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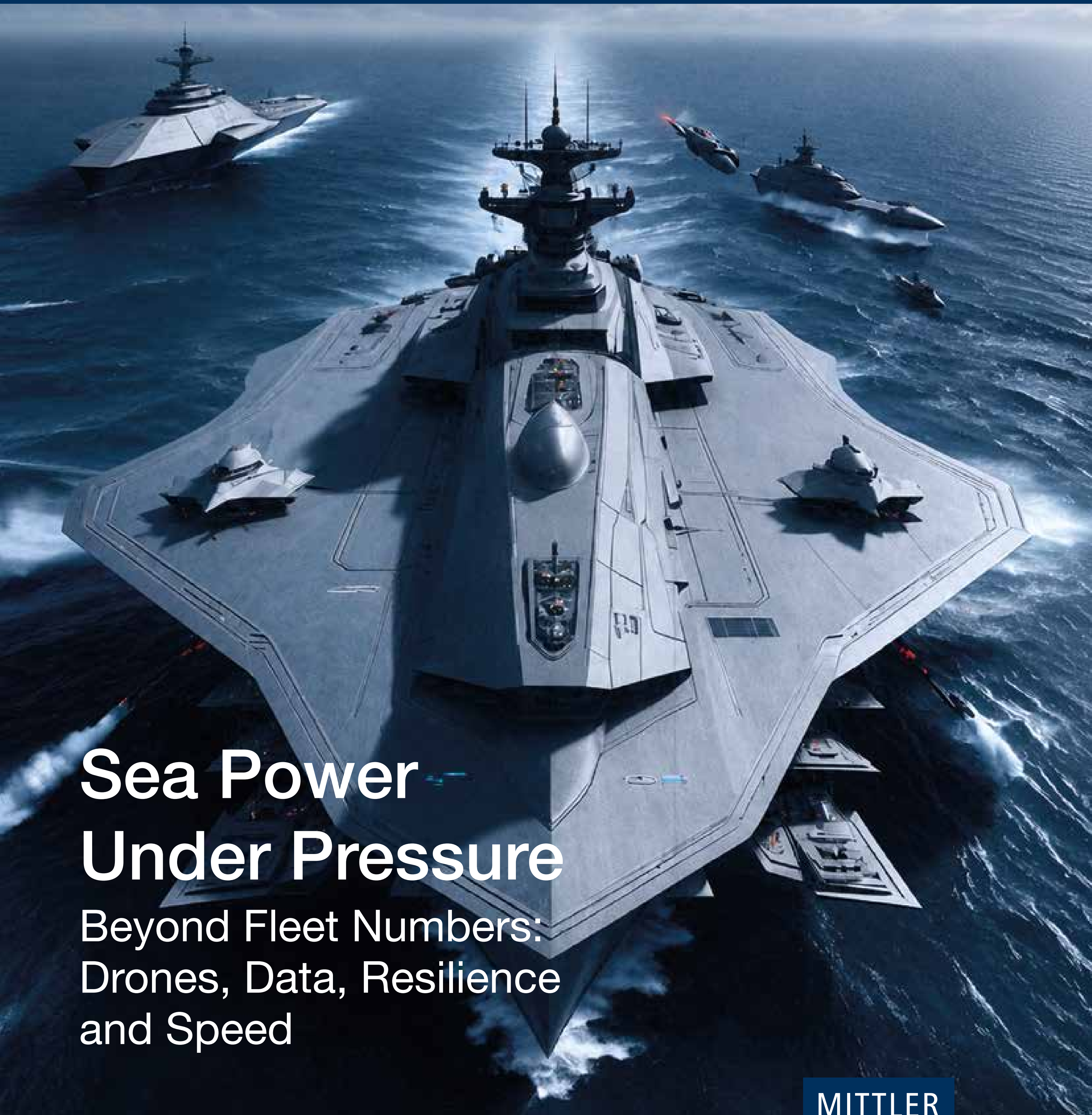

Sea Power Under Pressure

Beyond Fleet Numbers: Drones, Data, Resilience and Speed

MITTLER REPORT

The sea has always connected economies and societies. Today, it also exposes their vulnerabilities

Hans Uwe Mergener
Editor in Chief

Russia's war against Ukraine has returned large-scale war to Europe and forced NATO to rediscover deterrence on its northern and maritime flanks. Hybrid activity, attacks on undersea cables, GPS interference and the weaponisation of commercial shipping blur the lines between peace, crisis and war. The maritime domain has become a multidimensional strategic environment.

This magazine is intended to prepare the MS&D debate, not to repeat it. The contributions look behind fleet numbers and capability gaps. They ask a harder question: can Europe generate maritime power quickly enough?

For years, Europe has discussed common designs, standardisation and closer naval-industrial cooperation. Yet it still operates a fragmented fleet landscape, shaped by national requirements, small runs and slow procurement. Under time pressure, this becomes a liability. A future European fleet must mean availability, magazine depth, repair capacity, sustainment and regeneration.

At the same time, uncrewed and autonomous systems are entering the force structure. They promise mass, persistence, lower risk to crews and new options above, on and below the surface. But drones are not a shortcut around strategy. Layered onto fragmented fleets, they may add complexity rather than combat power. Their value depends on integration, secure C2, energy, endurance, software and scale.

Several articles examine the foundations of maritime power. Critical raw materials, industrial reserves and supply-chain resilience are preconditions for rearmament. Europe cannot strengthen its fleets if materials, components and production capacity remain exposed.

Other contributions address the operational shift at sea. Distributed warfare, long-range weapons, sensor networks and hybrid fleets are changing how naval forces must fight. Future combat power will stem less from individual platforms than from the ability to connect sensors, weapons, data, crewed ships and uncrewed systems into a resilient system of systems.

The underwater domain is a perfect example. Anti-submarine warfare, seabed surveillance, mine countermeasures and CUI protection converge. Persistent maritime domain awareness reaches from seabed to space.

The pressure will not wait for perfect solutions. Europe must become more capable of defending itself while keeping the transatlantic relationship strong. It must move faster without sacrificing interoperability.

MS&D brings together navies, industry, policymakers and the maritime community. This magazine is an invitation to enter that dialogue prepared – with a clear understanding that time and resilience have become decisive dimensions of maritime power. And it may help to overcome sea blindness in societies that depend on maritime flows but often notice them only when disrupted.

Yours Aye
Hans Uwe Mergener

CONTENT

Building MDA requires use of maritime sensing assets in all domains. The Royal Navy (RN) Type 23 frigate HMS St Albans (pictured in 2019) recently was a central platform in a NATO operation to deter Russian North Atlantic submarine activity. ***(© Crown copyright/UK Ministry of Defence, 2021)***

Masthead

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Cover: The European Combat Vessel (ECV) is a collaborative multinational initiative managed by the European Defence Agency alongside seven EU member states—Spain, Portugal, Italy, Belgium, the Netherlands, Cyprus, and Greece—to design a modular family of next-generation warships for the 2040s. (© European Defence Agency)

Welcome Remarks by the Commander German Fleet and Supporting Forces and Deputy Chief of the German Navy **Vice Admiral Axel Deertz**
(© Michael Nitz, Naval Press Service)

Transforming Under Pressure

Ladies and Gentlemen, Distinguished Participants of the MS&D 2026, The motto of this year's conference is "maritime security and defence in a changing world", a title perfectly befitting the reality and subsequent challenges we are facing. To speak from a fleet commander's perspective today, is to speak of transformation under pressure.

Russia currently poses the most serious threat along the entire northern flank in all dimensions: land, air, sea, space and cyber. In order to defend Europe in a conflict, we must be credible in deterring, countering direct attacks, degrading the enemy's military potential – and be able to endure conflict. For deterrence, defence and durability, sea control is substantial. The strategic sea lines from the North Atlantic to the Baltic Sea are threatened.

Their disruption would degrade Europe's supply and defence. What we already notice today: The opponent is preparing for conflict. The Russian Navy is testing our reactions at sea. Despite the war against Ukraine, Russia has been continuously expanding its capabilities. We must make it clear to the opponent that he has no prospect of success in a war. Therefore, we are to acknowledge several technical trends:

• The ascendancy of unmanned systems and their rapid proliferation are the most striking changes. These include systems in the air-, surface and subsurface domain, employed for reconnaissance, targeting, strike missions, and mine countermeasures. The impact is strategic.

• Long-range precision weapons, expanding reach and accuracy of kinetic effects, are another major trend. This shift has transformed the geography of naval warfare.

• State-of-the-art navies depend upon digital networks for command, navigation, targeting, communications, logistics, and intelligence. This dependence creates vulnerabilities. In conjunction, dominating the electro-magnetic spectrum has become especially critical because it can blind or confuse platforms without physically destroying them.

• The integration of naval warfare into a broader multi-domain operations battlespace means that navies become a delivery tool within an integrated sensor- /engagement grit. In order to fulfill this expectation, navies have to develop distributed, resilient naval force structures.

The German Navy can in no way disconnect from these

Vice Admiral Axel Deertz: "I prefer leading a transformation under pressure rather than managing an adaption under fire". Here pictured during exercise MILAN 2026 in Visakhapatnam (India). ***(© Michael Nitz, Naval Press Service)***

developments – it would try so at its own peril. On the contrary, by following the "Navigational Plan", we pursue the ultimate goal of forging a maritime fighting force which credibly deters aggression - a goal only attainable in close cooperation with our NATO allies. In addition, we are taking over more responsibility in order to get there - we remain regionally rooted but globally committed. We are transforming into a hybrid navy, consisting of conventional platforms, supplemented by a mix of unmanned systems. Acknowledging the rapid technical advance, we won't neglect the changing nature of leadership and command. The officer of the digital age must be able to act at speed without surrendering judgement, technically literate and strategically aware. Unmanned systems may increase persistence and reach, but they cannot substitute accountability. For that reason, education and training must evolve as quickly as the technology itself.

This is a significant challenge, even with extended budgets. But I may remind us: The sea does not wait for forms to be completed and imminent threats don't forgive delays. Therefore, I prefer leading a transformation under pressure rather than managing an adaptation under fire.

There is no better place to discuss all these questions, the actual and prospective technical trends which then spill over into tactics, doctrine and strategy, than this event. Four full days of keynotes, panels, expositions, as well as expert and stakeholder engagement. I challenge all participants to exchange their views, gather information and engage in lively discussion.

Fair wind and following seas.

Axel Deertz

Vice Admiral

The Yasen-class represents the present and future of the Russian Navy's nuclear-powered attack submarines. Of the twelve planned units, five are currently in service. At present, three of these submarines with a submerged displacement of 11,800 metric tons are assigned to the Northern Fleet, and two to the Pacific Fleet. Project 885M submarines are equipped with eight 533-mm torpedo tubes and eight VLS systems, which, in quad launchers, can accommodate 32 missiles of various types. The picture shows the first vessel of the class Severodvinsk in her maiden appearance in the Baltic Sea in July 2022.
(© Michael Nitz, Naval-Press-Service)

Admiral (ret.) Joachim Rühle

Reflections on the Tense Security Situation in Europe

Europe faces not a single threat, but a widening spectrum of military, hybrid and political risks. Against this backdrop, Admiral (ret.) Joachim Rühle calls for a fundamental shift toward deterrence, resilience and stronger European defence within a sustained transatlantic framework.

European security is shaped not only by the war in Ukraine, but by the wider challenge of restoring credible deterrence on NATO's northern and maritime flanks. Photo from the exercise Arctic Advance 24. *(© MoD Norway)*

Since Russia's unlawful attack on Ukraine, war has returned to Europe.

In Ukraine, what had been prevented for decades has now come to pass—first through deterrence based on nuclear and military strength, and after the fall of the Iron Curtain through dialogue and a strongly pursued alliance policy. This policy increasingly relied on economic power and led to a reduction and reorientation of the military. As we know today, the minimization of our military capabilities was a major mistake. It takes both economic and military strength to be a pole in a multipolar world.

For years, Ukrainian troops have fought continuously and with every means at their disposal to defend their homeland, and we must not stop supporting our Ukrainian friends in this struggle. Putin remains—his actions make this unmistakably clear—focused on conquest and destruction. And he is preparing for further wars. Russia has shifted its economy to a war footing and is still able to mobilize, equip, and train considerable forces. Russia's threat potential is steadily increasing, and will in the coming years become dangerous for us. While there have been no significant changes along the front line in Ukraine on either side, the threat situation in Europe continues to worsen steadily. Hybrid attacks extend far beyond Ukraine's borders. Both the drone sightings and incidents in Norway, Denmark, and northern and southern Germany, as well as the low overflights by Russian fighter aircraft over frigates of the navies of the Baltic littoral states, make the provocative posture of the Russian military very clear. In addition, the cutting of undersea cables has clearly shown how vulnerable we are. That must not be forgotten. Cyberspace is affected by countless daily attacks, and GPS systems are being disrupted more or less deliberately.

The fact that those responsible for this type of attack are often not clearly attributable confronts us with entirely new challenges. The boundaries between peace, crisis, and war are becoming increasingly difficult to define and are being continuously probed, tested, and recalibrated. Responding appropriately to the hybrid threat environment without losing sight of symmetrical warfare in conjunction with classic military means is an incredibly complex undertaking. It is a challenge we must face and for which we must find a solution if we are to stand firm against Russia in an emergency.

We live in a time of uncertainty and unpredictability. In addition to the current crises and conflicts, this also includes the growing polarization within our population. In my view, this polarization and emotionalization are, among other things, the result of political dissatisfaction, insecurity in security policy, and a perceived threat to one's own existence.

Monitoring critical infrastructure such as wind farms, submarine cables, pipelines or, for example, drilling platforms to prevent acts of sabotage: here the corvette "Oldenburg" in the Baltic Sea.
(© Bundeswehr/Kristina Kolodin)

The global threat environment is in no way bipolar. Rather, I would describe it as a polycrisis: multiple, complex, and interconnected crises are destabilizing our global security. And at present, we are not a noticeable pole within this web. The global balance of power has been severely shaken. Alongside the war in Ukraine, the more than unstable ceasefire between Israel and Hamas is just one further example. All nations of the world are closely interconnected politically, economically, socially, technologically, and ecologically. Even though we can observe international countermovements that refocus attention on the individual power and profit of one's own nation, this multidimensional interdependence cannot be denied.

Europe must change profoundly. This requires far-reaching decisions by the individual countries and by the EU leadership. The goal must be to become capable of acting and defending ourselves and to present our capabilities and strength externally. Not as a threatening gesture toward Russia, but as a clearly understandable message. Russia does not think in terms of escalation and de-escalation, but in terms of strength and weakness.

European states must become more resilient as whole societies. They need defence resilience—the ability to respond flexibly and effectively to sudden threats, attacks, or disasters and to mitigate the potential consequences effectively. What is needed is a change in mindset toward a resilient population, resilient politics, a resilient economy, and a resilient alliance community.

Among other things, we need close cooperation between the military and industry, as well as fast and efficient armaments processes. After all the years of disarmament, a massive reinvestment in national and collective defence is now required. We must credibly demonstrate that we can fight in order not to have to fight.

On our way back to national and collective defence, it is essential to take into account the lessons learned from current wars and crises, as well as innovation and creativity in research. These must be aligned in a targeted way with our national and international defence plans. Interoperability is essential for smooth cooperation with our international partners and allies. This may also mean relying, wherever possible, on standardized systems and, where necessary, reducing the diversity of systems currently found in Europe. The outbreak of the war in Ukraine has, on the one hand, highlighted the importance of our Western community of values—a community of values that must absolutely be preserved. For far too long, we have rested on our economic strength and relied on our transatlantic partner. Now we must actively and jointly set out toward a Europe capable of defence and prove ourselves as equal allies in the defence of our continent. Europe must not become a pawn. The nations of Europe must speak with one clear and united voice, act again from a position of strength in the foreseeable future, and become a strong pole within a multipolar world. And this is necessary not only because of the threats we face today, but also because of the uncertainties that await us in the future.

And as a firm and strong advocate of transatlantic ties, I would advise against abandoning our close partnership with our long-standing American friends, but rather to fight actively to maintain them. Together, we are clearly stronger than either of us is on our own.

Admiral (ret.) Joachim Rühle,
Chief of Staff at SHAPE until October 2024, Mons. Since October 2025, he is Member of the Supervisory Board, TKMS, Kiel.

Hans-Werner Kummerow

Securing the Supply of Critical Raw Materials for Europe's Strategic Industries

When European industry needed artillery propellants and precision-guidance components in 2022, the cupboards were bare. Who is responsible for securing Europe's supply of critical raw materials? The honest answer: nobody, in any operationally meaningful sense. The EU has legislation, benchmarks, and partnership agreements. NATO has a new project framework. Neither produces a kilogram of strategic reserve. What could be done to avoid that Europe's rearmament ambitions rest on a foundation that a single Chinese export decision could crack?

The Problem: Strategic Industries Without Secured Inputs

Every staff college officer — whether in a national army or a NATO joint command — is taught that the availability of rapidly mobilizable reserves determines operational capability in a crisis. The same logic applies directly to industrial production capacity. You cannot ramp up the manufacture of artillery shells, missile components, or naval propulsion equipment if the required raw materials are unavailable, subject to hostile supply restriction, or controlled by a strategic competitor.

This is not a theoretical future risk. The ammunition production crisis that followed Russia's full-scale invasion of Ukraine in February 2022 demonstrated the vulnerability with brutal clarity. Annual European production capacity for 155mm artillery ammunition stood at fewer than 500,000 rounds in 2022. Shortfalls affected not only finished ammunition but inputs: propellant powders, steel alloys, and specialised metallic components that no European producer had kept in adequate stock, because just-in-time supply chain logic had prevailed over strategic resilience for two decades. By end-2025, EU production capacity had risen to approximately 2 million rounds per year — but this expansion is already revealing the next layer of bottlenecks: propellants, miniature jet engines, and, critically, the rare earth permanent magnets required for precision-guided systems and advanced propulsion.

The material input vulnerabilities are structural. Titanium for airframes comes heavily from Russia. Tungsten for armour-piercing penetrators comes overwhelmingly from China. Gallium and germanium, essential for electronic warfare systems, have been under Chinese export controls since 2023. Each F-35 contains approximately 417 kilograms of rare earths and specialty alloys; European platforms have comparable dependencies. China controls an estimated 60–70% of global rare earth mining output and around 85–90% of global rare earth processing capacity — the technology at the heart of every electric motor, wind turbine generator, and guided weapons seeker head. When Beijing tightens export licences, European defence companies face immediate production consequences: administrative delays, supply uncertainty, and in some cases plant shutdowns. The EU defence industry warned urgently in October 2025 that the continent must reduce its dependence on Chinese-controlled materials. The European Commission's own RESourceEU Action Plan of December 2025

admits that the continent's 2030 defence readiness objectives risk being compromised by these dependencies.

The automotive sector presents the economic parallel. The value in an electric vehicle does not reside in its drivetrain engineering; it resides in its battery pack — with approximately 95% of the cost determined by the price of constituent battery metals: lithium, cobalt, nickel, manganese, and rare earth elements including neodymium and terbium for permanent magnet motors. Whoever controls affordable access to these materials controls the cost structure of electric vehicle production. European manufacturers now face Chinese competitors who have vertically integrated from lithium mines in South America and the Congo through battery cell production to final vehicle assembly — at cost structures European supply chains cannot currently match. There are corrective strategies still theoretically available: cross-shareholdings between automotive and raw materials producers to build combined capital for acquiring stakes in existing mine infrastructure; structured long-term offtake agreements; and EU-level demand aggregation through the Raw Materials Mechanism established under the CRMA. Whether these can be deployed at the required speed, given the years of delay already accumulated, is genuinely uncertain. What is not uncertain is the cause: two decades of strategic non-decisions.

Paper Architecture, No Metal

Europe is not without policy. The EU's Critical Raw Materials Act (CRMA), adopted in March 2024, identifies 34 critical and 17 strategic raw materials, establishes supply benchmarks, and lays out a governance framework for fast-tracking strategic projects. The follow-on RESourceEU Action Plan of December 2025 goes further: it commits the EIB to up to EUR 2 billion per year in CRM-related financing, designates 60 Strategic Projects, records 15 strategic raw material partnerships with countries from Canada and Chile to Kazakhstan and South Africa, and calls for the EU to mobilise EUR 3 billion in direct CRM investment within twelve months. In July 2026, NATO formally launched a multinational High Visibility Project on defence critical raw materials, bringing together twelve Allies — Belgium, Canada, Denmark, Finland, Greece, Italy, Luxembourg, the Netherlands, Norway, Spain, Sweden, and Türkiye — to work jointly on acquisition, storage, transport, and management of materials essential for defence production.

