MDM

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From the Sea and Beyond

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Naval Forces in the Baltic and Black Sea

- Cruiser MOSKVA: An Analysis of her Loss
- European Heavyweight Torpedo Programmes
- The Future of the Supercarrier

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MITTLER REPORT

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A Changed Maritime Security Environment


Photo: author

It is difficult to undertake any assessment of the current maritime security environment without viewing matters through the prism of the Russo-Ukrainian war. The return to state-against-state conflict in 21st Century Europe is as alarming as it is shocking, leading to profound changes in the continent's security architecture. Whether it is the demise of the peace dividend; the need to look to alternative sources of energy security; or the expansion of the defensive NATO alliance through the entry of long neutral countries, the war has changed Europe in ways that will be felt for a generation or more.

Although the war has been principally a land-based conflict, its maritime dimension looks likely to yield lessons that will also have a long-lasting impact on naval strategy. Of course, it is the destruction of the cruiser MOSKVA that has provided most of the headlines. Whilst much of the information in the public domain is inevitably speculative in nature, the loss of the largest post-Second World War warship to be sunk in combat is certain to be studied by analysts for years to come. We provide our own, initial assessment, in this edition. From what little hard evidence that has emerged, it seems that there are important lessons to be (re)learned in the areas of equipment serviceability and the importance of proper training; issues that have broad relevance to navies beyond the Russian fleet.

Putting to one side for a moment the loss of the MOSKVA, it is also valuable to consider the war's wider maritime lessons. In spite of its several setbacks, the Russian Navy's Black Sea Fleet has played an important role in the conflict that serves to demonstrate the vital influence naval power can exert on any conflict. The seizure of Ukrainian ports along the Sea of Azov in the first stages of the "special military operation" was an early success and might be an important factor in the war's eventual settlement. This speaks to the continued relevance of amphibious and littoral warfare forces. Given the absence of an effective Ukrainian Navy, Russian warships have also seemingly been able to maintain a blockade of the coastline that remains in Ukrainian hands; an achievement that is likely to have a significant impact on global food supplies in the months ahead. It will be interesting to see whether the outcome will lift the "sea blindness" that impacts so many trading nations.

This edition of Maritime Defence Monitor contains a number of articles that have relevance to the changed maritime security environment. We look at naval forces and procurement in the Black Sea and the Baltic, both regions on the frontline of the new east/west divide. From a technological standpoint, we assess current trends in mine warfare – a key determinant in littoral warfare – and examine recent European heavyweight torpedo development. An interview with the Director of the NATO Centre of Excellence for Operations in Confined and Shallow Waters in Kiel provides a further insight into current thinking about littoral warfare. Away from the coastline, we assess competing views about the future direction of aircraft carrier design from a US Navy perspective and examine naval rivalries in the Indian Ocean. Other important articles echo the importance of effective training already referenced with respect to the MOSKVA sinking and look at the difficulties of restoring naval power after a period of post-Cold War decline with the Dutch example in mind.

We, the editorial team, hope that you will find something in this edition to help guide you to safer seas.

Yours Aye
Conrad

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Photo: MoD Russia

MDM co-editor Hans Uwe Mergener provides an in-depth analysis of the dramatic circumstances which led to the sinking of the missile cruiser MOSKVA, Russia`s flagship of the Black Sea fleet.

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With the advent of hypersonic missiles, high-value targets such as aircraft carriers have become more vulnerable. Do aircraft carriers still have a future?

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EUROPE

France: Launch of the Replenishment Vessel JACQUES CHEVALLIER

(cw) The launch of the first of four force replenishment vessels (Bâtiments Ravitailleurs de Force or BRF) for France's Marine Nationale took place at the Chantiers de l'Atlantique shipyard in Brittany on 29 April 2022. The ships were ordered from a consortium that also includes France's Naval Group in January 2019 at a reported cost of €1.9Bn. The acquisition programme is being overseen by the European defence equipment procurement management agency OCCAR, which is working in collaboration with its French counterpart, the DGA. Delivery of the new JACQUES CHEVALLIER has been slightly delayed by the impact of the COVID-19 pandemic. However, sea trials are now anticipated to commence later in 2022 before scheduled handover in the first half of 2023.

MDM Editorial Commentary: Acquired to meet the French Navy's FLOTLOG requirement to replace the elderly DURANCE class replenishment oilers, the design of the four JACQUES CHEVALLIER vessels is based on the Italian Navy's VULCANO logistic support ship. Displacing some 31,000 tonnes at full load, the new ships will be the largest French naval vessels by tonnage after the aircraft carrier CHARLES DE GAULLE. They have a capacity for 13,000 M³ of liquid cargo and can also carry fuel, ammunition, spare parts and other solid stores. Capable of speeds of up to around 20 knots, they will have accommodation for a crew of 130 and some 60 supplementary personnel. France's decision to adopt a foreign design in lieu of a totally national solution was significantly influenced by Fincantieri's planned acquisition of the giant Chantiers de l'Atlantique facility. Given that this ambition was ultimately thwarted by European Union competition concerns relating to the cruise liner market, much of the initial rationale for the design choice has been superseded by events. Nevertheless, the use of VULCANO as the basis for the new vessels still has considerable merit. The replacement of the DURANCE class – which entered service from 1976 to 1990 – has become increasingly urgent, with only two now remaining operational. The choice of a proven design reference, doubtless speeding construction, therefore helps to resolve this problem. The selection also furthers Franco-Italian collaboration in the naval sphere, an endeavour most strongly evidenced by the Naviris joint venture.

Photo: Bruno Huriet

The first French BRF JACQUES CHEVALLIER has been launched by Chantiers de l'Atlantique at Saint-Nazaire, Brittany.

Denmark: First SM-2 Missile Firing

(cw) On 4 May 2022, the Royal Danish Navy carried out its first test firing of a RIM-66 STANDARD MISSILE-2 (SM-2). The launch was carried out by the IVER HUITFELDT class frigate NIELS JUEL from a test range off the coast of Norway and was part of a programme intended to integrate the area defence missile with the three-strong frigate class. Although the IVER HUITFELDT class were always intended to have a primary area air defence role – a capacity provided by their Thales APAR and SMART-L radar systems and MK 41 VLS – there was insufficient money available to purchase the SM-2 when the ships commissioned in 2011. Consequently, they have had to make do with the shorter-ranged Evolved SEASPARROW Missile (ESSM) system over the following decade. Funding for the new missiles was finally made available during the period of the current Danish Defence Agreement and it is believed 50 SM-2s have been acquired under the Foreign Military Sales (FMS) regime. The delay in integrating SM-2 into the frigates is indicative of the hard choices forced on many European navies during the post-Cold War era; the resulting economies now looking particularly short-sighted in the light of recent events in Ukraine.

Photo: Royal Danish Navy

NIELS JUEL carries out the Royal Danish Navy's first test firing of a SM-2 area air defence missile.

Germany: F126 Programme Makes Headway with Further Equipment Contracts

(jh/gwh) Germany's programme to construct its new F126 frigates is steadily gaining momentum with the award of contracts for key items of equipment. In April 2022, Hensoldt announced that it had signed a contract worth over €100M with the programme's mission combat system integrator Thales to deliver its TRS-4D naval radar for the four ships (with an option for two additional vessels) that comprise the programme, as well as to associated test and training sites. The integration of the radar on the ships and at the shore installations will be done by Thales. First deliveries are scheduled for 2025. The Hensoldt TRS-4D

Photo: German Armed Forces

As is the case for their predecessors, Germany's F126 class frigates will be armed with the OTO 127/64 (LW) VULCANO naval gun.

radar installed in the F126 class will be the non-rotating version with four fixed-panel arrays; a similar arrangement to that seen in the preceding F125 BADEN-WÜRTTEMBERG class. The single-arrayed rotating variant of the radar has been specified for the second batch of K130 series corvettes and modernisation of the existing F124 SACHSEN class, providing a considerable degree of commonality across the German fleet.

The previous month saw Damen Naval, the F126 programme's prime contractor, conclude an agreement with Leonardo to supply the OTO 127/64 LightWeight (LW) VULCANO naval gun for the new frigates. Just as is the case for the TRS-4D radar, this weapon is also found in the F125 class. The contract covers logistic support, as well as the delivery of simulators for crew training. As well as firing standard 127mm ammunition, the weapon can use the two variants of Leonardo's VULCANO ammunition – the Guided Long Range (GLR) and Ballistic Extended Range (BER) munitions. This capability extends the gun's range out as far as 85 km.

In yet another equipment announcement, Damen Naval has also announced the selection of ABB's modular Onboard DC Grid system for the new frigates.

United Kingdom: Contract for Future QUEEN ELIZABETH Class Aircraft Carrier Dockings

(cw) Babcock International has been awarded a 10-year contract to provide dry-dock maintenance for the Royal Navy's two QUEEN ELIZABETH class aircraft carriers. Performance of the £30M agreement will be carried out in the dry-dock at Rosyth – near Edinburgh – that was originally used to build the ships and follows on from a previous first docking period for QUEEN ELIZABETH completed at the yard in 2019. It includes all routine maintenance and repairs that cannot be done when the vessel is afloat. In addition to the scheduled dockings, Babcock will also provide facilities for any contingency dockings required over the contract's duration.

Sustaining some 300 jobs over its lifespan, the contract marks another important milestone for the Rosyth shipyard, which has seen over £100M in investment from Babcock in recent years. The facility is also the location for construction of the Royal Navy's new Type 31 INSPIRATION class frigates, for which a keel-laying ceremony for the first of the class – VENTURER – was held in late April 2022. Whilst undoubtedly good news for Rosyth, the award is, however, also indicative of the stretched nature of the infrastructure available to support the United Kingdom's carrier ambitions and, particularly, lack of funding to provide suitable docking arrangements at the ships' homeport of Portsmouth. It can hardly be optimal for the Royal Navy's most important units to have to travel to the other end of the country from their normal base to have such essential maintenance performed.

Photo: Conrad Waters

The QUEEN ELIZABETH class carriers are to be maintained in the dry dock in which they were built.

THE AMERICAS

United States: Future Plans Point to a Short Term Decline in Us Navy Fleet Strength

(cw) The US Navy's ongoing efforts to rebuild fleet strength have seemingly taken a significant short-term hit with the release of the Department of the Navy's Presidential Budget for FY2023 in March 2022 and the related Long Range Plan for Construction of Naval Vessels the following month. Plans for the wholescale and rapid withdrawal of so-called "legacy vessels" will see frontline fleet strength fall from just under 300 warships at the current time to 285 in the course of the next fiscal year and a low of 280 in FY2027. Various alternatives are presented for fleet growth in the longer term. However, even under the most optimistic assumptions, it will be more than two decades into the future before the current 355 ship target for the US Navy's battle force will be reached.

It is the planned short-term reduction in currently serving warships that has generated most headlines. The new budget envisages no fewer than 24 ships being withdrawn in the course of FY2023, 15 more than will enter service. Whilst the decommissioning of a number of these ships have been planned for a long time, the plans are notable for accelerating the withdrawal of the remaining TICONDEROGA (CG-47) class cruisers and expanding withdrawal of the almost brand new littoral combat ships to cover all the FREEDOM (LCS-1) variants that have already been delivered. The latter decision has reportedly been driven by termination of the development of the AN/SQS-62 Variable Depth Sonar (VDS) that was to form a key component of the littoral combat ships' anti-submarine module, a mission that will now no longer be performed by the type.

Photos: US Navy

TICONDEROGA (CG-47) class cruisers and FREEDOM (LCS-1) class littoral combat ships are slated for premature retirement under recently released US Navy plans.

MDM Editorial Commentary: The hard decisions taken in the latest US Navy Budget Request are seemingly intended to address problems that have been brewing for a decade or more but which have been exacerbated by the recent return to "great power" rivalry. Notably, shipbuilding budgets have been inadequate to sustain – let alone expand – US Navy fleet numbers, leading to the need to maintain vessels in service longer than initially expected at considerable short term cost. An associated issue has

Argentina: BOUCHARD Class OPV Programme Completed

(jh) The last of the four Argentinian BOUCHARD class Offshore Patrol Vessels (OPVs) acquired under a contract signed with Naval Group in 2019 has been delivered. ARA CONTRAALMIRANTE CORDERO was handed over at a ceremony at Piriou's shipyard in Concarneau on 11 April 2022 in the presence of Francisco Cafiero, Secretary for International Defence Affairs at the Argentine Ministry of Defence; Vice Admiral Enrique Antonio Traina, Deputy Chief of Staff of the Argentine Navy; and Alain Guillou, EVP International Development at Naval Group. The new vessel subsequently departed France in May for the long transatlantic crossing to her new home. The completion of the contract in line with the original schedule marks a major achievement for Naval Group and their Piriou partner given the inevitable complications caused by the pandemic.

Based on the Kership (the Naval Group/Piriou joint venture) OPV87 design, the Argentine quartet includes the former L'ADROIT (now ARA BOUCHARD) and three newly-built units. The lead ship was initially constructed as a private venture by Naval Group and subsequently loaned to the Marine Nationale to provide operational proof of the vessel's concept. Displacing around 1,650 tonnes, all the OPVs are equipped with a 360° panoramic bridge, innovative boat handling ramps and helicopter operating facilities. They incorporate Naval Group's POLARIS combat management system, which is optimised for constabulary missions. The newly-built units also feature a number of improvements over the lead vessel, including a more powerful propulsion train and active stabilisation.

Photo: Naval Group

BOUCHARD pictured whilst serving under French colours as L'ADROIT. The delivery of CONTRAALMIRANTE CORDERO in April 2022 marks the successful completion of Argentina's OPV acquisition programme.

been a question mark over whether there has been sufficient investment in the necessary infrastructure to support both construction and maintenance requirements; an issue reflected, for example, in recent delays in the once enviable record of VIRGINIA (SSN-774) submarine construction and overruns to the schedule of ship refits. The once in a generation investment needed to finance the replacement COLUMBIA (SSBN-824) class strategic submarines has caused additional financial pressure.

To a large extent, therefore, the current administration's plans reflect a pragmatic approach intended to use available resources to put naval procurement on a more sound footing. Welcome elements of this plan include maintenance of a steady "drumbeat" of VIRGINIA class submarine and BURKE (DDG-51) class destroyer construction, continued investment in shipyard infrastructure, as well as a further acceleration in research and development funding to support the next generation of

weapons. The growing risk of the need to conduct a "high intensity" war is reflected in the emphasis placed on expanding numbers of key weapons systems, including surface and underwater VLS cells, undersea torpedo numbers and naval aircraft sortie generation capacity.

Nevertheless, the new Budget Request does give rise to inevitable concerns over the care with which the navy's budget is being managed. For example, some of the TICONDEROGA class cruisers that are now slated for retirement have been subject to extensive and costly modernisation; VICKSBURG (CG-69) – slated for withdrawal in 2023 – is just about to complete a major life extension overhaul that has reportedly cost in excess of US$200M. However, perhaps most shocking is the decision to retire all the currently operational FREEDOM class littoral combat ships, a development that must also give rise to questions over the future of the remaining six units that remain under construction. The investment in these ships – and associated equipment and infrastructure – amounts to billions of dollars that will now be effectively wasted.

More broadly, the current plans seemingly reflect a "jam tomorrow; never today" approach to increasing US Navy numbers that stands at odds with the real progress that, for example, China's People's Liberation Army Navy has made over the last decades. It seems unlikely that Congress will be satisfied with this reality.

Asia-Pacific

India: Modernisation Momentum Grows as Further New Vessels are Launched

(cw) Recent months have seen further progress with the Indian Navy's often delayed modernisation programme with the launch of further vessels of three different types. First into the water was the KALVARI (SCORPÈNE) class submarine VAGSHEER, the sixth and final member of the class. The boat was floated out by Mazagon Dock Shipbuilders

Photo: Indian Ministry of Defence

The final KALVARI class submarine VAGSHEER has been floated out at Mumbai.

Ltd (MDSL) at Mumbai on 22 April, bringing a programme that was first contracted in 2005 close to its completion. Four of the boats are now in service following the commissioning of VELA towards the end of 2021 whilst fifth of class VAGIR is currently in the course of sea trials.

The following month, on 17 May, MDSL performed an unusual joint launch ceremony for the Project 15B VISAKHATAPNAM class destroyer SURAT and the Project 17A NILGIRI class frigate UDAYGIRI. The former is the fourth and final member of the Project 15B series, entering the water some seven years after the lead member of the class. NILGIRI is the second of four Project 17A frigates allocated to MDSL, which is sharing construction with east coast rival Garden Reach Shipbuilders & Engineers (GRSE). GRSE have been allocated three Project 17As, the second of which is due for launch later this year.

Whilst these developments are welcome news for the Indian Navy, it remains to be seen how quickly the new surface vessels, in particular, will enter service. The local shipbuilding sector has continued to struggle to outfit ships in a timely manner; VISAKHAPATNAM took over six years from launch until final delivery. A better industrial performance will be required if India is to have any hopes of matching the steady flow of warships that are being completed by Chinese yards.

Japan: First MOGAMI Class Frigates Commissioned

(cw) The Japan Maritime Self Defence Force's (JMSDF's) ambitions to expand the size of its surface fleet to a total of 54 frontline combatants have taken a significant step forward with the commissioning of its first two MOGAMI (FFM-1) class frigates. MOGAMI, the lead ship, was delivered at Mitsubishi Heavy Industries' Nagasaki shipyard on 28 April 2022; a month later than the commissioning ceremony for her sister KUMANO (FFM-2) at Tamano due to slight construction delays. In a reflection of the multi-mission nature of these new combatants, both have initially been assigned to the JMSDF's Mine Warfare Force, which is based at Yokosuka.

MDM Editorial Commentary: Construction of the multi-mission MOGAMI class design forms a key part of the JMSDF's efforts to grow its fleet through the introduction of compact, modular warships which are cheaper both to build and to maintain than its traditional destroyers. A total of eight of these ships have been ordered to date, with an additional two included in Japan's 2022 defence budget. Press reports state that a total class of as many as 22 ships is ultimately envisaged.

Displacing around 5,500 tonnes in full load condition (3,900 tonnes light), the new frigates are intended to perform surveillance and defensive duties in Japan's home waters. Their multi-role orientation, which includes an ability to deploy unmanned vehicles, will allow them to replace both the older surface escort vessels and the wooden-hulled minehunters that have traditionally undertaken these roles. A key design emphasis – given overall constraints on manpower – has been to reduce crewing levels through automation, with core complement being limited to as few as 90 personnel. As well as an integrated mast, the frigates are reported as introducing an innovative combat information centre that utilises a panoramic 360 degree screen incorporating augmented reality know-how.

Photos: JMSDF

Japan has taken delivery of the FFM-1 type frigates MOGAMI and KUMANO.

Japan: MQ-9B SEAGUARDIAN Selected for Japan Coast Guard

(jh) Early in April 2022, General Atomics Aeronautical Systems Inc. (GA-ASI) announced that the company's MQ-9B SeaGuardian had been selected to support the Japan Coast Guard's Remotely Piloted Aircraft Systems (RPAS) project. The selection follows a series of successful flight trials in 2020 that used SeaGuardian to validate the UAV's ability to carry out wide-area maritime surveillance in support of a range of Japan Coast Guard missions. SeaGuardian operations are expected to commence in October 2022 and will encompass search and rescue, disaster response, and maritime law enforcement assignments.

Photo: US Army

The MQ-9B SeaGuardian RPAS – derived from the MQ-9B SkyGuardian pictured here – has been selected to meet the Japan Coast Guard's wide-area maritime surveillance requirements

A member of the MQ-9 REAPER family, SeaGuardian is described as the maritime-focused sibling of the MQ-9B SkyGuardian, being adapted for naval operations by using "bolt-on/bolt-off" maritime sensors. It incorporates a multi-mode maritime surface-search radar with an Inverse Synthetic Aperture Radar (ISAR) imaging mode, an Automatic Identification System (AIS) receiver, and a high-definition-full-motion video sensor equipped with optical and infrared cameras. This sensor suite enables real-time detection and identification of surface vessels over thousands of square nautical miles and provides automatic tracking of maritime targets and correlation of AIS transmitters with radar tracks.

Africa & the Middle East

Qatar: Naval Modernisation Programme Enters the Final Strait

(cw) In a press release issued on 17 May 2022, Fincantieri announced the formal keel laying ceremony for the LPD-type amphibious transport dock being built for Qatar under the seven-ship naval expansion programme initially agreed in June 2016. Held at the group's Palermo shipyard in Sicily, the ceremony was attended by Brigadier Ahmad Al Hammadi, Head of the Project Control Office (Italy) for the Qatari Emiri Naval Forces, and Marcello Giordano and Umberto Aloi, respectively Fincantieri's Palermo Shipyard Director and its Vice President Export Programmes. Believed to be based on the Algerian KALAAT BÉNI ABBÈS – itself a derivative of the Italian SAN GIORGIO design – the new vessel will be circa 143 metres long, 21.5 metres wide and be able to accommodate a total of 550 crew and embarked personnel. It is equipped with two vehicle ramps and a floodable well deck for LCM type landing craft that can also be stowed on the garage deck and launched by means of davits. Its helicopter deck is capable of operating NH90-sized helicopters. Press reports also suggest that the new vessel will have an area air defence capability based around the MBDA ASTER surface-to-air missile system, supported by Leonardo's KRONOS radar.

MDM Editorial Commentary: The formal keel laying of Qatar's as yet unnamed LPD follows a first steel cutting ceremony held at Fincantieri's Riva Trigoso yard near Genoa in June 2021. The new vessel is the final member of the seven ship programme, which also comprises four frigate-sized AL ZUBARAH class air defence "corvettes" and two MUSHERIB class fast attack craft that are officially described as offshore patrol vessels. Two of the corvettes are now in service following the handover of DAMSAH at the end of April 2022 whilst the lead patrol vessel was delivered at the end of January. The selection of the group's Palermo yard – more usually associated with the construction of commercial vessels – for the ship's construction is an interesting one, possibly reflecting the heavy workload faced by the group's usual naval yards resulting from national and export orders. In any event, the programme's ongoing progress seemingly represents another major achievement for Fincantieri in the successful delivery of international programmes.

Photos: Fincantieri

Fincantieri has announced the formal keel laying of Qatar's new amphibious transport dock.

South Africa: Project Biro Starts to Deliver

(hum) The first tangible fruits of South Africa's naval modernisation programme were achieved in May 2022 with the delivery of SEKHUKHUNE (P1751), the lead ship of three Multi-Mission Inshore Patrol Vessels (MMIPVs) ordered under Project Biro. Constructed by Damen Shipyards Capetown, the new vessels are based on Damen's STAN PATROL 6211 design and incorporate a Sea Axe bow. Constructed with a steel hull and aluminium superstructure, they have a maximum speed of slightly in excess of 26 knots and a useful endurance of 4,000 nautical miles. Main armament comprises a SUPER SEA ROGUE remotely controlled weapons station fitted with a 20mm canon whilst the principal sensor is an RTS 3200 Frequency Modulated Continuous Wave Optronics Radar Tracker (FORT). The MMIPVs will replace the South African Navy's remaining WARRIOR class fast attack craft, which have been operating as interim patrol vessels following conversion between 2012 and 2014.

Photo: Damen

The MMIPV SEKHUKHUNE has been delivered to the South African Navy.

Late News Item

Late News: United Kingdom to Acquire a BMD Capability

(cw) On 24 May 2022, The United Kingdom's Ministry of Defence announced that the Royal Navy is to become the first European fleet to gain a detect and destroy Ballistic Missile Defence (BMD) capability. The UK has joined the Franco-Italian ASTER Block 1 missile programme and is to equip its Type 45 DARING class destroyers with ASTER 30 Block 1 missiles. An initial contract has been placed with MBDA to commence the upgrade programme, which is estimated to cost £300M when fully delivered.

The contract is based on the ASTER 30 Block 1NT (New Technology) modification launched by France and Italy in 2016 and that was initially intended for use with the SAMP/T land-based BMD system. In British service, the missiles will form part of the Royal Navy's SEA VIPER air defence system, the upgrade being the latest element of a broader SEA VIPER Evolution programme.

WATCH BILL

New French Minister of Defence

(hum) Sébastien Lecornu was appointed as the new French Minister of Defence on 20 May 2022, replacing Florence Parly in the role after her five-year tenure. Aged 35, Sébastien Lecornu is the youngest appointee to the position in recent years but has already served in a number of ministerial roles. He was Minister for France's Overseas Territories before assuming his current responsibilities and is also a reserve officer in France's gendarmerie.

The new minister will have a full inbox as he takes up his new appointment. In addition to focusing on the consolidation of the funding gains and modernisation initiatives undertaking by his predecessor, these include the need to enhance working relations between the ministry and its troops whilst increasing the overall attractiveness of the French Armed Forces as a potential career. Local media also emphasise the role of the defence minister in supporting arms exports; an endeavour that has reached a record value of €65Bn over the past five years and is regarded as crucial in securing the success of French armament programmes.

Bath Ironworks Appoints a New President

(cw) General Dynamics has appointed Gulfstream Aerospace executive Charles F Krugh as the new President of General Dynamics Bath Iron Works. A US Army veteran, Mr Krugh served in a variety of aerospace manufacturing roles before joining General Dynamics in 2011 as a Senior Vice President and General Manager for Jet Aviation. He was subsequently appointed as Gulfstream's Vice President for supplier operational support in 2018. He replaces previous President Dirk Lesko, a longstanding member of the Bath Iron Works team, who resigned unexpectedly in April 2022.

New Chairman for Terma

(jh) Carsten Dilling, who has been a member of Terma's Board of Directors for the past five years, became the new Chairman of the Board with effect from 25 May 2022. He succeeds Flemming Tomdrup, who decided to step down after 14 years' service as a member of the Board, including the last eight years as chairman. Carsten Dilling is regarded as being an experienced business leader. In addition to his position at Terma, he is also Chairman of SAS AB, NNIT A/S, MT Højgaard A/S and Icotera A/S. His appointment coincided with other senior level changes at Terma, notably the appointment of Lars Gert Lose, a former Permanent Secretary of State at the Danish Ministry of Foreign Affairs, and of Klaus Holse, former CEO of SimCorp and Vice Chairman of the Confederation of Danish Industry, to Board-level positions.

