

REPMUS 2026: From Sensor to Decision-Maker – Mine Countermeasures as a Driver of Innovation in the German Navy

Specialist Article REPMUS 2026



Early morning in Sesimbra, Portugal: The day starts early in the large white tent at the fishing harbour. Roughly the size of two tennis courts, it stands in a restricted part of the port. Fencing and olive-green screening keep curious eyes away. Inside, naval personnel from various nations, experts from the Bundeswehr Technical Centre 71 (WTD 71) and representatives of international defence companies sit close together. Large screens display maritime areas, search zones and routes. English is the working language.

Standing in front of the operational map is the Commander Task Unit (CTU) Sesimbra, Lieutenant Commander Julian A. from the Unmanned Systems Task Group of the 3rd Minesweeper Squadron in Kiel. Leaning on a pointer, he outlines the day's mission during the Daily War Council. The exercise scenario: hostile naval mines have been laid off the Portuguese coast. A designated Q-route towards Setúbal is particularly critical.



Red glow on the horizon, the smell of fish: the mine countermeasures day starts early in Sesimbra's fishing harbour. (Source: north.io)

Background: Q-routes are designated shipping lanes whose seabeds are surveyed and documented by sonar during peacetime. Known objects are catalogued. If a subsequent route survey reveals something new, it can be checked specifically for a possible mine. During a crisis or conflict, these corridors help make key port approaches and sea routes accessible more quickly to military and civilian shipping.

Military teams and participating companies are tasked with searching their assigned maritime areas. Julian A. makes clear what the staff needs: raw data, processed as little as possible, on detected mine-like contacts (MILCOs). Military reports are equally important. A technically successful survey alone does not complete the mission. Information must be processed and reported quickly enough for the staff to build an operational picture and make decisions.

This interface highlights the differences between naval and industrial environments. Not every civilian developer or engineer is familiar with naval reporting procedures, terminology and formats.

Requirements are repeatedly explained and clarified, translating military needs into technical language. The atmosphere is relaxed. Work is focused, but there is also room for humour. Sailors can explain exactly what information they need, while developers experience the conditions under which their technology must perform.

After the briefing, the tent quickly empties. A red glow still hangs over the horizon, and the air smells of fish. The first joggers pass along the promenade. As Sesimbra, a holiday town about an hour south of Lisbon, slowly wakes up, the mine countermeasures day is already in full swing.

Among the fishing boats, military and civilian teams, known as Task Elements, prepare to head out. Shortly afterwards, various autonomous underwater and surface vehicles are deployed off the coast, while aerial drones take flight. What existed on presentation slides moments earlier becomes a mine countermeasures (MCM) operation at sea. This reflects a development extending far beyond REPMUS (Robotic Experimentation and Prototyping using Maritime Uncrewed Systems): **mine countermeasures are once again becoming a technological driver of modern naval warfare.**



Ideal training conditions for the many underwater and surface systems operating off the Portuguese coast.
(Source: Markus Beer)

An Old Weapon Regains Relevance

It initially seems paradoxical that naval mines are driving such innovation. They are among the oldest weapons of naval warfare. Mines are inexpensive, can be deployed covertly and force an adversary to invest considerable effort before an area can be navigated at acceptable risk. Even a credible suspicion of mines can severely restrict maritime movement.

Russia's war against Ukraine has brought the importance of naval mines back into focus. Both sides have deployed mines in the Black Sea. Detached moored mines and apparently deliberately deployed drifting mines have also threatened shipping beyond restricted areas. For Germany and NATO, there is another dimension: in a conflict, the North and Baltic Seas are vital transport and supply routes. Mined port approaches or sea lanes could significantly hinder the movement of troops, ammunition and supplies to the Baltic states.

The Strait of Hormuz also illustrates the global dimension. According to US President Trump, American mine clearance operations began there in August 2026. Mining therefore affects not only military operations but also international trade and energy supplies.

Mine countermeasures are no longer a niche naval capability. They ensure freedom of movement at sea, both militarily and economically.