These measures are not insignificant. But every practitioner in the raw materials field understands the distinction between institutional architecture and operational output. The CRMA's 2030 targets — 10% domestic extraction, 40% processing, 25% recycling of annual consumption — are already being missed. Less than 1% of rare earth elements are currently recycled in the EU. For gallium, germanium, and heavy rare earths, Europe produces close to nothing and is entirely import-dependent. No structural EU-level instrument for acquiring and managing strategic reserves, or for coordinating their release in a crisis, currently exists. The CRMA's formulation on stockpiling — that "member states coordinate the strategic inventories of their domestic industries" — delegates a state function to the private sector. Companies cannot hold strategic reserves; their stockholding is governed by order books, not by security logic.

Compare the scale of ambition with strategic competitors. The United States launched a National Defense Stockpile replenishment programme in 2025 backed by a $12 billion fund; American firms have been acquiring raw material assets internationally at a pace not seen since the Cold War. China has spent several billion Euros per year for three decades building its dominant position — and has reinforced it through escalating export control measures now covering gallium, germanium, graphite, tungsten, bismuth, and, as of 2025, rare earth processing equipment and the rare earth elements themselves. Against this, EUR 2 billion per year in EIB commitments and a pipeline of un-built projects is a beginning, not a solution.

> **Member states coordinate the strategic inventories of their domestic industries.**

The Lesson Already Available

The structural problem is not new, and the evidence for what does not work is already in hand. In January 2012, following the rare earth supply shock of 2010–2011, leading European industrial conglomerates — among them BASF, ThyssenKrupp, Bosch, BMW, and Volkswagen — formed a joint procurement alliance with the objective of pooling purchasing power and co-investing in foreign raw material deposits. Two years later, the alliance was quietly liquidated without having procured a single kilogram of material. When China lost a WTO case on its rare earth export restrictions and markets temporarily stabilised, the business case for collective action dissolved.

This episode is diagnostic. Private enterprises competing in the same markets cannot maintain collective raw material security strategies against state-backed monopolies across economic cycles. The moment prices fall — whether through deliberate undercutting or genuine market correction — the private sector imperative to minimise input costs overrides the strategic security imperative. And with the WTO's enforcement capacity now deliberately weakened by the United States, the legal backstop that temporarily relieved pressure in 2014 is no longer reliably available.

China has drawn the lesson from that earlier dispute and now operates WTO-compliant export licence restrictions that achieve the same effect through administrative rather than tariff mechanisms — leaving European applicants waiting indefinitely for approvals while being required to disclose sensitive production details as a condition of the licence process.

The conclusion is unambiguous: the security of critical raw material supply for strategic industries cannot be delegated to market mechanisms. It requires a state-led, long-term commitment of public funds, with procurement terms specifically designed to resist market manipulation. Europe has formally recognised this — in the CRMA, in RESourceEU, and in NATO's new High Visibility Project. What remains is the operational follow-through: not more architecture, but physical metal in European storage.

What Must Be Done

Strategic reserves, physically held. The EU's July 2025 stockpiling strategy and its pilot project — with tungsten, rare earth elements, and gallium already shortlisted — must move from planning to acquisition. Reserves need to be physically held in European storage facilities, including major logistics hubs such as Rotterdam, and managed through a structural EU instrument with clear protocols for acquisition, rotation, and crisis release. Holding strategic reserves is a function of state-level crisis preparedness. The logic is identical to that of state oil reserves or food stockpiles: it was never the function of private industry to bear these costs on behalf of collective security, and the CRMA's instruction to member states to "coordinate the strategic inventories of their domestic industries" will not produce a single tonne of reserve stock.

Long-term, price-stable offtake contracts. The most effective mechanism for enabling non-Chinese raw material projects to reach commercial viability is a long-term offtake guarantee from a creditworthy public buyer, with price fixed for the full contract duration and insulated from spot market manipulation. Contract durations should be at least ten years, with delivery commencing no earlier than three years after award — reflecting the investment and scale-up timeline that new mining and processing projects genuinely require. Crucially, benchmark prices must not be indexed to Chinese commodity exchanges, where deliberate price manipulation has historically been used to drive competing projects into insolvency before they reach commercial scale.

A European Critical Raw Materials Centre with real powers. The RESourceEU plan calls for the establishment of this institution in 2026, with a mandate covering supply intelligence, stockpiling coordination, and joint purchasing. It must be given genuine operational capacity — empowered to negotiate and hold long-term supply contracts on behalf of member states, act as a portfolio manager for strategic reserves, and provide market intelligence and counter-manipulation capacity that no individual member state can sustain independently. An advisory body is not enough.

Financing at the required scale. The EU should treat the RESourceEU target of EUR 3 billion in direct CRM investment over the next twelve months as a floor, not a ceiling. Member states that have not yet established national CRM funds should do so without delay, following the precedents already set by France, Germany, Italy, and the Netherlands.

The rearmament budgets now being committed across Europe are rendered partially incoherent if the raw material base needed to produce the equipment is not simultaneously secured. It makes little strategic sense to commit hundreds of billions to new defence platforms while leaving the supply chain for their critical material inputs exposed to the discretionary export licencing decisions of a strategic adversary.

Conclusion

Europe currently produces between 1% and 5% of the critical raw materials it requires for key civilian and defence technologies. Demand will grow substantially over the next decade as rearmament, electrification, and digital infrastructure expansion simultaneously drive consumption of the same narrow set of materials upward. The institutional architecture is now largely in place. What must follow is the hard operational work: physically filling stockpiles, signing decade-long offtake agreements with new producers, empowering the European Critical Raw Materials Centre to act as a genuine buyer rather than a coordinator, and committing public capital at a scale commensurate with the strategic stakes.

The lesson from the ammunition crisis — a foreseeable gap addressed only through two years of emergency measures and hundreds of millions in emergency funding — should not need to be repeated for rare earths, permanent magnets, or battery metals. The window for corrective action is open. It will not remain open indefinitely. The cost of pre-empting the next supply shock is small compared to the cost of responding to it after the fact — and this time, a supply shock in critical raw materials would not merely delay deliveries to a battlefield. It would stall the rearmament of an entire continent.

Hans-Werner Kummerow is Kapitän zur See der Reserve (Captain Navy Reserve) and Chairman of the Bayerische Bergbau-Holding "SBI Sons of Bavaria Investment AG", Munich.

Dr. Sebastian Bruns

Six domains, seven Ms: The maritime sphere as a multidomain and multidimensional battlespace.

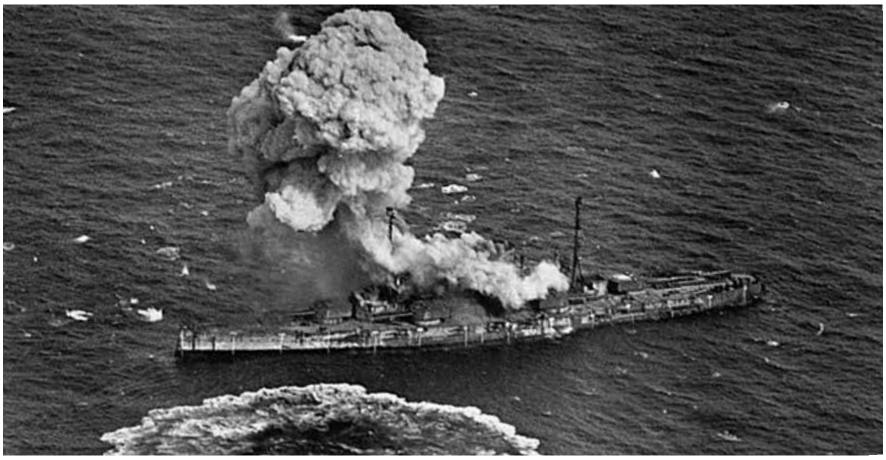
Multidomain warfare has become one of the most overused and least understood buzzwords in contemporary sea power, yet its roots run deep in naval history. By tracing the evolution from *SMS Ostfriesland* to today's cyber-enabled fleets, the article highlights why "seven Ms" remain decisive for maritime power.

Multidomain warfare has become one of the hottest, most overused, and probably least understood buzzwords in describing the realities of twenty-first century sea power. The term sounds impressive, suggests a spaghetti bowl of interdependencies, and can leave even seasoned observers nodding in appreciative awe. Yet, as the old 1980s Styx song asked "Haven't we been here before?", a closer look at the maritime domain and the history of twentieth-century naval warfare suggests precisely that. Navies have repeatedly confronted fundamental disruptions that challenged not merely tactics and technology, but their entire business model. Each time, they adapted, reshaped their value proposition to political leaders, and emerged intellectually renewed. Today's multidomain environment is another such moment.

History does not repeat, but it rhymes

On 21 July 1921, the former German battleship SMS Ostfriesland was deliberately sunk during bombing trials led by General William "Billy" Mitchell. A veteran of Jutland and just commissioned a decade before she was sent to the bottom of the ocean on purpose, she became the symbol of a profound shift. General Mitchell sought to demonstrate the vulnerability of capital ships to aircraft, but his greater achievement was forcing naval strategists to recognize that the air domain had become inseparable from maritime warfare. During the 1910s and in particular during World War I, dirigibles, balloons, and the first combat aircraft began to make the battlefield more complex for planners and operators. At much the same time submarines matured into an increasingly strategic weapons system. Within only a few years, the surface battlefield had become a genuinely three-dimensional battlespace.

Thinkers from Alfred Thayer Mahan and Julian Corbett to Alfred von Tirpitz and Raoul Castex grappled with these implications. Navies responded with better armor, larger guns, improved sensors, anti-aircraft weapons, and depth



SMS Ostfriesland burning. ***(© US Army)***

William 'Billy' Mitchell -'The father of the United States Air Force' ***(© US Army)***

HMS Invincible returns to massive celebrations following the Falklands Conflict in 1982, an important cornerstone in multi-domain naval warfare. ***(© Wikimedia Commons)***

charges. More importantly, they – often somewhat hesitantly – accepted that aircraft and submarines were not passing curiosities but enduring components of sea power. The Second World War confirmed this transformation. Battleships surrendered their central role to carrier aviation. Aircraft from HMS Ark Royal crippled Bismarck, while the Battle of Midway demonstrated that whoever mastered naval aviation could determine the course of a maritime war. Successful navies were those that embraced disruption rather than resisted it.

The atomic age posed another existential challenge. Nuclear weapons appeared to threaten the very future of fleets, yet within a few years nuclear propulsion extended endurance and sea-based deterrence became a cornerstone of strategic stability. During the Cold War, the electromagnetic spectrum emerged as yet another operational domain. Communications, navigation, sensors and electronic warfare became indispensable to waging naval war and fulfilling lesser naval tasks across the spectrum of seapower. If anything, this demanded a sustained investment even as shrinking budgets forced difficult choices, with the use of a networked naval force in combat probably most visible in the Six-Day War (1967) and the British campaign in the Falklands War (1982).

From the 1990s onward, cyber and space completed an even more interconnected battlespace. Satellites, digital networks and computing transformed naval operations while simultaneously creating unprecedented vulnerabilities. Once again, navies were required to rethink their strategic relevance rather than merely preserve existing force structures. This came against the background of the 'peace dividend' thinking after the end of the Cold War, as the value of large navies was less and less convincing to make policy-makers and the public. Some navies succeeded in adapting, others were more focused on retaining their shrinking fleets and their Cold War force structure against what former British Prime Minister Harold Macmillan once famously described as driving policy, namely "Events my dear, events."

Singing from the same sheet of music

Naval history is therefore rich in disruption, yet sea power has not lost its strategic importance. As long as maritime forces influence events ashore and safeguard vital sea lines of communication across peace, crisis and war, governments will continue investing in ships, submarines, aircraft, sensors, weapons and multidomain effectors.

The lesson is straightforward. Navies must embrace the multidomain reality of their operating environment while recognizing that there is also a multidimensional one. Multidomain concerns where navies operate; multidimensional concerns the broader factors that determine whether they

Industrial Base is key. Here shown German Navy's Replenishment Oiler Bonn arriving at German Naval Yards, Kiel. ***(© Wikimedia Commons)***

succeed. Here the framework of the "Seven Ms of successful strategy" remains remarkably useful.

In the mid-1990s, American naval historians Jon Sumida and David Rosenberg first identified five of these: men (and women, though equal opportunity is a more modern concept for many militaries), management, money, manufacturing, and machinery. It is a truism that funding matters, not least in times of competing budgeting priorities and ever-more asymmetry between cheap one-way systems like drones and expensive and rare high-end assets such as missiles. Furthermore, political leadership matters, and that too is a commodity that appears to be increasingly rare these days where alliances are under strain from outside and from within. Where the contemporaries of the post-Cold War years saw a unipolar world, we have long since entered a diffuse, chaotic multipolar world in the 2020s.

Still: Recruitment and retention remain indispensable despite automation. Relationships between navies, governments and society shape public support. Equally important is a resilient industrial base capable of producing good-enough ships and weapons on time and, ideally, on budget. Three decades after Rosenberg and Sumida penned their ideas, concerns in the West over de-industrialization and fragile supply chains have only reinforced the importance of these foundations.

In 2000, Winfried Stallmann, a retired naval officer of the German Navy, proposed a sixth M: mentality. Strategic culture, maritime awareness and freedom from sea blindness (a term

Airpower meets nuclear power: Balloons float skyward as the nuclear-powered attack submarine USS Salt Lake City (SSN-716) slides down the ways at the conclusion of the launching ceremony ***(© Wikimedia Commons)***

Public support begins at the top: President Ronald Reagan at The Recommissioning Ceremony for The Battleship U.S.S. New Jersey in Long Beach California. ***(© Wikimedia Commons)***

that usually refers to the inability to understand the maritime and naval dynamics on world politics and national security) all influence whether societies appreciate the oceans' central role in security and prosperity. Too often, maritime dependence becomes visible only when crises expose it. In light of shadow fleets in the Baltic Sea, naval blockades in the Strait of Hormuz, the bottleneck of maritime choke points from the Suez Canal and the Red Sea to the Strait of Malacca, and Russian submarines testing the West's ability and capability in the North Atlantic, there is ample evidence.

A seventh M deserves equal attention, one that is proposed here by the author: morale. Confidence, enthusiasm and professional commitment become decisive as navies return to preparing for high-intensity conflict after decades dominated by lower-intensity operations. Technology can amplify human performance, but it cannot replace determination. Clearly, in this day and age, many navies are returning to their unique and core basic functions of sea control, power projection, and reassurance/deterrence. This is something for which they often have been built and trained but did not get to engage in during three decades of low- and medium-intensity operations. How good a naval service is funded and managed, how functioning the industrial base and the mentality are, where and how they recruit remain crucial, but morale becomes another important factor. This is hard to quantify to quantify and to qualify, but worth intellectual and financial investments.

"Mmmmmmm" is thus not only a popular 1990s one-hit wonder by the band "The Crash Test Dummies", but also a very useful and lasting concept for thinking about navies and good strategy, both for members of the organization and for anyone working with them.

Encore

Maritime security of today is therefore far more than operations at sea. It requires sustained attention to the political, industrial, intellectual and human environment within which navies exist. This responsibility cannot rest with civilians alone, nor solely with those in uniform. Policymakers, industry, scholars and serving personnel alike must look beyond their individual perspectives. Calm but focused, they should remember the enduring lesson of modern naval history: successful navies have been those that adapted to disruption rather than succumbed to it.

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Nick Childs

Maritime Security & Defence Global Sea Power and Fleet Development

We have entered a new era of naval and maritime warfare. It is one characterised by an intensification of inter-state competition and confrontation together with rapid technological upheaval.

Events in the Black Sea, the Baltic Sea, the Red Sea and the Persian Gulf, not to mention the rising naval and maritime frictions in the Asia-Pacific region, have been a double-edged sword. On one hand, they have reawakened in the minds of many the significance of the maritime domain to global stability and the global economy. On the other hand, they have highlighted the challenges and shortfalls facing today's navies and other maritime security agencies in countering the rapidly evolving threats at sea.

A key factor is the complexity of these threats. The Ukraine conflict has highlighted the new demands of high-intensity warfighting, from dealing with hypersonic missiles to the mass use of low-cost drones and how to sustain a modern war machine. The proliferation – some call it the 'democratisation' – of asymmetric long-range precision sea denial capabilities of varying sophistication from anti-ship ballistic missiles to one-way attack drones among increasing numbers of actors, and the trade-off imbalance in the costs of defensive systems to protect against them, adds another element of complexity.

There are also the evolving challenges of hybrid warfare at sea, including the increasing use of 'shadow fleet' tankers and other vessels for not just sanctions evasion but also as suspected mother ships for other types of clandestine activities. Just what the roles and requirements are for navies in the new disciplines of 'seabed warfare' and the protection of critical undersea infrastructure (CUI) such as pipelines and communications cables also continues to play out as a set of issues.

Ukraine in the Black Sea and the Houthis in the Red Sea have shown how opponents with essentially no conventional naval capabilities can today embarrass and frustrate major naval powers. The Houthis again and the Iranians in the Gulf and the Strait of Hormuz have demonstrated how difficult it is to eliminate their relatively unsophisticated but mobile and easily concealed asymmetric sea denial capabilities.

Confined waters like those of the Black Sea tend to favour the weaker powers. So too do the littoral regions that restrict the room for manoeuvre and reduce warning times for powerful blue-water navies. The unique geographical challenges of the Strait of Hormuz have made it hard even for the US Navy and supporting US forces to assert sufficient control to reassure global shipping and thus restore full freedom of navigation in the face of the latent threat posed by Iran.

Not all the lessons from these waterways necessarily migrate to the open seas and the wider expanses of the Atlantic and Pacific oceans. But the scale, reach and sophistication of the threats posed by Russia and China present their own challenges to Western and other like-minded power-projection navies and shrink their room for naval manoeuvre.

All of this adds up to a serious new set of problems for traditional naval powers in exerting one of their core missions of sea control, and with it also the ability to project power in order to influence events on land, to deter and to provide reassuring naval presence and undertake effective naval diplomacy to maintain regional stability and general good order at sea. As a corollary to this, there is a new debate over the survivability of large and expensive surface combatants in an age of cheap and plentiful threats.

However, this is not an 'end of history' moment for navies. Far from it. States still need to project power and protect the maritime economy – which now encompasses ports and onshore infrastructure, the ever-growing offshore economy and CUI as well as sea lanes and shipping – and they still need navies to do that. But in an age of more lethal and ubiquitous sea denial capabilities and ever more pervasive maritime surveillance, navies require more effective lethality of their own and a multi-domain approach to their still critical missions.

Navies know they need to do things differently. The signs of that are already apparent. But there are no 'silver bullets'. There is also a realisation that what is needed is more than just the nuts and bolts of strengthened naval power. The solution needs to be about the broad regeneration of sea power, including the enabling and supporting shipping required for resupply and reinforcement and the maritime industrial base to build and perhaps more importantly sustain a naval fighting force.

The first signs of adaptation to the new complexities include the urgent demands from navies for different and more cost-effective counter-drone capabilities, from electromagnetic warfare including the accelerated development of directed-energy weapons to new close-in guns and missiles. Navies are also looking to raise their game against the more demanding threats from hypersonic weapons and anti-ship ballistic missiles. This means more capable outer layers of ship-based air defence as well. It means larger stockpiles of high-end missiles, greater magazine depths on platforms and among deployed forces, and – at least in the case of the US Navy – relearning the art of replenishing missiles at sea.

> **Nuclear-powered submarines are a major focus of investment and ambition**

More fundamental in terms of the shape of things to come is that naval fleets in the future will look different. The trajectory of navies is towards a hybrid or high-low mix of platforms in future fleet plans. This involves increasing reliance on uncrewed or autonomous capabilities to complement existing and future crewed warships. The drivers of this transformation are the need to deliver more effective capability with more affordable mass plus increased survivability and resilience in the face of the threats to traditional naval formations.

A watershed moment was the US Navy's first operational sea drone attack, on the Iranian naval base of Bandar Abbas, in July. But the revolution is about more than the proliferation of small remote-controlled one-way attack vessels. It is about fleets incorporating optionally-crewed, uncrewed and autonomous vessels that could be the size of large offshore patrol vessels or even corvettes and light frigates of only a few years ago, complementing new generations of crewed vessels. And it is about transformation below and above the sea's surface as well as on it, with underwater vehicles supporting submarines and drones forming hybrid air wings aboard aircraft carriers.

