



Ordine degli Ingegneri
della Provincia
di Roma



Infrastrutture, Sistemi e Servizi di posizionamento per applicazioni Underwater

Aula 3

8 Luglio 2025

Ordine degli Ingegneri della Provincia di Roma
Piazza della Repubblica 59 Roma

Ore 16:00 – 16:30

Ing. Michele Fiorini
Leonardo

**“Infrastrutture sottomarine, innovazione, sicurezza
e sfide strategiche”**

This study represents the opinions of the author and is the product of professional research. It is not meant to represent the position or opinion of the Leonardo S.p.A., nor the official position of any staff/employ members. Any errors are the fault of the author.

NORD STREAM

Gas pipelines damaged

Mysterious leaks in two undersea pipelines linking Russia with Germany have triggered concerns of possible sabotage and raised fears of a climate catastrophe.





Bornholm

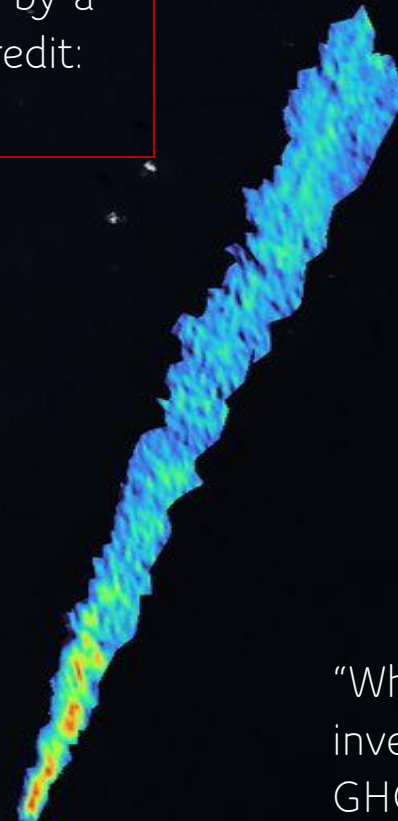
Nexø

Gas leaking in the Baltic Sea from one of the damaged Nord Stream pipelines seen bubbling up to the surface by a Pléiades Neo satellite. (Image credit: Airbus/Pléiades Neo)

Baltic Sea



Gas leak detected by the GHGSat satellite



Canadian firm GHGSat used its satellite to measure the amount of greenhouse gas methane escaping from the broken pipelines. (Image credit: GHGSat)

"While we await further investigation on the cause, GHGSat responded quickly, measuring 79,000 kg per hour of methane coming from the leaks."

Methane enhancement above average

30 September 2022, 10:28:12 UTC

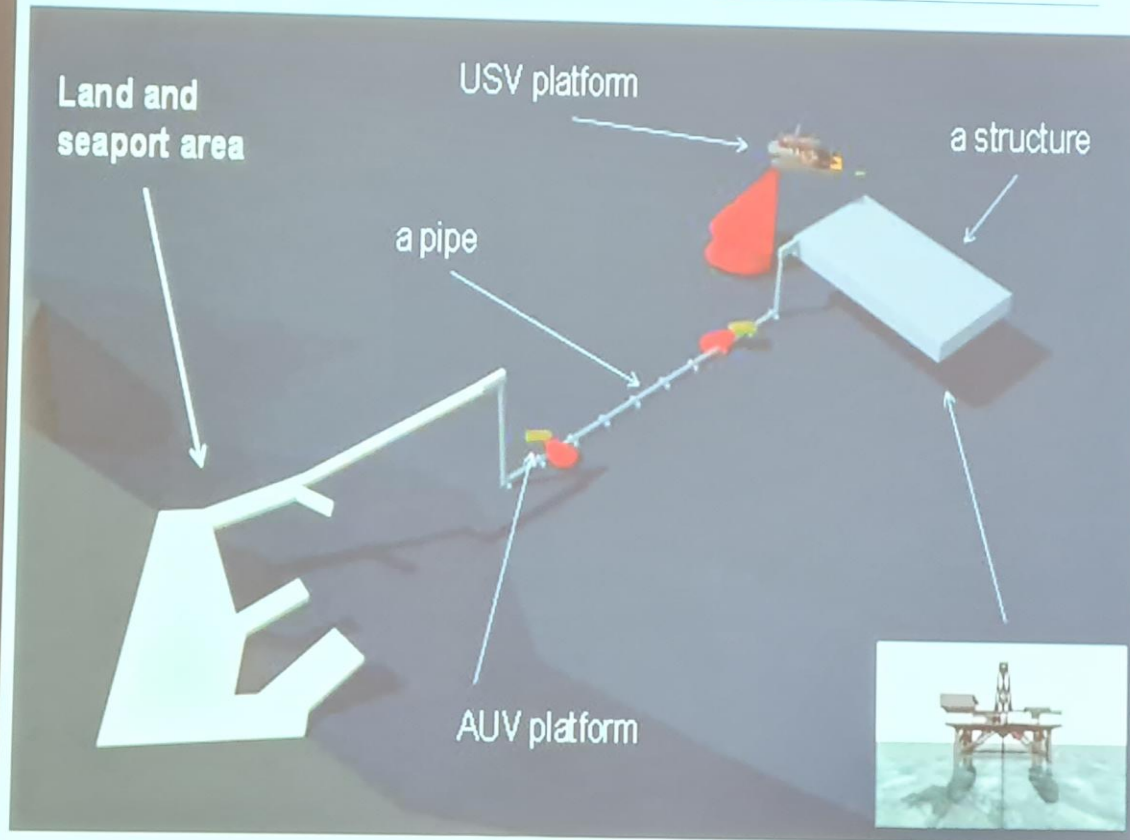
0 500 1000 ppb

2 km



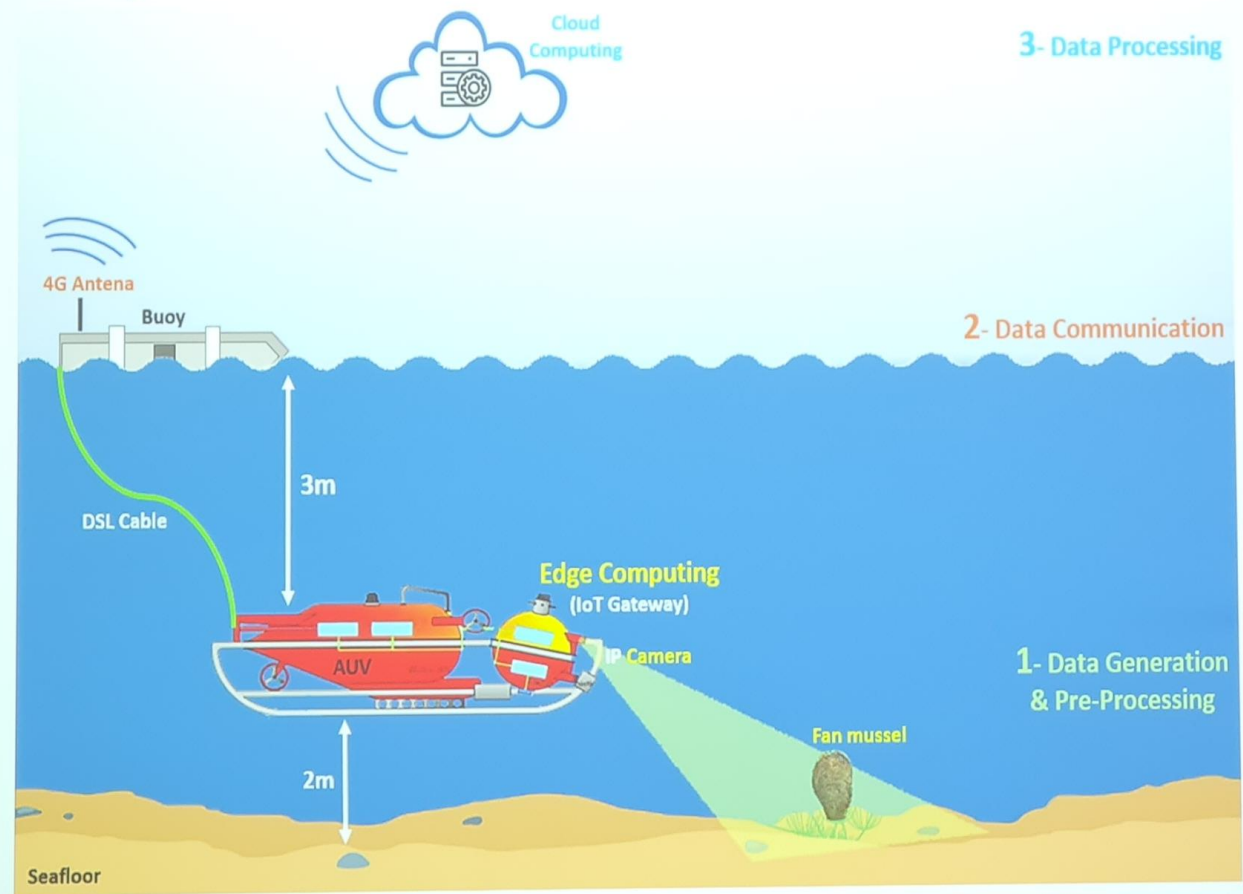
Major elements of a novel system for monitoring offshore structures

