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Guarding Europe's hidden lifelines: how AI could protect subsea infrastructure

EU-funded researchers are developing AI-powered surveillance tools to protect the vast network of subsea cables and pipelines that keep the continent's energy and data flowing.

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Thousands of kilometres of cables and pipelines criss-cross Europe's sea floors, carrying the gas, electricity and data that keep modern life running. Yet these critical links lie mostly unprotected.

A series of recent incidents, such as the Nord Stream gas pipeline explosions, has raised fears that Europe's underwater infrastructure is becoming a target, and that defending it requires new tools.

Researchers in one EU-funded initiative think AI may be part of the answer. By combining satellite images, ship tracking data and, eventually, acoustic signals from the cables themselves, they aim to build an early warning system for suspicious activity at sea.

A wake-up call in the Baltic

The turning point came in September 2022, when several explosions ripped through the Nord Stream pipeline under the Baltic Sea. The shock was revelatory: Europe's subsea networks were far more vulnerable than many had assumed.

At the time, security researcher Johanna Karvonen at Laurea University of Applied Sciences in Finland was coordinating an EU-funded project called AI-ARC.

Its researchers were using AI to monitor satellite imagery and ship tracking data – known as the Automatic Identification System (AIS) – to support safety in Arctic waters.

Its algorithms were designed to detect hazards such as icebergs, drifting oil, or ships in distress.

“After the Nord Stream incident, we realised we were developing a tool that could also help surveil critical submarine infrastructure,” Karvonen said.

AI-ARC was already able to flag unusual behaviour, such as a vessel unexpectedly slowing down or drifting off course.

A new EU-funded research initiative, VIGIMARE, set out to harness that capability for the protection of critical assets on the seafloor.

From Arctic safety to infrastructure protection

With new partners and countries on board, the VIGIMARE research team led by Karvonen began work in 2024 and will continue until the end of 2027. The objective is to train AI to spot suspicious maritime behaviour around Europe’s subsea telecommunication and power cables and its key gas pipelines.

“For instance, if a vessel is moving normally and then suddenly slows down, that would trigger an alarm,” said Karvonen.

Ships attempting to hide can also give themselves away. Some vessels illegally switch off their AIS transponders, going “dark”. But satellites can still see them, even without a signal.

“The AI ‘sees’ that there’s a vessel there, but there’s no AIS signal,” Karvonen explained. “That discrepancy alone is suspicious.”

The researchers hope to integrate data from coastal radar and other surveillance systems operated by national coast guards and security agencies, creating a fuller picture of maritime behaviour.

Intentional and accidental damage

Not all recent incidents in the Baltic have been explosive attacks. Several data and power cables have been damaged in the past two years by ships whose anchors were dragged across the seabed.

The most serious incident occurred on Christmas Day 2024, when the Estlink 2 power cable between Estonia and Finland was severed, causing energy prices in Estonia to spike. Four data cables were also cut.

Finnish authorities quickly seized a tanker suspected of causing the damage. Although registered in the Cook Islands, it was believed to be part of Russia’s shadow fleet – vessels that transport Russian oil and petroleum products in ways that avoid Western sanctions.

According to Karvonen, the ship had been dragging its anchor for a long time before anyone noticed. An AI-based early warning system might have raised an alert sooner, preventing, or at least limiting the damage.

The stakes for digital connectivity

Among the cables cut that month was C-Lion1, a major fibre-optic link running from Finland to Germany. “That’s the main vein for direct connectivity between Finland and central Europe,” said Mikko Tiensuu, a consultant at Cinia, the Finnish state-owned company that operates the connection.

The cable was repaired within two weeks, but had already been damaged a month earlier, also due to suspected anchor dragging.

“Last year was the first time we had any problems with C-Lion1,” said Tiensuu, noting that repeated incidents underscored the need for quicker detection.

Cinia is now a partner in VIGIMARE and hopes the project’s AI system will speed up reaction times. Even if damage cannot be fully prevented, early alerts could stop multiple cables from being cut in quick succession, which is what happened last Christmas.

Listening to the sea through fibre

One of the project’s most innovative components is a planned pilot study that turns Cinia’s fibre-optic cable itself into a sensor. By measuring tiny changes in how light travels through the glass fibre, researchers can detect vibrations, effectively giving the cable the ability to “hear”.

The AI system could then learn to identify what different vessels sound like and flag anomalies.

“The VIGIMARE system could detect the location of vessels on the surface, or submarines, or even detect if a vessel is dragging its anchor,” said Tiensuu.

Toward a continental early warning system

The VIGIMARE team is currently preparing to trial its technology in the real world. From 2026, pilot studies will take place in the Baltic Sea, as well as in the Mediterranean and the Irish Sea. The goal is to create a system that can operate at scale across Europe’s waters.

Whether it will be able to prevent future sabotage remains uncertain. Some attacks, like the Nord Stream explosions, may be too complex or covert to detect in advance.

But the ability to reconstruct ship movements in the days and weeks before an incident could provide useful information that would help investigators identify potential perpetrators.

And in many other cases – from drifting anchors to vessels behaving strangely – the system could provide early warnings that allow authorities to respond before disaster strikes.

“Ironically, these incidents in the Baltic are good for the project because it is great historic data to train our AI algorithms on,” said Karvonen.

Europe’s underwater networks may remain invisible to most of us. But as threats grow, the tools to protect these hidden lifelines are finally beginning to surface.

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More info

- AI-ARC (CORDIS)
- VIGIMARE (CORDIS)
- VIGIMARE project website
- Critical Entities Resilience Directive
- EU strengthens the Security and Resilience of Submarine Cables
- Joint Communication to strengthen the security and resilience of submarine cables