Test Environment Under Near-Ideal Conditions

Sesimbra offers exceptional conditions. During REPMUS 2026, around 300 MCM taskings, or individual operational missions, were scheduled within Naval Mine Warfare. Fewer than 30 were cancelled for technical reasons. Other factors, such as sea state, thermoclines or limited visibility, barely affected the exercise. Systems and procedures could therefore be tested intensively over several weeks without adverse environmental conditions masking technical problems.

The scale of the MCM activities is considerable: more than 240 participants from 13 nations work together in Sesimbra. They have 85 minehunting and harbour protection assets, including six aerial, eleven surface and 68 underwater systems.

These assets are organised into 36 Task Elements, operational teams assembled with the systems required for specific missions. They include the GREYSHARK from EUROATLAS and several Quadroin AUVs from EvoLogics, which can operate in swarms.

This diversity makes REPMUS a unique testing environment. Military forces and companies test more than individual platforms. They must integrate drones, sensors, software and procedures into a functioning system. The real challenge is therefore not the performance of any single system, but how all components work together.

First the Language, Then the Software

Looking back, the scene in Sesimbra's white tent has a prehistory. In mid-August, much of the workforce of north.io, a Kiel-based maritime data integration technology company, visited the training centre of the 3rd Minesweeper Squadron. Commander Inka von Puttkamer, commanding officer of the squadron, personally welcomed the group. The CEO, developers, geoinformatics specialists and project managers then attended a full-day MCM crash course.



Commander von Puttkamer welcomes north.io employees to the MCM training session. (Source: north.io)

Only unclassified content was covered: the fundamentals of mine warfare, mine countermeasures procedures, specialist terminology and military reporting formats. APP-11, NATO's catalogue of standardised military messages, was a recurring topic. What is a Mine-Like Contact (MILCO)? What information does a staff need? Which report must reach which recipient, and when?

This understanding is essential for developing military software. Anyone building digital tools for naval staff must understand what information operators need, when they need it and how it must feed into command processes.

Developers do not need to become mine warfare officers. But they must understand their language and workflows. What still seems theoretical in Kiel becomes reality in Sesimbra weeks later: MILCOs, search areas, deadlines, risk assessments and reporting formats.

OPEX: The User Sits Next to the Developer

This is where Operational Experimentation (OPEX) between the German Navy and north.io comes in. The German Navy has commissioned north.io to test its technologically mature Ocean Data technologies (Technology Readiness Level 9) under realistic operational conditions and assess their suitability for large-scale naval deployment.

The collaboration began in spring 2026. The aim is not to make an unfinished technology work for the first time, but to expose an operationally mature solution to actual military workflows, data volumes and requirements at an early stage. Naval operators can use and evaluate it under operational conditions.

This approach was already tested in April 2026 during the Seabed Security Experimentation Centre (SeaSEC) Challenge in Warnemünde. SeaSEC serves as a multinational innovation and experimentation platform for the German Navy, bringing military users, research and industry together to test and develop technologies and procedures under realistic conditions.

At REPMUS, the approach continues in a multinational setting. Sailors use the technology, define requirements and identify problems. Developers immediately see where workflows are too complex, information is missing or functions need to perform differently under time pressure.

Through experimentation, sailors evolve from future customers into active contributors. Developers, in turn, gain insight into workflows that can only partly be described in requirements documents.

In Sesimbra, this approach goes a step further. north.io programmers work where their software is actually used. Requirements arising during an exercise can be captured, assessed and sometimes implemented on site. Rapid prototyping, the fast development, adaptation and retesting of a technical solution, becomes the working method: test, observe, gather feedback, adapt and test again.

Rear Admiral (Flotilla Admiral) Torben Jürgensen from Naval Command in Rostock also witnessed this approach during an official supervisory visit to the CTU at REPMUS. For him, direct collaboration between military users and developers is key to faster innovation:

“What matters is that multinational forces, technology and engineers experiment together. Only through direct exchange can we identify more quickly which approaches work and which promising paths we should pursue consistently.”



Rear Admiral Jürgensen during an official visit to REPMUS, receiving a briefing on centralised data processing within the CTU staff. (Source: north.io)

From Sensor to Decision-Maker

As more uncrewed systems are deployed, data volumes will continue to grow. The decisive question is therefore not only what a drone can measure, but how quickly its data can become actionable information for decision-makers.

