Below the Surface: Undersea Warfare Challenges in the 21st Century

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Introduction

During the Cold War the naval stand-off between the USA and the Soviet Union (USSR) was an important part of the bloc confrontation. Within this stand-off, submarines evolved into the key strategic assets on both sides. To gain advantage, NATO and the USSR invested heavily not only in new submarines but also anti-submarine warfare (ASW) techniques and tactics. At the end of the Cold War fleets on both sides of the iron curtain were designed to either conduct submarine operations or counter them, and were and highly sophisticated in doing so. While the proud Soviet fleet fell victim to the economic, political and social turmoil in post-Soviet Russia and its former satellite states, Western navies quickly committed themselves to new but different tasks that made less use of submarines and anti-submarine warfare.

In the absence of a peer sea-control competitor, NATO's future role was questioned, and the alliance had to adapt its role within the architecture of international security—or alternatively become history itself. 'Out of area or out of business' was the motto of the hour. NATO units began to play an important role in conflict and crisis management in the Eastern Mediterranean, the Persian Gulf or the waters around the Horn of Africa. Those low-end maritime security tasks were executed by highly sophisticated cold warriors, optimised for the cold waters of the North Atlantic, with a strong emphasis on high-end warfare and ASW.[1] But the longer the situation remained, the more planners and operators adapted to it: Exercises focused more on humanitarian assistance and disaster relief (HADR), vessel boarding, and search and seizure operations rather than on convoy operations across the Atlantic or ASW in the Greenland–Iceland–United Kingdom (GIUK) gap. On the political side, there was a strong appetite to cash in on the so-called peace dividend after the victory of the Cold War.

1 See also this book's chapter by Sebastian Bruns.

This led to a broad decline in defence budgets and a significant reduction in the size of NATO's fleets.[2]

Today, all Western navies operate a significantly smaller battle force than in 1990. New platforms, ordered in fewer numbers, were designed to fulfil the plethora of low-intensity maritime security tasks Western navies faced in the 1990s and early 2000s. Multi-mission capability was the credo used to acquire funding at that time. Especially in Europe, this resulted in relatively large but, compared with their Cold War predecessors, lightly armed frigates optimised for long out-of-area deployment and the lower end of maritime security tasks—the latest F125 frigate class in the German Navy is archetypal of this development. It is fair to say that the extensive utilisation of the peace dividend resulted in the atrophy of high-end warfare capabilities and skills across all Western and NATO navies, but to varying degrees.[3]

Given the fact that developing and operating subs—and maintaining adequate countermeasures—means constantly pushing technological boundaries, ASW belongs to the most complex, difficult and expensive maritime warfare areas. It comes as no surprise that this capability has atrophied most since 1990. Moreover, because of its complex nature, it takes a lot of effort, time and money to bring ASW back into a fleet's mindset and platforms.

This chapter will examine why Western navies should start to invest effort, time and money in regaining their ASW capabilities sooner rather than later. It will look at current threats and developments in the underwater domain in Europe, the North Atlantic and beyond. It will further examine what future ASW will look like, what role unmanned systems could play and what problems may arise from this both tactically and strategically.[4]

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2 Jeremy Stöhs, "Into the Abyss? European Naval Power in the Post–Cold War Era," *Naval War College Review* 71, 3, Article 4 (2018). https://digital-commons.usnwc.edu/nwc-review/vol71/iss3/4.

3 For a detailed analysis of the development of European navies after 1990, see Jeremy Stöhs, *The decline of European naval forces: Challenges to sea power in an age of fiscal austerity and political uncertainty* (Annapolis, Maryland: Naval Institute Press, 2018).

4 I am indebted to friends and colleagues on both sides of the Atlantic for critically reviewing this chapter. You know your fair share! All remaining weaknesses are solely mine.

The bear and the dragon — current threats

Recent years have seen a boost in technological innovations in the undersea domain and submarine procurement all around the globe. This chapter provides a brief overview of this trend, focusing on the players that generate the most significant strategic challenges.

