A MUSt DO: REPMUS is Primary Means for NATO to Develop Maritime Uncrewed Capability

At Robotic Experimentation and Prototyping using Maritime Uncrewed Systems 2024, the Portuguese Navy tested a prototype of an offshore artificial island, designed to provide a base for forward deploying and sustaining autonomous capabilities. *Photo credit: Lee Willett*

NATO navies are steadily increasing their use of maritime uncrewed systems, or MUS, aided by an extensive exercise process that covers the development of vehicles, payloads, capabilities and supporting architecture through various phases.

These phases include research and development, test and

evaluation, operational experimentation and integration into frontline assets and task groups.

One exercise that has evolved to cover at least the first three phases in this process is the Portuguese navy-led Robotic Experimentation and Prototyping using Maritime Uncrewed Systems, which takes place annually off the Tróia peninsula in southern Portugal. Established in 2010, it is hosted by the navy's Tróia-based Navy Operational Experimentation Center, or CEOM.

REPMUS originally focused on the research and development and test and evaluation phases. However, in recent years, especially due to the accelerating requirement to integrate MUS capabilities into frontline operations, the operational experimentation phase has become an equally crucial part of the REPMUS process.

The exercise's operational importance is underlined by the fact that NATO's Allied Maritime Command has developed and attached Dynamic Messenger – the alliance's first and primary MUS operational experimentation exercise – to REPMUS.

The two exercises were run in tandem in 2022 and 2023, co-hosted by CEOM and MARCOM; Dynamic Messenger will return to Tróia for REPMUS 2025.

The significance of REPMUS is underlined by the fact that several other major international MUS development activities now seek to support, draw on or understand the REPMUS process:

• Representatives from the Australia-U.K.-U.S. strategic partnership are focused on advanced maritime technology capability.

• NATO's Defence Innovation Accelerator for the North Atlantic construct assesses, tests and develops startup technology to demonstrate potential defense capability and deliver it more quickly to frontline operators.

• The European Defence Agency is developing concepts and capabilities tested in and around REPMUS.

• NATO’s Norfolk, Virginia-based Allied Command Transformation branch and La Spezia, Italy-based Centre for Maritime Research and Experimentation’s in-house laboratory have been testing concepts, technologies and capabilities at REPMUS for several years.

The increasing importance of REPMUS was demonstrated in the 2024 exercise as more than 100 MUS vehicles were involved, more than 700 experimentation serials were conducted, and 30 countries participated, NATO allies and partners alike.

One partner of note was the Ukrainian Navy. Ukraine’s experience of operating and countering uncrewed systems in both offensive and defensive operations in its ongoing war with Russia underscores the role uncrewed systems play today in conflict.

Thus, REPMUS has become a more important tool for NATO and its navies, providing capability development from research and development and test and evaluation to operational experimentation and accelerating the generation of MUS capabilities for operations.

“The NATO defense planning process is the primary means for identifying NATO’s minimum capabilities requirements, the apportionment of those capabilities among allies and progress assessment,” Captain António Mourinha, the Portuguese Navy’s CEOM director and REPMUS chief of staff, told Seapower in an interview in December.

“Through this process, NATO allies are working together to develop and procure innovative maritime solutions and applications to increase operational effectiveness, limit risk to human life and reduce operational costs. In this context, and in the evolving landscape of maritime operations, MUS are seen as revolutionary and a dynamic force multiplier in the

composition of our future fleets.

“These systems may increase, at fast pace, the mass, reach and flexibility of our maritime capabilities, improving operational effectiveness, efficiency and safety and thereby maximizing the potential of these fleets in a new manned-unmanned teaming construct,” Mourinha said.

The role REPMUS plays here is in capability development, evolving and improving the MUS systems to meet operational requirements, including for interoperability between the MUS vehicles themselves, building creweduncrewed teaming and supporting multidomain operations.

“REPMUS provides a cooperative environment where academia, industry, national armed forces and NATO can work together to foster advances in MUS capabilities, with a focus on interoperability … [it] allows for an exchange of innovative ideas and knowledge, thereby accelerating the development of new capabilities and the testing of such systems in a realistic operational setting,” Mourinha said.

Uncrewed air vehicles work with crewed surface vessels at Robotic Experimentation and Prototyping using Maritime Uncrewed Systems 2022. REPMUS is an exercise in which NATO navies build capacity to deliver crewed-uncrewed teaming in multidomain operations. *Photo credit: NATO | Fran S. Dzioba*

Rolling Process

REPMUS is a rolling process, with capability developments and lessons learned taken forward into the following year's exercise.

REPMUS 2024 addressed national and NATO MUS capability development through focusing on technology, doctrine, training, interoperability and crewed-uncrewed teaming.