The sub-surface environment itself is gaining significance not least with the growing preoccupation with seabed warfare. More significantly, as the surface environment becomes more hostile and challenging, sub-sea capabilities are becoming more critical for warfighting, particularly for the early stages of conflict. Indeed, sub-surface capabilities, so long the supporting arm for surface forces, may in the early stages of future high-end conflict become the supported arm.

Nuclear-powered submarines are a major focus of investment and ambition. China's People's Liberation Army Navy (PLAN) is stepping up its capabilities while Australia, the UK and the US develop theirs under AUKUS and the two Koreas vie with each other on nuclear-powered submarine ambitions. All of this may affect the plans of others on the fringes of nuclear-powered submarine capability or contemplating it, including India, Brazil and even Japan. In Europe and Asia, navies are also investing in a more potent generation of conventionally-powered submarines.

As for the future for hybrid fleets generally, the trend in this direction is almost universal, but the term 'hybrid' clearly means different things to different navies. Most still see a critical role for high-capability crewed warships at the heart of naval formations. The PLAN continues its massive warship building programmes as it also introduces the new technology. In response, the US Navy is adopting a 'hedge strategy'. This envisages a more flexible mix of 'tailored' crewed and uncrewed platforms to sustain the ongoing demand signal of day-to-day operations plus a set of 'tailored offsets' of mainly new technology, uncrewed and autonomous systems to provide an immediate response to high-end crisis scenarios such as a Taiwan contingency.

Meanwhile, the US Navy's answer to worries about the vulnerability of surface ships to everything from hypersonic missiles to swarming drone attack is, in part at least, to go bigger still. Under the umbrella of President Donald Trump's 'Golden Fleet' vision, the US is reimagining the concept of the battleship as a 35,000-tonne nuclear-powered guided-missile warship also incorporating directed-energy weapons.

Others may not have the scale of resources of the US Navy. But the German Navy's 2035 future fleet plan envisages increased numbers of major warships and submarines, including 10,000-tonne air defence destroyers, as well as a range of uncrewed vessels. The Royal Australian Navy is another that has set out the ambition to grow its crewed destroyer and frigate force while also incorporating uncrewed or optionally-crewed missile platforms. Others are also incrementally making the change to a more hybrid, high-low mix for their future fleets.

In the United Kingdom, the Royal Navy – with its current fleet at a low ebb – is adopting a more radical approach with its hybrid vision. The current head of the Royal Navy speaks of a future fleet that is crewed only where necessary and uncrewed where possible. The UK has abandoned plans for a future large and expensive air defence destroyer or cruiser in favour of a class of simpler 'Common Combat Vessels' as command hubs for flotillas of uncrewed vessels carrying missiles and sensors.

With the support of new technology industries, these systems are starting to be incorporated into fleets now, not least due to the increased urgency in the current strategic climate to be ready for warfighting as soon as possible. But the new technologies will really begin to change the shape of navies in the next decade.

Much will depend on how the new technologies mature. Can they really deliver robust networks of uncrewed and autonomous platforms able to operate for months in the harsh open oceans of the Atlantic and Pacific in a contested and electronically-denied environment? That has yet to be tested. So too the assumption that the uncrewed and autonomous course necessarily leads to a more effective, more numerous and more affordable force make-up. Some of these new platforms will not be cheap or disposable. Getting the right cost and capability balance across the network of systems will be critical. To some, all this makes the Royal Navy's big bet on switching to a tapestry of new systems in particular look like a gamble. But the same may also be said of investing in even larger and more expensive crewed platforms to try to deliver a future capability boost.

Getting the right balance for the future also depends on strategic ambition and circumstances. A focused force concentrated in relatively confined waters will be more weighted towards uncrewed capabilities, not least for missions like mine warfare. How to deliver a hybrid force capable of operating at range, delivering a spectrum of tasks from warfighting to presence, deterrence and naval diplomacy, in grey zone environments of tension short of war, will be more complex.

Equally, it may be the pathway to delivering sufficient mass of force to be able to protect global shipping and the rest of the maritime economy and thus in a broader sense deliver enhanced sea power. There are also opportunities to regenerate and diversify the maritime industrial base to provide greater sustainment and resilience, as the US is seeking to achieve, including with the support of allies.

> **"Getting the right balance for the future also depends on strategic ambition and circumstances.**

Time will tell who has made the best judgements on balance. As the Ukraine war has taught everyone, rapid adaptation will also be key. The platforms and capabilities that emerge as the 2030s unfold will likely look very different from many of the concepts being touted by navies and industry now. In that sense, global sea power and the future development of navies really are at an inflection point.

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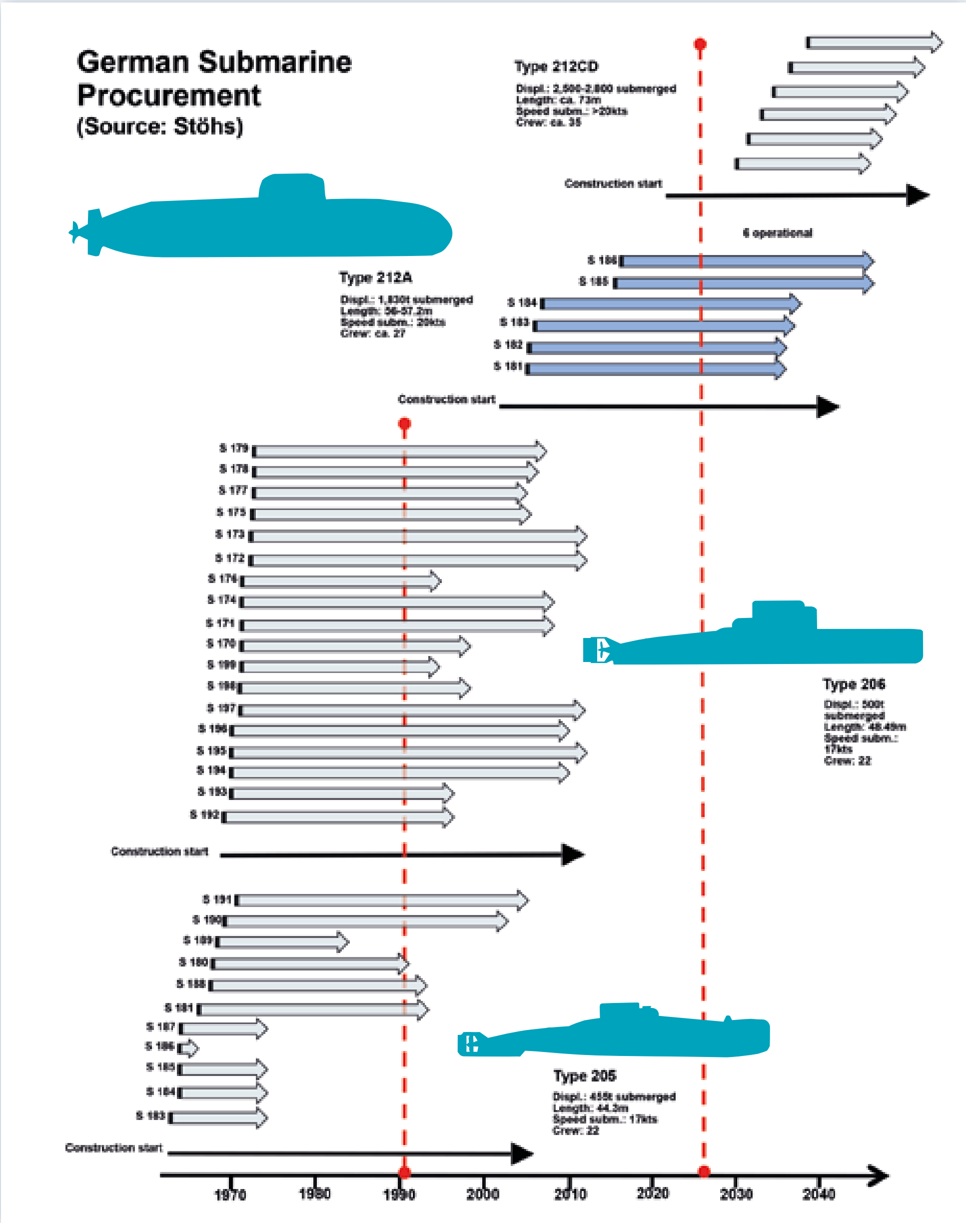
Japan’s submarine procurement relies on iterative modernization. ***(© Wikimedia)***

Jeremy Stöhs

Three Clocks Ticking! Europe’s Maritime Capability Gap under Strategic Time Pressure

The debate over Europe’s maritime future often focuses on fleet numbers and procurement plans. Yet, the decisive criterion is different: they are running out of time. This article argues that the continent’s real maritime capability gap lies in the growing mismatch between strategic urgency and the speed at which combat power can be generated, sustained and regenerated.



German submarine procurement ***(© Stöhs)***

"Strategy is increasingly measured not only by what nations possess, but by how quickly they can turn potential into power."

For much of the post-Cold War era, European navies operated in an environment where time was considered an abundant resource. Defense planning focused on technological superiority, expeditionary operations, and crisis management rather than the prospect of sustained high-intensity warfare close to home. Procurement cycles stretched over decades, industrial capacity was optimized for efficiency, and readiness was often judged by the sophistication of individual platforms rather than the resilience of the force as a whole. Those assumptions no longer hold. Intensified strategic competition, the return of interstate war, and persistent instability across Europe's maritime approaches have fundamentally changed the continent's strategic outlook. Concerns over the security of maritime supply routes and critical maritime infrastructure are front and center of today's political debate. At the same time, uncertainty about the future balance of transatlantic burden-sharing has accelerated the expectation that European nations will assume far greater responsibility for their own

security. The challenge facing European navies is therefore no longer simply one of modernization. It is one of speed.
The debate on Europe’s maritime future has understandably focused on capability gaps: too few frigates, submarines, and auxiliaries, a lack of longer-range fires and integrated air and missile defenses, uncoordinated and sluggish integration of autonomous systems alongside setbacks in enhancing maritime surveillance, and of course a shortage in personnel. Closing these gaps is indispensable. Yet such focus risks overlooking a more fundamental problem. Europe’s real maritime capability gap is increasingly measured not in capabilities or platforms but in time. The strategic warning available to European governments no longer exists. Between these two realities lies the defining challenge for maritime security in the coming decade.

Three Clocks Ticking Simultaneously

The sharp end of European maritime security debates is shaped by three interdependent timelines. The first is the **strategic clock**. For decades, European defense planning assumed that major conventional conflict was unlikely. Today, military planners assess that the strategic warning period has compressed dramatically. Whether in the Baltic Sea, the North Atlantic, the Arctic, or the larger Mediterranean region, the operational environment has become more contested and less predictable. The challenge is no longer preparing for a distant future but generating credible deterrence within a timeframe of a few years, marked by technological iteration cycles measured in mere weeks and months. Unless the current great powers undergo a marked shift away from their current competition over who gets what, when, and how, the strategic clock is unlikely to offer any respite to defense planners and their political masters in the foreseeable future.
The second is the **military clock**. European maritime forces remain among the world’s most technologically advanced. Modern frigates, submarines, maritime patrol aircraft, and other platforms provide capabilities within a range of national, bi-, mini-, and multilateral settings that few competitors can match. Frankly, no other region can draw upon comparatively comprehensive frameworks and common operational history, which include NATO’s standing maritime groups, the burgeoning Joint Expeditionary Force and new Norther Navies Initiative, the Belgian-Dutch naval cooperation, and the Swedish-Finnish Naval Task Group. However, neither formal arrangement nor high-end platforms guarantee combat power. The decisive factor is availability. A frigate in extended maintenance contributes little to deterrence. A destroyer with limited interceptor stocks can perform only a fraction of its intended mission. Anti-submarine warfare assets without sufficient crews, logistics, or maintenance support rapidly become operational bottlenecks. In prolonged conflict, the question is no longer how many ships appear in fleet inventories, but how many platforms and systems are immediately deployable, fully armed, and capable of sustained operations across all domains. In the recent past the lack of credible naval deterrence has become painstakingly clear, as key European assets were either unavailable or unsuited to address conflict and crisis. Worse still, they encourage already tentative political leaders to reconsider using one of the most flexible tools in their policy toolkit: maritime forces.
Recent analyses of European naval readiness argue precisely this point: High-intensity warfare demands larger missile inventories, greater magazine depth, resilient logistics, repair capacity, and the ability to regenerate combat power under combat conditions. Efforts across Europe to again become kriegstüchtig, to use German parlance, have resulted in system-level redesigns of how ships are crewed, maintained, and sustained all the while uncovering chronic inadequacies of a decades-long holiday from history. Ultimately, capability without availability creates an illusion of strength.

Industrial Capacity as a Strategic Capability

The third timeline is the **industrial clock**. This is perhaps the most complex and therefore least frequently discussed issue – and increasingly the most important. Europe possesses some of the world’s most capable defense industries, which includes the naval sector. Shipyards across the continent design sophisticated and internationally competitive submarines, frigates, mine countermeasure vessels, naval combat systems, anti-ship missiles, propulsion technology, and sensors. Technological expertise is not Europe’s principal weakness – it is time.
It is a foregone conclusion that a modern military platforms and combat system cannot simply be ordered and delivered within months. Design, engineering, procurement, construction, systems integration, certification, and sea trials routinely require five to ten years, often longer for highly complex platforms that include leap-ahead technologies.

Current fleet concepts have been thoroughly revised and published. ***(© Armada defensa)***

These timelines and procedures might have been acceptable when strategic warning was measured in decades. They are entirely incompatible with an environment that requires credible deterrence today.

The problem extends well beyond shipyards, and has an innate political dimension. Modern naval construction depends upon dense industrial ecosystems: specialized steel producers, propulsion manufacturers, combat-management software developers, radar suppliers, missile producers, electronics companies and thousands of highly skilled workers. Naval architects, systems engineers, certified welders, and software specialists cannot be generated overnight. Expanding dry docks, qualifying suppliers, and increasing production capacity require sustained investment over many years. What is more, large procurement projects carry a significant degree of national prestige, which frequently adds additional risk. The cancellation of the German F126 class frigate is a telling case in point. As one analyst put it, if such a project fails, despite receiving strong political attention, fulfilling a clearly identified capability requirement, and facing increasing urgency, then it automatically becomes a litmus test for political commitment towards Europe's deterrent posture. This also explains why increased defense spending alone will not automatically translate into increased military capability.

These challenges meet a European defense-industrial complex that for nearly thirty years largely prioritized efficiency over resilience. Four years into the so-called Zeitenwende many defense firms still struggle to adjust themselves to rapid expansion under conditions of strategic urgency. Against the backdrop of highly contest maritime commons, industrial capacity constitutes an operational capability in its own right.

Beyond Fleet Numbers

Time and again the measure of naval power has been reduced to the size and outward appearance of fleets. Sir James Cable quipped that "People go on counting ships as if they had a value as intrinsic, as comparable, as durable as gold coins in Zurich." Such simple metrics have long been insufficient. Maritime deterrence depends upon the interaction of four mutually reinforcing elements: capability, availability, sustainability and regeneration. Capability determines what a navy can do. Availability determines what it can do today. Sustainability determines how long it can continue. And industrial regeneration determines whether losses can be replaced and operational tempo maintained. These elements are inseparable. A navy that cannot effectively fight as part of a joint force across all domains becomes a liability rather than an asset. A fleet of advanced platforms but insufficient missile inventories faces operational limitations from the first days of conflict. Naval forces with excellent sensors but inadequate maintenance capacity gradually lose readiness. Industrial production that cannot innovate quickly enough and replace combat losses rapidly becomes part of the operational equation rather than merely an economic concern. The distinction between capability and capacity is therefore becoming increasingly important. The lesson from recent conflicts is clear: sophisticated platforms remain essential, but resilience determines strategic success. High-intensity conflict places renewed emphasis on mass and distribution – not necessarily in terms of larger ships, but in terms of magazines, logistics, maintenance infrastructure, unmanned systems, distributed sensing, and industrial endurance.

From Procurement to Readiness

The policy implications are significant. Europe does not primarily require another debate about future fleet concepts.

NATO capability targets, national procurement programs, and European defense initiatives (Zielbild Marine 2035+/ Kurs Marine, Loi de programmation militaire 2024–2030, Spain's Armada 2050) already provide considerable clarity regarding required capabilities. The greater challenge lies in translating plans into deployable combat power quickly enough.

This demands procurement systems that reward speed alongside technical excellence. It requires long-term industrial planning and evolutionary rather than episodic acquisition, as the figure of German submarine procurement painfully illustrates. Above all, it requires governments to provide industry with predictable demand that justifies investments in production facilities, supply chains, and skilled labor. Procurement projects and collaborative programs continue to be fraught with delays, setbacks, and cancelations (FCAS, F-126, European patrol corvette) due to political mismanagement, overambitious military requirements, and industrial inaptitude. All of which result in stubbornly long lead times. In this regard Japan's, South Korea's, or even China's procurement policies, with their continued and incremental approaches, can act as a lodestar for European planners.

Continuous production should replace stop-start procurement wherever possible. Promoting European preferences (and leveraging EU funding frameworks) can hedge against the dominance of US suppliers on the European defense market. Greater standardization across European programs can reduce unnecessary complexity while strengthening interoperability. In a fragmented European industrial environment, consolidation and rationalization should be accompanied by the gradual horizontal integration and interoperability of systems that respect national sovereignty, thereby offering a more flexible alternative to pursuing mergers on a case-by-case basis. In those cases where national interests militate against ceding defense industrial capabilities to other European states (there is no naval Airbus or common NATO Replacement Frigate 2030 on the horizon), mini-lateral defense cooperation have shown the way forward in European defense procurement. They satisfy regional needs, remain manageable, and thus reduce risks of failure. Therefore, the current development of roughly a dozen different types of next-generation surface combatants is not necessarily Europe's strategically most pressing problem. Rather, it is to build the capacity to generate maritime combat power faster than potential adversaries can exploit strategic opportunities.

Time as the Decisive Capability

During the post-Cold War era, European maritime power was largely defined by technological sophistication and increasing global presence. The strategic environment of today demands a different measure. Deterrence depends on the ability to generate, sustain, and regenerate combat power under conditions of prolonged competition and potential conflict. Ships, missiles, crews, logistics, and industrial capacity are no longer separate variables but components of a single system of maritime readiness. Europe's maritime capability gap is therefore not simply a deficit of platforms, or a result of too many different platforms. It is the widening distance between the speed at which the security environment is changing and the speed at which military capability can be generated.

Closing that gap will require more than larger defense budgets, additional procurement programs, or a further consolidation of European defense industry. It demands a sustained political commitment to readiness, resilient naval industries, continuous production, and acquisition systems designed for urgency rather than administrative convenience. Time has become Europe's scarcest strategic resource. The ability to convert industrial capacity into operational capability – rapidly, predictably, and at scale – will prove to be the decisive maritime advantage of the next decade.

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Sidney E. Dean

Distributed Maritime Warfare and the Rise of the Hybrid Fleet

Future maritime capabilities will no longer stem solely from platforms, but from sensor networks, data fusion, weapon range, C2 and resilience. These technological developments will permit large naval forces to operate in a dispersed manner while still coordinating and concentrating fire. Integrating crewed and uncrewed platforms into a hybrid fleet will maximize the potential of the distributed maritime warfare concept.

The Leidos Seahawk, one of two MUSV used for CONOPS experimentation, will integrate into the Theodore Roosevelt strike group for the aircraft carrier's upcoming deployment. ***(© US Navy)***

Concept of the Saildrone Spectre Silent Endurance variant. The 52 metre long stealth-USV can deploy a towed sonar array. Saildrone is partnering with Fincantieri for construction. ***(© Saildrone)***

Current technology developments have both defensive and offensive implications for fleet forces. Advances in sensor technology and long range anti-ship munitions (including the ability to mount swarm attacks with comparatively low-cost precision effectors) have significantly raised the threat level to ships at sea. This is increasingly forcing naval units to maintain greater distance to the adversary's anti-access/area denial (AA/AD) zones. Depending on the operational environment, large, concentrated formations can become a liability in terms of both force protection and offensive capability. They facilitate the enemy's ability to conduct surveillance and gather intelligence on the unit and to target vessels. Furthermore, maintaining concentrated naval task forces (even in the absence of robust hostile AA/AD capabilities) restricts immediate power projection capability to a smaller geographic zone and limits the number of targets which can be engaged simultaneously.

