Signals from the Deep

Submarine Cables for Safety, Science, and Security

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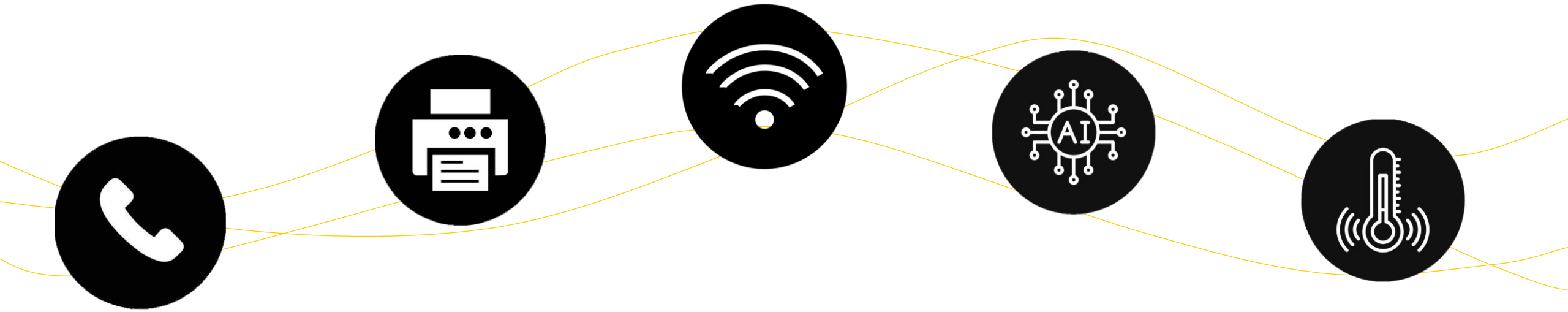
IEC-ITU-T Workshop on "Standardization Roadmap for Cabled Multi-Core Fibre and Optical Network Sensing Technologies"

Geneva, 17.10.2025

ANACOM AUTORIDADE NACIONAL DE COMUNICAÇÕES

From Voice to AI to Sensing



Telecom submarine cables have always evolved with technology:
from telegraph, voice telephony, telex, fax to TV, Internet, and now enabling AI

The next chapter is sensing:
turning these cables into scientific and safety assets

Submarine Network Sensing

Cables as multi-purpose observatories, by:

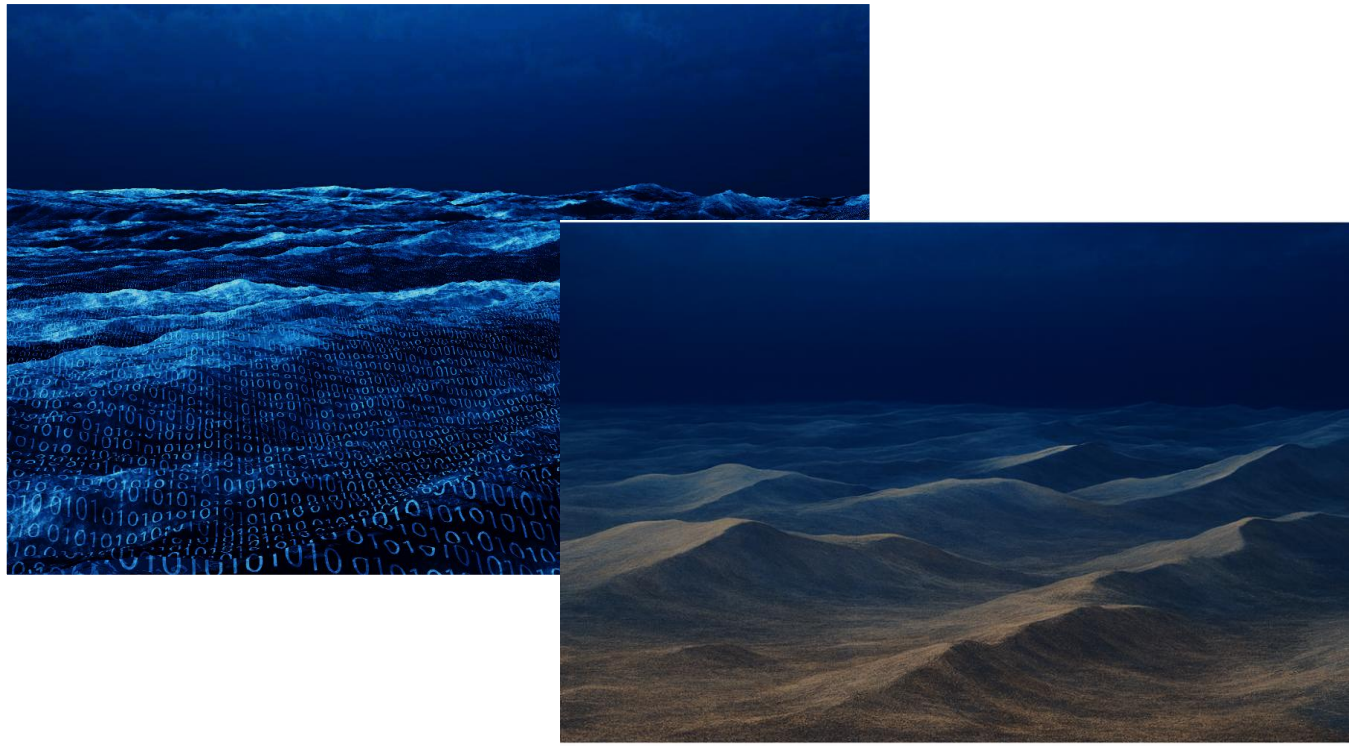
- **Exploiting optical fibre properties - Optical Fiber Sensing (OFS)**
- **Using wet sensors - SMART Cables**

