Whitepaper

One Platform
Many Missions

Reducing cost of change and
increasing availability

One Platform. Many Missions.

Designing and building naval platforms is a challenging, time-consuming and costly affair. Traditional shipbuilding processes – measured in decades – can no longer keep pace with rapidly evolving mission demands, the spread of disruptive technologies and the intensified need for interoperability across allied fleets.

This whitepaper explores how modular mission systems can help fleets stay ready, relevant and resilient without relying on specialised platforms. We discuss the reality fleets face today and why specialised platforms struggle to keep up. We investigate what mission modularity is – and what it is not – and how it can transform our concept of readiness, sustainment and modernisation. Finally, we explore some of the many mission modules available and provide a practical pathway to successful integration of modular capabilities in future naval platforms.

Contents

SH DEFENCE

Executive insights:
Missions change faster than ships can

The maritime environment has become more complex and more contested, and the technological development moves faster than traditional fleet models were designed to handle.

From a geopolitical perspective, multiple regions are now contested. Tensions rise and conflicts arise rapidly, requiring navies to be able to adapt quickly. Missions comprise everything from day-to-day presence to crisis response, infrastructure awareness, protection tasks and deterrence.

As demonstrated by recent events in the Middle East, the operational implication is clear: chokepoints and sea lines of communication can come under pressure with little warning, and forces must adapt to new threats quickly.

On the technological front, capability cycles now outpace ship refit cycles, creating a persisting integration gap. Emerging technologies such as AI-enabled sensors, autonomous platforms, networked weapons and multi-domain C2 architectures can render capabilities outdated before they are launched. The implementation of such technological advances usually requires long, costly refits to adopt.

This is not compatible with the increasing budget constraints resulting from prolonged downsizing and deferred modernisation, which has led to retirement of niche roles, fewer active hulls and constrained crew pipelines as well as shortages in shore support and skilled technical personnel.

Despite these megatrends, ships are still built and modernised on long timelines. Even when funding exists, modernisation competes with time, shipyard slots, integration capacity and availability. The result is a familiar gap: fleets may have capable platforms but still struggle to field the right configuration at the right time, which leads to increased cost and downtime.

Over the last 25 years, navies across the world have been investigating and trying different approaches to shipbuilding and capability management. In Denmark, for example, the StanFlex system was introduced on the Flyvefisken class. The system was a successful example of mission modularity, and the concept was also used on later ships such as the Iver Huitfeldt and Absalon classes in an adapted version with permanent primary combat systems, large reconfigurable mission spaces and growth margins. The German Navy adopted largely the same approach as the Royal Danish Navy with fixed sensors and weapons but with modular mission areas and boat/UAV integration. They found that availability and endurance mattered more than role switching.

The US Navy introduced the Littoral Combat Ship (LCS) with swappable ASW, MCM and SUW modules. However, this concept experienced reliability and survivability issues, and reconfiguration in theatre proved impractical. Basically, the LCS introduced too many immature technologies at once, so even though the failure of the LCS programme is often attributed to mission modularity, the failures were primarily due to sea frame and plant reliability issues – not failures of the mission modules themselves.

The Royal Navy introduced another mission modularity concept with large mission bays, structural and power margins and flexible internal layouts resulting in adaptable but not decidedly modular ships.

Despite the varying success of mission modularity concepts, the mission augmentation, adaptability and interoperability advantages of the concept are clear and the appetite for implementing some form of mission modularity is still very much there.

The US Navy is, for example, launching a new strategic 'Containerized capability campaign plan' making containerised mission modularity a design imperative for future naval ships design. European navies are moving in the same direction, aiming to introduce plug-in mission capabilities to increase firepower, flexibility and readiness across fleets.

The implementation of NATO's updated Alliance Maritime Strategy also requires agile allied maritime forces capable of supporting the alliance's three core tasks: Deterrence and defence, crisis prevention and management and cooperative security. [1]

At the same time, the NATO-sponsored Mission Modularity Cost-Benefit Analysis, which was launched to compare the costs of a modular versus a traditional fleet, also concludes that a modular fleet generally offers the best option in terms of performance and cost-effectiveness.[2]

By shifting capability into modules, navies can field more roles from fewer hulls, upgrade faster and leverage a broader industrial base, including suppliers and shipyards not specialised in complex warship integration.