TRANSNAV



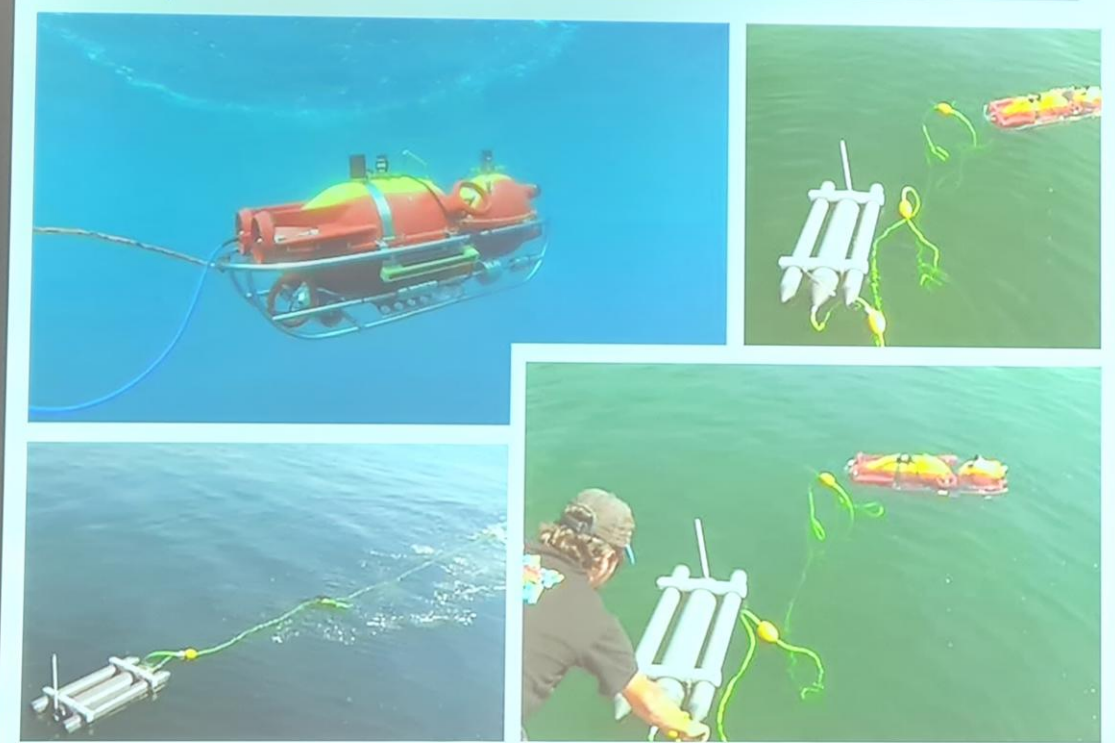
Nowak Karol Aleksander, MSc

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Nowak Karol Aleksander, MSc

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Nowak Karol Aleksander, MSc

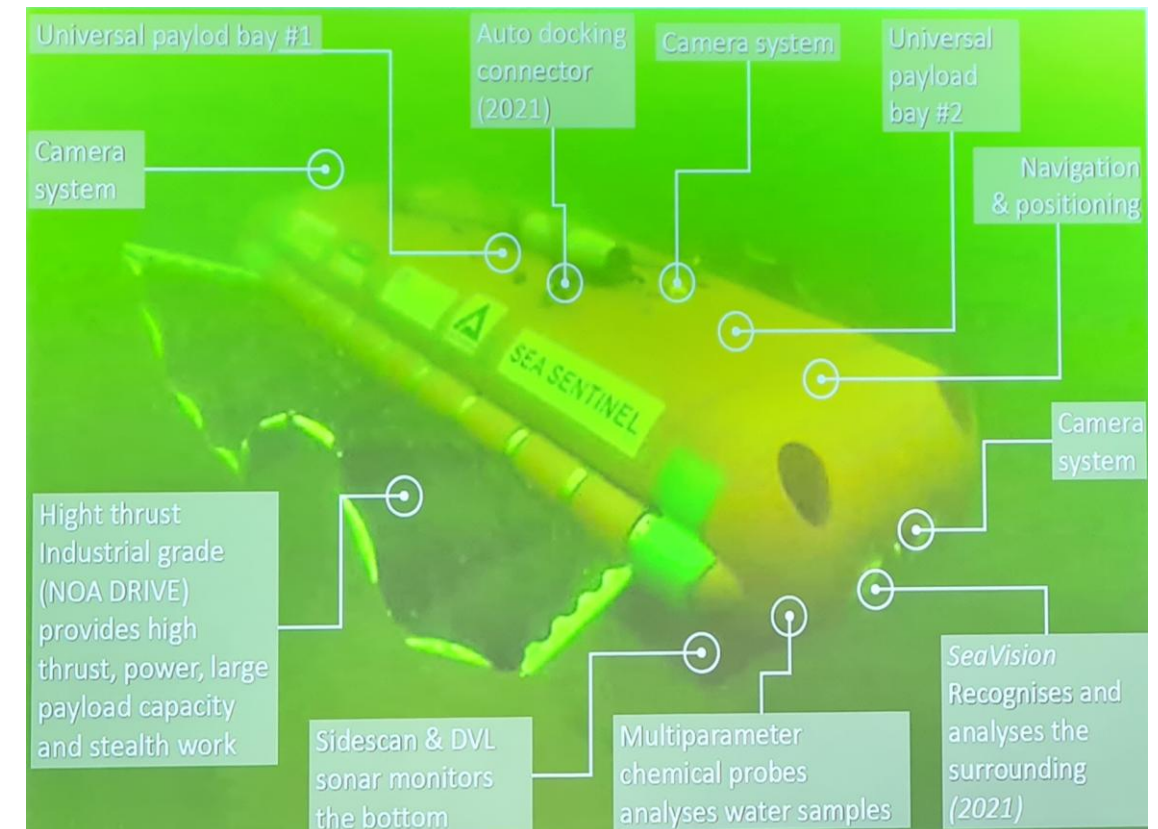
15



Wireless and autonomous

“NOA Sentinel” is the name of a system for under water data collection. It is based on the “NOA Drone Technology”, which is used within the frame of “BONUS” , an international program for research and development of the Baltic Sea.

NOA Sp. z o.o., Michał Łatacz, Krakow, Poland



“NOA Sentinel” is the cheapest wireless and autonomous system worldwide, and provides numerous additional advantages: High thrust power and therefore high load capacity, improved manoeuvrability and prevention of rotating parts are only some of them.

<https://www.igus.it/info/manus-underwater-technology>

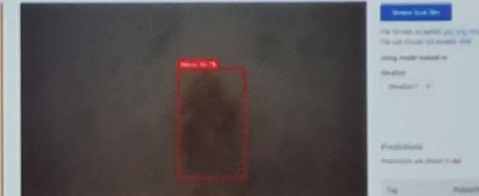
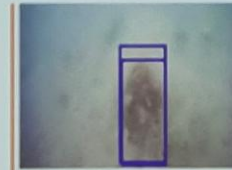
Google Cloud

IBM Watson

Azure Microsoft

Test 1 :

Google : 99%, IBM: 91%,
Microsoft : 60,7%



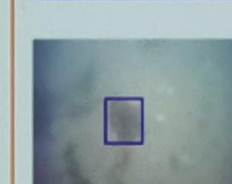
Test 2 :

Google : 98%, IBM: 59%,
Microsoft : 68,6%



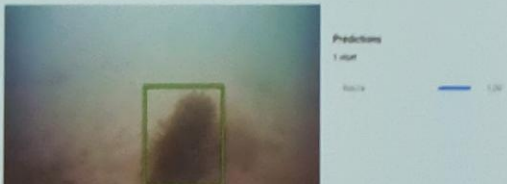
Test 3 :

Google : NoD*, IBM:
15%, Microsoft : 83,2%



Test 4 :

Google : 100%, IBM:
95%, Microsoft : 90%



Test 5 :

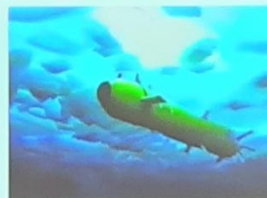
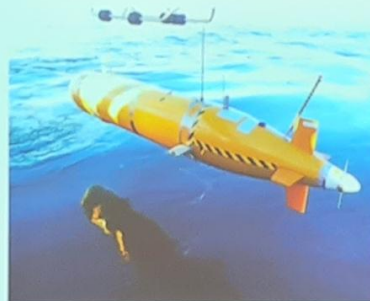
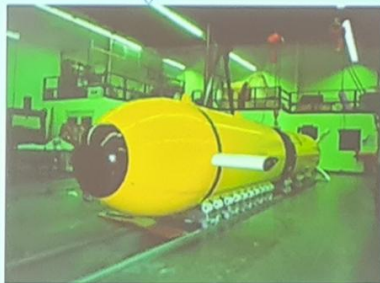
Google : 93%, IBM: 19%,
Microsoft : 92,9%



*NoD: No Object Detected

Nowak Karol Aleksander, MSc

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← → ↺ 🏠 https://www.terna.it/it/media/comunicati-stampa/dettaglio/terna-sperimenta-odisseo- drone-sottomarino-ispezione-fondali MFIORINI.EU

☰ **Terna**
Driving Energy 🔍

TERNA SPERIMENTA L'USO DI UN DRONE SOTTOMARINO PER L'ISPEZIONE DEI FONDALI MARINI

🏠 Home ▶ Media ▶ Comunicati Stampa ▶ [Terna sperimenta l'uso di un drone sottomarino per l'ispezione dei fondali marini](#) Condividi

Avviato **progetto "Odisseo"** in collaborazione con la startup statunitense Terradepth, gli Autonomous Underwater Vehicle (AUV) rappresentano un approccio innovativo per i rilievi dei fondali, a supporto della progettazione dei collegamenti elettrici sottomarini nel rispetto dell'ambiente

📅 11/01/2024 - 11:04 • Corporate

Autonomous Underwater Vehicle (AUV)

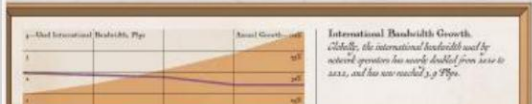
Drone GAVIA (in basso)
per l'ispezione degli elettrodotti sottomarini

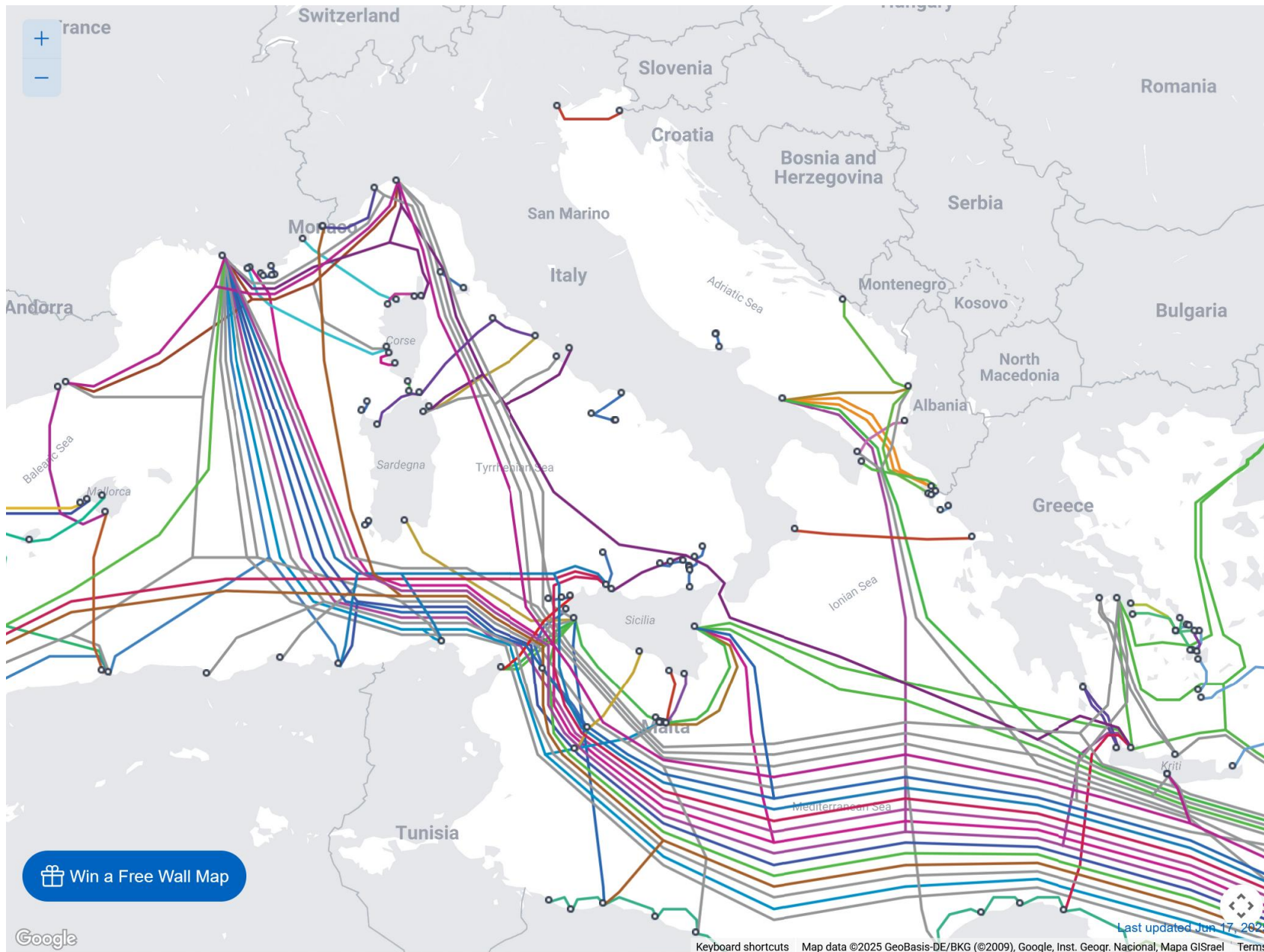


<https://www.terna.it/it/media/comunicati-stampa/dettaglio/terna-sperimenta-odisseo-drone-sottomarino-ispezione-fondali>



Source: <https://submarine-cable-map-2023.telegeography.com/>





<https://www.submarinecablemap.com/submarine-cable/blue>

Blue (RFS2023)

Cable Length: 5,055 km

Owners: Google, Sparkle, Zain Omantel Int.