Advantages vs dedicated systems: global, continuous, cost-efficient

Submarine cables can monitor seismic activity, pressure, temperature

and much more, across potential oceans of data…

which otherwise are “data deserts”



Some OFS technologies

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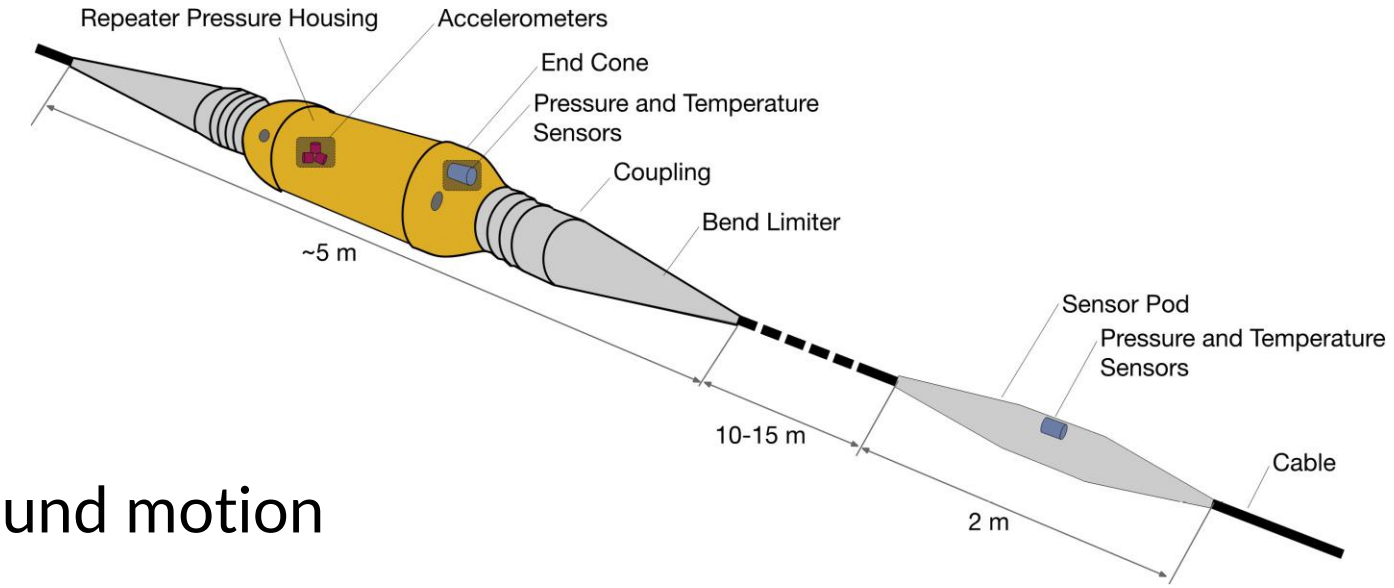
- Distributed Acoustic Sensing (DAS)
- State Of Polarization (SOP)
- Ultra-Stable Laser Interferometry (USLI)
- SOP-Optical Time-Domain Reflectometry (SOP-OTDR)
- Microwave Frequency Fiber Interferometer (MFFI)
- Active Phase Noise Cancellation (APNC)
- (…)