The REPMUS process also focuses on MUS use in all major warfare domains, including anti-air, anti-surface and anti-submarine operations, plus more specific taskings like mine countermeasures, force protection, harbor security, maritime security and critical undersea infrastructure protection.

At REPMUS 24, MUS use was tested in various conceptual and

technological contexts, and Mourinha highlighted several examples.

The exercise tested and developed the requirements for NATO Standardization Agreement 4817, a mainstay STANAG for underwater communications in particular, building multidomain command and control for underwater operations involving, for example, uncrewed underwater vehicles.

“STANAG 4817 is a key feature for allied interoperability in using MUS,” Mourinha said. Alongside being used for sharing the common operational picture, 4817 was used at REPMUS 24 to conduct MUS command and control for the first time, he said.

Several of the serials focused on underwater tasks. Reflecting what was an emerging operational requirement for NATO, but now is an enduring one, critical underwater infrastructure protection serials were conducted using maritime uncrewed systems.

Here, “blue force” surface ships, uncrewed surface and underwater vessels and acoustic sensors were used to detect and prevent “red force” disruption activities.

For mine warfare, the exercise tested the use and coordination of MUS alongside the development of a visualization and command and control tool that enables holographic presentation of the mine threat area.

With Russian submarine activity continuing to increase across the Euro-Atlantic theater, MUS – especially uncrewed surface vehicles and uncrewed underwater vehicles – are central to NATO’s development of its anti-submarine warfare barrier concept, for which multistatic acoustic detection was tested in REPMUS 24.

“The barrier is a defensive ASW concept, using MUS extensively to detect, track and, if necessary, neutralize adversary submarines attempting to penetrate strategic areas, like naval

bases, choke points or shipping lanes," Mourinha said.

The impact of Russia's invasion of Ukraine on NATO operational requirements is reflected in the REPMUS work on countering uncrewed systems. At REPMUS 24, counterdrone work encompassed testing capabilities and tactics in all maritime domains.

"This is an important area of development, since many actors can cause disruptive effects, even with the simplest of uncrewed systems," Mourinha said.

REPMUS also tests NATO navies' ability to integrate other concepts and technologies to enhance MUS capabilities, such as through exploiting artificial intelligence. In this context, a concept called "silicon sailor" was tested, involving experimenting with how AI can assist with accessing naval operational manuals and protocols, providing fast access to critical information, supporting decision-making processes and enhancing personnel training. Scenarios included maritime navigation and rescue tasks.

A notable REPMUS 24 development was the establishment of an artificial island – located in the Sado Estuary Natural Reserve, offshore from the main exercise base and CEOM headquarters at Tróia – designed as a prototype for a future, larger island construct designed to support MUS operations and wider surveillance and ocean monitoring.

"The structure was created … to test the requirements for MUS operation, ocean sensing, energy production and management, and efficient data processing and storage, with the testing of an underwater computer and server," Mourinha said. Drawing on data gathered and lessons learned from the prototype, the navy intends to develop the larger artificial island to deploy it close to the deep waters of the Setubal Canyon on the peninsula's seaward side.

Experimentation around these themes will continue at REPMUS 2025, with additional focus areas of persistent surveillance

and data exploitation – reflecting Dynamic Messenger.

At REPMUS 2022, a REMUS UUV is deployed from a Royal Canadian Navy Kingston-class maritime coastal defense vessel. REPMUS is a core exercise process for developing NATO maritime uncrewed systems capabilities. *Photo credit: Estonian navy | NATO*

Testing Zone

The testing conducted at REPMUS is enabled and supported by the fact that CEOM and the wider Tróia exercise area sit in the middle of a Portuguese government “technological free zone,” which the navy and Portugal’s naval industry can exploit.

The zone covers more than 1,000 square miles and permits testing and operational experimentation of new technology in a secure, at-sea space free from other users, enabling technology readiness levels to be developed to the point where the technologies can be presented to regulatory authorities for certification.

“The idea is to increase the use and efficiency of CEOM in a more cooperative way, by bringing more countries, international industry and research centers to experiment at CEOM in a concept closer to the one used in REPMUS, Mourinha said. The zone provides capacity for multiple stakeholders to be present at the same time to conduct testing, with this combined presence enabling synergies to be achieved and information to be exchanged, he said.

In 2025, CEOM will increase engagement with both Portuguese industry and NATO allies to increase their experimentation presence around the peninsula.

Allied presence at REPMUS 25 may also increase, possibly including one of the U.S. Navy’s latest MUS capability and operational development organizations, the U.S. 6th Fleet’s Task Force 66.

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