When the traditional model struggles

Why specialised platforms fall short

Specialised platforms excel within their intended role, and in a stable strategic environment with unlimited defence budgets, they would remain the optimal solution.

However, modern navies no longer operate in such conditions. Designing, constructing and integrating a specialised platform takes close to a decade, during which threat landscapes, technology and mission demands may change significantly. By the time a vessel enters service, its core capabilities may already require substantial upgrades.

Traditional naval design embeds sensors, effectors and mission systems deep within the ship's structure. This integration level was effective when technological cycles were long and threats evolved slowly. Today, it creates operational rigidity and financial strain that fleets can no longer afford.

Role rigidity at the point of need

A ship optimised for Anti-submarine warfare (ASW), Anti-air warfare (AAW), Mine countermeasures (MCM) or minelaying cannot easily shift to another mission. Even if the platform is physically available, reconfiguration typically requires major upgrades, extensive testing or even partial rebuilds. In fast-moving crises where missions change with little warning, the ship may simply not be ready in time.

Modernisation competes with availability

Deeply integrated systems make upgrades slow, complex and expensive. Even minor capability improvements can cascade across power, cooling, software baselines, sensor alignment, testing and certification. These dependencies, combined with limited shipyard capacity and long lead times, keep vessels out of service for extended periods.

The magnitude of this issue is illustrated by the US Congressional Budget Office's 2025 report, which projects that the US Navy's DDG-51 destroyers will spend more than a quarter of their expected service life out of service for maintenance.[3] This level of downtime is incompatible with growing operational demand and limited fleet size.

Specialised capability is often underused

Specialised platforms often spend long periods performing missions unrelated to their primary role. Episodic but essential capabilities, such as MCM or certain surveillance functions, may be tied to dedicated platforms that are disproportionately expensive to operate. Meanwhile, high-tempo mission sets dominate daily operations, leaving specialised capability dormant.

Concentration creates fragility

When unique capabilities reside on a small number of dedicated platforms, the fleet becomes vulnerable to single points of failure. Damage, maintenance delays or operational losses can temporarily remove entire mission areas, even if other platforms are available that could theoretically host the capability. In contrast, a modular capability – if lost – can be restored far more quickly than an entire specialised vessel.