SMART Cables



Source: Howe et al. (2019)

Sensors installed

- Inside the repeater housing, or
- In external pods

Core sensors

- Accelerometer/seismometer - ground motion
- Pressure sensor – ocean bottom pressure
- Temperature sensor – seafloor temperature

Other sensors

- Conductivity
- Gravity and tilt
- …

JTF SMART Cables – the ITU/WMO/UNESCO IOC Joint Task Force created in 2012 promotes the use of submarine telecommunications cables for ocean and climate monitoring and disaster warning. It pushes this agenda forward and advocates for standards and helps projects worldwide.

Complementarity between Submarine Cables Sensing Techniques

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- **SMART Cables**: more complete and precise solution, in particular for scientific and safety purposes
- **OFS (Optical Fiber Sensing)**: DAS more developed and already operational in some cables, useful in particular for cable structural protection; other OFS techniques are still in a more exploratory and research phase in submarine cables
- **Complementarity**: very useful to cross calibrate and cross-check data from the different technologies, in some cases for absolute reference and others for temporal drift

Applications

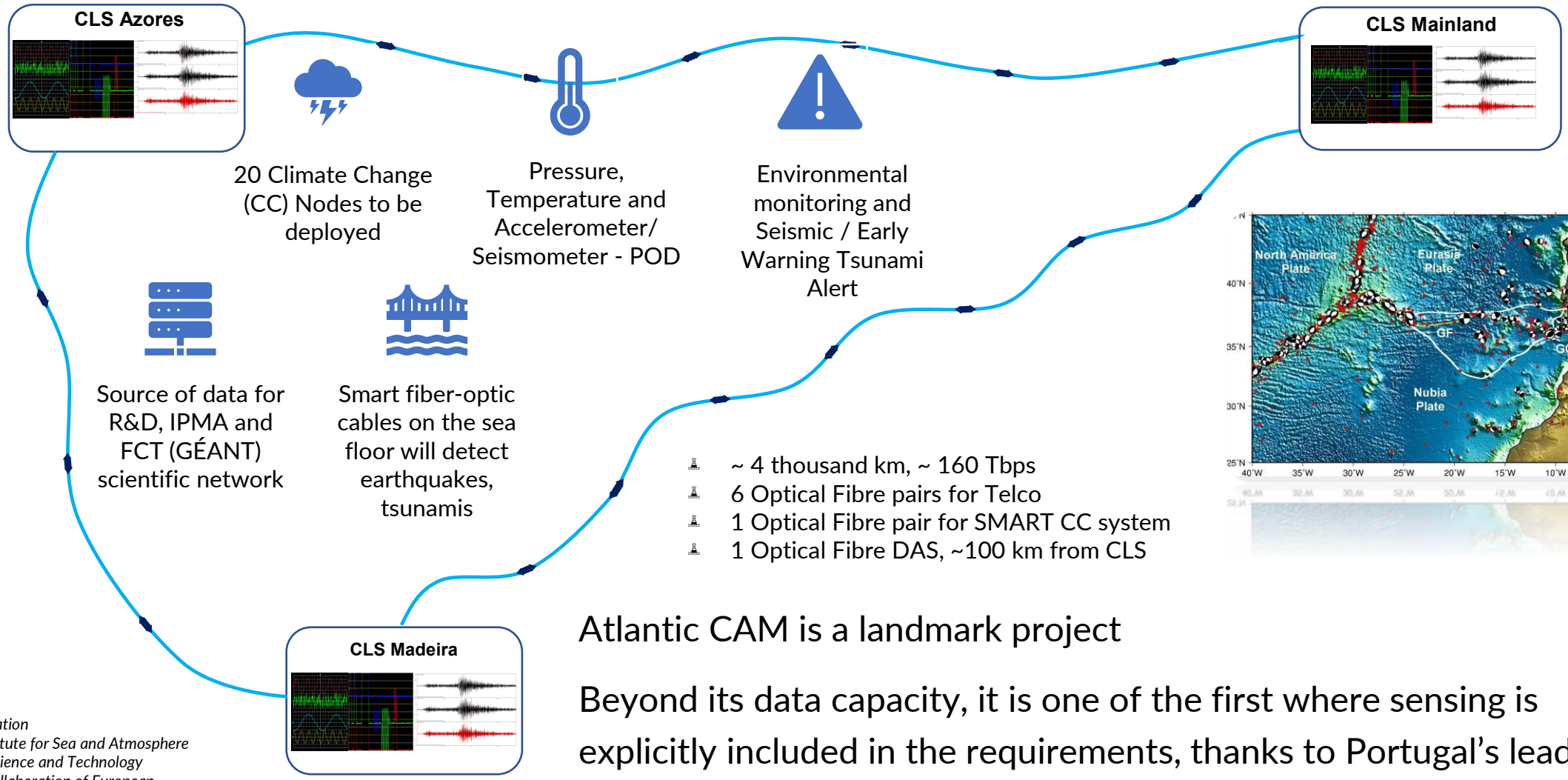