Suppliers: Alcatel Submarine Networks (ASN)

Landing Points:

Yeroskipos, Cyprus

Bastia, France

Marseille, France

Chania, Greece

Tel Aviv, Israel

Genoa, Italy

Golfo Aranci, Italy

Palermo, Italy

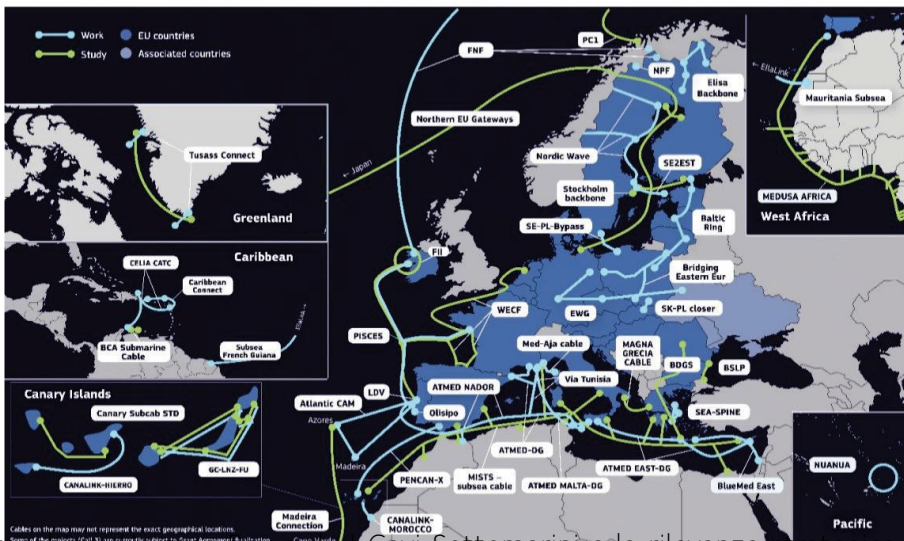
Rome, Italy

Aqaba, Jordan

Comunicazione congiunta per rafforzare la sicurezza e la resilienza dei cavi sottomarini

Per tutelare gli interessi strategici vitali dell'UE, la Commissione lancia una comunicazione congiunta volta a rafforzare la sicurezza dei cavi sottomarini

I cavi di comunicazione sottomarini trasportano il 99% del traffico Internet intercontinentale. Nel frattempo, i cavi elettrici sottomarini sono fondamentali per la sicurezza energetica, collegando i mercati dell'elettricità e portando l'energia rinnovabile offshore a terra. Una campagna ibrida rivolta a queste infrastrutture critiche può perturbare le funzioni e i servizi essenziali nell'UE con un impatto diretto sulle nostre vite.



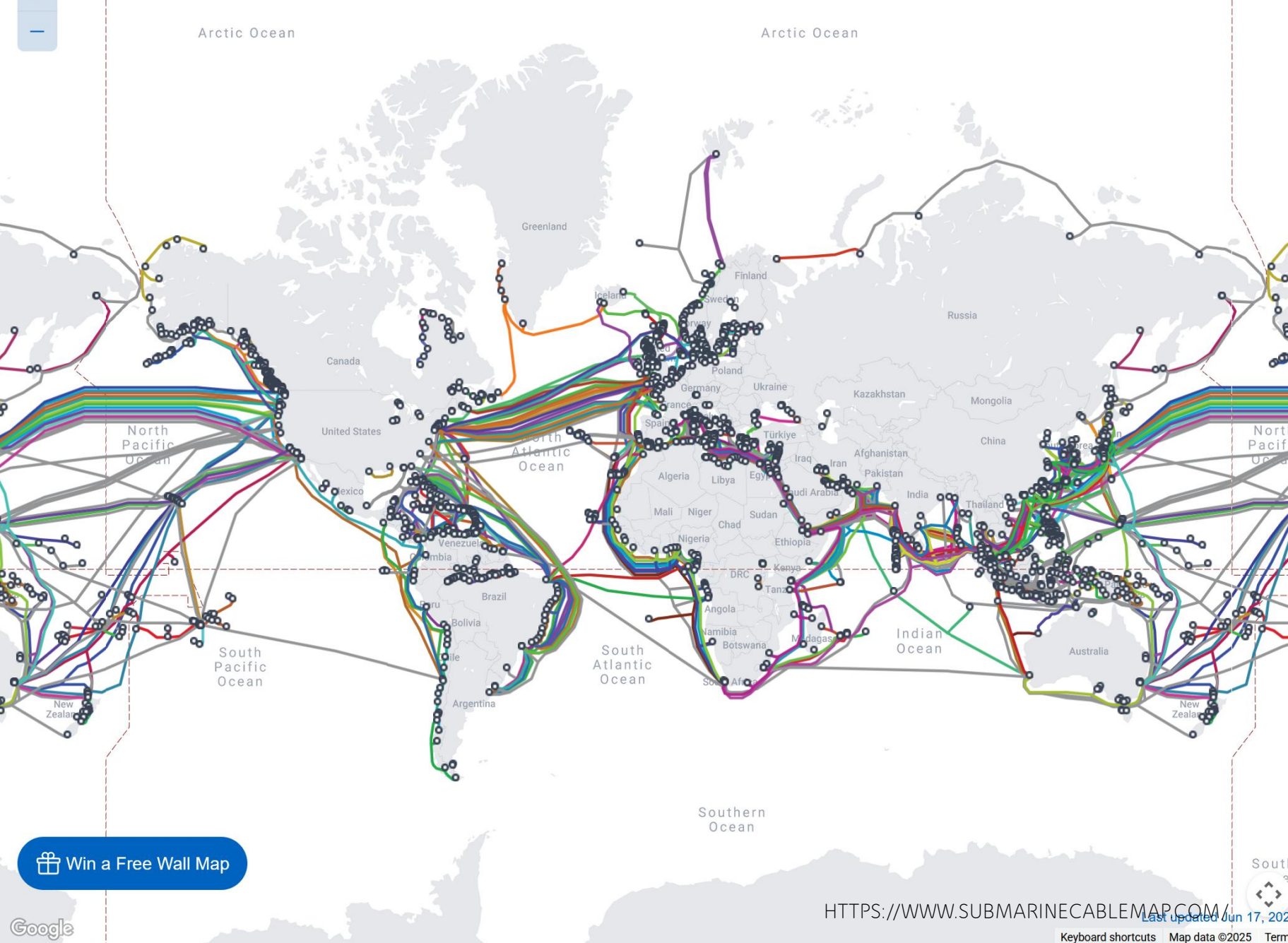
Source: Luisa Franchina, *Hermes Day* s.r.l. «Cavi Sottomarini e la rilevanza strategica delle infrastrutture critiche di connettività», mimit.gov.it, 12/03/2025

L'Unione Europea sta potenziando le proprie infrastrutture di connettività con **51 progetti** finanziati nell'ambito del programma Connecting Europe Facility Digital (**CEF Digital**), per un totale di **420 milioni di euro**.

PROGETTI EUROPEI DI CAVI

La mappa mostra i cavi finanziati nei primi tre bandi. Nel 2025-2027, verranno investiti **540 milioni di euro aggiuntivi**, portando il totale degli investimenti UE a quasi **1 miliardo di euro** per infrastrutture digitali strategiche.

Il programma supporta la **creazione di cavi sicuri**, riducendo le dipendenze da infrastrutture extra-UE e rafforzando la posizione dell'Europa come **hub globale di connettività**.



Worldwide, about 200 undersea cables have been cut or disrupted annually as of 2024, due most frequently to unintentional damage from fishing equipment or the anchors of ships.

Source: ENISA "Threat Landscape for Submarine Cables" (2023)



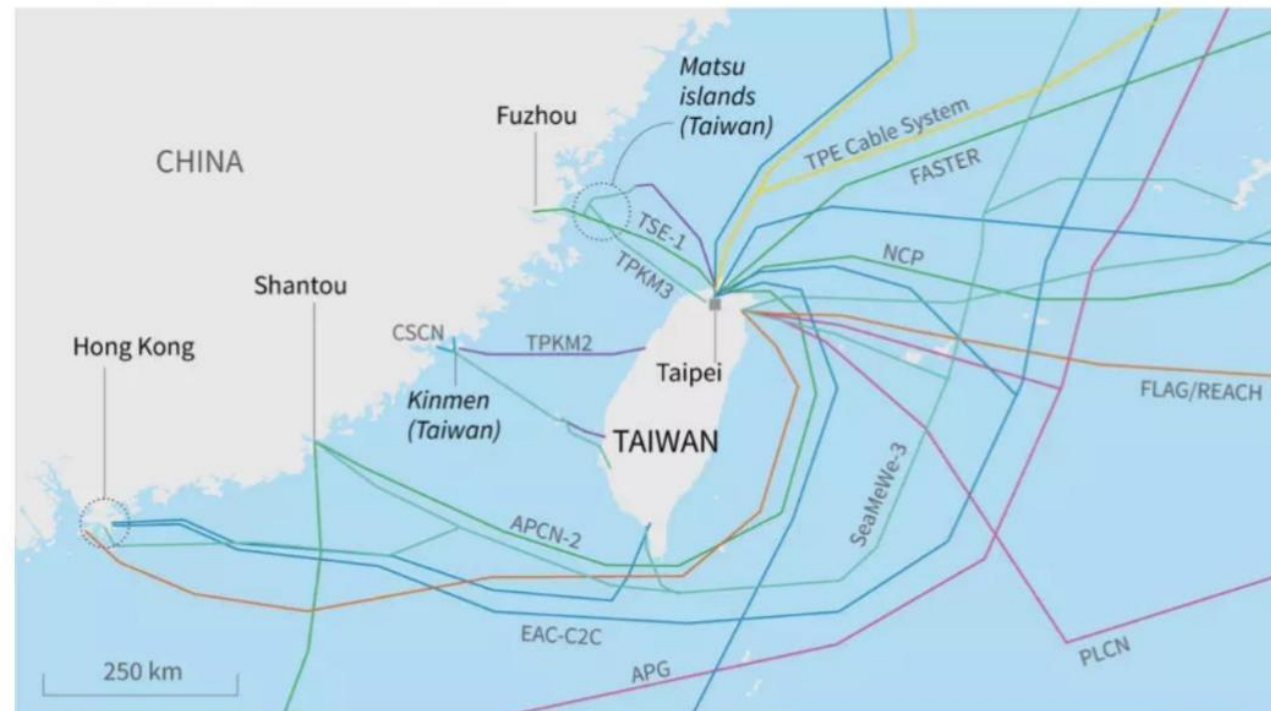
Taiwan ha sequestrato una nave legata alla Cina sospettata di aver danneggiato un cavo sottomarino

Condividi



la guardia costiera di Taiwan, in primo piano, e una di quella cinese, dietro, il 12 dicembre 2024 nello stretto di Taiwan (Taiwan Coast Guard via AP)