Changing of the Guard at the Top of Thyssenkrupp Marine Systems

(hum) In line with previously announced decisions, Dr Rolf Wirtz handed over the CEO position at thyssenkrupp Marine Systems (TKMS) to Oliver Burkhard on 1 May 2022. As CEO of TKMS since 2017, Dr Wirtz is credited with gradually expanding the company into a systems house, driving forward the full integration of Atlas Elektronik – of which he was previously CEO – into the business. Dr Wirtz's time in the top position was also marked by some notable contract wins, not least finalising the Norwegian-German order for six Type 212CD submarines – the largest in the company's history – in 2021. His replacement, Oliver Burkhard, has a background in labour relations, including lengthy service with the IG Metall metalworkers' trade union. He has been a member of the Executive Board and Chief Human Resources Officer of the thyssenkrupp AG parent company since 2013.

Photo: TKMS

Oliver Burkhard

Oliver Burkhard has already made some observations about the consolidation of naval shipbuilding, which he supports in both a German and European context. A first step would be the creation of a German national "champion" through the merger of NVL and/or German Naval Yards Kiel under the leadership of TKMS. TKMS is also in discussions to take over parts of MV Yards (MV Werften) following the latter's insolvency as a result of the COVID crisis.

The Sinking of the MOSKVA – an Attempt at an Analysis

Hans Uwe Mergener

All the hype surrounding the sinking of the Russian naval cruiser, already stylised as a battleship by some media, is dying down. A salvage ship, the 110-year-old KOMMUNA, has been dispatched to the site of the wreck. The Russian Defence Ministry has confirmed the loss, including casualties among the crew. Despite Moscow's acknowledgement, the causes remain largely unclear; all the more reason for us to take a closer look at the Russian operations in the Black Sea surrounding this total loss of the Black Sea Fleet's Flagship.

It should be noted in advance that it is information obtained on the basis of the scanty facts available in the public domain and by means of open reconnaissance (OSINT), supplemented by our own background experience and that of naval colleagues we have consulted, that lead us to the assessments and conclusions presented here. Reports from the Russian and Ukrainian authorities cannot be independently verified.

The Ship

The Russian guided missile cruiser Москва (Moscow in English), with hull number 121, sank on 14 April 2022. On the afternoon before, information spread that the lead ship of the Russian Black Sea Fleet had been targeted by coastal-launched missiles. The Defence Ministry in Moscow confirmed the sinking without citing a missile strike. The Russian Tass news agency reported that ammunition exploded as a result of a fire, causing severe damage. The crew was then evacuated, it added.

One of Three of the SLAVA Class

The MOSKVA was a 11,500-tonne cruiser whose construction began in the late 1970s in Mykolayiv (Ukraine) for the then Soviet Navy. Commissioned in 1982 as the SLAVA ("For Glory" in English), she was the lead ship of her class. The name SLAVA was used to designate the series by NATO. In Soviet nomenclature, she went under the designation Project 1164 or ATLANT (Atlas), while NATO also referred to her as BLACKCOM 1 (Black Sea Combatant 1) after her first appearance. Later, in 1995, SLAVA was renamed MOSKVA.

The Russian cruiser SLAVA - the future MOSKVA - in the Strait of Messina, 1984.

The ten SLAVA class units that were originally envisaged were designed as aircraft carrier killers and were to engage NATO carrier battle groups on the open sea. Their main armament consisted of 16 supersonic heavy ship-to-ship missiles of the type P-500 BAZALT and/or P-1000 VULCAN (an improved version), designated as the SS-N-12 SANDBOX by NATO. In 1986, the "Маршал Устинов" (MARSHAL USTINOV) followed as the second ship in this series of cruisers. She was assigned to the Northern Fleet and made history as the first ship of the Soviet fleet to call at a US port (Norfolk in 1989). The third ship, commissioned in 1990 as the Червона Украйна (CHEVRONA UKRAINA) and renamed the Варяг (VARYAG) in 1995, serves as the flagship of the Pacific Fleet. A fourth, unfinished SLAVA class vessel, the UKRAINA, formerly the ADMIRAL FLOTA LOBOV, still lies unfinished in Mykolayiv, Ukraine. [1]

Among the ships from the Soviet era, MOSKVA and her sisters were heavyweights. Only the KIROV class battle cruisers, the aircraft carrier ADMIRAL KUZNETZSOV and the KIEV class "through deck cruisers" surpassed their dimensions and strike power. The SLAVA class impresses with its eight forward-facing twin launchers for the SS-N-12 SANDBOX ship-to-ship missile system located on both sides of the superstructure. It also has a double-barrelled 130 mm gun, six 30 mm CIWS systems (AK-630), two short-range ship-to-air missile systems (OSA-MA or SA-N-4, GECKO, in NATO designation) with a total of 40 missiles, and eight long-range ship-to-air missile systems (S-300F FORT or SA-N-6, GRUMBLE) with 64 missiles. Ten torpedo tubes, as well as two RBU-6000 submarine missile launchers complete the armament. All this in combination with the two surveillance radar systems, the three fire control radar systems and several ESM and ECM antennae, gives the visual impression of combat power.

The SLAVA – and later MOSKVA – was the flagship of the Black Sea Fleet throughout her life. Prior to her role in the current dispute, she was deployed in military conflicts in Georgia (2008), Crimea (2014) and Syria (2015). The SLAVA even entered the world political stage at the Malta Summit in December 1989, a few weeks after the fall of the Berlin Wall. She was used as quarters for Soviet leader Mikhail Gorbachev and his delegation. The US delegation under President George H. W. Bush was based on the cruiser USS BELKNAP (CG-26). During the summit, Bush and Gorbachev announced the end of the Cold War.

Data Sheet of the MOSKVA:
Project 1164 ATLANT
Commissioned 7 February 1982 as SLAVA
Crew 476 - 529
Length 186.4 m
Displacement 11,490 tonnes (full load)
Propulsion COGOG
2 shafts + 4 gas turbines
Speed 32 knots
Range 12,000 nm
Armament 8 x 2 SS-N-12 SANDBOX / P-1000 VULCAN
8 x 8 SA-N-6 GRUMBLE / S-300F FORT
2 x 20 SA-N-4 GECKO / OSA-M
1 x 2-AK130 130mm/L70 (A-218)
6 AK-630 Gatling Gun
2 x 12 RBU 6000
2 x 5 Torpedo 533mm
Aircraft(s) 1 Helicopter KA-25/27

Events Surrounding the MOSKVA before its Sinking

The Russian Black Sea Fleet has supported the war from the sea with the use of cruise missiles. As far as is known, its operations were an important support in the attempts to take Mariupol.

Possible Landing Operations

The MOSKVA had the role of a command ship. Its other tasks included (artillery) fire support in operations on land positions, as well as long-range air protection for other surface units, especially landing units (which, as far as we know, have not yet come into action). As far as can be deduced from its armament, the cruiser was not itself necessarily involved in missile attacks on land targets. The SS-N-12 is not a cruise missile and experts confirm that land firing against land targets is only possible as an emergency procedure. It is, however, conceivable that the ship's naval artillery could have been used against land targets. The double-barrelled 130 mm mounting is said to have a range of about 25 km against surface targets. Which, in the case of supporting land operations in the Donetsk oblast, would mean navigating in the Sea of Azov.

The photo shows the IVAN GREN - lead ship of her type - during her passage in the Fehmarn Belt on 16 April 2022. Her sister ship, the PYOTR MORGUNOV, is currently in the Black Sea.

Three missions performed by the MOSKVA can be traced. On the very first day of the Russian invasion of Ukraine, on 24 February, the ship made history again with the episode around Snake Island. Escorted by the patrol ship of the Project 22160, series VASILY BYKOV, she demanded that the Ukrainian company stationed there surrender. The vulgar refusal of the defenders, transmitted by radio, now has gained philatelic significance. On 15, as well as on 30 March, she was recorded as participating in the two most important examples of attempted amphibious operations in the Odesa region (which, to date, have not yet been brought to implementation).

Initial deception operations, which occurred from 2 March onwards, were followed by the staging of amphibious demonstrations by the Russian Navy. On both 15 and 30 March, six landing ships manoeuvred south of Odesa towards the coast. However, an amphibious assault on Odesa did not materialise. One explanation for this could be that the advance by land from the Crimea was halted. Another reason for the Russian Navy's restraint could have been the danger of sea mines in the area. Furthermore, it is conceivable that the actions were intended as deceptive manoeuvres to tie down Ukrainian forces.

Be that as it may, since the beginning of the war, units of Russian naval forces have been observed from shore operating in a predictable pattern off the coast of Odesa and near Snake Island. [2]

Other Operations

It is possible that the MOSKVA was also involved in enforcing the naval blockade; attacks on her part against merchant ships are not documented. According to American information, she remained within range of the coast. Like all Russian warships, the MOSKVA returned regularly to her home port of Sevastopol. Interestingly, she docked at her usual position. However, this predictable pattern of movement did not work to her disadvantage. The behaviour of the Russian Navy could be an indicator of how safe Sevastopol is considered to be.

Ukrainian Maritime Capabilities

As of mid-March 2022, Ukraine had virtually no navy. On 3 March 2022, the HETMAN SAHAIDACHNY, a KRIVAK III class frigate, was scuttled to prevent the flagship from falling into the hands of the Russians. Some of the navy's remaining ships and boats were subsequently destroyed by the advancing Russian forces.

The missile system popularly credited with MOSKVA's destruction, the RK-360 MC NEPTUNE, was developed by the Kyiv-based defence company Luch and handed over to the Ukrainian Navy in March 2021. The system's missile, the R-360, is based on a Soviet-era development by Luch, the Ch-35 (NATO designation SS-N-25, SWITCHBLADE). According to the manufacturer, the system has a range of up to 300 km. The launch posi-

tion should not be further than 25 km from the coast. The NEPTUNE receives its initial target data from an external source. For a more precise determination of the target position, the radar belonging to the RK-360 MC NEPTUNE's command and control system is used, the relevant data being transferred to the R-360. [3] After launch, the missile uses its inertial navigation system to navigate towards the target and activates its own search radar in the final approach phase. Its detection range is given as 50 km. After successful target acquisition, the 150-kg warhead can be "brought" onto the target. The flight altitude is given by the manufacturer as 3 to 10 metres, depending on the sea state.

A NEPTUNE battery consists of four carrier vehicles with a total of 16 missiles, as well as a command vehicle that can guide a second battery.

The rumoured attack on the frigate ADMIRAL ESSEN (picture: see page 56) on 4 April may have been one of the first attempts to use the NEPTUNE system in combat.

What Might have Happened…

MOSKVA was last observed leaving Sevastopol on 10 April - with its hull number painted over. On 13 April, Ukrainian military sources reported the missile attack on the cruiser. A Pentagon press briefing on 14 April confirmed that the MOSKVA was badly damaged. It is admitted that a Ukrainian missile attack could be a possible cause. But whether the damage was due to a Ukrainian attack remains an open issue. On 15 April, Moscow confirmed that the flagship of its Black Sea fleet sank while trying to tow it to Sevastopol. It was admitted that there had been a fire and explosions of ammunition stored on board.

Accident vs. Weapons Impact

There is no reliable information about what actually happened and whether missiles hit the cruiser at all. What is certain is that both Russian and Ukrainian sources agree that there was a large fire and explosions. Pictures on social media confirm this.

Given the circumstances, it does not seem completely impossible that this was a random accident. It might sound cynical, but such disasters are not uncommon in the Russian Navy. The KURSK was lost due to the mishandling of ammunition. Admittedly, accidents also occur in Western navies. The HELGE INGSTAD is a prominent example. The German Navy has also suffered accidents with missiles. In the early years of the missile-armed fast boat flotilla, a container fire of an MM 38 EXOCET occurred. In June 2018, a STANDARD MISSILE-2 burnt out after ignition in its vertical launch container on board the SACHSEN. In both cases, handling of the ammunition was not the cause of the accidents.

However, analysts claim to have found metal bulges emanating from the inside out at suspected impact points on the MOSKVA's hull. This could support the theory of one or two missile hits. A mine hit seems unlikely. Since the damage is above the waterline, a torpedo is also out of the question.

Photo: UKRINFORM

Photo taken during the handover of the prototypes of the RK-360 MC NEPTUNE mobile missile system to the Ukrainian Naval Forces in March 2021.

Based on this, it seems plausible that one or two NEPTUNE/R-360s are the cause of the fires on board the MOSKVA. A total of 300 kg of explosives can make a considerable difference. In the Falklands War, the Royal Navy lost two vessels to the EXOCET AM 39 missile, which – at just over 40 kg – delivers a much smaller charge to the target. Ultimately, it was not the detonation of the warheads that led to the loss of HMS SHEFFIELD, a Type 42 destroyer, and the ATLANTIC CONVEYOR, a large supporting container ship, but the secondary effects. In the case of the MOSKVA, the detonations possibly led to fires in the ammunition chamber(s) in the midships area, as well as in the magazine of the S-300 F missiles behind the ship's funnels.

There is also speculation about the origin of the target data for the suspected NEPTUNE strike and, in particular, whether it could have come from a drone or from third parties. ISR (Intelligence, Surveillance and Reconnaissance) aircraft from various NATO countries are repeatedly observed over the Black Sea. According to Ukrainian sources, the attack on the MOSKVA was supported by a BAYRAKTAR unmanned aerial vehicle manufactured in Turkey. Allegedly, this was to make radar detection of the incoming missiles more difficult, in other words, to deceive. The BAYRAKTAR could just as well have been used to provide the 'initial' targeting information. To what extent the new MINERAL coastal radar system might have contributed to the strike remains uncertain.

Possible Sequence of Events

There is different information about the weather conditions at the time of the event. On the one hand, it is assumed that they were not exactly favourable for incoming missile identification at Sea State, level 3. Other sources take a more moderate view. The photograph of the burning MOSKVA taken the following day suggests that the weather conditions were just about "manageable" for a cruiser.

Weather conditions, especially the sea state, influence the probability of detecting low-lying targets. Wave heights and rain can cause interference on radars, which affects the ability to detect sea-skimming missiles, i.e. flying at a very low altitude above the water surface, at a sufficient distance from one's own ship.

Tactical calculation is required to disable a warship like the MOSKVA. The tactical operational principles of the German

Navy's speedboat flotilla of the Cold War era provided for two missiles hitting a landing ship for a so-called "mission kill", which was the declared object of operations during the Cold War. "Mission kill" describes the state in which the enemy is no longer capable of further operations, i.e. incapable of fighting. To achieve this, several missiles, ideally launched from different directions, were required. The tactical formation of a unit was chosen accordingly. The required number of missile hits varied depending on the type of ship and was calculated according to a formula laid down in an Allied regulation classified at the time. For the layout of the battle and the number of missiles to be used, other factors were taken into consideration in addition to size in the fast-attack flotilla, for example the enemy's capabilities for missile defence by means of electronic measures, chaff, ship-to-air missiles, and artillery.

In the case of the MOSKVA, around five to six hits would be regarded as being necessary to put the ship out of action and temporarily prevent it from future operations. It can be assumed that Ukraine was aware of these principles. Based on this, it can also be assumed that the Ukrainians fired either eight or sixteen missiles – precisely correlating to either half of or a total missile battery belonging to a NEPTUNE system. The number of missiles, and also their possible approach via certain waypoints, served to saturate the situational picture of the MOSKVA in order to achieve the expected hit effect.

So much for the case of shooting according to operational principles. Of course, it is also conceivable that fewer R-360s left the launch containers - to the point that only two were actually fired and found their target. In other words, they were "lucky shots".

Alternatively, it is quite possible that the MOSKVA was able to repel all but two of the approaching missiles. The VOLNA 3R41, "TOP DOME" fire control radar, which is "responsible" for long-range air defence, can simultaneously engage two to three approaching missiles. To do this, it is capable of directing two (other sources speak of three) 5V55RM, S-300 F FORT (SA-N-6 GRUMBLE) missiles against each target. In addition, for missile and anti-aircraft defence, the SLAVA class has at its disposal other radar and weapon systems that enable a layered defence.

However, some experts are not convinced of the Russian Navy's capabilities, especially on board older vessels, to defend against modern missiles. Apart from the performance of the radar systems, possibly hampered by less than optimal weather conditions, target detection also depends to a large extent on display capabilities. Small screens with low resolution make determination of small, fast targets difficult. Moreover, to what extent some form of automation of target recognition-weapon assignment-combat was achieved on the SLAVA class units is not known. The prospects of engagement improve with higher technological standards and/or with increasing automation. In relation to a R-360, a realistic detection distance of 6 km leaves a reaction time of 21 seconds. This is sufficient time for a crew trained to Western standards. However, under the technological conditions prevailing on Soviet units of this generation, the chances of detecting a missile approaching just above the water surface at a speed of more than 1,000 km/h appear to the author to be low.

Be that as it may, it seems that two missiles achieved their fatal effect. They hit. The resulting fires, possibly also aided by the detonation of ammunition, did the rest. Currently, there is no real confirmation of what happened.

Source: State Design Bureau Luch, Kiev

РАКЕТА Р-360

Призначена для ураження бойових кораблів класів крейсер, есмінець, фрегат, корвет, десантних, танкодесантних кораблів та транспортів, які діють як самостійно, так і в складі корабельних груп, і десантних загонів, та берегових радіо-контрастних цілей в простих і складних метеорологічних умовах, у будь-який час доби, при активній радіоелектронній протидії противника.

ОСНОВНІ ТАКТИКО-ТЕХНІЧНІ ХАРАКТЕРИСТИКИ Р-360

Маса ракети в контейнері, кг	до 870
Маса бойової частини, кг	150
Діаметр ракети, мм	420
Максимальна дальність, км	до 300

АП «ДЕРЖАВНЕ КИЇВСЬКЕ КОНСТРУКТОРСЬКЕ БЮРО «ЛУЧ»
РАКЕТНИЙ КОМПЛЕКС 3М6МЦ «НЕПТУН»

07

The R-360 missile used with the NEPTUNE coastal defence system.

Why did the MOSKVA sink?

It can be assumed that in the event of a fire, the catastrophic extent of which can be seen from the available photos, the power supply on board failed quite quickly. This largely deprived the crew of the possibility to limit the damage and to take targeted fire and leakage prevention measures. There is no evidence of the existence of autonomous generators and pumps. Photographs taken on 14 April give the impression that the ship had been abandoned. The boats are no longer on the upper deck and the port side life rafts are no longer present. The helicopter hangar is open. Towing the ship to safety, as announced by Moscow, could not be completed. The ship sank. Contrary to what the Russian agency Tass portrayed, heavy weather was hardly the cause of the sinking. German meteorologist Karsten Schwanke tweeted on 14 April: "There was no storm in the area between Odesa and Sevastopol today. Wind force 4 on average, gusts up to 6 Beaufort."

Although badly damaged, the total loss of the MOSKVA is a mystery. It suggests that the crew's damage control efforts may not have been optimal. Was it abandoned too soon? This question is at least still open.

Ship design also plays a role in a ship's ability to survive damage. American analyses point to the lack of smoke and watertight compartments and separate damage control zones in Russian warship construction. To what extent this is true remains to be seen. Certainly, the photographs that have become known support the frequently expressed assumption that one or more explosions in the area of the SS-N-16 launchers could have contributed to the disaster. In view of the damage in the area of the large aft deckhouse, which carries the TOP PAIR, VOSKHOD MR-8003-D search radar, and the smoke and fire still visible there after a day, it seems reasonable to assume that this may be one of the main causes.

It seems certain that the design of Russian warships does not meet Western standards in terms of ship safety. According to the author's recollection, fire extinguishing and water ingress defence devices are not as obvious as in units of the German Navy, to give just one example.

Another reason could be the Russian Navy's personnel structure. Russian crews do not have a balanced non-commissioned officer corps. Middle-ranking specialists with years of experience bring the necessary expertise and routine that are required in daily service, but especially in dangerous situations. Consequently, the achievement of ship security in the Russian fleet may be organised quite differently to that in Western navies.

Ultimately, a combat service's organisation and its level of training will play a decisive role. Especially in a conscript navy like the Russian one, training and constant practice are important. If this is approached with a lack of motivation and/or professionalism on the part of superiors, deficits are inherent in the system. The Russian Navy is also known to have decentralised procedures, especially in command and weapons deployment, as well as in ship security and damage control. Unlike in Western navies, the different command and weapon deployment systems are managed in separate organisational cells, the so-called "cabinets". This can lead to differences in situational assessment between the different units and, thus, have a negative influence on response capability. There is a lack of a unifying and coordinating structure. In addition, the chain of command is more accentuated than in Western armed forces. Finally, it is possible that a certain complacency prevailed, since nothing significant had taken place after 48 days of war. Lax handling of readiness conditions could have resulted in the crew not being at the "right" battle stations. Possibly it was a combination of all these factors – set in motion by an element of luck in a Ukrainian strike – that resulted in the ship's loss. [4]

Whatever the reasons, the leadership of the Black Sea Fleet should certainly have been aware of the threat posed by the coastal missile systems. Why the flagship of the Black Sea Fleet was in the area where she was lost will remain one of the mysteries that will occupy later historians. Perhaps the suspicion will be confirmed that the incident is part of a chain of inadequate reconnaissance by the Russian Armed Forces. And that the Black Sea naval command lost sight of the condition and deployment of Ukrainian coastal missile capabilities, or did not even take them into account.

Consequences

With the sinking of the MOSKVA, the Black Sea Fleet lost its lead unit and a valuable air defence platform. The sinking of the flagship named after the Russian capital means more than just the loss of a military object. It is a symbolic defeat that Russian state propaganda finds difficult to explain.

At the request of MDM, Johannes Peters from the Institute for Security Policy at Kiel University commented: "In addition to the hardly compensable military weakening of his Black Sea fleet, the loss of the ship is also symbolically a catastrophe for Putin. The SLAVA class ships are icons and have been a central part of the domestic narrative of a powerful navy with global standing for decades. How does one explain the loss of the flagship of the tradition-steeped Black Sea fleet during a "special military operation" that was supposedly going according to plan? Add to this the name - Ukraine has not only avenged the defenders of Snake Island, who were posthumously declared heroes, but literally sunk Moscow."

Certainly, the stationing of the MOSKVA in the Black Sea seems to be as much a question of prestige as of operational value, precisely because of the meaning associated with the name. "Moscow has put its prestige on the line and lost prestige with it," a Pentagon analyst noted.

Practically, however, since the invasion of Ukraine, Russia has now lost two important naval units. The first was the Russian ALLIGATOR class landing ship SARATOV on 24 March. "Both events are likely to cause Russia to reconsider its maritime posture in the Black Sea," commented the UK's Ministry of Defence.

Russia now faces the dilemma of not being able to provide replacements or additional forces. Since Turkey has closed the Bosphorus, there is no possibility of replacing the MOSKVA with one of its two sister ships. Moreover, the Russian Navy's surface units will be forced to operate further away from the coast. Thus, they will have less influence on operations on land. The very assumption that there are missile sites on the coast increases the risk in an amphibious operation. With the change in behaviour that can be observed, NEPTUNE is indirectly confirmed as the cause for the loss of the MOSKVA.

While in the short term there is increasing pressure within the Russian Armed Forces' leadership to rethink their current operational approach, the case may also have consequences for the longer term naval armament and operations of the Russian Federation, and beyond. Vessels the size of the MOSKVA are not suitable for warfare in littoral seas. The US Navy has a saying: "Don't give a cruiser a task for which a frigate is sufficient!" Smaller units with powerful and long-range armament could see a resurgence. This is already, ironically, a path that the Russian Navy has been taking for some time.

Finally, the event could also trigger other international reactions. The destruction of tanks, armoured personnel carriers and helicopters by Ukrainian defenders allowed the global public to observe that the cost-benefit effect of missiles for defending armed forces is high. Reflections on the performance of naval air defence systems and the resulting operational consequences, as well as on the importance of effective on-board damage control – both in terms of infrastructure and training, organisation and operation – may gain momentum. Coastal missile emplacements may be given a broader scope in armament planning than before.

Photo: MoD Russia

The burning MOSKVA. Two pockets of fire can be seen in the forward deckhouse. The photo was taken from one of the two NIKOLAY MURU rescue tugs (Project 22870). A second rescue vessel lies alongside on the starboard side of the MOSKVA cooling it with its water cannons.

Epilogue

The wreck of the MOSKVA has been classified as a national underwater cultural heritage site. This decision was announced by the Ukrainian Ministry of Defence on Facebook on 21 April, reporting the registration number 2064. The position of the wreck, derived from a British expert on Open Source Intelligence (H I Sutton), is 45 degrees 7 minutes 28.308 seconds North, 31 degrees 33 minutes 36.432 seconds East (45 degrees 7.471 minutes North, 31 degrees 33.607 minutes East), about 155 km south-southeast of Odesa and about 80 km southwest of Cape Tarkhankut in Crimea, about 160 km northwest of Sevastopol. In contrast, the Ukrainian news portal Defense Express locates the position of the wreck with "the approximate coordinates 44 degrees 56 minutes north, 31 degrees 44 minutes east"; a little closer to the mainland of Crimea. The water depths in this sea area are 50 to 60 metres.

The last observation of the MOSKVA was on 13 April at position 45 degrees 10 minutes 43.39 seconds North, 30 degrees 55 minutes 30.54 seconds East. This position is almost 30 nautical miles northwest of the wreck. From which it can be concluded that a tow was indeed attempted until the ship sank.

On 21 April, the website of the Ukrainian Mezha-Media reported conspicuous activity around the site of the sinking, including rescue and dive boats from the Black Sea Fleet. Presumably, this is related to attempts to locate the wreck and mark its position for later action.

Around 22 April, a salvage ship was reportedly dispatched from Sevastopol. The KOMMUNA (Коммуна) was laid down in 1912 and launched as a submarine salvage ship in St. Petersburg in 1913. The catamaran is capable of carrying mini-submarines between its hulls. One such deep-diving submarine, a deep-diving rescue boat AS-28, has already been used with or by her. These PRIZ class deep submersibles, of the Project 1855 type, weigh 55 tonnes and are capable of reaching depths of 1,000 m. According to reports, the KOMMUNA will be used to recover weapons and other sensitive material, such as telecommunications and encryption equipment. So far – as of the end of April – the ship has not been observed at the suspected wreck site.