Earthquake & Tsunami Alerts

Climate & Ocean Data (ocean heat and circulation, sea level rise, climate change)

Cable Integrity & Security

These applications range from saving lives through tsunami early warnings, to supporting climate science, and cable integrity and security awareness

Atlantic CAM - SMART Cable



Atlantic CAM is a landmark project

Beyond its data capacity, it is one of the first where sensing is explicitly included in the requirements, thanks to Portugal's leadership

CLS: *Cable Landing Station*
IPMA: Portuguese Institute for Sea and Atmosphere
FCT: Foundation for Science and Technology
GÉANT Association: collaboration of European National Research and Education Networks

Azores Inter-Island Ring

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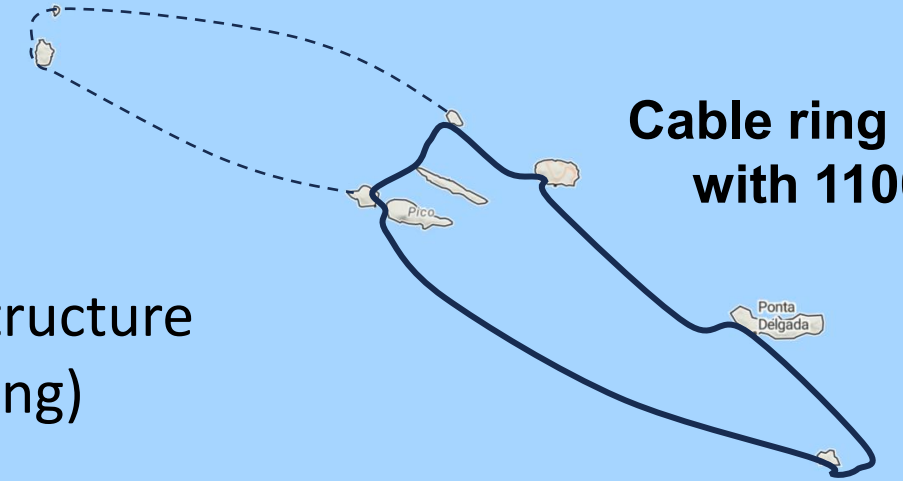
ORDER No. 9169/2024

Creates a project group called “Inter-Island Ring Project Group” to study and analyse the most appropriate technical and financial configuration for the timely replacement of the current system

The group should also consider the use of this system for seismic detection (geophysical studies and the production of earthquake and tsunami alerts and warnings), possibly extending the scope of detection to the areas of the environment, seismology and oceanography