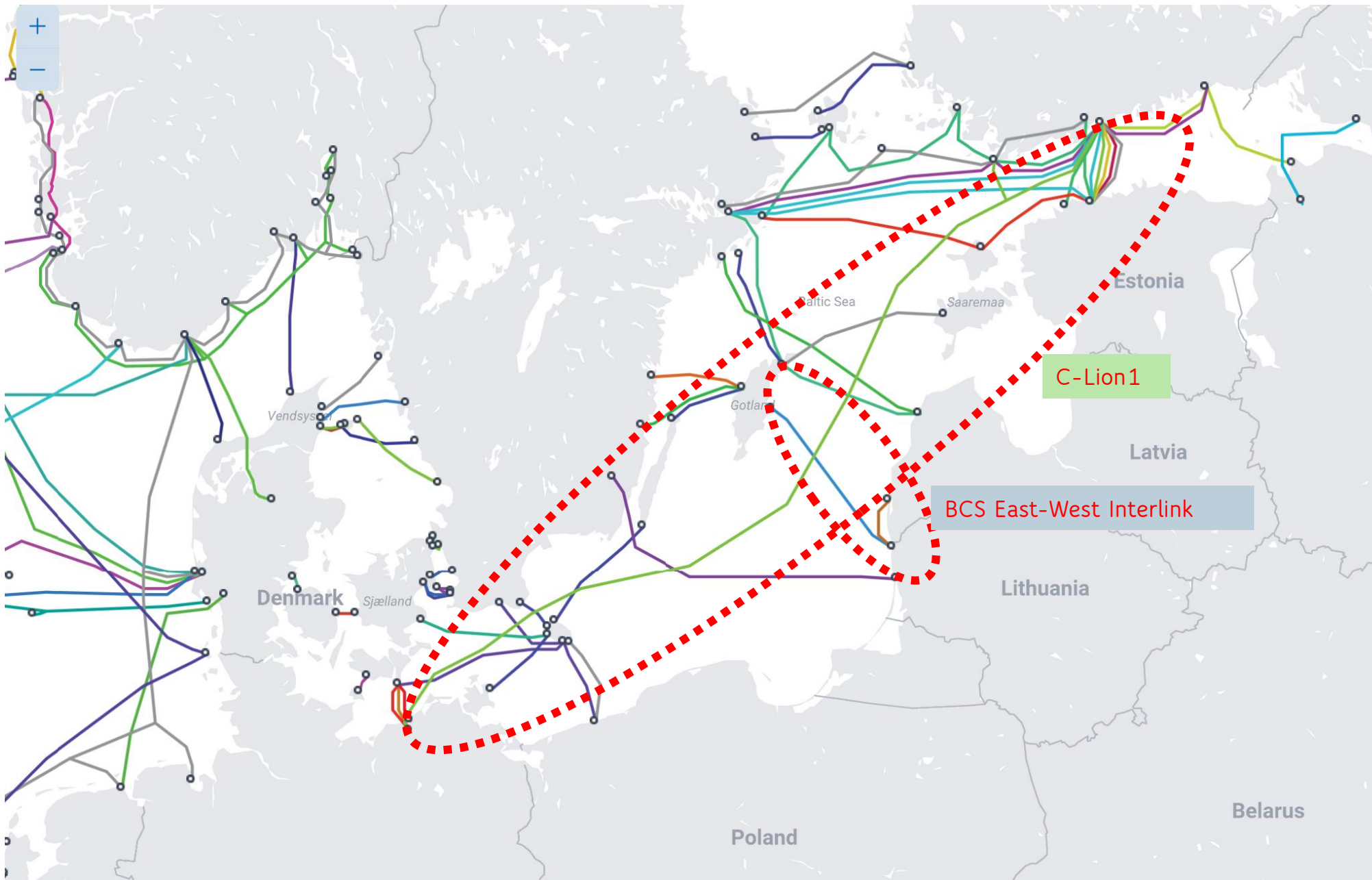
La guardia costiera di Taiwan **ha sequestrato** una nave mercantile legata alla Cina, sospettata di aver danneggiato un cavo sottomarino che fornisce connessione internet alle isole Penghu nello stretto di Taiwan, il braccio di mare che separa l'isola dalla Cina continentale. La nave si chiama Hong Tai 58, ha un equipaggio cinese ma batte bandiera del Togo: secondo la guardia costiera taiwanese la nave sarebbe in realtà a tutti gli effetti cinese e batterebbe una bandiera di convenienza. La connessione internet comunque non è stata interrotta dato che i dati sono stati reindirizzati su altri cavi.



Source: TeleGeography

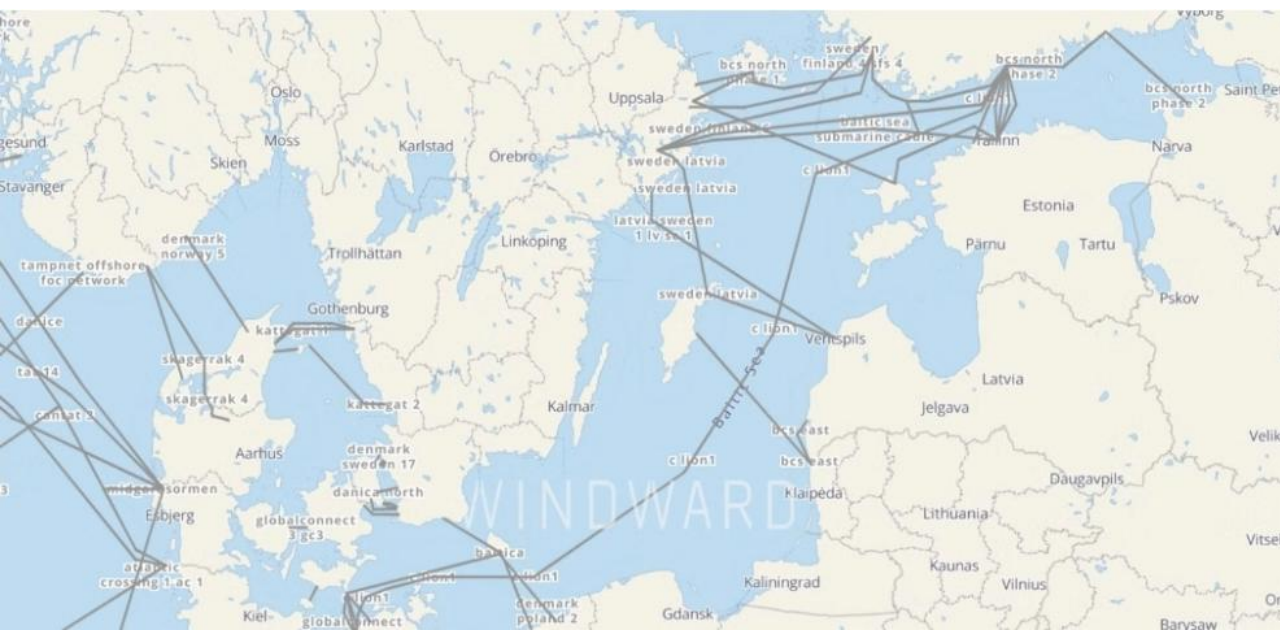


Source: Antonio Deruda «Scenari Geopolitici dei Cavi Sottomarini», mimit.gov.it, 12/03/2025

