, non-deck penetrating, semi-automatic and stabilised gun mounting systems, equipped respectively with KAE 20mm, BK 27mm and KCE-30/ABM 30mm guns. The first new gun system to be released this year is the SeaSnake 27 which succeeds the well-known MLG-27 system in service worldwide. Designed as a primary armament for small craft or a secondary armament for larger ships, the SeaSnake 27 features a new generation reduced weight, low silhouette and compact stealth gun mounting equipped with the same MLG 27 gun and an optionally integrated or detachable EO/IR director with daylight/IR sensors and laser rangefinder on a stabilised pan and tilt platform that can be moved and steered independently of the weapon. Capable of firing up to 1,700 27x145mm frangible armour-piercing sabot (FAPDS) rpm and featuring the latest electronics and interface standards to facilitate CMS integration or independent operations, the SeaSnake 27 version, with a 225 round magazine, weighs less than 600 kg compared to the MLG 27 with its total mounting weight of 850 kg, including the EO/IR director. The 691 kg-heavy SeaSnake 30 equipped mount is fitted with a 30mm KCE30/ABM cannon, offering greater range as well as the ability to use different types of ammunition including the Missile Piercing Discarding Sabot (MPDS) and programmable air burst ammunition (ABM).

Bofors 40 Mk 4

In May 2015, BAE Systems announced the Brazilian Navy as the launch customer for the Mk 4 version, followed by the Finnish Navy in 2018 and Swedish Navy in 2019, all of which are long-time Bofors 40mm users. More recently, Babcock was identified as the prime contractor for the Royal Navy's Type 31 light frigate programme. The latest Bofors family's iteration was developed in order to obtain a substantial reduction in volume, weight and price compared to the earlier Mk 3 version. BAE Systems significantly reengineered the gun mounting, introducing a more compact and stealthier cupola, a fully digitised modular architecture, the same elevation mass as the Swedish Army's CV90 armoured vehicle and new electric drives instead of older hybrid electro-hydraulics. The Mk 4 maintains the up to 300 rpm rate of fire, but can now provide any firing rate between 30 and 300 rpm, while the maximum range reaches 12.5 km. With a gun mounting weight of 2,300 kg, excluding ammunition, compared to the 3,700 kg Mk3 version, the new model has 30 ready-to-fire rounds in the primary magazine, plus 70 rounds in an intermediate magazine, with the possibility to shift between two different ammunition types. Capable of employing any 40mm L/70 round, the Mk 4 version offers full compatibility with the latest 'smart' 3P (Pre-fragmented, Programmable, Proximity-fused) programmable ammunition, providing 6-mode programmable all-target ammunition, which means fewer round types, transport, storage, weight and space requirements.

OTO MARLIN 40

The new all-digital, non-deck-penetrating OTO MARLIN 40 mounting has been developed to provide greater range and lethality than the existing 30mm weapons, but of a weight and size which enables its installation on vessels down to patrol vessel

Photo: BAE Systems

The MSI-Defence Systems family of SEAHAWK DS 30-or-40mm gun systems come in three different configurations including the DS A2 with associated EO/IR director, the DS A1 with coaxial mounted sensors and the DS Remote managed from the CMS.

size. Building on Leonardo's long heritage in 40mm weapons, the OTO MARLIN 40 is engineered around a high rate of fire (300 rpm) 40/L70 cannon with selectable rate of fire (single shot, 100 rpm or 300 rpm) fed from a 72-round ready-to-fire magazine. A dual-feed mechanism allows the gun operator to switch between programmable and conventional ammunition. The gun assembly and ammunition box are enclosed within a compact and stealthy carbon-fibre gun shield, which does not require deck penetration and weighs approximately 1,900 or 2,100 kg without ammunition, depending on the gun system version. In the first remotely controlled configuration, the gun is controlled by an external FCS, while in the independent line-of-sight configuration, the gun has its own EO/IR director and performs

Photo: Luca Peruzzi

Rheinmetall Defence offers the new family of SeaSnake remote-controlled, non-deck penetrating, semi-automatic and stabilised gun mounting systems, of which the SeaSnake 27 equipped with a BK 27mm cannon is the first available version.

Photo: BAE Systems

The latest iteration of Bofors 40 gun system family features a substantial reduction in volume, weight and price compared to earlier versions, in addition to providing full compatibility with the latest 'smart' 3P programmable ammunition.

both ballistic and target prediction computations. The Royal Australian Navy is the launch customer for the OTO MARLIN 40 to be installed on the new ARAFURA class OPVs currently under construction and set to enter service from 2021, and which has also attracted interest from other potential customers, according to Leonardo.

RapidFire Naval

Thales and Nexter Systems are offering the naval version of the RapidFire system equipped with the CTA 40mm gun. Called RapidFire Naval T40AA, it is centred on an over-deck self-contained gyro-stabilised gun mounting equipped with the 40CTA gun (40mm Cased Telescoped Ammunition, developed jointly by Nexter and BAE Systems) and ammunition package, a co-located but independent optronic sensor head, and a moving target tracking function for a total weight of 3,000 kg, including a 140 ready-to-fire round magazine. Developed for autonomous operations with a single console operator or integrated with the CMS, the system's 40CTA gun combines the 40mm calibre power with a 25mm compactness, the two companies claim, while benefiting from using the same gun and ammunition as the land forces. The gyro-stabilised gun has a firing rate up to 200 rpm with an effective range up to 4,000 metres against air targets thanks to the kinetic energy airburst (KE-AB) round under development, the latter carrying hundreds of tungsten pellets, and up to 2,500 metres against surface threats (with general purpose and APFSDS rounds). The RapidFire naval gun system was developed for both export and national programmes, the latter based on a French Navy programme for a multirole self-defence system based on a 40mm gun, still to be officially assigned. Although successfully live-tested on land test-range demonstrating performances and capabilities, it requires development and qualification in the naval domain, together with the new KE-AB round.

76/62 SUPER RAPIDO

The most widely used medium calibre naval gun, with over 60 customers, operating the latest iteration of Leonardo's OTO 76/62mm gun mount, is the SUPER RAPIDO with 40 customers and 240 guns ordered and delivered since the late 1990s. The latter is currently offered with the capability to fire the VULCANO family of long-range guided and unguided ammunition, as well

Photo: Luca Peruzzi

Thales and Nexter Systems are offering the RapidFire Naval T40AA gun-mounting version equipped with the 40mm Cased Telescoped Ammunition (CTA) gun, developed jointly by Nexter and BAE Systems and a co-mounted but independent optronic sensor head.

Photo: US Navy

The BAE Systems Bofors 57 Mk 3 is the third generation of a naval gun system, which, together with its associated 3P multi-purpose ammunition, is registering new injection of latest technologies to cope with challenging threats.

as the DART (Driven Ammunition with Reduced Time of Flight) guided rounds for anti-ship missiles and asymmetric threat defence. In the latter case, the DART is currently coupled with the STRALES guidance kit mounted on the gun, or alternatively with compatible shipborne fire control systems (FCSs), such as the new Leonardo dual-band radar-EO/IR NA-30 Mk2 or the Thales Nederland PHAROS.

With a 120 rpm rate-of-fire and limited onboard footprint and weight (7,900 kg mass without ammunition which reaches 9,200 kg with the STRALES guidance kit on the gun mount), the SUPER RAPIDO comes with a multi-feed (hence the 76/62mm SR MF designation) ammunition magazine based on two distinct branches, each capable of accommodating up to 38 rounds each, allowing the employment of specific ammunition for different types of threat; a new AC3v2 remote digital console and digital link to FCSs enabling it to cope with the latest gunfire requirements and new functionalities, and a new universal ammunition programmer able to set both the 4AP and VULCANO fuse to enhance AAW and ASuW capabilities. Leonardo has applied the same larger calibre (127/155mm) VULCANO family of Guided Long Range (GLR) and Ballistic Extended Range (BER) technological achievements to develop the 76mm sub-calibre non self-propelled guided and unguided ammunition versions equipped with 4AP programmable fuse capability. While the BER round, with a 27 km range, (versus 16 km with conventional ammunition and up to 20 km with Leonardo's SAPOMER ammunition) is already available and in service with an undisclosed South Asian customer, Leonardo is working on the 76 VULCANO GLR (equipped with IMU and GPS for autonomous guidance) with a range of up to 40 km for shore bombardment and stationary naval targetengagement. The Italian group is expected to launch the qualification activities in 2021 for production rounds delivery in 2023-24. Since 2019, all new guns are now fitted for the 76 VULCANO kit required to fire the GLR round, including a dedicated software module inside the digital console and GPS receiver and antenna, in the latter case not required if data are provided by the ship's CMS together with target coordinates. Leonardo is registering a strong interest from potential Middle Eastern, Asian and European customers for new gun and upgrading kits for the 76 VULCANO family and the 76 SR MF with the DART guided ammunition in order to cope with anti-ship missiles and asymmetric threats already in service with the Italian and Colombian navies. In August 2020, the Indian MoD approved the procurement through the Indian company, BHEL, (the licensee for the its manufacture in India) of a SUPER RAPIDO upgraded version which ESD understands - from the indicated requirements - as being both the STRALES/DART and VULCANO long-range guided ammunition capabilities. Leonardo has also developed a lightweight and lower footprint version of the 76 SR called 76 Single Deck; this doesn't require deck penetration and with an almost 40% weight reduction, while maintaining the same gun rate of fire, ready-to-fire ammunition and the VULCANO/DART-guided ammunition firing capabilities. The Italian Navy is the launch customer for the new version already available and attracting the interest of first-rank navies.

Bofors 57 Mk 3

The BAE Systems Bofors 57 Mk 3 is the third generation of a naval gun system which, together with its accompanying 3P multi-purpose ammunition, is gaining worldwide success and a new injection of the latest technologies to cope with serious and emerging threats. Developed from the beginning to capitalise on the multi-target functionality afforded by the 'smart' 3P 57mm ammunition, the Bofors 57 Mk 3 maintains the family's lineage of a high rate-of-fire, multipurpose weapon system with a compact, lightweight mounting able to be installed on smaller surface combat vessels (down to 150 tonnes) in order to provide a credible anti-air, anti-surface and shore bombardment capability. Equipped with a fully automatic, computerised ammunition handling system able to accommodate 120 ready-to-fire rounds in the gun mount with a loading system from the magazine centred on two parallel hoists enabling instant switching between ammunition types, the Bofors 57 Mk 3 has a 220 rpm maximum rate of fire and 17 km maximum range, with a gun dispersion in training and elevation of 0.4 mrad. The gun is controlled by a single remote operator console but as a back-up, it can also be controlled from a PC-based gun panel

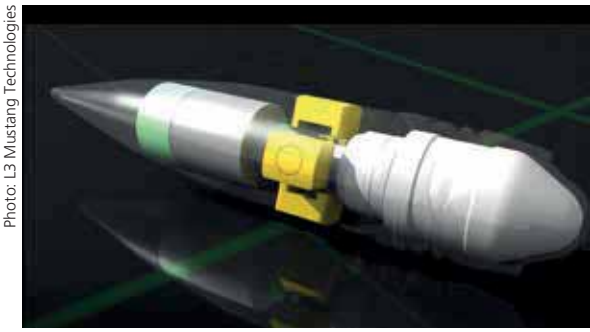

Photo: L3 Mustang Technologies

Under the ALaMO (Advanced Low-cost Munitions Ordnance) programme, the US Navy developed the 57mm MK 332 HE-4G guided ammunition to significantly increase the gun's lethality and effectiveness against FAC/FIAC and air targets.

Photo: Leonardo

The most widely used naval medium calibre gun with over 60 customers, the latest iteration of Leonardo OTO 76/62mm gun mount, is the SUPER RAPIDO with 40 customers and 240 guns ordered and delivered since the end of the 1990s.

Photo: Leonardo

The Leonardo OTO 127/64 LightWeight (LW) VULCANO is the only 127mm gun mount developed and built in Europe and capable of automatically handling and firing the VULCANO family group of guided and unguided long-range ammunition.

located anywhere on board thanks to a gun-mounted TV-camera. An integrated muzzle-velocity radar is fitted to supply data to the fire-control computer for calculating ballistics and the target intercept point, enabling the Bofors 57 Mk 3 to achieve maximum accuracy and fully exploit its 3P capability. The latter is programmable in six different modes, to provide optimised effect against any aerial, surface and shore target. The only utility required is the power supply. The total system weight, including 1,000 rounds, is around 14,000 kg. Either under order, or in service in the latest Mk 3 iteration with the navies of Sweden (in the latter case in the stealthier configuration to equip VISBY class corvettes), Mexico, Finland, Malaysia, Norway, US, the German Federal Police's Coast Guard, and more recently Indonesia and Saudi Arabia, the gun was also chosen for the UK Royal Navy's Type 31 light frigate programme. Designated as Mk 110 Mod 0, it is the standard medium calibre for the US Navy and Coast Guard, equipping both in-service and new generation ships. In addition to the 3P ammunition (designated Mk 295 Mod 0), under the ALaMO (Advanced Low-cost Munitions Ordnance) programme, the US Navy developed the 57mm MK 332 High Explosive-4 Bolt Guided (HE-4G) cartridge ammunition to significantly increase the gun's lethality and effectiveness against FAC/FIAC and air targets. Contracted and developed by US company L3 Mustang Technologies, the ammunition is described as consisting of a Radio Frequency Guided Projectile (RFGP), brass cartridge case, and energetics qualified for navy use. The RFGP features a guidance section, an advanced divert module with a fuse safe and arm, and a warhead allowing it to engage moving sea-surface targets at significantly longer ranges and with greater accuracy compared to current 57mm ammunition, with the aim of providing defence against swarm attacks by small boats. According to the US DoD, the ALaMo programme transitioned to production in FY2019, while the follow-on counter-unmanned aerial systems (CUAS) capability testing and evaluation was expected - before the outbreak of the coronavirus pandemic - to be concluded by Q4 2020.