Possibility of using wet sensors in some segments, complemented using DAS



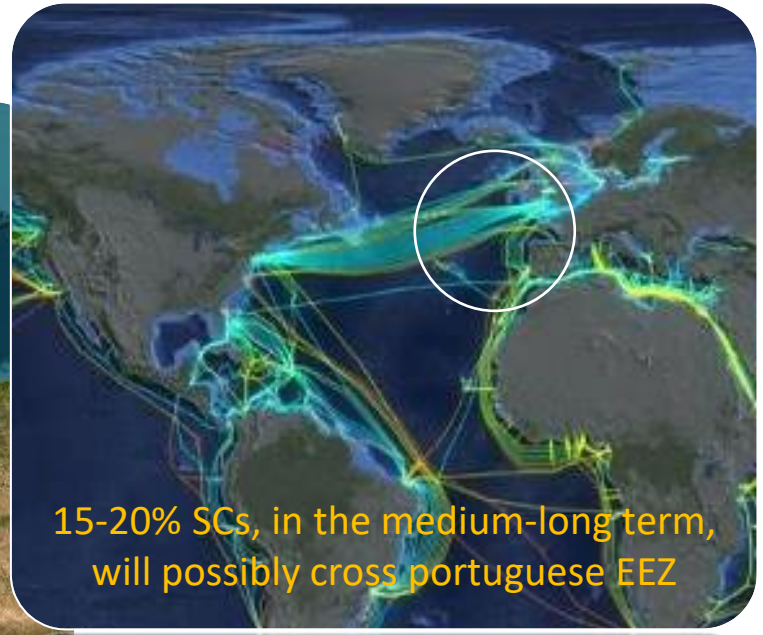
Cable ring system with 1100 km

Multipurpose infrastructure (telecom + sensing)

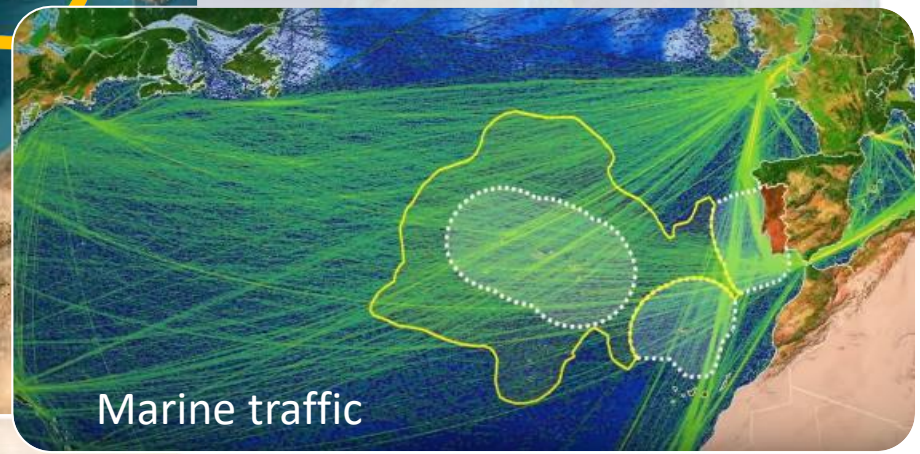
3D EEZ

Free Tech Zone

~4 M km ^{2}



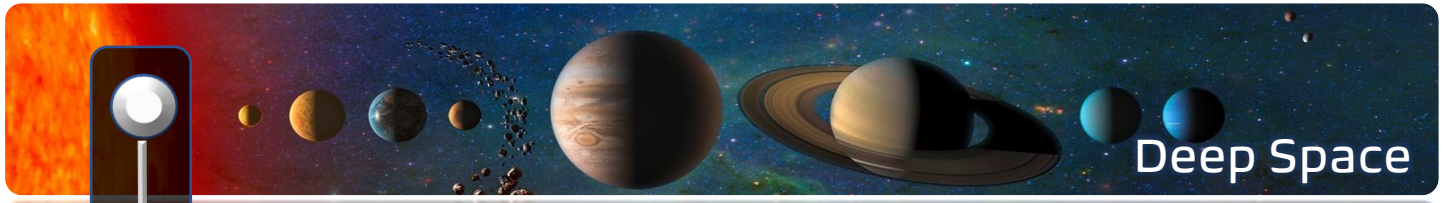
15-20% SCs, in the medium-long term, will possibly cross portuguese EEZ