From a NATO but also an EU perspective, the strategic challenger in the underwater domain is Russia. The Russian Navy went through a valley of tears in the 1990s and early 2000s, with the loss of *Kursk* as a dramatic low point, and has only slowly recovered in partial areas. However, the nuclear submarine force, the traditional heart of the fleet, managed to maintain at least some of its capabilities and platforms. The Sevmash shipyard, Russia's only yard capable of building nuclear-powered submarines (SSN/SSBN) was able to slowly modernise its manufacturing lines and keep a core of skilled workers. The same applies to the Rubin design bureau, the brain behind Russian submarine development. Nevertheless, both institutions face problems in acquiring young skilled manufacturers and researchers—it is unclear, how this will affect Russia's future submarine capabilities.[5]

For the time being, the Russian submarine fleet (nuclear and conventionally powered) mainly consists of modernised and upgraded cold warriors. However, some significant progress has to be acknowledged. Unlike the USSR, Russia is currently streamlining its submarine fleet to two nuclear-powered classes and one conventional class. The future nuclear fleet will be formed by the Projekt 885 general attack submarine of the *YASEN* class and the Projekt 955 ballistic missile submarine (SSBN) of the *BOREI* class.[6] The successor to the recently updated diesel electric (SSK) *KILO* class, the *KALINA* class, which is planned to be equipped with an air-independent propulsion (AIP)[7] system, seems to have overcome some major problems recently. More important, however, is that Russia has established serial production for its SSK. In other words, findings from sea trials and deployments have fused directly into the production process, making innovation cycles shorter and less predictable.

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5 Yoshiaki Sakaguchi, *Russia's Policy on Strengthening the Navy and the Defense Industry*; in: NIDS Journal of Defense and Security 15 (December 2014): 64ff. http://www.nids.mod.go.jp/english/publication/kiyo/pdf/2014/bulletin_e2014_4.pdf.

6 Kathleen H. Hicks, *Undersea warfare in Northern Europe* (Washington, DC, Lanham, MD: Center for Strategic & International Studies; Rowman & Littlefield, 2016), 14ff.

7 Conventional submarines equipped with AIP are referred to as SSP.

The planned ten *BOREI* SSBN will replace the aging *DELTA-III* and *-IV* boomers and will form the backbone of the Russian sea-based nuclear deterrent. Currently four out of ten planned boats are in service. While the first three platforms were built by cannibalising older *AKULA* and *OSCAR* classes, the *Knyaz Vladimir* (commissioned in 2020) marks the first all new *BOREI*, incorporating improved stealth and systems and is therefore titled *BOREI-II*. It can carry 16 Bulava ballistic missiles with a range of 5000 nautical miles (nm).[8]

The nuclear-powered attack/cruise missile submarines (SSN/SSGN) of the *YASEN* class face a similar fate. While the first of the *Severodvinsk* class took almost 18 years to complete, her successor is on a better schedule and is expected to enter into service this year. Like the *BOREI*s, the second boat incorporates significant design changes, resulting in its classification of *YASEN-M*. The boats are equipped with a vertical launch system (VLS) and can carry 32 cruise missiles. They are seen as comparable in stealth and acoustic sensing to the Virginia class, and have more VLS cells than all but the future Block V Virginias.[9] Overall, they are highly sophisticated boats and real peer adversaries to Western navies.[10] Armed with Kalibr and/or Onyx cruise missiles and capable of carrying the hypersonic Tsirkon cruise missile recently under development, these platforms are embedded into a comprehensive national security strategy that incorporates the upgrading of sea, air, land and space assets in combination with enhanced long-range precision strike capabilities. This makes them a strategic challenge for NATO and Western navies.[11] Russia also improved the operational schedule for its submarines. In October 2019, it made international headlines by deploying no fewer than ten nuclear-powered subs in the north Norwegian Sea and the North Atlantic. Western navies were caught off guard. Flanked by exercise Ocean Shield in the Baltic and smaller exercises in the Mediterranean, it created shockwaves across the Atlantic and caught Western navies short-handed. Also serving domestic needs, it was a strong stra-

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8 H.I. Sutton, "H I Sutton—Covert Shores," accessed 12 January, 2021. http://www.hisutton.com/Borei-A.html.

9 Dave Majumdar, "U.S. Navy Impressed with New Russian Attack Boat—USNI News," accessed 24 February, 2021. https://news.usni.org/2014/10/28/u-s-navy-impressed-new-russian-attack-boat.

10 Franz-Stefan Gady, "Russian Navy to Speed up Test Launches of Tsirkon Hypersonic Missile," accessed 13 January, 2021. https://thediplomat.com/2020/04/russian-navy-to-speed-up-test-launches-of-tsirkon-hypersonic-missile/.