Quite quickly after the sinking, suspicions made the rounds that the ship's P-1000 VULCAN/SS-N-12 might be nuclear-tipped. The P-1000 VULCAN can be equipped either with a conventional warhead of 1,000 kg or a nuclear one with an explosive force of 350 kilotons. Which of the two versions was on board the MOSKVA is currently unknown and subject to speculation. The Pentagon doubts the nuclear armament theory.

In addition to speculation about the sinking and its causes, the ill-fated ship is also the object of scandal. It has been reported that the ship had a valuable religious relic, a piece of the "true cross" on board. The political treatment of the case by Moscow appears in an even more outlandish light, according to the Financial Times. According to this paper, the Russian president is said to have seriously considered a peace agreement with Ukraine as a result of the military setbacks that had become known to him. But after the sinking of the MOSKVA, he refrained from doing so. ■

Photo: George Chernilevsky via Wikipedia

The KOMMUNA rescue ship-catamaran was constructed in 1911-1913 and launched in 1913. The ship has been in service by the Russian, Soviet and now Russian Navy since 1915. It is Russia`s oldest Navy ship. The photo was taken in Sevastopol harbor in Ukraine. The KOMMUNA was deployed from Sevastopol to the area of the sunken MOSKVA.

Notes

1. The sister ships MARSHAL USTINOV of the Northern Fleet and VARYAG of the Pacific Fleet were ordered to the Mediterranean during the preparatory phase of Moscow's invasion of Ukraine, where they are currently still located.
2. It should be mentioned here that Moscow had transferred landing units from the Northern and Baltic Fleets to the Black Sea before the outbreak of hostilities. As reported, five ROPUCHA class landing ships and the PYOTR MORGUNOV, a modern IVAN GREN class landing ship, arrived in Sevastopol on 10 February. Three of the ROPUCHAS were from the Baltic Fleet; the other three 'amphibians' were detached from the Northern Fleet. Their departure took place on 15 January - if you like, that was the maritime prelude to the invasion of Ukraine. The 6,000 tonne IVAN GREN class ships can carry 380 marines with 36 infantry fighting vehicles or 13 main battle tanks and two shipboard helicopters (Ka-29 or Ka-52K). The smaller ROPUCHAs are capable of carrying 340 men with three main battle tanks or 12 infantry fighting vehicles. After the loss of the SARATOV, the Russian armed forces command in the Black Sea had about ten operationally capable large amphibious units at its disposal. With this comes the ability to commit over 3,800 men, more than 180 armoured personnel carriers and/or more than 50 battle tanks.
3. It is known that Ukraine has been experimenting with a mobile coastal radar system called MINERAL, which has a range of up to 600 km. It is a further development of the Band Stand installed on the TARANTUL III/III MOD class corvettes and should have been operational as early as 2021. According to reports, the contracted company was unable to deliver the chassis for the carrier vehicles on time, resulting in a delay.
4. The loss of capital warships due to arrogance, bumbling and sloppiness, a lack of ship security and incompetent superiors has a certain tradition in the Black Sea Fleet. In 1916, the IMPERATRITSA MARIYA, a newly built battleship, exploded in the harbour of Sevastopol. Subsequently, in 1955, the former Italian battleship NOVOROSSIYSK, also sank in Sevastopol. The battleship, which had only been in service for six years, capsized as a result of an explosion, the cause of which is still disputed today. Due to misjudgments on the part of the Navy and the ship's command, more than 600 Russian sailors lost their lives. The disaster was kept secret until the 1980s.

Indian Ocean Rivalries: China and India in the Indian Ocean

Peter Layton

China is a one-ocean country with a two ocean posture. In the Pacific, the People's Liberation Army Navy (PLAN) focuses on defending the country's East Asian seaboard at ever increasing distances from the coast. In the Indian Ocean, the driver is quite different.

Here the PLAN's flag is following China's trade, a reversal of the old maritime dictum of trade following in the wake of a nation's warships to regions those ships have made safe.

This policy emerged in December 2008 when three PLAN warships were dispatched to the Indian Ocean to conduct counter-piracy patrols in its north-western corner. This was the first time in modern history that China's navy had conducted operations outside its territorial waters. Unlike the other navies involved, the PLAN joined neither of the two international task forces then coordinating UN counter-piracy operations. Instead, the PLAN undertook independent convoy operations, primarily protecting Chinese merchant ships although other nations' vessels could also join. Of interest, the PLAN then would also escort Taiwanese cargo ships, as these were considered Chinese and so deserving of PLAN protection.

At the time, the PLAN's involvement was seen as a positive step towards China becoming a constructive member of the world community. This view has progressively altered since President Xi Jinping came to power in 2013. China's new diplomatic assertiveness, its adoption of grey zone coercion techniques and its tremendous naval shipbuilding programme have all created a sense of foreboding in many Indian Ocean countries. India, the ocean's resident great power, considers itself the guardian of the ocean and is becoming increasingly concerned. This apprehension is only being magnified by China's growing military aggressiveness on India's northern border.

Photo: NATO

A PLAN Type 054A JIANGKAI II class multi-role frigate at Oman's Salalah Port whilst deployed as part of China's ongoing presence in the Indian Ocean.

The PLAN in the Indian Ocean

The most discussed Chinese trade driver is oil imports. The country imports some 75 percent of the oil it consumes and has become the world's largest crude oil importer. More than three quarters of China's imports transit through the Indian Ocean and into the Pacific through the Malacca Strait in the east. Of note though, some 25 percent of China's oil needs comes from its own proven oil reserves, while the country also has significant stockholdings. In extremis, China could function for some years if oil imports suddenly ceased.

Even so, the Indian Ocean would still matter to China. Almost all of China's sizeable merchandise trade with the Middle East, Africa, and Europe passes through the Indian Ocean. Moreover, China has sizeable investments in numerous Indian Ocean countries, many made as part of Xi Jinping's signature Belt and Road Initiative that funds and builds large transportation infrastructure. Such interest means many regional countries now also have a growing Chinese expatriate community.

Taking these various factors into account, China's area of most concern is the northern Indian Ocean, running from the Malacca Strait westwards across the ocean – and including Pakistan – to the Middle East and North Africa. The Sea Lines of Communication (SLOC) in this sizeable maritime area along which China's inwards and outwards trade flows is both distant to China and effectively controlled by other states. For any modern blue water navy, being able to protect such SLOCs in time of tension or war would be considered important. However, four factors currently constrain the PLAN from achieving such an aspiration.

First, the PLAN has only a relatively small presence in the Indian Ocean. There are generally only two warships and a support vessel deployed, mostly to the Gulf of Aden. The current Indian Ocean deployment cycle typically involves a Type 052D LUYANG III class guided missile destroyer (broadly similar to an early-build US Navy

Author

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Photo: US Navy

Chinese Indian Ocean deployments are usually led by a destroyer of the Type 052D LUYANG III class or the slightly older Type 052C LUYANG II variant, pictured here.

ARLEIGH BURKE (DDG-51) class destroyer), a Type 054A JIANGKAI II class multi-role frigate (broadly similar to a Royal Navy Type 23 frigate) and a Type 903/903A FUCHI class replenishment ship (broadly similar to a German Navy BERLIN class replenishment vessel). [1] Such naval task groups are dispatched for five to six months, aiming to overlap with the previous deployment so three vessels are always available in the Gulf of Aden. By the end of November 2021, the PLAN had completed more than 1,450 counter-piracy escort missions and gained considerable experience and expertise in conducting such distant naval operations.

Second, the deployed warships usually operate unsupported by other PLAN assets such as aircraft, land-based missiles or submarines. Their protection is limited to their onboard systems. This could be insufficient to ensure survival in a major conflict given the considerable distance from China and the passage home requiring transit through narrow, possibly hostile, straits. This vulnerability persists even though the defensive capacity of the Chinese warships deployed has markedly improved in recent years; for example the LUYANG III class destroyers have 64 Vertical Launch System (VLS) cells, mostly for air defence missile use.

Third, the PLAN has only a small number of replenishment ships capable of supporting Indian Ocean operations. There are only around ten Type 903/ Type 903A FUCHI class supply ships and just two of the newer and much larger Type 901 FUYU class fast combat support ships in service. In the counter-piracy deployments a single FUCHI can only support the escort patrol vessels for approximately two weeks before itself sailing to a nearby port for replenishment. In 2017, the complications that can arise during these distant Indian Ocean deployments were highlighted. A LUYANG III class destroyer – CHANGSHA (173) – broke down while transiting to join a Russian Navy exercise in the Baltic Sea. This required her recovery and subsequent replacement by sister ship HEFEI (174).

Finally, the PLAN only has limited Indian Ocean support infrastructure. The combination of having few replenishment ships and the considerable distance from China, has forced the PLAN to adopt a support model built around an overseas naval base, supplemented by commercial facilities as necessary.

PLAN Base Infrastructure

In mid-2017, the PLAN opened a naval logistics facility in Djibouti, after some decades of asserting such bases were a mark of imperialism. Justifying this change, the official statement argued the base was needed for missions "…such as escorting, peacekeeping and humanitarian aid in Africa and West Asia [as well as] military cooperation, joint exercises, evacuating and protecting overseas Chinese and emergency rescue."

Djibouti is in a strategically important location on the Bab-el-Mandeb Strait, at the approaches to the Red Sea and the Suez Canal, and adjacent to the Gulf of Aden. The PLAN's base today houses some 1,500 personnel, delivers maintenance support for ships and their onboard helicopters, and includes a base hospital together with storage for fuel, weapons, and equipment. A large, 330 metre, dual side pier has been built able to accommodate multiple PLAN vessels including ships of aircraft carrier and large amphibious ship size and draught. In addition, at the neighbouring Doraleh Multipurpose Port – controversially controlled by China Merchants Port Holdings – one of the six deep-draught berths has been reserved for PLAN use. The base also has a heliport with eight hangars, a short 400-metre runway and an air traffic control facility allowing light aircraft and unmanned air vehicle operations. Base security is provided by a battalion-sized PLAN Marine Corps unit equipped with eight-wheeled armoured ZBL-08 infantry fighting vehicles and ZTL-11 armed assault vehicles.

The PLAN base is adjacent to American, French, Italian and Japanese military bases of varying sizes and capabilities. Like the PLAN base, all are leased; the total annual base payments reportedly make up 5% of Djibouti's annual GDP.

Beyond Djibouti, the PLAN can get some support in Pakistan, with Gwadar in Western Pakistan often touted as a future PLAN naval base in the style of Djibouti. Gwadar port is being developed as the terminus of the US$60Bn China-Pakistan Economic

Photo: Conrad Waters

A Type 903 FUCHI class replenishment ship. Lack of logistic support capacity is a constraint on China's Indian Ocean presence.

Corridor project, the flagship project of China's Belt and Road Initiative. Unlike Djibouti however, security is a major problem forcing China to financially support the Pakistani Navy's recently formed Task Force 88. Charged with defending Gwadar against conventional and non-traditional threats, the task force includes two frigates, some fast attack craft, manned and unmanned aircraft, and maritime surveillance assets.

Commentators have long argued that the PLAN in the Indian Ocean could draw on so-called "string of pearls" ports. There are several commercial ports in the Indian Ocean built and operated by Chinese state-owned enterprises that may be obliged by their home-government to help the PLAN if requested. Such ports include Colombo and Hambantota in Sri Lanka, Port Klang in Malaysia and Khalifa in the UAE. It's also conceivable, that the large Chinese investments in the Seychelles, Maldives, Mauritius, Kenya, Tanzania, Mozambique and Myanmar may make these countries vulnerable to Chinese pressure for their ports also to support the PLAN if necessary. Local domestic political factors though could always outweigh any such future Chinese pressure and, accordingly, create real uncertainty for the PLAN. The PLAN therefore can't realistically plan to rely on such "string of pearls" ports and they seem an unreliable foundation for Chinese long-term strategic policy.

Photo: US Navy

India views the ongoing Chinese naval presence with concern and is adopting counter strategies accordingly. This is the frigate TEG during the course of an Indian Ocean deployment.

The Indian Response

PLAN activities in the Indian Ocean are currently meagre but, with the PLAN now the world's largest navy and having significant experience in the area, it possesses considerable ability to surge. India has taken notice, adopting counter-strategies accordingly.

India has proclaimed itself the net security provider for the Indian Ocean region. This involves cooperating with friendly nations to make the region more prosperous, including through improved maritime security. As part of this strategy, India aims to be the first responder in a crisis. India now regularly conducts Humanitarian And Disaster Relief (HADR) exercises with its Indian Ocean neighbours, deepening HADR cooperation and coordination, sharing its expertise and building local capabilities. This is a strategy of building friends across the Indian Ocean who can then be relied upon to provide Indian naval and air deployments with access and support.

Two aspects of this strategy of interest are mission-based deployments and maritime domain awareness. The former involves year-round patrols by designated Indian Navy warships in seven high priority zones: the Gulf of Aden, the northern Arabian Sea, Lakshadweep and the Maldives, the Seychelles and Mauritius EEZs, the northern Bay of Bengal, the Andaman and Nicobar Islands, and the Malacca Strait. Each warship patrols for some three months before being replaced. The warships are further supported by P-8I maritime patrol aircraft that fly almost daily surveillance sorties from INS RAJALI in Tamil Nadu.

Under the mission-based deployment concept, each warship carries several HADR "bricks" to allow a quick reaction to natural disasters in the zone they are patrolling. The bricks are organised into those that have a long shelf life, such as electric generators, tents, communication equipment, clothing and medical supplies, and those having a short shelf life like dry food, perishable items and drinking water. Perishable bricks containing food items are constructed based on the numbers of individuals to be fed, for example 100, 500 or 1,000 people.

Outside of rare HADR events, the warships have the operational flexibility to participate in other activities, including escorting merchant ships working for the UN's World Food Programme, participating in regional bilateral naval exercises and undertaking capacity building initiatives with local partners. Overall, this is a very significant commitment of Indian Navy resources to naval diplomacy tasks but has raised India's regional standing, while providing it with increased maritime domain awareness.

The 2008 Mumbai terror attacks launched from the sea highlighted the need for India to have much improved maritime domain awareness. To provide this, the Information Management and Analysis Centre (IMAC) was established at Gurugram Air Force Station. Jointly operated by the Indi-

Photo:Boeing

Indian's Boeing P-8I maritime patrol aircraft are an integral part of its efforts to improve maritime domain awareness across the Indian Ocean.

Photo: US Navy

Indian warships on exercises with the US Navy aircraft carrier RONALD REAGAN (CVN-76) in mid-2021. Indian diplomatic support for attempts to force the United States out of its critically important Diego Garcia base facilities threaten to undermine this cooperation.

an Navy and Coast Guard, IMAC generates a common operational picture by fusing data from coastal radars, "White Shipping" agreements, Automatic Identification System transponders fitted on commercial vessels, air and ship traffic management systems and global shipping databases. [2] Work is underway with France on adding space-based sensors.

The IMAC has now become a regional information coordination body, working with more than 20 partner countries and many multi-national agencies. Coastal radars in Mauritius, Seychelles and Sri Lanka feed in data, with plans underway to include the Maldives and Myanmar, and discussions ongoing with Bangladesh and Thailand. Future integration with Singapore's Information Fusion Centre and Madagascar's Regional Maritime Information Fusion Centre will pave the way for wide-area, Indian Ocean maritime domain awareness. The centre also has naval liaison officers from the US, France, the UK, Australia, Japan, Singapore and the Seychelles, with more nations seeking inclusion. All this builds an Indian Ocean sense of community, positions India as the regional leader and, not unintentionally, disadvantages China diplomatically and militarily.

The net security provider strategy has been well thought through and resourced. In contrast, there is considerable vagueness about Indian strategy should a major conflict with China occur. Strategies canvassed include SLOC interdiction, sea control, and sea denial but none are presently dominating debates. India, as the seventh largest navy globally and with more than 130 ships and submarines, has numerous possible warfighting options. Strategic ambiguity can have advantages but does detract from deterrence and in this case might unintentionally encourage some future Chinese adventurism, including on India's Himalayan border. India making its warfighting strategy explicit may deter, not provoke, conflict.

More certain is the role of the Andaman and Nicobar Islands at the strategically important western entrance to the Malacca Straits. The islands form an 'unsinkable aircraft carrier', able to be used as India's forward outpost for staging combat operations to prevent hostile powers entering the Indian Ocean from that direction. History influences this Indian thinking. The islands were occupied by the Japanese during World War Two and used to support naval raids by surface ships and submarines deep into the northern Indian Ocean.

There is now a minor Indian military infrastructure building boom underway in the Andaman and Nicobar Islands, particularly in the construction of airfields to support Indian Air Force fast jet operations. For maritime strike missions, the air force has fitted 120 km range, subsonic Harpoon missiles to its JAGUAR strike aircraft and the Mach 2.8, 300 km range BrahMos missile to its Su-30MKI fighters. Working with the Indian Navy's P-8Is, these aircraft would be a formidable threat to any opposing navy's surface ships.

Looking Forward

The PLAN looks set to continue addressing the current capability shortcomings of its small Indian Ocean fleet. In the next few years, China will probably include one of its new Type 055 RENHAI class guided-missile cruisers in its counter-piracy patrols. These impressive 12,500 tonne ships are heavily armed and have some 112 VLS cells and will probably be used in the Indian Ocean just as the LUYANG III class destroyers are now. Towards the end of the decade the PLAN is anticipated to begin deploying Type 003 aircraft carriers. At about 100,000 tonnes, fitted with catapults and employing conventional fast jets these will allow much more ambitious PLAN operations. This might include large joint exercises, challenging expatriate evacuations, amphibious assaults and possibly even the coercion of smaller Indian Ocean nations.

Even so, in a major conflict, PLAN forces in the Indian Ocean would remain quite vulnerable. They would need to leave the Indian Ocean quickly or, if this option was impossible, sail to Gwadar, where they could undertake a useful fleet-in-being role while protected by Pakistani forces. Less obviously, PLAN ships operating in the more northerly parts of the Indian Ocean could also be supported by land-based, long-range H-6K bombers armed with anti-ship standoff missiles or even by DF-26 intermediate range ballistic missile units with anti-ship versions of the weapon.

Similarly, India will continue on incremental, and bureaucratically slow, improvements to its force structure. In that regard, its recent decision to lease for a third time a Russian Navy nuclear-powered attack submarine (an AKULA class boat), together with talk of this possibly being joined by a second leased boat later, highlights Indian desires to retain strategic options beyond an over-reliance on the United States. This split personality is evident in India throwing its political weight behind attempts to force the United States out of its critically important Diego Garcia naval base. While driven by memories of decolonisation, if India succeeded it would both damage India's standing with the Americans and weaken its strategic position in the Indian Ocean vis-à-vis China.

Of more utility, India is now building robust links with Madagascar as part of countering growing Chinese interests in countries bordering the busy Mozambique shipping channel. India is also building military infrastructure in the Seychelles and on North Agalega, an island some 1,100 kms north of Mauritius. On North Agalega, India is creating a mini-Diego Garcia with a port, barracks, a jetty and a 3,000 metre runway.

For the foreseeable future, the PLAN will continue to follow Chinese trade as this grows in most Indian Ocean nations. Similarly, India will continue to work on building a network of reliable partners and friends across the same region as a counter-strategy. In some respects, China has the initiative and could intensify or reduce Indian concerns and its naval arms build-up as China wished. China's presence, though, has had a deeper, long-lasting impact in forcing India to 'discover' the Indian Ocean. The ocean now looms large in Indian strategic thinking, a development with significant implications for all Indian Ocean countries. ■

Note

1. NATO reporting names are used for PLAN vessel classes.
2. A White Shipping agreement refers to the exchange of prior information on the movement and identity of commercial non-military merchant vessels.

Status Report: The Royal Netherlands Navy

A Larger Budget, but the Dutch Navy is facing Difficult Times

Jamie Karremann

Photo: DMO

Artist impression of the ASW frigate 2020. Discussions are currently taking place to revise the design.

The budget of the Dutch armed forces will be increased considerably in the coming years. Nevertheless, there are difficult times ahead for the Royal Netherlands Navy (RNLN). The RNLN has seen budget cuts for decades and the consequences will be felt for another ten years. In September 2021, the outgoing Dutch cabinet decided to increase the defence budget by €185M to €12.5Bn. A few months later, an increase of €3Bn was included in the coalition agreement of the new cabinet, which would bring the Netherlands' defence spending to between 1.88 and 1.91 percent of GDP in 2024 – depending which data and approach one uses. However, that was still less than the €4.5Bn that, according to the previous Minister of Defence, was needed to keep the Dutch armed forces afloat.

After the start of the war in Ukraine, there was more support for a further increase in the budget. At the end of March, the Dutch press reported that the Dutch government still wants to elevate the defence budget to 2 percent, as the Netherlands had promised to NATO in 2014. This will require an additional increase of approximately €3Bn.

Photo: Dutch MOD

An ESSM block 1 missile launched by DE ZEVEN PROVINCIËN, one of the four LCFs.

At the cut-off date for this publication, the exact amount was unknown. And how it will be spent has not yet been made public either. The Defence White Paper will answer these questions. That document is expected before the beginning of the summer.

Cutbacks and Delay

Despite additional investment and replacement programmes, the situation of the Royal Netherlands Navy is worrying. Due to budget cuts, several replacement programmes have been delayed. This will affect the Dutch fleet in the 2030s.

This is particularly noticeable with respect to the replacement of the four WALRUS class submarines and the update of DE ZEVEN PROVINCIËN Air Defence and Command Frigates (LCFs).

The replacement of the submarines will take longer than expected and the WALRUS class must remain in service for even more time than was previously anticipated. The first of the new submarines is not expected to be operational earlier than 2034. In order to be able to keep the old boats operational – the first, HNLMS ZEELEUW entered service as long ago as 1990 – it was decided to decommission two submarines and use them for spare parts. The first boat will be decommissioned shortly.

Photo: DMO

Artist impression of the Combat Support Ship.

With only two submarines, the Dutch Submarine Service is vulnerable. The WALRUS class submarines are already the oldest boats in the 115-year history of Dutch underwater operations. The Ministry of Defence (MOD) does not rule out that the current submarines will be decommissioned before the new boats arrive. Everything will be done to prevent a capability gap, State Secretary Christophe van der Maat wrote to the Dutch parliament, but safety comes first. Even a (minor) accident with one of the two boats could cause severe troubles for the Submarine Service.

The number of LCFs will remain at four, but the MOD has announced that two of the frigates will not receive APAR Block 2 and ESSM Block 2. According to the MOD, the new radar and missiles are needed to defend the ship against the latest anti-ship cruise missiles. The two frigates that will be equipped with new systems can be deployable in conflict areas. The Dutch MOD wrote in a letter to parliament that the two other frigates will only be deployed in a low-threat environment, being made available for operations such as FRONTEX, anti-piracy and counter-drug patrols.

N and HNLMS TROMP have already been modernised and are sailing with the new Thales SMART-L MM/N, with which they can detect ballistic missiles in space on distances up to 2,000 km. The midlife upgrade of HNLMS DE RUYTER is almost completed and HNLMS EVERTSEN is currently being modernised. The four will also receive the new Leonardo 127/64 LW naval gun; HNLMS EVERTSEN will be fitted first with it.

The cut-back in the scale of the modernisation programme for the LCFs has been caused by the previous postponement of the Royal Netherlands Navy's next surface combatants, the replacement for the 'M' series of frigates. Thales' new APAR Block 2 X-band multi-function radar was initially developed for these Anti-Submarine Warfare Frigates (ASWFs), which will replace the four existing Dutch and Bel-

Photo: Dutch MOD

Launching of the partly completed hull of the Combat Support Ship on the site of Damen Shipyards Galati in Romania.

175 YEARS OF HAPAG-LLOYD 1847-2022

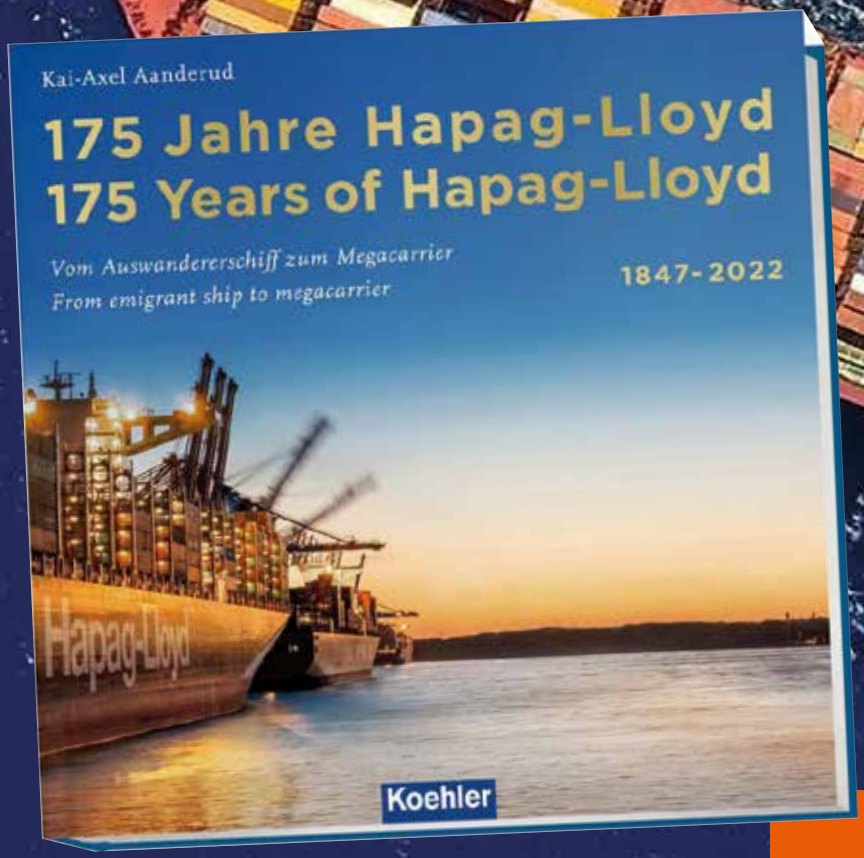

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Photo: DMO

Artist impression of the CSS during a replenishment at sea with EVERTSEN.

gian 'M' class vessels by the end of the decade. However, money was needed for the barracks and buildings of the MOD and the all-new radar, which will also be part of the sensor suite of the four German F126 frigates, cannot now be delivered to Defence Materiel Organisation (DMO) earlier than 2027. That means that there is not enough time to equip all four LCFs with the new radar before they are due to be taken out of service. Moreover, according to the Dutch MOD the legacy APAR is not suitable for operating with the new ESSMs.