Structural limitations of the platform-centric model

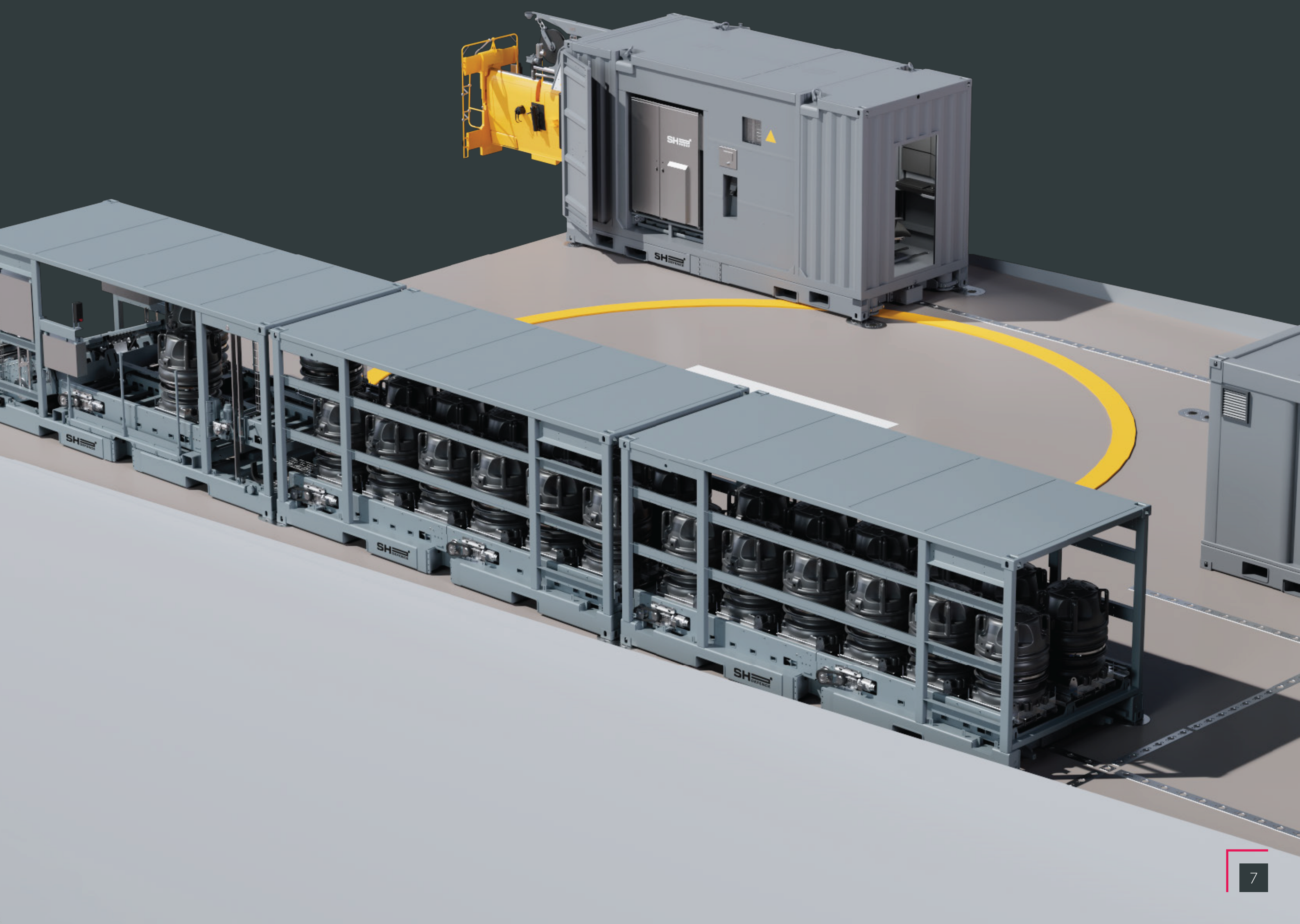
All these factors stem from the platform-centric model, an approach that is increasingly mismatched to a world in which threats evolve faster than ships can be designed, built or refitted.

The solution is not to abandon specialised ships altogether but to shift from 'ships with mission' to 'ships as hosts', where capability can move at the speed of relevance.

Mission modularity:
Not a jack of all trades – but a master of one after another

Traditional specialised ships are built around fixed, integrated capabilities. Their sensors, effectors and mission systems are embedded deep within the hull, making the vessel highly effective in its intended role, but slow, costly and intrusive to reconfigure. Changing the primary mission of such a ship often requires extensive reconstruction, long yard periods and full re-certification cycles.

Mission modularity fundamentally shifts the balance between what is fixed and what is flexible. Instead of installing every mission system permanently inside the platform, modularity moves selected capabilities into interchangeable mission modules, while leaving only the systems that cannot be converted to modules as fixed shipboard installations. The ship becomes a host with stable interfaces, margins and infrastructure; the mission capability becomes portable, upgradeable and scalable.



Mission modularity:

What is mission modularity?

Mission modularity is often confused with modular construction where a ship is assembled from structural blocks that ultimately form a permanent hull. Such blocks are not interchangeable once the ship is built.

Mission modularity is different. Here the mission systems themselves are packaged in standardised modules (for example, the size equivalent of a standard 20-foot ISO container), enabling them to be exchanged within a matter of days as mission requirements change.

A platform designed for modularity is still capable of high levels of specialisation. The difference is that its specialisation is configurable rather than hard-wired. Instead of rebuilding the vessel, the crew can remove one module and replace it with another, enabling rapid transitions between highly specialised roles as the security environment evolves.

Mission modularity does not require ships to carry multi-role crew. Instead, specialised operators are assigned to the mission module itself. The ship retains a stable core crew responsible for navigation, platform systems and safety, while mission execution is carried out by the embarked module team.