Distributed Maritime Warfare

The concept of Distributed Maritime Warfare or DMW (introduced into US Navy operational doctrine under the designation Distributed Maritime Operations or DMO) is designed to address these issues. It combines the dispersal of forces (platforms, sensors, weapons) across the operational theatre while retaining the ability to concentrate effects. Distributed operations permit maintaining a force presence across a much larger area. The force dispersal complicates the adversary's ability to detect, track, and attack naval forces, and adds unpredictability regarding the plans and movements of this force.

Advanced, high-capacity and secure networking permits the dispersed platforms to share sensor data, creating a cloud-based situational awareness. Ships can attack targets located far beyond their own sensor range, ensuring that the platform with the most suitable weapon load conducts the strike rather than the ship which happens to be closest to the target. Coordinated attacks can be conducted by multiple platforms, using identical or complementary weapon systems; these dynamic kill chains, executed from multiple directions and potentially from unexpected positions, are expected to strain or overwhelm enemy air and missile defence (AMD) systems, enhancing the odds of target elimination. Enhancements in land-attack and anti-ship munitions – including low-observable attributes, greater range and speed, and swarming ability – permit future fleets to take fullest advantage of combat cloud and cooperative engagement capability technologies.

Hybrid Fleet

The hybrid fleet concept calls for the operational integration of traditional manned platforms and uncrewed assets. This goes well beyond the already institutionalized deployment of Unmanned Aerial Systems (UAS) as well as smaller surface and subsurface vessels. Numerous major fleets are

The Spectre Stealth Strike accommodates the Mk 70 Payload Delivery System and achieves a sprint speed of 30 knots. There are currently no orders for the system, but Fincantieri is planning live fire demonstrations during RIMPAC 2027. ***(© Saildrone)***

introducing medium-sized to large uncrewed vessels as integral elements of the future operational force. These include unmanned surface vessels (USV) and unmanned underwater vessels (UUV). Mission and capability profiles include communications node, intelligence, surveillance and reconnaissance (ISR), and weapons carrier. In the latter category, options include land-attack and anti-ship cruise missiles as well as air- and missile defence (AMD) effectors. Electronic warfare suites are also considered a strong fit for USVs.

To date, the US Navy (USN) has announced the most ambitious plans in this regard. The service's Force Design 2045 plan presented in 2022 called for more than 350 manned ships and 150 large unmanned units, in addition to 3,000 aircraft. In 2023 the Pentagon proposed a new long-term force level goal, calling for a future battle fleet inventory of 381 manned ships and 124 major unmanned units (78 Large and Medium Unmanned Surface Vehicles or LUSV/MUSV, and 56 Extra Large Unmanned Underwater Vehicles or XLUUV). In May 2026 this was superseded by a new and accelerated US Navy shipbuilding plan. The associated force structure tables call for 299 manned battle force units and 83 MUSV by FY 2031; associated procurement plans also call for acquiring 16 XLUUV by 2031. In FY 2056, the final year of the 30-year shipbuilding plan, the fleet would include 398 manned battle force vessels (including circa 160 frigates, destroyers and battleships) and 72 MUSV, plus an as yet to be determined number of XLUUV.

> **" The Fleet of the Future is not a collection of platforms; it is an integrated system designed to generate combat power across domains.**

Acquiring technology alone will, however, not automatically lead to integration the fleet. A solid foundational understanding of capabilities is built up over time, through experimentation, trial and error. Concepts of operations (CONOPS) must be developed, tested and revised to ensure that the unified force is more than the sum of its parts, and that the various components do not actually interfere with one another's efficient deployment. As the 2026 shipbuilding document states: "The Fleet of the Future is not a collection of platforms; it is an integrated system designed to generate combat power across domains. Key doctrinal concepts like Expanded Maritime Maneuver (EMM) and Distributed Maritime Operations (DMO) depend on it."

The US Navy has been systematically evaluating the hybrid fleet concept under the service's Hybrid Fleet Campaign. To this end, Task Force 59 (TF 59) was established in 2021. Operating in the US Central Command area of responsibility (AOR) in the Middle East, TF 59 is tasked with integrating manned platforms with various USV and UAS types, and

Both the US Navy and the British Royal Navy envision hybrid air wings aboard aircraft carriers. Here the Boeing-developed MQ-25 refuels a US Navy F/A-18 during testing. ***(© US Navy)***

testing AI enabled ISR networks and sensor fusion across platforms. Small USVs (SUSV) in the 5-10 metre range have been used here, reflecting not only the operational environment but also the fact that these can be purchased in large numbers, maximizing availability for intense experimentation. Among other positive results, the unmanned surface vessels successfully established a persistent maritime domain awareness presence in chokepoints like the Strait of Hormuz, and established picket lines in the Arabian Gulf and other zones. This significantly reduced operational stress on manned units, which could then concentrate on responding to actual sightings of suspicious vessels (USVs are now deployed in the same manner in the US Southern Command AOR, with 10 metre Saildrone Voyager vessels acting as long-endurance pickets to detect drug trafficking boats and to shadow Russian naval vessels near Cuba).
On 10 June 2026 a 7.3 metre Saronic Corsair USV operating under TF 59 autonomously rescued two helicopter pilots who had been shot down by Iranian forces near the junction of the Strait of Hormuz / Gulf of Oman. According to military sources, the Corsair was chosen for the rescue because it was the closest available asset. Additional considerations, not openly discussed by the military, may have also been a factor. Sending the USV rather than a manned boat or helicopter kept additional personnel out of range of Irani arms, and avoided further escalation.

Hybrid Fleet – A Global Phenomenon

Other nations are also explicitly creating hybrid fleets. Among the leading services in this regard are the Royal Australian Navy (RAN), the German Navy and the UK's Royal Navy (RN). Given the much greater size of the overall USN battle force, the Australian and German plans actually point toward a significantly higher ratio of unmanned to manned combatants (approaching 1:1 in some cases).
In April 2026 the RAN activated the Maritime Autonomous Systems Unit (MASU), transitioning the service's uncrewed programs from prototype status to operational deployment, marking what the RAN calls "a key step in Navy's transition to a more integrated and highly advanced technology enabled future force." The unit will control several classes of unmanned autonomous underwater and surface systems

TKMS and IAI delivered the first BlueWhale large autonomous underwater vehicle to the German Navy in February 2026. The autonomous UUV combines reconnaissance, ASW sensor technology and data fusion in a single system. ***(© Bundeswehr/M. Krönke)***

comprising dozens of units optimised for persistent, long range ISR and kinetic strike missions. Additionally, Australia plans to acquire six Large Optionally-crewed Surface Vessels (LOSV), arsenal ships with 32 Mk 41 VLS cells to augment destroyers and frigates. Equipped with Aegis Baseline 9, the LOSV will have Cooperative Engagement Capability with other Aegis-equipped ships for conducting conventional and ballistic missile defence.

Germany's "Kurs Marine" long-term modernization program explicitly reframes the German Navy from a platform-centric fleet into a hybrid force of networked manned and unmanned systems. Uncrewed systems are to be an integral part of every task group, not a niche capability. This manned-unmanned integration is set to go far beyond deployment of UAS and SUSVs. Three Large Remote Missile Vessels (LRMV) will complement and support manned frigates in the air defence (including ballistic missile defence) and maritime strike role.

Citing German naval sources, German defence media have reported that the LRMV are conceived as arsenal ships equipped with vertical launch systems (VLS). Targeting data is to be provided by external platforms, either via direct transmission or satellite link. The uncrewed vessels will be designed for prolonged high-seas operations in the Atlantic. Some sources postulate that this might include autonomous patrols without immediate manned escorts.

The Future Combat Surface System (FCSS), armed with a 30+mm gun and loitering munitions, is designed to support manned corvettes through above water warfare (AWW) and maritime strike operations in marginal seas; procurement of 18+ units to support the fleet's nine manned K130 corvettes is planned. The swarm capable FCSS will be able to operate autonomously in designated operational areas or as part of mixed manned-unmanned task groups. Under water, a dozen or more Large Unmanned Underwater Vehicles (LUUV) will conduct reconnaissance and AWW missions in support of manned attack submarines. Finally, new ship- and land-based USVs and UUVs will support manned minehunters in the MCM and underwater reconnaissance mission. According to the official "Kurs Marine" document released in late 2025, the FCSS is expected to join the fleet by 2035, with the other unmanned systems fielding no later than 2029. As for the UK, the government formally presented the much-anticipated Defence Investment Plan (DIP) on 30 June, 2026. The plan includes significant developments for the RN. "[We] will build a new hybrid Royal Navy so that when our frigates move to intercept a threat, they will do so

> **"We will build a new hybrid Royal Navy so that when our frigates move to intercept a threat, they will do so with outriders – uncrewed ships, above and below the surface.**

Human crews will remain the core of future fleets, regardless of hybrid fleet integration. Here the bridge of the USS George H.W. Bush (CVN 77). ***(© US Navy)***

with outriders – uncrewed ships, above and below the surface, their AI systems working in unison with our warships, operating as a single integrated force." The planned acquisition of the highly sophisticated Type 83 AMD destroyers has been cancelled, leaving no manned replacement for the Type 45 destroyers on their retirement. Instead, the RN is set to acquire three classes of large USV (designated Type 91, Type 92 and Type 94) as well as one class of XLUUV (Type 93). The USVs will function as missile-armed arsenal ships, ASW reconnaissance vessels and AMD sensor platforms, respectively, while the XLUUV will assist crewed hunter-killer submarines in the ASW mission. The uncrewed systems will be designed for operations in the North Atlantic. At least six manned Common Combat Vessels or CCVs (themselves armed with interceptor missiles) will be acquired by the early 2030s as the command and control hubs for the hybrid fleet, particularly in the AMD role.

According to a British government press release, the uncrewed systems will be designed for operations in the North Atlantic. Together with the CCVs, they will form the backbone enabling implementation of the RN's three Atlantic Initiatives: Atlantic Bastion (a strengthened, persistent UK/NATO posture in the North Atlantic and High North); Atlantic Shield (protecting critical undersea infrastructure across the North Atlantic); and Atlantic Strike (providing a distributed maritime strike capability in the Atlantic theatre). Together, they form a coherent Atlantic posture built around hybrid fleets and autonomous systems. This doctrinal shift away from concentrating capability in a handful of large destroyers, geographically distributing operations among a larger number of unmanned platforms teamed with manned vessels, should extend the Navy's "reach, resilience and firepower without a proportional increase in crew or cost," according to an MoD statement.

Like the US Navy, the RN is also planning to field hybrid carrier air wings. The USN cleared the MQ-25A for Low-Rate Initial Production in May 2026, and expects to announce IOC for the large UAS in 2027. The USN plans to acquire 72 units. Six will be integrated into each carrier air wing to serve as refueling aircraft. The Royal Navy plans to integrate jet-powered collaborative combat aircraft serving alongside manned F-35B fighters in its future hybrid air wing. An autonomous airborne early warning aircraft is also planned for the British carriers.

Hybrid Fleets Optimal for DMW

The hybrid fleet concept is intended to address numerous challenges faced by today's conventional fleets, including personnel shortages and backlogged shipbuilding programs. Western navies recognize a need for larger fleets, both to respond to obligations and crises in various regions simultaneously, and to contend with significant fleet expansion by potential adversaries such as China. Adequate force structure is a prerequisite for DMW/DMO. The integration of manned and high-end unmanned systems, augmented by even larger numbers of SUSV and UUV platforms, presents itself as the most viable path to acquiring the necessary mass quickly and at a reasonable cost.

Unmanned units are already making significant operational contributions, and they promise to make considerably more as various services transition to full-fledged hybrid fleets.

They provide long-term persistent ISR capabilities, reducing stress on larger manned platforms as well as on the human crews. Depending on the type, some uncrewed systems can deploy for months at a time, making them ideal candidates for independent and dispersed early warning missions. Ukraine has already proven the ability of USVs to establish intercept cordons against manned and unmanned aircraft. In April 2026 the defence ministry in Kiev announced the downing of a Russian Shahed UAS using a Ukrainian-built Sting interceptor drone launched by a USV. According to press reports, the remotely controlled Sting can be deployed by an operator located up to 2,000 kilometres away. A year earlier, in May 2025, a Ukrainian Magura7 USV reportedly shot down two manned Su-30SM fighter jets using AIM-9 Sidewinder missiles adapted for surface-to-air launch.

Magazine limitations have emerged as a significant concern during recent naval operations. A prime example is the deployment of multinational forces to the Red Sea/Gulf of Aden region, where warships came under massed attack by simple but effective drones. Commanders on the scene quickly sought alternative means to neutralize drones and missiles, including increased reliance on deck guns. Even without this threat, VLS-equipped warships find themselves needing to prioritize targets. Pairing an uncrewed arsenal ship could effectively double the magazine depth available to the manned vessel, with AMD capabilities likely to remain at a premium in future deployments. Instead of dispatching two manned vessels together for mutual support, two manned-unmanned teams can cover two distinct zones simultaneously.

USVs can be forward deployed ahead of manned units to reduce risk to human crews. One scenario would be advanced deployment of unmanned units toward enemy AA/AD zones to neutralize anti-air and anti-ship launchers, sensors and C2 infrastructure. In addition to their own arsenals they could direct the fire of dispersed manned units' long-range missiles, or even transmit coordinates to aircraft and land-based batteries. Whether offensive or defensive, such coordinated fires among platforms represents a key element of DMW.

A major challenge of distributed operations lies in logistics. Sustaining distributed units – especially conventionally crewed vessels – with food, fuel and munitions will require additional supply platforms. Here, too, integrating a significant number of uncrewed platforms would ease the strain on the current manned logistics fleet. Several USVs could receive supplies from a logistics vessel positioned at a safe distance from the main line of conflict and deliver them to warships or beachheads in the combat zone, enabling a single replenishment ship to simultaneously support operations at diverse locations.

Fleet of the Future

Nothing in this analysis should imply that uncrewed systems will become the dominant factor in future fleets. Rather, naval forces – whether the USN, other NATO forces, or Indo-Pacific fleets – are shifting from single (manned) platform tasking to distributed sensors, distributed fires, and distributed kill chains. Every combat force element – whether manned or unmanned – will contribute across the full operational spectrum. The whole will be considerably more powerful than the sum of the parts, but manned vessels – across all categories – will remain the backbone of the fleet. Uncrewed systems will be force multipliers, providing greater presence, greater situational awareness, and additional firepower, permitting Distributed Maritime Warfare doctrine to achieve its full potential.

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Jens Balle, Robert Hendriks, Klemens Ehret

Utilising Uncrewed Platforms for Persistent, Cost-Effective ASW in the North Atlantic

The future of ASW in the North Atlantic - a too vast, too contested and operationally too demanding area - will not be decided by a single frigate, aircraft or submarine. It will depend on how effectively navies combine uncrewed systems, resilient command networks and scarce high-end assets into a scalable system of systems.

Anti-submarine warfare (ASW) in the North Atlantic has again become a central requirement for NATO maritime security. Russian submarine activity, the enduring importance of the Greenland-Iceland-UK (GIUK) Gap and Bear Island Gap, the protection of sea lines of communication between North America and Europe, and the vulnerability of critical underwater infrastructure all point to the same operational problem: the area to be monitored is vast, the environment is difficult, and the number of available high-end crewed ASW assets is limited.[1]

The core challenge is therefore not only how to defeat a submarine once it has been found. It is how to generate enough persistent search presence to detect, classify, track and cue relevant contacts in the first place. In fact, classical sea denial is as relevant as it was in the Cold War. Maritime patrol aircraft, ASW frigates, submarines and helicopters remain indispensable, but they are too scarce and too expensive to provide continuous wide-area coverage on their own. This is the capability gap that uncrewed maritime systems are now beginning to address.

In 2023, we argued that a notional ASW barrier in the North Atlantic could be generated more persistently and at lower total cost by combining large uncrewed surface vessels (LUSVs) and extra-large uncrewed underwater vehicles (XLUUVs) than by relying primarily on maritime patrol aircraft and expendable sonobuoys. The 2023 analysis compared an MPA-based barrier with an uncrewed concept built around teams of sonar-equipped LUSVs and XLUUVs. It suggested that a persistent uncrewed barrier could deliver a comparable surveillance effect at a significantly lower monthly total cost of ownership, while freeing crewed platforms for higher-value tasks.[2]

Three years later, the basic logic of that argument has not weakened. It has become more relevant. What has changed is the conceptual frame. The debate is no longer primarily about whether one uncrewed platform can substitute for one crewed platform. The more important question is how navies can build a distributed ASW architecture in which autonomous sensors, remotely operated vehicles, resilient command-and-control, AI-supported acoustic processing and high-end crewed platforms work together as a coherent system of systems.[3]

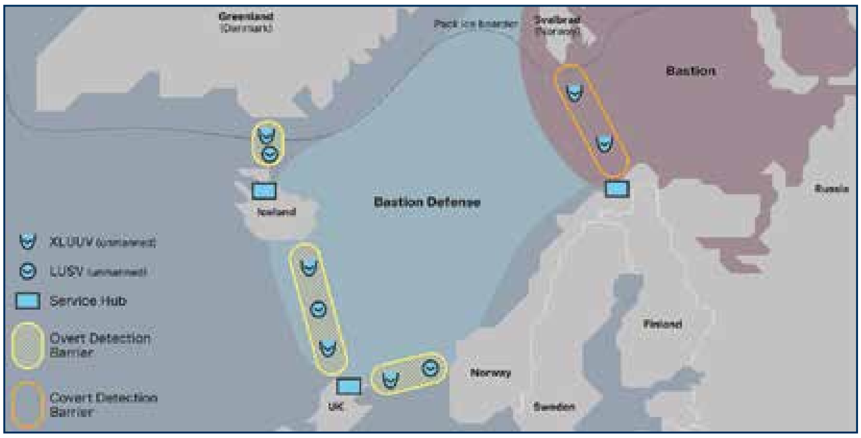
From Concept to Programme

The clearest operational example of this shift is the Royal Navy. Under Project CABOT, the Royal Navy has been exploring a scalable ASW barrier in the North Atlantic based predominantly on autonomous and remotely operated systems. Publicly available descriptions of CABOT link it to earlier Royal Navy work under Project CHARYBDIS and to the UK-led NATO ASW Barrier Smart Defence initiative. The programme is intended to create a deployable and persistent wide-area ASW search capability using a portfolio of lean-crewed, remotely operated and uncrewed or autonomous airborne, surface and subsurface systems, sensors and nodes.[4]

The project is being delivered in two phases. The first, ATLANTIC NET, would use a contractor-owned and contractor-operated model under naval oversight. Existing uncrewed underwater and surface systems, including gliders or other available UXVs, would gather sensor data, conduct initial processing and pass semi-processed information to a secure remote operations centre for Royal Navy review. This model is significant because it seeks to move capabi-

lity into the water quickly, reducing the delay normally associated with traditional force generation.[4]

The second phase, described as BASTION ATLANTIC, would move towards a government-owned and government-operated construct. At its core are envisaged new uncrewed platforms, including the Type 92 “Sloop”, a large ASW-capable uncrewed surface vessel, and the Type 93 “Chariot”, an extra-large uncrewed underwater vehicle. These systems would not remove the need for Type 26 frigates, P-8A Poseidon aircraft, submarines or helicopters. Rather, they would extend the sensor layer forward and increase the number of detection opportunities available to those high-end assets.[4]



Map of Bastion Defense, Bear and GIUK Gaps. ***(© Rand, Enhancing deterrence and defence on NATO’s northern flank, p. 6, Figure 0.1)***

The broader UK policy frame is now visible in the 2026 Defence Investment Plan. The plan states that the foundations for a Hybrid Navy are underway after Atlantic Bastion was launched in December 2025. It describes Atlantic Bastion as a programme combining autonomous surface and underwater vessels, digital infrastructure, warships and patrol aircraft to secure the North Atlantic for the UK and NATO against the growing underwater threat from a modernising Russian submarine force. It also commits an additional GBP 1.5 billion over four years to support the effort, alongside GBP 330 million for critical underwater infrastructure protection.[5][6]

This distinction matters. Project CABOT provides a concrete ASW barrier concept and development path. Atlantic Bastion, as framed in the Strategic Defence Review and Defence Investment Plan, represents the wider force-design logic: a hybrid naval force in which crewed platforms and uncrewed systems are networked together to generate mass, persistence, resilience and speed of decision. That is close to the operational architecture anticipated in 2023, but now expressed in official procurement and force-development language.[5][7]

The Emerging Operational Model

A 2026 understanding of uncrewed ASW should therefore begin with the network rather than the vehicle. A future North Atlantic barrier will not be one line of identical platforms. It will be a layered architecture: fixed or deployable seabed sensors, underwater gliders, UUVs, XLUUVs, uncrewed surface vessels, crewed frigates, submarines, maritime patrol aircraft, remote operations centres and national or alliance-level command networks.