The four ASW frigates (from the Belgium-Dutch programme) will, however, still receive the new sensor.

ASW Frigates

The ASWFs are being built by the Dutch shipyard Damen Naval, but the preliminary design comes from the DMO. That design was presented in June 2020 and outlined a ship of 133 meters with 5,700 tonnes displacement. The ships will receive two strike-length MK 41 vertical launch systems of eight cells each for ESSM Block 2. Belgium also wants to install the Standard Missile 3 for Ballistic Missile Defence in order to be able to offer a BMD launch platform to NATO (the frigates won't receive a BMD radar).

Apart from APAR Block 2, another new radar that is a further development of the Sea Master 400 and NS100 radars will also be fitted.

The Low Frequency Active Passive Sonar (LFAPS) of the Netherlands Organisation for Applied Scientific Research (TNO) and Ultra's Canadian division will be the most important underwater sensor for the ASW ships. The frigates will also receive a hull mounted sonar.

DMO needed considerable time to achieve the June 2020 preliminary design. One of the challenges was the limited budget of about €500M per ship. In 2021 it turned out that not all the navy's requirements fit into the design. The frigate can be lengthened, but that has consequences for the diesel-electric propulsion and, therefore, for the budget. Options are currently being worked out to ensure that the ship meets the requirements.

The first frigate should be put into service in 2028. The contract between DMO and Damen was expected to be signed at the end of 2021 but has not yet been inked. The project has not only faced technical

Photo: Dutch MoD

A WALRUS class submarine.

challenges as collaboration with the suppliers has also proved difficult at times. The Director of the DMO, Vice Admiral Arie Jan de Waard, criticised the Dutch industry's approach to the project. Collaboration has improved since the start of 2022 and changes have been made to the way of working. Recent reports about the ASWFs are more positive.

Submarines

A far more complex project is the replacement of the WALRUS class submarines. In line with the established procedure for military procurement within the Dutch system to achieve Parliamentary approval, the dialogue phase of this programme started at the beginning of 2021. The requirements were shared by the DMO, which discussed the ideas with three shipyards: Naval Group (which cooperates with Royal IHC), Saab Kockums (which cooperates with Damen) and tkMS. This phase was planned to last until the end of 2021. In 2022 one or more yards would then be asked for a quote.
Through this dialogue, DMO intended to get a clearer view of the designs proposed by the different yards. Vice Admiral de Waard said that the designs were not of sufficient maturity to be started quickly. Moreover, DMO no longer wants to speak of an evolved military off-the-shelf design. Instead, it prefers a unique submarine based on existing designs.
Later that year, in the summer 2021, it turned out that the dialogue phase was not going well. The yards provided much less information than DMO had hoped. The dialogue phase also took a lot of time and manpower. There was criticism from the yards that DMO had shared the requirements but had not prioritised them. The dialogue phase was stopped.
State Secretary Van der Maat, who took office in January 2022, decided to make changes to the project. The DMO will first make a procurement model that will include the criteria that the new boat must meet. A request for quotation will then be sent to all three yards in the last quarter of 2022.
Interestingly, Van der Maat made one of the new requirements public. The new submarines must be suitable for launching cruise missiles that can be used against ships and targets on land.
As described earlier, the project has been delayed and it is expected that the costs of the boats will be higher than previously thought. The question is whether the project will receive extra budget needed to meet the requirement.

Mine Countermeasure Vessels

The new mine countermeasure vessels (MCMVs) for the Netherlands and Belgium are currently being built in France.
The project is under Belgian leadership and is on schedule. Since last November, work has been underway at the Piriou shipyard in Concarneau on the first ship of the Belgian CITY class (OOSTENDE). Steel for the first Dutch ship was cut in February and the keel of the future HNLMS VLISSINGEN (VLISSINGEN class) will be laid on 14 June at the Kership facility in Lorient.
An important part of the MCMVs' capabilities are their unmanned systems. These systems are being developed by the French ECA in collaboration with the Royal Netherlands Navy. The RNLN has rented the vessel GEOSEA for tests. Since the beginning of this year, the ship has been testing a smaller version of the INSPECTOR 125 Unmanned Surface Vehicle (USV). The A-18M Autonomous Underwater Vehicle (AUV) has also been on board for some time. The K-STER and SEASCAN systems are also being added to the test programme.
OOSTENDE will enter service with the Belgian Navy in 2024. DE VLISSINGEN will enter Dutch service a year later.

Artist impression of the future mine countermeasure vessel for the Netherlands and Belgium.

Photo: Naval Group

Combat Support Ship

Another Dutch naval vessel under construction is the Combat Support Ship (CSS). While her construction will take place far away from the Dutch naval base, the ship will be named DEN HELDER. Like many other Dutch naval vessels constructed since 2000, the DEN HELDER is being built by Damen Shipyards Galati in Romania.
In 2020, the first steel was cut. DEN HELDER's keel was laid in the summer of 2021 and her hull is now almost complete, the diesel generators and electric motors having already been installed. The ship is initially being built in a shallow part of the dry dock. When the hull is complete, the propellers have been placed and the paintwork is finished, the ship will move to the deeper part of the dry dock. Parts of the superstructure will be added there.
In May 2023, the ship's systems should start up and the crew will board. The Harbor Acceptance Trials and Sea Acceptance Trials take place in the Black Sea. DEN HELDER is due to arrive in Den Helder in June 2024, and will be put into service in 2025.
The war in Ukraine has caused concerns for the project organisation of the CSS. Galati is only about nine kilometres from the Ukrainian border. Although Romania is a member of NATO, the DMO has been preparing for problems that would be caused by a huge influx of refugees or food shortages. However, the construction of the ship has not been affected by the war to date. [1]
Although the project is now going well, the CSS also had a bumpy start. In terms of systems, the CSS is a sister ship of HNLMS KAREL DOORMAN. The latter, however, has many more capabilities than DEN HELDER, such as a large helicopter deck and a vehicle deck. It turned out to be too complex to base the design of the DEN HELDER on that of KAREL DOORMAN. However, Damen had designed a supply vessel for a tender from Norway. The Logistic Support Vessel (LSV) was eventually built in South Korea, but Damen's design was used as the basis of the CSS. Notable changes were the addi-

Photos: Dutch MOD

First pictures of the new interim uniform of the Royal Netherlands Navy.

tion of weapons and advanced sensors. For example, the CSS got a Thales NS100 radar (also found on board HNLMS ROTTERDAM and HNLMS JOHAN DE WITT) at the design stage. A Leonardo 76mm gun and Thales Goalkeeper were also added. However, the cost of the CSS turned out to be higher than budgeted and so the design was cut: the NS100, the gun and the Goalkeeper were all removed. In order to leave open the original concept of an "oiler with a bite", provision was made for this equipment on a "fitted for but not with" basis.

Given the planned additional investment mentioned at the start of this article, the MOD could reverse this decision. However, that is not expected to happen, and the CSS will be armed mostly with machine guns. This is probably due to a lack of personnel, forcing the navy to apply a different crew concept. Complex weapon systems also require more specialised technical personnel.

Other Projects

The RNLN expects to receive the first replacement for the LCFs in 2033. A letter of intent was signed with Germany at the end of 2020 for the Future Air Defence Ships (FuAD). In September 2021, Vice Admiral Carsten Stawitzki, Germany's National Armament Director, said the future ships may be based on the German F126 class frigates designed by Damen. Both countries would also strive for identical ships. That would be a first. However, the DMO considered these statements by Stawitzki premature. If both countries want identical ships, it means that tough choices will have to be made when it comes to radar systems, as both countries want to have their own radars on board.

In The Netherlands, the so-called 'A' letter of the replacement program is expected in 2023. This letter concludes the first of three phases and describes the plans for the replacement.

Meanwhile, at t the beginning of this year, the 'B' letter (marking the conclusion of the 'B' phase), was expected for ten auxiliary vessels. That project also appears to be delayed. Ten different ships have to be replaced at once. These are the submarine tender HNLMS MERCUUR (1987), the diving vessels of the CERBERUS class (1992), the training vessel VAN KINSBERGEN (1999), the hydrographic vessels of the SNELLIUS class (2003) and Caribbean support vessel HNLMS PELIKAAN (2006). An important requirement for the replacement is the reduction of CO2 emissions. These ships should be built to commercial off-the-shelf standards as far as possible. Besides Damen, Royal IHC is also one of the potential builders of these ships.

In the next decade, the Landing Platform Docks HNLMS ROTTERDAM and HNLMS JOHAN DE WITT are also to be replaced. The RNLN has been thinking about a new concept for some time now in conjunction with the United Kingdom and the United States, which has consequences for the replacement. The first ship should arrive in 2030.

A New Uniform

In addition to ships, the daily working uniform of the entire Dutch armed forces will also be replaced. However, the tender for this uniform was delayed and, in order to provide the armed forces with better clothing, it was decided to adopt an interim solution. This process has also not gone entirely to plan but, from autumn, 2022 all Dutch soldiers will receive the interim uniform. This uniform is based on the uniform worn by the Royal Netherlands Marine Corps.

The new uniform means a major change for the Dutch fleet. For the first time, Dutch sailors will be given a uniform with a blue 'camouflage' print. It will be the blue variant of the Netherlands Fractal Pattern, developed by TNO. It is not yet known when the final uniform will be issued.

The new uniform is the first visible sign of the renewal of the RNLN. Over the next 15 years, the fleet will be almost completely refreshed, even if expansion is not currently contemplated. Before this the renewal is complete, there is still a lot of work to be done. In the meantime, the RNLN will have to continue sailing with a fleet that is not fully adequate for the tasks in hand. ■

Note:

A matter of speculation is whether the new frigates will also be built in Romania. Twenty years ago, Romania was chosen for Dutch warship construction because of its low wages, but now the differences have become small. Damen says that the ASWFs, like the LCFs, can be built in Vlissingen, if the DMO so wishes.

The Maritime Capabilities and Modernisation Plans of the Baltic States

Robert Czulda

The naval forces of the Baltic States (Estonia, Latvia and Lithuania) have two major tasks – to protect national waters and to provide support to their NATO allies. Although their naval capabilities are limited and based on used vessels, all three fleets are compliant with NATO standards and form the first line of defence along NATO's Eastern Flank.

All three states share the same threat perception and consider the Russian Federation as the sole challenge to their security and independence. The risk posed by the Kremlin became more imminent as early as 2014, when Putin started its aggression against Ukraine. One element of Moscow's more aggressive approach was to boost the forces allocated to its Baltic Fleet, and use them to put pressure on Central-Eastern Europe. In April 2018 Russia conducted naval drills with live surface-to-surface and surface-to-air missile firing in which three corvettes, one frigate and helicopters were involved in three separate areas in the southern and south-eastern Baltic Sea (between Sweden, Poland and Latvia). These drills were considered by then Latvian Prime Minister Maris Kucinskis as "a demonstration of force that it is hard to comprehend can happen so close to our country".

The direct aggression of Russia against Ukraine in February 2022 only increased fears in Vilnius, Riga and Tallin. The Baltic States immediately decided to increase their military spending. Most likely, this will benefit their navies. Whilst, on the one hand, these are not a priority force for the Baltic States, on the other hand, they are considered as an important element in the security arrangements with other NATO member states. Particularly, in the event of any hostilities, the naval forces of the Baltic States would be tasked with assisting NATO's reinforcement activities in the Baltic.

Photo: MoD Estonia

Ships of the Baltic States - including Latvian minelayer A53 VIRSAITIS – during "Cold Response 2022".

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Photo: MoD Estonia

In 2006 Estonia procured three lightly armed SANDOWN class minehunters, including M313 ADMIRAL COWAN.

Maritime Capabilities

Turning to the capabilities of the three navies, their focus is mainly on securing territorial waters and Exclusive Economic Zones (EEZs). They clearly lack offensive capabilities – these would be provided by NATO allies. A top priority is to maintain robust mine countermeasures units. Beyond Search And Rescue (SAR), the most important peacetime task is to detect and destroy mines and other unexploded ordnance as legacies of both World Wars. According to NATO, 160,000 mines were deployed in the Baltic Sea during WW1 and WW2 of which, up to the current date, barely 20% have been removed or destroyed in clearance operations. Another important role is to provide protection for visiting alliance warships, both in "blue water" and "green water" naval scenarios. Both these roles will have an impact on procurement schemes, as well as determining future fleet force structures. All three Baltic States are actively involved in Standing NATO Mine Countermeasures Group One (SNMCMG1).

The main cooperation platform among the Baltic States is the BALTRON (Baltic States Naval Squadron), which was established in 1998 to ensure "permanent rapid response capabilities at sea during the peacetime and crisis". Its goal is also to enhance interoperability and to provide the Baltic States with a maritime force capable of participation in NATO-led peace operations. As explained by the Latvian MoD, "Baltic national fleet ships rotate to BALTRON, a mine countermeasures squadron of two mine countermeasures vessels (MCMVs) and one command/supply vessel, for 6-12 months. BALTRON is engaged in mine clearance operations and military exercise enhancing safety of navigation in the Baltic Sea. The squadron is also involved in search and rescue operations". While in 2021 the BALTRON was commanded by the Latvian Navy's commander, in January 2022 this responsibility was taken over by Lithuania.

Modernisation Plans

Estonia

Estonia has both the longest shoreline (1,241 km or 3,800 km if islets are included) and the most ambitious fleet renewal plans among all three Baltic States. The Estonian Navy's *(Merevägi)* primary focus in the upcoming years is to maintain and further develop the capabilities of the current fleet, in essence its mine-hunting capabilities.

In 2006, Estonia procured three lightly armed SANDOWN class minehunters (M313 ADMIRAL COWAN, M314 SAKALA and M315 UGANDI), all of which are still operational. These units, built and previously used by the United Kingdom, are the backbone of the *Merevägi* and serve as Tallin's contribution to NATO. In February 2019 the first unit, ADMIRAL COWAN – which is a flagship of the Merevägi – was upgraded with the Thales Sonar 2193, a hull-mounted wideband

Photo: MoD Latvia

Official celebration on the 30th anniversary of the Latvian Navy: A53 VIRSAITIS, M-04 IMANTA, M-08 RŪSIŅŠ, and four SKRUNDA-class patrol boats.

Photo: Crown Copyright 2021

Between 2011 and 2014 Latvia commissioned five SKRUNDA class SWATH patrol vessels - three were built locally.

minehunting sonar. It replaced the previous Sonar 2093, a variable depth sonar. The ship also received an upgraded navigation system and the Thales M-CUBE command-and-control system (replacing the BAE Systems NAUTIS 3). The upgrades were carried out by Babcock and Thales, which have now completed work on the other two ships. The Estonian Navy believes that its "future MCM-capabilities need to be further modernised in the future timeframe of 2030+", but "a decision on next generation MCM-capabilities has not yet been made".

Another reinforcement occurred in 2016, when the Merevägi commissioned the LINDORMEN class auxiliary ship WAMBOLA, which had been acquired from Denmark in the previous decade, to replace its sister TASUJA. Subsequently, in December 2020, the Merevägi took deliveries of two fast (more than 30 knots) Saaremaa-built force protection vessels, named RISTO and ROLAND. They were manufactured in eight months by Baltic Workboats AS (BWB). The total cost of the two boats was €3.9M. Although these are small (18 metre) units, the procurement is significant for two reasons. Firstly, they are the first vessels built locally since the restoration of independence in 1991. Secondly, the boats will fill a significant gap: their task is to provide protection for Allied warships visiting Estonia both at sea and in port. The previously-used boats were too large to operate in smaller and shallower port areas. The Saaremaa-boats will also be used for inshore patrolling and for the training of naval personnel. They are armed with two 12.7 mm heavy machine guns. FN SEA DEFNDER, a remotely controlled 12.7 mm weapon station manufactured by FN Herstal, was installed 2021.

Apart from technological changes, Estonia has also initiated organisational transformation. In January 2023, the assets of two naval forces – the Merevägi and the Politsei- ja Piirivalveamet (PBGB, Police and Border Guard Board) – will be merged. Two separate operations centres, the civilian Maritime Surveillance Centre and the military Maritime Operations Centre will be combined. This is the biggest state reform in the near term. The main rationale is to improve Estonian situational awareness, to mitigate a risk of duplication and to improve national readiness. Maritime rescue operations will remain a responsibility of the PBGB, while maritime situational awareness, surveillance of the sea border and pollution control will be transferred, together with the relevant vessels, to the Merevägi.

Apart from new tasks, the Merevägi will get an access to the PBGB's major vessels, notably the 64-m PVL-101 KINDRAL KURVITS (in service since 2012) and 24-m VALVE (2008) pollution control vessels; as well as the 30-m PVL-103 PIKKER (1996) and hybrid-engine PVL-203 RAJU (2018) patrol vessels. The two last-mentioned units can perform multiple tasks, such as search and rescue, pollution control, firefighting, and hydrographic missions. The PBGB will still be authorised to call on some of the *Merevägi's* vessels to support its own operations.

Future acquisition plans are relatively limited; although Russia's current attack on Ukraine might expand the current posture. Already, back in October 2021, Estonian Defense Minister Kalle Laanet hinted that Tallin wanted to boost its national defence capabilities, including in the naval domain. That month, the Estonian Centre for Defence Investment (ECDI) signed a contract with Proteus Advanced Systems, a joint venture company comprising Israel Aerospace Industries (IAI) and ST Engineering Land Systems, to equip the Estonian Defence Forces with BLUE SPEAR (5G SSM) sea-skimming anti-ship/ground-attack missile systems with a maximum range of 290 kilometres. Later, in December of the same year,

Photo: MoD Latvia

Lithuania has four former Danish FLYVEFISKEN class patrol vessels, including P15 SĖLIS (ex P552 HAVKATTEN).

Estonia received an initial batch of influence naval mines, which were delivered from Finland.

It has also been revealed that Estonia has a pilot project to build unmanned vessels. No details have been yet revealed, except an ambition to launch the first ship in 2026. The ambition seems to be realistic since Estonia already has significant experience with unmanned solutions. Apart from Milrem Robots – a leader of an international consortium with a task to develop a standardized European iMUGS (Integrated Modular Unmanned Ground System) – Estonia has already designed NYMO – a civilian, autonomous ship, which was developed by Tallinn University of Technology. The prototype was launched in 2019.

Latvia

Latvia has the second longest coastal zone among the Baltic States (slightly less than 500 km). An ex-Norwegian minelayer (VIDAR class), A-53 VIRSAITIS (in service since 2003), and an ex-Dutch (BUYSKES class) hydrographic survey vessel, A-90 VARONIS (in service since 2004), are the two major units of the Latvian Naval Forces *(Latvijas Jūras spēki)*. Between 2011 and 2014 the *Jūras spēki* commissioned five SKRUNDA class SWATH patrol vessels – two were built in Germany (P-05 SKRUNDA and P-06 CĒSIS) and three in Latvia (P-07 VIESĪTE, P-08 JELGAVA and P-09 RĒZEKNE. A further capability boost occurred in October 2018, when Jūras spēki units received the iSea-30HD gyrostabilised, electro-optical/infrared (EO/IR) surveillance system manufactured by Controp Precision Technologies.

Three of the five ex-Dutch TRIPARTITE class minehunters (M-04 IMANTA, M-05 VIESTURS, M-06 TĀLIVALDIS, M-07 VISVALDIS, and M-08 RŪSIŅŠ), all commissioned between 2007 and 2011) will see a major refit by 2025. One of the remaining two will go out of service. In September 2020 France's ECA Group was awarded a contract worth €20M to upgrade three units. Legacy hull sonars will be replaced by the UMIS Unmanned Mine Countermeasures Integrated System consisting of underwater drones of the AUV A18-M type (with the UMISAS synthetic aperture sonar) for detection and underwater robots of the SEASCAN MK2 and K-STER C types for identification and mine clearance. These upgrades are considered by the Latvian Navy as an interim solution before the fleet is reinforced by new ships in the 2030s. It is not ruled out that Latvia would then procure ships jointly with Lithuania. Moreover, the Latvian Navy recently indicated to consider the procurement of coastal anti-ship systems.

Lithuania

Lithuania's coastline is just 100 km long. No wonder that its naval forces (Lietuvos Karinės jūrų pajėgos) are relatively small. Currently there are no major procurement plans – the only expected tender for a new SAR ship (as a replacement for the ex-Soviet PGL ŠAKIAI) remains suspended.

Just as for the other Baltic fleets, maintaining an effective mine countermeasures capability is a priority. Two ex-British MCMVs are currently in service – M53 SKALVIS and M54 KURŠIS. Both Royal Navy HUNT class vessels, they were commissioned in 2011. A third unit is expected to enter into service in 2023. Previously Lithuania acquired an ex-Norwegian VIDAR class multi-role ship (N42 JOTVINGIS) in 2006, which now serves as a command/supply ship. Other important assets include four former Danish FLYVEFISKEN class patrol vessels – P11 ŽEMAITIS, P12 DZŪKAS, P14 AUKŠTAITIS and P15 SĖLIS – transferred between 2008 and 2016.There are no plans to upgrade any of these units in the near future. ■

Photo: Crown Copyright 2021

N42 JOTVINGIS is a command and minelaying ship of the Lithuanian Navy - previously it serves in Norway as HNoMS VIDAR (N52).

Knockout Punch: European Heavyweight Torpedoes

Richard Scott

Serving as both the primary Anti-Submarine Warfare (ASW) armament and a potent Anti-Surface Warfare (ASuW) weapon, the heavyweight torpedo constitutes the single most important part of a submarine's armoury.

Technology advancement over the last 80 years has seen what was a relatively simple, short-ranged, "straight running" explosive projectile evolve to become a highly sophisticated underwater guided weapon capable of prosecuting difficult targets at extended range.

Modern heavyweight torpedo designs are the function of a number of complex and sometimes competing drivers. These include, amongst others, acoustic discretion, extended range, high maximum speed, sufficient manoeuvrability to overcome a target's evasive manoeuvres, a wide range of operating depths (maximum and minimum), high lethality, accurate weapon guidance and navigation, robust target homing against quiet or stopped targets in difficult water conditions, and a high degree of resistance to countermeasures.

Overall dimensions (length and even more so diameter) are necessarily constrained by standard launch tube dimensions. It should also be remembered that the torpedo is the effector within a larger weapon system: given the extended ranges involved, there needs to be a high level of integration between the torpedo itself and the host submarine's tactical weapon system (comprising sonar, command, and fire control).

Furthermore, the restricted size of the torpedo acoustic homing head requires operation at higher frequencies where losses through propagation limit range: to overcome this, modern torpedoes use a wire guidance link so as to receive target position updates post-launch, and thereby take advantage of the extended range detections available from the submarine's own towed array and/or flank array sonars.

At a close range to the target, the torpedo will accelerate to high speed and use its own active sonar to detect and home on the target. The homing head must embody sophisticated processing to discriminate the target from jammers and decoys. Some weapons may additionally employ "upward-looking" high frequency wake-homing sonars.

Finally, the weapon must deliver the required lethal effect upon the required targets, and demonstrating the combination of accurate weapon placement, accurate fuzing, and optimum explosive effect to disable/destroy the target. Against surface ships, a detonation is required under the keel so as to create a pressure bubble that will 'break the back' of the vessel. Against submarines, the warhead effect must rupture the pressure hull of the target.

Operational performance alone does not condition torpedo design. Weapon safety (notably Insensitive Munitions [IM] compliance), environmental compliance, and through-life servicing and support costs must all be considered. So too must the costs associated with in-water runs during peacetime trials and exercises; in-water test and trials are important for building confidence in the weapon, growing operators' familiarity with tactics and procedures, continued tactical development, and validating modelling and simulation.

It is noteworthy that, despite relatively small production volumes, Western Europe still boasts five contractors involved in the design, manufacture and support of heavyweight torpedoes. While three of these companies have successfully exported derivative weapons, the remaining two operate solely to meet the specific sovereign requirements of their home navies. Further east, Turkey has now completed development of an indigenous heavyweight weapon.

Photo: Atlas Elektronik

The SeaHake mod4 torpedo is the export version of the German Navy's DM2A4.

SeaHake mod4

Atlas Elektronik is a long-standing and highly successful exporter of electrically-powered heavyweight torpedoes, with the current SeaHake mod4 weapon (the ex-

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Photo: BAE Systems

The British Royal Navy's SPEARFISH heavyweight torpedo was initially developed in the Cold War era.

Photo: Richard Scott

A Demonstration and Full Manufacture contract was awarded to BAE Systems in 2014 to bring SPEARFISH Mod 0 up to the new Mod 1 standard.

port version of the German Navy's DM2A4) building on a 50-year pedigree dating back to the SST4 and SUT weapons. The company currently claims that its heavyweight torpedoes are used by 18 navies on over 150 submarines, with exports currently accounting for over 95% of production; the fact that Atlas Elektronik – now as part of the kta naval systems joint venture – is also the leading supplier of combat systems/sonar sensors for ThyssenKrupp Marine Systems has positioned the company to offer a fully matched 'detect-to-engage' solution.

DM2A4 was introduced by the German Navy in 2004; variants of the export-derived SeaHake mod4 are in service or on order for at least nine international navies, with over 400 torpedoes delivered to date. European customers include Norway, Spain and Greece.

SeaHake mod4 is a dual-purpose, fibre-optic wire-guided heavyweight torpedo designed to operate in both shallow water and deep ocean scenarios. Specific features include: a modular battery section allowing for configurations of between one and four silver zinc (Ag/Zn) compact batteries (cost and capability are traded relative to the standard four-battery configuration); a stepless permanent magnet high-speed propulsion motor driving skewed contra-rotating GRP propellers; digital strapdown fibre-optic gyros; a digital homing head with a wide field-of-view conformal array sonar; and an optional wake-homing sensor. Another feature of SeaHake mod4 advertised by Atlas Elektronik is its computability with various different weapon discharge techniques (swim-out, push-out, or water ram).

Atlas Elektronik has also developed a long range variant, known as SeaHake mod4 ER, which is intended to be used as a coastal defence weapon (launched from ashore or a purpose-built surface vessel). For this mission, the baseline mod4 torpedo is fitted with a new antenna and GPS receiver to enable targeting at ranges exceeding 140 km.