Photo: Leonardo/BAE Systems

Leonardo's family of VULCANO ammunition includes both the unguided BER round with a 60 km range and the GLR IMU/GPS guided ammunition with up to 85 km range. The latter can be also equipped with a Diehl Defence IR terminal seeker to engage moving sea surface targets.

OTO 127/64 LightWeight (LW) VULCANO

The Leonardo OTO 127/64 Lightweight (LW) VULCANO is the only 127mm gun mount developed and built in Europe for current and future requirements worldwide, including the capability to automatically transfer ammunition - without crew assistance - from the ship's magazine to the gun mount and fire the only 5-inch qualified naval family of VULCANO guided and unguided long-range ammunition developed by the same Italian Group. The OTO 127/64 LW VULCANO system consists of four key sub-systems: the medium calibre gun assembly, the automated ammunition handling system, the Naval Fire Control Support (NFCS) and the OTO VULCANO family of ammunition. The 127/64 LW has a 64-calibre water-cooled barrel and two loading arms offering a 32 rpm rate of fire and a 33,000 kg dry weight depending on 1 or 2 deck magazine installation. It is equipped with a modular feeding magazine, composed of four drums, each holding 14 ready-to-fire rounds, able to be reloaded during firing, and highly flexible in terms of ammunition selection, independently from their position in the drums and with a strike-down function. The Automatic Ammunition Handling System (AHHS) is a modular solution adaptable to any ship ammunition magazine layout, without manual intervention to allow for sustained firing. The gun system has a digital/analogical interface and ballistic calculation capabilities while the NFCS allows for the best firing solution for both conventional and VULCANO family of sub-calibre, non self-propelled ammunition with 4AP programmable fuse technology. The latter includes both the unguided Ballistic Extended Range (BER) round with a 60 km range and the Guided Long Range (GLR) ammunition with up to 85 km range. Already qualified and available under a joint Italian and German Government programme, with Leonardo and Diehl Defence industrial contributors, the VULCANO GLR is equipped with an IMU/GPS guidance package offering <10m CEP accuracy. The same ammunition can be equipped with an infrared (IR) terminal seeker from Diehl Defence, to engage moving sea surface targets. In addition to being in service with the Italian and German Navies, the 127/64 LW has also found strong success internationally, currently in service with the Algerian Navy and contracted by the Spanish and Royal Netherlands Navies (also both interested in the VULCANO ammunition), and potentially by the Egyptian Navy, if the 2+2 FREMMs deal will be concluded between Fincantieri and the Egyptian MoD. ■

CBRN Defence and Navies

Dan Kaszeta

In most militaries around the world, chemical, biological, radiological, and nuclear (CBRN) defence is largely, if not entirely, concentrated in armies. It is in land warfare where CBRN defence gains the most traction. Navies sometimes ignore the CBRN threat or give it a low priority.

Armies often have specialists in CBRN defence, but such specialists and specialised training are far rarer in the sea services around the world. Are navies justified in giving a low priority to CBRN threats? This author worked with naval officers at various points in his career and often struggled to get CBRN concerns acknowledged. To this day, CBRN defence in maritime settings is often an afterthought. As a general rule, it is land forces that drive the major programmes and expenditures in CBRN defence. In some countries, navies are lucky to get anything in CBRN defence. This is a market segment where there really are not any major programmes at the moment, and it may be worth examining why this is the case.

Historically, there has been little threat to naval forces from CBRN threats. Navies generally did not use chemical weapons or face serious attack from them. However, the Cold War and the threat of both strategic and tactical nuclear warfare brought the idea of radiological contamination home in the Western and Soviet-bloc navies. In the Cold War, in most navies, "CBRN training" really meant "using radiation detectors and flushing the fallout over the deck." But it is not a long conversation to get from radiological contamination to scenarios involving chemical contamination

In the United States Navy, CBRN warfare was briefly considered a bit more seriously than in other navies because aircraft carriers were platforms for deploying both chemical and nuclear weapons. At one point, a bewildering array of tactical nuclear weapons were fielded to various US Navy ships. Several nerve agent weapons were designed for employment by US Navy jets based on aircraft carriers. Eventually, safety issues forced the US Navy to push back against several types of nerve agent weapons and it is not at all clear if chemical weapons were actually ever deployed on a US aircraft carrier in the Cold War.

Author

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Contamination Threats

In land warfare, offensive chemical doctrine typically involved use of persistent chemical warfare agents as both area denial weapons and attrition weapons. "Area denial" at sea is a difficult concept with chemical weapons, but once you start to realise that aircraft carriers are basically airfields that happen to be at sea. Airfields can be contaminated. Persistent chemical agents could take strategically significant airpower out of use for days or even weeks. Contamination threats are not just a problem for aircraft carriers. All surface ships could become contaminated. Contamination of the external areas on a ship could seriously inhibit many types of operations, such as gunnery or anti-submarine warfare, when crew would be forced to operate in CBRN PPE. Flight deck operations on a contaminated deck would be highly troublesome. Degradation of operations of a degree similar to land warfare could be expected. In other words, throwing a bunch of persistent chemicals at an aircraft carrier could effectively interdict it for hours or even days. Such contamination threats drive a number of CBRN defence technologies and initiatives not dissimilar to those in armies and land warfare.

Protection and citadels

Ships at sea cannot quickly replace sick or dead crew. Even very modest chemical or biological attacks could affect a ship's ability to operate. But the situation is not all bleak.

In many ways, modern navies have some advantages in CBRN protection. Most modern naval vessels rely heavily on air-handling and air-conditioning for ventilation and climate control on ships. Such systems can lend themselves to filtration and positive pressure – "collective protection" – to protect against CBRN hazards. It is possible to protect an entire interior space of a naval vessel if enough effort is expended. It is not always economical to do this as a post-design retrofit. In which case, given the older ships, it is possible to select a portion of the interior spaces as a CBRN-protected "citadel". Either whole-ship protection or "CBRN Citadel" protection strategies have now become commonplace. Due to factors such as shelf-life of filters it becomes a matter of budget and operational readiness as

Photo: U.S.M.C.

During Exercise Sea Saber, a US Marine Corps CBRN assessment team conducts tests on a simulated suspicious crate aboard USS SATURN to determine its contents.

Photo: U.S. Navy

Soldiers from the USS Chemical, Biological, Radiological, Nuclear(CBRN) Company take part in a simulated maritime interdiction operation and subsequent boarding during Exercise Phoenix Express 2019.

to whether the whole ship or some interior "citadel" is always protected in peacetime operations. Further, such systems require a fair bit of maintenance if they are to work properly, and if upkeep is neglected, then an older CBRN filtration system may not help when it is needed most.

Several companies do a lot of work in the CBRN filtration and collective protection market space. This is not an area of major specific programmes and expenditures. Rather, this sort of equipment is buried well within the construction and/or retrofit of major naval vessels. There are several important manufacturers in this area. HDT Global (USA) is a market leader in this space, with not just filtration but pressure instrumentation and other components of collective protection systems for shipboard use. Europe is also well-served in this market segment. ENGIE-Axima (Germany) sells its CBRNflex 3600 filtration unit as well as smaller modular systems for smaller craft. Heinen & Hopman (Netherlands) sells a CBRN filtration system for mine countermeasures vessels and similar-sized craft. Van Halteren (Netherlands) sells a full range of filter systems ranging from small to large. A branch BAE (UK) provides similar support to the Royal Navy.

Contamination Avoidance and Detection

In land warfare, "contamination avoidance" is a key discipline. It involves both detection systems and forecasting to try to determine areas where CBRN hazards may pose a threat of contamination. In many ways, contamination avoidance is more streamlined at sea. The "terrain" at sea is mostly water and sky, so modelling of hazards is simpler and broader, more open horizons may give greater scope to detecting some hazards from a distance. On the other hand, it should be noted that chemical warfare detection on ships has been made difficult in the past by some facets of the operational environment. Salt water is famously bad for electronics. Radiation detectors can be more easily sealed from the ambient environment than chemical point detectors, which usually need to literally inhale a specimen. Some of the other substances routinely found on ships like fuel or firefighting foam have, in the past, proven to be the source of many false alarms on several generations of chemical warfare detection equipment.

Both point detection and standoff detection have been used on major warships for some time now. Older systems like the UK NAIAD and the MCAD (Smiths Detection) were used in major navies, but have given way to more modern systems. The same industrial players are relevant in this space – Bruker (Germany), Smiths Detection (UK), and Environics (Finland) all have adapted their land-based CW detection technology into naval applications for point detection. Bruker's US subsidiary landed major US Navy business by getting the Improved Chemical Agent Point Detection System contract, selling these point detection systems at USD 120,000 per unit. This system is hard-wired into many US naval vessels. A very similar system, the RAID S2 MV Plus, is made by Bruker for use in other navies around the world. The systems are visibly quite similar. Smiths, which made the older GID-2A and similar systems, has sold systems based on its widespread LCD product line for naval use. Several thousand M4 JCADs (the US DOD version of the LCD) went into service with the US Navy in handheld role. Environics fields its rival, the ChemProFXi, for naval use as well, with less market uptake.

In the radiological space, the technology is more mature. Some aspects of maritime radiation detection have barely changed since the 1970s. Mirion (US) – which absorbed the Canberra brand, produces the NASRAMS system for naval use. Ultra (UK) has long marketed the ANV S2 in the same maritime space. Bruker also produces radiation probes in this space, which can be integrated with its chemical detection products.

Photo: Environics

The ChemProFXi fielded by Environics for naval applications

Standoff Detection

Navies have long been a logical customer for standoff detection. The ability to see threats at a distance is important. Navies have had sensors like radar and sonar that can perceive threats at significant distance and have not always understood why such remote sensing is not available Although nuclear and biological standoff detection still lag behind in this area, chemical stand-off detection is a capability that is now available. In some ways, stand-off detection is less troublesome at see as the seascape provides fewer opportunities for false alarms than land environments, where the possibilities for false detections are widespread, particularly in urban environments. Standoff detection was covered by this author in detail in issue 01/2018. The overall state of standoff detection has progressed only modestly since that article. One of the bigger players in the naval standoff chemical is Bruker, which fields a naval variant of its long-standing RAPID passive infrared standoff detector. Chemring (USA) produces the ISCAD, which uses very similar technology. Several other detection technologies in this area have been in the development pipeline for some time.

Decontamination

Detection sometimes fails. Even the best detection schemes cannot rule out the possibility that a ship might get contaminated by hazards. Shipboard decontamination has been a traditional concern in naval CBRN defence. However, it has been one that has been historically approached with a general lack of sophistication. While water supply is often the critical logistical gap in decontamination on land, seawater is in infinite supply to a navy. Most modern naval vessels have significant plumbing devoted to fire-fighting and conduct significant crew drills in emergency fire-fighting. Shipboard decontamination has long consisted primarily of using seawater to flush contaminants into the sea.

Specialty decontamination products for the naval environment are not very prevalent. In theory, many of the decontamination chemicals used by armies for decontamination of equipment would be useful on ships. However, storage becomes a serious issue and giving up scarce space onboard ships for dozens or even hundreds of drums of decontamination chemicals is usually a hard thing to ask a naval vessel to do. Seawater is famously destructive to chemical warfare agents, so many of these expensive products are only marginally more effective that the infinite supply of free water. There are still a few naval-specific decontamination products on the market. ENGIE-Amixa (Germany) has a CBRN pre-wetting system which can be activated to spray down the surfaces of the ship with seawater, either proactively or as a decontamination process. Cristanini (Italy) has deployed some of its technology and systems with the Italian navy, no doubt helped by the fact that they are a supplier of firefighting systems as well. The other major European decontamination companies, Kärcher and OWR (both German) concentrate on the land market, not the sea.

Photo: US Navy

Sailors assigned to the Military Sealift Command hospital ship USNS MERCY care for a mock patient in casualty receiving during a CBRN decontamination drill.

Biological Vulnerability

COVID-19 in general and the USS THEODORE ROOSEVELT situation in particular, demonstrate the fact that navies are still vulnerable to disease. The Roosevelt situation saw that aircraft carrier face a serious coronavirus outbreak which necessitated evacuation of much of the crew. The whole affair grew into a political scandal. Scandal aside, the situation demonstrated that ships are crewed by people, and people are vulnerable to disease.

In some ways, naval vessels are, in some ways, more vulnerable to biological attack than their land-based counterparts in armies. Crews live in confined proximity. Air handling systems act to concentrate biological agents, unless the whole ship is heavily filtered. Recirculation of air can spread disease. Many vessels may have only a few crew members in particular key technical specialties. For these reasons, it is often the medical staff in navies that have the strong concerns about CBRN defence.

Rapid identification and diagnostic equipment is often of keen interest in naval medical circles. A ship may be a long way away from a well-equipped diagnostic laboratory, but the ability to identify pathogens and toxins quickly in order to protect naval crews is important. Various products have come and gone in this market space, and biological detection is a troublesome field of technology. Smiths Detection (UK) once had several biological detection systems with application in the naval market, but has since retreated from this segment. See ES&D issue 02/2019 for this correspondent's more detailed treatment of this market niche. One by-product of the COVID-19 pandemic is that it has made many more small, deployable diagnostic capabilities available. Whether this translates into more products to detect non-COVID-19 threats remains to be seen.