The uncrewed layer provides persistence and sensing mass. Its purpose is to be present in larger numbers, for longer periods and in areas where it would be inefficient or politically difficult to keep crewed units continuously on station. Some systems may act as passive listeners. Others may support active, bi-static or multi-static sonar operations. Some may be optimised for choke points such as the GIUK Gap or Bear Island Gap; others may be assigned to critical underwater infrastructure or approaches to the North Sea.

The crewed layer remains decisive. Frigates, MPAs, submarines and helicopters provide higher-end sensors, weapons, command judgement, tactical flexibility and escalation control. In practical terms, uncrewed systems should be viewed less as replacements for these platforms and more as tripwires, cueing assets and persistence multipliers. They increase the probability that a submarine or suspicious underwater activity is detected early enough for a scarce crewed platform to be sent where it matters most.

Artificial intelligence is also important, but it should be described carefully. The central near-term value is not autonomous lethal decision-making. It is acoustic triage, anomaly detection, data reduction, operator support and the acceleration of the sensor-to-decision chain. Distributed ASW generates large volumes of acoustic, environmental and platform-health data. Without automated support, a larger sensor network can overwhelm the operators it is meant to help. With reliable processing, it can become a scalable surveillance system.

This is why command-and-control and data architecture are as important as hull forms. A persistent ASW barrier depends on secure data links, edge processing, robust communications, assured timing, cyber resilience, interoperability and clear operational authority. The hard problem is not only building uncrewed vessels that can survive in the North Atlantic. It is also integrating them into a trusted operational picture that commanders can use under peacetime surveillance, crisis management and wartime conditions.

Reframing the Economics

The economic argument from 2023 should be retained, but it needs to be reframed. The advantage of uncrewed ASW is not simply that individual platforms are cheaper than aircraft, frigates or submarines. In some cases, they will not be cheap at all, particularly once payloads, communications, support infrastructure, remote operations centres, cyber protection and lifecycle upgrades are included. The more useful metric is operational effect: how much continuously available sensing, cueing and search opportunity can be generated per euro or pound spent.

Viewed in that way, uncrewed systems become compelling because they can shift the balance between persistence and cost. MPA-based ASW is highly capable but OPEX-intensive, especially when large numbers of sonobuoys are used to maintain a barrier over time. A distributed uncrewed architecture requires upfront investment, but its value lies in endurance, reusability and the ability to keep sensors in the water without tying down crews and high-end platforms continuously.[2]

MEKO® S-X SWASH-type LUSV deploying active and passive towed sonar. *(© TKMS)*

The decisive driver for an uncrewed ASW barrier is therefore no longer cost reduction alone, but the operational requirement to generate persistent sensing mass, resilient cueing and scalable response options across a theatre too large to cover continuously with crewed assets. In that sense, affordability and operational necessity now reinforce each other. Navies need more sensing presence than their crewed force structures can provide, and they need to create it in a way that can be sustained politically, financially and industrially.

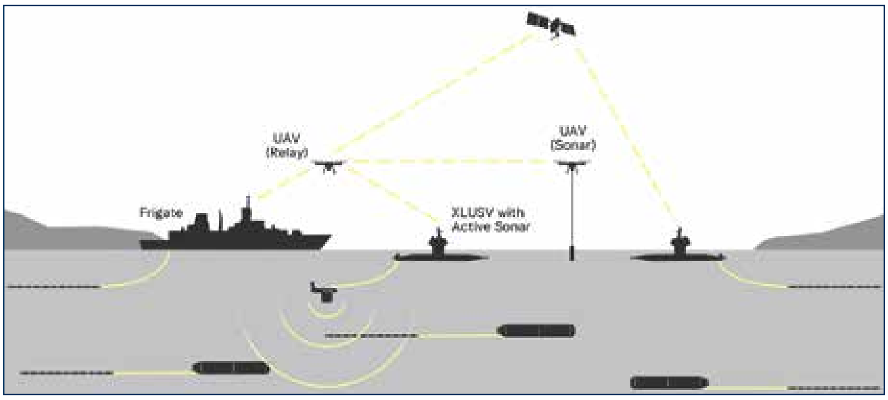
The contractor-operated logic proposed for ATLANTIC NET is particularly noteworthy. This service-like model is not a universal answer, and it will raise questions around security, liability, operational control, survivability and escalation. But it offers one practical route to rapid experimentation and early deployment. It also changes the industrial relationship: industry is no longer asked only to deliver platforms against fixed requirements, but to help deliver a measurable operational outcome.[4]

Implications for European Shipbuilding Primes

For large European shipbuilding primes, the shift towards hybrid ASW has consequences beyond any single programme. The future surface combatant is no longer only a self-contained platform with sensors, weapons and command systems onboard. It is increasingly a command node, payload host, data gateway and force multiplier for a wider ecosystem of uncrewed and autonomous assets.

This does not mean that crewed warships are becoming obsolete. The opposite is true. High-end crewed platforms will remain central because they provide survivability, command authority, weapons capacity, aviation facilities, endurance, maintenance capability and political signalling. What changes is the design assumption. Future ships will have to be conceived from the outset as part of a distributed force. Mission bays, modular payload interfaces, unmanned-vehicle handling, open combat-system architectures, data-management capacity and interoperability with allied networks will become core requirements rather than optional growth features.

The implication for industry is clear. Primes that remain focused only on exquisite platform delivery risk missing the centre of gravity. The value proposition is moving towards integration: ships, underwater vehicles, sonar



Notional Concept of a system-of-systems ASW barrier ***(© TKMS)***

payloads, combat systems, remote operations, data fusion, lifecycle support and alliance interoperability. The companies best positioned for this environment will be those able to connect platform engineering with naval electronics, autonomy, mission systems and operational support.

The TKMS Approach

This trend is directly relevant to TKMS. The company's evolving structure combines submarine design and production, surface vessel engineering and naval electronics through TKMS ATLAS ELEKTRONIK. That combination is well suited to distributed maritime operations because hybrid ASW is not a single-product problem. It requires underwater endurance, surface seakeeping, acoustic sensors, combat-system integration, secure communications, payload modularity and manned-unmanned teaming.

TKMS ATLAS ELEKTRONIK provides the sensing layer. Modern ASW increasingly depends on multi-static operations, automated acoustic support and the ability to integrate sonar data from different sources. Modular sonar payloads, mission modules, combat-system interfaces and integration into command structures can allow a broader range of platforms to contribute to the underwater picture. This is where TKMS can credibly link platform design with sensor integration and data exploitation.

In the underwater domain, TKMS is developing the XLUUV stargazer® as a multi-role platform for covert underwater surveillance and other military missions, such as seabed warfare. In a hybrid ASW architecture, its relevance lies primarily in adding persistent, hard-to-detect underwater presence to the sensing layer, not in replacing crewed submarines or surface ASW platforms.

Another example for the overarching technology strategy of the TKMS group is the TKMS MEKO® S-X concept. The platform points towards a future uncrewed ASW solution, that is designed to provide a persistent ASW contribution in demanding North Atlantic conditions. It is designed for a seamless integration in existing NATO ASW doctrines for ASW barriers and escort operations, calling for high speed and seaworthiness. It comes in two variants as passive only sonar picket or in an active / passive variant.

Conclusion

The 2023 conclusion can be retained, but it should be sharpened. Uncrewed platforms should no longer be viewed primarily as niche adjuncts to conventional ASW forces or as cheaper one-for-one replacements for maritime patrol aircraft and frigates. In the North Atlantic, they are increasingly becoming the foundation of a broader surveillance and cueing architecture that links autonomous sensors, digital command networks, AI-enabled processing and selective deployment of high-end crewed assets.

Current UK efforts under Project CABOT and Atlantic Bastion show that the debate has moved from analytical concept to force design. The same operational logic applies more broadly to NATO and to European navies: the underwater battlespace is becoming too large, too contested and too data-intensive to monitor with traditional assets alone.

The promise of persistent, cost-effective ASW therefore lies not in any single vehicle, but in the creation of scalable, interoperable systems of systems. The aim is to deliver sensing mass, endurance, cueing and operational flexibility across a contested underwater environment. Cost-effectiveness remains important, but the stronger 2026 argument is operational: hybrid ASW gives commanders more options, earlier warning and better use of scarce high-end assets against a threat that is becoming more capable and more persistent.

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Dr Lee Willett

From seabed to space: NATO navies build information sharing and maritime domain awareness to enhance CUI security

Evolving operational requirements and realities are driving accelerating focus across alliance navies on broadening maritime surveillance – especially underwater – to counter the risk to seabed infrastructure.

In early April 2026, the UK Ministry of Defence (MoD) revealed that a Russian submarine incursion into NATO waters had been deterred. The MoD believed the Russian operation was targeting critical undersea infrastructure (CUI) assets of a NATO member state, in North Atlantic waters just outside the UK's exclusive economic zone.

While the Russian operation appeared to focus on specific CUI, the NATO effort to deter it involved building maritime situational awareness (MSA) both at a multi-domain level and broadly (in geographic terms) across the North Atlantic region.

According to the MoD, the NATO operation began when UK aircraft and warships detected and then identified a Russian Navy Akula-class nuclear-powered attack submarine (SSN) entering international waters in the High North. Over the next month, NATO assets deployed to track the submarine '24/7'. However, the allies assessed the SSN activity as being used as a diversion for the primary mission – the deployment of undersea assets from GUGI (Russia's Main Directorate of Deep-Sea Research) to conduct operations against CUI sites that were understood to be of interest to UK and other NATO countries.

GUGI's force structure includes both crewed and uncrewed platforms capable of conducting deep-submergence operations, including against CUI.

As the Russian operation developed, the MoD statement said UK and allied forces began a campaign of overt activities, to send a message to Russia and its assets that they were being observed. The aim of such messaging was to deter further activity. The statement said the Russian units then returned home.

In a media briefing, then-UK defence secretary John Healey said the UK and NATO response exposed covert Russian underwater activity, but also demonstrated the UK armed forces' capacity to detect, deter, and respond to such threats.

The UK assets used underlined the multi-domain approach, which encompassed air, surface, and sub-surface maritime platforms. These included a UK Royal Air Force (RAF) P-8A maritime patrol aircraft (MPA), the sensor fit for which included deploying sonobuoys, a move that was part of the overt deterrent messaging employed; HMS St Albans, a UK Royal Navy (RN) Type 23 anti-submarine warfare (ASW) frigate, whose role as a towed-array patrol ship (and thus

In 2020, UK air assets photographed a Russian Navy Oscar-class nuclear-powered guided-missile submarine entering the Baltic Sea. Increasing risks in the underwater domain are driving NATO efforts to expand MDA from seabed to space. ***(© Crown copyright/UK Ministry of Defence, 2022)*** referred to colloquially as a 'TAPS 23') is enabled by its Thales Type 2087 active low-frequency towed body/passive low-frequency towed-array sonar system; the Royal Fleet Auxiliary (RFA) tanker RFA Tidespring; and multiple Merlin Mk2 ASW helicopters, embarked across St Albans and Tidespring. RN assets also deployed sonobuoys.

Real threat

While NATO navies have been talking openly for some time about the growing underwater threat including to CUI, the incident showed that the threat is real.

The apparent Russian focus on CUI in the operation illustrated how NATO's adversaries may target CUI, to deter NATO presence or postures in peacetime or to attack NATO countries in times of crisis or conflict. Indeed, this incident was just the latest in a sustained series relating to CUI across the North Atlantic: this list includes two incidents in Norwegian waters (in November 2021 and January 2022, one each at either end of the Bear Island Gap maritime chokepoint), and five incidents in the Baltic Sea between September 2022 and January 2026 starting with the Nordstream explosions.

Moreover, the Russian operation – blending ASW and CUI elements – reflected NATO's own evolution in sub-sea strategy. Many NATO navies now view ASW, CUI, and mine counter-measures (MCM) tasks as being an integrated collection within what are now more often termed underwater warfare (UWW) operations.

The broadening operational and geographical nature of the threat NATO navies face is reflected in the different layers of concepts for dealing with UWW issues that NATO, its member states, and their navies are putting into place.

At the NATO level, the alliance is looking to expand and improve its effectiveness in building maritime domain awareness (MDA), through its evolving Digital Oceans Vision concept. Underlining the all-encompassing nature of the UWW threat – many of the Baltic CUI incidents, for example, have been attributed publicly by NATO political and naval officials to commercial ships dragging their anchors across the seabed at speed for considerable distances – the Digital Oceans vision is based around using multi-domain sensors from seabed to space, but significantly including commercial vessels sharing data on 'patterns of life' anomalies they observe at sea.

It is worth noting here that, even in the complex area of building underwater warfare MDA – where, by definition, it is difficult to monitor who is doing what and where – space and surface assets play a particular role in surveilling surface activity, to search for any suspicious patterns exhibited by surface vessels that may point to covert activity being conducted below. This is particularly relevant to CUI threats in (for example) the Baltic, where shipping traffic is very dense and where a fairly anonymous ship could subtly deploy a small uncrewed underwater vehicle (UUV) over the side or just drag its own anchor. Such patterns of routine and anomalous behaviours are also something NATO's Allied Maritime Command (MARCOM) now monitors daily, especially through the ships deployed on NATO's two North Atlantic-focused standing naval forces (SNFs), Standing NATO Maritime Group 1 (SNMG1) and Standing NATO Mine Counter Measures Group 1 (SNMCMG1). These ships now harness MARCOM's bespoke 'Mainsail' data fusion and analysis software tool to assess shipping patterns, as a core part of enhanced vigilance activities conducted on the 'Baltic Sentry' CUI security operation.

Such wide-area surveillance capacity, and the data emanating from it, needs to be networked and shared efficiently and effectively, so that threats can be detected and then deterred or defended against. For UWW operations, NATO is in the process of putting together a bespoke architecture infrastructure designed to deliver command and control (C2), and to harness and exploit increasing data levels. This architecture is known as the Allied Under Water Battlespace – Mission Network (AUWB-MN). In September 2025, a multinational consortium called 'Mangrove' (led by Swedish ship and submarine-builder Saab Kockums, and consisting of defence technology companies from 'primes' to small/medium enterprises, plus research organisations), was awarded a one-year contract to get the AUWB-MN programme underway with the first phase of work.

NATO member state navies are also developing architectural and operational concepts that could feed into AUWB-MN, especially in providing networked capability (assets) and capacity (C2) to conduct surveillance and wider MDA operations.

Atlantic Fleet

As a major North Atlantic naval power, including possessing significant UWW capacity, the RN is again a significant player here.

Its own response to building greater MDA capacity to deter the growing naval threats across the wider region is transitioning to a 'hybrid' force structure. Under this structure, maritime uncrewed systems (MUS) will be used en masse to provide multi-domain surveillance capacity.

Building MDA capability and capacity sits at the core of an operational construct that is itself the centrepiece of the RN's 'hybrid' transition. The 'Atlantic Fleet' construct integrates three concepts that will deliver manned/unmanned teaming (M/UMT) to generate greater mass in sensing, lethality, and wider MDA that will deter and defend against threats to national and NATO interests.

'Atlantic Bastion' is designed to build UWW surveillance presence, integrating UUVs of all sizes with crewed platforms in all domains to gather data from key areas across the North Atlantic region, and to counter both ASW and CUI threats. The other two concepts, 'Atlantic Shield' and 'Atlantic Strike', respectively are intended to deter and defend against integrated air and missile defence (IAMD) threats; and to generate long-range precision strike capability (to deter the IAMD threats in the first place, through the risk of response).

The importance of 'Atlantic Bastion' in building UK and NATO MDA against UWW and multi-domain threats was illustrated by its prominent position in the MoD's Defence Investment Plan (DIP), announced in June 2026 and providing the budgetary and programmatic detail to fill in the strategic framework set out by the UK's June 2025 Strategic Defence Review (SDR).

To meet SDR's vision, the DIP set out both short- and medium-term spending and programme profiles on new maritime capabilities, which highlight the UK focus on investing in UWW capability to fund programmes like 'Atlantic Bastion' and deal with risks like threats to CUI.

For 'Atlantic Bastion', the DIP said the programme was created as a direct response to increasing Russian underwater activity around UK waters, including deployments of GUGI platforms and the navy's survey ship Yantar. 'Atlantic Bastion' was launched in late 2025, with the MoD seeking a commercial company to manage the programme's C2 development, plus industry suppliers to provide various UUV-based sensing technologies that can be in the water in 2026 and scaled up across 2027.

For 'Atlantic Bastion', and particularly its first phase 'Atlantic Net' (under which UUV-based sensors will be deployed around key areas like the Greenland-Iceland-UK [GIUK] Gap), the MoD will spend an additional GBP1.5 billion in the short term, between 2026 and 2030, to get 'Bastion' going.

For CUI security in the short term too, the DIP committed to spending GBP330 million to deal with hostile threats in and around UK waters. This includes enhancing the capabilities of the UK's dedicated seabed operations vessel RFA Proteus, which entered service in 2023 having been procured from the commercial market. Proteus has already participated in high-profile CUI security deployments, including being one of several naval vessels sent to the UK's southwestern approaches in November 2024 to deter Yantar's presence.

In the medium term, between 2030 and 2035, within an overall total of at least GBP32 billion the UK stated it will spend on new maritime capabilities, according to the DIP the RN will focus on fully integrating autonomous underwater, surface, airborne capabilities with its own and allied crewed assets, to build mass and persistence in delivering core tasks, including supporting NATO North Atlantic security and protecting CUI.

Storing and sharing

How to build MDA from seabed to space to deter the CUI threat continues to be a focus of discussions amongst senior naval, industrial, and academic leaders, as shown at several high-level naval conferences in Europe in 2026. Such conferences have included two Navy Leaders events: 'Navy Tech/Seabed Defence', in Sweden in February; and the 'Combined Naval Event', in the UK in May.

To enhance MDA, NATO navies are building layers of assets, and testing such multi-domain layers during exercises like 'Dynamic Mongoose' (pictured, in 2026).
(© Crown copyright/UK Ministry of Defence, 2026)

Across these events in particular, a range of themes were raised relating to building the ‘seabed to space’ infrastructure to enhance MDA in support of CUI security.
According to industry experts, much of the required CUI surveillance technology already exists, but there remains a need to do more to work together; and, within efforts to improve such co-operation, standardising approaches to CUI security across countries to enable industry to engage in a common manner in each instance would have impact. This view was put forward despite the evident operational co-operation at sea when immediate CUI threats need to be countered.
Where navies could do more together themselves, according to the conversations, is connecting their technical research organisations to share different understandings of the real CUI risk and how new technologies (like long-endurance UUVs) may shape the risk going forward, plus to develop environments in which the technology can be more properly tested.
One question of cross-government co-operation raised was whether governments together could put in place legislation that requires commercial ships to operate with their automatic identification system (AIS) transponders switched on. Ships engaged in covert activities like illegal fishing, oil bunkering, or loitering around CUI often ‘go dark’ when needed.
The discussions also highlighted that significant volumes of data for building MDA do exist. Yet, there remain challenges to the more effective use of such data to support operations. These include: introducing technologies like artificial intelligence (AI) to sift data, but without significantly impacting what is already limited at-sea bandwidth; overcoming intellectual property, national security, and legal barriers to the sharing of commercial or defence data between various stakeholders; breaking down technical information system ‘silos’ in instances where information sharing is already permitted; and developing structures like ‘data warehouses’ that can accommodate vast pools of data, but store it in an accessible, standardised, and secure manner.
Despite the technology developments that are helping to expand MDA and MSA knowledge through harnessing more data, experts also underscored the need to understand even more both the operational environment and the data; to understand (and develop a common view of) the nature of the threat itself; to decide together how to respond; and to have the right number of the right effectors to provide response options. Such options could include having UUVs or uncrewed surface vessels forward deployed around CUI networks to enhance security. A key component of the message being sent here is that building MDA and MSA is an important step, but is not enough on its own.
Central to growing the military capability to deter and respond to CUI threats will, of course, be establishing C2 connectivity between all stakeholders – navies, coastguards and other maritime security forces, and the civilian/commercial sector – so that the MDA and MSA pictures relating to CUI security broadly or to a specific threat can be shared more easily.
All of this needs to be considered, experts assessed, to enable stakeholders to take what is still one of the big steps in CUI security – more effective use of information.

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Tactical command and control supported by a shared operational picture, as seen in the US Combined Space Operations Center. ***(© David Dozoretz, US Space Force)***

Giuseppe Magnotta

From core to tactical edge: A unified platform for defence innovation

Military organisations increasingly operate across disconnected, contested and highly heterogeneous digital environments. Defence IT is becoming more distributed, autonomous and contested. To turn the resulting complexity into operational advantage, they need a common platform that links core infrastructure, deployed edge and tactical edge without sacrificing sovereignty or security.