Mission modules can be prepared, tested and certified ashore, ready for installation on any compatible platform whenever required. Similarly, they can be maintained or upgraded off ship while a different module occupies the deck slot, drastically reducing downtime and avoiding costly yard stays.

What changes when fleets go modular

- **Role change becomes routine.** Ships can re-role through module exchange.
- **Manning becomes modular.** Specialised mission crew follow the module, not the platform.
- **Modernisation becomes faster.** Upgrades move into modules, not hull refits.
- **Readiness becomes distributed.** More work happens ashore, under controlled conditions.
- **Capacity becomes scalable.** More platforms can contribute when standards align.

Modularity meets the mission by enabling fleets to adapt at operational pace, while keeping safety, governance and predictability in place.

What does modularity deliver?

The value of mission modularity goes well beyond simple payload swapping. When implemented as a structured system with standard interfaces, it reshapes fleet operations at every level and becomes a genuine force multiplier.

Faster mission change

Instead of binding a vessel to a fixed mission profile, modular systems allow the same platform to shift from one task to another at very short notice. Ships can adapt to new missions by exchanging modules rather than waiting for refits.

Each mission module is supported by a dedicated specialist crew that follow the module throughout its lifecycle – from configuration and validation ashore to deployment onboard a host platform. This separation ensures that ship crew are not required to maintain proficiency across multiple highly specialised mission systems, reducing the training burden, easing certification and increasing operational predictability.

Scalable capacity

From a strategic perspective, modularity can be applied to scale horizontally across a much broader range of platforms. Rather than limiting mission systems to naval vessels, modular payloads can be deployed on auxiliary ships, coast guard vessels, offshore supply vessels and even commercial ferries. This cross-platform scalability significantly expands the number of ships that can contribute to naval missions. In times of crisis, civilian ships taken up from trade can be rapidly equipped with mission modules, delivering a surge in capacity that fixed-role military ships alone could never achieve.

Technology-rate modernisation

Modules can be upgraded independently of the platform, enabling rapid adoption of emerging technology. Continuous refresh cycles keep fleets aligned with innovation without congesting shipyard schedules.

Interoperability

Standardised modular systems allow fleets to share or jointly support mission modules. This strengthens multinational response options across NATO and partner navies.

Reduced total cost of ownership

Separating capability inves™ent from platform inves™ent creates significant lifecycle savings. Modules can be shared across classes, maintained ashore, procured incrementally and replaced individually as threats evolve. Platform availability increases, and procurement becomes more flexible and less risky.

Realising these benefits in practice requires more than modular payloads alone – it requires a structured backbone that governs integration, crewing and operation.

Not just payload swapping
Modularity does not remove the need for discipline. It makes discipline repeatable, so speed and scale become achievable without losing control.

The modular backbone

Successful integration of mission modularity

A container-shaped module alone does not constitute mission modularity. Successful integration of mission modularity relies on a complete ecosystem that enables modules to be installed, operated, maintained and exchanged safely and predictably. This ecosystem must address not only the physical integration of modules, but also interfaces, handling, crewing, sustainment and governance. Without this backbone, modularity risks becoming improvised, platform-specific and difficult to certify.

A modular fleet therefore relies on a stable backbone consisting of:

- Standardised physical and digital interfaces between platform and module
- Transport, handling and onboard relocation systems
- Sea fastening solutions suitable for naval loads
- A capability management framework
- Module sustainment and maintenance arrangements
- Modular crewing and training plans

Together, these elements ensure that capability can move without transferring complexity to ship or crew.

Modular crewing: separating platform operation from mission execution

Mission modularity only delivers value if it does not require ship crew to accumulate multiple highly specialised mission skillsets. In a modular construct, this is addressed by decoupling mission expertise from the platform.

The host vessel maintains a stable core crew responsible for platform operation, navigation, safety, command and ship systems. Mission-specific expertise is instead assigned to dedicated specialist crew that belong to the mission module itself.

The specialist crew follow the module throughout its lifecycle:

- During configuration, testing and certification ashore
- During transport and embarkation
- During deployment on a host platform

When a mission module is embarked its specialist operators are embarked with it, integrating into the ship’s command structure while retaining responsibility for the mission system.

