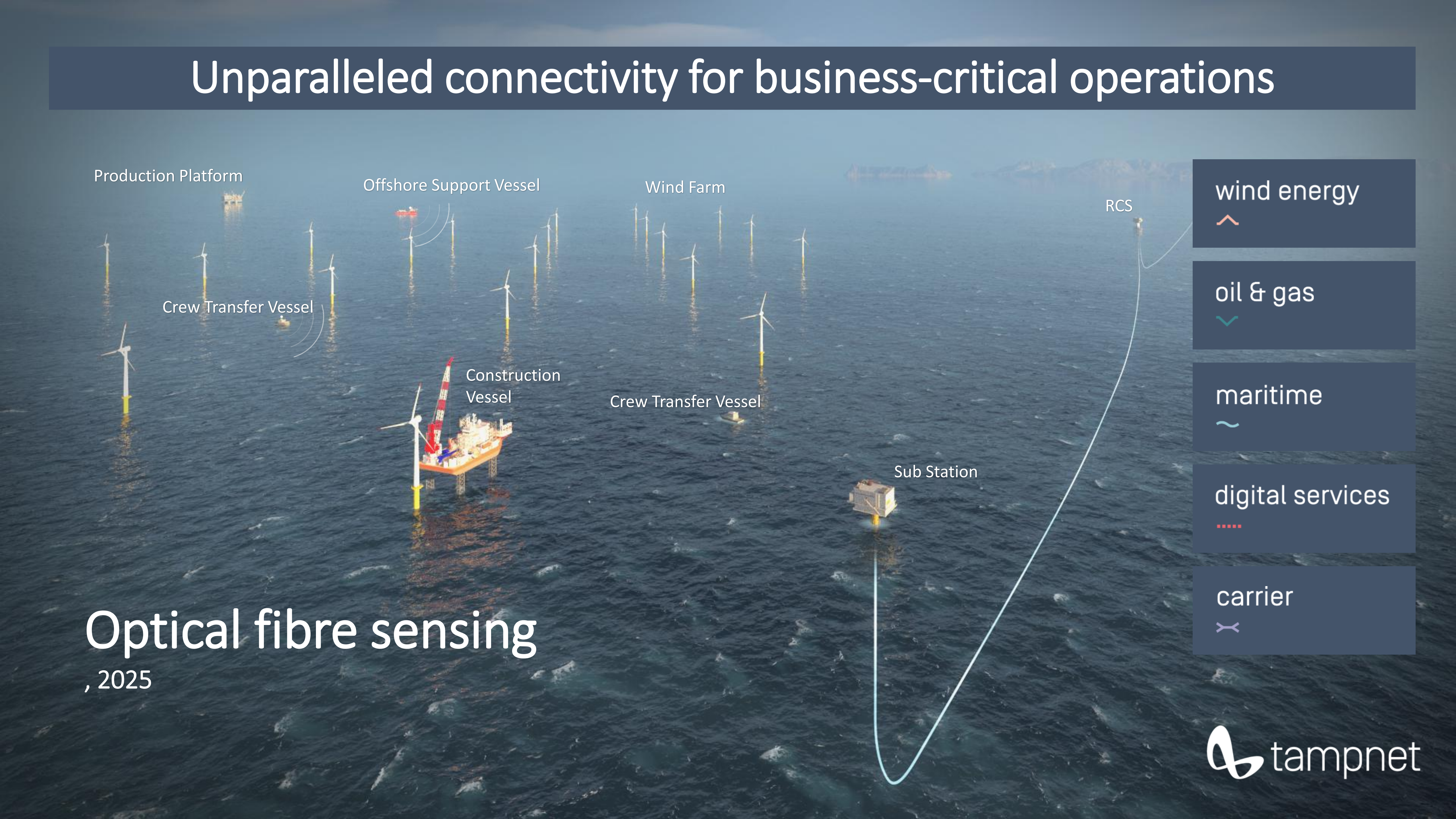
Unparalleled connectivity for business-critical operations



Optical fibre sensing

, 2025

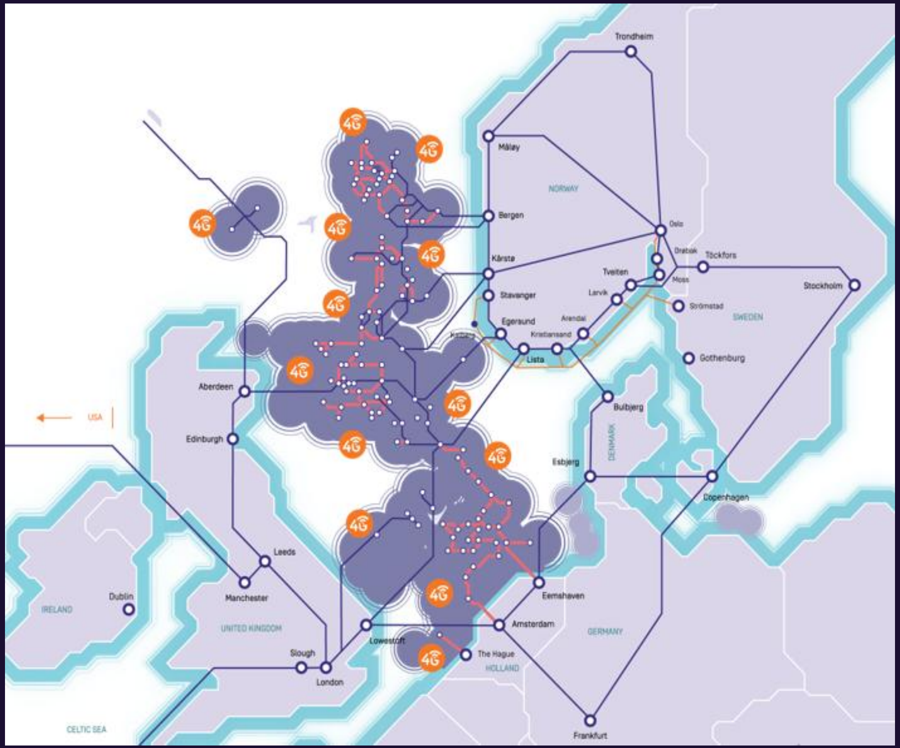
Fibre sensing – current main applications

- Availability and security of critical submarine infrastructure
  - Discovering trawling and anchoring that may harm subsea cables
- Geophysical and climate related effects
  - For government, energy business

Offshore communication Europe and US – Critical communication
Control of performance and resilience is key

tampnet

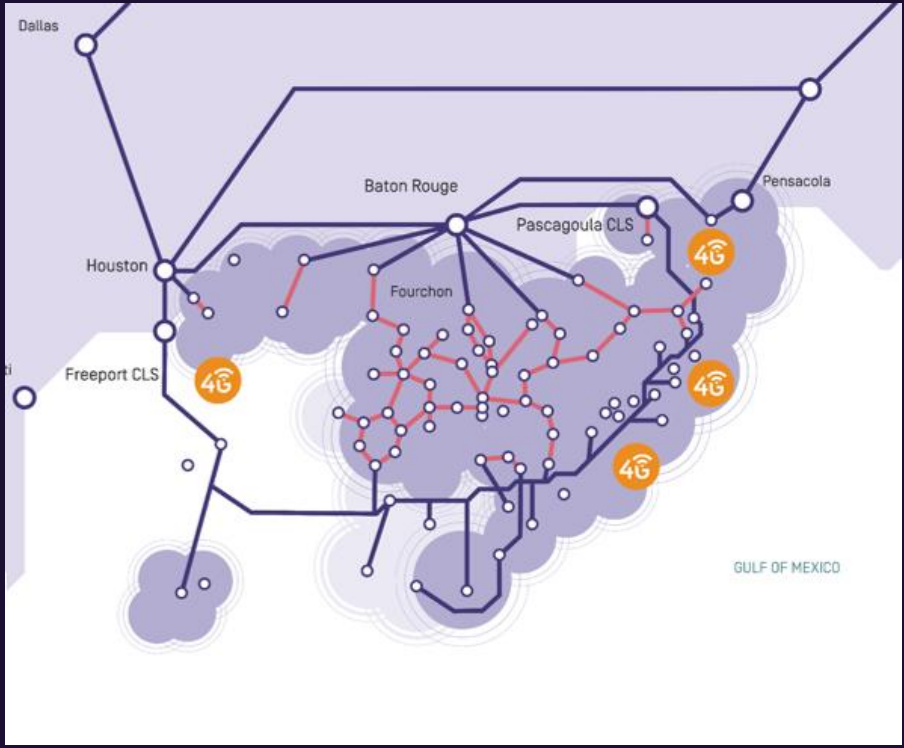
Tampnet operates 100% of the fiber network in the NS (~68% owned, ~32% leased from energy majors)