11 Magnus Nordenman and James Stavridis, *The new Battle for the Atlantic: Emerging naval competition with Russia in the Far North* (Annapolis, Maryland: Naval Institute Press, 2019), 132ff.

tegic signal towards NATO and the US that Russia is able to disrupt transatlantic reinforcement on a large scale and with almost no warning time.[12][13]

While it is safe to say that submarines appear to have a high priority in Russia's effort to rebuild its naval might, it is not entirely clear how they will be deployed. With its naval base in Tartus, Syria, Russia has achieved its long-desired goal of an ice-free warm water port in the Eastern Mediterranean, unbinding it from the limitations of the Montreux Treaty, which governs the Bosporus. In November 2020, Russia signed an agreement to establish a naval base in Sudan capable of hosting nuclear-powered ships. Should this materialise, Russia would become a strategic competitor both north and south of the Suez Canal.[14] However, Western intelligence analysts and strategists alike are well advised not to solely rely on Cold War assumptions when assessing future challenges.[15]

Parallel to revamping its navy, Russia has put significant efforts into its deep-sea capabilities. The *Belgorod*, commissioned in 2019 and a transformed *OSCAR-II* SSGN, the biggest submarine currently in service worldwide, will function as a test platform for new underwater weapons but first and foremost as a mothership for deep-diving midget subs. Enriched by a new class of deep-sea research vessels, Russia is primarily aiming at undersea cables. In an early stage of a conflict, disrupting these cables would be one of Russia's main tactics. Wiretapping to gain operational advantages is another option to consider. Lying exposed on the seabed, these cables have become the lifelines of the digital age, transferring ca. 99% of the world's data. These cables are too often legally private property of the companies which operate them, instead of critical infrastructure for Western security, prosperity and well-being. Being able to protect and defend this infrastructure should be a top priority in any Western maritime strategy. The fact that Russia's deep-sea assets are not part of the navy but of the Main Directorate for Deep Sea Research (GUGI) makes their legal status in a conflict

12 Michael Kofman, "The Russian Navy in 2019 (year in review)," accessed 8 February, 2021. https://russianmilitaryanalysis.wordpress.com/2020/03/07/the-russian-navy-in-2019-year-in-review/.

13 Richard A. Moss, "Russia basks in cold war glory," *US Naval Institute Proceedings*, 20 October, 2020.

14 Joseph Trevithick, "Russia To Establish Naval Base Capable Of Supporting Nuclear-Powered Ships In Sudan," *The Drive*, 17 November, 2020, accessed 17 November, 2020. https://www.thedrive.com/the-war-zone/37671/russia-to-establish-naval-base-capable-of-supporting-nuclear-powered-ships-in-sudan.

15 Norman Polmar, "To understand Russian submarines, think outside the box," *US Naval Institute Proceedings*, October 2019 (2019), 22ff..

less clear and therefore harder to address—thus, a classic grey-zone challenge.[16]

The other strategic challenger is China and its People's Liberation Army Navy (PLAN). Though mainly challenging the US Navy (USN), forcing it to relocate both personnel and platforms to the Pacific theatre, this has had direct consequences for NATO and the EU. The often-quoted American pivot to Asia has to be compensated for in Europe and in the North Atlantic by European navies—something which can be challenging, to put it mildly.

The PLAN has undergone impressive modernisation and build-up for the last twenty-five years, making it the world largest navy by sheer asset count. In addition to it adding more and expeditionary capabilities, its primary goal is to reach superiority in the South East Asian theatre.[17] This includes submarine procurement as well. While the mainstay of the PLAN´s submarine force is diesel electric, China operates a small fleet of SSN (7) and SSBN (4) with plans for further growth. Though current US analysis estimates that by 2030 the SSK fleet will remain constant (at 55 boats), China aims to replace old and noisy *Kilo* and *Song* class SSK with quiet and capable *Yuan* class SSP, thus increasing the operational value of its conventional fleet significantly. In parallel, the nuclear fleet will almost double to 13 SSN and 8 SSBN. As of today, Chinese nuclear subs are estimated to be well behind Russian boats in regard to their capabilities and stealth. Even though too little is known about the operational viability of the PLAN, the past has shown that China's pragmatic way of dealing with copyright—ranging from simple copy and paste to the aggressive stealing of know-how—has led to it leapfrogging development steps. In combination with the sheer endless capacity of its workforce, Chinese innovation cycles are hard to predict and may be quite short.[18]

To complicate matters, Russia and China are strategic challengers in their own right. Another dimension is added by increased cooperation be-

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16 Usman Ansari, "Worldwide net cable vulnerability opens new front in any future war," *Warships International Fleet Review*, No. 2 (2021).