The company has in recent years sought to adapt its business model in order to reflect the realities of a changing and challenging market for a complex engineered weapon system (35,000 individual parts) characterised by low production volumes, relatively few new major contracts, long product life/sustainment (over 30 years), and increasing demands for offset and Transfer of Technology (ToT). To address issues germane to sustainability, lifetime supportability, obsolescence management and future growth, Atlas Elektronik has sought to engineer a more 'open' product model that transitions away from a monolithic design towards an architecture based on functional modules.

Specific action taken by the company include replacing third-party supplied components/technologies with proprietary developments; near complete ownership of intellectual property rights throughout the product; consolidating all principal control functions into the electronic section; standardisation of all internal/external interfaces; the development of business cases to meet ToT requirements at product design level; and a product development strategy that looks both forwards and backwards/sideways to address the upgrade/technology insertion needs of legacy weapons still in service.

SPEARFISH Mod 1

The UK Royal Navy's (RN's) SPEARFISH Mod 0 heavyweight torpedo was developed by Marconi Underwater Systems – now part of BAE Systems Maritime Services – in the Cold War era to address the threat posed by fast, deep-diving Soviet submarines. An upgraded Mod 1 variant, benefitting from significant advances in its homing, warhead, guidance link and tactical systems, is now entering RN service.

Originally entering service in 1994, the SPEARFISH Mod 0 heavyweight torpedo equips all RN submarines, providing them with a capability against both submarine and surface targets. The SPEARFISH Upgrade (SFU) programme, which brings the weapon up to Mod 1 standard, is designed to address the need for incremental improvements in safety, remove obsolescence, and enable through-life cost reduction.

Mod 1 upgrade embodiments include the introduction of a fully digital weapon architecture (both hardware and software), replacement of the current copper/cadmium wire guidance link with a fibre-optic system (reducing the data latency between the platform and the weapon), and the introduction of an IM-compliant warhead. In addition, the SPEARFISH Mod 1 weapon transitions to a single fuel (Otto) propulsion system that will offer cost and safety benefits over the Mod 0's dual-fuel (HAP-Otto) system.

Key subcontractors for the SFU programme include MBDA TDW (responsible for the IM warhead), Atlas Elektronik UK (fibre-optic guidance link and signal processing in the digital homing head), and GE Intelligent Platforms (processing boards). The existing SPEARFISH Mod 0 hull and Collins Aerospace (formerly Hamilton Sundstrand) 21TP04 thermal propulsion system are retained.

A Demonstration and Full Manufacture contract was awarded to BAE Systems in 2014. It is thought that between 140 and 160 existing Mod 0 weapons will be upgraded to Mod 1 standard; the RN plans to maintain SPEARFISH in service through to around 2060.

The RN declared an Initial Operating Capability (IOC) with SPEARFISH Mod 1 in May 2021. IOC was declared after successful firing trials from the TRAFALGAR class nuclear-powered attack submarine (SSN) HMS TALENT on the British Underwater Test and Evaluation Centre range in early 2021.

Following the IOC declaration, the ASTUTE class SSN HMS AUDACIOUS subsequently completed a series of SPEARFISH Mod 1 firings on the Atlantic Undersea Test and Evaluation Center deep water range in the Bahamas. Five upgraded torpedoes were fired over a three-day period to allow the performance of the weapon to be evaluated at its maximum operating depth, and to assess homing performance against countermeasures.

Work is now underway to upgrade SPEARFISH stocks to Mod 1 standard meet the RN warstock requirement. All RN submarines should be equipped with the upgraded weapon by 2025.

Full introduction of the upgraded weapon capability to RN service is dependent on three separate but interrelated lines of development: the SFU project itself, which builds and delivers modification kits to convert existing SPEARFISH Mod 0 torpedoes to Mod 1 standard; the weapon thread, which establishes the physical interface between the platform and weapon and an update to submarine combat system software; and the in-service support of the torpedo warstock, which will embody the modification kits into the inventory.

AKYA National Heavyweight Torpedo Development Programme

Having previously acquired heavyweight torpedoes from Germany (SST4 and DM2A4), the UK (TIGERFISH) and the United States (MK 48 Mod 6AT), Turkey in 2009 established the AKYA National Heavyweight Torpedo Development Programme under the sponsorship of the Presidency of Defense Industries (SSB). Roketsan was appointed as main contractor for the programme; other key industry participants include Meteksan Defence and Koç Information and Defence Technologies.

Relatively little detail has been released on AKYA. However, the weapon is known to be electrically-powered with a maximum range of over 50 km and a sprint speed in excess of 45 kn, and combines a fibre-optic guidance link with internal navigation and an active/passive acoustic homing head; an adjunct wake-homing sensor is employed for surface targets.

In-water testing of the AKYA vehicle prototype (without warhead or acoustic homing head) commenced in the Sea of Marmara in July 2013 with the support of the Turkish Naval Research Center Command. Two more launches were completed during Phase 1 development.

Photo: Roketsan

Roketsan is the lead contractor for Turkey's AKYA National Heavyweight Torpedo Development Programme.

A contract for AKYA Phase 2 "industrialisation" was signed by the SSB and Roketsan in July 2016. This follow-on activity has seen industry mature, test and integrate critical subsystems, and qualify the weapon for series production.

A first test of an AKYA heavyweight torpedo equipped with an acoustic homing head was conducted in December 2019. For the purposes of this trial, the prototype weapon was launched - using the 'swim out' technique - from a torpedo tube mounted on an underwater test platform at a depth of 40 m.

In January 2021, a first firing of an AKYA heavyweight torpedo training variant was conducted from the Type 209/1400 submarine TCG GÜR in the Sea of Marmara. This was followed in March this year by a test from TCG PRVEZE (the first Type 209/1400 boat to be upgraded with the indigenous MUREN command and weapon control system). Low-rate initial production deliveries of AKYA warshots are planned to begin in 2022.

BLACK SHARK ADVANCED

Italy's Leonardo - previously the Whitehead Alenia Sistemi Subacquei business of Finmeccanica - has developed a next-generation BLACK SHARK heavyweight torpedo to meet the needs of the Italian Navy's Nuovo Siluro Pesante (NSP) requirement. Known as BLACK SHARK ADVANCED, this latest evolution of the widely exported BLACK SHARK weapon is replacing the legacy A 184 Mod 3 torpedo in Italian service.

BLACK SHARK, itself an evolution of the earlier A 184, is in service with the navies of Chile, Indonesia, Malaysia, Portugal and Singapore. Development and initial production of BLACK SHARK ADVANCED has been underwritten by two contracts awarded in 2011: while evolved from the existing Black Shark weapon to meet the NSP requirement, the new weapon differs from its export-oriented forebear by virtue of its interchangeable battery section (either warshot or exercise), a new IM warhead, and a new reinforced fibre-optic cable dispenser.

Two different BLACK SHARK ADVANCED configurations have been developed: a warshot torpedo powered by a new sin-

Photo: Leonardo

Leonardo's BLACK SHARK ADVANCE is the latest evolution of the widely exported BLACK SHARK torpedo.

Photo: Naval Group

Naval Group formally handed over the first batch of production F21 torpedoes for the French Navy in November 2019.

gle-shot Al-AgO battery; and an exercise variant using a rechargeable Lithium-ion Polymer (LiPo) battery

According to Leonardo, the new LiPo battery is the same form factor and weight of a legacy Ag/Zn battery, but produces 100% more energy and 70% more power. In January 2014 a first launch of a LiPo-powered BLACK SHARK ADVANCED exercise torpedo was conducted from the U212A submarine SCIRE in the Gulf of La Spezia. According to Leonardo, testing and qualification of the new battery has demonstrated performance in excess of requirement, while at the same time affording significant reductions in cost of ownership.

It was announced in June 2018 that Leonardo would supply BLACK SHARK ADVANCED torpedoes and associated logistics for the Italian Navy's U212A Batch 2 submarines. OCCAR has subsequently confirmed that the new U212 NFS submarines (two on order with options for two more) will also be equipped with BLACK SHARK ADVANCED.

F21 ARTÉMIS

France's Direction Générale de l'Armement (DGA) awarded what was then DCNS - now Naval Group - a €420M contract in April 2008 for development and production of the F21 wire-guided heavyweight torpedo. Being acquired under the umbrella of the ARTÉMIS programme, the F21 torpedo is planned to replace the F17 Mod 2 heavyweight on French Navy LE TRIOMPHANT and RUBIS class nuclear-powered submarines, as well as equipping the new SUFFREN class SSNs and, further downstream, the future SNLE 3G deterrent submarine.

Naval Group is under contract to deliver just under 100 F21 torpedoes, as well as to perform integration into both existing submarines and the new SUFFREN class boats. Atlas Elektronik is principal subcontractor for the power and propulsion system (derived from that used in SeaHake mod4), while Thales is providing the acoustic homing head. The F21 adopts a fully digital architecture, and employs a fibre-optic guidance link.

Powered by a new generation of Al-AgO primary battery, supplied by Saft, the F21 is capable of trading range for speed up to respective maximums of over 50 km and greater than 50 kn. Operational depth ranges from under 10 m to over 500 m.

According to Saft, the Al-AgO battery stack delivers twice as much energy and power as conventional silver-zinc batteries for the same mass and volume. As well as providing propulsive power, the battery also powers the torpedo's onboard electronic control and guidance systems.

Initial in-water testing of the F21 used development weapons launched from the test vessel PÉGASE and the COMEX vessel JANUS, as well as from submarines. A milestone qualification test event using a production-standard torpedo occurred in May 2018 from an unidentified RUBIS class on the DGA underwater acoustic range off the coast of Hyères coast.

Photo: Naval Group

Naval Group was awarded a contract or development and production of the F21 wire-guided heavyweight torpedo in 2008.

Naval Group formally handed over the first batch of production F21 torpedoes for the French Navy in November 2019 at its facility in St Tropez. Deliveries to Brazil – the first export customer – commenced in January the following year; the F21 will equip its four new RIACHUELO class conventional submarines of the SCORPÈNE type. It is understood that F21 has also been ordered by an unidentified North African navy.

TORPEDO SYSTEM 62

Developed by Saab Dynamics under contract to the Swedish Defence Materiel Administration (FMV), the TORPEDO SYSTEM 62 wire-guided heavyweight weapon has been in service with the Royal Swedish Navy's (RSwN's) submarine force since 2001. TORPEDO SYSTEM 62 uses a bi-propellant propulsion system (a combination of 85% high-test peroxide and 15% kerosene) to power a seven-cylinder piston engine driving a pumpjet propulsor to achieve speeds of over 45 kn.

Work is now underway to extend the life of TORPEDO SYSTEM 62 warstock out to the mid-2040s. FMV awarded Saab an initial four-year contract, worth SEK485M, in July 2020: the scope of work covers a baseline review, identification of candidate modifications and enhancements, and preparations for future stages of the life extension programme.

As well as addressing obsolescence in the existing TORPEDO 62, the life extension studies being performed by Saab are also evaluating what technologies and techniques could be brought across from the TORPEDO SYSTEM 47 and autonomous underwater vehicle products. TORPEDO SYSTEM 47 is the RSwN's new-generation lightweight torpedo also being developed by Saab.

A second contract, valued at SEK145 million, was awarded to Saab in December 2021. This work package funds feasibility studies and prototyping in support of the TORPEDO 62 heavyweight torpedo life extension, including subsystem demonstrators to de-risk and cost key aspects of the programme. Work will run to the end of 2023, with activity taking place in Linköping and Motala. ■

Photo: Copyright Saab AB

In service with the Royal Swedish Navy's submarine force since 2001, Saab's TORPEDO SYSTEM 62 is now subject to a major life extension programme.

Emerging Trends in Naval Mining Capabilities

Scott Savitz

Although mines using decades-old technology – some of it from the First and Second World Wars – remain menacing, several broad technological trends are likely to enhance the threat from naval mines in the next few decades. In this article, we begin by briefly characterising traditional naval mines and mine countermeasures. We then describe the impact of two broad sets of technological trends that can reshape mine warfare in the next 10-20 years, and have already begun to do so. One is the growing capabilities of un-crewed (sometimes termed unmanned) vehicles, and the other is a combination of enhanced sensors, algorithms, and networks.

Naval mines have long been highly capable, threatening weapons. Beyond their ability to damage or sink individual ships, they can thwart whole fleets: minefields have immobilised naval forces for protracted periods in locations as diverse as the Mediterranean, the Sea of Japan, and even the rivers of Paraguay. Moreover, a credible naval mine threat can achieve many of the operational and even strategic effects of a formidable minefield by holding a fleet in check, even if the actual risk from the mines is limited or non-existent. These weapons are also relatively inexpensive and accessible to low-end actors, exacerbating the threat that they pose.

Photo: US Navy

A mine is detonated during a mine countermeasures training exercise. Sea mines remain highly capable, threatening weapons and technological changes are likely to increase the threat that they pose.

A Brief Overview of Naval Mine Warfare

Naval mines are defined by three key features. The first is that, rather than seeking out their targets, they wait for those targets to come to them, or for the currents to passively bring them into proximity. The second is that they inflict damage when they autonomously sense the presence of their targets. The third is that they are difficult for the target to detect or classify as a threat, making them hard to avoid.

Since the inception of naval mining during the American War of Independence, these weapons have mostly belonged to two broad categories. Contact mines detonate when they are struck by a vessel. Contact mines often take the form of classic "spiky balls" that most people envision when they think of naval mines, and usually reside close to the surface, moored to anchors that hold them in place. They may also drift freely with the current. Influence mines detonate when their sensors detect the magnetic, acoustic, and other signatures associated with a target ship. They usually sit on the seabed, and can be somewhat discriminating about which vessels they choose to target. Both types of mines can be laid from aircraft, surface vessels, or submarines, as long as they have enough payload capacity. Later in this article, we will discuss exceptions to these generalisations, as well as emerging mine capabilities.

Mine Countermeasures

Mine countermeasures (MCM) include an array of ways of reducing mine risk, such

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as targeting or observing minelayers, reducing ships' signatures to deceive influence mines, or having a series of ships confine movement to a single lane to reduce their collective risk. Most MCM efforts, though, take the form of minehunting or minesweeping. Both are done primarily by specialised assets that are designed not to detonate naval mines, such as helicopters, low-draft wooden ships, or certain un-crewed vehicles. Minehunting entails searching the water using sonar and/or visual scans to detect and classify mines. The mines can then be neutralised, which means that they will be targeted with time-delayed explosives, often delivered by a diver; alternatively, they can be avoided. Influence minesweeping involves dragging gear through the water to prematurely detonate mines that respond to the gear's acoustic, magnetic, or other signatures. In mechanical minesweeping, device-studded cables are dragged through the water, severing the tethers of moored mines so that the mines float to the surface. Mechanical minesweeping has become rare, because drifting mines are difficult to neutralise. While minesweeping is generally faster and less resource-intensive than minehunting, it is also less thorough in reducing risk: a common mantra is, "Hunt when you can, sweep when you must." Moreover, both hunting and sweeping require orders of magnitude more time and resources than the minelaying they are intended to counter.

MCM efforts have long been hindered by a variety of clever tactics, using mid-20th century technologies. As early as World War II, some mines were designed to detonate when exposed to light, targeting divers and other MCM forces that might be scrutinising them. Influence mines have been designed that do not detonate the first time they detect the signature of an appropriate target, but the second, third, or beyond; the result is that influence minesweeping primes them, rather than prematurely detonating them. For the same reason, influence mines can also be set so that they have a probability of detonating when they detect a target, rather than definitively doing so; they can also have dormant periods that render them temporarily invulnerable to sweeping. Some mines have been designed with irregular shapes, or to resemble industrial detritus, to make them harder to hunt. Their shapes may also foster partial burial in silt or mud. These effects can be exacerbated through the use of biophilic coatings that shroud them with organisms for disguise, or sound-absorbing coatings that reduce their sonar signatures.

Emerging Technological Capabilities

Un-crewed Vehicles: Increasingly autonomous and capable un-crewed vehicles can transform naval mining in several key ways. The first is by providing novel minelaying capabilities. Using un-crewed air, surface or undersea vehicles (termed UAVs, USVs, and UUVs, respectively) can reduce risk to personnel, meaning that these vehicles can potentially operate in environments that would otherwise be deemed too dangerous. They can also increase minelaying capacity at a lower cost than their crewed counterparts, whilst their endurance is not limited by human capabilities. Un-crewed vehicles designed for a simple mission—dropping mines into the water—can be inexpensive and potentially expendable. They can also have large payloads relative to their size, given the absence of protective systems, damage-control systems, weapons, or space for humans and their needs. A swarm of un-crewed vehicles can lay mines even in contested or hostile environments, with the knowledge that some of them may be lost to attrition. [1] The ability to substitute un-crewed systems for crewed ones can also reduce demand for scarce crewed assets in a crisis, freeing vital submarines, ships, and aircraft to perform other missions. For example, using a handful of UUVs to clandestinely lay mines, instead of laying them with a valuable, multi-mission submarine is a self-evident improvement.

In addition, un-crewed vehicles also open the door to novel types of mining. A purpose-designed, inexpensive, UUV or low-visibility USV (i.e., with just a snorkel/antenna breaching the surface) can serve as a self-deploying mine. It just needs to migrate to a specified location and then linger there indefinitely, detonating when a target ap-

Photo: US Navy

US Navy divers insert a charge to a dummy contact mine during a training exercise.

Photo: Norwegian Armed Forces – Torbjørn Kjosvold

The Royal Norwegian Navy minesweeper MÅLØY (foreground) and minehunter RAUMA (middle) pictured during a NATO training exercises. Minesweeping is generally faster and less resource-intensive than minehunting but is also less thorough; both require far more resources than the minelaying they are intended to counter.

Photo: US Navy

A Mk 67 Submarine Launched Mobile Mine (SLMM) is loaded into the US Navy attack submarine ANNAPOLIS (SSN-760). Using a handful of UUVs to clandestinely lay mines, instead of laying them with a valuable, multi-mission submarine is a self-evident improvement.

Photo: Crown Copyright 2019

The British Royal Navy's ARCIMS (Atlas Remote Capability Integrated Mission Suite) modular 11 metre USV is one of the many un-crewed systems that are being increasing used for MCM.

Photo: US Navy

An explosive ordnance disposal diver approaches a dummy mine in the course of training. Un-crewed vehicles could help a miner to hinder such laborious MCM operations.

proaches. This is not a wholly new capability, with the US having developed the self-deploying Submarine-Launched Mobile Mine (SLMM) during the Cold War. However, as USV and UUV capabilities become more advanced and available, as well as less expensive, they can be readily incorporated into future mines. Mines could even be designed to self-deploy for hundreds of kilometres. Operating just beneath the surface and periodically extending a snorkel to burn energy-dense fossil fuels, they would switch to battery-only mode when submerging to lay themselves. A further advantage of self-deploying mines is that, after laying, they could potentially relocate themselves every so often, thwarting MCM efforts that are predicated on the mines remaining in place. One approach would be to have individual mines migrate to other parts of the field; given enough mutual awareness, they could "fill in" locations near where other mines had previously detonated. Alternatively, the entire field could migrate, creating a novel mine problem without even the involvement of a minelayer, mystifying and confusing the other side. Two key issues with respect to self-deploying mines is that they are more expensive than traditional devices, and that they need to be able to migrate despite local currents and sea states.

Self-deploying mines could also provide highly responsive mining on demand, which would be particularly useful if a nation needed to conduct mining quickly in the face of a rapidly emerging threat. For example, Taiwan could continually maintain self-deploying mines in key offshore areas and then activate them to lay themselves in the face of an impending Chinese invasion. Chinese awareness that Taiwan had this capability could even serve as a deterrent, if Chinese forces knew that they were unable to hinder a substantial component of Taiwan's minelaying capacity.

A loitering UUV or low-visibility USV could also serve as an autonomous torpedo-launcher, building on another Cold War system, the US's encapsulated torpedo (CAPTOR) mine. The CAPTOR was ensconced on the seabed, where it would launch a torpedo when it detected a submarine in the vicinity. The result was that it could target submarines at ranges many times greater than an explode-in-place mine could, and relatively few CAPTORs could be used to target submarines across vast areas. Today, an un-crewed vehicle laden with torpedoes could be deployed to key waters—for example, outside an adversary's homeport for its submarines—and linger in the environment until a target appeared, then autonomously launch a torpedo. As with

the aforementioned self-deploying mines, these un-crewed vehicles would be more expensive than traditional mines and would have to overcome sea states and currents during their journeys.

Un-crewed vehicles can, of course, also be used to conduct MCM operations, and some of them already are. Sonar-toting UUVs have been used for decades to detect and classify mines. Remotely operated underwater vehicles, with cables that provide ship-based operators with awareness and control, are used to investigate potential mines and to emplace explosive charges to destroy them. The US Navy's Unmanned Influence Sweep System (UISS) entails having a USV drag minesweeping gear, and it is testing use of the same USV to conduct minehunting. [2] In the future, Vertical Take-off UAVs (VTUAVs – essentially, un-crewed helicopters – could also be used to drag minehunting sonar or minesweeping gear. Given advanced enough autonomy, UUVs could be trusted to emplace explosive charges next to mines to destroy them, rather than using divers or human-controlled remotely operated vehicles. Removing personnel from the minefield not only avoids putting them at risk, but can also reduce costs. A platform that is not designed to support personnel, and that does not need to be durable to protect them, is often less expensive. This enables more of them to be deployed, particularly if the elimination of space for personnel makes them more compact, facilitating logistics.

Beyond replicating current MCM practices, un-crewed vehicles could also create entirely new modalities of mine countermeasures. Relatively inexpensive USVs could be used as expendable minesweepers, either as a hasty substitute for other MCM efforts or as a final "proofing" tactic before high-value assets transit a cleared area. Such USVs could take the form of purpose-designed platforms, or they could be old civilian "rustbuckets" endowed with remote controls and filled with foam to make them more durable. Pairs of USVs could also be used to counter drifting mine threats, by trawling nets behind them to collect these insidious devices before they approached the fleet. [1]

Perhaps most importantly, un-crewed vehicles could be used to detect, observe, and potentially interfere with mining efforts before the mines are even in the water. Intelligence, surveillance, and reconnaissance (ISR) has always been a critical part of MCM. Knowing the approximate location and characteristics of the minefield can greatly reduce mine risk and accelerate operations; identifying the rough locations of individual mines, if possible, is even more valuable. Expendable un-crewed vehicles – such as low-visibility USVs studded with antennae, cameras, and microphones both on their snorkels and below the waterline – could lurk in the vicinity of a mining operation and collect critical intelligence. If this enables targeting of the minelayers, perhaps by other un-crewed vehicles, it may even obviate the need for most other MCM operations.

Photo: US Navy

A multinational group of mine countermeasure ships pictured in the Arabian Gulf. Improved sensors, algorithms, and networks can be used either to obstruct or enhance MCM efforts.

At the same time, un-crewed vehicles could help a miner to hinder MCM operations. MCM systems are inherently fragile, and move slowly and predictably in a minefield, making them easy targets. They also depend critically on precision navigation and communications. UUVs or low-visibility USVs operating upstream of a fixed minefield could launch small armed or kamikaze UUVs to target MCM forces, or could burble up drifting mines or small floating jammers. Trying to hunt them down, or to conduct MCM under fire while experiencing substantial losses, would protract MCM operations and make them less effective.

Improved Sensors, Algorithms, and Networks

Diverse types of visual, acoustic, and other sensors are continually growing in capability, even as their sizes and costs often shrink. At the same time, algorithms capable of automatically interpreting those sensors' data are also improving, including through the use of Artificial Intelligence (AI). This intelligence is amplified by the growing ability of different machines to communicate with one another as part of an integrated network. While electromagnetic communication is impeded underwater, devices can be hard-wired to one another, or send low-bandwidth signals using sound (or even light, over very short ranges). Networked devices can fundamentally alter the dynamics of mine warfare, since the sensor no longer needs to be in the same place as the weapon. An array of distributed sensors and weapons can collaborate to make a minefield more resistant to countermeasures, more selective, more enduring over time, and more deadly.

One way in which these technologies can contribute is by obstructing or targeting MCM efforts. Networked influence mines with advanced sensors and algorithms can better distinguish minesweeping gear from actual targets, ignoring attempts to prematurely detonate mines. They may also be able to target the low-signature assets that conduct MCM. For example, if a network can identify an MCM ship or helicopter as it passes overhead – perhaps by integrating visual, acoustic, thermal, and other cues – it can attack that platform. A short-range mine blast would devastate a fragile MCM ship, impeding further operations. Targeting a helicopter would require a different weapon, but it would not be difficult to distribute a handful of short-range anti-helicopter missiles in buoyant cases that would be tethered to the bottom. When sensors below the water discerned a noisy object above them with a characteristic helicopter shape, they could release the buoyant casing, with the missile launching when it breached the surface. A helicopter conducting slow, painstaking MCM operations, while emitting intense thermal and acoustic signatures, would be an easy target.

Improved target selectivity would make minefields more effective in ways beyond resistance to countermeasures. A minefield

An unmanned US Navy RHIB deploying the AN/AQS-24 mine hunting sonar system participates in MCM operations. The extent to which mines sink ships and stymie fleets in any given situation will depend heavily on the extent to which each side wields emerging mine warfare technologies well.

with numerous, advanced sensors that could collectively harvest data from multiple vantage points and use AI to interpret those data points could more deliberately strike the highest-value targets. Given high enough selectivity, a minefield could even be designed such that the miner's own ships could pass through with impunity, but an enemy's would be relentlessly targeted. However, this requires not only a high degree of technical sophistication, but also a tremendous amount of command confidence in such capabilities.

A distributed network of sensors and devices would also facilitate use of torpedo-launching seabed mines, like the aforementioned CAPTOR. A modern approach could employ multiple torpedoes in each mine, with scattered sensors whose outputs would be integrated and analysed by AI. The network would then direct particular mines to launch torpedoes.

The growing capabilities of sensors, algorithms, and networks can also contribute to MCM operations. Improved minehunting sonar and other sensors can help to overcome miners' attempts to conceal or disguise their devices. Moreover, advanced algorithms and AI can transform the time-consuming, laborious process of interpreting minehunting data into one that is performed more quickly and accurately at a lower cost. Automated communications among systems can also facilitate the transfer of data in ways that enable more efficient and effective operations. For example, if the goal of an MCM operation is primarily to clear a narrow path through the minefield as quickly as possible, a series of minehunting UUVs taking parallel routes could periodically surface to "compare notes" regarding the density of mines each was encountering, then focus their collective efforts on the most desirable path, and alert follow-on un-crewed vehicles which mines to neutralise. By networking un-crewed and crewed systems across multiple domains, the entire MCM operation could be made more efficient and effective.