North Sea infrastructure

3,900km of subsea fiber	145+ microwave hops
50+ 4G LTE base stations	~250km^2 LTE coverage

Tampnet owns 100% of the fiber cable systems in the GoM – and expanding



Gulf of Mexico infrastructure

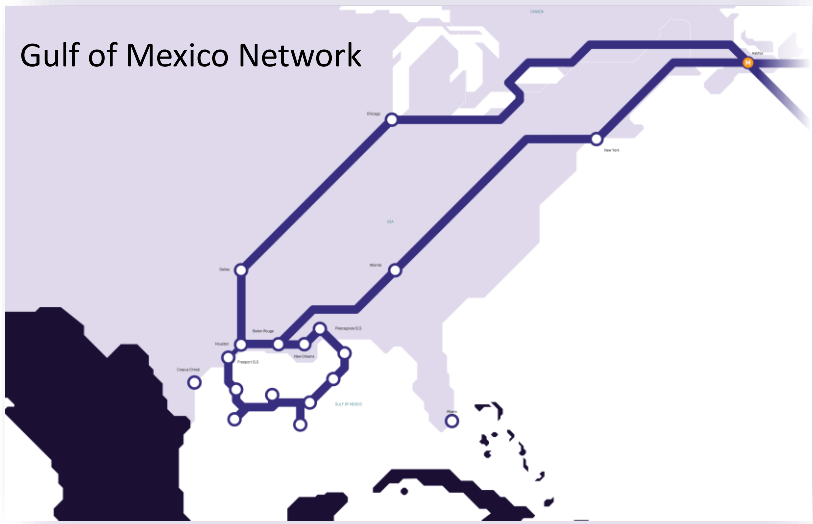
1,500km of subsea fiber	40+ 4G LTE base stations
55+ microwave hops	~250km^2 LTE coverage

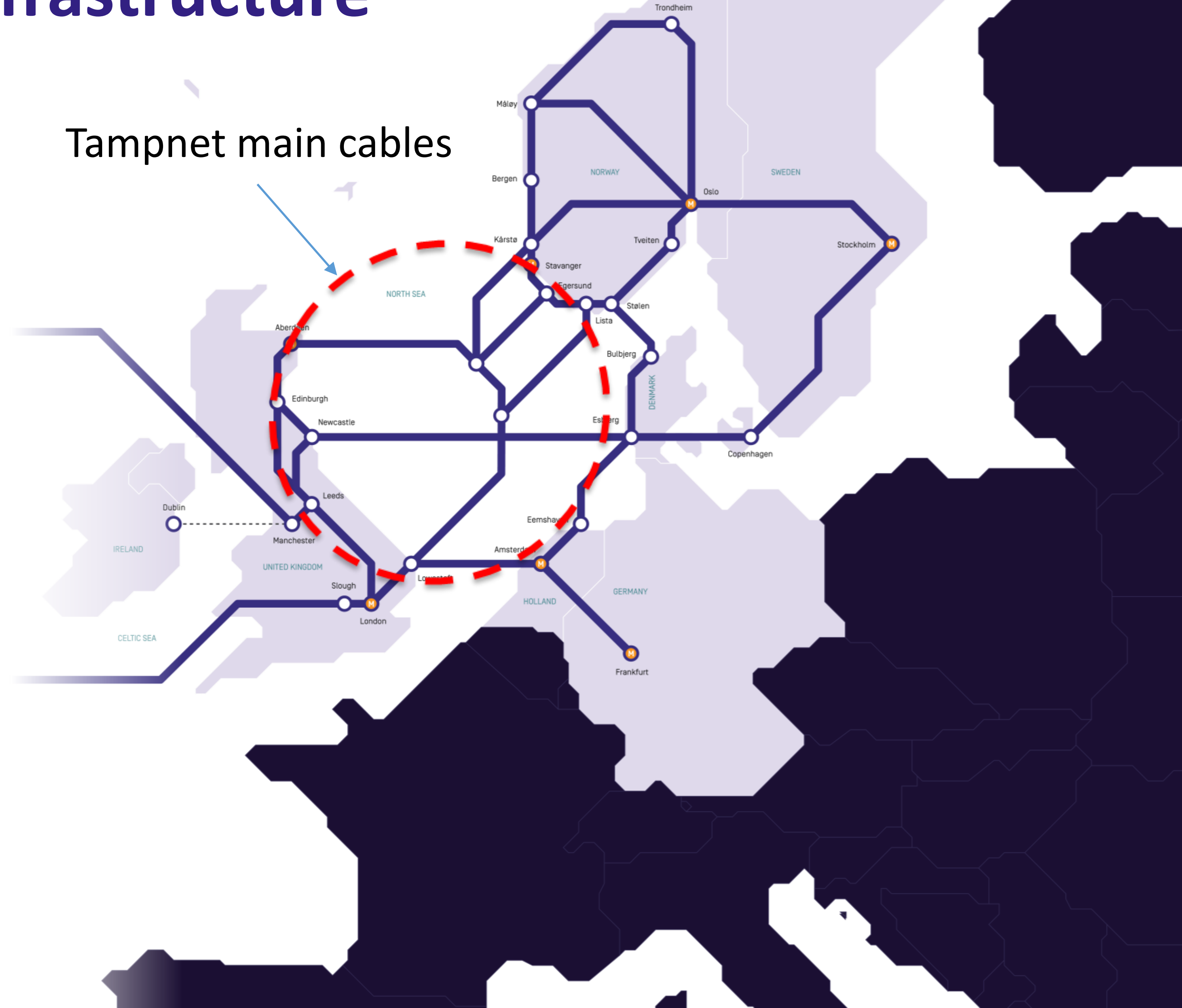
Multiple spectrum licenses in all markets

Company facts

- Founded 2001
- Owners 3i & ATP
- CEO Elie Hanna
- Offshore installations 450+
- Local Presence 7 Countries
- Headquarters Stavanger
- Offshore Network 600.000 km^2
- Fibre Optic Network 5,400 km
- Euro Turnover 100 Million