17 For a detailed analysis of the People's Liberation Army Navy, see Sarah Kirchberger, *Assessing China's Naval Power: Technological Innovation, Economic Constraints, and Strategic Implications,* Global Power Shift, Comparative Analysis and Perspectives (Heidelberg, New York, Dordrecht, London: Springer-Verlag Berlin Heidelberg, 2015).

18 Ronald O'Rourke, "China Naval Modernization: Implications for U.S. Navy Capabilities—Background and Issues for Congress" (Congressional Research Service, 2020).

tween the two countries. Both face strict Western sanctions, which limit their access to dual-use technology. China relied heavily on Russian arms sales and technology transfer. Russia, in turn, bit the bullet of strengthening a potential adversary to bolster its own weak economy. This partnership by destiny has evolved into deep, mutual military cooperation covering the whole intensity spectrum, including even sensitive areas like intelligence, surveillance and reconnaissance (ISR). Officially not labelled an alliance, their relationship consists of mutual support even if it is of next to no use in supporting their own strategic interests. Russian fighter jets have frequently supported Chinese planes entering disputed airspace between China and Japan around the Senkaku Islands. China supported Russian strategic signalling in the Baltic by sending a naval task group for a combined exercise in 2019. Some experts argue that Sino–Russian ties have become so tight that they could easily evolve into a wartime coalition.[19] A whole new dimension could be added if Russia and China should decide to counter their main competitor—the US—with a combined effort in the Arctic. Russian infrastructure developed and modernised with the industrial and financial power of China would secure Russia de facto control over the Northern Sea Route, increasing its influence on Sino–European trade in the future. In return, China could be granted stationing rights for their SSBN in these Arctic ports. This would provide Beijing with the alternative of having the US mainland within striking distance of their submarine ballistic missiles (SLBM) and reduce the risk of their own SSBN being detected. Perhaps far-fetched today, the possibility of such cooperation should not be neglected altogether.[20]

Modern, state-of-the-art submarines are often considered to be the weapon of choice with which to counter a superior surface fleet because of their stealth and the fact that sanitising a certain sea space from a probable submarine threat is a time-consuming effort that requires a significant

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19 Stephen Blank, "China and Russia: a burgeoning alliance," *US Naval Institute Proceedings,* March 2020, 63ff, and Sebastian Bruns and Sarah Kirchberger, "The PLA Navy in the Baltic Sea: A View from Kiel," accessed 22 February, 2021. https://cimsec.org/pla-navy-baltic-sea-view-kiel/33526.

20 Lyle J. Goldstein, "Chinese Nuclear Armed Submarines in Russian Arctic Ports? It Could Happen," *The National Interest*, 1 June, 2019, accessed 21 January, 2021. https://nationalinterest.org/feature/chinese-nuclear-armed-submarines-russian-arctic-ports-it-could-happen-60302.

number of assets.[21] China's massive naval build-up has therefore led to a submarine arms race in South East Asia. Almost all nations in the area have invested or are currently investing heavily in either acquiring submarine capabilities or upgrading their existing fleet.[22] This alters the strategic calculus for all players within the region by offering both potential for new alliances and emerging conflicts alike. The common denominators are submarine and anti-submarine warfare capabilities.

The same can be said for a less remote area (from a European/NATO perspective) in the world—the Eastern Mediterranean. Traditionally a maritime security hotspot, Turkey, Israel and Egypt are currently bolstering their submarine forces with new, state-of-the-art SSP from the German manufacturer ThyssenKrupp Marine Systems (TKMS). Together with Russia's established, permanent submarine presence from its Syrian harbour in Tartus, the underwater domain in the eastern Mediterranean is becoming even more contested.[23] It was already a busy area with its energy resources in high demand.

While some experts argue that technological leaps like the use of big data at least alter the strategic significance of submarines, the trends in global submarine procurement indicate that submarines will remain the cutting-edge adversary on the maritime battlefield for the coming decades. To underpin this with some numbers: Today only three states operate strategic bombers and a dozen deploy aircraft carriers (in various forms), but more than forty countries field submarines.[24]

That leads to the question of how ASW technology and tactics will have to evolve to keep up with this trend.

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21 This chapter focuses on the traditional role of submarines as a peer competitor in a naval conflict. However, submarines (and midget subs in particular) can play a decisive role in maritime hybrid/grey-zone conflicts as well. For a detailed analysis of this kind of conflict and its implications for AMS, see this book's chapter by Frank Hoffmann.