Seaport Vulnerability

Navies require significant shore-based infrastructure to operate. Ports are needed for repairs and logistical support. Every ship deployed at sea is supported by a large footprint of supply and support ashore. Deployed aircraft on aircraft carriers are generally supported by airbases on land. Food, ammunition, and fuel for forces at sea originate on land. This onshore infrastructure is far more vulnerable to CBRN attack than naval vessels at sea.

Historically, there has been a fair bit of neglect in protecting naval support facilities ashore. One of the few major programmes

has been the JPM-GUARDIAN programme in the US Department of Defense, which has a long history of investing in CBRN defence at US bases, including naval bases. Naval presence in JPM Guardian's management structure has mostly been lacking. Comparable programmes in other countries are noted mostly by their absence.

Hazardous Materials at Sea

An area that is often not given sufficient consideration is the CBRN aspect of the role of navies and coast guards in safeguarding maritime commerce, combating smuggling, rescuing people at sea, and dealing with environmental disaster. Navies and their sister services, the various coast guards, spent more time not at war than fighting war. Many of these peacetime missions involve the possibility of encountering CBRN hazards or similar environments.

The mission to combat smuggling and prevent illegal migration means that navies and coast guards are, on a daily basis, boarding suspicious vessels both small and large. Such scenarios can put boarding parties (and their ships) into contact with such things as dangerous narcotics, hazardous chemicals, smuggled radiological sources, or infectious diseases.

Boarding party missions lead to requirements for handheld detection and identification instrumentation, as well as appropriate PPE. These systems and technologies are entirely identical to their land-based equivalents, and the same products are in use at sea as on land. Although exact information is difficult to locate for many navies, the US Navy is known to use the Smiths Detection HazmatID 360 – a "Fourier transform infrared" device and the Hapsite by Inficon (Switzerland), a mobile gas chromatograph and mass spectrometer. Both are state of the art mobile instruments for definitively identifying unknown substances.

Efforts to organise for such missions vary greatly around the world. Some are ad hoc, but others are lengthy and well organised. Italy's "Operation Mare Nostrum" effort in 2013-2014 was an extensive maritime rescue and interdiction, followed by the EU's "Operation Triton". Although both operations were primarily focused on migration, they had significant dealings with pollution and drug trafficking as well.

An article on CBRN and hazardous materials in maritime settings would be remiss without mentioning the United States Coast Guard. A separate military service in its own right, the US Coast Guard is large enough that it is actually larger than many navies. Because of its unique legal role in responding to oil spills, hazardous materials incidents at sea and on inland waterways, and drug smuggling, there is some serious expertise and equipment adaptable to CBRN situations. Indeed, the US Coast Guard's "Strike Teams" are among the best equipped maritime CBRN/Hazmat response forces in the world.

Conclusion

CBRN spending in militaries is largely a function of reaction to perceived current and future threats. Historically, navies have often not perceived much threat in this area. This is an area where extensive consideration of CBRN issues is the exception not the rule. However, this historic neglect may be a bit too optimistic given the complex nature of modern warfare. International power projection is an important mission for navies, and CBRN weapons could be used in ways that prevent major navies from performing this geopolitical function. Further, navies are used for a variety of missions other than combat, such as anti-smuggling and disaster relief, that could put naval ships and personnel into situations where CBRN defence technologies would be useful. Deeper consideration of CBRN threats in the maritime environment is certainly warranted.

European Submarine Builders

Bob Nugent

Europe's submarine builders have a long and distinguished history of technical, tactical and manufacturing innovations. Companies building submarines in Europe have also achieved significant export success over decades; many of today's submarine fleets around the world are still made up mostly of European-origin platforms.

However, the continuing decline in domestic submarine procurements in Europe, and increasing competition for submarine export from new market entrants like China, Japan and Korea combine to challenge to the future of the European submarine industrial base.

Introduction

This article examines the current state of European submarine builders, beginning with a review of domestic and export demand, followed by a short look at programmes and financial performance of Europe's submarine-building companies. We conclude with a short commentary on the prospects for consolidation in the industry. Our analysis draws on AMI International's proprietary data on current and future naval programmes worldwide.

Submarine Market Drivers

Europe operates almost 100 of the world's nearly 500 submarines in service today, but submarines still represent a very small portion of naval fleets, making up about 3.5% of all ships and craft now in service among European NATO navies. The market for submarines is growing, in contrast to some other market segments, such as cruisers, destroyers, and amphibious ships.

Author

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This growth is driven by the increasing importance of the submarine's unique stealth and survivability characteristics in the face of increasing numbers and lethality of anti-ship weapons coming into service. And submarines remain a uniquely effective instrument of strategic leverage for navies and national leaders, both in their ability to strike ships and land targets at stand-off ranges with missiles, and interrupt flows of commercial and naval traffic at sea with weapons such as long-range torpedoes and mines.

Submarines are the most expensive platforms navies buy on a ton-for-ton basis, and the cost of nuclear-powered hulls is substantially higher those of conventionally powered boats. AMI's forecast of new submarine procurements below show that 65 new submarines are expected to join world fleets over the next 20 years, representing some US$368Bn in programme value. To put in to perspective just how much naval investment is concentrated in submarines, the 65 new hulls (less than 5% of all new platforms worldwide), account for over one third of all forecasted expenditures of all types new naval vessels and craft forecast to be acquired over the next two decades.

Photo: Crown Copyright

The UK`s HMS AMBUSH

Total Number of Projects	In Progress	Planned	Total Value	Total Build 2020 to 2039
65	30	31	368,728.00	315

The European share of this new construction submarine market is significant, accounting for some two-thirds of new hulls (45 of 65). Submarines will make up about 10% of all new platforms (counted as numbers of hulls) that European navies are expected to buy through 2040.

Conventional and Nuclear Power

France and the UK are the only two European (NATO or EU member) countries to build, maintain and operate nuclear powered submarines. These "nuke" boats represent a large portion of company revenues derived from naval shipbuilding for the two companies involved – France's Naval Group and BAE Shipbuilding in the UK. Both countries have significant new nuclear submarine programmes now underway and planned for the future. These domestic programmes will keep both of those companies comfortably in the nuclear submarine business for at least the next two-three decades.

The domestic market situation is not so comfortable for other European builders of conventionally powered submarines. A review of current and planned submarine

Photo: US Navy

Italian submarine SALVATORE TODARO pulls into US Naval Base New London.3

programmes at those yards in Germany, Italy, Spain and Sweden shows that all those countries rely on single yards for submarine construction, and capacity at those single yards still exceeds domestic demand. With the small scale of domestic programmes (typically 2-6 hulls per programme), consolidation of sub building into single yards is not surprising.

Domestic and Export Markets

Many of Europe's domestic submarine programmes now underway will end within 10 years. Construction is slated to end soonest in Spain (around 2025) and latest is Sweden (2035), based on current schedules. Absent follow-on submarine procurements beyond those currently approved, most European submarine builders face an uncertain order book from their national naval customers beyond 2030.

Table 1 details the six countries in Europe with active domestic submarine procurements now underway. Another four European countries are forecasted to commit to domestic submarine programmes over the next decade. We assess that budget support for some of these domestic programmes may weaken over the next year or two as governments in Europe deal with widespread and long-term economic disruptions associated with the COVID pandemic.

If governments delay or cancel these submarine programmes, that would strain an already fragile conventional submarine construction infrastructure in Europe. Reductions in production volume also highlight that the export submarine market – always vital to most European yards – will become even more critical to their survival.

Naval Group has had the most notable success in securing submarine export contracts over the past five years, with key wins in Brazil and Australia. Building on decades as Europe's foremost exporter of submarines, TKMS-HDW has also recorded recent awards in Egypt and Norway over the same period. Saab's Kockums yard, previously successful in furnishing the design for Australia's COLLINS class submarine (award in 1987), is one of three offerors for the Netherlands submarine program, together with DW and Naval Group. Kockums also remains a competitor in Poland's oft-delayed ORKA submarine procurement.

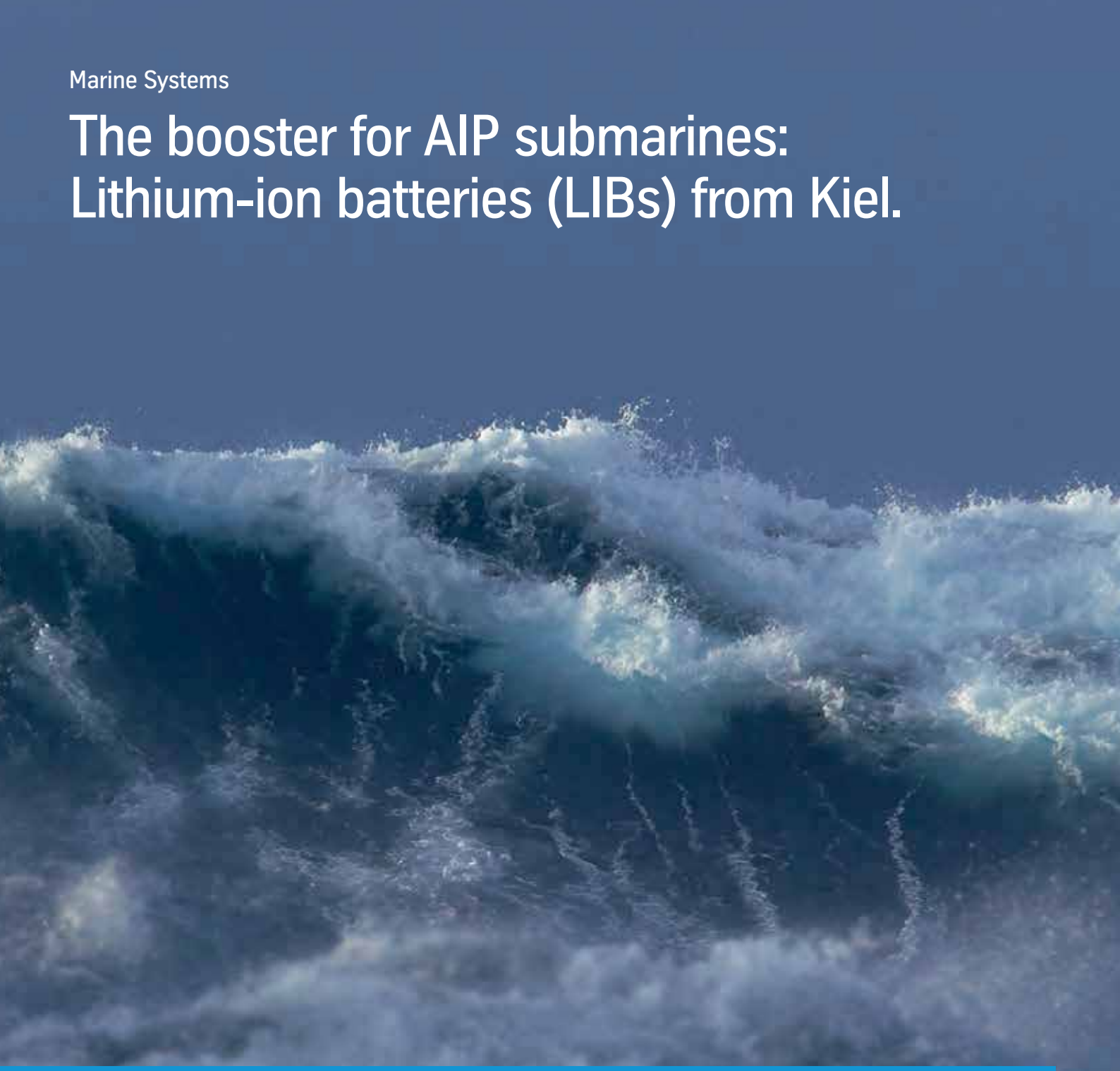
Navantia's S-80 design has been less well-received in international market, due in part to issues with the domestic programme, now reportedly resolved. Navantia remains a candidate to supply India's P-75I programme, along with Naval Group and TKMS. Fincantieri has a strong record as a naval surface ship exporter but to date has not recorded any submarine export

Domestic Programs		**Hulls**	**Shipyard**
France	» Barracuda Class Nuclear-Powered Attack Submarine (SSN)	6	Naval Group
France	» 3G (Third Generation) Nuclear-Powered Ballistic Missile Submarine (SSBN) (4)	3	Naval Group
Germany	» Type 212CD Class Submarine	2	TKMS-HDW
Italy	» Near Future Submarine (NFS) Type 212 (Todaro Batch III)	4	Fincantieri
Spain	» Isaac Peral (S 80A) Class Diesel Electric Submarine	4	Navantia
Sweden	» Blekinge (A26) Class Submarine (5)	5	SAAB-Kockums
United_Kingdom	» Astute Class Nuclear Powered Attack Submarine (SSN)	4	BAE
United_Kingdom	» Dreadnought Class Nuclear Powered Ballistic Missile Submarine (SSBN)	4	BAE
Total		***32***	
Euro Exports with Local Industry Participation			
Netherlands	» Future Diesel-Electric Submarine (SS)	4	Open (SAAB-Damen, Naval Group, TKMS-HDW)
Norway	» Type 212CD Submarine	4	TKMS-HDW
Poland	» Future Submarine (Project ORKA)	2	Open (SAAB, Naval Group, TKMS-HDW)
Romania	» Future Submarine	3	Open (Naval Group, TKMS-HDW, SAAB)
Total		***13***	
Exports Won			
Australia	» Attack Class (Project SEA 1000) SSK (12)	5	Naval Group
Brazil	» Alvaro Alberto Class Nuclear Powered Attack Submarine (SSN)	1	Naval Group
Brazil	» Riachuelo (Scorpene) Class Diesel Electric Submarine (SSK)	4	Naval Group
Egypt	» 541 (Type 209) Class Submarine	4	TKMS-HDW
Total		***14***	
Near Term (to 2025) Export Competitions			
India	» Project 75-I	6	Open (Nval Group, Navantia, TKMS-HDW)
Total		***6***	

Table 1: European and International Submarine Programme Status

Marine Systems

The booster for AIP submarines: Lithium-ion batteries (LIBs) from Kiel.