The North Sea Network: A critical infrastructure

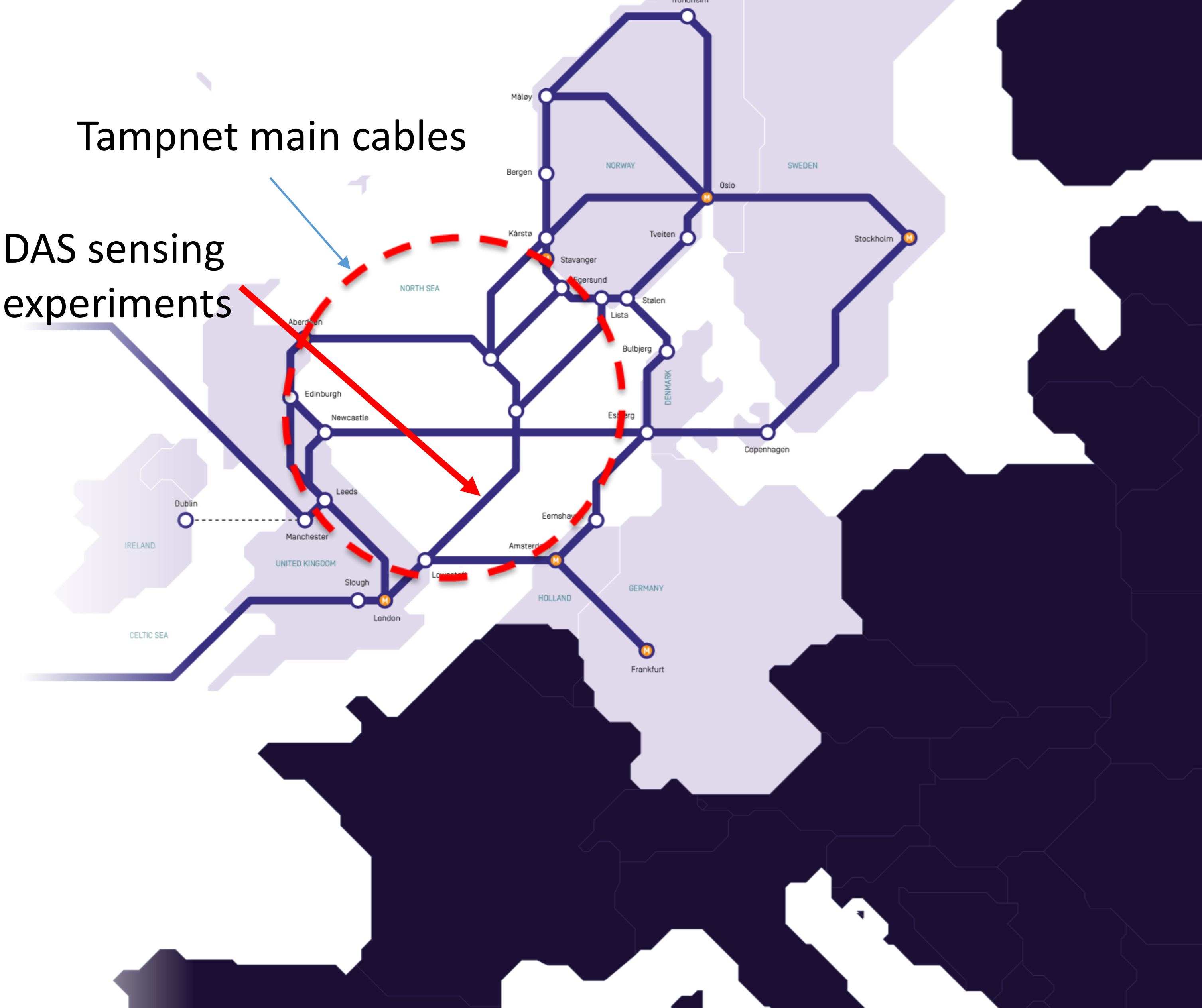




The North Sea Network

Passive fibre cables

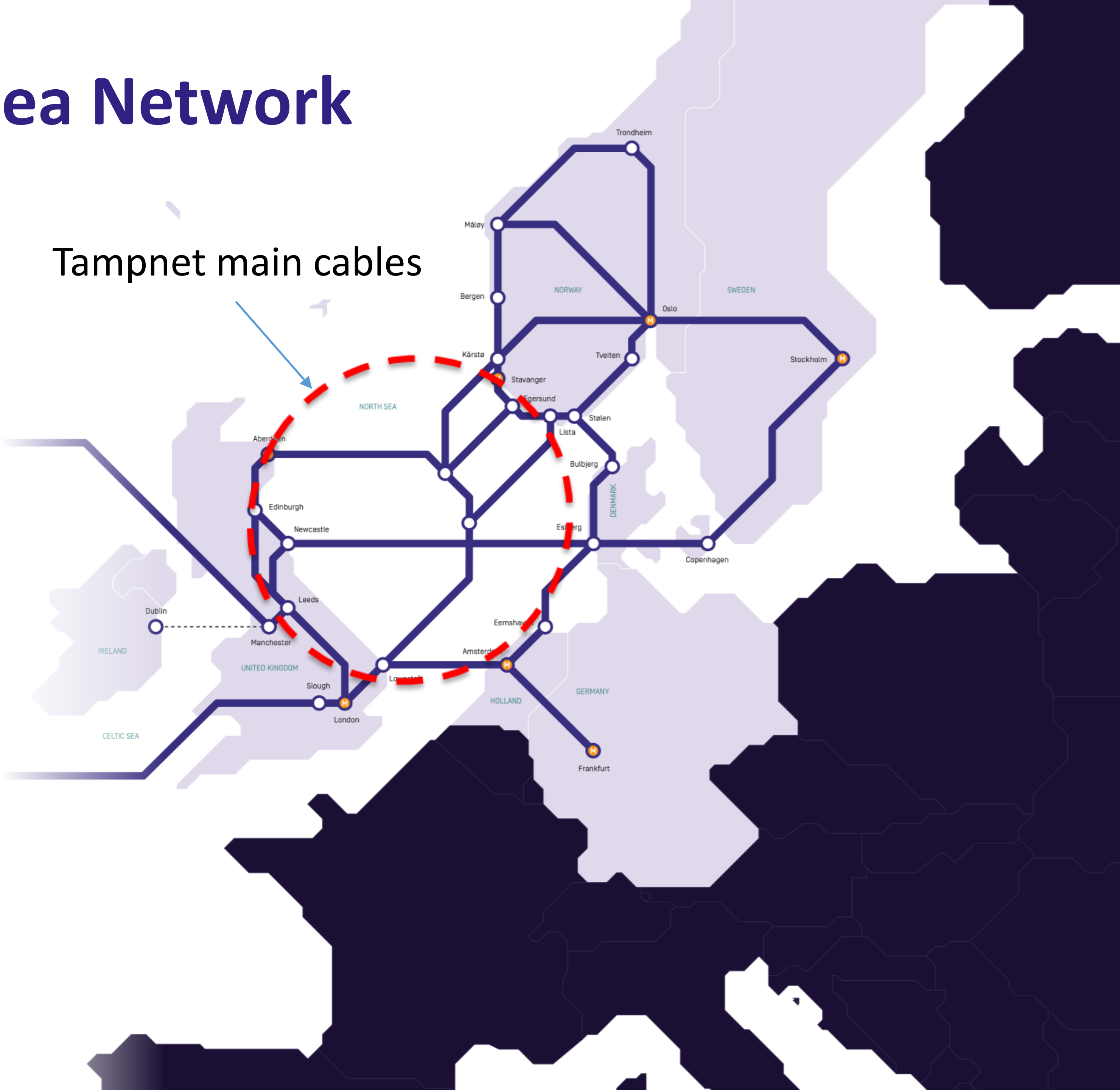
- Areas with oil and gas production
- Distributed Acoustic sensing (DAS)
- State of Polarization (SoP) sensing
- Span lengths up to 300 km.



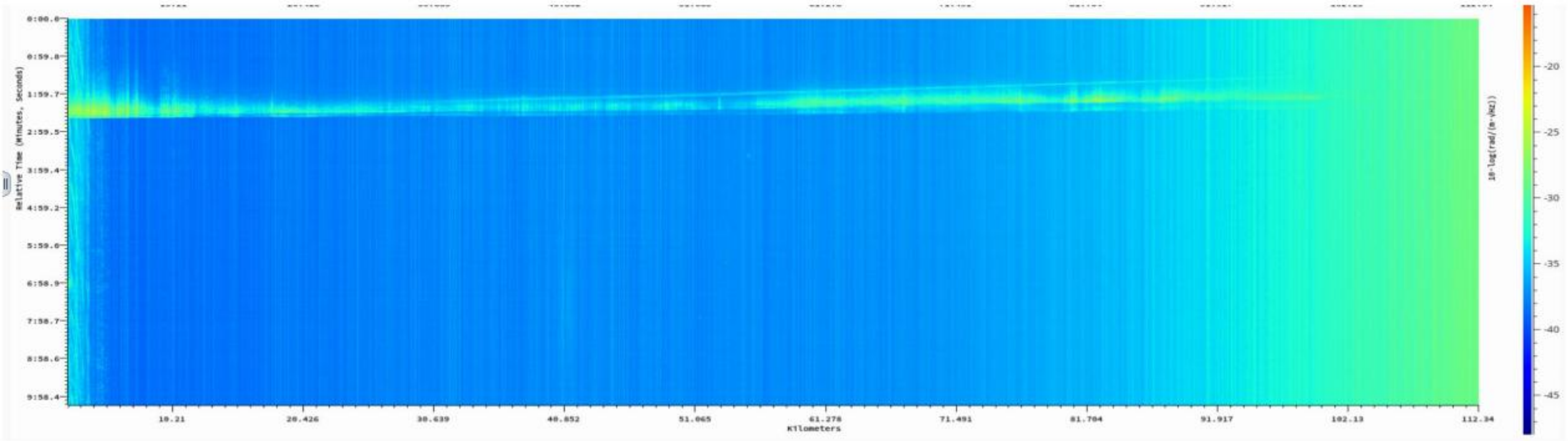
The North Sea Network

Passive fibre cables

- State of Polarization (SoP) sensing
- Amplification at oil and gas intstallations
- Handles span lengths of 300 km and more.