22 Geoffrey Till and Collin Koh Swee Lean, eds., *Naval Modernisation in Southeast Asia, Part Two: Submarine Issues for Small and Medium Navies* (Cham: Springer International Publishing, 2018).

23 Russia has also been basing Kilo SSKs in Sevastapol but characterising their visits as voyage repairs to comply with the Montreaux Treaty. It is, however, essentially homeporting, thus enlarging the Russian footprint in the Black Sea. See H.I. Sutton, "Russian Black Sea Sub Deployments to Mediterranean Could Violate Treaty —USNI News," accessed 24 February, 2021. https://news.usni.org/2020/07/08/russian-black-sea-sub-deployments-to-mediterranean-could-violate-treaty.

24 Bryan Clark, Seth Cropsey and Timothy A. Walton, "Sustaining the Undersea Advantage: Disrupting Anti-Submarine Warfare Using Autonomous Systems" (2020), 11.

Traditional ASW and its shortfalls

ASW has always been a hide-and-seek competition between submarines and their adversary forces. This competition was characterised by the predominant ASW detection method and submarines' efforts to counter it. During WWII, this competition was carried out in the electromagnetic (EM) spectrum, with ASW forces deploying ever-capable radars, taking advantage of the fact that WWII U-boats were in fact submersible ships rather than submarines, as we think of them today. The German type XXI boats were the first to break out of this cycle late in the war, without having any effect on the battlefield though. With the introduction of nuclear propulsion, submarines needed neither to travel on the surface nor to snorkel, ending the electromagnetic-based ASW period abruptly. Since then, the weak point of nuclear submarines has been the constant noise emitted by their nuclear reactors. ASW forces just had to listen carefully. The era of passive sonar and low-frequency analysis and recording (LOFAR ASW) began. This led to a circle of acoustic quietening vs. ever more sensitive sensors. With the introduction of air-independent (AIP) systems, modern SSK (which emit zero machinery noise while submerged) can stay submerged for weeks, narrowing the operational gap to their nuclear-powered sisters and making them peer competitors. Today's cutting-edge submarines, like the American Virginia class SSN or the class 212A SSK operated by the German Navy, are almost impossible to detect with passive sonar alone.[25]

If ASW forces cannot build on passive sonar alone to stay fit for purpose, what will the future ASW game look like and what will be the determining factors? Non-acoustic detection methods will likely become a factor. When travelling through the water column, a submarine disturbs its environment by creating a bow wave or by changing the sound pattern of a certain sea space. While the physics behind these effects are well known, they could not have been utilised in the past due to the sheer amount of data that needed to be collected and processed. Today "big data" provides the computing power to run alphanumeric real-time models to make use of this data.[26] For example, low-frequency (LF) active sonar has a much higher range than regular active sonars. This is offset by its limited infor-

25 Bryan Clark, "The Emerging Era in Undersea Warfare | CSBA," accessed 26 January, 2021. https://csbaonline.org/research/publications/undersea-warfare/publication/1.

26 Clark, "Emerging", 10.

mation content and the degrading of the signal at longer ranges. Big data may help to overcome these limitations by enhancing the signals through interpolation—as is done with digital photos. There is a similar way to further improve passive listening devices by using big data to filter out all the ocean noise, enabling them to concentrate on the minor sound emissions of a modern submarine.[27]

While the possibilities of big data still have to be considered with 'might', one agreed game changer is about to alter the hider–seeker competition fundamentally over the next few years: the introduction of unmanned systems into the ASW game. Classic ASW centres on detecting an adversary submarine using seabed-mounted, space or surface assets. After detection, the contact is passed to a maritime patrol aircraft (MPA) to constantly track the submarine using large numbers of sonobuoys. Meanwhile, surface ships and submarines are directed into the estimated operating area of the submarine to finally engage and defeat the adversary. If contact is lost within this process, the whole game is put to a halt and has to restart—at enormous cost for the seeker. As shown, traditional ASW has always been a joint, if not a combined, endeavour requiring a lot of communication, integration and platforms. As shown above, all larger Western navies are struggling with a (overly) small order of battle and are overstretched with a multitude of tasks across the whole intensity spectrum—leaving limited to no capacities for a major-scale ASW operation.[28]

Another shortfall is that it is principally designed for narrow sea spaces, where geography limits the possible routes for submarines to pass through (like the GIUK gap, for example). While this concept might still be suitable to prevent Chinese submarines from operating behind the first island chain, it has become less appropriate in the North Atlantic. Parallel to modernising its submarine fleet, Russia has put a strong emphasis on building up robust long-range precision strike capabilities. The Kalibr cruise missiles it fields put Russia in a position to threaten main European ports of disembarkation, like Bremerhaven, from the relatively safe waters of the Norwegian or Barents Sea. Instead of traditional SLOC protection, NATO and its allies would need open ocean ASW capabilities to counter this threat.[29] Traditional offensive open ocean ASW is a task for SSN, leav-