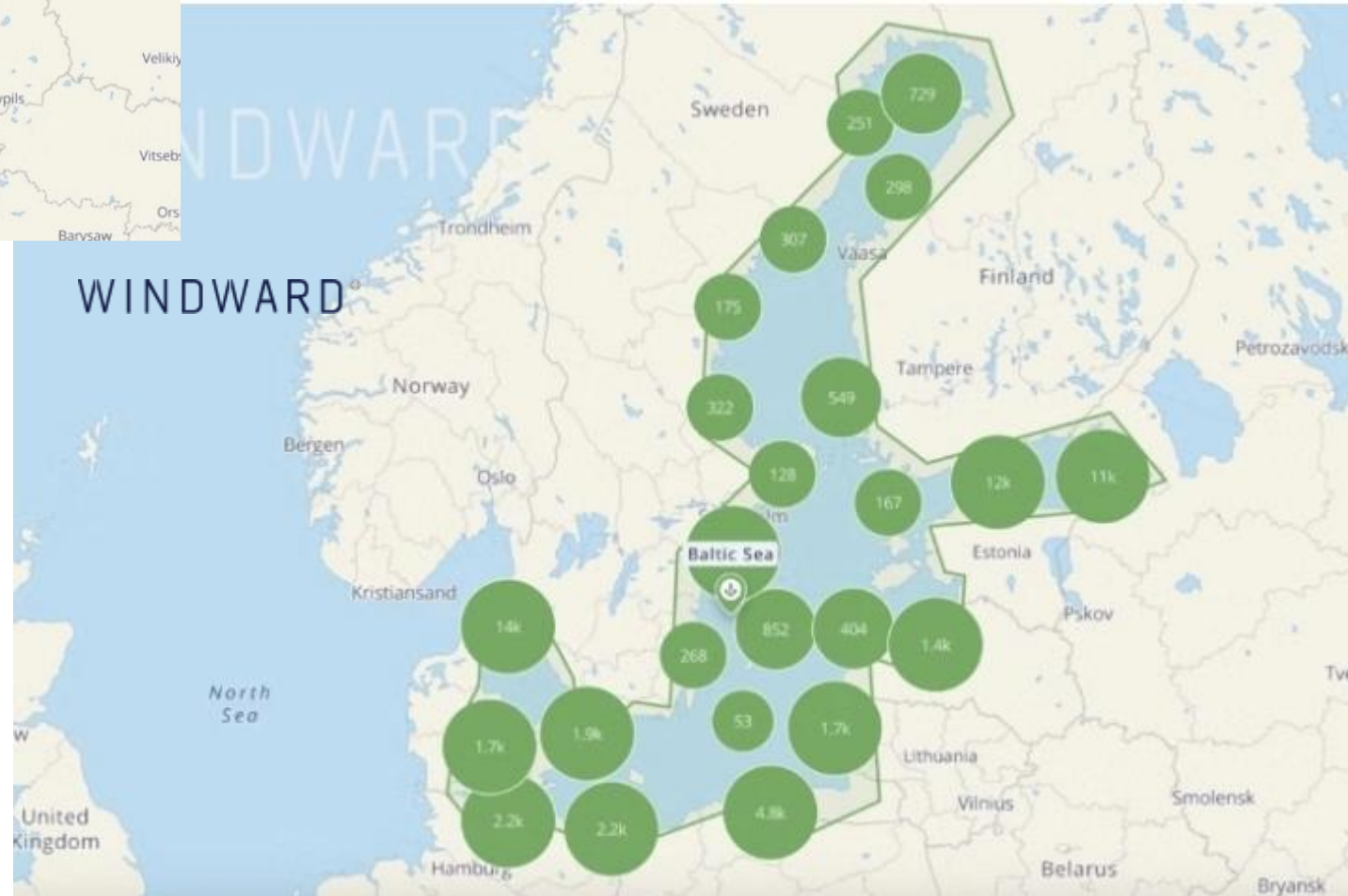


<https://www.submarinecablemap.com/submarine-cable/c-lion1>

<https://www.submarinecablemap.com/submarine-cable/bcs-east-west-interlink>



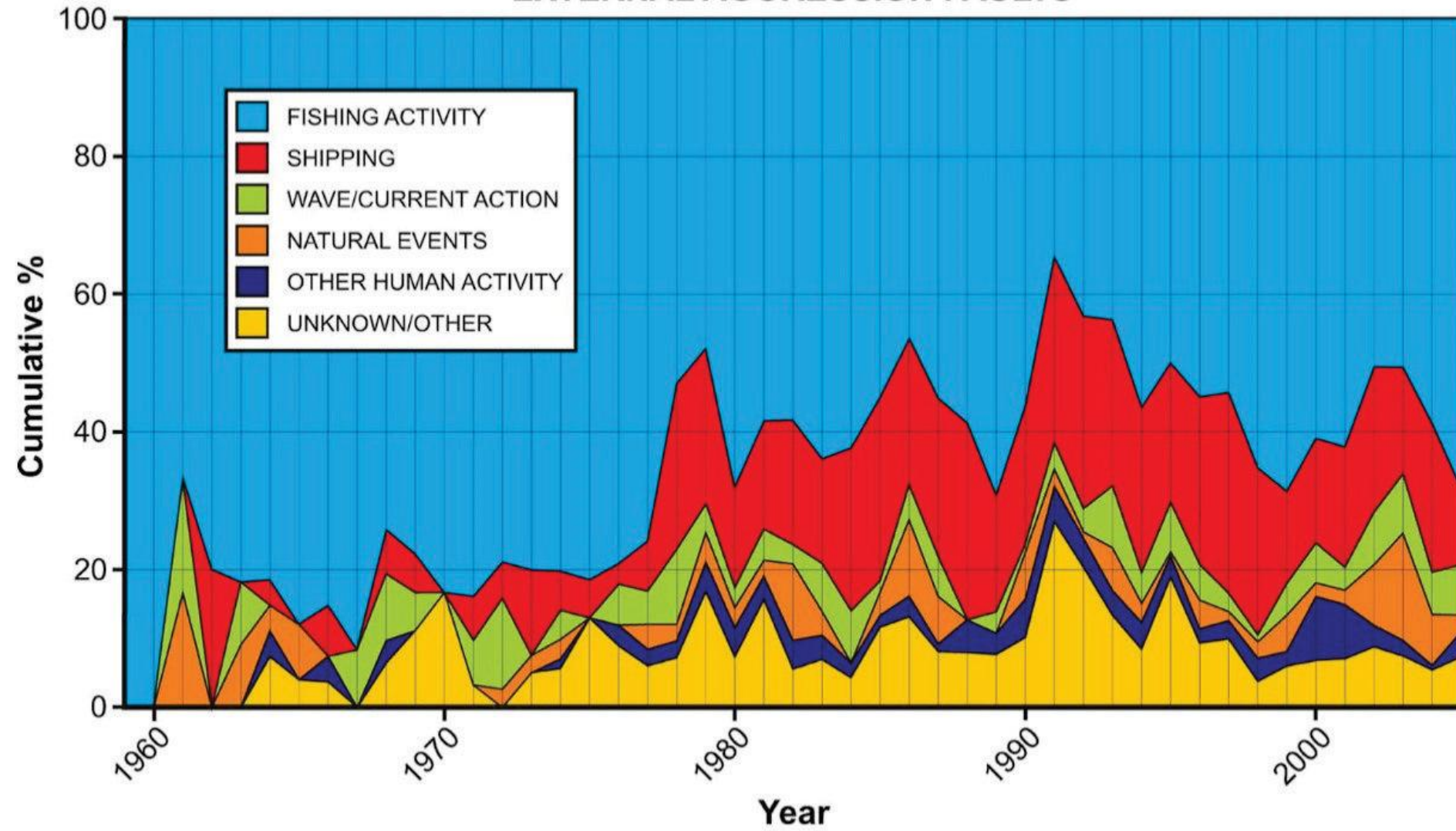
According to Windward Intelligence data, **6,130** individual vessels conducted a cumulative **60,076** anchoring activities in the Baltic Sea over the past year (February 2024-February 2025).



A total of **3,509** “drifting activities” (vessels shutting off their engines but not lowering their anchors) were conducted in the Baltic Sea **in 2020**, many directly above undersea cables. **Twelve percent (12%)** of the vessels conducting these activities were labeled as high or moderate risk, due to various factors and behavioral patterns in line with deceptive shipping practices (DSPs). Eighteen percent (**18%**) were affiliated with the Russian regime.

Locations of drifting activity in the Baltic Sea in 2020.
Source: Windward's Maritime AI™ platform

EXTERNAL AGGRESSION FAULTS



Marina Militare e Sparkle in accordo per la protezione dei cavi di telecomunicazione sottomarini

[Home page](#) > [Pubblica Informazione](#) > [Notiziario della Marina online](#) >

Marina Militare e Sparkle in accordo per la protezione dei cavi di telecomunicazione sottomarini

Creazione di procedure operative condivise per cooperare in un settore ritenuto strategico per lo sviluppo socio-economico dell'Italia

12 luglio 2022 Veronica D'andrea



https://www.marina.difesa.it/media-cultura/Notiziarioonline/Pagine/20220712_Marina_Militare_e_Tim_Sparkle_in_accordo_per_la_protezione_dei_cavi_di_telecomunicazione_sottomarini.aspx

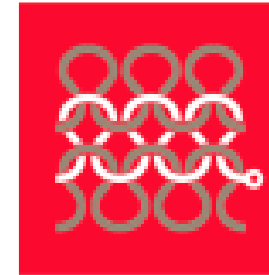
Comunicato Stampa

Sparkle e Fincantieri firmano un Memorandum d'Intesa per la protezione e sorveglianza dei cavi sottomarini

Roma/Trieste, 17 dicembre 2024

<https://www.gruppotim.it/content/dam/gt/archivio-stampa/sparkle/2024/CS-Sparkle-e-Fincantieri-firmano-un-Memorandum-d%E2%80%99Intesa-per-la-protezione-e-sorveglianza-dei-cavi-sottomarini.pdf>

Il tessuto intelligente Knitronix



Knitronix
industrial flexible sensors

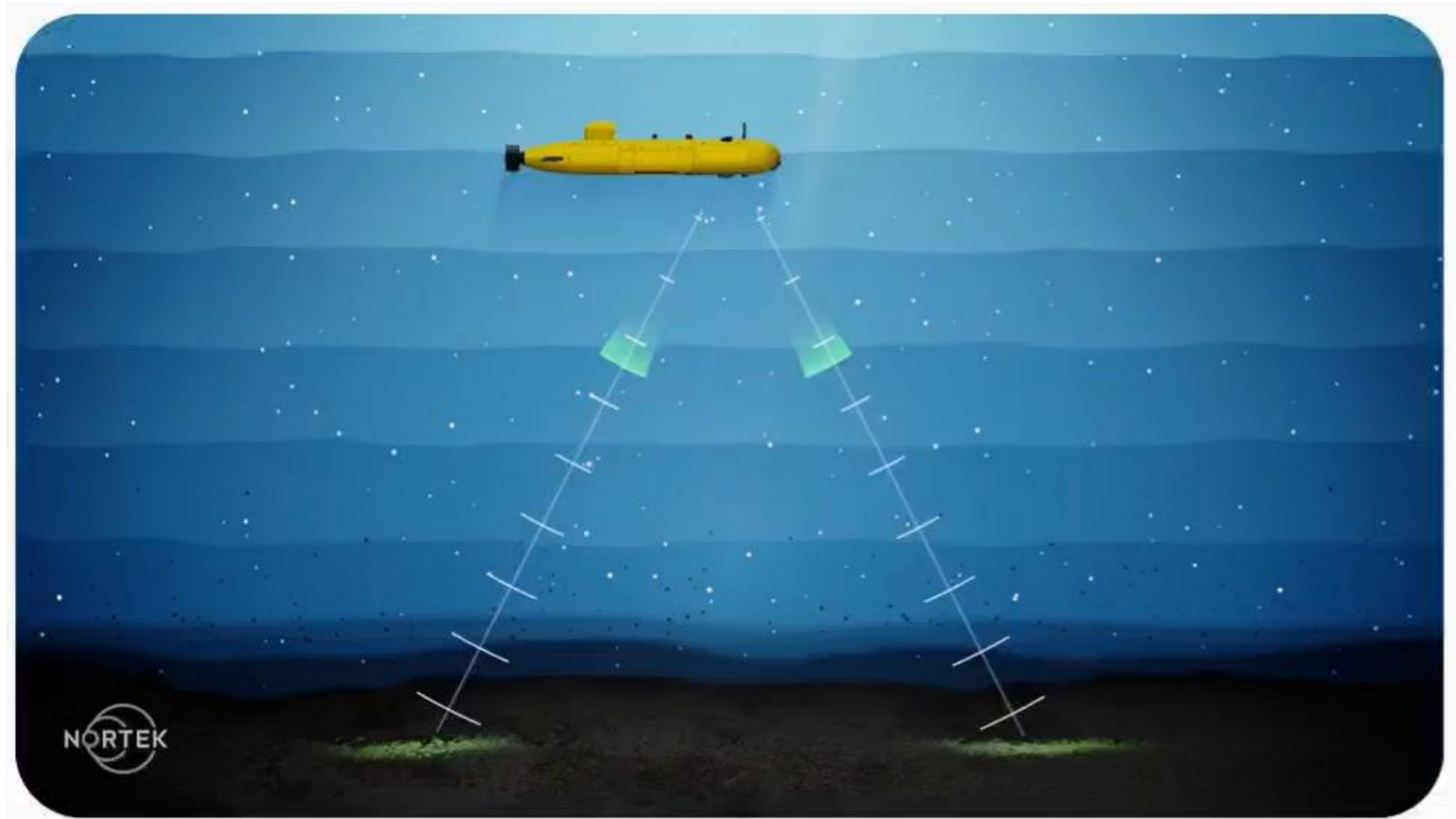
È il caso per esempio di Knitronix, che ha sviluppato un nuovo tessuto intelligente in grado di comportarsi come un “sensore continuo”. Questo *smart textile*, già sperimentato in altri tipi di tubazioni e condotte, può avvolgere l'infrastruttura sottomarina consentendo di rilevare alterazioni o manomissioni su tutta la sua lunghezza in tempo reale. In una prospettiva che vede sempre di più i cavi in fibra ottica come obiettivi di attacchi ibridi, l'ambito dei sensori pensati specificamente per il monitoraggio delle arterie digitali sarà uno di quelli con maggiori potenzialità in un'ottica di collaborazione tra aziende private e apparati di sicurezza.