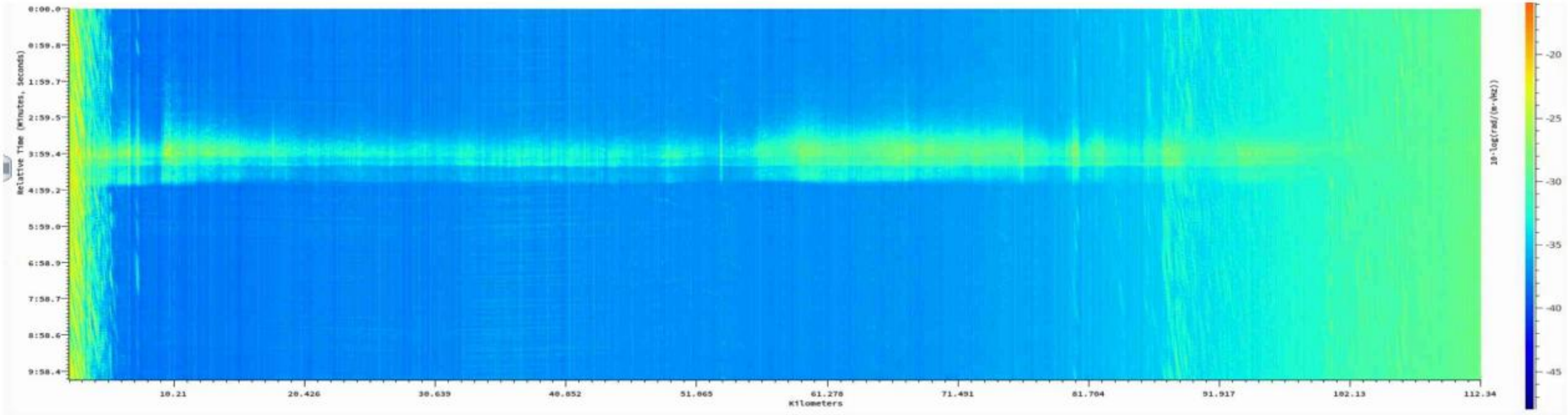


DAS: Example of explosion observation



Bandpass 3-80 Hz
Underwater explosion (shallow), approx 100 km from cable

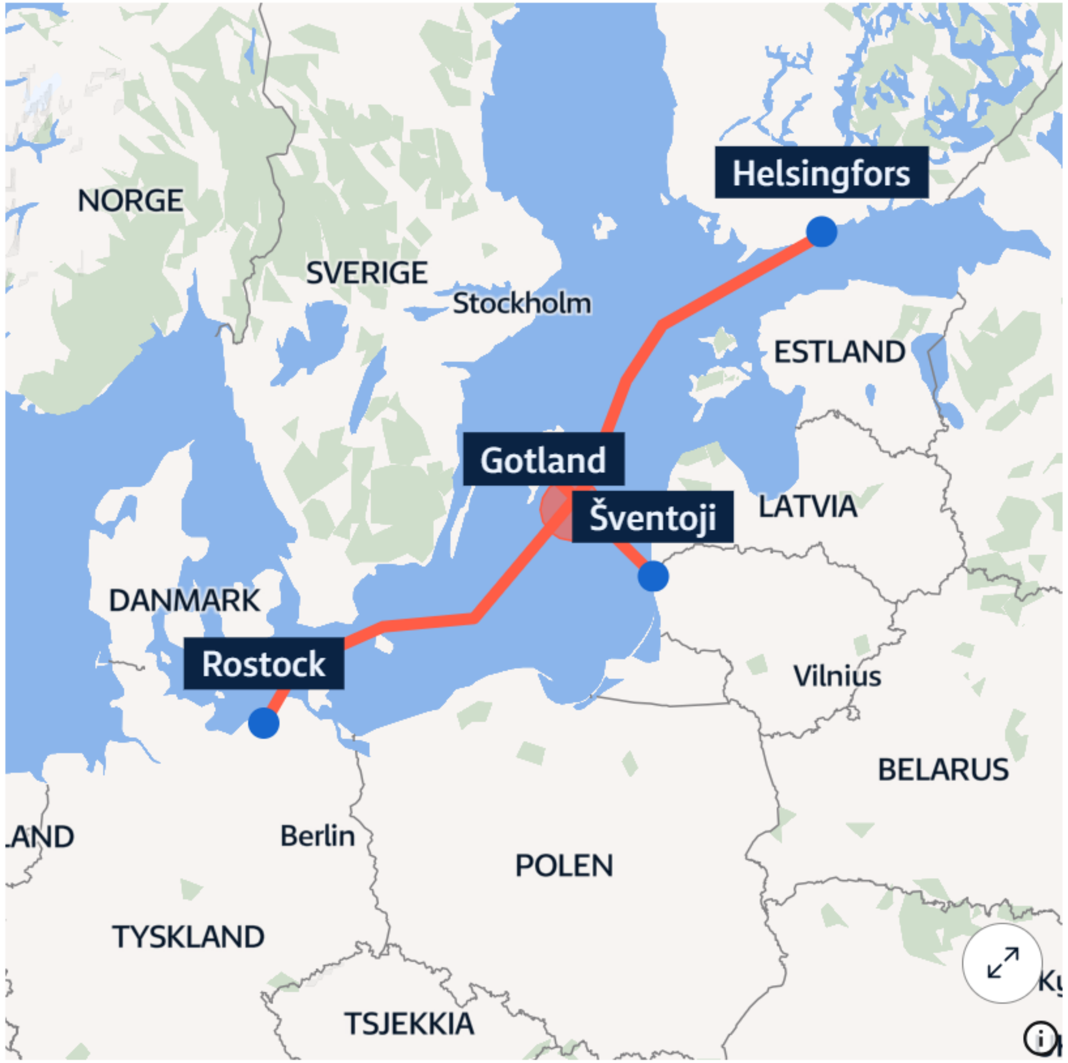
DAS: Example of eartquake observation
Interest from O&G and CCS