Marine Systems has forged ahead to provide partner navies with the advantages and benefits of LIB technology – an energy storage system in its own class.

Thanks to high power characteristics, LIBs are a symbiotic supplement to our Fuel Cell AIP system, now in the fourth generation. The combined effect of Fuel Cells and LIBs leads to an improvement of vital operational capabilities and tactical performance parameters. Underwater endurances increase and indiscretion rates sink, especially under high load conditions.

The new LIBs for submarines, developed in co-operation with our long-time partner SAFT, are absolutely safe and maintenance free. First modules will be ready for integration in the near future – and set tomorrow's standards in underwater technology.

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thyssenkrupp

Photo: US Navy

The S80 submarine as it was commissioned by Spain

Photo: via author

A Type 212 Submarine manufactured by thyssenkrupp Marine Systems in the docks in Kiel, Germany

contracts. Fincantieri submarine offers include the U212A built in partnership with HDW, and earlier the S1000 diesel-electric submarine design in originated by Russia's Rubin Naval Design Bureau.

The Picture in Mid-2020

The status of Europe's submarine builders can be viewed from two perspectives: technical/performance and financial. In both of these areas, all of Europe's yards have been affected to some degree in the first half of 2020 as governments and companies responded to the pandemic. As noted above, European companies building nuclear submarines for domestic navies (UK, France) appear to be in the strongest financial position. The outlook for conventional submarine builders in Europe is more uncertain, but yards in Spain, Italy, and Sweden all benefit from robust surface ship businesses, both domestic and export. That diversification mitigates the risk to the submarine product line. Yards that have built submarines in the past, such as Damen in the Netherlands and Hellenic Shipyards in Greece, might also return to the business as local partners in international teaming agreements, but these are more distant prospects.

UK – BAE Systems

The company's mid-2020 results reaffirm that the submarine business remains a bright spot in its maritime portfolio. Maritime products make up 15% of the company's total income, and within that, submarine programmes are two of four key revenue sources. Some COVID-related disruptions have affected the UK production sites, but the company forecasts that production of the DREADNOUGHT SSBN and a follow-on to the ASTUTE SSN represent strong business pipelines through at least 2040.

France – Naval Group

The company's financial report for 2019 does not include COVID-related impacts. Year-end results stated the company's 2019 revenue, was €3.7Bn, up 2.9% compared to 2018. Of this, international (export) revenue made up 29.3%. Three submarine programmes are in the company's product line: Ballistic missile nuclear submarines, BARRACUDA nuclear attack submarines, and SCORPÈNE class for export (14 sold to Chile, Malaysia, India and Brazil). The company does not identify revenues specifically tied to submarine sales, but in public statements has emphasised the continue production of the BARRACUDA and the submarine export programme in Australia as highlights in its 2019 operations.

In April 2020, the company announced it would cut costs to conserve cash, responding to slowing shipbuilding activity due to COVID-19. The company maintained furloughed worked on full pay. By May, the company reported its production activities were returning to pre-crisis level, with 10,000 (of 15,000) employees returning to their physical work locations. No announcements have been made of any delays in domestic or export submarine programmes of the company, and in April the lead hull of the BARRACUDA class nuclear attack submarine, SUFFREN, began sea trials as scheduled.

Germany – Thyssen Krupp/HDW

Thyssen Krupp continues to restructure to focus on higher margin businesses and away from industrial manufacturing under the leadership of CEO Martina Merz. Following the sale of the company's elevator business in early 2020, it has been widely reported that Thyssen Krupp is pursuing sale of other industrial units, including steel and shipbuilding. ThyssenKrupp Marine Systems has reportedly been in discussions with German Naval Yards (GNYK) and Luerssen about a naval partnership moderated by the German government.

Notably absent is any mention that the company is looking to divest its submarine construction business. A shrinking domestic market and increased competition for exports might combine to make such a development more likely. However, we assess the submarine yard in Kiel continues to be viewed as a strategic asset by the company and the government. As such HDW would be the most likely to be retained by ThyssenKrupp in the event other Marine Systems facilities or business lines are divested.

Sweden – SAAB/Kockums

One of six operating segments in SAAB, Kockums Group sales and operating income increased in the first half of 2020 compared to the same point in 2019, with growth in both submarine and surface ship revenues. Kockums contributes about 9% of the company's total revenue. As the BLEKINGE class (A26) submarine moves from

design and development to production, this will further improve financial performance. One note of interest is that exports make up on 4-5% of Kockums' maritime business currently, in contract to much greater contributions from export businesses of most other European submarine builders. Should SAAB record a significant win in submarine export programmes such as the Netherlands or Poland, that would further reinforce Kockum's already solid business position over the next decade.

Italy – Fincantieri

Shipbuilding is the largest of three segments in the company, and combines production of commercial ships (cruise ships and expedition cruise vessels, ferries and mega yachts) as well as naval vessels. The segment contributes about 80% of the company's revenue. Exposure to the commercial maritime market definitely had an effect on Fincantieri's performance, with mid-2020 revenues of 2.3 billion Euro off from the $2.8 billion Euro generated by mid-2019. This downturn reflected the exposure to declining demand in commercial maritime product markets, as well as suspension of production activities in many yards due to protective measures implemented against the pandemic. The naval business fell from 25% of segment revenue to 22%, with a net decline from 723 million to 526 million Euro. That said, the company reported that production had returned to about 90% of pre-pandemic levels by the end of June. AMI assesses that the submarine business share of Fincantieri's naval business is around 15-25% of total revenue. The downturn in overall naval revenue, and pressure on government spending may see delays in the next set of U212 submarines scheduled to be procured.

Spain – Navantia

As a state-owned company, Navantia does not issue the kinds of financial statements required of commercial companies. However, limited financial information is available from the Spanish Government ministry responsible of the company's operations: Sociedad Estatal de Participaciones Industrialesy Sociedades Dependientes (Grupo SEPI). No reporting has identified any significant COVID-related impacts on domestic submarine construction to date. In December 2019, Navantia reported that the pressure hull of the lead hull in the S-80 programme, S-81 ISAAC PERAL had been sealed, and the that the submarine was scheduled to be launched in October 2020. In January 2020, the company was one of five international companies selected to compete in India's P-75I, joining Rubin Design Bureau of Russia, Naval Group, ThyssenKrupp Marine Systems, and Daewoo Shipbuilding & Marine Engineering of South Korea.

Other Potential Submarine Builders

Netherlands

In December 2019, the Dutch Ministry of Defence issued the B-Letter for the Walrus class submarine replacement programme, confirming plans to acquire 4 new submarines. On the shortlist for the programme are Naval Group, Saab and TKMS, with Navantia now out of the race. The next stage of the competition is expected to select one of the three companies as the prime contractor. Originally this was final choice was expected to be made in 2022, but will likely be delayed into at least 2023 due to ongoing pandemic-related disruptions.

Photo: Saab

As a result of its modular design and build, Saab`s A26 can change its form to accommodate new technical advances or particular defence capabilities.

Whichever company is chosen is expected to build submarine hull components in the home country yard (French, German or Swedish), with assembly and fitting out at a shipyard facility in the Netherlands (in the case of Damen, in Vlissingen). Investments in these local facilities will not transform Dutch yards into submarine construction facilities. These upgrades will equip them to participate in component production, fitting out and maintenance of both the domestic submarine fleet, and potentially of exports of the design acquired by the Netherlands government.

Norway

Atlas Elektronik, Kongsberg, and Thyssen-Krupp Marine Systems established kta Naval Systems joint venture in October 2017 to support the joint Germany-Norway submarine program. kta Naval Systems will develop, produce and maintenance systems and weapons on the new submarine. Headquarters is located at Kongsberg, Norway, with a branch in Bremen. Kongsberg and Atlas Elektronik are each contributing 50% equity to the joint venture.

As for the submarine construction programme, schedules have slipped somewhat from the initial plan for a ten-year programme, with the first submarine delivered some seven years after the construction contract. Initially the first submarine was expected to be delivered in 2025, but now is expected no earlier than 2030.

Greece

In June 2020, the Greek government approved funding to certify UGM-84 Sub-HARPOON missiles and other systems for the country's existing fleet of Type 214 submarines, as well as the resources for their maintenance. The contract to build three of the German-designed boats for the Hellenic Navy dates to February 2000, with a fourth unit ordered in June 2002. The first boat was built at HDW in Kiel, Germany and the rest at the Hellenic Shipyard in Skaramangas, Greece. The first hull, S-121, was launched in 2014. Hellenic Shipyards remains in financial limbo and current funding constraints make it unlikely the yard will return to a submarine assembly of construction role.

Outlook

Is Consolidation of European Submarine Builders Likely in the Future? The call to consolidate European naval shipbuilding has been long, loud and steady, with advocates citing the need to compete better against emerging competitors in Asia, and cut costs as a "Naval Airbus." Past initiatives in this direction have encountered friction, not the least of which are the different ownership and cost structures of these facilities in different countries, as well as concerns over losing strategic capabilities and increasing dependence on uncertain suppliers. The latter concerns appear to still be at work in considering consolidation of submarine building in Europe.

The cooperative programme between Germany and Norway is the most recent example of a European bi-lateral submarine naval programme. However, it is not really an indicator of the prospects that European sub builders are consolidating. Norway does not currently have a shipyard assessed as capable of submarine construction, and Norway's industrial participation is related to combat systems and weapons via contributions from Kongsberg. The submarines for the program will be built in Germany.

The Naviris joint venture between Naval Group and Fincantieri represents more of a consolidation of peer shipbuilders in Europe. The two companies signed a joint-venture agreement in 2019 and Naviris began operations in in January 2020. The terms of the agreement are for equal ownership by both groups as they cooperate on bi-national domestic projects and export offers. The Naviris website specifically states the two companies will cooperate on surface ship programmes, but makes no mention of working together on submarines. This is explained by three factors. First, Italy's domestic submarine programme involves existing cooperation with Germany. Second, Naval Group's submarine export programmes are much larger in scale and scope than what Fincantieri is in the position to execute. Lastly, France has no current domestic programmes to build conventionally powered submarines, while Italy's capabilities are limited to conventional submarine building. It would appear that submarine construction and export will remain within governance of the two companies, and two countries, separately.

These two examples suggest that the prospects are limited for widespread consolidation among existing European submarine builder, despite excess capacity across those yards that some view must shrink if European naval yards are to become more competitive in the export market. Submarine construction remains a strategic capability for the governments of France, the UK, Germany and Sweden. Industrial policy and the need to retain critical infrastructure and support shipyard employment will keep government funding in place for submarine building in Spain and Italy.

We conclude that governments prefer to maintain independent submarine construction capabilities in Europe and will continue to do so in the future. Government support will continue to sustain these shipyards, despite limited prospects for growth in domestic programmes. Competition in the export market for submarine will also continue pose a challenge to the structure of Europe's submarine industry, as new market entrants like China take market share in countries like Pakistan and Thailand. However, these forces do not appear strong enough, yet, to drive consolidations among Europe's submarine builders. ■

Consolidation Potential of European Naval Shipbuilding

Dieter Hanel

France, Germany, Italy, the Netherlands, Spain, Sweden and the United Kingdom have a globally active national naval shipbuilding industry as their defence industrial and technological base, which urgently needs consolidation in Europe due to its high degree of fragmentation and overcapacity.

Naval shipbuilding in Germany is faced with the important decision of how it should be strategically oriented in the future and whether national consolidation takes precedence over European consolidation.

Naval shipbuilding consists of the shipyards and the supply industry and can be divided into the following system areas: Surface combatants, submarines, MCMV, landing craft, naval support vessels, as well as subsystems including propulsion systems, weapons, command and control systems, radar, sonar and other sensors.

Europe has a broad technological competence and a high systems capability in the integration of complex technological knowledge areas such as sensors, propulsion, electronics, weapon systems, protection technology and lightweight construction, as well as efficient project management.

Cross-border joint ventures, cooperation and armament programmes have so far been the exception. Only three of the 14 European armament programmes managed by OCCAR are naval shipbuilding programmes: the French-Italian multi-purpose frigate project FREMM, a Landing Support Ship (LSS) and the Italian multi-purpose patrol ship PPA.

The design and development of a prototype of the European Patrol Corvette is the only one of six projects of the Permanent Structured Cooperation PESCO of the EU

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Photo: DMO

Damen Schelde Naval Shipbuilding were prime contractor for the RNLN's HOLLAND class OPVs.

Member States in the maritime sector, which concerns naval shipbuilding. To this end, France, Greece, Italy and Spain have agreed to cooperate in the European Patrol Corvette (EPC) project, which involves the design, development and construction of a prototype of a new class of military ship within PESCO under Italian leadership. Germany is not involved in any of the six maritime projects.