An autonomous underwater vehicle can survey large maritime areas with sonar, generating enormous amounts of data. But that data only becomes useful when it is analysed promptly, compared with existing information and presented in a way the staff can understand.

“Modern maritime operations are no longer conceivable without powerful data fusion,” says north.io CEO Jann Wendt. “With our dual-use Ocean Data Platform, we provide the foundation for integrating sensor data from a wide range of sources quickly and securely. And not just for mine countermeasures.”

At REPMUS, the Ocean Data Platform and its associated processing technology are used for shore-based mine countermeasures, Rapid Environmental Assessment (REA) and Maritime Safety and Security (MSS). north.io integrates, processes, fuses and distributes seabed and sensor data from different sources.

The processed information can then be fed into Systematic’s SitaWare Headquarters, a command-and-control system that combines operational information from various sources and presents it to the staff.

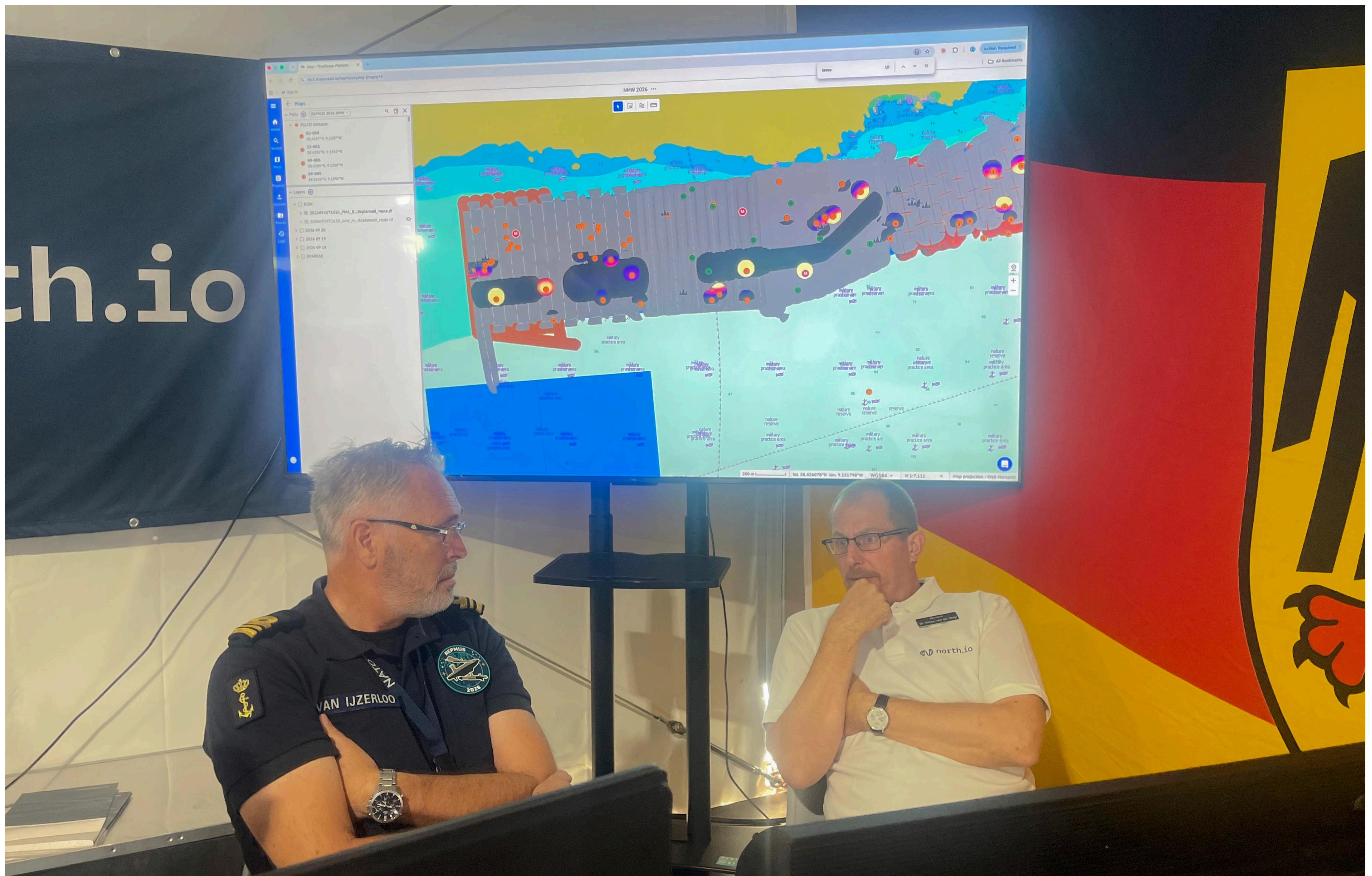
At REPMUS 2026, it supports the Naval Mine Warfare staff in Sesimbra with planning, tasking, the assignment of specific missions to participating units and systems, and reporting, the standardised communication of results under APP-11.