Bandpass 3-80 Hz
Magnitude 2.7, approx 350 km from cable

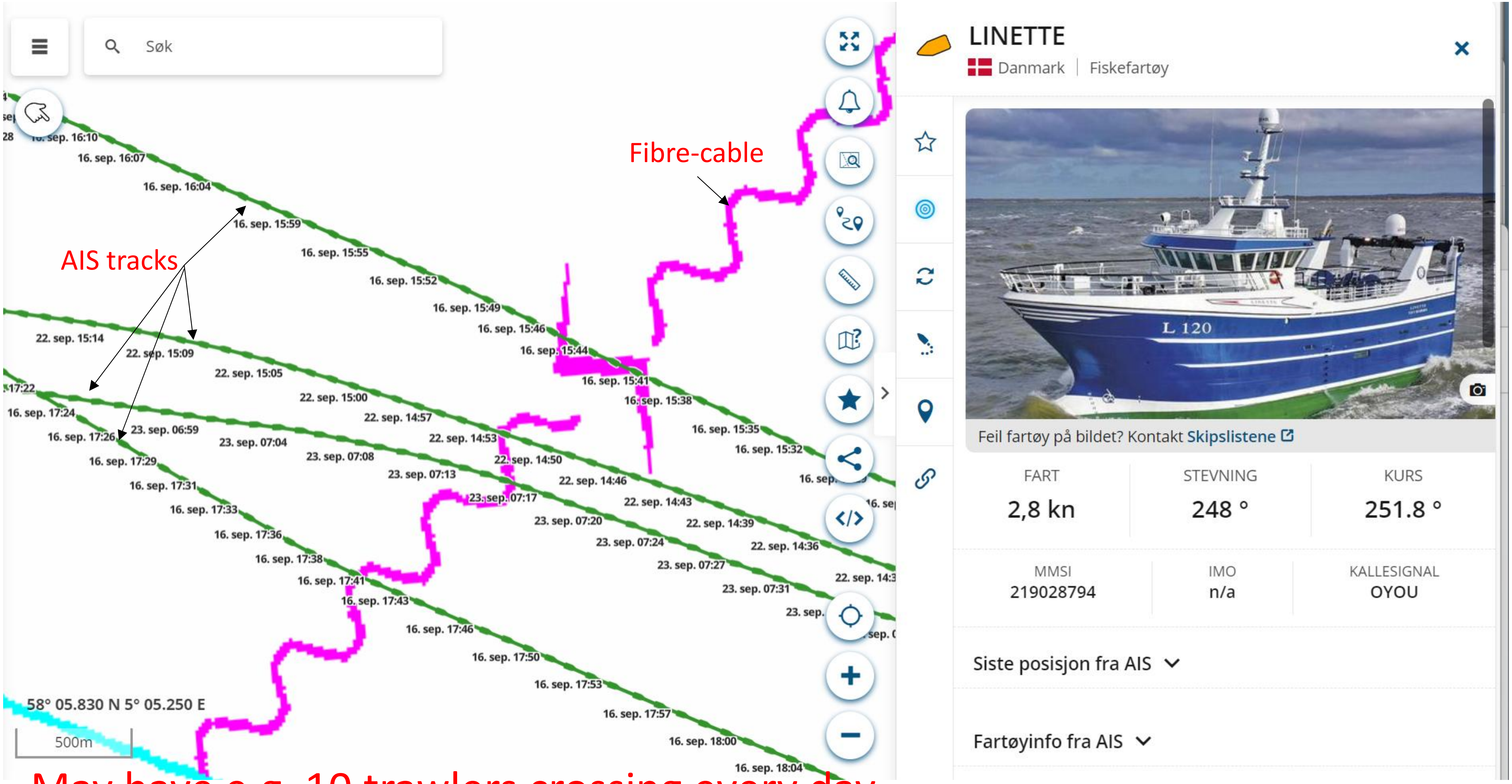
Cables damage
What has actually happened?

- Early speculations
- German defence minister:
  - No accident
- Few early facts available
- Many vessels cross every day



Kartet viser omtrentlig hvor begge sjøkablene går, og hvor skaden er registrert.