International competition is considerably intensified by the US and Russia and with the emergence of efficient naval shipbuilding in the Asian countries China, South Korea and Japan for European shipyards. In addition, industrial policy in France, Italy and Spain aims to safeguard national defence capabilities and key technologies of state-owned companies and to provide government support for export activities. Among these countries, there has been increased cooperation and joint ventures in naval shipbuilding, involving the European organisations OCCAR and PESCO, which is increasing the competitive pressure, especially for German companies.

Naval shipbuilding is an indispensable strategic partner for the navy, and national industrial policy in most countries is therefore geared to securing domestic capacities, technologies and employment through contracts, preventing undesirable dependencies on foreign countries and ensuring participation in international armament cooperation. At the same time, the successful foreign orders placed by the major European shipyards have so far made it difficult for Europe to consolidate its position on a large scale.

Capacities and Potential Mergers

Germany

The German naval shipbuilding industry consists of five shipyards operating as a group or individually and some 400 suppliers. These yards are system houses in

Shipyard		Submarines			Surface Vessels				JV
Navantia	SP		Scor-pène		EPC + Greece				
Naval Group	FR							FREMM	NAVIRIS
Fincantieri	IT	U212A							
tKMS	GE					F125			
Lürssen	GE				K130		MKS180		announced
German NY Kiel	GE								
Damen	NL			WAL-RUS (WRES)					
Kockums	SE								
BAE Systems	GB			Van-guard Class				QE a/c carrier	
Babcock	GB								

Cooperation schemes in European Naval Shipbuilding

their specific product area and in some areas global technology leaders. In particular, thyssenkrupp Marine Systems and the Fr. Lürssen Werft group have made a considerable contribution to the consolidation and restructuring of the German shipbuilding industry in recent years through company acquisitions. At the same time, a new efficient shipyard, German Naval Yards Kiel, entered the market in 2011. Other shipyards include the Abeking & Rasmussen shipyard, which specialises in MCMV and patrol boats, and the Fassmer shipyard, which is particularly successful in export markets with OPV designs.

Photo: RNLN

KAREL DOORMAN, the joint support ship of the Royal Netherlands Navy

In 2005, thyssenkrupp Marine Systems, based in Kiel, was created from the merger of the former Howaldtswerke-Deutsche Werft (HDW) in Kiel, HDW-Nobiskrug in Rendsburg, Blohm + Voss and Blohm + Voss Repair in Hamburg, Nordseewerke in Emden, Kockums in Sweden and Hellenic Shipyards. Since 2017, ATLAS ELEKTRONIK has also been a business unit of thyssenkrupp Marine Systems.

In October 2017, thyssenkrupp Marine Systems and ATLAS ELEKTRONIK founded the 50/50 joint venture kta naval systems with the Norwegian company Kongsberg in view of the upcoming joint Norwegian-German programme of six Class 212CD submarines. The company is headquartered in Kongsberg, Norway, with a branch office in Bremen. kta naval systems is to become the exclusive supplier of command and weapon control systems for thyssenkrupp Marine Systems.

Today, thyssenkrupp Marine Systems has annual sales of more than €1.5Bn and employs around 6,000 people at its sites in Kiel, Bremen, Hamburg and Emden. The company is world market leader in the development and production of non-nuclear submarines. Since 1960, it has signed contracts with 20 countries for 167 submarines, including 114 construction contracts in Germany and 53 for prefabricated material packages with technical support from Germany for production in the respective customer country.

thyssenkrupp Marine Systems was successful in developing a submarine propulsion system that is independent of outside air and based on silent and emission-free fuel cells for the submarines of the classes 212A and 214. 21 Class 214 submarines have been procured from four countries.

The core business of thyssenkrupp Marine Systems also includes the development and design of modern frigates, corvettes and naval support ships as well as service offerings. As the lead company of ARGE F125, thyssenkrupp Marine Systems delivered the second of four F125 class frigates for the German Navy to the Lürssen shipyard in March 2020.

With the closure of the shipyards for surface vessels, which had been part of the German Naval Yards site in Kiel since 2011 and the Lürssen shipyards in Hamburg since 2016, the thyssenkrupp group took a far-reaching strategic decision in this market segment. With a view to focusing on core business, Hellenic Shipyards was sold in 2010 and Kockums in 2014. While thyssenkrupp Marine Systems ordered the construction of the five Israeli corvettes and two Algerian frigates from German Naval Yards Kiel, the construction of three Egyptian frigates will be carried out at the shipyard of the Rönner group of Bremerhaven.

In the last decades, the Bremen-headquartered Fr. Lürssen Werft group of companies has pursued a successful strategy of growth and specialised orientation and has considerably expanded its capacities and product range by horizontally acquiring several shipyards. In addition to the operating divisions Aumund, Berne and Lemwerder, the group of companies has included the Lürssen-Kröger shipyard in Schacht-Audorf since 1986 and the Neue Jadewerft in Wilhelmshaven since 2004. The Norderwerft in Hamburg followed in 2012, the Peene shipyard (Wolgast) in 2013 and Blohm + Voss in 2016.

Lürssen is the lead company of the K130 joint venture, which also includes thyssenkrupp Marine Systems and German Naval Yards Kiel. The contract to build a second batch of five K130 corvettes for the German Navy was signed on 12 September 2017.

Photo: Michael Nitz

thyssenkrupp Marine Systems were contracted for the Egyptian Navy's class 209/1400 submarines (shown her is S43, the third of class) as well as for the MAGEN class corvettes of the Israeli Navy.

German Naval Yards Holdings is a new shipyard alliance in Schleswig-Holstein, which includes the three shipyardsites German Naval Yards Kiel, Nobiskrug and Lindenau. It is owned by the Lebanon-based Privinvest Group, which also owns CMN in France, Isherwoods in the UK and PISB with the shipyards Hellenic Shipyards and Abu Dhabi Mar. Privinvest employs over 2,500 people worldwide.

German Naval Yards Kiel employs 450 of a total of 500 employees in the defence technology sector and is currently building four corvettes for the Israeli Navy on order to the prime contractor, thyssenkrupp Marine Systems.

France

Naval Group, Chantiers de l'Atlantique and Constructions Mécaniques de Normandie (CMN) are efficient French shipyards which, with strong political support, are strategically successful in the naval shipbuilding sector on an international scale.

With 15,168 employees and a turnover of €3.64Bn in 2019, Naval Group is a leading company in European naval shipbuilding. The French state owns 62.25% of the shares and Thales 35%. Naval Group

Photo: German Naval Yards

German Naval Yards Kiel facilities

founded the 50/50 consortium Armaris with Thales France in 2002.
The product range includes aircraft carriers, surface combatants, landing ships as well as nuclear and conventionally powered submarines. In addition, Naval Group has expanded its business activities in the field of drone operations. Major programmes include the FREMM frigate project, the construction of nuclear submarines for the French Navy and SCORPÈNE class conventional submarines for foreign navies.
The shipyard Chantiers de l'Atlantique (based in St. Nazaire) was taken over by the Italian shipyard Fincantieri in 2017 with a 50% stake. The French State retains a 34.3% stake. The EU Commission#s pending investigation procedure regarding the acquisition of Chantiers de l'Atlantique by Fincantieri is still ongoing.
Constructions Mécaniques de Normandie (based in Cherbourg) has been part of the Privinvest group of the French-Lebanese entrepreneurial family around Iskandar Safa since 1992.

Italy

The Italian shipyard Fincantieri is one of the largest shipbuilding companies in the world, with 19,823 employees and a turnover of €5.85Bn in 2019. It is the largest naval shipbuilding yard in Europe and a partner of foreign shipyards in major supranational naval shipbuilding programmes. The product range includes aircraft carriers, frigates, corvettes, OPVs and submarines. The Italian state holds a direct 71.6% stake in the company.
Since 2014, Fincantieri has cooperated with Leonardo, Italy's largest defence group and number 13 worldwide with 49,550 employees and a turnover of €13.78Bn, with the aim of pooling expertise in naval shipbuilding and opening up new markets. To this end, the two companies set up a joint venture (Fincantieri 51%, Leonardo 49%) Orizzonte Sistemi Navali (OSN) as systems integrator. OSN is the systems integrator for the ten Italian FREMM frigates, of which the 8th unit was delivered to the Italian Navy in April 2019.
In addition to the strong orientation of the Italian naval surface shipbuilding sector towards France, close relations in submarine construction with Germany are still maintained. The German-Italian cooperation in the procurement of Class 212A submarines, which started in 1996, was subject to an intergovernmental agreement between the ministries of defence of both countries and by an industrial agreement between the German submarine shipyards and the Italian construction yard Fincantieri as licensee.
Italy now intends to continue the German-Italian submarine cooperation and signed a governmental Memorandum of Understanding with Germany on 10 March 2017, for the planned procurement of another four Class 212A submarines.

Photo: MSD archives

In the scope of the Franco-Italian FREMM programme both navies are receiving a total of 18 frigates. Export customers include Morocco and Egypt. Shown here is AQUITAINE, first-of-class.

United Kingdom

The "National Shipbuilding Strategy" published on 6 September 2017, in con-

junction with the planned procurement programmes of the Royal Navy, forms the basis for the future direction of British naval shipbuilding. The Royal Navy's major naval programmes, such as the Type 31e frigate, also known as the General Purpose Frigate, the Type 26 frigate, the ASTUTE nuclear submarine programme and the QUEEN ELIZABETH class aircraft carriers, are based on this government strategy.

British naval shipbuilding strategy is primarily driven by national interests with the aim of using British design to build ships in the UK with the involvement of foreign partners and to support British industry in its export efforts through the Government in order to maintain national shipbuilding capacity.

British naval shipbuilding enjoys strong government support, which is also reflected in the marketing of British naval products abroad. For example, Australia has built nine HUNTER-class frigates and Canada's Canadian Medium Service Combatant, which has built up to fifteen vessels with a design similar to the Type 26.

British naval shipbuilding has undergone profound restructuring in recent years in the form of mergers, factory closures. BAE Systems is the largest European defence company with 87,700 employees and a turnover of £20.1Bn in 2019, ranking seventh in the world. The Maritime Division employs 16,300 people and has a turnover of £3.1Bn in 2019. The QUEEN ELIZABETH Class aircraft carriers, the Type 26 frigates and ASTUTE and DREADNOUGHT Class submarines, as well as the Royal Navy's Offshore Patrol Vessels programme and foreign orders, contribute significantly to the utilisation of maritime capacity.

With 35,000 employees and sales of £4.45Bn in 2019, 52% of which will be in the Defence sector and £1.2Bn in the Naval sector, Babcock International Group is the UK's second largest defence technology company and has a significant involvement in the Royal Navy's major naval programmes.

Spain

The government-owned Spanish shipyard Navantia has a wide range of naval shipbuilding products including aircraft carriers, destroyers, frigates, submarines, patrol boats and support vessels. The company has around 5,000 employees and a turnover of €1.08Bn in 2018. It developed the SCORPÈNE submarine with the French Naval Group. It could successfully be marketed abroad, but has not been introduced in Spain or France. Navantia is currently building four Class S80 submarines for the Spanish Navy.

Sweden

Saab Kockums is a business area of the Swedish Saab Group, which has 17,420 employees and a turnover of SEK35.4Bn in 2019. In addition to this shipyard, Saab is highly active in the naval business with weapons, missiles, communication and command and control systems.

Saab Kockums' product range, which employs around 1,200 people, includes naval surface vessels, the national Class A26 submarine programme currently under development, autonomous underwater vehicles, weapons and other naval systems for communication, underwater reconnaissance and protection.

The Swedish Government had decided on an industrial policy shift towards more national sovereignty and to keep the competence in submarine construction in the country, to secure foreign markets and to increase international cooperation. On 22 July 2014 thyssenkrupp Marine Systems sold the Swedish shipyard Kockums, acquired in 1999, to Saab, which now operates under the name Saab Kockums.

Netherlands

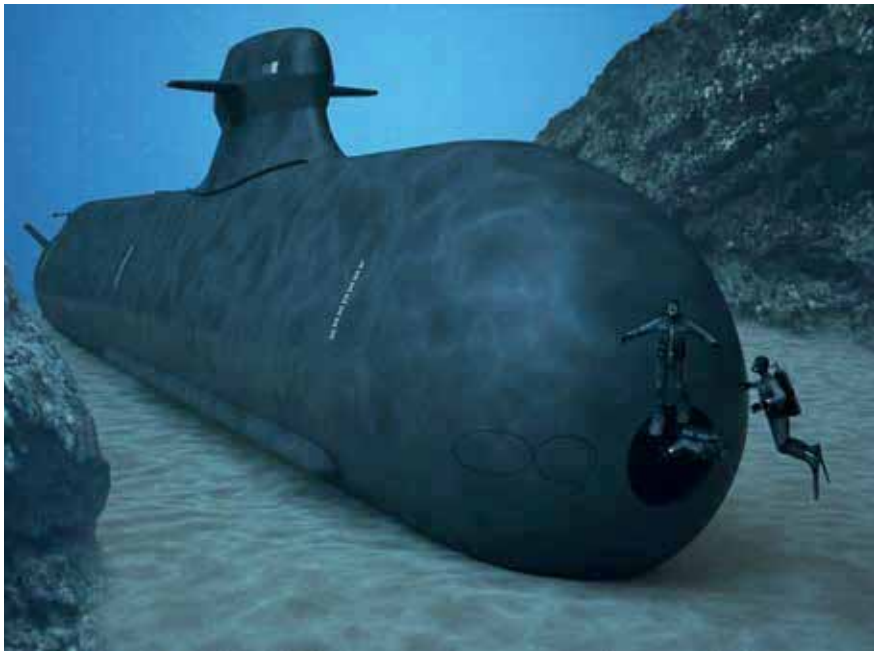
The Dutch family-owned company Damen Shipyards Group had a turnover of two billion euros in 2018 with 12,000 employees, 3,500 of whom work in the Netherlands. The Damen Schelde Naval Shipbuilding programme in Vlissingen includes frigates, patrol and MCMV. The yard was selected as the main contractor for the procurement of the German multipurpose combat ships 180 (MKS 180). The ships will be built in cooperation between Damen Schelde Naval Shipbuilding, Thales Nederland and the Lürssen shipyard with the involvement of the German Naval Yards Kiel in Hamburg at Lürssen's Blohm + Voss shipüyard.