27 Robert Elliott, "Finding the enemy below," *US Naval Institute Proceedings*, October 2019 (2019), 27–29.
28 Clark, Cropsey and Walton, "Sustaining," 41ff..
29 Andrew Metrick, "(Un)mind the gap," *US Naval Institute Proceedings*, October 2019 (2019).

ing it, from a Western perspective, mainly to the US Navy and, to a limited extent, to France and the UK.

Future ASW technology and tactics

As shown, traditional ASW is time-consuming, asset-intensive and extremely costly. It has to be conducted by allied navies that are operating smaller fleets than thirty years ago across the board and have struggled hard to turn their decline into an upward trend since 2014. Rebuilding a navy is hard; it seems that rebuilding a submarine force is even harder. Given the ramifications of the COVID-19 pandemic, it is unsure whether this trend of growing navies has been built on sand or not. To avoid the dilemma of rising demands against the backdrop of fiscal uncertainty, future ASW concepts have to be both more affordable in peacetime and more effective and scalable in war. They will therefore have to rely on unmanned and autonomous systems. Fielding these systems will be the disruptive leap in the coming decades.

ASW can be divided into three steps: detection, tracking and engagement. History has shown that a submarine, once it is detected, loses its tactical advantage due to its relatively low speed and its lack of sufficient countermeasures. A detected sub will most likely evade a certain area instead of staying on post and engage. Therefore, much more emphasis has to be put on the first two steps, detection and tracking. Here, unmanned systems offer great potential for more effective and relatively cheap new ASW concepts (see Figure 1).

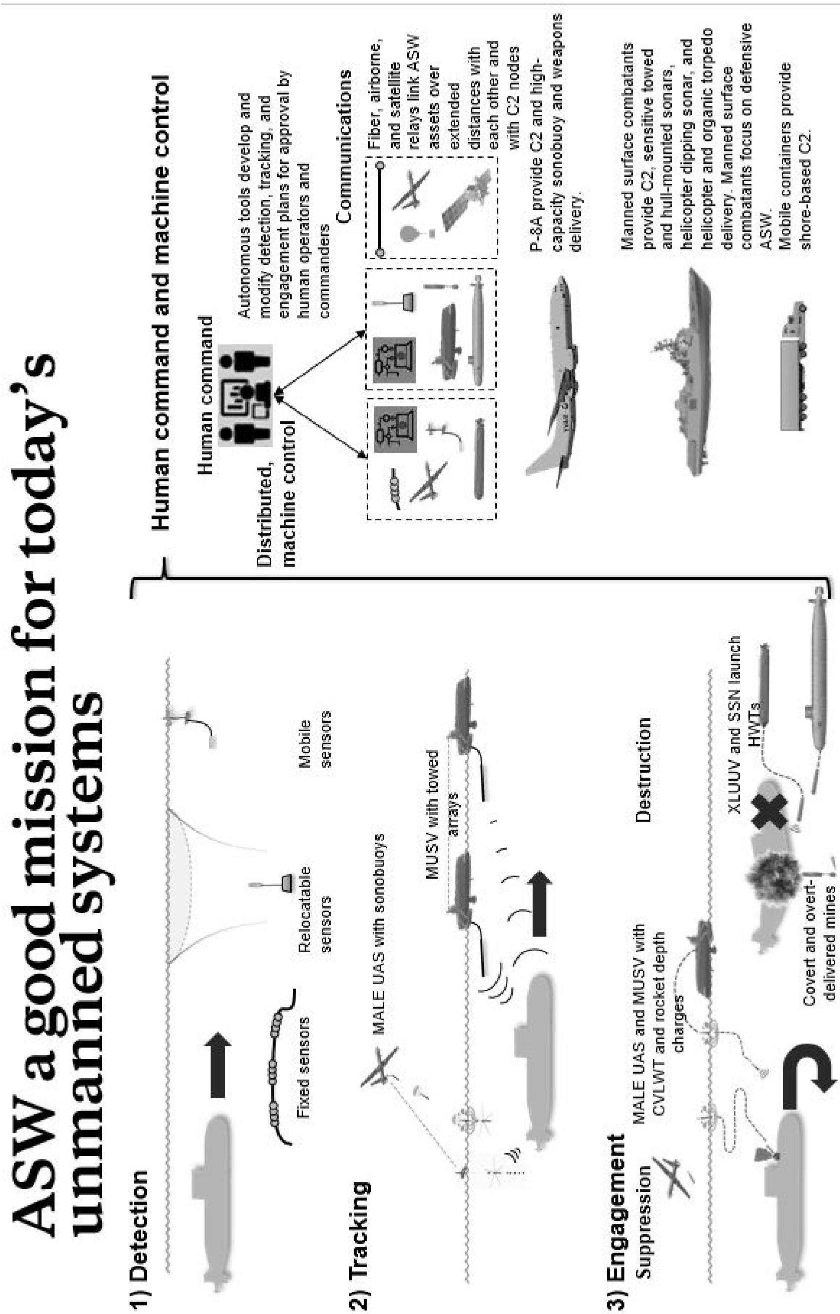
An integrated system of unmanned systems could detect adversaries much closer to their homeports, using fixed and deployable listening devices complemented by medium unmanned surface vessels (MUSVs) or extra-large unmanned underwater vehicles (XLUUVs) with towed passive sonar arrays. Once a contact is established, medium-altitude long endurance (MALE) unmanned aerial vehicles (UAVs), like the MQ-9B SeaGuardian, would track the contact by deploying sonobuoys or using radars. Alternatively, MUSVs, like the Sea Hunter, could trace the contact with passive or active sonars functioning as emitters in a multi-static sensor network, with XLUUVs receiving the signals and keeping contact with the target. In the meantime, manned surface or subsurface assets would be directed to the area to complement the ASW network and to be on the scene should the third step, engagement, become necessary. In a first step, unmanned systems could attack the adversary with small, non-lethal weapons like small depth charges or compact, very lightweight torpedoes