Closing Remarks

The emerging technologies mentioned above are not the only ones that will improve mine warfare capabilities in the coming decades. For example, the increasing energy density of batteries will extend mines' endurance, as might "energy harvesting" from the environment: recharging batteries with energy from currents, thermal gradients, and other sources. At the same time, novel materials, coatings, and designs for mines can make them harder to detect. However, it is the growing capabilities of un-crewed vehicles, sensors, algorithms, and networks that are likely to have a transformative effect on mine warfare in the next 10-20 years. In many cases, these technologies can be used to counter one another, in the continual interplay between mining and MCM operations. The extent to which mines sink ships and stymie fleets in any given situation will depend heavily on the extent to which each side wields these technologies well, combining them with innovative tactics to achieve military s uccess. ■

Mine Warfare in History

Although mine warfare began during the American War of Independence, there are some mine-like technologies that precede this date. A non-explosive variant that fits our definition was used at the Athenian siege of Syracuse in 415-413 B.C., where sharp stakes were implanted into the seabed to rip open the hulls of Athenian ships that passed over them. See Thucydides, The Peloponnesian War, Book 7, Chapter 25. Chinese forces used submerged explosive devices in the 14th century, but these were timer-detonated based on the length of the fuse, rather than responding to targets. In the 17th century, remotely controlled explosive maritime devices were used in China; see Needham, Joseph, Science and Civilization in China, Volume 5, Part 7, but these also were not autonomous. For the same reason, limpet mines – explosive charges attached to a ship or maritime infrastructure, set to detonate based on a timer or external signal – are not true mines in a tactical sense; the threat they pose and the countermeasures required are very different. The ancient technology of fireships, burning ships that are released up-current of the enemy, meets the first two parts of the definition, but not the third: they are easily seen, though not necessarily easily avoided.

Notes

1. See Savitz, Scott, "Rethink Mine Countermeasures," U.S. Naval Institute Proceedings 143, no. 7 (July 2017) and Savitz, Scott, Irv Blickstein, Peter Buryk, Robert W. Button, Paul DeLuca, James Dryden, Jason Mastbaum, Jan Osburg, Phillip Padilla, Amy Potter, Carter C. Price, Lloyd Thrall, Susan K. Woodward, Roland J. Yardley, and John Yurchak, U.S. Navy Employment Options for Unmanned Surface Vehicles (USVs), Santa Monica, Calif.: RAND Corporation, RR-384-NAVY, 2013.
2. These and other programmes were initially developed as part of a set of mission modules for the US Navy's Littoral Combat Ship, which was intended to launch a series of un-crewed systems to conduct MCM. However, most of these programs were ultimately cancelled.

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W(h)ither the Supercarrier?

The Debate over the 21st Century Role of Aircraft Carriers

Sidney E. Dean

Since their inception in the early 20th century, aircraft carriers have undergone numerous changes impacting everything from design to operational concepts. While only a relatively small number of maritime nations have ever fielded carriers, they have been considered the most decisive naval warship category of the last eight decades. In recent years, a number of technological developments – as well as evolving operational doctrines – have spawned debate about the long-term future of the aircraft carrier. This debate includes questions about the appropriate number, size and role of this component in future fleets.

Aircraft carriers in service today can be roughly categorised as fleet carriers, light carriers, and hybrid carriers, although these categories are fluid. All of these ships deploy fixed wing aircraft, as well as a smaller number of support helicopters. In addition to these ship categories, numerous fleets also operate helicopter carriers, which frequently constitute part of the amphibious force but can be deployed for sea control and anti-submarine warfare (ASW) missions. For clarity and focus, this article will not discuss helicopter carriers.

Photo: US Navy

ABRAHAM LINCOLN (CVN-72) – seen here underway in the Atlantic Ocean in 2019 – is a good example of the CATOBAR-equipped supper carriers that only the US Navy currently operate.

Current Carrier Configurations

Fleet carriers are very large ships designed to operate with the main fleet to conduct offensive or sea control missions including reconnaissance, anti-surface warfare and land attack. These ships are designed for high-intensity combat and generally are the primary capital ships of the fleet, carrying several squadrons of fixed-wing combat aircraft. Tonnage of full-sized modern fleet carriers generally exceeds 50,000 tonnes. Ships of circa 90,000 tonnes or more are often referred to as supercarriers.

Vessels with larger decks typically launch and recover aircraft using the CATOBAR (Catapult Assisted Take-Off / Barrier Assisted Recovery) system, which generally permits deployment of heavier aircraft (with greater payloads and longer range) than other launch systems. Fleet carriers with smaller decks utilise either the Short Take-Off But Assisted Recovery (STOBAR) or the Short-Take-Off/Vertical Landing (STOVL) system, both of which usually utilise a "ski-jump" ramp near the bow for launch. STOBAR vessels recover planes with an arresting wire, as do CATOBAR equipped ships. STOVL vessels typically require planes to hover for landing.

While light carriers also operate with the blue-water fleet, their smaller size (generally under 40,000 tonnes) and, consequently, smaller aircraft contingent translate to lesser combat power. Hybrid carriers can vary in size, but also have smaller aircraft contingents than regular fleet carriers. These vessels are often actually helicopter carriers which can be deployed with fixed wing aircraft as a secondary capability. Light and hybrid carriers generally operate with STOVL or purely VTOL aircraft. While their aircraft capacity is limited, these vessels do provide medium-sized fleets with an enhanced sea-control capability, including a potent long-range strike arm capable of defending the remaining surface force by engaging enemy squadrons at standoff range.

Currently Operational Carrier Fleets

Of the 21 aircraft carriers currently operated worldwide by eight nations, 11 belong to the United States Navy (USN). The US is currently the only nation to operate supercarriers. The US Navy's NIMITZ (CVN-68) and FORD (CVN-78) class carriers all have over 100,000 tonnes displacement and the capacity to accommodate more than 100 aircraft. During the Cold War US Navy carrier wings normally consisted of more than 90 aircraft; today's vessels generally deploy with a maximum of 70 aircraft. This large

airwing is highly versatile and includes four fixed-wing strike squadrons as well as electronic warfare, anti-submarine, reconnaissance, and Airborne Warning And Control System (AWACS) aircraft, augmented by ASW and support helicopters. Additions to the USN air wing in the near future will include unmanned aerial refuelling aircraft.
The Russian Navy operates a single ADMIRAL KUZNETSOV class carrier which can accommodate 24 fixed wing combat aircraft. The STOBAR enabled 43,000 tonne hybrid vessel is officially designated as a "Heavy Aircraft Carrying Cruiser" and is equipped with a cruiser's full complement of anti-ship missiles, air defence weapons and rocket launchers. The strike aircraft have relatively short range and are deployed primarily for air defence and anti-ship missions.
China's People's Liberation Army Navy (PLAN) currently operates two fleet carriers. Both are based on the KUSNETSOV class, but eliminate the cruiser arsenal in favour of greater deck space. This permits deployment of 40-44 aircraft including up to 26-32 fixed wing multirole fighters.
Three other nations – France, India and the United Kingdom – operate medium sized fleet carriers ranging between 42,000 and 65,000 tonnes. These ships deploy with standard air wings of 24-40 fixed wing aircraft, although maximum capacity can be larger. Spain and Italy operate light carriers (10,000-27,000 tons) which can also deploy as amphibious assault ships. Fixed wing capacity ranges from eight to circa 30 STOVL aircraft.

The US Supercarrier Debate

The debate over the future configuration and use of aircraft carriers is most intense in the United States. Only few strategists or naval theorists advocate elimination of the aircraft carrier per se, but many question whether the supercarrier or even the full-sized fleet carrier is the optimal choice for the emerging maritime threat environment.
The debate took on a new quality in 2010 when then US Defense Secretary Robert Gates publicly questioned the need to retain eleven 100,000 tonne carriers in the fleet. "Consider the massive overmatch the US already enjoys," Gates said. "Consider, too, the growing anti-ship capabilities of adversaries. Do we really need 11 carrier strike groups for another 30 years when no other country has more than one? Any future plans must address these realities." In addition to tactical and strategic considerations, Gates also questioned the viability of continued procurement of "US$11Bn carriers" in light of static defence budgets.
The twelve years since Secretary Gates' assessment have seen a massive change in the geostrategic environment. His quip that the US Navy "[does not] necessarily need a billion-dollar guided missile destroyer to chase down and deal with a bunch of teenage pirates wielding AK-47s and RPGs" would be impossible in today's world of renewed great power conflict. However, the debate continues. Some experts still favour revamping the force structure by procuring light aircraft carriers (CVL) to augment supercarriers. Opinions vary on the optimal ratio of large to smaller vessels. The more radical proposals have suggested a 2:1 ratio in favour of CVLs.

Photo: Japan Ministry of Defence

China's STOBAR based carrier LIAONING is derived from the Russian ADMIRAL KUZNETSOV design.

Photo: US Navy

Italy's CAVOUR and the United Kingdom's QUEEN ELIZABETH participate in an interoperability exercise in the Mediterranean. Both of these ships are good examples of STOVL carriers.

Photo: US Navy

The first US Navy nuclear-powered supercarrier – the now retired ENTERPRISE (CVN-65) sails in formation with the smaller French CHARLES DE GAULLE. The US Navy is in the course of an ongoing debate as to whether a carrier fleet comprising solely supercarriers is the optimal mix for its fleet.

Photo: Crown Copyright 2021

The British Royal Navy's QUEEN ELIZABETH and PRINCE OF WALES pictured in company. Such vessels might form an attractive alternative to the US Navy's current supercarrier designs.

In his January 2017 white paper "Restoring American Power," the late Senator John McCain called for a "high/low mix" in the aircraft carrier fleet, with supercarriers dedicated to the most challenging scenarios of major power conflict, supported by CVLs where needed in combat. "The goal should be a future fleet and air wing comprised of larger numbers of smaller and relatively cheaper systems that can operate in denied environments, rather than smaller numbers of larger and more expensive systems that our adversaries can increasingly locate and target," McCain wrote.

In 2020, the then US Defense Secretary, Mark Esper, struck a similar tone, advocating procurement of up to six conventionally powered CVLs to augment current nuclear powered large carriers (CVNs). These additional carriers would provide expanded forward presence capacity, freeing up supercarriers for missions which truly require their capabilities. Reducing the operational tempo of supercarriers would ease personnel burden, permit overdue maintenance to be performed on time, and provide better predictability for deployments. Light carriers could operate independently or directly support supercarriers as needed. "While we anticipate that additional study will be required to assess the proper high/low mix of carriers, eight to 11 nuclear-powered carriers will be necessary to execute a high-end conflict and maintain our global presence, with up to six light carriers joining them," Esper said in October 2020. The Pentagon maintained at the time that considerably more study would be needed regarding the viability or desirability of adding CVLs. In January 2021 the Naval Sea Systems Command (NAVSEA) confirmed that it was already conducting design and engineering studies for the CVL concept. Various design options – including a "light" variant of the FORD class – were being investigated with regards to their potential operational benefit, capabilities trade-off compared with current carrier designs, and potential acquisition and operating cost when compared to the FORD class supercarriers now being introduced. Rear Admiral Jason Lloyd, NAVSEA deputy commander for ship design, integration and engineering, stated that NAVSEA was also re-examining concepts which had been rejected a decade earlier. "Just because a decision was made 10 years ago does not necessarily mean that decision is the right decision now. When you're looking at littoral warfare or you're looking at great power competition, those are two different adversaries, and the weapons that you need to fight those adversaries might be very different," Lloyd said in January 2021. He added that air wing composition would also influence the viability of CVL concepts, suggesting that supercarriers might remain optimal for manned aircraft, while light carriers might be better suited for operating unmanned aircraft.

Photo: US Navy

An April 2022 picture of the US Navy amphibious assault ship TRIPOLI (LHA-7) with as many as 20 F-35B LIGHTNING II strike fighters embarked as part of ongoing trials of the "Lightning Carrier" concept.

Alternatives to Supercarriers

Several alternate carrier types have been proposed for the USN.

Mid-Sized Carriers: A cheaper, high-capacity alternative to supercarriers would be conventionally sized fleet carriers. Advocates of this concept point to USS MIDWAY (CV-41), which served from 1945 to 1992. A thorough modernisation increased the ship from 45,000 to 64,000 tons displacement, with a 305 metre flight deck. In the 1970s and 1980s, MIDWAY carried 70 aircraft, including F/A-18 HORNET fighters – roughly the same sized airwing as fielded on today's 100,000 ton carriers. One proposal is to build CATOBAR enabled fleet carriers based on a modified version of the current 65,000 ton British QUEEN ELIZABETH class or on the new, nuclear powered

75,000 ton French aircraft carrier design currently under development.
Such proposals are supported in principle by a 2017 RAND Corporation study which concluded that a carrier in the 70,000 tonne range would be the only acceptable alternative or adjunct to current carrier configurations. Most smaller configurations were found to have insufficient combat power, especially in the most challenging scenarios.

Lightning Carrier: A frequent proposal favours so-called Lightning carrier, a CVL with a full contingent of F-35B LIGHTNING II aircraft. These proposals often centre on a modified 45,000 tonne AMERICA (LHA-6) class amphibious assault ship (LHA). Two of the AMERICA class vessels have been designed without a well deck, which will provide additional storage for aviation fuel and ordnance and permit embarkation of a larger air group. If reconfigured as light aircraft carriers, these ships are expected to accommodate circa 20 fixed-wing SVTOL aircraft. In practical terms, this would likely include 16 F-35B LIGHTNING II combat aircraft, and four V-22B OSPREY tiltrotor aircraft, reconfigured as aerial tankers to extend the F-35's combat radius. Attaching only one CVL to a CVN for major combat operations would increase the carrier group's available strike aircraft by one-third. The basic operational concept was validated in the 1991 and 2003 Gulf Wars, when amphibious warships deployed as "Harrier Carriers" with their maximum capacity of AV-8B Harrier strike aircraft. Another consideration is interoperability with Washington's security partners. With the exception of French and Indian ships, the majority of allied aircraft carriers of all sizes, including those coming into service over the next decade in Japan, South Korea and Turkey, will in fact be "Lightning Carriers." Planes deploying from a USN CVL would be able to refuel and rearm on allied vessels, adding tactical flexibility and potentially enhancing operational tempo. In April 2022 the USN and US Marine Corps (USMC) teamed up for a concept demonstration testing the AMERICA class's capacity in this role. TRIPOLI (LHA-7) sortied with 20 LIGHNING II aircraft, or the equivalent of two USMC fighter squadrons on board. The planes performed "high tempo" combat drills, verifying the viability of using the amphibious warships as dedicated fixed-wing strike platforms.

Drone Carriers: An alternative to the Lightning carrier would be equipping the AMERICA class – or another CVL – with Unmanned Combat Air Vehicles (UCAVs). The US Navy – and other services around

Photo: Crown Copyright 2021

British, Italian and US Navy F-35B LIGHNING II aircraft aboard QUEEN ELIZABETH. The high performance of 5th generation aircraft such as the F-35 allows even a smaller carrier group to deliver considerable damage and fits well with current "distributed lethality" concepts.

Photo: US Navy

US Navy F/A-18 SUPER HORNET aircraft conduct training operations with Greek F-16 FIGHTING FALCONs. The range and payload of CATOBAR compatible aircraft is an important argument in favour of the supercarrier.

the world – are actively pursuing development of carrier-capable, unmanned aircraft to serve as reconnaissance, strike or refuelling assets beginning in the 2030s. Given the smaller size of UCAVs vis-a-vis equivalently capable manned aircraft, these carriers would most likely field a larger number of planes than the same size ship fielding manned aircraft.

In October 2020, the then US Secretary of the Navy, Kenneth Braithwaite, called for six light carriers, each with a full complement of UCAVs. Braithwaite referenced recent neglect of blue-water capabilities, the expansion of the Chinese fleet, and the "challenging and concerning" Russian submarine capability as requiring the US Navy to catch up quickly. Braithwaite envisioned the UCAV carriers as being deployed against Chinese or Russian threats in the Pacific and Atlantic.

Photo: US Navy

T-45C GOSHAWK training aircraft prepare to launch from the latest US Navy supercarrier, GERALD R. FORD (CVN-78). Whilst the US Navy currently remains firmly wedded to its supercarriers, it seems that the option of supplementing them with other types still remains open.

Arguments in Favour of Fleet Diversification

Advocates of acquiring medium-to-smaller fleet carriers present various arguments.

Survivability: A frequent argument against the supercarrier is the development of potent long-range anti-ship missiles (ASMs) in conjunction with modern surveillance and targeting systems. including ocean-surveillance satellites. Opponents can combine these various technologies to create so-called Anti-Access/Area Denial (A2/AD) zones, defined as airspace and maritime space which is under such heavy surveillance and defence that naval vessels and aircraft entering this space would be in grave danger. The most frequently cited weapon systems in this context are the Chinese DF-21D and DF-26B "Carrier Killer" ballistic missiles, with purported ranges of 1,800 km and 4,000 km respectively. Russia also has high-performance ASMs, including submarine and ship-launched hypersonic weapons such as the 3M22 TSIRKON, which will be difficult to thwart because of their high speed (estimated at Mach 8-9, with a reported surface-to-surface range of 1,000 km) and high manoeuvrability. Very quiet diesel-electric submarines armed with high-speed torpedoes constitute another threat. Advocates of fleet diversification cite the operational risk of concentrating a very large percentage of a fleet's combat power on one, increasingly vulnerable, platform. At best, they warn, the advent of "carrier killer" systems would require supercarriers to operate at a greater distance to their target zone, thereby reducing the power projection capacity of the carrier-based airwing.

Distributed Operations: Advocates of smaller carriers argue that several such units could disperse within an operational zone, providing an equivalent or even greater cumulative combat power than a supercarrier. They emphasise that precision weapons and high performance sensors on modern aircraft – especially the 5th Generation F-35 – would enable even a single smaller carrier to deliver considerable damage to enemy forces. According to this view, "Lightning Carriers" would be especially useful for disrupting A2/AD networks, opening gaps for non-stealthy land or CVN based aircraft to exploit. Dispersion of the carriers would also strain enemy defences by enabling coordinated attacks from several angles, an approach in tune with the USN's "distributed lethality" concept. Advances in tactical networks, such as the USN's Cooperative Engagement Capability which permits the exchange of targeting sensor data among geographically dispersed platforms, enhance the lethality of ships and planes operating in a dispersed but coordinated manner.

Flexibility: Another major argument is greater force availability and distribution. Adding a number of CVLs (and their associated escorts, forming a Light Carrier Strike Group or LCSG) could establish a steady peacetime US presence in sometimes uncovered regions, such as Southeast Asia, the Mediterranean and the North Atlantic. By maintaining a larger permanent global presence, the smaller carriers could react swiftly to emerging conflicts, suppressing enemy formations short of large-deck carrier groups and/or forming a vanguard response force until larger USN contingents could arrive in the crisis zone. The light carriers and their accompanying vessels could also deploy in support of amphibious groups or cruiser-destroyer groups without tying down a supercarrier.

Construction and Manpower Considerations: One advantage of smaller carriers would be reduced crew size, which is especially important given current manpower and recruiting difficulties. The FORD class CVN requires nearly 5,000 hands (ship's crew, air component crew, and support personnel), while the British QUEEN ELIZABETH class berths a total of 1,600. If unmanned aircraft eventually form a major portion of the air wing, manpower requirements are likely to be reduced even further. CVLs could also be acquired faster than CVNs, making it easier to adjust procurement to meet emerging needs. Just as important is the possibility to update designs frequently rather than lock in an entire 30-40 year production run around one design.

Counterarguments in Favour of Supercarriers

Counterarguments in favour of supercarriers emphasise the special attributes of large aircraft carriers, regardless of the navy in question. This begins with the tactical flexibility and versatility of the vessels. Larger ships embark a more diversified airwing, making the ships operationally autonomous.

Technology developments also favour the offensive capabilities of the aircraft carrier; the larger the deck (and the airwing), the greater the impact of these new capabilities. This begins with the introduction of unmanned aircraft, which can act as reconnaissance and refuelling assets for manned aircraft, or which can – in the future – act as armed wingmen for manned combat aircraft.

A related argument in favour of continuing the large-deck carrier programs cites the ongoing development of long-range air-launched precision weapons, which will permit carrier-borne aircraft – especially stealthy assets such as the F-35 and future aircraft generations – to launch from outside enemy A2/AD zones while maintaining a potent offensive capability. The argument that smaller carriers would be more flexible has been countered with their likely performance characteristics. Compared with nuclear powered vessels they would have significantly less endurance and range. If the ships were limited to STOVL/VTOL aircraft, the range and payload capacity as well as the sortie rate of the airwing would also be reduced when compared to CATOBAR-capable carriers. CVLs based on current amphibious warship designs would also have significantly lower speeds than CVNs and even current European full-sized fleet carriers.

Status Quo Plus?

In much of the world, aircraft carriers continue to be viewed as powerful military platforms and as a symbol of national prestige. Many current operators are planning to replace their older ships or expand their carrier fleets. Additional nations which do not currently operate fixed-wing aircraft carriers – including Japan, South Korea and Turkey – are planning to acquire them. Notably, a significant number of these acquisition programs are tending towards medium-sized to larger fleet carriers, especially in countries intent on expanding their power projection footprint. France plans to replace its 42,000 ton CHARLES DE GAULLE with a 75,000 ton vessel in the 2030s. Turkish media reported in 2018 that the ICDAS Shipyard was preparing to build a 300 metre, circa 60,000 ton STOBAR fleet carrier. Russia is considering replacing its current hybrid carrier with the PROJECT 23000E supercarrier. If built, this nuclear powered ship would displace 90,000-100,000 tons and accommodate up to 90 aircraft. And India is developing its second indigenously designed carrier, to be considerably larger than previous ships. INS VISHAL will have a displacement of c. 65,000-70,000 tons and utilise the CATOBAR system. It will carry up to 55 fixed wing aircraft, including heavier, fifth generation fighters.

The most notable development is Beijing's plan to maintain a total force of six large aircraft carriers, which will provide China a probable numerical advantage in the western Pacific theatre. The first vessel of the CATOBAR equipped TYPE 003 carrier class is under construction. Tonnage is estimated at 85,000-100,000, making it a supercarrier designed to rival the US Navy's vessels in size and capability. The first-in-class ship is expected to launch sometime during 2022.

As for the United States, Admiral Michael Gilday, the Chief of Naval Operations, stated on 18 February 2022 that he favours a continued force of 12 aircraft carriers as part of a vastly enlarged fleet of circa 500 ships (including 150 unmanned vessels). His remarks, which included no reference to light carriers, likely reflects the trajectory of the USN's ongoing force structure assessment. The USN's 2023 Long-Range Shipbuilding Plan, which was presented in April 2022 and provides force structure options through the year 2052, specifically references the nuclear powered aircraft carrier (CVN) as the joint force's most survivable and adaptable aviation basing concept featuring "combat capabilities unmatched in the world." The document envisions procurement of seven aircraft carriers through 2052, and retirement of eight units over the same timeframe. The shipbuilding plan makes no overt mention of alternate carrier types, but does leave an opening for their future introduction; referring to new operational concepts such as distributed lethality, it cites continuing experimentation and studies to determine optimal future force structure, including the aircraft carrier force.

From a warfighting standpoint, the CVL concept might ultimately be seen as counterproductive for the USN, despite the purported advantages presented by advocates. US Navy supercarriers are fully interoperational with the medium and smaller carriers of allied nations. Allied and US forces already count on operating jointly or in coordination. Even without the addition of US CVLs, allied vessels can and will tactically augment and support US supercarriers. To this extent, European and Asian partners of the US will contribute the same value to joint operations as could be derived from American CVLs. In contrast, a reduction of supercarriers in favour of procuring US Navy CVLs could weaken the overall joint capability.

The United States aside, ongoing and planned procurements show that fleet carriers of all sizes will continue to form core assets of those navies which can afford them and whose strategic doctrine calls for this level of capability. ■

Photo: Marine Nationale

A graphic of the planned French Porte-Avions de Nouvelle Génération (PANG). Fleet carriers of all sizes will continue to form core assets of those navies that can afford them.