Driven by the need for agility, security, and sovereignty, the defence sector is undergoing rapid digital transformation. Military organisations are increasingly operating across hybrid infrastructure spanning the strategic core, deployed edge, and tactical edge, while maintaining absolute control over their systems. However, this evolution presents significant challenges, from siloed technologies to cybersecurity threats. Defence organisations must navigate these obstacles by adopting a unified platform approach based on open standards, strengthening autonomy, security, and seamless operations across all environments.

Traditionally, defence operations began in the strategic core, which consisted of large on-premises data centres disconnected from the internet. These handled everything from mission planning to logistics. The first wave of transformation introduced private cloud solutions, allowing military organisations to scale infrastructure dynamically while maintaining digital sovereignty. Many defence entities remain cautious about using the public cloud due to security concerns, opting instead for air-gapped private clouds: physically isolated environments within their facilities that only screened personnel and verified secure networks can access.

The rise of edge computing

Today, the focus has shifted to edge computing, highlighting the need for smarter, real-time, and autonomous decision-making in the field. Defence organisations now operate across two key edge environments: the deployed edge and the tactical edge. The deployed edge consists of mini data centres capable of running mission-critical applications, processing intelligence, and supporting AI workloads. Meanwhile, the tactical edge encompasses lightweight, ruggedised devices such as drones, autonomous vehicles, and soldier-worn systems that can collect, analyse, and act on data in real time, often completely disconnected from central networks.

Unlike commercial IoT, military edge devices do not rely on constant connectivity. Instead, they synchronise data intermittently via private 5G networks or secure satellite links, providing operational continuity even in contested environments.

Key challenges in defence digital transformation

While hybrid infrastructure offers flexibility, defence organisations face a number of critical hurdles. One major obstacle is technology silos. Different environments, such as core, cloud, and edge, often use incompatible technology stacks, forcing organisations to rebuild solutions for each deployment. This fragmentation means soldiers and engineers must learn multiple platforms, slowing mission readiness.

Another challenge is the complexity of manual processes. Moving data between core and edge and back again requires custom workflows, increasing deployment times. At the same time, legacy security models struggle to adapt to distributed architectures, leaving gaps that adversaries can exploit.

Perhaps the most pressing concern is the growing threat of supply chain and cyberattacks. Software supply chain attacks, where malicious code is injected into open-source libraries, can compromise entire fleets of drones or vehicles. Similarly, man-in-the-middle attacks can alter firmware updates in transit to tactical devices, potentially sabotaging critical missions.

To counter these challenges, organisations increasingly adopt a single platform with greater consistency across the entire operational spectrum. In the strategic core, container orchestration and automation capabilities enable robust, scalable infrastructure. The deployed edge benefits from compact clusters, while the tactical edge leverages lightweight runtime environments for ultra-portable operations.

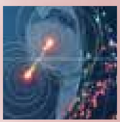
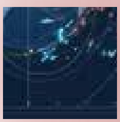
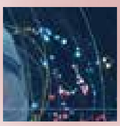
This unified approach delivers significant advantages. By enabling deploy once, run anywhere capabilities, it dramatically accelerates time to mission. Soldiers and engineers can use familiar tools across all environments, reducing training overhead. And because the platform is open, defence organisations can integrate third-party solutions without vendor lock-in, maintaining flexibility for future needs.

To help counter evolving cyber threats, advanced security measures should be incorporated. A Software Bill of Materials capability allows organisations to track every component in a deployed system, so only trusted code runs on drones, vehicles, or command centres. Cryptographic attestation verifies that firmware and updates are not tampered with during transit, and disconnected automation enables patching of field devices via USB or ruggedised laptops, with no internet connection required.

Proven use cases in defence

Several defence organisations have successfully implemented solutions to overcome critical operational challenges. One European air force confronted persistent mission disruptions caused by network outages in field operations. By implementing portable edge data centres, they enabled




Centralised command and control for distributed defence operations, illustrated by SAAB's 9LV concept. ***(© SAAB AB)***

local AI processing capabilities that maintained continuous operations regardless of connectivity status, while significantly reducing bandwidth requirements.

In another demonstration, a major defence contractor showcased the ability to perform in-flight software updates on unmanned aerial systems. Using lightweight edge infrastructure, they successfully deployed AI model upgrades to drones during active missions, enhancing real-time target recognition capabilities without requiring mission interruption or system downtime.

A different national defence organisation achieved remarkable efficiency gains by automating its platform-as-a-service processes with container automation and orchestration tools. Infrastructure deployment times were reduced from several weeks to just a few hours, while simultaneously expanding developer capacity nearly fourfold within a single year, all while maintaining strict security protocols.

Sovereignty, systems security, and speed

Defence organisations cannot afford fragmented, insecure IT infrastructures. An open hybrid platform helps deliver three critical advantages:

1) Complete digital sovereignty by enabling strict control over data and infrastructure.
2) Unified operations via a single platform spanning from core to tactical edge.
3) Proactive security measures through SBOM, attestation, and zero-trust principles.

The future of defence demands systems that are connected yet autonomous, and agile yet resilient. With a unified open platform, organisations gain the confidence to deploy, update, and operate anywhere, supporting mission success in an increasingly complex threat landscape.

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H I Sutton

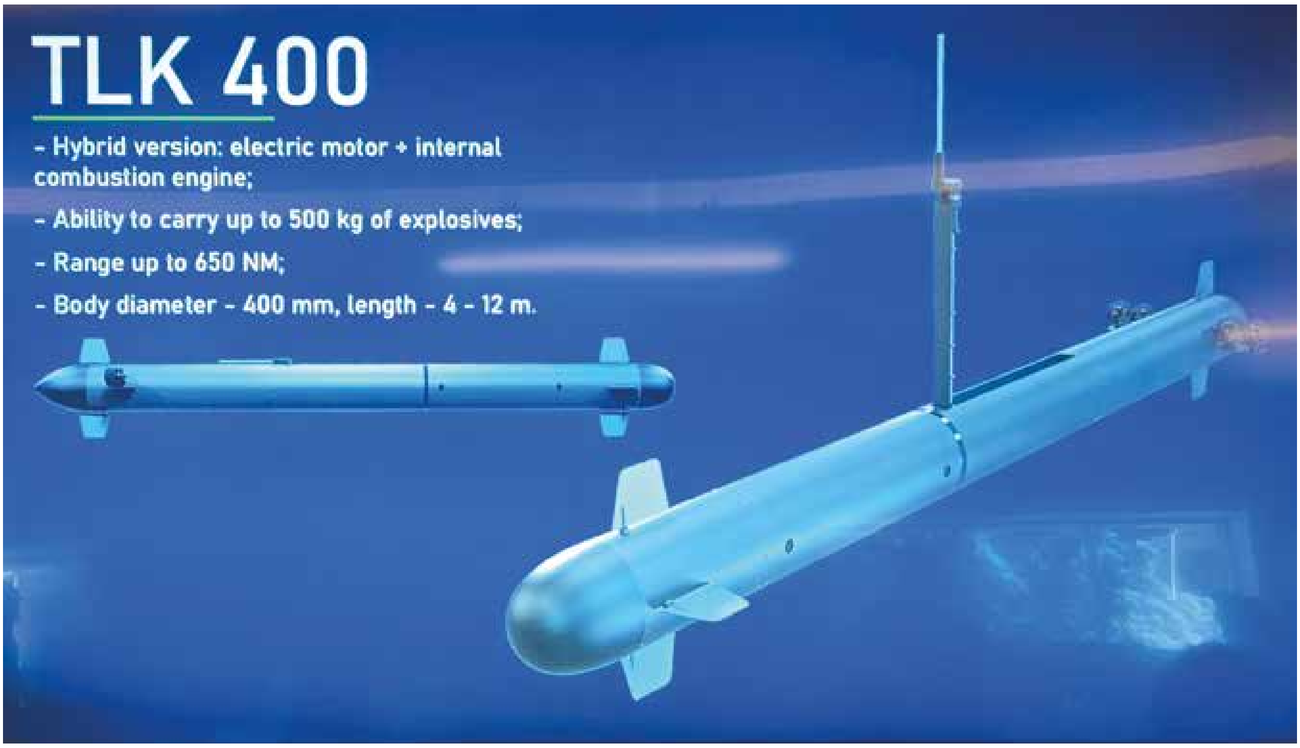
The Challenges & Opportunities of the Industrialisation of Uncrewed Underwater Systems

As large and extra-large uncrewed underwater vehicles gain strategic relevance, European navies face a more difficult question: how to move beyond experimentation and build the industrial, doctrinal and procurement base for scale.

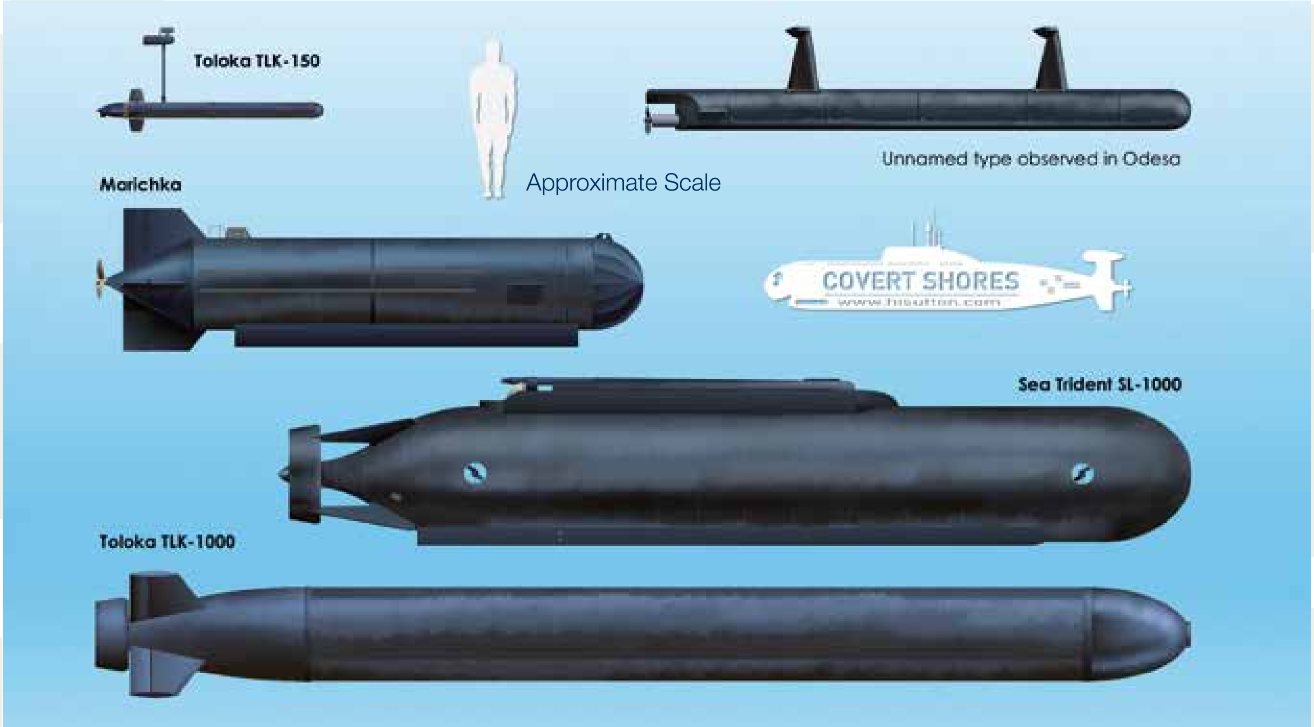
From Prototype to Capability: Scaling Europe's Underwater Drone Revolution

We are in the midst of a drone revolution, which is reshaping warfare at a pace and scale few would have anticipated just a few years ago. Like the ascent of aviation in the First World War, innovation is accelerating so rapidly, and on such a scale, that it is hard to ignore.

Yet while recognition of the drone revolution is gaining acceptance, even within navies that may feel somewhat insulated by geography, established force structures, and legacy procurement priorities, the question of how to respond remains far more challenging. Unsure what to do, and how fast to move, we have yet to see the type of transformation



Toloka is a Ukrainian developer of autonomous underwater drones, delivering AI-enabled UUV platforms for long-range reconnaissance, surveillance and other missions. Photo taken from an industry-presentation. **(© hum)**



Ukrainian drones are going to be the reference point for the drone revolution. ***(© H I Sutton)***

that we should expect of European Navies. There are of course numerous small-scale programs afoot and some, notably the Royal Navy, are defining their strategy around a hybrid model with vast fleets of uncrewed platforms. And European manufacturers are ready with an ocean of design proposals to fill as-yet undefined requirements. But in terms of an industrial strategy to match the quickly evolving needs, we are still some way off.

Europe's uncrewed naval vessels scene is awash with prototypes and demonstrators. Numerous companies, many of them smaller or start-ups, are joining the race. There are over 20 European manufacturers building naval drones. In almost every European country bordering the sea there is at least one company offering uncrewed platforms. Most of these are surface drones, but underwater drones are out there too. And, slowly, governments are starting acquisition processes. Yet moving beyond the prototyping phase will be challenging for many governments.

This is particularly the case in the new arena of large and extra-large uncrewed underwater vehicles (LUUV and XLUUV respectively), which will become the norm. These terms are ill-defined, but it is clear that the trend is towards larger underwater drones. For our purposes here we can use the familiar term AUV (autonomous underwater vehicle) to mean LUUV or XLUUV.

Adapting to this new reality requires overcoming institutional inertia, rethinking long-held assumptions, and making difficult choices about future capabilities, concepts, and investments. European navies need to rapidly adopt new uncrewed technologies, in the surface, air, but also underwater domains. At the same time, they need agile acquisition, the openness to integrate them into their force structure, and the industrial strategy to provide the numbers of systems required.

The Drone Revolution At Sea

The war in the Black Sea has revealed the growing importance of uncrewed platforms. Most visibly this has been Ukraine's pioneering use of uncrewed surface vessels (USVs). These small boats, initially using commercial off the shelf (COTS) jet ski parts, have been successful in driving the Russian Navy into the relative protection of a single major port. Ukrainian USVs have been used effectively to strike, and in several cases sink or destroy, Russian naval vessels at sea and in port. They have also been used to sow minefields outside Sevastopol which likely contributed to the Russian withdrawal from that base. And, in a deliberate and limited way, to disable merchant vessels which are supporting the Russian War effort.

Even deep in the protected harbour of Novorossiysk Russian warships and submarines are vulnerable to uncrewed

Greyshark is a German USV; designed by EUROATLAS and EvoLogics. ***(© hum)***

platforms, including recently the increasing threat of precision guided deep strike aerial drones (OWA-UAVs – one way attack uncrewed air vehicles). These same aerial drones, although limited by relatively small warheads, are increasingly being flown on missions to attrit and constrain Russian logistic in the Sea of Azov.

Russia for its part is also switching to USVs for offensive operations, although much slower than Ukraine. These have been used for attacks on Ukrainian vessels in the Danube and the port of Odesa. They have so far been used in close coordination with aerial drones which provide real time intelligence and likely act as communications relays. The UAVs then conduct their own strike missions.

Yet unseen below the surface Ukraine has also been developing and deploying underwater drones. The AUVs have not been used as frequently or as successfully, although their potential was demonstrated in an attack on the Kerch Bridge on 3rd June 2025. And again, when another exploded deep inside Novorossiysk's submarine basin on 15th December 2025. More than anything, the AUVs create a threat which helps shape Russia's operations.

Of Ukraine's AUVs the Marichka and Toloka families have received the most press attention. The former is around 6 meters long by 1 meter diameter, and the latter about twice that at 12 meters. Both are designed for long range missions with large explosive payloads. Other publicly revealed Ukrainian designs include the slightly larger Sea Trident SL-1000 which has yet to be launched, and an unnamed type used by the Ukrainian Navy which is smaller, around the size of a heavyweight torpedo. So there is plenty of variety, and at least 4 manufacturers, but also a clear trend towards long range expendable types capable of carrying a large payload.

Ukraine's AUVs are not at all like the myriad of smaller types which dominated Western acquisition programs in the years before the 2022 full-scale invasion of Ukraine. Those smaller systems, typically designed for intelligence gathering and mine countermeasures, still have a role to play, and a bright future, but the drive to weaponize underwater drones has led to much larger types in Ukraine. And the wartime realities and efficiencies have led to cruder construction and more limited specifications.

This latter aspect is key; Ukraine's AUVs, like their surface and aerial equivalents, are expendable systems. They have distributed supply chains and dispersed production and have minimised the need for specialist tooling. They are designed to operate at relatively shallow depths, just tens of meters, and their equipment fit is comparatively sparse. At the same time, range and payload are emphasised.

It is not entirely fair to credit Ukraine with everything in the naval drone revolution, although they are undoubtedly the

go-to example to learn from. Iran too was a pioneer of uncrewed naval systems, not just of attack USVs which they and their Houthi allies used effectively, but also weaponised underwater drones. Iran's designs, built largely from COTS parts, blurred the line between drone and torpedo.
In these examples we see an emphasis on offensive employment. The inherent expendability of uncrewed platforms, particularly ones designed to be cheap, changes the risk calculation on offensive operations. Even if the uncrewed vessels themselves are individually inferior, and suffer incredible attrition rates of 90% or more, they can be extremely effective strategically; they only have to get through once. This is supported by the fact that we barely hear about the hundreds of naval drones which are destroyed before they reach their target, it's not even a metric among Russian milbloggers. But the world hears every time even one drone does get through. So, the asymmetry is not just in the tactical and operational sense, it is in the narrative sense also.

The LUUV Blue Whale – product of a joint venture of ELTA Systems and Atlas Elektronik. The photo depicts an original model as exposed at UDT 2023 in Rostock. **(© hum)**

Looking East

To learn from leading exponents of the industrialisation of AUVs we should not look West to the traditional leaders of naval technology. Instead, we should look to China. The Chinese Navy (PLAN) has built a commanding position in extra-large AUV development. From modest beginnings around 10 years ago, they have built and tested more vessels and more designs than any other country. We can conservatively estimate at least 20 XLUUVs have been built, including the eight present at the parade in Beijing last September. The parade also showed that China has moved beyond prototyping and trials to the serial production phase. The prototypes we see now are their second or even third generation.
Unlike other countries which build single demonstrators, China pits multiple design institutes against each other in comparative trials of prototypes, much like Cold War American fighter jet development. And while the winners are already entering series production and service, the losers trickle into the export market.
Chinese XLUUV design thinking is interesting in several ways. They can afford dedicated designs for limited mission sets such as minelaying or intelligence gathering. And while most are road mobile, fitting inside standard ISO shipping containers does not appear to be a requirement in the same way it is becoming in the West. This frees designers of the physical constraints of a rectangular storage space and allows optimisation for the mission above transportability. But the biggest difference, and learning point, is that they are in many cases armed with torpedoes. This gives them a stand-off engagement capability against ships, compensating for their slow speed.
So Chinese XLUUVs do not have to be multi-mission. Designs are optimised for just one or a few closely related roles. While this makes individual vehicles less flexible, it likely saves huge amounts of money in design, development and production. The prime example of this is the AJX002 which was displayed in Beijing last year. That seems designed solely for minelaying. It lacks the large masts and sonar of other designs, for example the similar sized HSU100 which was paraded beside it. By contrast that seems intended for ISR (intelligence, surveillance and reconnaissance), although it is less clear about that design.
One area where China is far ahead of other countries, but where Europe may not want to follow, is in building uncrewed full-size submarines. At least two designs, unofficially classed as XXLUUVs (extra-extra large…) are being testing together. One is around 35 meters long and the second around 42 meters. Although it is difficult to sense from the length alone, these are much larger than anything elsewhere. Even the MUM2 demonstrator being built by TKMS

doesn't come close. That is around a quarter to a third of the size of the Chinese designs.

Although public information is limited to satellite images, we can be confident that these are uncrewed platforms. Like other designs they are likely armed. The unrivalled size is likely intended primarily to provide more range, giving the designs an estimated range of around 10,000 nautical miles in a diesel electric configuration.

Building such large underwater drones introduces new problems which chip away at the underlying benefits of uncrewed platforms. They are much more complex to build and maintain, requiring more sub-systems and submarine-size pressure hulls. They also require regular port infrastructure and basing, or as the Chinese have done, dedicated floating docks. The Chinese Navy (PLAN) uses the floating docks for launch and recovery at sea, as well as in-port berthing, which likely simplifies port manoeuvres. At the moment they are known to have two prototypes, each with a floating dock. But there is an argument that this approach could be cheaper and more practical even when scaled to an operational fleet. But it is hard to imagine European ports crammed with floating docks.