(CVLWT), forcing the submarine to take evasive action. The engagement phase would become more scalable, making it appropriate even to greyzone scenarios, in which it is unclear what rules of engagement apply. Manned submarines would merely come into play when an assured hard kill capability is needed, as only a submarine can carry a torpedo large and capable enough to guarantee a kill on another submarine, especially an SSN.

Even though unmanned systems would act autonomously to a certain degree in the detection and tracking phase, relying on programmed schemes and machine learning, command and control and the final decision on whether to use force or not would remain in the hands of a human ASW officer deployed to a manned asset (airborne or seaborne). But rather than being directly engaged in the loop, he would be on the loop.[30]

30 Clark, Cropsey and Walton, "Sustaining," 6ff. ASW lends itself to humans being on or in the loop because it progresses more slowly than other areas of naval warfare, like missile defence or surface attack.

Figure 1[31]


ASW a good mission for today's unmanned systems
1) Detection
Fixed sensors
Relocatable sensors
Mobile sensors
2) Tracking
MALE UAS with sonobuoys
MUSV with towed arrays
3) Engagement
Suppression
MALE UAS and MUSV with CVLWT and rocket depth charges
Covert and overt-delivered mines
Destruction
XLUUV and SSN launch HWTs
Human command and machine control
Human command
Distributed, machine control
Autonomous tools develop and modify detection, tracking, and engagement plans for approval by human operators and commanders
Communications
Fiber, airborne, and satellite relays link ASW assets over extended distances with each other and with C2 nodes
P-8A provide C2 and high-capacity sonobuoy and weapons delivery.
Manned surface combatants provide C2, sensitive towed and hull-mounted sonars, helicopter dipping sonar, and helicopter and organic torpedo delivery. Manned surface combatants focus on defensive ASW.
Mobile containers provide shore-based C2.

Implications for allied maritime strategies

The development and proliferation of long-range precision (air, land and sea) strike capabilities has made vast parts of the world's oceans a more contested environment for surface ships than ever before. This, and the fact that submarines are sometimes estimated as a force equaliser against a superior surface fleet, has led to a boost in global submarine procurement in recent years.

Headed by the (re-)emergence of the Russian submarine fleet in the Western and the Chinese submarine fleet in the Eastern theatre, this development has pushed ASW to the top of the prioritisation lists of Western navies and their allies. The complex nature of ASW has always made it not only a joint but a combined endeavour, making it a true alliance case. Simple unboxing of Cold War techniques and tactics has proven improper in countering today's challenges. Buying more equipment will not ease the pressing shortfalls given the long and insufficient procurement lines. Further, the ever-increasing costs of state-of-the-art major combatants have emptied the tight budgets of NATO and EU navies alike, leading to trade-offs and (very) small budgets.[32]

On the operational side, hybrid or grey-zone activities carried out by irregular forces with unclear affiliations and conducted below the threshold of an act of war are more likely to occur than 30 years ago. Addressing these threats on the political level requires common acknowledgement of their existence, an agreed definition of such an attack and the criteria of how to measure it. While submarines need not necessarily play a role in hybrid or grey-zone activities, the underwater domain will.