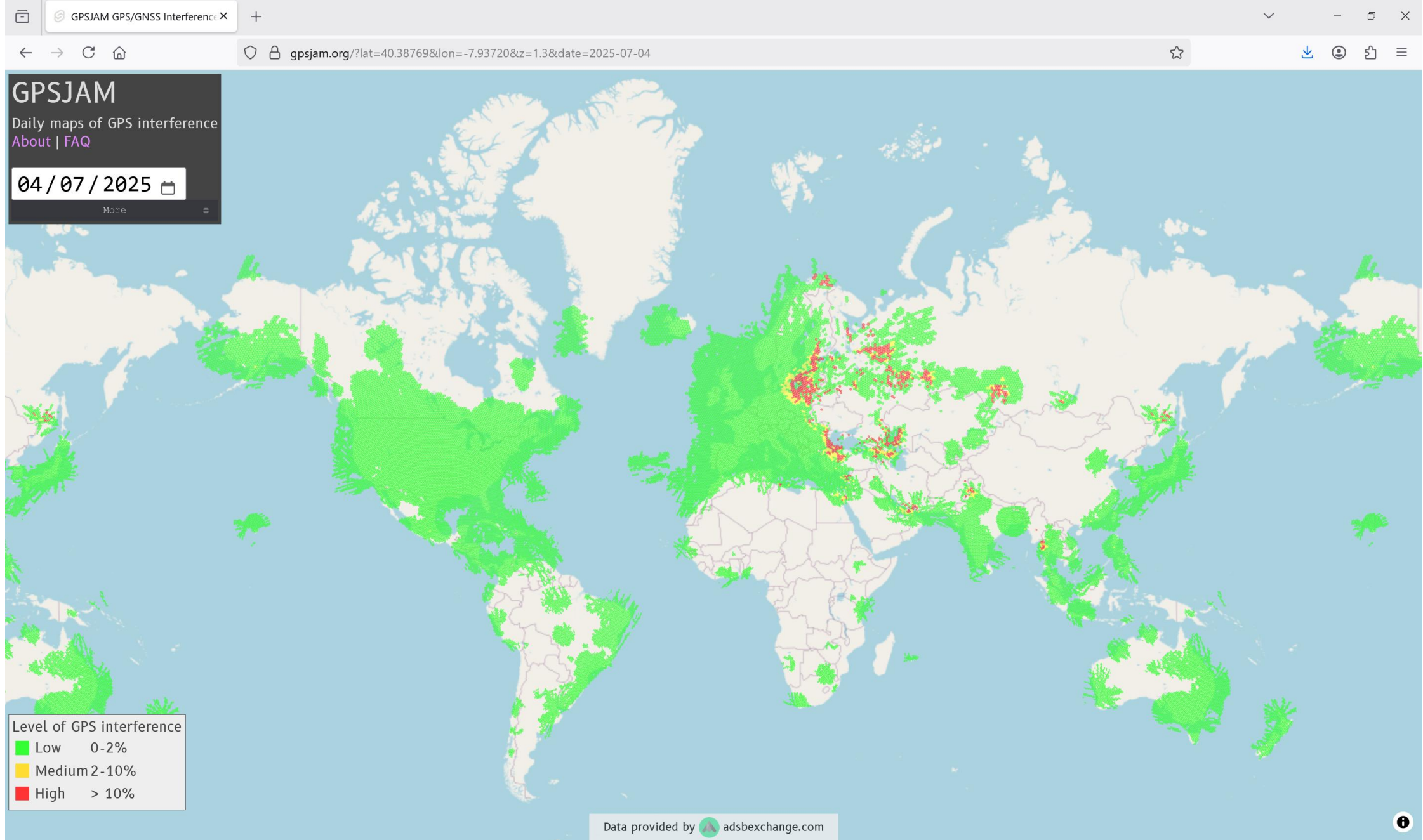


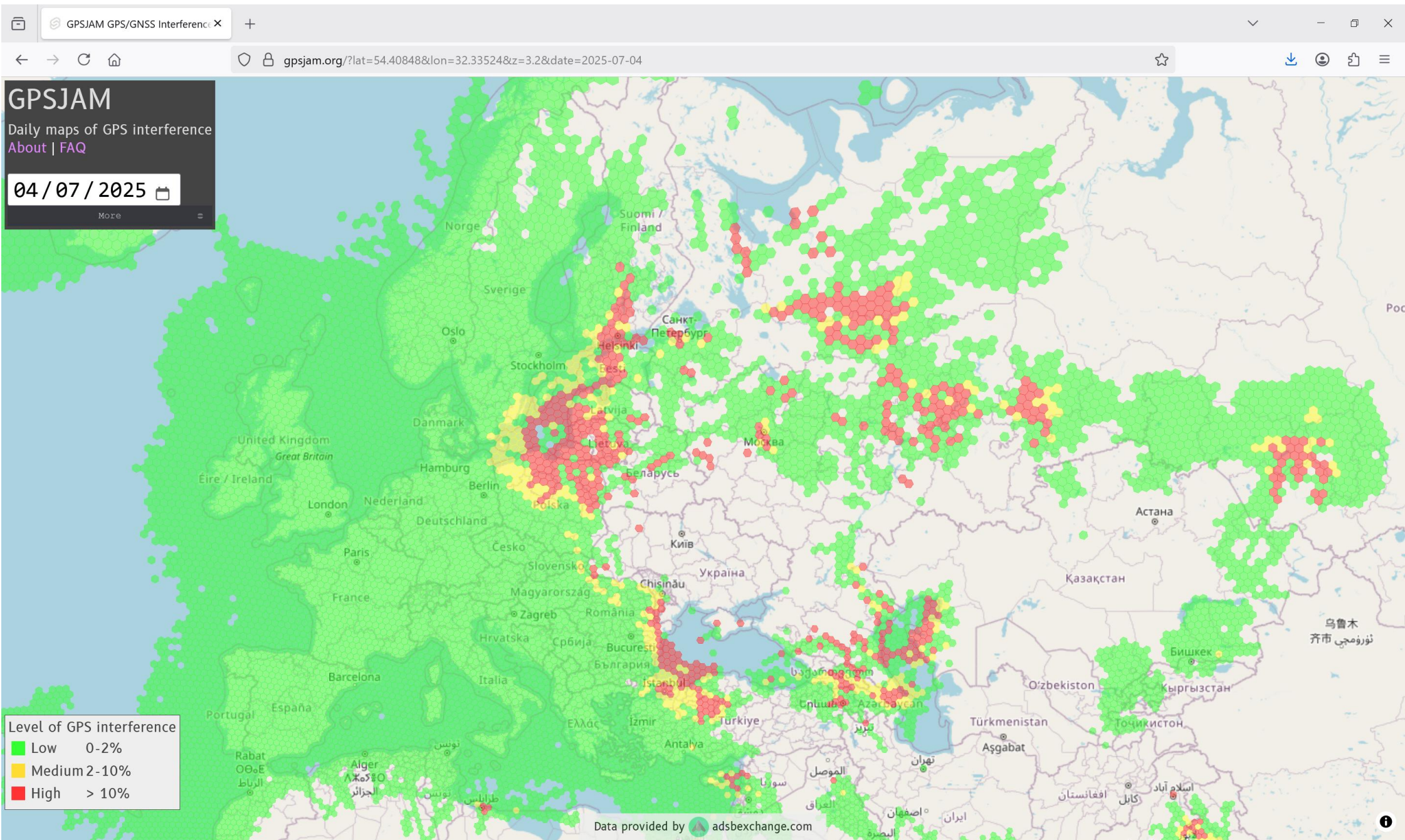
<https://www.agendadigitale.eu/infrastrutture/protezione-dei-cavi-sottomarini-litalia-si-candida-a-leader-europeo/>

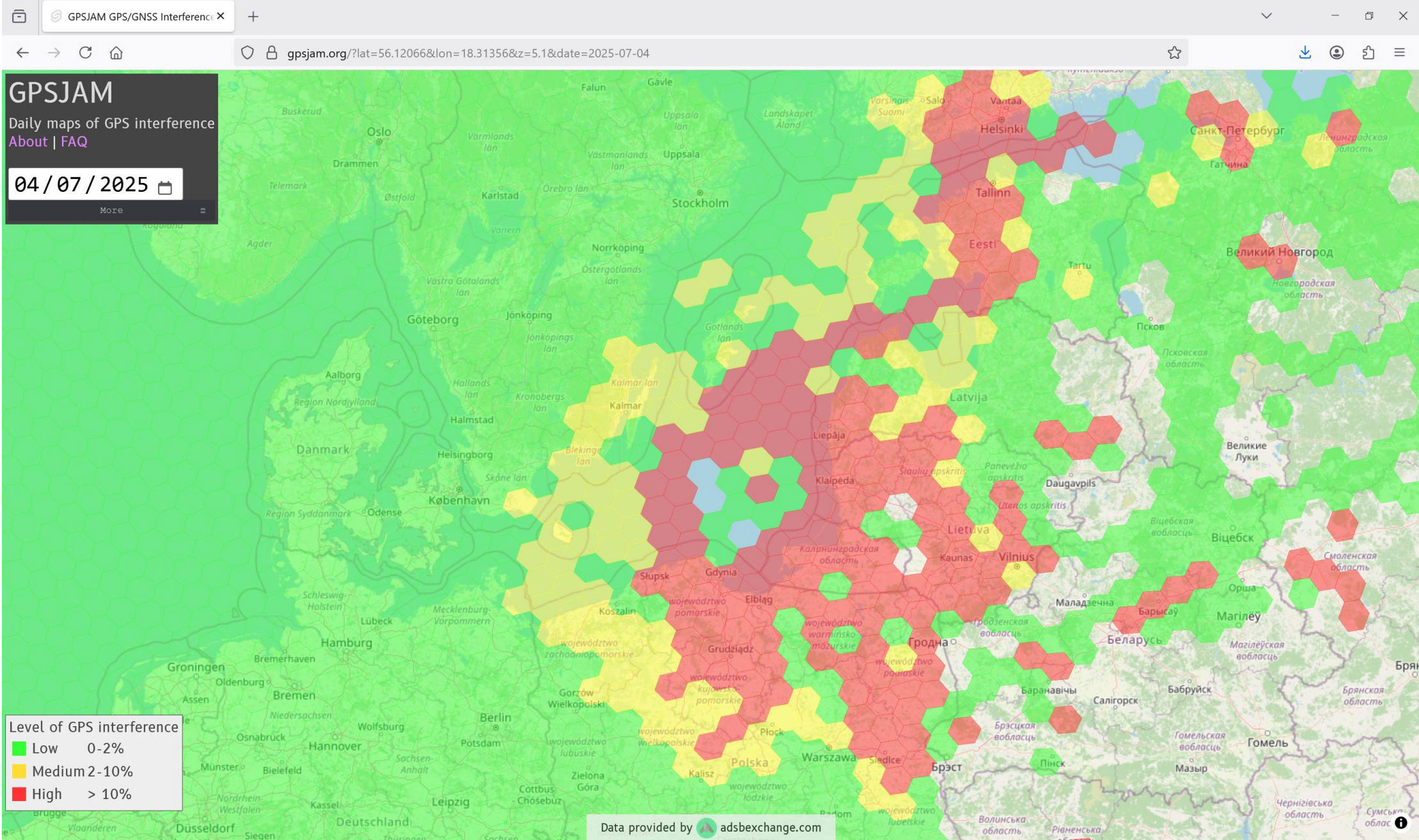
<https://www.knitronix.com/en/index.php>