- Reduced training burden on ship crew
- Clear division of responsibility between platform and mission module
- Easier certification and release to service
- Improved availability by avoiding skill dilution on board

Modular crewing ensures that expertise is applied where needed without increasing baseline crew size or undermining shipboard competence.

The specialised enclosure is therefore engineered to naval standards and incorporates:

- Structural reinforcement suitable for naval loads, shock and vibration
- Environmental protection ensuring system integrity while underway
- Defined interfaces for power, data, fluids and services
- Compatibility with standard seafastening solutions

By embedding these characteristics within the module rather than the ship, mission capability can be prepared, tested and validated ashore, where cost, time and control are more manageable.

Interface between platform and module

For mission modularity to be predictable and certifiable, the interface between the host platform and mission module must be standardised.

Standardised connection panel forms the technical contract between platform and module. It consolidates all physical and digital connections into a single, defined interface point.

Depending on mission configuration, connection panel provides standardised connection points for:

- Electrical power
- Data and networks
- Communications
- Cooling and ventilation
- Hydraulics and fluids
- Grey water and potable water
- Other platform services required

By concentrating these connections into a single, standardised panel:

- Prevents bespoke ship-side cabling and piping
- Contains complexity within the module rather than the vessel
- Shortens integration and verification time
- Clarifies certification and responsibility boundaries

Integration becomes a controlled procedure rather than an engineering exercise, supporting repeatability across ships and classes.

Mission modules

Handling, movement and sea fastening

Mission modules must be moved, positioned and secured safely under operational conditions. The modular backbone therefore includes proven handling and seafastening solutions aligned with naval practice.

Modules can be loaded onto vessels using port-side cranes, vessel cranes or dedicated loaders. Once onboard, modules are secured using standard seafastening solutions such as manual or remote-operated twist locks, ensuring reliable fastening and compatibility with existing maritime infrastructure.

For platforms equipped with skidding rails, modules can be repositioned onboard using either internal movers integrated in the module base frame or external movers. Rail clamps and lock pins ensure that modules always remain secured to the deck – including during relocation at sea.

This capability supports safe repositioning between stowage and deployment positions and reconfiguration during transit.

Shifting workload off the platform

With mission modularity, much of the work that traditionally happens onboard shifts ashore, including:

- Configuration
- Testing
- Maintenance
- Documentation
- Certification

This shift requires well-defined processes for capability management, training and sustainment as well as appropriate storage solutions that maintain modules at defined readiness levels aligned with the current threat landscape.
Modules rotate through readiness, deployment and sustainment cycles, while the platforms remain available.

Mission modules as a portfolio

A portfolio of mission modules

Mission modularity delivers its full value only when it is understood and managed as a portfolio of mission modules, not as a collection of isolated, single-purpose capabilities. Modularity is not about replacing one permanent system with one removable alternative, it is about building a balanced set of mission options that can be combined, rotated and evolved over time.

A portfolio approach recognises that modern naval operations rarely focus on a single warfare area in isolation. Task groups, patrol forces and deployed vessels are continuously required to transition between deterrence, surveillance, security operations and, at times, high-end warfare. Mission modules make it possible to compose these capabilities dynamically, matching the mission set to the operational context rather than the platform's original design intent.

Within a NATO maritime framework, a mission module portfolio typically spans multiple recognised warfare areas:

Anti-submarine warfare (ASW) modules focus on sensing, acoustic processing, data fusion and control of unmanned undersea or surface systems. These modules emphasise persistence and information dominance rather than permanently installed, platform-specific sensors, allowing ASW capability to be added where and when required.

Anti-surface warfare (ASuW) modules support detection, tracking, targeting and mission planning against surface threats. In a modular construct, ASuW is not defined solely by weapons, but by the ability to rapidly add targeting, coordination and optionally launcher control functions as operational conditions evolve.

Mine countermeasure (MCM) modules typically integrate unmanned systems control, sensor processing, mission planning and data exploitation. They enable the separation of personnel from the mine threat while allowing MCM capability to be deployed across a wider range of hulls than would be feasible with traditional, specialised platforms.