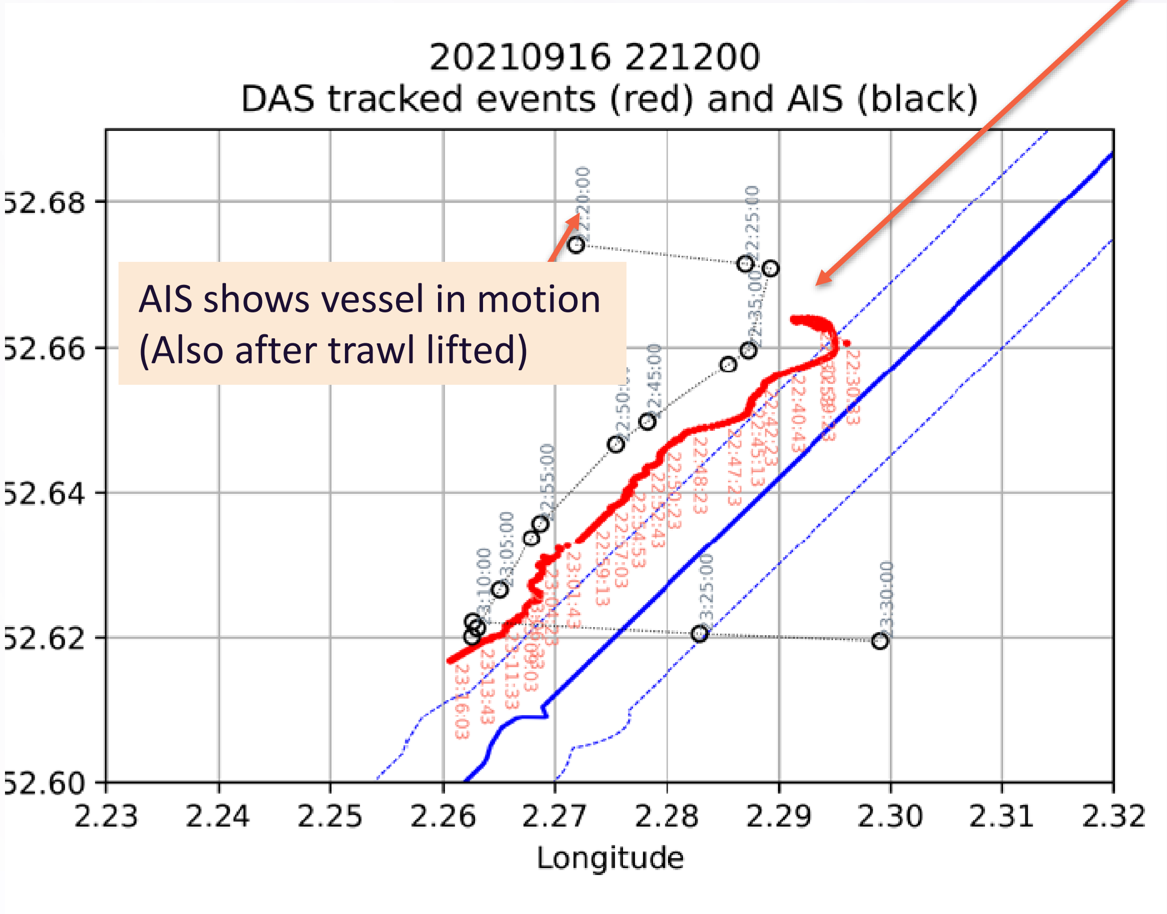
Egersund – Yme trawl crossing - Example

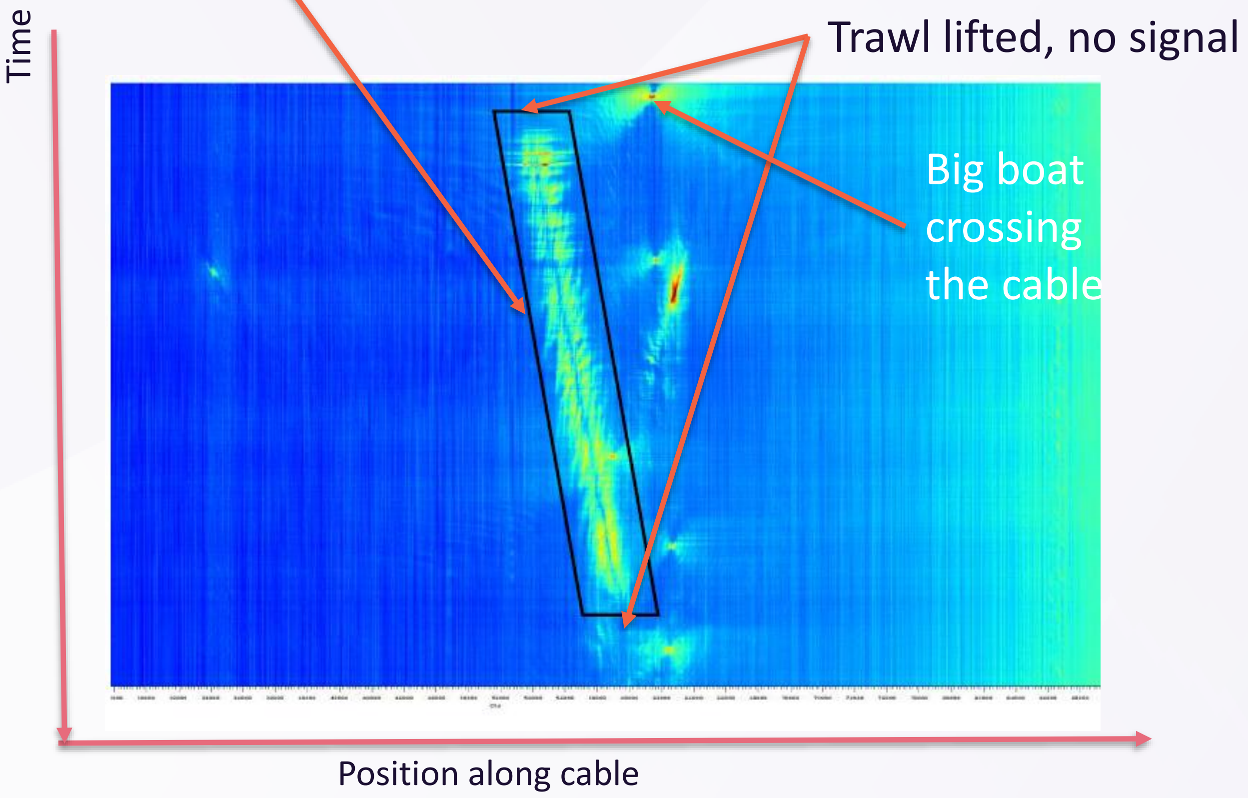


May have e.g. 10 trawlers crossing every day

Distributed Acoustic Sensing (DAS) for tracking threats to subsea fibrecables

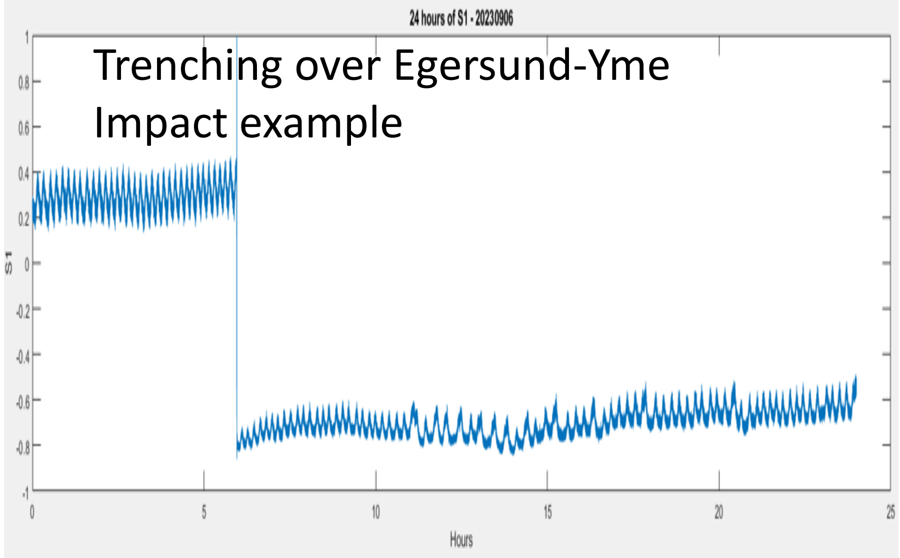
DAS detection: Trawl on seafloor





Tampnet Polarisation (SoP) monitoring
System dedicated to SoP monitoring in telecom

Monitor for impacts on fibrepaths



Correlation with other data sources for identification of events and position of events

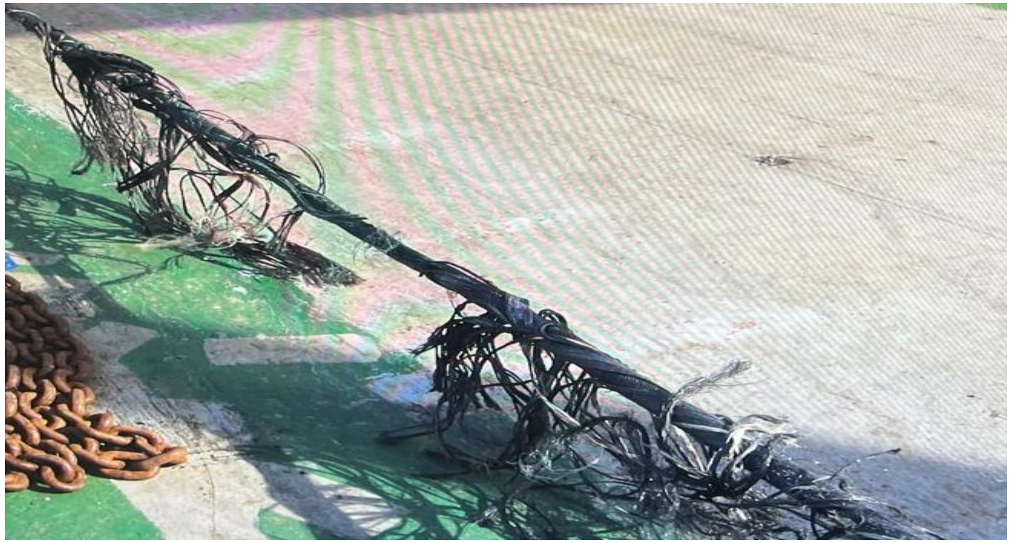
- In-house developed and manufactured System
  - Hardware
  - Embedded software
  - Client software, servers, etc.
- 1U instrument for installation in node rooms – Telecom friendly.
- Collects data to central server
- Stream processed data to Network Operation Centre (NOC)
- Monitoring and alarming in NOC
- Manual analysis for identification of type of event
- Transmitter where needed

Fibre sensing main applications

- Protecting subsea infrastructure
  - Sub-sea activity: Anchoring, trawling, dredging
  - Sub-sea attacks on the subsea power-cables or other sub-sea infrastructure
- Geophysical related effects
  - Sub-sea landslides (protection of subsea cables)
  - Microseism: Sub-sea stability, Co2 capture, oil and gas wells

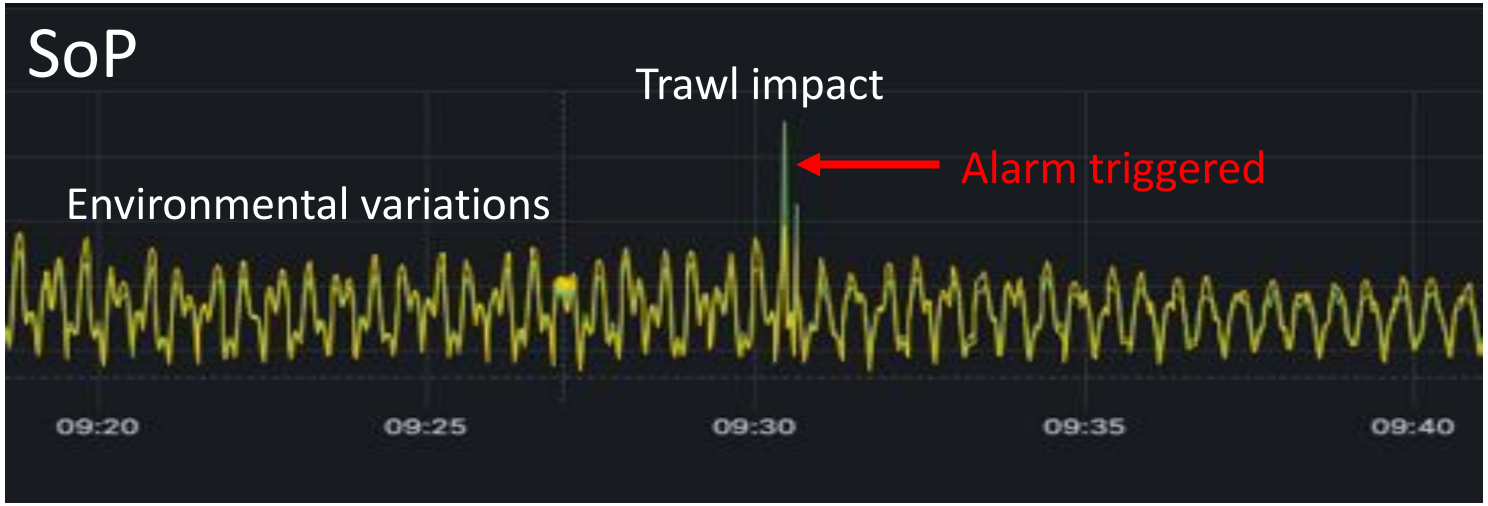
Fibre sensing in telecom: Main challenges