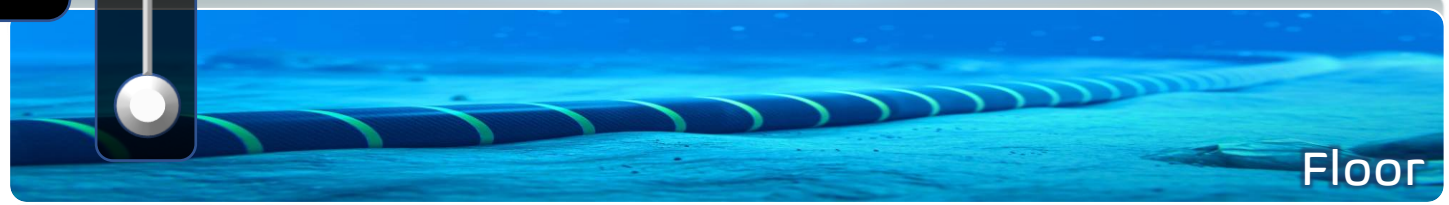


Marine traffic

All about data

CONNECTIVITY ECOSYSTEM





Challenges & Expectations

- Standardisation
- Funding & governance
- Data ownership/security
- Need of information (some in real time) for public good
- Sensing as default feature

The challenges are not only technical. We must agree on some (high-level) standards, on who pays, who owns/access the data, together with how to ensure information utilization for public good

But the expectation is clear: sensing will become a default

ITU References

- **WTSA Res. 73 (Rev. New Delhi, 2024) ICTs, environment, climate change and circular economy**

  "to report on" progress of the JTF of ITU, the WMO and the IOC-UNESCO to investigate the potential of using submarine telecommunication cables for ocean and climate monitoring and disaster warning

- **Rec. ITU-T G.9730.2 (08/2024) (G.smart) Scientific monitoring and reliable telecommunication submarine cable systems**

  "identifies the capabilities and features of fibre optical submarine telecommunication cable systems equipped with scientific monitoring sensors along the length of the undersea optical cables (i.e., SMART cables). It describes at a high-level the characteristics and requirements of a scientific monitoring and reliable telecommunication (SMART) cable system…"

- **PP-22 Resolution 182 (Rev. Bucharest, 2022) Role of telecommunications/ICTs in regard to climate change and the protection of the environment**

  considers "that other technologies are currently being developed and deployed for climate monitoring, including, but not limited to, oceanic sensing technology, which may be deployed through or using submarine cables, including the Science Monitoring and Reliable Telecommunications (SMART) initiative, for better knowledge of climate evolution"

- **Other references - PP-22 Resolution 136 (Rev. Bucharest, 2022; WTDC Resolution 34 (Rev. Kigali, 2022); WTDC Resolution 66 (Rev. Kigali, 2022)**

International Advisory Body for Submarine Cable Resilience

Created by ITU on 23.09.2024, to promote dialogue and collaboration on possible ways and means to enhance the resilience of this critical infrastructure, through which 99% of international communications pass

Co-chaired by:

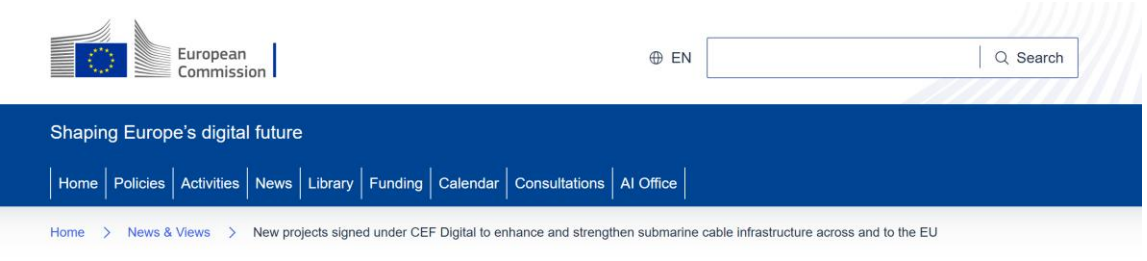
- Prof. Sandra Maximiano, Chair of the Board of Directors of the National Communications Authority (ANACOM), of Portugal
- H.E. Minister Bosun Tijani, Minister of Communications, Innovation and Digital Economy, of Nigeria

In February this year, it organized in Abuja the **International Submarine Cable Resilience Summit 2025**, which:

- Endorsed the **Abuja Declaration**, a collective commitment by governments, industry leaders, and international organizations to enhance the resilience and sustainability of submarine cable infrastructure.
- Established 3 dedicated Working Groups focused on:
  - **Timely Deployment & Repair** – Addressing regulatory and logistical challenges to accelerate cable repairs and new deployments
  - **Risk Identification, Monitoring & Mitigation** – Strengthening data-driven risk assessment and promoting advanced monitoring technologies
  - **Fostering Connectivity & Geographic Diversity** – Encouraging investment in diverse cable routes to improve network resilience and bridge connectivity gaps