north.io provides data for the underwater operational picture. This makes the chain from sensor to decision-maker visible: an uncrewed system collects data, the data is processed and fused, and the resulting information becomes available for command decisions.

Lasse Krabbesmark, Product Manager for SitaWare Maritime, highlighted the progress made at REPMUS: “This is an ideal training environment for bringing different sensors and users together into a single operational picture, improving interoperability for the German Navy as well.”

This is particularly important in mine countermeasures. Suspicious contacts must be detected and classified, their positions determined and new survey data compared with previous measurements. The more systems provide data simultaneously, the more important a shared technical foundation becomes for processing that information.

Ultimately, everything comes down to one simple operational question: What level of risk does a ship face when passing through this sea route?



Captain Hans van IJzerloo emphasises that collaboration between civilian companies and the navy works and drives progress. (Source: north.io)

Mine Countermeasures as a Driver of Innovation

This is where mine countermeasures gain significance beyond their immediate mission. They are increasingly becoming a testing ground for capabilities that the entire German Navy will need in the future.

Autonomous systems must be controlled, sensors from different manufacturers connected, and their data transmitted, processed and prioritised. Artificial intelligence can support detection, classification and identification. At the same time, all these procedures must function in multinational NATO operations.

German mine countermeasures are particularly well positioned for this development. They have relied on sensors for decades, are accustomed to integrating highly specialised technology and have extensive experience with uncrewed systems. The TROIKA system already used remotely controlled “Seehund” vessels, uncrewed minesweeping craft that simulate ships' acoustic and magnetic signatures to trigger mines.



“Modern maritime operations are no longer conceivable without powerful data fusion.” north.io’s compact Naval Ocean Data Warehouse at the CTU headquarters in Sesimbra. (Source: north.io)



REPMUS 2026 once again featured a strong German presence. (Source: north.io)

Today's autonomous systems build on a technological tradition that has shaped German mine countermeasures for decades.

The real innovation does not lie in the next underwater drone alone, but in the interaction of software and data, common standards, communication and command procedures, and in how quickly these elements can evolve together.



85 mine countermeasures systems were deployed in Sesimbra, including the GREYSHARK. (Source: Markus Beer)

This development extends far beyond mine countermeasures. At its core is the integration and analysis of diverse underwater data to create a comprehensive 3D underwater operational picture.

In Sesimbra, alongside sonar data for MSS, initial data from hydrophones was also processed. Hydrophones can capture acoustic signatures in the water column, providing indications of moving contacts.

In the future, this could create a comprehensive underwater operational picture supporting not only MCM, but also the protection of ports and critical infrastructure, as well as defence against submarines, combat divers and uncrewed underwater vehicles. What is being tested in mine countermeasures today could become the technological foundation for a far broader understanding of the underwater domain.

What began in mid-August in a classroom of the 3rd Minesweeper Squadron in Kiel, with MCM abbreviations and reporting forms, continues just weeks later in Sesimbra's white tent. Sailors explain to developers what information they are missing. Developers adapt the software. In the near future, the results will be tested at sea again, this time in German waters.

About the Author

Arne Krüger, retired German Navy Commander, served in the German Navy for 31 years, including as a mine clearance diver, minehunter commanding officer, training officer for specialised forces, and commander of the Naval Protection Forces and the Sea Battalion. Today, he works as a Naval Advisor.