Damen Shipyards Group and Saab, which agreed to cooperate in January 2015, are, like thyssenkrupp Marine Systems and Naval Group, bidding for the Dutch WALRUS submarine replacement Programme (WRES), which envisions the procurement of four boats.

Prospects for European Consolidation

Although it was already agreed in the coalition agreement of 17 February 2018 to classify German naval shipbuilding as a key technology overall, the necessary cabinet decision by the Federal Govern-

Picture: MSD archives



In the scope of the A26 programme, the Royal Swedish Navy plans to procure two BLEKINGE class submarines.

ment was not taken until 12 February 2020, too late to adequately safeguard German maritime interests in the MKS 180 procurement project.

The decision of the German MoD to commission the Dutch company Damen with the construction of the four multi-purpose class 180 surface combatents will have a decisive influence on the future strategic orientation of German naval shipbuilding and thus on national and European consolidation. There are justified concerns that the awarding of the largest German naval contract abroad, worth €5.7 billion, to Damen, contradicting German security and technological interests, could result in the irrevocable loss of systems engineering competence, key technologies and expertise in Germany, while at the same time making comprehensive national consolidation of German naval shipbuilding more difficult.

There is thus a risk that the creation of a consolidated strong German champion as a counterweight to the French, Italian and British shipyards will no longer be possible. Future procurement plans and current ownership, capacity and structures give little chance of success to a consolidated strong German shipyard group, as long favoured by the Federal Governments, including the "Joint Declaration of the Federal Chancellor and the Federal Minister of Defence with Companies of the German Army and Naval Shipbuilding Industry" of 28 October 2000.

With this reference order, the the MKS 180 contract award to a foreign shipyard considerably strengthens Damen's market position in international competition - especially vis-à-vis German shipyards. Following this award decision, Lürssen, as a subcontractor of Damen, now intends to set up a joint venture with German Naval Yards Kiel in the construction of naval surface vessels under the leadership of the Bremen-based Lürssen Group. In a joint statement issued by the two companies the objective is "to improve the national industrial structure and to strengthen efficiency and sustainability". For Lürssen, the merger will primarily provide access to the efficient infrastructure of German Naval Yards Kiel as a construction yard.

For Damen, the MKS 180 project has the potential to develop into an efficient shipyard alliance with the participation of German companies as a counterweight to the French and Italian shipyards. The cooperation between Damen and Kockums, which was agreed on 23 October 2018, could also contribute to this. Damen competes with thyssenkrupp Marine Systems and Naval Group for the planned procurement of four new submarines for the Dutch Navy in the WALRUS Replacement Programme.

The question remains as to how thyssenkrupp Marine Systems will position itself in the future, particularly as the global market leader in conventional submarine construction, but also supported by foreign orders in surface shipbuilding. It is not expected that the larger and, with ATLAS Elektronik, much broader-based thyssenkrupp Marine Systems will join the planned shipyard alliance of Fr. Lürssen and German Naval Yards Kiel. And the proposed merger in submarine construction with Fincantieri would not bring significant synergy effects and would not have any relevant influence on the decision in Italy to procure a further batch of four Class 212A submarines.

Naval Group pursues a strategy of "tous azimuts" open in all directions. It cooperates with Fincantieri in the scope of the FREMM project. On the basis of the cooperation agreement signed on 14 June 2019 between Naval Group and Fincantieri to set up a 50/50 joint venture based in Genoa, NAVIRIS started operations with government support on 14 January 2020. The aim is to "strengthen cooperation in naval shipbuilding and create a more efficient and competitive European shipbuilding industry". On 22 July 2020, NAVIRIS agreed with OCCAR on a feasibility study to improve the performance of the four HORIZON frigates launched in Italy and France.

The access of the Spanish shipyard Navatia to the South American market has contributed to the fact that Naval Group and Navatia have jointly developed the two Chilean submarines of the SCORPÈNE class and built one each.

Particular obstacles to international cooperation and to the creation of cross-border joint ventures in Europe are the small number of joint projects, insufficiently standardised procedures in development and procurement, unequal conditions of competition ("level playing field") in the European Union, the lack of harmonisation of European arms export regulations, which hinder equal opportunities and the ability to cooperate. The protectionist and competition-distorting offset laws enacted in many countries, which require compensation in defence transactions, contribute to the development of new capacities, in particular through the relocation of production shares and licensing.

There are three main factors currently hampering the consolidation of naval shipbuilding at German and European level:

Firstly: low merger potential. The privately managed German companies have achieved a strong market position at home and abroad with efficient products. The current ownership, capacities and structures stand in the way of a German and European shipyard alliance with significant German participation.

Secondly, there is a lack of significant national and European plans in the near future that could promote comprehensive consolidation.

Thirdly, the restrictive German arms export policy makes consolidation at European level difficult.

A comprehensive consolidation of the European naval shipbuilding industry is therefore a long way off. ■

Consolidation of Marine Industry in Northern Europe

Jaime Karreman

In most European countries with their own naval industry, increasing calls are being made to produce more naval vessels at home than is currently the case, while at the same time, consolidation within the same naval industry is higher on the agenda than ever before. And it can be expected that there will be a shift in northern Europe on this issue, but it remains to be seen how big this will be.

The United Kingdom, Germany, Sweden and the Netherlands are the four countries in the northern part of Europe that design and build their own naval ships. These countries, except for the Netherlands, make up the six European countries, together with Spain, France and Italy that have the largest number of original equipment manufacturers (OEMs). Most of these countries have a closed, national market, with their own suppliers.

Naval Procurement

Although these countries have their own national naval markets, the clear political will was previously present in the United Kingdom, the Netherlands and Germany, especially around the beginning of the previous decade, to award more naval projects internationally. In addition, the European Union launched the "European Defence Package" in 2007, designed to transform defence markets in the EU that had traditionally been nationally based into a common European defence market.

Meanwhile, European nations launched international tenders for various reasons. The United Kingdom had their TIDE class tankers built by Daewoo (South Korea) in 2012 and started the tender for the Fleet Solid Support Ships in 2018, but this competition was paused at the end of 2019. The Netherlands agreed to the Belgian plans for a European tender for their mine countermeasure vessels; these twelve ships were designed and built by Naval Group and ECA Group (both France). Germany was the only country to outsource frigates internationally. The tender for the MKS 180 frigate project went to Damen (the Netherlands) in collaboration with Blohm+Voss, which belongs to the German Lürssen Defence Group.

Later on, the reactions in the three countries to international tenders were very similar, especially in the United Kingdom and Germany, when they made it very clear at a certain point that they wanted the practice to end. For decades, the UK had already decided to build complex naval vessels at home and limited any international procurement for its ships. Yet there were fears that British ships would be built abroad. In Germany, the reaction of many politicians was also clear - surface-warship-building was declared a "key technology" in February 2020.

The will to invest more heavily at the national level though does not preclude continued and closer cooperation between these countries.

Photo: Damen Shipyards

The MKS 180 Multi-Role Combat Ship for the German Navy will have a length of around 163 meters and a displacement of 9,000 tons making it a stable platform for the North Atlantic.

Pressure

This all relates to, among other things: a) what is happening in France and Italy between Naval Group and Fincantieri; b) the pressure from French and German politicians in particular, to make Europe more united in the field of defence and, finally; c) the still modest building plans of most European navies.

However, with the arrival of Naviris, the equal joint venture between Naval Group and Fincantieri, a new player in naval construction has emerged in the southern half of Europe. Although the future of Naviris still seems uncertain, this development forces other countries to reconsider the situation and their own positions. In addition, for example, the former CEO of Naval Group has repeatedly spoken out in favour of a 'Naval Airbus'.

This pressure is not necessarily appreciated everywhere in the northern part of Europe. In Germany, there are real concerns that France's cooperation with Italy will negatively affect Germany's naval industry and autonomy.

Furthermore, there are fears within Europe that German and French naval industry groups will dominate the European market. This became clear when the United Kingdom offered the Type 2076 sonar - so much sought after by the Dutch Submarine

Photo: Damen Shipyards

The Landing Platform Dock HNLMS ROTTERDAM

Service - exclusively to the Saab-Damen consortium for the Dutch submarines. In effect, this deprived the French and German shipyards of including this sonar in their tender, much to the annoyance of the Dutch procurement department, Defence Materiel Organization (DMO).

Little can be expected from a consolidation of British naval yards with foreign companies. With Brexit and the successful Type 26 and 31 frigates (sold mainly to countries outside Europe), plus plans for new submarines, the British naval industry, for the time being at least, may well not be in a situation where they need to consider mergers with foreign shipyards, nor will there be pressure by the British Government in this regard.

In Germany, the situation is quite different. The tender for the new MKS 180 multi- purpose combat ship caused quite an upset in Germany, with concern from some quarters that it might result in closer cooperation between the Netherlands and Germany as it would increase the need for consolidation in the region`s naval industry.

Again and directly related to the situation surrounding the MKS 180 tender, this consolidation actually took place in Germany earlier this year after it became clear that Lürssen Defence Group, German Naval Yards and thyssenkrupp Marine Systems had lost the tender for the MKS 180 project. A few months later, it was announced that Lürssen (owner of the Blohm+Voss shipyard) and German Naval Yards intended to merge their naval shipbuilding capabilities.

Thyssenkrupp Marine Systems was initially involved in the tender process, but the German conglomerate was not in favour, or was unable to merge their naval department with the aforementioned yards. Thyssenkrupp Marine Systems would have considered entering into talks with Fincantieri of Italy, with whom it has cooperated in the construction of Type 212A submarines for the Italian and German navies. It is now far from clear what the future for thyssenkrupp Marine Systems holds, not least because one disadvantage is that it has long been rumoured that thyssenkrupp wants to sell the company and that the German Navy would be dissatisfied with the cooperation around the F125 frigates.

The tricky issue for thyssenkrupp Marine Systems is that one of the shipyards related to the MKS 180 tender - Damen - is in fact closely connected to a competitor and ex-partner of thyssenkrupp Marine Systems, namely Saab Kockums of Sweden.

Saab Kockums is a company with no plans to merge with a foreign shipyard any time soon. In Sweden, consolidation is clearly not high on the priority list. Saab Kockums, which is in the race in the Netherlands for the tender for new submarines, builds mainly for its own market. A few years ago, under pressure from the Swedish Government, the company was bought back from thyssenkrupp Marine Systems. As in the United Kingdom and Germany, submarine technology is considered by Sweden to be of strategic value. Autonomy is therefore more important in Sweden than a merger. Nevertheless, Saab Kockums also follows developments in Europe in terms of consolidation, and the Swedish Government's plans with the Navy are modest. If closer cooperation is indeed chosen, the Damen partnership may come in handy. Precisely because thyssenkrupp Marine Systems is no longer involved with MKS 180 companies, there are opportunities for the Swedish company to work more closely with Germany and Sweden – thereby circumnavigating thyssenkrupp Marine Systems.

Photo: OCCAR

The FREMM frigate design and construction process has been implemented by Naval Group in close collaboration with OCCAR, the DGA and the French Navy.

German-Dutch Cooperation

Due to the MKS 180 project, the Dutch naval industry, with Damen at the helm, will be working intensively with German industry in the coming years. The MKS 180 project is huge and at least for another ten years, Damen and the German shipyards will have to work closely together to build the four to six frigates for the German Navy. This intensive cooperation could even be a prelude to consolidation.

"It's not whether but how," Dutch Vice Admiral Arie Jan de Waard, director of the Defence Materiel Organisation (DMO) said in a still unpublished interview in late June.

"When you see what is happening geopolitically, then Europe has to make sure that it can contribute to the warranty of peace and security. In my view, this cannot be done if all countries buy different systems and do not cooperate with each other. On the other hand, if you want to do that with 27 countries, it gets complicated. So, you have to look for countries with which you have the connection."

"The intention was to replace the [Dutch and Belgian – note by the editor] M frigates and MKS 180 together. But we decided years ago not to pursue this cooperation because of elections, austerity and sometimes different demands. But I hope that we will also look at the longer term. And I also know that the Secretaries of State of Germany and the Netherlands are talking about this and agree to explore further cooperation."

The possible cooperation is already quite concrete. In this regard, De Waard states

that "MKS 180 is the stepping stone to the further development in the maritime domain, consolidation of shipbuilding Germany-Netherlands, making beautiful products together, playing in the Premier League and looking at the first project on the list: replacements of the LCFs (Air Warfare and Command frigates) and the F124 frigates. After that, we have to replace the Landing Platform Dock ships HNLMS "ROTTERDAM" and "JOHAN DE WITT" and we want to see what Germany's requirements are in this area."

Although Germany and the Netherlands are gradually moving closer together, discussions are also being held with the United Kingdom, although these are not so concrete. "The British are highly valued colleagues," added De Waard. "Just look at the UK Amphibious Force. So it is important that we continue to talk to our British colleagues as well."