Dead-reckoning (DR) navigation









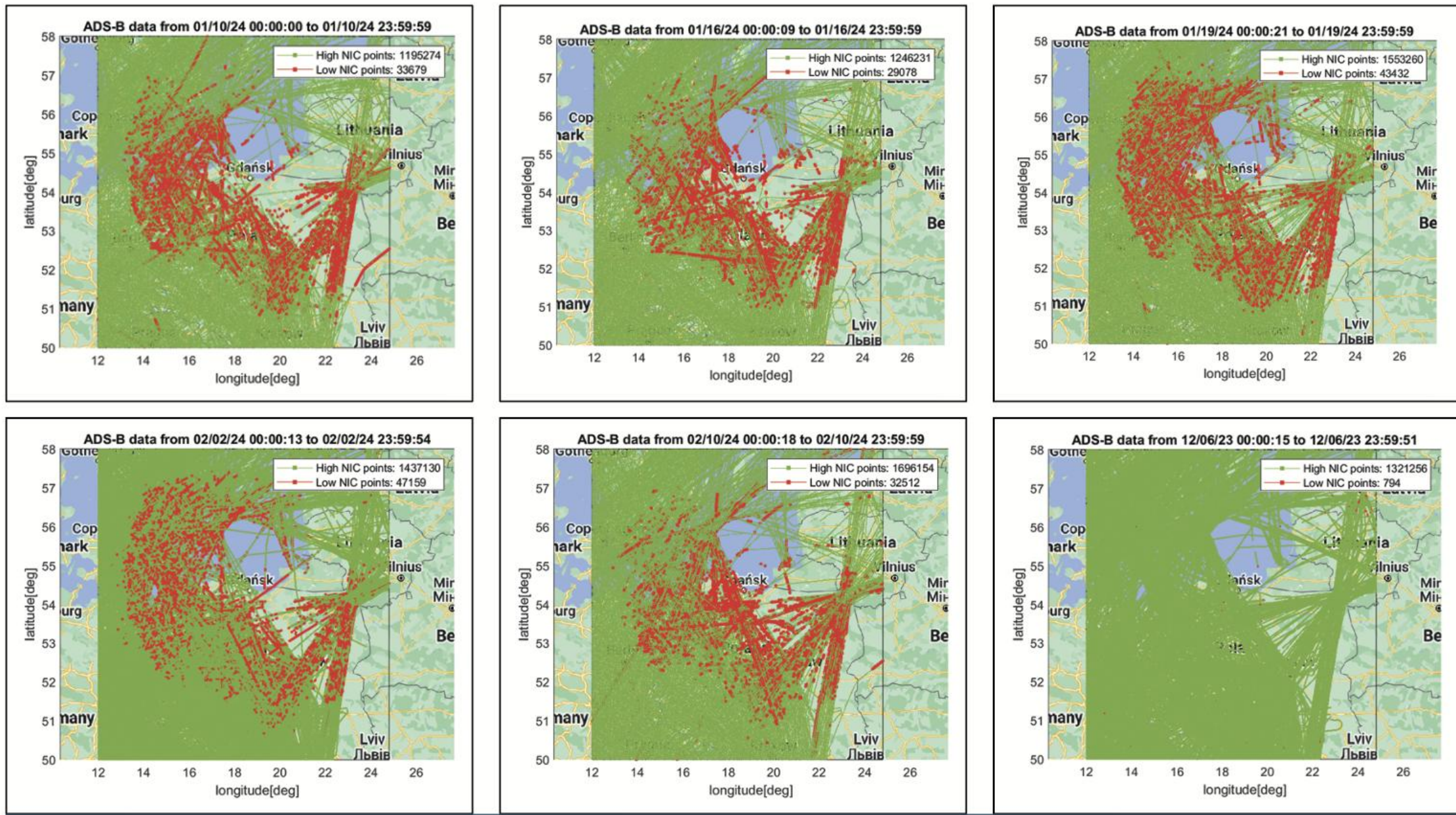


FIGURE 3 RFI over the Baltic Sea Region (December 25, 2023 to February 10, 2024) compared to a normal day (December 6, 2023).

Opens maritime test bed for protecting critical infrastructure

KONGSBERG is responding to growing demand for the protection of critical maritime infrastructure with the launch of a unique test bed, the Oslofjord Critical Maritime Infrastructure Protection Test Bed in Horten, Norway.

01 July 2025

The new facility strengthens KONGSBERG's ability to offer integrated solutions that protect potentially vulnerable assets foundational to modern life, from subsea pipelines and power cables to energy installations and ports.



<https://www.kongsberg.com/discovery/autonomous-and-uncrewed-solutions/auv/hugin/>

<https://www.kongsberg.com/newsroom/news-archive/2025/opens-maritime-test-bed-for-protecting-critical-infrastructure/>

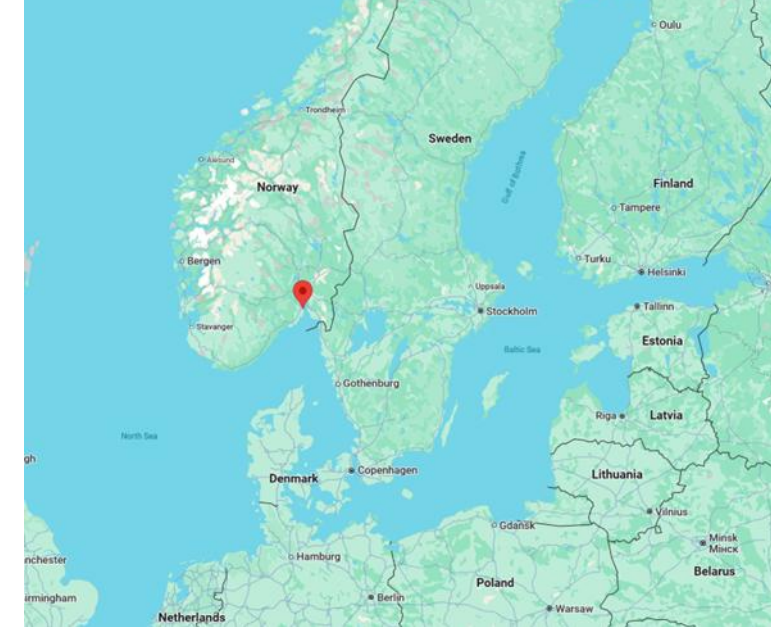
The Oslofjord CMI Protection Test Bed has been launched in the aftermath of the **Norwegian government's White Paper on Total Preparedness**, which stressed the need for **deeper co-operation between public authorities and industry** to meet complex, evolving security challenges.

Speaking about the new facility, Kongsberg CEO Geir Håøy stated, *We are dedicated to developing technology that enables users to patrol, surveil and protect critical maritime infrastructure with the utmost confidence. Our systems work across all layers of the maritime environment to collect data, with advanced software, AI and machine learning harnessing that power to deliver intelligence, understanding and optimal situational awareness.*

<https://euro-sd.com/2025/07/major-news/45253/kongsberg-opens-cmi-test-bed/>



The Oslofjord Critical Maritime Infrastructure Protection Test Bed, located in Horten, Norway, was officially opened by Kongsberg on 30 June 2025.
[Kongsberg]



HUGIN® AUTONOMOUS UNDERWATER VEHICLE (AUV)

HUGIN® is the most successful commercial AUV available. It is the most capable AUV combining IHO quality positioning with the highest resolution sensors on the market. HUGIN® collects data from many different sensors concurrently, providing a complete data product from a single mission.

The HUGIN® system is designed for a variety of survey missions including:

- Seabed mapping
- Pipeline inspection
- Mine reconnaissance

HUGIN® can operate autonomously or under supervision, meaning operators can monitor its progress and receive real-time samples of the sensor data for quality control purposes.

The complete HUGIN® system can be supplied in DnV certified shipping containers. Everything required for day-to-day operations is installed in the containers making HUGIN® a portable survey tool.

SENSORS

HUGIN® is delivered with a range of sensor options:

- Sidescan Sonar or Synthetic Aperture Sonar
- Multibeam echo sounder
- Sub-bottom profiler
- Still Image Camera
- Turbidity Sensor
- Environmental and Geochemical Sensors.



<https://www.kongsberg.com/discovery/autonomous-and-uncrewed-solutions/auv/hugin/>

TECHNICAL SPECIFICATION

WEIGHT AND DIMENSIONS

- Length: 5.2-6.4 m
- Outer diameter: 0.75 m
- Weight: 1000-1550 kg
- Weight in water: Neutrally buoyant
- IP code: IP9064/5920

DEPTH RATINGS

- 3000 m
- 4500 m

VEHICLE SPEED

- 2-6 knots

ENERGY

- Pressure tolerant lithium polymer battery
- 1 or 2 exchangeable 24 kWh power packs
- Charge time 5-8 hours
- Battery blocks transportable by air, sea or land

ENDURANCE

- 24-74 hours with all sensors operating

NAVIGATION

- Kongsberg NavP aided Inertial Navigation System (AINS) with Honeywell HG9900 Inertial Measurement Unit (IMU)
- IHO compliant
- Acoustic positioning using cNODE and HiPAP (option)
- Novatel GPS
- Forward Looking Sonar with advanced terrain following and collision avoidance
- Broadband 300 kHz Doppler velocity log
- Paroscientific Digiquartz depth sensor
- Terrain referenced navigation (option)
- Underwater transponder positioning (UTP)

COMMUNICATIONS

- cNODE acoustic command and data link
- Wi-Fi
- Iridium
- UHF radio link

AVAILABLE PAYLOAD SENSORS

- HISAS interferometric synthetic aperture sonar
- EM 2040® multibeam echo sounder, 200-400 kHz, 0.7° x 0.7° beam width, swath coverage sector up to 140° (+/- 70° single RX) 160° (+/- 80° dual RX)
- EdgeTech dual/triple frequency Sidescan Sonar
- EdgeTech single/dual frequency Sub-bottom profiler 1-6 kHz, 2-16 kHz or 4-24 kHz
- SAIV conductivity, temperature, depth (CTD) sensor
- Still Image Camera
- Environmental and Geochemical Sensors
- Turbidity Sensor
- Further options and custom integration available

SOFTWARE

- HUGIN operator system (HOS)
- Autonomous pipe tracking using Sidescan Sonar and multibeam echo sounder (option)
- NavLab navigation post-processing (option)
- Reflection post-mission analysis (option)

TOPSIDE EQUIPMENT

- Operator and payload computer
- Post-mission analysis computer
- Vehicle battery charger
- Maintenance trolley
- GPS / heading sensor (option)
- HiPAP acoustic positioning and communication (option)

LAUNCH AND RECOVERY SYSTEM

- Open deck based stinger system
- Containerized stinger system.



12 / February 2015

<https://www.kongsberg.com/discovery/autonomous-and-uncrewed-solutions/auv/hugin/>

What is S-100?

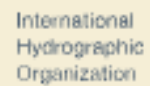
IET
The Institution of
Engineering and Technology

ICT Solutions and Digitalisation
in Ports and Shipping

Edited by
Michele Fiorini and Natalie Gupta



<https://www.youtube.com/watch?v=VIAP4Uo11xw&t=1s>



The Institution of
Engineering and Technology

ICT Solutions and Digitalisation in Ports and Shipping

Edited by
Michele Fiorini and Natalie Gupta



S-100 WORLD

S-104 Water Level Information for Surface Navigation

S-412 Weather Overlay (JCOMM)

S-112 Dynamic Water Level Data Transfer

S-101 Electronic Navigational Chart (ENC)

S-123 Radio Services

S-201 Aids to Navigation Information

S-111 Surface Currents

S-124 Navigational Warnings

S-128 Catalogues of Nautical Products

S-129 Under Keel Clearance Management (UKCM)

S-127 Traffic Management

S-122 Marine Protected Areas

S-102 Bathymetric Surface

S-126 Physical Environment

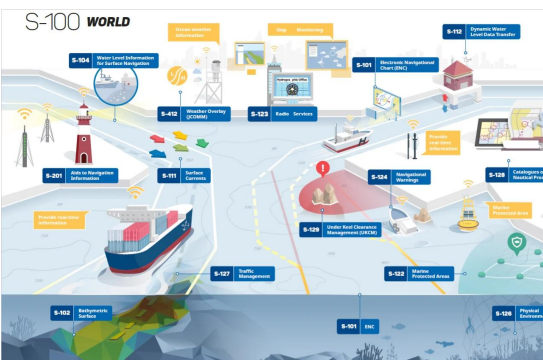
Provide real-time information

Marine Protected Area

Hydrographic Office

Ship Monitoring

Ocean weather information



S-100 Products

The S-100 will play a critical role in the digitalisation of the world of hydrographic data, functioning as a platform on which a range of new products and applications can be built to cater to various maritime end-user needs. Some of the most relevant S-100 products, which all have their dedicated S-10x number, are as follows:

S-101 Electronic Navigational Chart (ENC): The S-101 is the new product specification for Electronic Navigational Chart (ENC) datasets. It includes most of the characteristics of the current S-57 based ENCs but improves elements that will benefit from a more flexible framework. Compared to the S-57, the S-101 will enable easier data updating processes, software enhancements and improved symbology. Ultimately, the S-101 will replace the S-57 as the official chart data for ECDIS, provide the base layer for all S-100 products and underpin e-navigation services development.