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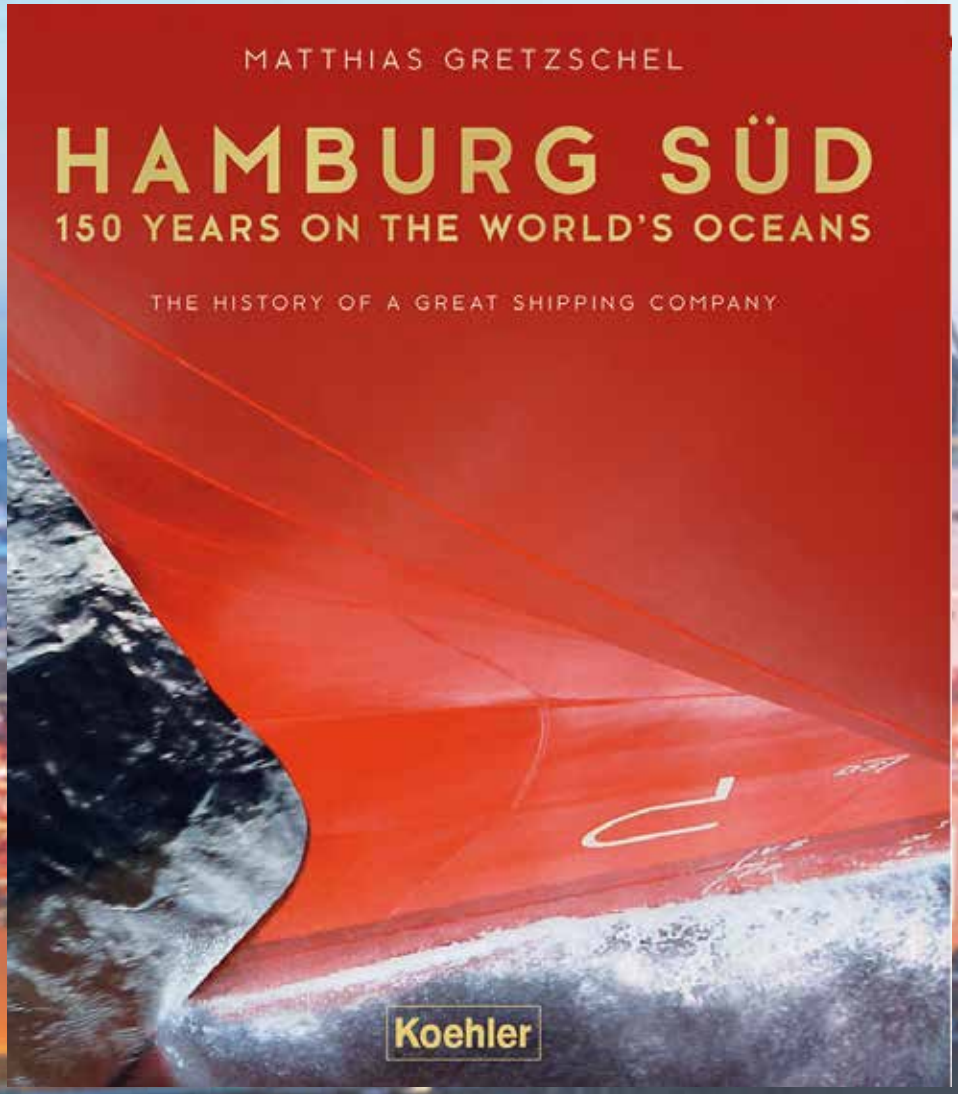

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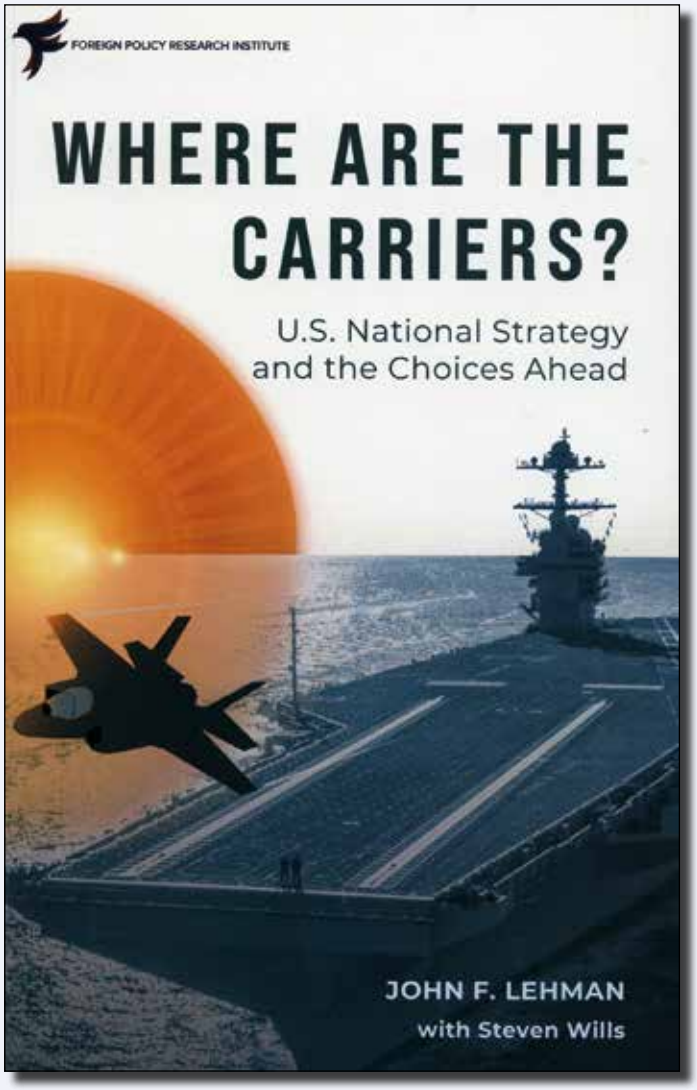
Where Are The Carriers?

US National Strategy and the Choices Ahead

John F. Lehman with Steven Wills
Philadelphia PA, Foreign Policy Research Institute, 2021
ISBN 978-0-910191-17-3



Written by a former Secretary of the Navy during the Reagan presidency in collaboration with a leading research analyst at the Center for Naval Analysis, Where Are The Carriers? explores many of the issues raised by Sidney E. Dean in this edition's review of the supercarrier's future. Whilst providing a wide-ranging assessment of the relevance of carrier-based airpower in the current age, this study essentially focuses on the options available to the US Navy if it is to retain an effective, carrier-based fleet. It concludes that there is a strong case for resumed construction of medium-sized aircraft carriers similar in concept to the late Second World War MIDWAY (CV-41) class in the American navy of the future.

Lehman's book commences by summarising US Navy carrier policy in the Cold War and post-Cold War eras. This "scene-setting" overview is one of the book's strengths, drawing on Lehman's experience as one of the key decision makers of this period. Where Are The Carriers? then poses a series of questions that are key to the current aircraft carrier debate, including the missions, indispensability and survivability of carrier-based airpower; the number of US Navy carriers required; key design characteristics of future vessels; and the composition of their air wings. The two authors' answers to these questions effectively comprise the rest of the book.

Although covering a wide range of pertinent issues, it is the wisdom of focusing limited resources on continued construction of nuclear-powered supercarriers that it is at the heart of the authors' discussion. They assess the weaknesses of the current FORD (CVN-78) class aircraft carrier, criticising the cost and unreliability of the new technology that it contains. They compare it with a number of alternatives, including an updated MIDWAY concept; the European QUEEN ELIABETH and CHARLES DE GAULLE designs; and the "Lightning Carrier" variant of the AMERICA (LHA-6) class amphibious assault ships. An associated discussion evaluates the merits of nuclear compared with conventional propulsion. They make the valid point that past arguments supporting nuclear-powered carriers – both in terms of operational superiority and economic advantage – are less compelling than they might have been in the past.

The book's support for a MIDWAY-sized medium carrier is justified by a number of well-reasoned arguments, including the proven survivability of such ships (for example, in SINKEX testing); the potent size and composition of the air group that such carriers could still deploy; and their improved cost characteristics. Breaking the monopolistic position in aircraft carrier construction currently held by Huntington Ingalls Industries' Newport News yard and opening up the market to competition – at least four American shipyards could build such ships – is seen as a potential major benefit. However, not all the authors' arguments seem watertight. For example, the use of the BONHOMME RICHARD (LHD-6) fire to criticise the vulnerability of a "Lightning Carrier" to action damage seemingly ignores the particular circumstances that led to her total constructive loss. It is also arguable that insufficient weight is given to the higher sortie generation rates available from modern STOVL aircraft and the full potential of light, unmanned aircraft to perform the airborne early warning function currently undertaken by US Navy CATOBAR Hawkeye aircraft. An unduly cynical reader might sometimes be drawn towards the inference that too much effort has been made to marshal the evidence to support the book's preferred conclusion.

These minor criticisms aside, Where Are The Carriers? is essential reading on a subject that is critical to the continuation of the United States century-long role as a global naval power. The proposed way forward certainly merits serious consideration given the US Navy's ongoing struggle to grow fleet numbers in an affordable way against a backdrop of resumed great power rivalry. (cw)

Emergent Changes in Naval Training and Simulation: Drivers and Implications

William Smallman

People are at the heart of every navy's operational capability. Investment in equipment and systems is worthless unless personnel – individuals and teams – receive suitable training.

Training requirements are changing as global competition, challenges to international norms and laws, political upheaval, climate change and the complexity of technological advances in weaponry and navigation increase both the difficulty, and the tempo, of modern naval operations. The breadth of these operational demands, not least the management of data, is driving a need for modernisation of training strategies that exploit new technologies, including synthetic environments. Naval training systems that are adaptive, resilient, and scalable can provide critical flexibility in preparing sailors efficiently and effectively for today's challenges. The learning expectations of digitally literate sailors also call for immersive, adaptive training scenarios, in line with the video games and virtual worlds they inhabit in their off hours. Benefit will also come from an enhanced emphasis on learner-centric systems with tools housed in an adaptive training network.

Photo: Swedish Navy

Swedish sailors receiving training at a Naval Warfare Training Station.

Drivers in Technology Development and Implementation

Data is the foundation of future operations in all battlespace domains. In a maritime context, data refers to the production and sharing of increasing volumes of information from an increasingly diverse collection of sources. Its value resides in the assessment of these sources and their intent (friendly or hostile), reliability, and a requirement to record, share, analyse, and either act on it or ignore it. Data is an invaluable and highly mobile resource in both operations and training. When integrated and contextualised, operational data forms the engine of synthetic environments, offering exciting opportunities for ships' crews to train as they will, then, fight.

By linking clusters of sensors, weapons systems, communication devices and diagnostic devices, networks have become the great enabler of maritime warfare. Navigation has evolved from a compass, a chronometer, a paper chart, and a sextant, to a sophisticated network of Integrated Bridge and Navigation Systems (IBNS). Finding, assessing and engaging targets has become more complex, involving tightly connected communications and data sources. Our reliance on networks has evolved, as has the corresponding need to train future operators to perform effectively within them.

Interoperability is another driver of change, as warfare becomes increasingly digitised. An entire Task Force can share the same picture, in real-time, of ship movements and locations, sensor and effector states, Rules of Engagement, and potential threats. This is enabled by linking (networking) the IBNS to both the Combat Management System (CMS) and the Integrated Platform Management System (IPMS). Sharing both operational and maintenance data from a myriad of sensors including radars, inertial navigation, global positioning, meteorological and platform systems, enables optimised operations and maintenance under the full range of required missions and priorities. Modern synthetic environments can mirror these connections to bring incredible realism to training for watch keepers, technicians, and battle staffs. Integrating Live, Virtual and Constructive (LVC) training options enables whole ship or multi-domain integrated task groups to conduct concurrent training, both ashore and afloat. Once individual and team skills have been learned and mastered, the same technology can be used to maintain

Author

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readiness and conduct mission rehearsals – all without leaving the jetty.

Modern warships are increasingly collecting, integrating, and networking data. The US Joint All Domain Command and Control initiative (JADC2) is an example of how this network approach to warfare facilitates command engagement throughout the decision cycle and across theatres of operations. In current and future systems, all units can share the same level of situational awareness; decisions taken in one ship can be seamlessly executed in another through processes such as the Cooperative Engagement Capability (CEC). For effective training, this Distributed Mission Operations (DMO) approach must be replicated via Distributed Mission Training (DMT).

DMT capabilities can be enhanced by leveraging Artificial Intelligence (AI) and Machine Learning (ML) to develop realistic and credible training scenarios and foster assessment and analysis. Drawing on operational data integrated with doctrine libraries and intelligence, AI and ML can support synthetic scenarios that provide both effective learner-centric training tools and powerful mission rehearsal aids.

Training Needs of the Modern Sailor

Technology is not the only driver of change dictating how maritime training is best delivered. Change is also required to align training methods with the expectations of the new generation of sailors that are more diverse and more digitally aware than their predecessors. As the Baby Boom recedes, as economies continue to transform, and with demand for workers once again outpacing supply, recruiting has become more challenging than ever. In an increasingly tight and competitive talent market, navies need to adjust their training activities to be more creative and relevant, offering recruits opportunities and experiences comparable to that which civilian trade schools, universities, and the job market provide. Today's sailors will respond more positively to training that marries the world of social media and online digital technology with the tailored and precise individual and team training that is required for operational effectiveness at sea.

Implications for Naval Training Systems

Optimising technology and easing the challenges faced by maritime forces does not require a complex new strategy. A

Photo: Swedish Navy

Swedish Navy students undergoing training.

Photo: via Florian Kutzschebausch

A Bridge Simulator of a large auxiliary vessel.

Photo: via Florian Kutzschebausch

Modern training strategies exploit new technologies, including synthetic environments.

Photo: EAZSM / Wilke

Damage Control training.

systematic approach to training, similar to that which military forces have successfully used since World War II, will help identify needs, define problems, illustrate opportunities and constraints, and offer insights for development, delivery, and evaluation of modernised training approaches. Training providers must identify where, when, and how LVC training can support learning for individual sailors up to Task Force Command Staff. This includes more efficient and effective delivery of everything from basic maintenance tasks to battle staff training.

Training innovation involves the application of new ideas, devices, and/or methodologies to existing training systems and routines. Given the challenges facing modern navies, instructional designers are rethinking how they train and the tools they need. Many of the world's navies have recently released innovation or modernisation strategies aimed at addressing the issues presented in this article. Among these, four main lines of effort can be determined:

1. Increasing the use of LVC tools and embracing synthetic environments to improve both individual and collective training.
2. Implementation of digital frameworks to house content, enable collaboration and streamline training management.
3. Adoption of Data Driven Decision Making (DDDM) processes and learning analytics to improve evaluation and drive continuous improvement.
4. Leveraging technology to create learner-centric approaches to training.

Working with an organisation that understands simulation and immersive learning, and has deep training experience across all domains, can significantly simplify and speed the improvement process. The key to success is the ability to integrate new learning approaches and advanced educational technology, including the collaboration and support of multiple stakeholders.

As technology, data, networks, and integration continue to shape the way navies operate, training systems and approaches must match operational requirements with the learning needs of the organization as well as today's sailors. Providing the right training, at the right time to the right sailors – effectively and efficiently - calls for a dedicated multidisciplinary team with the necessary expertise to integrate training solutions to meet the complexities of naval operations, today, and into the future. ■

Photo: EAZSM Kröncke

Sailors tackle a fire during a damage control training exercise.

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Status Report: Naval Programmes in the Black Sea

Conrad Waters

Russia's assault on neighbouring Ukraine has inevitably put the naval balance in the Black Sea into sharp focus. Essentially a "closed lake" by virtue of the tenets of the Montreux Convention governing transit of the Bosporus and Dardanelles Straits, the sea had been something of a naval backwater in the post-Cold War environment until Russia's 2014 occupation of Crimea.

The shock produced by Crimea's annexation – and the subsequent modernisation of Russia's Black Sea Fleet – provided the impetus for many of the region's smaller navies to re-assess their own requirements. However, practical realisation of these ambitions has been hesitant. This status report assesses the state of naval procurement in the Black Sea at the start of the Crimean War and briefly speculates on its possible future trajectory.

A graphic of the Turkish frigate ISTANBUL – launched in January 2021 – that has been developed from the MILGEN 'ADA' class design.

Photo: TKMS

TKMS' Type 214 submarine design forms the basis for Turkey's REIS class submarines, which are being equipped with much locally-developed technology.

Turkey

Arguably the most potent regional navy, Turkey's fleet structure is inevitably made more complex by the need to secure the nation's maritime interests in both the Black Sea and the Mediterranean. This has resulted in a requirement for a balanced fleet capable of both littoral and open water deployment. Another strong influence has been a sustained desire to develop a national military shipbuilding infrastructure; an objective that has been a key influence on overall naval procurement.

Having historically placed heavy reliance on American and European – particularly German – naval industry to support its fleet requirements, Turkey's abilities have steadily progressed to the extent that it can now build, design and – increasingly – equip many of its warships from within its own industrial resources. In addition to an increasingly proficient national shipbuilding sector, the role of the Turkish defence conglomerates ASELSAN and HAVELSAN has been crucial in developing this capacity. The success of Turkey's efforts in this field is reflected in the fact that it has now become a major exporter of warships in its own right.

A key initial focal point for the national naval effort was the MILGEM – an acronym of the Turkish word Milli Gemi (national ship) – programme for four corvettes. Originating in the late 1990s, this eventually saw the quartet of ADA or HEYBELIADA class ships delivered by Istanbul Naval Shipyard (ISN) between 2011 and 2019. This basic design has now spawned a number of variants. The first of a planned class of 'I' or ISTANBUL class frigates was launched by ISN on 23 January 2021 and the intelligence-gathering variant UFUK commissioned in January 2022. The ADA class hull is also being used as the basis for the lead unit of a series of ten planned HISAR class offshore patrol

vessels that has now commenced construction at ISN. The design's export credentials have been demonstrated by sale of ADA type vessels to Pakistan and Ukraine under contracts involving an element of shared construction.

The underwater counterparts to the MILGEM series are the REIS class AIP-equipped submarines. A circa €2.1Bn contract for six of these Type 214-TN variants was first agreed in 2009, with construction being assigned to the Gölcük Naval Shipyard. Although based on a ThyssenKrupp Marine Systems (TKMS) design, the REIS class incorporate large amounts of Turkish technology as part of a stepping-stone towards producing a truly national MILDEN submarine. [1] This focus on indigenisation may explain a protracted construction programme that only saw the lead boat – PIRI REIS – floated out towards the end of December 2019. As of mid-2022, she has yet to enter service. Latest official statements suggest that the second of class, HIZIR REIS, will be launched during the current year and that all six submarines will be in service by 2027.

A recent influence on Turkish Navy force structure has been increasing tensions over natural resources in the Eastern Mediterranean and a consequent desire to expand power projection capabilities. Central to these will be the new LHD type amphibious assault ship ANADOLU, which has been built by the privately-owned Sedef Shipyard to a variant of Navantia's JUAN CARLOS I design. The ship commenced sea trials at the end of February 2022 following delays that included the impact of an onboard fire in April 2019. The United States' decision to eject Turkey from the F-35 programme means that an original intention to operate strike fighters from ANADOLU will not be realised. However, numerous reports suggest she will, instead, be equipped with an improved TB3 variant of the Baykar BAYRAKTAR TB2 drone used to good effect by Ukrainian forces during the current Russian conflict. Also important to the fleet's power projection aspirations is a new fast fleet replenishment vessel being built vessel at the Sefine Shipyard under a contract signed in July 2018.

It is possible that the Russo-Ukrainian war will result in a shift in Turkish naval attention away from the Mediterranean towards securing its interests in the waters of the Black Sea. Although many of its current programmes have relevance to both seas, the conflict is likely to emphasise the importance of its submarine arm given the need to counter Russia's latest Project 636.3 variant KILO class submarines. The vulnerability of warships operating in the region to missile attack demonstrated by the loss of the Russian cruiser MOSKVA might also emphasis state-of-the-art air defence capabilities. This might give impetus to of long-awaited plans to construct a class of large TF-2000 air defence destroyers. Design work on these ships started in 2017 and is being influenced by the current mid-life upgrade of the MEKO 200-TN Batch 2 BARBAROS class frigates. The update will be used to prove some of the technology being developed for the new destroyers as a joint ASELSAN/HAVELSAN effort. The TF-2000 design is also likely to use a new MILDAS Vertical launch system being developed by Turkey's Roketsan and deploy a range of indigenously-developed missiles.

Romania

Romania's Navy has seen only limited investment since the end of the Cold War. With the exception of two second-hand Type 22 frigates of British Royal Navy origin acquired soon after the turn of the Millennium, the bulk of the fleet's equipment still dates back to the era of the Warsaw Pact. Although there are longstanding plans for naval modernisation, these have failed to gain significant traction.

In July 2019, the Romanian government announced the selection of France's Naval Group, acting in partnership with local company Santierul Naval Constanta (SNC), to undertake a major programme of fleet renewal. The project – reportedly valued at €1.2Bn – encompassed the modernisation of the existing Type 22 frigates, the construction of four new GOWIND corvettes and the creation of training and maintenance facilities. Contemporary reports suggested that the first of the newly-built vessels could be delivered in the course of 2022. However, as of May 2022, a contract

Photo: US Navy

Major Romanian fleet assets such as the frigate MARASESTI are long overdue for replacement.

Photo: Naval Group

Naval Group continues to negotiate the sale of four GOWIND series corvettes to the Romanian government.

had yet to be finalised against a backdrop of legal challenges and speculation in the local press about tensions within the Naval Group/SNC alliance. Further delay would provide Damen's Galati shipyard – which was the losing bidder in the original competitor and a significant builder of warships for export – with an opportunity to revitalise its own proposals. These are based on the SIGMA 10514 variant of Damen's well-known SIGMA design armed largely with US-sourced weaponry.

It is apparent that the Romanian government now sees realisation of the programme as a high priority given the assault on its Ukrainian neighbour, making it likely that a contract – in one form or another – will proceed before too long. Reports at the end of April 2022 indicated that the Naval Group consortium had been given a further extension of the deadline to finalise the deal and that it is now hoped that this will be signed by the autumn. Speaking to MDM, Naval Group said, "We are committed to providing the Romanian Navy with the ships it needs to fulfil its missions on the Black Sea in the best possible timeframe and are in discussions with the Romanian authorities to finalise the contract."

Meanwhile, Romania has strengthened its maritime coastal defences as a result of an agreement announced in May 2021 to acquire Raytheon-manufactured NAVAL STRIKE MISSILES (NSM) under the US Foreign Military Sales program. The reported circa US$300M contract is the first Raytheon export of the system under its 2015 partnership with the missile's designers, Norway's Kongsberg Defence & Aerospace. It is believed to encompass two complete NSM Coastal Defense System (NSM CDS) units. Each of these comprises a fire distribution centre and associated mobile launch and transport loading vehicles. The acquisition is certainly a timely one given the proven efficacy of such weapons in the Russo-Ukrainian War.

Bulgaria

The general direction of the Bulgarian Navy has closely followed that of its Romanian Navy in recent years. Acquisitions of a small number of second-hand warships from Western European sources have been used to bolster an essentially Cold War-era fleet. The most significant of these "new" vessels are the three former Belgian WIELINGEN class frigates acquired in the first decade of the current millennium. These have been supplemented by three former Belgian and

Photo: Crown Copyright 2020

The Bulgarian Project 1159 corvette SMELI. Like Romania, much of Bulgaria's fleet is currently composed of Cold War-era assets.

Dutch TRIPARTITE minehunters, two of which are relatively recent additions.

Also in similar fashion to Romania, Bulgaria has accorded a high priority to inducting modern surface combatants into its fleet. Their acquisition has also proved to be somewhat protracted due to competing priorities for finite defence funding. However, a contract for two "Multipurpose Modular Patrol Vessels" (MMPVs) was finally signed with Germany's Lürssen (now NVL) in November 2020. The agreement is reportedly valued at circa €450M and is based on the group's OPV-90 design. This is essentially an enlarged variant of the OPV-80 class vessels that have already been acquired by Brunei and Australia. The Bulgarian variants are essentially large corvettes armed with surface-to-air and surface-to-surface missiles and equipped with a Saab combat management system. [2] The contract is being implemented in conjunction with local shipbuilder MTG Dolphin of Varna, which has been allocated responsibility for the two vessels' construction. A first steel cutting ceremony for the lead ship was held on 3 December 2021. Updating MDM in May 2022, NVL said, "The project is well on track. NVL is preparing for the upcoming keel-laying on time. This will foster NVLs strong relationship with the Bulgarian Navy."

It is, perhaps, too early to speculate on the impact of the current Ukrainian war on future Bulgarian naval procurement. However, it seems possible that the MMPV programme could be expanded to meet the new strategic environment.

Photo: NVL Group

A computer generated image of NVL's MMPV90 design, which forms the basis for Bulgaria's new surface combatants.

Ukraine

Having lost much of its naval infrastructure after Russia's 2014 seizure of the Crimea, Ukraine subsequently embarked on a long-term naval strategy that adopted a phased approach to rebuilding the country's naval forces over the period to 2035. The initial part of this plan was aimed at developing capabilities to establish control over territorial waters up to around 40 nautical miles from the coast. The creation of effective maritime domain awareness was to be followed by the acquisition of sea denial and, subsequently, sea control capabilities. One element of this approach was the construction of a "mosquito fleet" of small craft typified by the Project 51855 GYURZA M armoured gunboats. Seven out of a planned class of 20 of these circa 50 ton vessels had been completed by the Kuznya na Rybalskomu armaments plant in Kyiv at the time of Russia's 2022 invasion. A further two related Project 58503 CENTAUR-LK assault craft had been completed but not yet accepted due to a contractual dispute with the builders.

The next stage of Ukrainian naval reconstruction was well underway at the start of 2022. This had a number of strands, including the purchase of up to 16 Mk VI patrol boats from US-builder SAFE Boats International and 20 OCEA FPB 98 Mk I patrol boats from France, the latter for border guard use. Both of these acquisitions can be regarded as being in line with the mosquito fleet philosophy. A more ambitious plan involved the purchase of ADA class corvettes from Turkey, with contracts reportedly in place for two of a planned four-vessel class by the end of 2021. Construction of these vessels has been allocated to the privately-owned RMK Marine, which laid down the lead vessel in September 2021. The programme envisaged final outfitting at the Okean shipyard in Mykolaiv, an eventuality which recent events would seemingly make unlikely.

Less advanced at the time of the Russian invasion was a major Ukrainian Naval Capabilities Enhancement Programme (UNCEP) agreed with the United Kingdom. A framework agreement for this project was concluded in November 2021 and ratified on 27 January 2022, less than a month before the current war broke out. Led by Babcock International, it encompassed a number of elements, including:

- The transfer and modernisation of two former Royal Navy SANDOWN class minehunters.
- The construction of eight P-50U fast attack craft, at least six in Ukrainian facilities. These 50 metre vessels are intended to be powerfully armed for their size. Weapons systems reportedly including MBDA MARITIME BRIMSTONE surface-to-surface missiles.
- The revitalisation of Ukrainian shipbuilding infrastructure.
- The training of Ukrainian naval personnel.
- The potential acquisition of a modern frigate capacity based on the ARROWHEAD 140 design.

Clearly, the future direction of UNCEP is now clouded by uncertainty alongside other Ukrainian naval modernisation efforts. Even assuming the country's defences prevail against the Russian assault, the task of reconstruction will be immense and much infrastructure might be inaccessible. However, with the bulk of Ukraine's existing naval assets lost to the current conflict, the existing contracts in place with overseas suppliers might well form a swift route to rebuilding capacity once the current fighting ends.

Photo: Ukrainian Ministry of Defence

Ukraine has acquired small vessels such as the Project 51855 GYURZA M armoured gunboats as part of its "Mosquito Fleet" concept. The majority of those completed have been lost as a result of the Russian invasion.

Photo: STM

Ukraine had ordered two ADA type corvettes – the Turkish BÜYÜKADA is seen here – for joint completion by Turkish and Ukrainian yards before the current conflict began.