Intelligence, surveillance and reconnaissance (ISR/JISR) modules form a backbone of most portfolios. ISR modules provide multi-sensor fusion, analysis workspaces and secure connectivity, supporting all warfare areas and enabling rapid technology refresh cycles without platform modification.

Maritime interdiction operations (MIO) and **Maritime security operations (MSO)** modules emphasise command and control, situational awareness and coordination of boarding teams and unmanned sensors. These modules are critical for presence missions, enforcement tasks and escalation management, particularly in multinational settings.

Command and control (C2) modules allow vessels to assume task group leadership or act as coordination nodes when required, without being permanently configured as command ships, and if a platform is not equipped with its own C2/CMS, a modular C2/CMS and possibly COMMS module can provide the platform with the necessary C2 capability.

Mission modules as a portfolio

A portfolio view also enables scalable force generation. Modules are allocated across fleets, forward bases or logistics hubs and embarked as missions change. For example, a ship providing water and medical aid near a crisis zone can integrate C-UxS modules as threats emerge, maintaining humanitarian access while enhancing perimeter safety, or an offshore vessel shifts from relief modules to surveillance and protective counter-drone functions for safe convoying through contested littorals.

Over time, the portfolio can be adjusted, adding new modules, retiring obsolete ones or upgrading individual capabilities, without re-architecting platforms.
In practice, mission modularity succeeds when decision-makers shift from asking which ship has which mission, to asking which combination of modules best addresses today's problem. That shift, from platforms to portfolios, is what allows naval forces to keep pace with missions that change faster than ships ever can.

How modularity works in practice

A portfolio of mission modules

Modularity becomes valuable when it is proceduralised. A clear, predictable workflow that is safe and easy to repeat.

SH Defence's Cube™ ecosystem is a complete system supporting each step of a cyclic and repeatable process to enable fast and safe swapping of modules. The ecosystem consists of:

- Mission modules
  - mission equipment,
  - a ruggedised enclosure capable of withstanding the structural loads, shock, vibration and environmental forces present on a naval platform, and
  - fitted with integrated mover (to allow moving of modules in port and at sea) or prepared for external mover (to allow moving of modules in port)
- Remote-operated twist locks installed in the deck for safe fastening,
- Skidding rails installed in the deck, allowing modules to travel along designated paths on the ship.

Modules can be loaded onto the vessel by different means. Conventional port-side cranes can be used to lift the modules onboard, and they can then be moved to their stowage position along the skidding rails. The second option is an overhead crane/davit installed in the mission bay. The overhead crane adds redundancy and the capability to launch and recover rescue boats and to load/unload mission modules directly into the mission bay. A third option is to use specialised onshore loaders such as the stern loader and the side loader from SH Defence, which can load and unload modules directly through the vessel's mission bay doors.

How modularity works in practice

Applying the Cube™ ecosystem, module swaps would involve the following steps:

1. **Prepare ashore**
   Modules are configured, documented, tested and placed into a defined readiness state ashore. Specialist mission crew train against the configured module in parallel.

2. **Validate ship interfaces**
   The host platform confirms readiness of power, cooling, data and safety checks.

3. **Transport from onshore hub to port**
   Modules are loaded onto conventional lorries and transported to the port of embarkation.

4. **Load and secure**
   Modules are loaded onto the vessel by means of port crane, vessel crane, side loader or stern loader. The modules are secured to the deck by means of remote-operated twist locks, which reduce the manual labour required and increase safety.

5. **Verify integration**
   The modules are connected to the platform by means of the Cube Connect interface panel integrated in the module enclosure. Connectivity, services and data exchange are verified against standard acceptance criteria.

6. **Confirm readiness state**
   The module enters an operational state under defined safety and governance rules.

7. **Certify and release**
   Readiness is signed off through a repeatable acceptance routine.

8. **Deploy and operate**
   The ship is mission-ready and leaves port. If the mission module requires repositioning before deployment, it is moved to the deployment position using the integrated mover and skidding rails. Rail clamps and lock pins ensure that the module is always secured to the deck while travelling along the skidding rails. Mission operations are conducted by the module-assigned specialists, integrated with the ship's command structure.