Operationally, it adds another aspect to the challenges NATO and EU navies have to address. To avoid the dilemma of doing more with less and draining tight budgets with highly sophisticated platforms, allied navies will have to rely much more on unmanned and autonomous systems in the future.

Fielding these systems will provide NATO and the EU with affordable, adaptable, quickly deployable and scalable ASW techniques and tactics. Procuring systems at hand off the shelf will help to maintain their under-

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31 Graphic taken from Clark, Cropsey and Walton, "Sustaining," 7. I am indebted to Bryan Clark for his kind permission.

32 For a detailed analysis of the challenges smaller navies face when modernising their inventories and how this affects AMS, see Jeremy Stöhs, "How High? The Future of European Naval Power and the High-End Challenge" (Centre for Military Studies, Copenhagen, 2021).

sea advantage, thus generating a lot of bang for their buck. It will further open up an opportunity for smaller navies to have a significant share in combined ASW. For example, the Baltic States should invest in a system of listening devices (both seabed-mounted and deployable) to create a sonar barrier right at the outlet of the Gulf of Bothnia, instead of seeking to acquire costly platforms. Poland, in addition, could opt for a XLUUV with towed sonar array capability instead of maintaining conventional submarines. Completed at the end of the food chain by the highly sophisticated 212A AIP subs of the German navy and its state-of-the art SIGINT ships[33], a layered ASW network would be established in the Baltic (whether this comes under the NATO or EU flag, FIN and SWE capabilities can be excluded or included). A similar approach with a larger scale and more partners seems appropriate for the North Atlantic.

To unfold the full potential of unmanned systems for NATO, some homework has to be done:

a) ASW has to be exercised frequently. The annual Dynamic Mongoose/Manta exercises have to be enhanced with a dedicated unmanned component.
b) Development, implementation and procurement of new technologies has to be streamlined to ensure interoperability and safe communication. The recently established Centre for Maritime Research and Experimentation (CMRE) and the NATO Maritime Unmanned Systems Net-

33 The three German SIGINT ships are of great value not only for Germany but also in an EU and NATO framework, especially against the backdrop of the current situation in the Baltic Sea and the Northern Flank. Though technically state of the art, these platforms are well beyond their initially planned service life and in need of replacement within this decade. While this is acknowledged in general, no design plan or procurement decision has been made yet. The same is true for the eight P3-C Orion MPAs currently in service in the German navy. After the navy cancelled a major service-life extension programme, all platforms will be phased out by 2025. While the German navy strongly argues for the P-8 Poseidon as the only reasonable off-the-shelf replacement, a political procurement decision is not foreseeable. With the economic impact of the COVID pandemic and a national election ahead in September 2021, it is unclear whether any decision will be made this year. Any further delay increases the risk of a capability gap from 2025 onwards weakening Germany's and Western strategic and operational capabilities in the European theatre significantly and sending a disastrous signal to NATO allies about Germany's will to fulfil its defence spending commitments.
For the MPAs, see i.a. Thorsten Bobzin, "Deutsche Fähigkeit zum Seekrieg aus der Luft," accessed 23 February, 2021. https://marineforum.online/die-faehigkeit-zum-seekrieg-aus-der-luft/.

work (MUS) are steps in the right direction. The EU PESCO initiative could function the same way.

c) There is a different political appetite for unmanned systems. While states like the USA, GB or France, for example, see the opportunities and operational benefits, parts of the political establishment and society in Germany see the first step towards Terminator-like robo-wars conducted by armies of immoral joystick killers in the mere procurement of such systems. Each ally must therefore define a clear position on to what extent it will support unmanned systems and define its possible role within a combined ASW scenario of manned–unmanned teaming.

Manned–unmanned teaming will be the future for all warfare areas, including ASW. NATO and EU member states alike hold the financial power, research landscape, industrial base and military might to become technology leaders in this warfare area. To do so, political caveats have to be addressed and overcome, national procurement has to be harmonised with allied needs and the potential of every member must be utilised in the best possible way.

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