Russia

Turning to the other side of the hill, Russia's Black Sea Fleet has lost much of its previous "Cinderella Status" in recent years, receiving the investment needed to become a more balanced and effective force. Accelerating after the annexation of Crimea, this process of modernisation has clearly been influenced by ongoing tension with Ukraine and a desire to dominate the northern shores of the Black Sea. However, another important driver has been Russia's desire to increase its influence in the neighbouring Mediterranean. The Black Sea Fleet's involve-

Russia's Black Sea Fleet has acquired a large number of modern combatants over the last decade. Amongst these are the trio of Project 11356 frigates – this is ADMIRAL ESSEN.

ment both in sustaining and providing strike capabilities for Russia's involvement in the Syrian Civil War provides a good illustration of this dimension.

From a materiel perspective, the most important aspect of the Black Sea Fleet's modernisation has been the arrival of the six new Project 636.3 KILO class submarine variants. These were delivered by Saint Petersburg's Admiralty Shipyards between 2014 and 2016. In addition to providing significant sea denial capacity, their ability to deploy KALIBR cruise missiles gives them an important offensive capacity. Bolstering these assets have been the three Project 11356 ADMIRAL GRIGOROVICH class frigates completed at Kaliningrad by the Yantar facility between 2016 and 2017. Perhaps ironically, an inability to source Ukrainian-manufactured gas turbines meant that it proved impossible to complete another three members of the class for Russian service. Supplementing these "fleet" units have been a number of smaller vessels. These include Project 21631 BUYAN M class corvettes built by the inland Zelenodolsk Shipyard, as well as the larger Project 22160 VASILY BYKOV class patrol vessels. As is the case for the GRIGOROVICH class frigates, both these types either deploy or are capable of deploying KALIBR. Interestingly, the most recent BYKOV class vessel was built at the Zaliv shipyard in Kerch, Crimea. This facility is also involved in building the new Project 22800 KARAKURT corvettes and Project 23900 IVAN ROGOV class amphibious assault ships.

The Project 22160 VASILY BYKOV class patrol vessels are amongst a number of smaller combatants that have been delivered to modernise Russia's Black Sea Fleet.

In spite of a number of well-publicised setbacks, the modernised Black Sea Fleet has provided Russia with a decisive advantage at sea during the course of the current conflict. It has provided the means to deny Ukrainian access to important maritime trade routes crossing the Black Sea, whilst supporting littoral operations in the Sea of Azov. Its various KALIBR-armed vessels have been at the forefront of conducting precision strikes on important Ukrainian infrastructure. Nevertheless, a number of important deficiencies have become apparent. These include an obvious vulnerability to surface strike weapons and a lack of modern amphibious shipping.

Looking to the future, any further enhancements to the Russian Black Sea forces will obviously be complicated by the potential long-term closure of the Bosphorus and Dardanelles to its warships. An important mitigant to any such action is the alternative means of access provided by the network of inland waterways that forms the Unified Deep Water System of European Russia and the ability to reinforce the fleet with smaller warships by this means. However, the ability to bolster the Black Sea Fleet with larger vessels will inevitably depend on further efforts to expand local shipbuilding infrastructure at Kerch and elsewhere. ■

Notes:

1. Interestingly, press reports dating from September 2021 stated that the bow section for the third Type 214-TN submarine, MURATREIS, had been locally constructed by the Gürdesan Shipyard in a first for a Turkish submarine. Whilst is not entirely clear whether or not the associated torpedo handling equipment is of indigenous manufacture, this suggests further progress towards making the MILDEN concept a reality.
2. Saab has also supplied a derivative of its 9LV combat management system for the Royal Australian Navy's NVL OPV-80 ARAFURA class design.

A Turning of the Times

Photo: DGAP

Thorben Schütz

Zeitenwende (a turning point in history); under this Heading the newly instituted German government announced nothing short of a paradigm shift in Germany's political, military, and economic policy. The biggest in Germany's policy since the Cold War. It dates to German Chancellor Olaf Scholz's declaration on 27 February 2022, three days after Russia's invasion of Ukraine. In the Bundestag, he announced the launch of a €100Bn programme to upgrade the Bundeswehr. In order to facilitate this investment, he proposed a special fund be approved by the Bundestag, the German Parlialment. In addition, the German defence budget will be increased to at least two per cent of the gross domestic product with immediate effect. Apart from an early announcement for the procurement of the US F-35 from Lockheed Martin to replace the ECR Tornado, other decisions on military acquisitions are pending.
What are the implications of the German move? MDM had the opportunity to interview Torben Schütz, Associate Fellow Security and Defence Programmes at the German Council on Foreign Relations.

MDM: What positive effects in the international context do you see from the realisation of the special fund?
Schütz: If Germany realises the special fund as announced by Chancellor Scholz on February 27th, it will be an important signal to Germany's allies that the country is getting serious about defence. It will help convince partners that Germany will now fulfil what it promised back in 2014 in terms of defence spending – at NATO's Wales Summit – and in terms of military capabilities from 2016 onwards. Especially the focus on providing NATO with three (multinational) land divisions will gain more importance given the Russian invasion of Ukraine and thus the return of high-intensity and large-scale mechanised warfare to Europe.
At the same time, the special fund will create funding security for a range of multinational armament projects that Germany is pursuing with its allies. These include not only the ones that are large and politically visible, like the Future Combat Air System (FCAS, with France and Spain) or the Main Ground Combat System (MGCS, with France). Others serve capabilities that are vital for Germany and NATO while simultaneously being in short supply, such as the development of a new amphibious bridg-

Photo: NATO

On 17 May 2022, NATO Secretary Jens Stoltenberg received the official letters of application to join NATO from the ambassadors of Sweden and Finland.

Masthead

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Cover photo: The Lithuanian naval patrol vessel SĖLIS
(Photo: MoD Lithuania)

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ing vehicle with the UK. Yet others serve the closer integration of European military and industrial capabilities, like the submarine project with Norway. All these, plus a range of national projects with alliance-wide repercussions like purchasing F-35 combat aircraft, among other tasks for Germany's participation in NATO's nuclear sharing, will profit from enhanced financial security. Overall, realising the special fund would stabilise and increase Germany's (and hence Europe's) military capabilities and its defence industrial base – important goals of both NATO and the EU.

MDM: How do you assess this turning point in security policy and defence budgeting with respect to NATO and the EU?
Schütz: Beside signalling intent, the most visible impact of Zeitenwende would be that Germany would fulfil both parts of NATO's defence investment pledge: spending both at least 2% of its GDP on defence and at least 20% of that on investments. At the same time, it would probably fulfill the PESCO criterion of real year-on-year defence budget increases – unless inflation runs even higher in the near future. If Zeitenwende entails a steadily growing regular defence budget, it will provide planners in the Ministry of Defence with room for manoeuvre to both invest in and promise greater German involvement in the respective multinational defence planning, coordination and cooperation formats, i.e. NATO's Defence Planning Process (NDPP) and the EU's Permanent Structured Cooperation (PESCO). Interlocking parts of the defence spending Zeitenwende with the EU Commission's incentives, e.g. via a more active outreach by Germany to other member states potentially willing to participate in planned German procurement projects, could further increase its buying power as Germany and willing allies could make use the of proposed VAT exemption.
Lastly, it remains to be seen how Zeitenwende will affect future arms export decisions by the government. So far, the government framed the export of weapons into the active conflict in Ukraine as an exception. Its focus remains on a tighter arms export regime, including enacting an arms export law and thus codifying such a restrictive approach. Depending on how it is applied in practice, this could present a risk for future exports of multinational projects and make integration of Europe's defence industrial base more difficult. If, on the other hand, arms exports and industrial integration win political support from the government, it could very well benefit NATO and the EU in terms of less industrial and equipment fragmentation and thus increased interoperability.

MDM: What risks exist that could be absorbed by partners?
Schütz: There are three principal risks against which partners might want to hedge. First, their own defence spending increases can limit the impact if the German Zeitenwende does not materialise or not on the scale envisioned by Chancellor Scholz in his speech on February 27th. At the time of writing, at least twelve NATO allies have already stated their intention to increase their defence defence spending and that is a good sign in that regard. Second, Germany's allies should continue to pressure Germany to increase its spending (incl. via the special fund). This includes carefully profiling European defence spending increase timelines as no industrial and procurement system in Europe is prepared to handle a sudden massive influx of money. The (politically understandable) intention to spend the money quickly to present results to both a domestic audience and to international allies has several adverse effects, from overburdening the procurement system to incentivising industry to maximise margins.

Third, partners should keep the defence industrial aspect in their view. If Germany does increase its defence spending significantly, this will have ripple effects for other potential buyers of such equipment, potentially delaying their procurement. Hedging might seem like a logical conclusion, e.g. pursuing parallel negotiations with other suppliers, but up-front coordination with Germany likely leads to lower costs for overall projects. Such coordination should include their domestic defence industrial base, if existing, to explore, e.g. integration into Germany's industrial supply chains or or licensed production, which increase overall European industrial resilience. For points two and three, and besides bilateral negotiations, strong allied support for the EU Commission's planned Defence Joint Procurement Task Force, designed to coordinate the influx of money and its effects on the overall defence industrial and procurement ecosystem, is critical. Consequently, if the Commission's proposed EU Joint Defence Strategic Programming and Procurement initiative is realised as a successor to the Task Force, it would contribute to such coordination amongst the European allies in the medium-to-long term.

MDM: What would be the consequences of a failure of Zeitenwende in the context of Germany's network of international relations?

Schütz: Conversely, a failing Zeitenwende would send a disastrous signal to Germany's allies. It would mean a further deterioration of trust towards Germany, especially in Central and Eastern Europe, where allied patience is already worn thin due to Germany's reluctant Ukraine policy since the Russian invasion. German leadership in Europe would become even more of a pipe dream. Moreover, the personal reputation of leading German politicians that announced the aim to create a modern Bundeswehr, even the most effective forces in Europe, would certainly also take a hit. In turn, closer European military integration, especially in the EU framework, will likely get more difficult as disappointed allies turn towards NATO or bilateral negotiations with the USA and UK. Even cooperation structures in NATO, in which Germany has positioned itself prominently, like the Framework Nation Concept (FNC), wouldn't be immune to the fallout for two reasons: First, allies would not want to closely integrate with the Bundeswehr for fear of diverging defence policies and second given the fact that the Bundeswehr would likely cease to remain a full-spectrum force over the medium term as old equipment would retire without funds to replace it. Both effects would render the idea of a framework nation quite useless.

Such planning insecurity would hence affect many procurement projects, and political and industrial interests would then decide which projects to cut and which to keep. In the direct relations with partners, it might threaten FCAS and MGCS, whose financial security was already a point of contention between France and Germany, dampening the outlook of a successful continuation of both programs. Lastly, a lack of trust in German leadership and a lack of substantial forces that could serve as a framework for allies will increase the political and military influence of the USA and the industrial footprint of US suppliers. Increased European dependency and decreased autonomy would inevitably follow. ■

The Baltic Sea under Different Auspices

Photo: Bundeswehr / Deutsche Marine

Rear Admiral (LH) Henning Faltin, Commander COE CSW and Commander EF 1.

The Centre of Excellence for Operations in Confined and Shallow Waters (COE CSW) is a NATO think tank, based in Kiel, Germany. It develops new operational approaches, adapts existing concepts and, in cooperation with research, development and industry, provides impetus for new technologies and systems. The centre is involved in the conception and organisation of international conferences and other maritime security related events.It has gained an outstanding reputation as part of the Munich Security Conference. MDM had the opportunity to talk to Rear Admiral (Lower Half) Henning Faltin as the Commander COE CSW who is simultaneously Commander of the German Navy's EF 1.

The COE CSW was established in 2007 and accredited by NATO as an International Military Organisation in 2009. In 2012 and 2018 the COE CSW was successfully reassessed by the Headquarters Allied Command Transformation.
Operational Flotilla 1 – Einsatzflottille 1 or EF 1 – is one of the three major formations of the German Navy. It includes K-130 type corvettes, submarines, fleet service units and MCM-vessels as well as the "Seebataillon" (naval battalion) and the Navy's Special Forces Command. In addition, EF 1's supply ships maximise the range and endurance of its corvettes, MCMVs and submarines. Units of EF 1 are involved in many overseas operations. This applies not only to maritime operations such as UNIFIL in Lebanon or the EUNAVFOR MED "Irini" operation and the Central Mediterranean. The Flotilla also regularly provides specialists for operations in the Balkans, Mali and Western Sahara. In addition, its units regularly take part in operations or exercises of the NATO intervention forces and can be found at national and international manoeuvres.
5,000 soldiers and employees serve in Operational Flotilla 1. Four seafaring squadrons, two land-based formations and three naval base commands belong to the Flotilla. The Flotilla Headquarters, the 3rd Minesweeper Squadron and the Support Squadron are based in Kiel. Eckernförde is home to the 1st Submarine Squadron, the Navy Special Forces Command and the Sea Battalion. The units of the 1st Corvette Squadron have their home port in Rostock-Warnemünde.

MDM: Admiral Faltin, you are the Director of the NATO Centre of Excellence for Operations in Confined and Shallow Waters in Kiel, COE CSW for short. What are your tasks and duties?
Director COE CSW: The founding idea for the establishment of the COE CSW in 2007 is still valid today: to contribute our knowledge to NATO's "Warfare Development". Then as now, we support NATO with our expertise in the field of maritime operations in coastal waters. We do this with Germany as a framework nation and with the personnel and financial support of Denmark, Estonia, Greece, Italy, Lithuania, the Netherlands, Poland, Turkey and the USA. But we also do this in concert with other COEs, other NATO elements and in cooperation with science and industry.

MDM: Are you completely free to choose your projects and activities?
Director COE CSW: The participating nations grant us a comparatively high degree of freedom in the choice of our work packages and possible project partners within the framework of the MoU on which our organisation is based. Finances and the work programme are submitted to our "Steering Committee", a kind of supervisory board made up of representatives from all participating nations, for approval every six months. The content, however, is of course open-ended.

MDM: How does the work of the COE CSW actually take shape within the framework of NATO?
Director COE CSW: The CSW COE supports all areas of transformation in NATO as a first priority. This is laid down as a requirement for all COEs.
For example, we work intensively in numerous NATO working groups, such as the "Working Group for Maritime Operations" and its subgroups, and in the area of the "NATO Naval Armament Group". We regularly support NATO exercises by designing, planning, conducting and evaluating certain exercise components. In addition, strategically oriented projects are also part of our portfolio – for example, our annual "Maritime Security Round Table" within the framework of the Munich Security Conference.

MDM: Could you say something about cooperation with the other NATO-accredited COEs?
Director COE CSW: There are currently five COEs that have a direct maritime connection. In addition to the COE CSW, we have the Centres of Excellence for Combined Joint Operations from the Sea (COE CJOS) in Norfolk, USA; for Naval Mine Warfare (COE NMW) in Ostend, Belgium; for Maritime Security (COE MARSEC) in Istanbul, Turkey; and – last but not least – for Maritime Geospatial, Meteorological & Oceanographic (COE MGEOMEOTOC) in Lisbon, Portugal.
Cooperation with these maritime COEs is intensive and extends to many aspects of our work. But there is also a lively exchange of information and ideas with non-maritime competence centres, such as the Joint Air Power Competence Centre (JAPCC), the Improvised Explosive Devices (COE C-IED) or the COE for Military Engineering based in Ingolstadt.

MDM: What are the current focal points of work in the COE CSW?
Director COE CSW: What all our projects and activities have in common is that they occupy fields of the future. This includes our initiative to develop a NATO-inherent Live Virtual Constructive Training (LVC-T)

Photo: 2018 Bundeswehr/Jane Schmidt

The minesweeper with tender RHEIN (left) and MAIN (right) sails in the Bay of Kiel as part of the multinational squadron exercise SquadEx to search for mines in the western Baltic Sea, Feb. 26, 2018.

Photo: 2019 Bundeswehr/Marcus Mohr

Corvette F 262 ERFURT fires two RAM Rolling Airframe Missile air-launched missiles from the aft (rear) and forward launchers to shoot down a drone target during the MISSILE FIRING EXERCISE 2019 in Sweden, May 18, 2019.

Photo: Bundeswehr/Marcel Kröncke

Soldiers of Bordeinsatzkompanie 2 from the Sea Battalion pass the frigate F 222 BADEN-WÜRTTEMBERG during trials of the boat type Buster in the Kattegat maritime area, 06/08/2019.

capability; the development of a software-supported wargaming capability; the investigation of the diverse possibilities of drone operations in marginal sea areas; the field of electromagnetic operations; and the use of satellite data for situational awareness and harbour and force protection. We are also involved in exploring aspects of counter-improvised explosive devices (C-IED) in the maritime environment. Despite the wide variety of topics, our projects and activities always have one thing in common: they are geared to NATO's current needs and closely follow the "maritime pulse of time".

MDM: Admiral Faltin, as well as your responsibilities for the COE CSW, you are also commander of a German Navy operational flotilla. What is your assessment of the situation in terms of the availability and capabilities of the units of your flotilla against the backdrop of the war in Ukraine?

Director COE CSW: The variety of formations, units and weapons systems that comprise my flotilla provide important multi-faceted capabilities for the Baltic Sea/Northern Flank area of operations. With the start of Russia's war of aggression against Ukraine, we were able, almost without delay, to have a large number of units of the German Navy and Operational Flotilla 1 operating in the Baltic Sea under the operational name BALTIC GUARD, thus also making a significant contribution to NATO's situational picture. Through the deployment of these various units, we were able to demonstrate vigilance and defence readiness. Moreover, through joint exercises with and port visits to our partners in the eastern Baltic Sea, we showed that we are a presence that can be relied upon. This signal reached our allies in the Baltic States and in Sweden and Finland in particular, but also had an impact beyond them.

Even though we were able to demonstrate our responsiveness in this specific situation, the struggle to improve availability is an issue that occupies me on a daily basis. While the men and women in the fleet are literally busting a gut and fulfilling our missions with flexibility, creativity and, above all, unconditional commitment, we are still only at the beginning of turning around underlying limitations that repeatedly restrict us. There are repairs that regularly exceed the planned time frame. In procurement, lengthy award procedures and, when they occur, contract appeal processes are slowing us down. Capacity bottlenecks in procurement and maintenance as well as the lack of availability of spare parts lead to a materiel state with which I am not satisfied.

The reconsideration of national and alliance defence, which was already initiated in the run-up to the current crisis, takes on additional importance in view of the current security situation. In a joint effort, all agencies involved should proceed as quickly as possible in coming to grips with systemic problems that have already been identified in order to increase the availability of the existing fleet.

MDM: In your assessment, what impact will the crisis have on naval warfare, especially in littoral seas?
Director COE CSW: The Baltic Sea is probably the most demanding maritime area of operation for the German Navy. This calls for forces that demonstrate versatile skills and act with determination. Not everything is as it used to be, but not everything is different either. Whereas in the Cold War the task was to prevent the enemy from breaking out of the Baltic Sea, today it is important to preserve the use of this area of operations for us in the face of potentially hostile influence.
Securing and strengthening our Baltic allies and also supporting our allies on the northern flank in conjunction with other partner nations is of indispensable importance here.
This operational space must be kept open for our use; the trade and supply routes for energy, raw materials and information require credible protection and deterrence. In this context, the Baltic Sea is a narrow and demanding area of operations in which only those who know how to operate professionally and decisively can survive. This requires the ability to act in a practised, coordinated manner with the various weapon systems available within the framework of a group, both nationally and internationally.
Even though the number of friendly states on the Baltic Sea has increased since the end of the Cold War, this has not made freedom of operation any greater or easier. It is only a given if we know how to cooperate with each other. For this purpose, it is necessary to obtain a common situational picture in order to create immediate superiority of action by means of information.
This includes the use of a sensor network that is robust in the face of cyber-attacks as well as solid satellite surveillance for extremely short response times and rapid focus on the basis of a common real-time situational picture. Faster, safer and more decisive joint action will be crucial. Only in this way can we, as a reliable partner in the heart of Europe, also fulfil our obligation as lead nation in the Baltic Sea region.
In the past, my flotilla and its subordinate units for submarine warfare have always

Photo: 2020 Bundeswehr/Friedrich Weishaupt

Minehunting boats set course for Norway as part of the summer manoeuvre SquadEx from the 3rd Minehunting Squadron in the North Sea and Baltic Sea, 14.08.2020.

emphasised on fulfilling missions in the littoral regions adjacent to the Atlantic. Our focus is the Baltic Sea and the North Sea and have built up competencies in the areas of anti-submarine warfare, anti-surface warfare and mine warfare. The crisis has once again clearly confirmed this focus on the part of our NATO partners. The German Navy is seen as a key enabler for many of NATO's operational requirements, not only in the area of submarine warfare, but also in the Baltic Sea and the Baltic Sea approaches. We provide important regional know-how for naval warfare and also take on coordination tasks for cooperation with non-NATO states.

MDM: Will recent events also have an impact on cooperation between the Baltic Sea navies?
Director COE CSW: Cooperation with our allies and partner navies in the Baltic Sea was already very good and reliable in the past. This mutual understanding could be quickly built upon in the current situation and an increase in joint activities within the framework of presence operations and exercises could be achieved almost without delay.
For me, it is now important to expand further the role of Operational Flotilla 1 as a vanguard of developing maritime competence in the Baltic Sea/Northern Flank area whilst strengthening integration and cooperation. In addition to deepening the bilateral cooperation of our units with the navies of our allied partners and, especially, those of the Baltic Sea countries, we will make a significant contribution with our capabilities to fulfilling the overall objective of the Chief of Naval Operations to play a leading role in the Baltic Sea region as a lean-to nation and as a "Regional Maritime Domain Advisor" for NATO.
MDM: Admiral, thank you very much.

The interview was conducted by Hans Uwe Mergener.

The Participating Nations of the COE CSW

Germany acts as the framework nation for the COE CSW and provides the infrastructure, basic services, financial support and core staff as well as a number of subject matter experts. Following the establishment of the COE CSW, Greece, the Netherlands and Turkey joined as sponsor countries with voting rights in the Steering Committee and provided subject matter experts. In 2009, Poland joined and in 2014 Italy joined as a sponsor country. NATO COE partner countries are also invited to participate. From 2011 to 2019, Finland supported the CSW COE, making it the first ever contributing partner of a NATO COE.
The US, Denmark and Lithuania also contribute to the COE CSW. The US Navy participates through the Personnel Exchange Programme with the German Navy. Denmark and Lithuania contribute on a voluntary basis in preparation for official accession to the COE CSW.

The Mission

The COE CSW provides NATO and the countries participating in the COE CSW with joint and combined expertise in confined and shallow water (CSW) operations to drive future developments and, in particular, to support the transformation of NATO.

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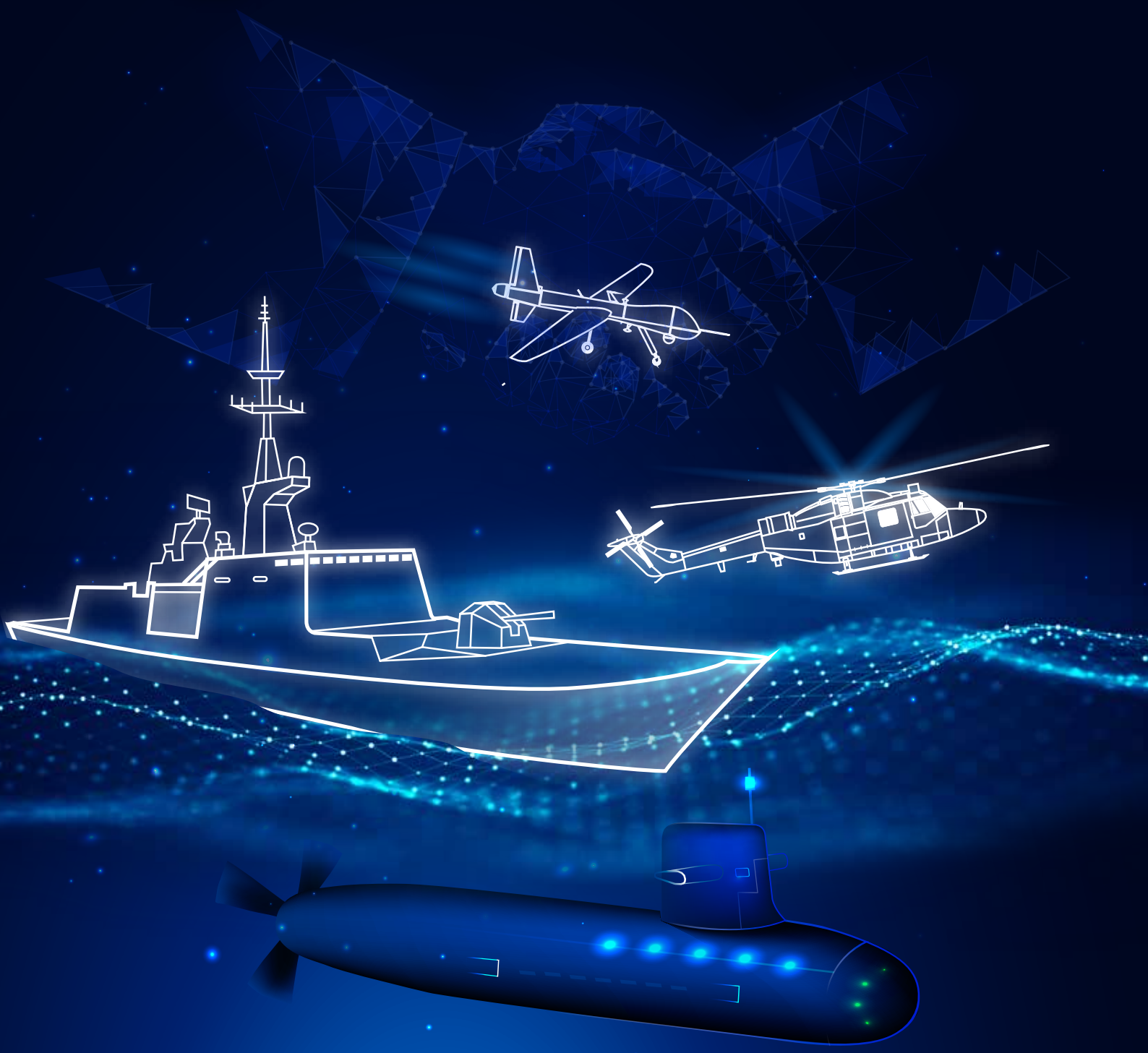
EURONAVAL

THE WORLD NAVAL DEFENCE EXHIBITION



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