Challenges

Meanwhile in Europe XLUUVs are an emerging, yet still experimental, category. Progress suffers from the long development cycles, possibly exacerbated by unrealistic or overly broad requirements, typical of post-Cold War procurement. European products risk being exquisite, like the traditional view of Western Navies rather than purposeful like Ukrainian or even Chinese designs.

Much of it will come down to institutional inertia. In some cases, decision makers may fixate on economic development rather than developing capability. We live in a time where many decision makers still view 'defence investment' as being much more about investment than defence. Commercial considerations, especially those which cast European allies as competitors should not slow down the transformation which European navies need to make.

This is particularly true in the underwater space. All other things being equal, AUVs are harder to design, to build, and to test. They will need slightly more time. Investing in defence projects must be more than an economic win. As convincing as that can be, it must not get in the way of delivering capabilities.

European governments will also have to tackle the legal and ethical issues surrounding and operating these vehicles. From the mundanity of safe port operations to the question of weaponisation and automated decision trees. Chinese XLUUVs we must remember are often armed with mines or torpedoes. These topics are easier to negotiate during the demonstration and prototyping phase, where exceptions can be accommodated (albeit often too slowly), but it could easily hold back service introduction. They therefore need to be addressed head on and resolved before armed AUVs can become part of European fleets. Clearly if they aren't tackled, or if the decisions go against arming AUVs, then Europe could quickly be left behind.

The time for European Navies to Adapt

European defence acquisition is only slowly undoing the decay of years of underinvestment. And it is a mindset shift as much as a budget shift. Most of us are of a generation whose careers have been shaped by constant and steady defence cuts. European navies have become accustomed to accepting an ever-smaller fleet of vessels, often trading quantity for quality. At the same time defence acquisition has been geared to ever longer cycles, project delays and weak decision making. Those things always existed, but one must wonder whether the defence world hasn't reshaped itself around them. In the new world of heightened threat levels, questions on major alliances, and rapidly changing technology it could be crippling. The countries which adapt fastest will ultimately be those which do it most affordably.

Larger navies may seek a hybrid navy; smaller navies may find it expedient to create drone forces as separate flotillas. Especially given the offensive nature of drone warfare at sea. European planners must allow a diverse inventory, losing the focus on single types which can do everything. This will have the added benefit of allowing many smaller companies to continue to compete, bringing in fresh ideas. At the same time, key concepts such as interoperability over interchangeability need to be relaxed, at least in the uncrewed space. Uncrewed platforms need to be attritable, even in peacetime, and expendable in wartime. We are in a time when something is truly better than nothing, but at the same time, prototypes alone will no longer cut it.

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Dr. Alix Valenti

The Power Problem – The Less Sexy Side of Autonomy

Unmanned surface and underwater vehicles are rapidly becoming central to missions from CUI protection to ISR and hybrid fleets – but their most critical constraint is how to power them.

OPT has tested a wave-powered PB3 PowerBuoy as a standalone UUV charging and communications hub ***(© OPT)***

Despite all the hype around UxVs (unmanned surface and underwater vehicles), a critical, though admittedly less glamorous, conversation is still largely missing: how to power them. From Critical Underwater Infrastructure (CUI) monitoring to Intelligence Surveillance and Reconnaissance (ISR), all the way to the concept of the "hybrid fleet", these systems are set to become critical nodes in maritime security strategies worldwide.

Yet in the absence of viable boundless sources of energy, how do we keep them running as we continue to demand more of them – payloads, communications, demanding operating environments?

"It's really dependent on the concept of operations (CONOPS)," Simon Adams, Founder and Director of the USV Group, told MS&D: "What are we trying to achieve, and how does that impact our endurance?" Powering UxVs may be one of the least publicly discussed technology stacks, but it is key to making autonomous operations at sea work – and navies and industry are quietly working to untangle it.

Endurance starts with the mission

For navies across the world, UxVs are set to fill one critical gap that has been growing over the past decade: recruitment difficulties compounded with financial constraints – even as budgets increase – are at odds with increasing challenges and threats to maritime security. Navies are investing heavily in UxVs to build fleet architectures that support more efficient deployments across the maritime security spectrum.

As a result, the scope of these systems' missions is expanding quickly. "We want them to be out at sea for longer, potentially going further, and with greater energy demand for the sensors onboard," Dr Thomas Beard, Clean Shipping Service Lead at BMT, told MS&D.

It starts with the operating environment. "Before you even meet the enemy or the threat, half the battle for energy endurance is the operating environment," Peter Karlström, Product Manager for Autonomous & AI Systems at Saab Naval, told MS&D. Currents, winds, wave heights, temperatures and salinity can all increase the power needed to move efficiently – and successfully – from point A to point B.

Then come the sensors and effectors. "Back to the old chestnut of CONOPS and what navies need that system for," Adams explained. Depending on mission requirements, UxVs may carry more or less power-hungry systems – from communications, acoustic sensors, electro-optical and infrared (EO/IR) sensors and radar to electromagnetic warfare systems and, in some cases, weapons. Many will also require edge computing for mission planning, sensor interpretation and decision-making.

Together, the operating environment, payload and mission profile determine the real endurance requirement. Power is not a fixed technical specification; it is a CONOPS problem.

Unplugged uses inductive wireless power transfer: a receiver inside the UUV communicates with a charging pad on a fixed or towed station ***(© Unplugged)***

Getting a UUV to within five to ten metres of a subsea charging station is a solved problem; guiding it to docking precision without GPS remains a challenge ***(© Unplugged)***

Persistence Below the Surface

One of the key challenges navies are seeking to address through UxV acquisition and fleet integration is CUI monitoring. Europe alone gives the scale: the North Sea has more than 45,000 km of subsea assets – pipelines, umbilicals and cables – installed since 1966, per ScienceDirect/UK HSE and Norwegian Petroleum Directorate data; Western Europe hosts 35% of all submarine cable landings, with another 30 cables expected before 2027 (Analysys Mason, 2024); and enclosed and semi-enclosed seas bordering Europe total approximately 4.4 million km3.

By comparison, European NATO nations count approximately 70 submarines and a little over 100 frigates/destroyers – not all always operational, and many already stretched across a wide range of maritime security missions. The math is simple: there are not enough assets, nor the money to buy enough assets, to ensure persistent CUI monitoring.

“The endurance challenge is a cost challenge,” Dr Thomas J.J. Meyer, CGO of Unplugged, told MS&D. Most of these platforms are battery-operated UUVs with battery lives ranging from a few hours to four or five days – except for XL UUVs, which can operate autonomously for roughly 45 days. “And as soon as you have to plug something to recharge it, you need a human,” Dr Meyer added, “and as soon as you need a human, you break the loop of autonomous operations.”

Unplugged, a NATO DIANA cohort company currently finishing its programme, is building what Dr Meyer describes as the underwater equivalent of a Tesla charging station. “The charger is the product,” he told MS&D. “Persistent underwater presence is the outcome, and interoperability is how we deliver it.” The technology uses inductive wireless power transfer: a receiver inside the UUV communicates with a charging pad on a fixed or towed station. No connectors, no crew, no physical intervention – the vehicle hovers within roughly one centimetre of the pad, and power and data transfer begin autonomously.

That last centimetre is where most of the engineering challenge lives. Getting a UUV to within five to ten metres of a subsea charging station is a solved problem; guiding it to docking precision without GPS – which does not penetrate water – requires acoustic transponders, camera-based fiducial recognition and Unplugged’s magnetic homing technology. “The ability of a UUV to find its position and come back into the vehicle is a hot topic which is proprietary for most UUV makers,” Meyer said.

The system supports three deployment configurations. The first, the “garage”, draws power from nearby fixed infrastructure such as an oil and gas platform, port installation or lighthouse, with the UUV returning to recharge much like a Roomba returning to its dock. The second pairs a subsea docking pad with a wave-powered surface buoy, enabling persistent operations where there is no offshore footprint. The third is a towed charging station beneath a mothership: the vessel transits, the UUV departs on mission, then returns to recharge before deploying again.

A Saipem vehicle with a 12-hour battery lifetime, once requiring recovery and recharge every half-day, has been operating on eight-month residency missions since Unplugged’s technology was integrated. Unplugged’s charging stations have logged more than 800 dockings in real-world deployments.

The same principle – keeping vehicles in the water continuously rather than cycling them through surface recovery – is also driving development at Ocean Power Technologies (OPT), whose wave-powered PB3 PowerBuoy has been tested as a standalone UUV charging and communications hub. The solutions differ in architecture but converge on the same operational imperative: if persistent autonomous presence at sea is the ambition, the energy problem must be solved at the vehicle level rather than by bringing the vehicle home.

ISR at the Surface

Beyond CUI protection, navies are also increasingly turning to UxVs for ISR. In this context, the power question begins to shift. Endurance still matters, of course, but the operational value of the system is increasingly measured by what it can see, how quickly it can communicate, and how reliably it can keep feeding information back into the command chain.

That is why navies – including the US Navy, the Royal Navy, the Royal Australian Navy and France – are predominantly turning to USVs, rather than UUVs, for these missions. But powering USVs for persistent ISR comes with its own trade-offs. Today, the vast majority of these platforms run on diesel or, increasingly, diesel-electric engines. According to Adams, there are two key reasons for this.

First, diesel remains the most energy-dense power source. As USVs grow in size to accommodate more missions and, with them, more power-hungry payloads and C2 systems, navies continue to rely on proven technology that allows these platforms to go faster, further and with a degree of redundancy.

Second, as Adams points out, "the infrastructure for other sources of energy – e.g., hydrogen, methanol, ammonia – simply isn't there yet." Additionally, many of these alternatives still require too much onboard real estate, which navies can ill afford. Trials are underway in the commercial domain, with ACUA Ocean testing hydrogen, for instance, but several challenges, including safe bunkering, remain unresolved.

Until new solutions emerge, and the infrastructure follows – something likely to be driven by the commercial sector – diesel-electric systems remain the technology of choice, conveniently combining diesel's range and speed with electric's stealth where and when needed.

Diesel, however, comes with its own problems. On long missions, where the usual challenge is finding space onboard for sufficient fuel, that calculus shifts to weight once refuelling at sea is off the table. "The weight margins aren't there when you can't rely on refuelling at sea," Dr Beard told MS&D. Replacing diesel engines with batteries, even lithium-ion batteries, would potentially make matters worse. Diesel contains roughly 12,600 Wh per kilogram, while a lithium-ion battery contains roughly 150–250 Wh per kilogram. That is a gravimetric energy-density gap of approximately 50:1 in favour of diesel.

Autonomous diesel bunkering at sea is equally complex. Since December 2024, as part of its No Manning Required Ship (NOMARS) programme, the US Navy has been running autonomous bunkering trials. The latest, in September 2025, were successful, but they used water rather than fuel. "We are simply not there yet with trusting an autonomous system to put a nozzle on another boat," Karlström concluded. Sea state would also be a severe limiting factor.

UxVs CONOPS, power sources and trade-offs (ChatGPT-generated, based on article research)

Finally, for smaller USVs, and potentially even medium-sized ones, diesel-electric generators have limits of their own. A DC variable-speed generator runs at very high RPMs, creating heat and, consequently, wear. That not only decreases reliability but also increases noise signature. "You would have to be careful about how you install and configure your system and power sources onboard, so as not to impact your stealth, reliability or even sensors," Adams explained. This is why many smaller USVs remain battery-powered when they need to move fast and/or carry multiple payloads or use alternative energy sources – such as solar or wind – when they are passively collecting information without critical communications requirements.

Hybrid Fleets, Hybrid Burdens

Several navies are also working on developing 'hybrid fleet'. The drivers differ, but the destination is the same: a fleet ar-

In a test as part of the NOMARS programme, the USV Mariner (right) deploys a refueling probe towards the USV Ranger (left) in the first test of fueling at sea (FAS) without any human interaction required on the part of the receiving vessel. The personnel aboard the Ranger are observers only **(© DARPA)**

chitecture in which unmanned systems, launched from motherships, deliver the reach, mass and persistence that conventional means alone cannot.

The US Navy, which coined the term, is building toward a fleet of 350 crewed ships alongside 150 large USVs. Its Modular Attack Surface Craft (MASC) requirement also gives a glimpse of the power burden, with containerised payloads expected to consume up to 75 kW each. "The Defence Investment Plan explicitly embeds both USVs and UUVs in the Royal Navy's force architecture, with the First Sea Lord framing the shift around mass and lethality that neither budgets nor recruitment can deliver conventionally." South Korea's Navy Sea GHOST programme is driven by demographic pressure as much as technology ambition. Portugal launched Europe's first purpose-built drone carrier, NRP D. João II, in 2025. And several navies, including the French, Belgian and Dutch navies, are preparing for advanced combined-domain MCM mothership capability, with each vessel designed to deploy USVs, AUVs, ROVs and UAVs as a single integrated mine warfare system.

The Royal Navy example shows how quickly this becomes a force-architecture problem. As Dr Beard explained, the hybrid navy concept is built around a mix of functions: sense platforms for air and subsurface threats, an effects platform and a command-and-control vessel tying the group together. That architecture promises more hulls in the water and greater mass, but it also multiplies demand. If the original ambition was to keep these systems at sea for 30 days, larger sensors, effectors and communications payloads mean more fuel, less range, or a harder design loop.

For diesel or diesel-electric USVs, this raises an immediate logistics question. Larger platforms may deploy from shore or with the task group, but if there are no friendly ports to refuel in, the fuel has to come with them. The issue then scales up to the mothership. If it is expected to support multiple unmanned systems, it must also absorb their energy demand without compromising its own propulsion, HVAC, weapons and sensors. At some point, this becomes less about buying UxVs than designing the group's energy budget, as Dr Beard pointed out.

Battery-powered UUVs and smaller USVs do not make the problem disappear; they simply change its shape. Bringing them back onboard to recharge or hot-swap batteries sounds simple until the battery pack weighs tonnes, requires cranes, dedicated charging capacity and shipboard infrastructure that many vessels were never designed to host. Launch and recovery then becomes part of the endurance equation: if the vehicle can operate in a higher sea state than the ship can safely recover it in, it cannot reliably come back to refuel or recharge. And, as Adams warned, if an entire unmanned fleet depends on one host ship for charging, refuelling and recovery, that ship becomes "one massive single point failure" for the fleet.

From Energy Architecture to Operational Advantage

None of this means the challenge is intractable. Unplugged, OPT, NOMARS trials and ACUA Ocean's hydrogen work all show that the energy problem is being attacked from multiple angles.

But the pace and shape of that movement will be driven as much by commercial operators as by defence requirements, and navies will still have to do the hard work of integration. "The main challenge is to see all of this as one coherent software stack, from the lowest node of the USV all the way up to the point where a human has to decide whether to employ deadly force," Karlström concluded. It will also require standardization across many of the charging systems – think the equivalent of the one standard charging cable across Europe. The navies that crack that architecture first – energy, autonomy, logistics and command – will gain more than endurance. They will gain operational advantage.

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PERISCOPE

The last year has been a significant one for the world's navies. Notably, the United States has undertaken a major revamp of its security strategy and embarked on a series of foreign interventions that have revealed the strengths and weaknesses of its naval power. Meanwhile, global tensions are spurring on warship and submarine construction in Asia, Europe and elsewhere. Naval Periscope highlights some of the main developments in the 12 months to mid-2026 and analyses their implications.

The US Navy aircraft carrier Gerald R. Ford (CVN-78) pictured underway in the Caribbean on 27 January 2026. Maintaining hegemony over the Western Hemisphere is a key element of the latest United States' defence strategy.
(© US Navy)

GLOBAL OVERVIEW

The defining driver of naval and maritime developments over the past year has been, as in so many other spheres, the actions of the United States' Trump administration. The scene has been set by the publication of two strategic documents: the National Security Strategy of the United States of America: November 2025 (NSS 2025) and the 2026 NDS National Defense Strategy (NDS 2026). Taken together, they confirm a decisive reorientation in the United States' approach to defence policy. Forsaking its previous role as the focal point of a mutually-beneficial system of long-term international alliances, the United States will adopt a more transactional stance. Under this, short-term economic and security benefits will be the guiding principles of any 'deal'. The shift is accompanied by a new emphasis on the defence of the US homeland, with the attainment of hegemony over the Western Hemisphere (North and South America) viewed as a prerequisite of this aim. Meanwhile, the danger from China is seen predominantly in economic terms, whilst Russia and North Korea – regarded as key threats in previous security documents – are deemed worthy of little more than a brief mention. If carried through, these new strategies will degrade the US Navy's role as the ultimate guarantor of international maritime trade and security, with significant consequences for fleets across the world.

The new American strategy also contains a "predisposition to non-interventionism". The potential of this stance to conflict with other strategic objectives was quickly challenged by the seizure of Venezuela's President Maduro under Operation Absolute Resolve on 3 January 2026. Whilst undoubtedly furthering the aim of regional hegemony, the same could not be said for Operation Epic Fury; the US-Israeli assault on Iran that was launched on 28 February. Like the previous intervention in Venezuela, this mission demonstrated the power of American arms. Initial strikes, which encompassed the use of US Navy Tomahawk cruise missiles and stand-off weapons deployed by carrier aircraft, quickly overwhelmed Iranian defences. Notably, a series of operations against the Iranian naval forces – including the sinking of the frigate Dena by the nuclear-powered attack submarine Charlotte (SSN-766) in the Indian Ocean –largely destroyed the fleet's conventional warships in little more than a week.

Despite these achievements, it can hardly be claimed that the overall US operation was a strategic success. Iran responded to the assault by closing the Strait of Hormuz on 3 March 2026, essentially placing a stranglehold over a choke point that accounts for around a quarter of international energy trade. Whilst bereft of traditional maritime power, the asymmetric forces available to Iran's military were more than sufficient to hold commercial shipping at risk, bringing trade to a standstill. It quickly became apparent that the US Navy had no realistic means of countering the danger, particularly given the unwillingness of traditional allies to contribute support to a war over which they had had no say. This impasse played a significant part in the signature on 17 June 2026 of a framework agreement – the Islamabad Accords – aimed at ending hostilities.

Another negative impact of the war from the United States' perspective was the prodigious expenditure of precision munitions that the fighting entailed. Previous US Navy and allied defensive operations against Houthi rebel attacks on shipping in the Red Sea had revealed the limits of magazine 'depth' in warships performing contested missions close to shore. The conflict with Iran, however, demonstrated the ability of intensive warfare to deplete weapon stocks to the extent that it might have strategic consequences. For example, open source reports suggest more than 1,000 Tomahawk cruise missiles had been expended by April 2026, around a third of the US Navy's total inventory. Even though weapon-production is being expanded, it will take several years before stocks are rebuilt to pre-war levels. This could impact the course of a future Pacific war if Chinese 'expansionism' developed into outright aggression.

The last year has certainly seen China make further progress towards achieving the means to obtain Pacific dominance. On 5 November 2025, the People's Liberation Army Navy (PLAN) commissioned the Type 003 aircraft carrier Fujian, the first in its fleet to benefit from catapult-assisted take off but arrested recovery (CATOBAR) technology. Satellite imagery has also confirmed that an even larger Type 004 vessel is under construction at the Dalian Shipbuilding Industry Company (DSIC) shipyard in north-eastern China. Unlike other Chinese ships of the type, it has been speculated that the new carrier will be nuclear powered. US naval intelligence estimate that the PLAN will take delivery of six carriers – giving them nine in total – between now and 2035. When combined with considerable progress in nuclear-powered submarine construction, it seems that China is doing much to close the qualitative naval gap with its American rival.

MSD editorial comment: Although the consequences will take time to make themselves fully felt, the weakening of the United States' network of alliances heralded by its new strategic posture will likely have an enduring impact on global naval investment and fleet structures. The configuration of many Western Navies has, until now, been influenced by a conscious decision to provide complimentary capabilities to their US Navy counterpart in specialisms such an anti-submarine warfare (ASW) and mine countermeasures. This decision made sense when America could be counted on to provide the core capabilities required to produce a balanced naval force. With US Navy support less certain, there will be an incentive to ensure a similarly balanced fleet can be created in the absence of American capabilities, perhaps in collaboration with regional partners. This is likely to accelerate an existing trend that is seeing countries invest in costly new equipment such as aircraft carriers and nuclear-powered submarines.