9. **Return to port**
   After completed mission, the vessel returns to port, the module is disconnected, twist locks are removed and the module is unloaded and returned by lorry to the module hub.

This workflow does not eliminate complexity. It turns complexity into a controlled process, and mission modularity succeeds when complexity is moved out of the ship – into certified modules, standardised interfaces and dedicated specialist teams – rather than being imposed on platforms and crew.

Cyber security, safety and governance are part of the design

If modules connect to networks or interact with mission systems, governance matters. A credible modular model includes:

- configuration control and baseline verification,
- chain-of-custody discipline during transport and storage,
- defined readiness states and activation rules,
- documentation routines that support repeatability and trust.

Speed is achieved when safety and governance are built into the concept from the beginning.

Readiness, sustainment and modernisation

Optimising readiness, sustainment and procurement

The operational benefits that mission modularity offers while deployed are one thing; another is the benefits it offers in terms of optimising readiness, sustainment and procurement.

Being able to remove a capability for maintenance or technological upgrade rather than having to take out the entire vessel for shorter or longer periods of time is a real game changer in terms of vessel readiness and availability. Mission modularity means that it is possible to perform extensive repair work and maintenance ashore, keeping the vessel available for other missions or the same mission with another operational module.

Readiness becomes distributed

When modules are held in mission-ready states ashore, fleets reduce dependence on ship-side preparation. Crew can train against representative systems without tying up platforms. Certification can become a continuous process, optimising ship availability rates.

Sustainment becomes capability-centric

A module can be removed for service while the ship continues operations with an alternative mission set. Specialised teams can work ashore under controlled conditions. Over time, this reduces the onboard maintenance burden, including required technical knowledge onboard, and increases availability. By keeping mission-specific expertise with the module rather than on every platform, the training burden is reduced while availability increases.

Modernisation becomes faster and less disruptive

Many mission capabilities improve faster than ship refit cycles can follow. A modular approach supports upgrades through module refresh cycles, keeping fleets aligned with evolving technology and reducing pressure on shipyard availability.

Readiness, sustainment and modernisation

Procurement becomes scalable

Instead of relying only on large refits or new ship programmes, a modular model supports incremental investment:

- define host interfaces and margins,
- build a module portfolio,
- scale inventory based on operational demand.

This can reduce risk, smooth budgets and keep capability aligned with reality.

Measures that matter (practical KPIs)

A modular system becomes credible when performance is measurable. Useful indicators include:

- time from alongside to mission-ready after a swap,
- first-time integration success rate,
- module readiness availability,
- unplanned ship-side work required during integration,
- time to restore module readiness after maintenance.

These measures connect directly to outcomes such as readiness, tempo and reliability.

Conclusion:
Modularity meets the mission

Modern fleets are asked to deliver more missions across wider areas with constrained budgets, limited shipyard capacity and fast-moving technology cycles. Traditional platform-centric approaches will remain important. But on their own, they often cannot provide the speed of change and the breadth of configuration that today's maritime environment demands.

Mission modularity based on standard ISO container footprints offers a practical way to close the gap between mission demand and platform pace. It supports faster role change, technology-rate modernisation, distributed readiness and scalable capacity across more platforms.

Modularity does not replace shipbuilding. It strengthens what fleets can do with the ships they have, and it improves how fleets prepare for what comes next.

In a world where missions and technology change faster than ships can, the advantage belongs to the fleets that can adapt.

References

1. Revision of the Alliance Maritime Strategy; NATO; 2025; Link accessed on 7 April 2026

2. NATO Mission Modularity Cost Benefit Analysis; Logtmeijer, RA; Caron, JD; Fee, M; Rudius, AM; Otten, SR; Manley, D; Clarke, MS; Lin, J; Conference Proceedings of INEC; 2020; Link accessed on 31 March 2026

3. Maintenance Delays for Conventional Navy Ships; Congressional Budget Office, 2025; Link accessed on 1 April 2026

4. Standard Flex 300 – The True Multi-role Ship; Danyard, NobelTech, TERMA Elektronik AS; 1992; Link accessed on 7 April 2026

SH DEFENCE