The **International Submarine Cable Resilience Summit 2026** will take place in Portugal

EU funding (e.g., CEF Digital) & Security



All beneficiaries of CEF grants are **EU-controlled entities** and the cables that will be deployed are built with **secure technology**. Besides guaranteeing the secure transmission of terabytes of data per second, almost all the funded cables include SMART technologies, which act as large geographical sensors to monitor nearby activities, acting as **early warning systems** to protect the infrastructure itself.

Document 52025JC0009

JOINT COMMUNICATION TO THE EUROPEAN PARLIAMENT AND THE COUNCIL EU Action Plan on Cable Security

JOIN/2025/9 final

2.2.3 Smart Cables and early warning

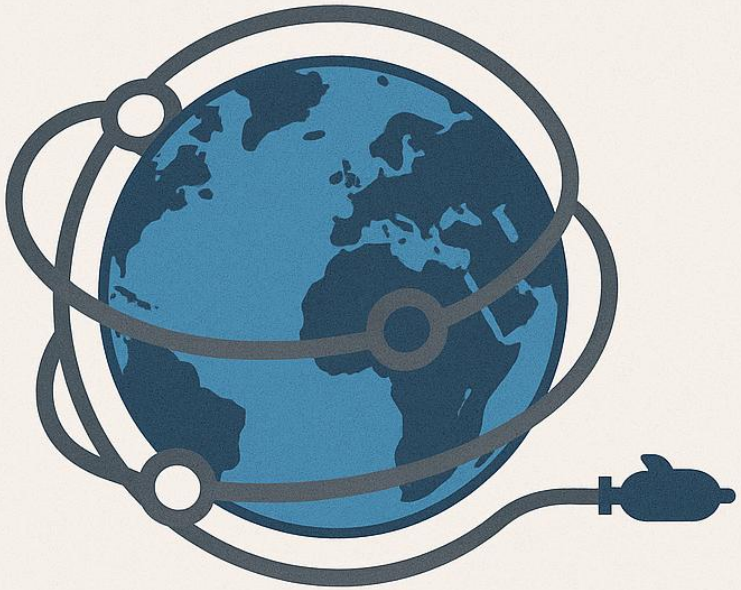
Smart cable systems offer an interesting perspective for preventing attacks and detecting incidents. They can be used as large geographical sensor networks to monitor nearby activities, anticipate threats and vulnerabilities, acting as an early warning system to protect the cable infrastructure itself and the surroundings, including for both civilian (e.g., environmental monitoring) and military purposes.

CEF Digital promotes smart cables in the 2024-27 work programme. The Recommendation on Secure and Resilient Submarine Cable Infrastructures also includes references to sensor and monitoring systems as well as the uptake and deployment of innovative solutions to detect and deter threats. The TEN-E Regulation also promotes cross-border smart electricity grids and CEF Energy has already facilitated funding of EUR 410 million for such projects, mostly for works.

Besides their primary use as broadband cables, smart communication cable systems can be used as backbones for connecting underwater resources such as docking stations (launch, recovery, data transfer) for uncrewed underwater vehicles and systems, to perform seabed exploration, repair functions, surveillance, etc. In the long term, the expansion of the fleet with these advanced vehicles and facilities, their interoperability with modern vessels and their operational support could be envisaged under future EU programmes.

Feasibility studies will be launched under CEF in close coordination with the European Defence Fund and the European Maritime, Fisheries and Aquaculture Fund (EMFAF). BlueInvest projects already running and addressing underwater observation, detection communication and surveillance, in particular on launch and docking solutions for Autonomous Underwater Vehicles (AUVs), as well as the use of swarm intelligence technologies. Coordination will be ensured also with relevant Horizon Europe funding, notably through a dedicated action on "preparing the advancement of the state of the art of submarine cable infrastructures".

Takeaway



FROM COMMUNICATION TO OBSERVATION

Submarine cables have always connected societies

Now they can also help protect them

Portugal is at the forefront, but success requires global collaboration between regulators, industry, scientists, and security