Meanwhile, the war in the Middle East has revealed both the strengths and limits of US naval power. Whilst America's technological capacity to overwhelm a mid-sized military has been vividly demonstrated, the US Navy proved poorly prepared to maintain commercial traffic in the Strait of Hormuz in the face of ongoing asymmetric threats. This failure is particularly surprising given recent demonstrations of the challenges involved in conducting naval operations in straits and other confined waters during operations in the Black and Red Seas; perhaps suggesting a degree of hubris at the Pentagon. The unwillingness of traditional partners to assist the US Navy with the challenges it faced is also noteworthy, indicating that America's move to a more transactional approach also comes with a cost.

The US Navy destroyer Thomas Hudner (DDG-116) fires a Tomahawk cruise missile during the opening stages of Operation Epic Fury on 1March 2026. Operations against Iran have significantly degraded US navy inventories of precision missiles.
(© US Navy)

ASIA-PACIFIC

The Japanese Mogami class frigate Kumano pictured entering Sydney Harbour in March 2026. The Royal Australian Navy will start to take delivery of 'Upgraded Mogami' class vessels before the end of the decade. *(© Australian Department of Defence)*

The Asia-Pacific region remains at the forefront of naval investment due to a combination of economic growth and heightened political tensions. This has resulted in a remarkably wide range of warship programmes at various stages of completion. Although no one country can hope to match the rapid rate of Chinese naval expansion, the totality of investment across the region is producing some capable fleets supported by an increasingly efficient industrial base.

People's Liberation Army Navy (PLAN) expansion: Perhaps inevitably, the commissioning of the aircraft carrier Fujian has been the PLAN development that has attracted the most headlines. However, two other aspects of Chinese naval expansion are worthy of note. One was the commencement of sea trials by the prototype Type 076 amphibious assault ship, Sichuan, in November 2025. Unusually for her type, she is fitted with an electromagnetic catapult similar to those installed in Fujian and is optimised for uncrewed air vehicle (UAV) operation. As such, she is evidence of ongoing PLAN interest in drone technology that, in some ways, appears to be ahead of Western naval thinking.

The PLAN has also made considerable progress with its nuclear-powered submarine construction over the past year. This follows significant investment in expanding capacity at the Bohai Shipbuilding Heavy Industry Company's shipyard, the principal Chinese facility for building the type. This is seemingly allowing production of the latest Type 093B 'Shang' nuclear-powered attack submarine (SSN) at the rate of two boats each year; a rate which exceeds current US Navy production. Images have also emerged of a new, larger Type 095 boat at Bohai, as well as an unusual 'finless' submarine at the Jiangnan Shipyard on Changxing Island near Shanghai. All-in-all, the level of activity suggests a concerted effort to close the gap with US Navy leadership in the underwater domain.

Australia's Mogami class purchase: In a decision that could have major strategic ramifications across the Asia-Pacific region, the Australian government announced in August 2025 that Japan's 'Upgraded Mogami' class design had been selected in preference to Germany's MEKO A-200 for up to eleven general purpose frigates. Contracts for an initial three members of the class – which will be built in Japan by Mitsubishi Heavy Industries (MHI) – were subsequently signed in April 2026. Current plans envisage the remaining eight ships being built by Austal in Western Australia under transfer of technology arrangements. Delivery of the first frigate is planned as early as 2029, likely through switching production slots previously allocated to Japan Maritime Self Defence Force (JMSDF) orders for the type.

Rapid deliveries of Project 15A Nilgiri class frigates – Taragiri is pictured here – over the last year suggest that Indian shipyards are becoming more proficient.
(©Indian Navy)

South Korea plans nuclear-powered submarines: On 26 May 2026, the Republic of Korea formally announced a 'Basic Plan for the Development of South Korean Nuclear-Propelled Submarines'. The announcement had previously been heralded by a November 2025 agreement with the United States that paved the way for American support for the construction of conventionally-armed, nuclear-powered submarines, including assisting South Korea to obtain nuclear fuel for the new flotilla. The new programme will be known as the 'Chang Bogo N Project' after the name of South Korea's first submarine and aims to start bringing the new boats into service from the end of the 2030s onwards. Open source information suggests that it is intended to adapt existing indigenous civilian nuclear technology to help produce the new submarines. South Korea already has considerable experience designing and building large, ballistic missile armed submarines through its KSS-III series but will inevitably face a large and expensive step upwards in transitioning to nuclear-powered boats.

Significant improvements in Indian shipyard performance: Long-noted for extended production times and missed deadlines, India's major shipyards are achieving significant improvements in their performance. The flagship example of this is the Project 17A programme for the construction of Nilgiri class frigates. This was contracted in 2015 and has involved the completion of seven units. The approximately 6,700 tonne ships are high end vessels with a powerful suite of weapons. These include the Israeli EL/M-2248 MF-STAR multi-function radar and Barak 8 surface-to-air missile system also found aboard other recent Indian surface ships. Construction was split between Mazagon Dock Shipbuilders Ltd (MDSL) of Mumbai (four frigates) and Kolkata's Garden Reach Shipbuilders & Engineers (three ships), with deliveries initially planned to start from 2022-23 onwards. Whilst this deadline has not been met, Nilgiri was handed over in December 2024 and was followed by no fewer than five of her six sisters between July 2025 and April 2026. Notably, Mahendragiri – MDSL's final ship – was completed in less than four years from keel-laying to delivery. The improvements can be attributed, at least in part, to significant investment in modernising the two shipyards before the start of the programme. This has allowed a significant shift towards the use of modular construction techniques.

MSD editorial comment: Recent naval developments in the Asia-Pacific region continue to be driven by the ongoing growth in Chinese military potential. This is reflected in contracts for new warships, efforts to expand and improve indigenous naval shipbuilding, and a willingness to acquire new capabilities. Amongst these developments, Australia's acquisition of Japanese frigates is significant on a number of levels. The contract clearly offers a major boost to the Royal Australian Navy, which should start to receive major new additions to its surface fleet before the end of the decade. More importantly, however, the transaction is Japan's first overseas sale of a major weapons-system since the end of the Second World War. As such, it marks a major shift in the previous policy restricting transactions of this type, potentially opening the door for further such deals. More broadly, it can be argued that the deal is emblematic of a gradual shift towards stronger regional defence ties driven by uncertainties over long-term American support and continued Chinese expansion.

AFRICA & THE MIDDLE EAST

Developments in the Middle East have been dominated by the US-Israeli attack on Iran, destroying – at least for the time being – the country's status as a regional naval power. Other Gulf navies have been active in the conflict. For example, the Qatari amphibious transport dock Al Fulk and Al Zubarah class corvettes assisted successful engagements against Iranian ballistic missiles and drones, demonstrating the value of the country's recent costly programme of naval investment. Away from the fighting, the region's naval industrial base has continued to develop as local fleets continue to refresh their equipment.

Naval construction in the Persian Gulf: A noteworthy feature of the Middle East's naval sector has been the growing success of Abu Dhabi Shipbuilding (ADSB), part of the United Arab Emirates' (UAE's) EDGE Group. The shipyard's breakthrough contract came in 2021, when it secured an order for four 'Falaj 3' type missile boats from the UAE Navy. The programme, which has been carried out with considerable technical support from Singapore's ST Engineering, delivered its first vessel in February 2025. Subsequently, in June that year, the yard gained a larger, approximately USD 2.5 billion order from Kuwait for eight vessels of the 'Falaj 3'type through a contract signed with parent company EDGE. The project is, again, benefitting from the partnership with ST Engineering, which will actually build three of the vessels in Singapore. With work also secured for the Angolan Navy (see below), the UAE is becoming a significant new player in the ever-competitive global naval shipbuilding market.

Angolan naval modernisation: On 4 March 2026, the Constructions Mécaniques de Normandie (CMN) shipyard in Cherbourg, France launched Ekuikui II, the first of three BR71 Mk II corvettes destined for the Angolan Navy. The corvette, which is based on the UAE Navy's Baynunah class, was ordered from EDGE Group in February 2023 and is one of two of the units sub-contracted to CMN. The remaining vessel is being built at ADSB in the UAE. Deliveries of all three ships are expected to be completed by 2027. Angola has been undertaking a significant if little-reported programme of naval renewal in recent years with a view to protecting exclusive economic zone (EEZ) assets. In addition to a large programme of patrol vessels and interceptors, this has included construction of a new naval base at Soyo in the north of the country and a shipyard at Lobinave. This sustained investment offers the prospect of the Angolan Navy becoming one of the most well-equipped and effective in sub-Saharan Africa.

MSD editorial comment: The development of the UAE's naval industrial sector has been impressive. It forms part of a pattern of increased regional self-reliance that has also included growing Saudi Arabian involvement in the outfitting of corvettes ordered from Spain's Navantia. However, there has to be some speculation as to where things develop from here. The Iran war has been hugely costly to the Gulf economies and they also have to balance further naval investment against other needs, such as the restocking of depleted air defence missiles. This might make future naval procurement less of a priority, hindering further progress.

The Qatari Emiri Navy's hybrid amphibious transport dock Al Fulk contributed to Qatar's air defences during the recent conflict in the Middle East. (©Fincantieri)

THE AMERICAS

The US Navy has launched a new naval shipbuilding plan that aims to improve the performance of its indigenous shipyards. This photograph shows the Virginia class nuclear-powered attack submarine Minnesota (SSN-783) at Huntington Ingalls Industries' Newport News Shipyard. (©Newport News Shipbuilding)

The United States is backing its new security and defence strategies with a planned FY2027 defence budget of USD 1,500 billion, a more than 40 percent increase over that agreed for the previous year. The US Navy is allocated USD 377.5 billion, around a quarter of the total defence 'pie'. The increased spending will be used to support what the administration claim is a generational investment in American shipbuilding to restore and increase US Navy warship numbers. Elsewhere in North America, Canada has significant new procurement programmes underway after years of hesitation, whilst many South American navies are replacing elderly assets with new construction.

US naval shipbuilding: The US Department of the Navy released the new US Navy Shipbuilding Plan in May 2026. The plan acknowledges that past attempts to grow fleet size have failed despite a significant growth in the shipbuilding budget, laying out three remedies to fix the problem. Firstly, the fleet will move to a 'high end/low end' mix. Under this structure, lower cost frigates and attritable drones will supplement a main battle force headed by the so-called 'Trump' (BBGN-1) class nuclear powered battleships as part of a construct known as the 'Golden Fleet'. This will be accompanied by further significant investment in the American shipbuilding industrial base that includes a focus on distributed shipbuilding to open up the industry to non-traditional defence contractors. Interestingly, there is also a willingness to expanding relationships with overseas shipbuilders. These will be used both to modernise American shipyards and to build some auxiliaries and combatant modules overseas. Finally, it is intended to shift the Department of the Navy from "a compliance-based bureaucracy to a result-driven warfighting enterprise". This will be combined with a much greater focus on results and less tolerance of industrial delays and cost overruns. The plan aims to achieve a combined force of 450 naval vessels by FY 2031, a third of which will be either auxiliaries or uncrewed. This compares with a total inventory of around 350 vessels today.

The plan's publication followed a somewhat turbulent year for American naval procurement. Most significantly, this saw the truncation of the Constellation (FFG-62) class frigate programme at just two ships in November 2025 and its subsequent replacement by the much simpler FF(X) design. This is based on the US Coast Guard's 'Legend' class national security cutter. The initial batch of FF(X) designs will lack a vertical launch system, although this omission may be remedied in later ships. Meanwhile, the proposed 'Trump' or Defiant class battleships announced in December 2025 will replace the former DDG(X) programme. There are significant reservations about how this programme will be executed given the complexity of the design and the already severe bottlenecks impacting American nuclear-propulsion capacity.

Canadian submarine procurement: On 6 July 2026, Canadian Prime Minister Mark Carney announced that Germany's TKMS had been selected as preferred supplier for the Canadian Patrol Submarine Project (CPSP). CPSP aims to renew and expand the country's existing flotilla of four Victoria (formerly British Upholder) class diesel-electric submarines with up to twelve new, foreign-built boats for delivery from the mid-2030s onwards. Previously, in August 2025, TKMS had been shortlisted alongside South Korea's Hanwha Ocean as qualified suppliers for the project. The two companies offered, respectively, their Type 212CD and KSS-III submarines to meet the Canadian requirement.

With the technical qualities of the two submarines reportedly quite evenly matched, it seems that the decision was influenced by other considerations. For example, both bidders offered a considerable programme of industrial offsets to support their offers. However, it may well be that political considerations also played a leading role, with the procurement seen as bolstering Canadian security ties with NATO allies Germany and Norway (Germany's partner in the Type 212CD programme). In any event, the decision is a major boost to TKMS, which will see its order book for the Type 212CD expand to no less than 24 units. Canada intends to conclude formal contract negotiations during 2027 and hopes to take delivery of the first four submarines by 2034.

Brazilian naval renewal: The long-delayed renewal of the Brazilian Navy's surface fleet took a major step forward with the commissioning of Tamandaré, the first of a quartet of MEKO A-100 frigates, on 24 April 2026. The frigates are being constructed in Brazil by Águas Azuis, a consortium of TKMS, Embraer, and Atech, at the TKMS Estaleiro Brasil Sul shipyard under a

A view of the forward 76mm gun of the Brazilian MEKO A-100 class frigate Tamandaré taken whilst the ship was undergoing sea trials in November 2025. She was subsequently commissioned on 24 April 2026. (©Brazilian Navy) contract signed in March 2020. Whilst Tamandaré's delivery was slightly delayed from a reported target completion date of 2025 when the contract was first signed, Brazil appears to be more than happy with the programme's performance. This is evidenced by the signature of a memorandum of understanding for the acquisition of four more units on the same day Tamandaré was commissioned. The new ships are needed with some urgency given that the fleet's main surface component is largely comprised of frigates completed in the late 1970s.

MSD editorial comment: There is much to like about the US Navy's new shipbuilding plan. Clearly identifying previous problems, it sets out a clear vision of achieving a larger fleet and, importantly, supports this with a major increase in funding. It also tries to address problems in the shipbuilding sector, accepting the value of using overseas expertise to address deep-rooted issues. However, an important determinant of the plan's success will be its ability to maintain its course against the backdrop of a poor American track record in this regard. This is demonstrated by the demise of the Constellation class frigate programme, itself a replacement for foreshortened littoral combat ship construction. The fact that the plan's primary architect, former Navy Secretary John Phelan, was summarily fired in April 2026 after less than a year in the role does not necessarily inspire confidence. Beyond the United States, acquisitions by countries such as Canada and Brazil suggest, perhaps, a greater focus on maritime interests after past neglect.

EUROPE

The British Royal Navy is turning towards a 'Hybrid Navy' vision in which networks of crewed and uncrewed vessels will work in concert. This is a graphic of Navantia UK's LSAV75 concept for an uncrewed missile ship corresponding to the proposed Royal Navy Type 91 requirement. (©Navantia)

The adverse threat environment – exacerbated by uncertainty over America's commitment to the NATO alliance – means that European navies are in an expansionary phase. However, a mixture of industrial capacity constraints and finite funding suggest challenges in securing swift improvements. As a result, growth in fleet numbers and capabilities is only taking place at a slow rate, with some navies even seeing a continued decline whilst waiting for new vessels to come on line.

Scandinavian naval investment: Scandinavian countries are rebuilding their navies against a backdrop of fears of Russian aggression that have been driven by the ongoing war in Ukraine. The last year has seen fierce competition between European and other shipyards to gain the lucrative construction contracts that are arising from this process of renewal. On 31 August 2025, Norway announced that it had selected the Royal Navy's Type 26 design over competing offers from France, Germany and the United States to meet its requirement to acquire at least five new frigates. Reportedly valued at EUR 11,7 billion, the agreement was claimed to be the biggest ever British warship export deal by value. It is intended that the Norwegian Type 26s will be operated collaboratively in conjunction with their Royal Navy sisters to improve the security of the North Atlantic and adjacent seas from a growing Russian submarine threat.

On 19 May 2026, it was French Naval Group's turn to taste success when it was named as the preferred bidder to meet the requirements of Sweden's Luleå class programme, winning out over rival proposals from Spain's Navantia and an Anglo-Swedish consortium of Babcock and Saab. Four

A graphic of the German F126 Niedersachsen class frigate. The programme was cancelled on 24 June 2026 following significant delays and cost overruns. (©Damen)

Amiral Ronarc'h class frégates de défense et d'intervention (FDIs) will be acquired under a deal reportedly valued at over EUR 3,5 billion. An important factor in the French bids success was their ability to complete the new ships at an early stage. Deliveries are expected to commence as early as 2030. Attention is now turning to Denmark's frigate replacement programme, which is also subject to fierce competition.

German naval construction woes: On 24 June 2026, the German Federal Ministry of Defence announced that it had decided to cancel its flagship surface combatant programme for six F126 Niedersachsen class frigates. Initially known as the Multi-Role Combat Ship 180 (MKS-180), the project involved a multi-national structure. Under this, Dutch Damen was the contract and design lead but physical construction was allocated to German shipyards operated by the then Lürssen (now Rheinmetall's NVL business) and German Naval Yards Kiel. A contract for an initial four ships was signed in June 2020, with an option for an additional two vessels exercised in June 2024. First steel cutting for the lead ship took place at the NVL Peene shipyard in Wolgast on 5 December 2023 and was followed by a keel laying ceremony on 3 June 2024. At that stage deliveries were expected to take place from 2028 onwards. The 10,000 tonne vessels were the largest ordered for the German Navy since the end of the Second World War and intended to provide critical ASW capabilities.

The project quickly went awry as a result of a complex series of problems that included a troubled interface between Damen, the German defence procurement office (BAAInBw) and the shipyards tasked with undertaking the work, as well the challenging introduction of a new shipbuilding software programme. As costs and delays mounted, an attempt was made to restructure the project by transferring leadership to Rheinmetall's NVL. Whilst negotiations reached a tentative conclusion, a likely cost of over EUR 18 billion – compared with previous estimates of around EUR 10 billion – was too much for Germany's political establishment to stomach. Accordingly, the Ministry of Defence cancelled the programme and proposed an alternative procurement solution based on the acquisition of up to eight – four firm and four optional – MEKO A-200 DEU frigates from TKMS at an estimated cost of EUR 11.6 billion. The new ships will carry the F128 designation.

The German Parliament's Budget Committee approved this way forward in early July 2026, albeit with significant reservations about the project's cost and the ability to meet a planned delivery schedule that anticipates the first F128 arriving by the end of 2029. There is also unease about the loss of workload in the shipyards involved in the previous project.

Artist Impression of MEKO A-200 DEU. *(©TKMS)*

Meanwhile, it is reported that a further EUR 2.3 billion already spent on the F126 programme may be written off.

United Kingdom's Defence Investment Plan: The British Defence Investment Plan 2026 was published on 30 June 2026. Covering spending for the period through to 2030, it held mixed news for the United Kingdom's Royal Navy. Spending on the Defence Nuclear Enterprise – which encompasses both the new Dreadnought strategic submarines and also the planned SSN-A nuclear powered attack submarines being acquired under the AUKUS partnership – is growing rapidly. This has rendered previous plans for new Type 83 air defence destroyers and Type 32 general purpose frigates unaffordable. Instead, the Royal Navy is being forced to embrace a 'Hybrid Navy' vision under which a family of large autonomous drones will be networked together by a 'Hybrid Fighting Web' and controlled by cheaper command vessels. The new uncrewed vessels include a Type 91 uncrewed missile ship, a Type 92 uncrewed underwater sensing platform, a Type 93 extra-large uncrewed underwater vessel and a Type 94 uncrewed radar platform. At least six Common Combat Vessels (CCVs) will also be acquired to act as command platforms. From 2035 onwards it is anticipated that a 'Hybrid Navy Maritime Air Defence' system comprising Type 91 and Type 94 drones controlled by the CCVs will replace the existing Type 45 Daring class destroyers as the focal point of the Royal Navy's anti-air warfare capabilities.

U212CD as showcased at UDT 2023. *(©hum)*

MSD editorial comment: The revival of Europe's navies is revealing the damage to the continent's naval industrial base caused by decades of post-Cold War neglect. Events such as the F126 debacle point to a loss of experience and skills in implementing complex naval procurement projects that will take time to correct. In this environment, shipyards which have been able to maintain their expertise through domestic and export contracts have a competitive advantage, being more likely to guarantee the early delivery slots that many navies are demanding. This, for example, appears to have been a critical factor in Naval Group's recent successful bid to fulfil Sweden's Luleå class requirement. Meanwhile, the compromises being made in British naval investment illustrate the fact that the vast financial demands made by rearmament mean that difficult choices remain.

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