S-102 Bathymetric Surface: The S-102 product will provide maritime users with detailed bathymetric data as a coverage layer to improve decision making on ship navigation and for other purposes. The S-102 product enables end-users to generate 3D visualisations of underwater ocean floors, so-called high-definition gridded bathymetry (HDGB), to support safety at sea, facilitate precise navigation and improve route planning operations for navigators and pilots.

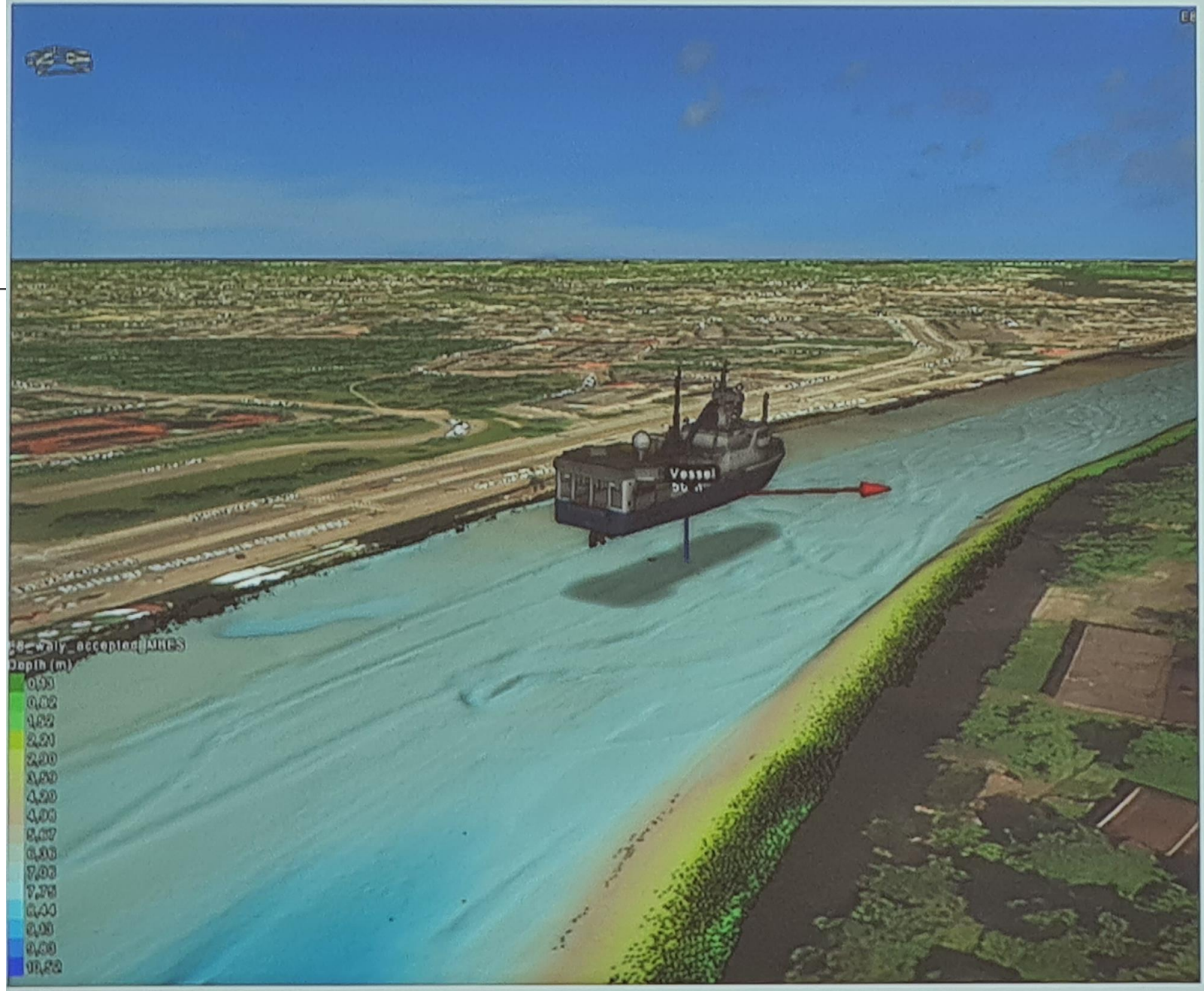
S-104 Water Level Information for Surface Navigation: The S-104 product aims to encapsulate and transfer tidal and water level data to be used in ECDIS or any other dynamic tide application. Under development, the S-104 will soon provide end-users with information on historical and real-time water level observations and water level predictions.

S-111 Surface Currents: The S-111 aims to provide end-users with critical information on surface currents. As surface currents significantly affect vessel motions, the S-111 will ultimately help to maintain safety of navigation.

S-122 Marine Protected Areas: The S-122 product will supplement the S-101 ENC by encoding information on protected areas, oceans, estuaries or large lakes, so-called Marine Protected Areas (MPAs), so it can be used in ECDIS and other information systems.

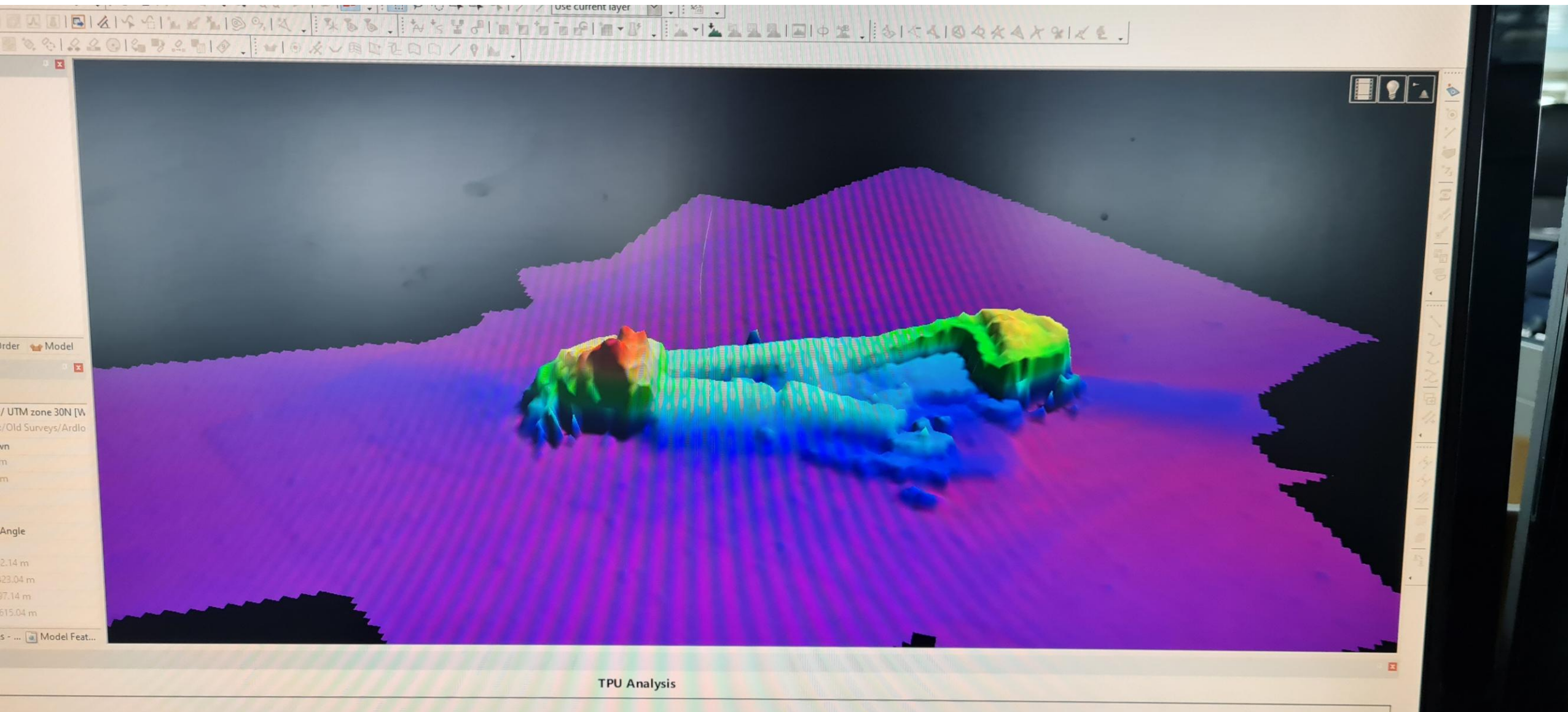
S-129 Under Keel Clearance Management: The S-129 product intends to support maritime safety and efficiency of marine traffic by focusing on the clearance between vessel keel and bottom. The S-129 will help navigators plan sailings in areas with small margins between keel and vessel and provide information on the optimal sailing time based on water levels.

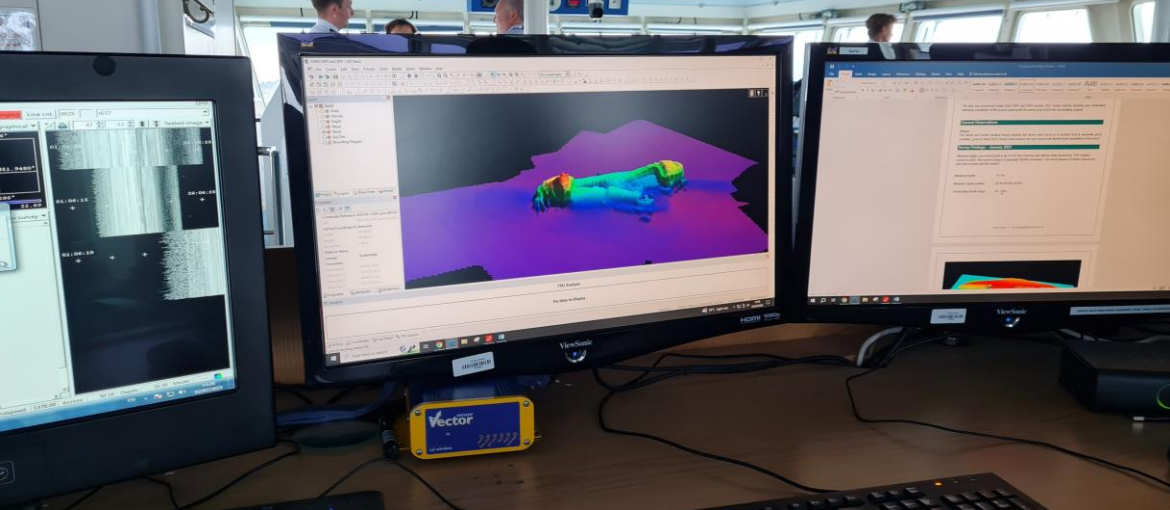
Credit: Svein Skjæveland, Norwegian Hydrographic Service, Electronic Chart Centre (ECC)





IHO 100 family





TRINITY HOUSE



Yara Birkeland



Photo credits: Knut Brevik Andersen, Wilhelmsen Ship Service

Ore 16:00 – 16:30

Ing. Michele Fiorini

Leonardo

“Infrastrutture sottomarine, innovazione, sicurezza
e sfide strategiche”



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