More than Just Shipbuilding

When it comes to the handful of naval yards in Europe, getting a good understanding is not always easy as the overall picture surrounding Europe's naval industry is murky. Many large and smaller companies provide support to European shipbuilding though not all of them are located in northern Europe. One of the most important naval sensor companies in the United Kingdom and the Netherlands is Thales, a French company. Other companies are not engaged in the construction of naval vessels, but they are nevertheless of great importance to national security, such as Kongsberg in Norway.

In addition, many of these national or international crown jewels face stiff competition from other countries in northern Europe. For example, Germany's Hensoldt, Denmark's Terma, France's Thales, UK-based BAE Systems and Sweden's Saab are all active in the radar field.

This kind of competition can actually hinder international cooperation and certainly any consolidation efforts. In the south of Europe, there are similar issues and the shared fields of work between Thales and Italy's Leonardo certainly complicates the Franco-Italian joint venture, Naviris. At the same time, competition between Hensoldt and Thales would have hindered the plans between the Netherlands and Germany regarding joint submarines and frigates, because in the field of platforms, agreements could be reached on distribution, but not in the field of sensors.

The Same Ships?

However, Germany, the United Kingdom and the Netherlands have all cooperated in the development of naval vessels in the past, and even at quite an intensive level when one recalls the Dutch and British navies up until the 1970s. A more recent example is the current German F124 frigates and the Dutch LCFs.

But it is precisely these frigates that make it clear why it remains to be seen whether there will really be consolidation in the northern half of Europe in the near future, not least because all countries and their respective navies want different things, best seen with the F124s and LCFs, along with the British Type 45s and the French and Italian HORIZON class frigates, which origi-

nated from the failed NATO frigate for the 1990s (NF90). That project failed completely despite enormous efforts and pressure because of the different wishes and demands of the countries involved.
Is the NH-90 helicopter a success story? Or the French and Italian FREMM frigates? They have the same name, but are configured differently for each country.
The Dutch DMO, whose director is strongly in favour of consolidation and international cooperation, also does not exactly want the same ships as Germany. In an earlier interview, Vice-Admiral De Waard said that he wanted to work mainly in the field of sensors, weapons, and software; there was a reason therefore for selecting the Netherlands for the MKS 180 project.

A European Platform?

There are, of course, those who suggest that European countries should aim for one type, but there is a thin line between advocating for international cooperation and promoting one's own industry these days. In 2016, for example, the German (then) Navy Captain Henning Faltin, Chairman of the Submarine Conventional Round Table, a club founded by Germany in 2014, said during a Dutch Parliament hearing on new submarines: "We bring together, as I said, NATO countries in Europe that run conventional submarines (...). Within the working group dedicated for in-service support, there is a lesson learned which is: we could be better if we were to operate on the basis of one identical European platform, or at least on the basis of common components."
By this, Faltin did not mean that all European countries were obliged to order their submarines from, for example, a French shipyard. Moments later, he said he hoped that the Netherlands would buy the new submarines, which tkMS is developing together with Norway and Germany. "Maybe we can come together on a submarine issue. We would like that. We would be happy to discuss functional requirements on a government-to-government basis. I have the yellow card here. The first point here is that Germany keeps its submarine service and will increase the number of submarines. The second point is that we aim for a multinational effort, both to cut costs and to support our key national technology. Surely we look for partners such as the Netherlands."
National industries have long been regarded by many as being of great importance for national security, especially those nations who build and operate nuclear submarines. Rarely are large projects outsourced to other countries. This is the reality for many countries in Europe; between 2011 and 2015, France ordered 98% of its defence contracts at home, Italy 85%, while in Germany it was 96%, the United Kingdom 84%, Sweden 80% and the Netherlands at 57%. Only countries with smaller defence industries, such as Belgium, Finland and Portugal spent less than half at home.
Only the future will show just how international consolidation in the European naval industry will evolve, especially when one considers that countries want to have different ships, want to keep parts of their own industries alive, and maintain effective control over multinational organisations. There is certainly considerable room for improvement. ■

Expertise in the naval sector

Saab – your innovative partner

The Swedish manufacturer Saab is a multi-industry company with a portfolio of about 500 products. Saab generate more than 20% of their turnover in the naval sector. Saab is a recognised global player, equipping many Navies around the world, including the US Navy, the Royal Navy (UK) and the French Navy.

Thanks to the two shipyards Kockums and Docksta, Saab is one of the few European suppliers that can build submarines and surface ships like corvettes, combat boats (CB90) and MCM ships. Saab is also capable of integrating its wide range of products such as communications systems or combat systems with other manufacturers' vessels. At the same time Saab is also a world leader in the Remotely Operated Vehicle (ROV) sector.

Underwater safety for the Netherlands

In April this year, the Netherlands became the first European country to opt for the Sea Wasp underwater robot system from Saab. Underwater systems such as ROVs are suitable, among other things, for harbour protection and explosive ordnance disposal (EOD). Sea Wasp can reliably locate, identify and neutralise explosive devices even in confined spaces and under difficult conditions. The system navigates with advanced sensors to any pre-defined position and operates with six degrees of freedom. Sea Wasp is designed for rapid response and operations flexibility in currents of up to 2.5 knots, guaranteeing safety while optimizing cost efficiency. Modularity is at the very heart of Saabs Sea Wasp. Customized integration of payloads makes Sea Wasp the tailor-made underwater system for every mission.

Fire control system for the German Federal Police

Autumn 2019 Saab signed a contract in for delivery of 9LV FCS tracking system for three German Federal Police offshore patrol vessels. With highly accurate tracking of air and surface targets the Fire Control System 9LV FCS creates an unmatched situational picture, enables faster reaction times and ensures high-precision striking performance. The 9LV FCS is a solution that provides rapid, reliable response against any threat in any environment, including asymmetric surface threats.

Graphic: Saab

9LV FCS can include the EOS-500, which is a lightweight (150 kilograms) high accuracy stabilized optronic 3D tracking system designed for use on all naval ships. EOS-500 includes a gyro-stabilized platform with three electro-optical sensors. The high quality stabilization and advanced TV & IR cameras and laser rangefinder provide operators with an efficient solution for observation, target identification and fire control. Saab's advanced video tracker uses simultaneous input from the TV and the IR camera in a data fusion process. It hits accuracy and ability to deal with the demands of multiple incoming targets and tight time constraints is what sets the system apart from the competition.
The EOS-500 is offered as a part of a 9LV combat system solution or as a weapon control system together with parts like: CEROS-200, gun fire control and missile control modules, where the operators dynamically allocate any combination of tracker and weapon for flexible handling of surrounding threats or stand alone.

Belgian and Dutch Navy communicate with TactiCall

In the area of C2, the French Naval Group and Kership recently selected Saab's integrated communications system, TactiCall, for the Belgian-Dutch Mine Warfare Programme (MCM). The TactiCall system is designed to facilitate the chain of command within armed forces for joint operations, and supports the operators' ability to effectively manage operational duties. TactiCall interconnects all communication subsystems into one single IP platform infrastructure, allowing 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. It is designed as one integrated communication platform serving multiple domains with voice and data communication capabilities. The core TactiCall integration platform is delivered to both civil and military customers in both air and naval applications. TactiCall provides multi-level secure voice and data communication and the ability to share information via connected voice and data communication infrastructures. This includes different classification levels with an assurance level of EAL 5+.

Read more: saab.com.

Southern European Navies and Naval Projects

Luca Peruzzi

European Navies Are Grappling with Aggressive Russian, Chinese Operations in the Baltic and Mediterranean. For many years, they were underfunded, but that is now slowly changing.

The French Government maintains a capable navy with a nuclear-powered aircraft carrier battle group, as well as an attack and ballistic missile submarine fleet. France also has a well-established naval industrial system with strong export capabilities and support from the national authorities, as demonstrated most recently by the establishment in July 2020 of the Ministère de la Mer (Ministry of the Sea).

Photo: Marine Nationale

The first boat of the six new nuclear-powered attack submarines under construction for the French BARRACUDA programme is expected to enter service in 2021.

France

Under the current military planning law - Loi de Programmation Militaire (LPM 2019-2025) - the French Navy received a significant boost in terms of its platforms and systems development, in addition to its procurement programmes. While the coronavirus pandemic is causing delays in the implementation of current activities, the effect should be limited for the longer-term programmes since the industry is receiving Government support to overcome the impact of the pandemic. Detailed design studies for the third-generation ballistic nuclear submarine (SNLE3G) are in progress, under a co-contracting agreement between Naval Group and TechnicAtome, while the same industrial team led by Naval Group is committed to delivering the first SUFFREN class SSN by late 2020 with entry-into-service foreseen for 2021. The new class of SSN represents a significant boost in terms of at-sea presence and the French Navy's operational capabilities, thanks to its new generation hybrid nuclear/electric propulsion, together with its weapons systems.

Following the latest studies provided by an industrial team consisting of Naval Group, Chantiers de l'Atlantique, Thales, MBDA and Dassault, a decision by French President Emanuelle Macron on the second-generation aircraft carrier, or PANG (Porte-Avions de Nouvelle Génération), was expected by in July. This will open the door for the award of the detailed design contract in order for sea trials to commence in 2036, with delivery planned for 2038, according to French Minister of Defence, Florence Parly. The Marine Nationale's surface fleet was also boosted by Naval Group launching the construction of the first-of-class frégates de défense et d'intervention (FDI) in October 2019, set to be delivered in 2023. The new platform is the first expression of Naval Group's 4.0 shipyard revolution and the first-digitally developed project by French naval industries. In the meantime, the FREMM programme's two last frigates - in the air-defence version - are being prepared for delivery in 2021-2022, while mid-life upgrades on the first of three LA FAYETTE class light frigates will begin later in 2020. In July, the French and Italian MoDs, through the OCCAR agency, awarded Naviris (a joint venture between Naval Group and Italian firm Fincantieri) the feasibility study contract for the mid-life upgrade of the two navies' HORIZON class AAW destroyers centred on enhancing the ships' main mission capabilities, including against the latest and future air and ballistic missile threats. The new generation BRF (Batiments Ravitailleurs de Forces) logistic support ship programme led by Chantiers de l'Atlantique with Naval Group, and supported by Fincantieri, entered the construction phase in the first half of 2020, boosting the French Navy's expeditionary capabilities.

Two key programmes are supporting the rejuvenation of the French Navy's patrol vessel fleet and capabilities: the six patrouillers d'outre-mer (POM) and the 10 larger high-seas patrol (patrouilleurs océaniques) platforms. The former were assigned to the Socarenam/CNN MCO consortium in December 2019, while the latter is expected to be awarded in 2021. In addition to the larger and small combat, patrol and support vessels produced by Kership (a joint venture between Piriou and Naval Group), and smaller naval shipbuilders, including CMN, CNIM, Couach, OCEA, Raidco, Socarenam and Ufast, the GOWIND corvette and the FDI medium-size frigates, both purpose-built for export,

are at the centre of export programmes with Egypt, Romania, and the UAE, after global campaigns undertaken by French naval industries and Naviris JV. In February 2020, Naval Group indirectly acknowledged having received a contract in 2019 for two GOWIND corvettes from the UAE. Shipbuilding is reported to be ongoing with options for two additional units. Among the smaller shipyards, CMN is delivering fast interceptors to Saudi Arabia, while OCEA signed a contract in July with the State Border Guard Service of Ukraine for 20 patrol boats. CNIM is working on a new generation landing craft and Pirou on new green tugboats for the Marine Nationale. Fincantieri's acquisition of the shipbuilder Chantiers de l'Atlantique is, however, under an in-depth EU investigation. Its experience and know-how in the underwater domain allows Naval Group to conquer new markets, just as it has done with the Australian SEA 1000 submarine programme, as well as with the Indian and Brazilian Navies' SCORPENE based conventional (and nuclear for Brazil) submarine programmes. In all cases, this has happened with an extensive technology transfer package and strong involvement in the platform design, in addition to development and construction in support of local industry. Today, the focus is on the Indian P-75I AIP-equipped and the new submarine procurement tenders for the Netherlands.

Photo: Naval Group

Naval Group developed the new Frégate de Défense et d'Intervention (FDI) both for the French Navy and for export customers.

Italy

With the latest naval procurement law approved in 2015, Italy launched the renovation of its surface fleet, including the development and construction of the PATTUGLIATORE POLIVALENTE D'ALTURA (PPA) type PAOLO THAON DI REVEL class combat patrol vessels (seven units, plus three options), a new Logistic Support Ship (LSS), with both programmes managed by OCCAR, and the new TRIESTE class LHD. Fincantieri is the prime contractor and platform provider, while Leonardo will act as the combat system integrator and main supplier, together with MBDA and Elettronica. All three shipbuilding programmes are currently affected by the pandemic, even though the industrial team and the Italian MoD's Naval Armament Directorate are working towards limiting any possible delays. The PPA programme, which sees three different platform configurations – PPA Light, Light Plus and Full – featuring a completely new generation combat and weapon systems, is proceeding towards the first-of-class delivery in 2021. The LSS VULCANO was expected to be delivered in September but this is now planned for the beginning of 2021, while the TRIESTE LHD is planned to be delivered in 2022.

In the meantime, Orizzonte Sistemi Navali, the joint venture between Fincantieri and Leonardo, is working on fitting the last two FREMM frigates (in ASuW configuration) for the Italian Navy. However, the Italian Government has acknowledged these ships could eventually find an export customer, possibly Egypt, with a contract expected to be awarded to Fincantieri by 2020-end/beginning 2021. The deal with Italian industry is also expected to include the option for two additional FREMMs and a number of patrol vessels to be built locally with a technology transfer package, together with training and support. This export sale will require the procurement of two additional FREMMs for the Italian Navy, for which a contract could be signed as early as late 2020 to be in service by 2024. The Italian Navy acknowledges that funding has been secured for the service-life extension of in-service platforms until the delivery of new ships. In the meantime, a Fincantieri-led team recently completed a renovation programme on the CAVOUR aircraft carrier, which will embark the F-35B Lightning II STOVL aircraft.