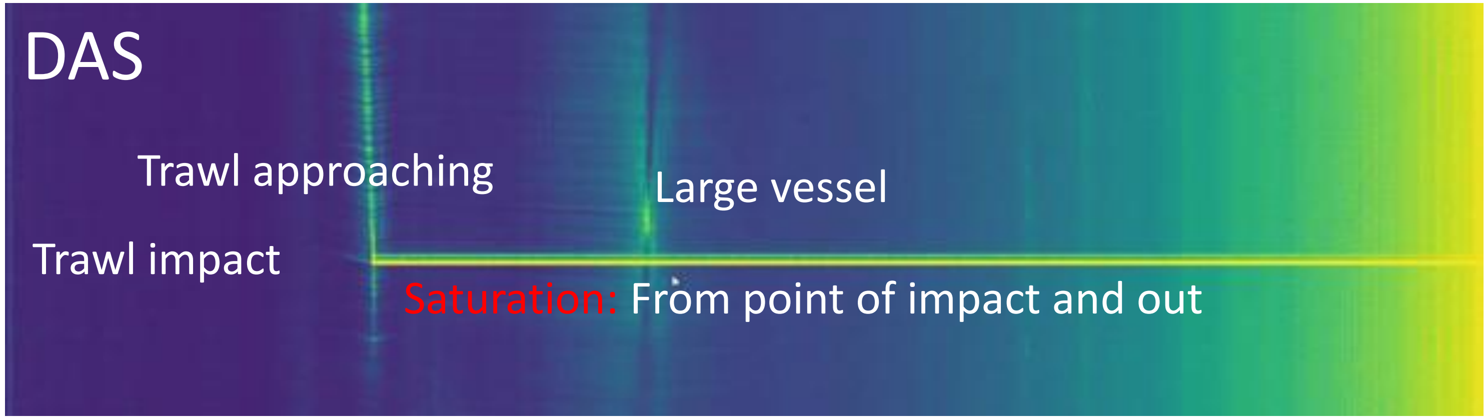
- Scaling to many sensing units at many cables
- Proactive alarming and action in Network Operations Centre (NOC)
- Avoid this:



Typically many hits before a break occur

Cable impacts and alarms to the operation centre: Combining sensing techniques and algorithms



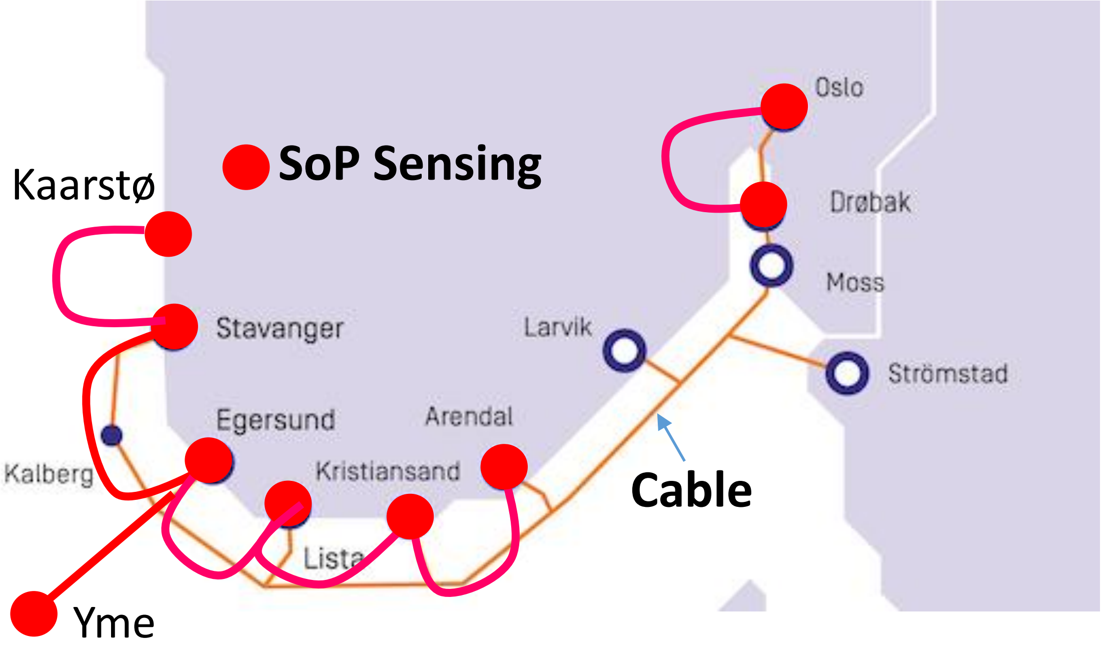


- DAS detects trawls approaching
- Can be e.g. 10 trawl crossings every day over one cable
- SoP detect *hits* on the cable
- Separating close contact and fibre hit challenging with DAS

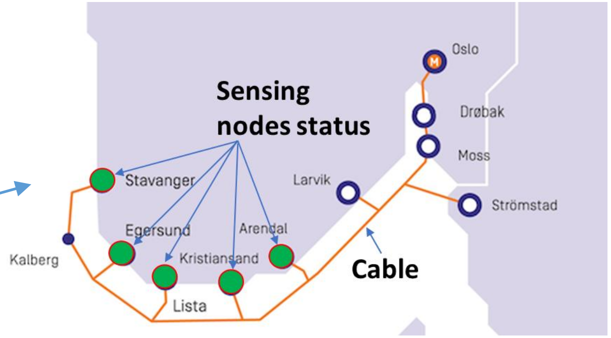
SoP: Promising technique for NOC alarming

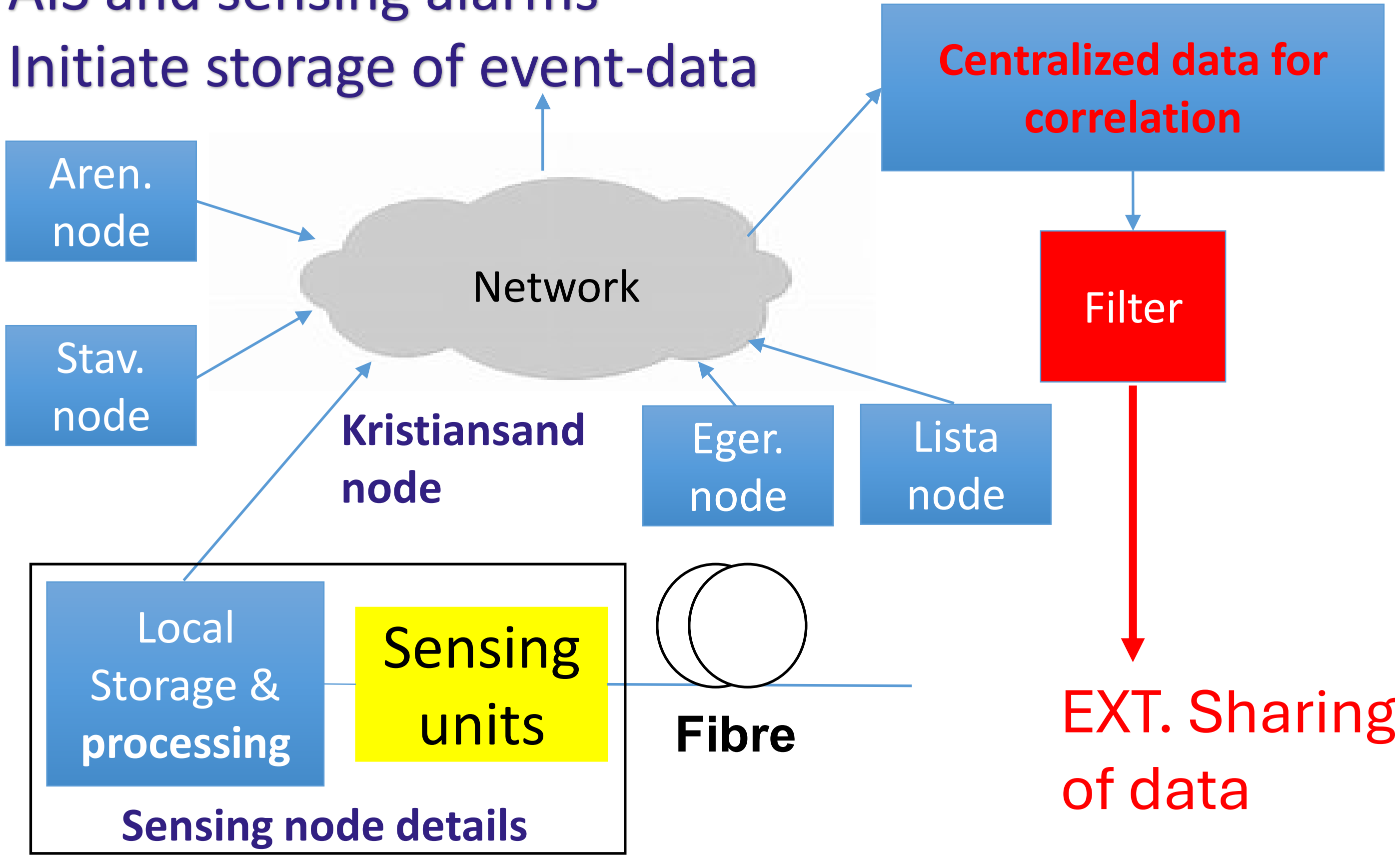
Scaling fibre sensing: NORFEST-testbed EU proj. ICON