The Italian MoD's Naval Armament Directorate is also working on the Near Future Submarine (NFS) programme to procure four new-generation submarines with significant national industry-provided combat, platform and propulsion systems content. These units are based on the Type 212A platform already in service in four units with the Italian Navy as part of the joint German and Italian shipbuilding and support programme. The contract for 2 + 2 locally built units, plus in-service training and logistics support, is expected to be assigned to Fincantieri in late 2020. Fincantieri recently acknowledged that it was discussing deeper cooperation with Thyssenkrupp in the underwater domain,

Photo: Luca Peruzzi

The first-of-class PAOLO THAON DI REVEL Pattugliatore Polivalente d'Altura (PPA) 'dual-role' multirole combatant platform is currently undergoing sea trials and due for delivery in 2021.

Photo: NATO

The contract for locally built Type 212A (2nd batch) units plus training and logistics support will probably be awarded to Fincantieri in late 2020.

Photo: Italian Navy

In July 2020, OCCAR awarded Naviris, a joint venture between Fincantieri and Naval Group, a feasibility study contract for the Mid-Life Upgrade of the four HORIZON-type air defence platforms in service with both navies.

further strengthening the European shipbuilding industry.

In late 2020, the Italian MoD is also expected to award the contract for a new multi-purpose ship capable of conducting submarine rescue and special forces and diver support. A new oceanographic vessel is also planned to be acquired while studies are set to be launched on new smaller hydrographic platforms and new large mine-countermeasures mother-platforms for unmanned systems. In addition to the feasibility study contract for the MLU of the HORIZON type AAW destroyers, the Italian MoD is nearing the study phase for the new air defence-oriented destroyers due to replace the two ageing LUIGI DURAND DE LA PENNE vessels and the three amphibious assault platforms to replace the in-service SAN GIORGIO/SAN GIUSTO LPDs.

Italy is also looking at PESCO's European Patrol Corvette (EPC) project and the Naviris joint venture to replace its fleet of offshore patrol vessels (OPV) starting with the CASSIOPEA class of patrol vessels.

With strong support from the Italian Government and the MoD, the Italian naval industry, led by Fincantieri and including Leonardo, MBDA and Elettronica, has been awarded an almost €4Bn shipbuilding and support programme to provide Qatar with four new design multi-purpose corvettes, two OPVs and an amphibious and command and control vessel, in addition to crew and shore personnel training and local support.

Leonardo is the only European enterprise capable of providing the whole range of naval artillery and guided rounds, with the 127/155 mm VULCANO long-range guided ammunition developed and qualified together with the Italian and German MoDs and industries, and the future 76/62 mm VULCANO. A customised version of the FREMM platform proposed by Fincantieri's US subsidiary, Marinette Marine, has been selected and a contract was awarded to provide the US Navy with the first platform (with an option for an additional nine) under the FFG(X) programme. As anticipated, the Italian shipbuilder is also discussing the sale of FREMM platforms to Middle Eastern customers, including Egypt and reportedly Saudi Arabia, while also bidding for fast patrol vessels in Kuwait.

Amongst the Italian naval enterprises, which includes Intermarine, FB Design, Fincantieri's subsidiary Seastema and GEM Elettronica, Cantiere Navale Vittoria is building an OPV for Malta's Armed Forces and was recently awarded a contract for one (plus three options) new smaller OPV for Italy's Guardia di Finanza. Intermarine shipbuilder and Leonardo have recently signed a strategic research and development agreement to pursue business opportunities in the MCM, fast patrol boat and hydrographic vessel sectors.

Joint French-Italian Naval Initiatives

Following the intergovernmental agreement signed last year and the operational launch in early 2020 of the equally-owned Naviris joint-venture between Fincantieri and Naval Group in the surface vessels sector, cooperation between the two countries and their naval industries has further evolved; this is largely based on the HORIZON, FREMM and LSS programmes, the latter two managed by OCCAR. The same procurement and management organisation was selected by the two respective MoDs to award a contract to Naviris regarding five naval research and technologies (R&T) development projects to support both national and export requirements. In July, the OCCAR agency awarded Naviris the contract for a 12-month feasibility study for the mid-life upgrading (MLU) programme of the four HORIZON-type air defence platforms in service with both navies. The Naviris joint venture is also pursuing export opportunities with initial campaigns ongoing in the Asian region. Within the European Union's PESCO efforts, Italy, as programme leader, together with France and more recently Spain and Greece, are involved in the European Patrol Corvette (EPC) programme due to be launched in 2021, with Naviris expected to be the lead actor, aided by Navantia.

Spain

Despite the impact of the pandemic, the Spanish Government has recently approved a number of important defence projects, providing support to its defence industry in the midst of a challenging economic environment not only for Spain, but

also for other European nations. The Spanish Navy maintains a well-balanced surface fleet whose platform designs have found success abroad in recent years, notably in Australia with a customised version of the ALVARO DE BAZAN class F-100 air-defence frigates, the JUAN CARLOS I LHD and the CANTABRIA replenishment support ship, patrol vessels in Venezuela and more recently in Saudi Arabia with the AVANTE 2200 corvette programme.

The Spanish MoD and the Navy are revamping the underwater platform sector with the S-80 Plus AIP submarine procurement programme. They are also working on a new-generation multi-purpose frigate with the F-110 project, which is revolutionising both the national shipbuilding and naval defence sector led by the Navantia shipbuilding group with its parent company SEPI (Sociedad Estatal de Participaciones Industriales), together with the Indra defence group, and also Saes and Tecnobit. The ISAAC PERAL S-80 Plus AIP submarine programme (four vessels), which was plagued by development problems, has reached an important new milestone with a contract awarded to the ABENGOA group for the AIP propulsion system, although the pandemic has caused an estimated six-month delay, with the first submarine delivery now planned for the first-half of 2023. Currently, there are no plans for fitting the new submarine with TOMAHAWK cruise missiles but in the meantime, Boeing HARPOON Block II with land attack capabilities is being considered. A contract was signed between the Spanish MoD and Navantia in April 2019 for the €4.31Bn development, construction and delivery programme of the new class of five multi-purpose F-110 frigates to replace the SANTA MARIA class starting from 2026 and to be completed in 2031. The Spanish Government has approved a loan of up to €1.63Bn to begin financing the F-110 frigate project in December 2019, with construction work planned to start later in 2020, pandemic permitting. A high degree of industrial and technological sovereignty is involved in the project with about 80 % of equipment and supplies being developed and provided by Spanish companies. This includes the combat system and new generation sensors in addition to the shipbuilding programme, which will be the first developed within the framework of Navantia's ASTILLERO 4.0 digital ecosystem, benefiting from nearly a decade of work. The Spanish Navy is also planning to upgrade the ALVARO DE BAZAN class frigates with new combat capabilities, as well as extending the GALICIA class LPD's service life, while looking together with industry partners towards the EU's programmes, starting with the European Patrol Corvette (EPC). In October 2019, Navantia launched construction activities and in July celebrated the launch of the first of five AL-JUBAIL class AVANTE 2200 corvettes for Saudi Arabia made possible due to the €1.8Bn contract, including a five-year support package awarded by Saudi Arabian Military Industries (SAMI) in July 2019. This was followed by the creation of the SAMI Navantia Naval Industries joint venture and a €900M contract award for combat system integration in September 2019, set to play a key role in local industrial development, and opening the way for other potential opportunities. More recently, in June, the Australian
Department of Defence signed a strategic agreement with Navantia Australia, recognising Navantia as a design authority for the four classes of ships provided to the Royal Australian Navy (RAN).

Photo: Navantia

Navantia and Indra are working on the new five new five F110 multi-purpose frigates to be delivered between 2026 and 2031.

Photo: ©Turkish MoD

In the scope of the MilGem programme, the Turkish Navy took delivery of four ADA class corvettes between 2011 and 2019.

Turkey

Because of the Turkish Government's strong emphasis on indigenous manufacturing and development, Ankara has invested heavily into local defence sector capabilities. The national naval shipbuilding industry has achieved important development milestones and export success under the supervision and management of the Turkish MoD's procurement authority, the Presidency of Defence Industries (SSB), and the ASFAT company. This grouping manages 27 military industrial facilities and three military shipyards, in addition to private shipbuilders, including Sedef, Anadolu and Sefine (under the TAIS consortium), Dearsan, Selah, Istanbul and RMKMarine, but also the Ares and Yonca-Onuk joint venture of smaller vessel shipbuilders. The MilGem project is the

Photo: ©Portuguese Navy

The Portuguese Navy's two BARTOLOMEU DIAS (M) class frigate are currently subject to a life extension programme.

first example of Turkey's domestic capability to design, build and integrate a naval platform and combat system under cooperation between the Turkish Naval Forces (TNF) and the Turkish defence industry led by Aselsan, Havelsan and STM. Under the MilGem project, four ADA class corvettes were built and commissioned between 2011 and 2019, enabling national production and development of critical technological systems provided by companies such as Aselsan, Havelsan, Meteksan Defence, Tubitak, Roketsan, STM and Yaltes. The MilGem design gave Turkey's naval industry the first export success with a contract awarded by Pakistan in September 2018 for four customised ADA class corvettes, with the first-of-class ship's steel cut in September 2019 with delivery set for 2023. Thanks to a technology transfer and training package, two ships are being built in Turkey and two in Pakistan. The customised corvette will be longer, heavier and with extended endurance in addition to being equipped with VLS for air-defence missiles, and Chinese or Pakistani surface-to-surface missiles, while still maintaining most of the Turkish combat system and platform equipment. Pakistan is also the recipient of a fleet tanker design by Turkish STM and built at the Karachi Shipyard. Based on the ADA class corvette design, the Turkish Navy commissioned the development and construction of the I class frigates, equipped with VLS for air-defence missiles and with the latest in Turkish industry's equipment and weapons, the first of which is to be delivered in 2023. The Turkish Navy also assigned the MLU programme for the BARBADOS class frigates to Aselsan and is working on the new class of seven 7,000-tonne TF-2000 Air Defence Warfare (ADW) destroyers equipped with latest-generation fixed-faces AESA multifunction radar and new air defence missiles. Sedef shipyard is also building the Turkish Navy's flagship, the 27,436-tonne ANADOLU LHD, due to be delivered in 2021, while Sefine shipyard will deliver the 22,000-tonne fleet replenishment ship (DIMDEG). Turkey's naval industry is also working on the Preveze submarine MLU. Furthermore, under the New Type Submarine Project (NTSP), six REIS class Type 214 TN submarines are being constructed ahead of the fully indigenous underwater platform under the Milden programme which is planned to enter service in the second half of the 2030s. Smaller vessel builders have also found export success, notably the Ares shipyard with the Qatari Armed Forces and their Ministry of Interior-Coast Guard.

Greece

In May, the Greek Parliament approved different armed forces' programmes, including those aimed at strengthening the capabilities of the Hellenic Navy's fleet after a long period when funds were unavailable. The Hellenic Navy received the long-awaited green light for the modernisation of the four MEKO 200HN frigates which represent the backbone of the fleet. The final configuration of the upgraded platforms will depend on costs and requirements. Other funds were approved for enhancing the operational capabilities and in-service support of the Type 214 submarines, as well as introducing into service the last two SUPER VITA/ROUSSEN class fast-attack missile vessels. The sixth unit was delivered in July, while the seventh is under final construction. Among the approved programmes, the potential procurement of two Naval Group FDI frigates armed with long-range strike missiles, due to be built in France with support from Greek companies, is reportedly still under discussion, although French newspapers have indicated a potential mothballing of the project due to costs and pandemic funding needs. The US Government is also reported to have offered a proposal based on a customised Littoral Combat Ship (LCS) design. In the meantime, the US group Onex acquired the Nerion and Elefsina shipyards and in June, Onex and Israel Shipyards announced the promotion and local construction, together with Greek support, of the THEMISTOCLES corvette/OPV project which is based on Israel Shipyards' SA'AR 72 platform design; this is all opening new horizons for the further strengthening of the Hellenic Navy.

Portugal, Romania and Bulgaria

In December 2019, the Portuguese Government approved funding for armed forces' procurement for the current decade, including for a new multipurpose logistics ship, a replenishment tanker and six OPVs, in addition to the upgrade for the VASCO DA GAMA class frigates. In the meantime, the two BARTOLOMEU DIAS (M) class frigates are currently undergoing mid-life upgrades in the Netherlands carried out by the Dutch Defence Materiel Organisation, centred on new Thales Nederland sensors, systems and Raytheon Evolved SeaSparrow Missile Block II, which is to be completed in early 2021 and Q2 2022. In the wider South-Eastern European region, in July 2019, the Romanian MoD announced the selection of French Naval Group and local partner Santierul Naval Constanta (SNC) shipyard, together with local industry, for the programme to build four new GOWIND multi-mission corvettes and the modernisation of the two Romanian Navy Type 22 frigates. More recently, in March, the Bulgarian MoD announced the selection of the German shipyard, Lürssen Defence, for two multifunctional modular patrol vessels (corvette class) destined for the Bulgarian Navy. It was planned to award the contract later in 2020 with delivery of the first ship foreseen for 2023, but Fincantieri has contested the selection. ■

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