SoP: Integrity monitoring
DAS: Environment and geophysical
Monitoring, proactive failure prevention



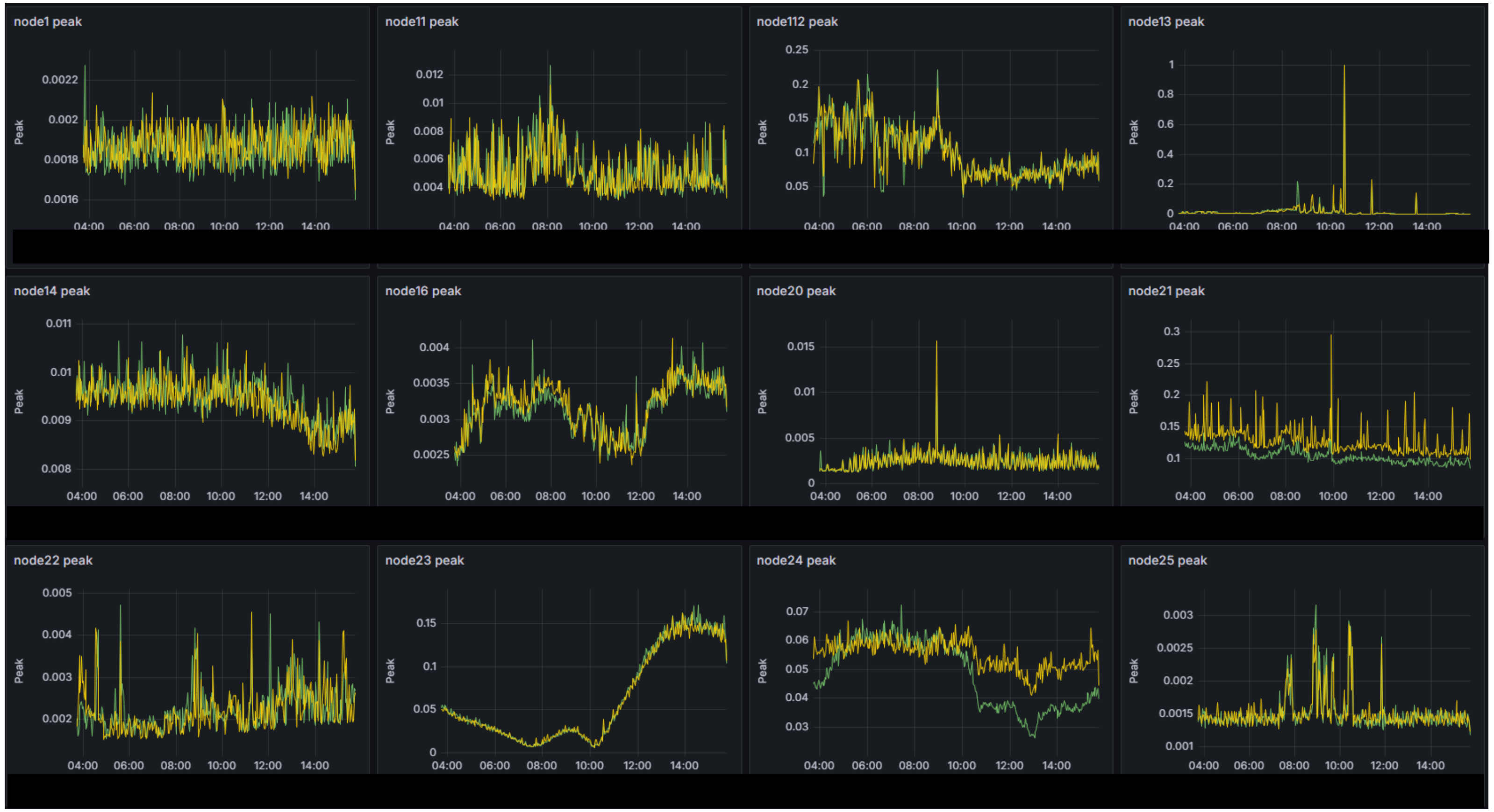
Operation centre/NOC:
Processed data
GUI application
AIS and sensing alarms
Initiate storage of event-data





Edge computing reducing datavolume

Scalability: Signals from many cables



SoP downsampled signals real-time streaming from 12 different cables

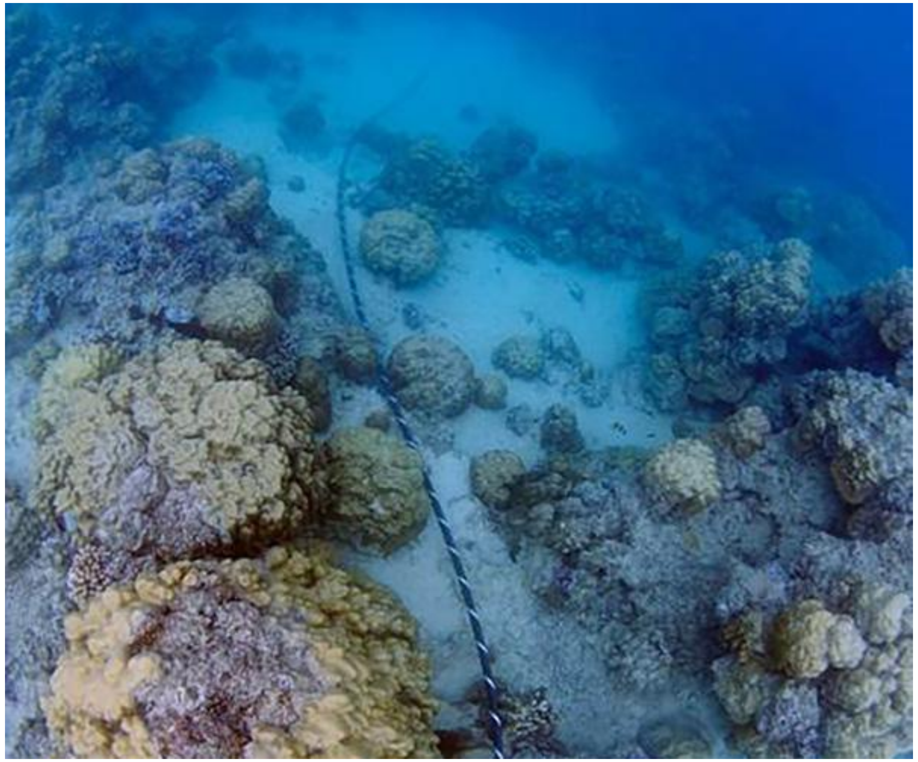
- Cables give different signals and alarm conditions.
- Distributed processing (edge): Reduce data volume
- Centralized processing:
    - Correlating data sources
    - Shaping for different applications: Filtering and processing

Work in progress

- Identifying "dark vessels"
  - Vessels not transmitting AIS signature information
  - Can vessels be identified by noise signature, using DAS?
- Alarms and actions in Network Operation Central (NOC)
  - Avoiding false alarms: Alarms should trigger an action
  - Information and accuracy in alarms: Deciding the NOC action
- Automatic event identification
  - Separating data to different applications
  - E.g. Anchor drag info to NOC and tsunami warning to public alarm

Summary

Subsea cable monitoring



Source: ASN

- Protect infrastructure combining DAS and SoP – use algorithms and AI
- Scaling: Reduce data volume at edge, centralized correlation
- Separate data to different user groups
- Network Operation Centre needs precise alarms and action plans