



Non-IP Technologies in the GÉANT Project

Dr. sc. Ivana Golub, PSNC

5th Global Research Platform Workshop, 16-17 September, Osaka, Japan

Public (PU)

GÉANT Project

Provides a stable and innovative environment for research, education, and innovation

Through a long-standing and highly collaborative relationship of European Union, NRENs and GÉANT

Project generations:

- GN5-1 - current, until Dec 2024
- GN5-2 - starts 2025

500 contributors from 37 R&E partners

50 million users

9 projects



Network Development: Non-IP network technologies



**Optical Time and
Frequency Networks**

Quantum

Fibre Sensing



Optical Time and Frequency Networks

OTFN

The background is a dark blue gradient with several overlapping, semi-transparent circles and a series of diagonal lines that create a sense of depth and movement. On the right side, there is a vertical band of multi-colored light, transitioning from blue at the top to yellow and white at the bottom, resembling a light flare or a spectrum.

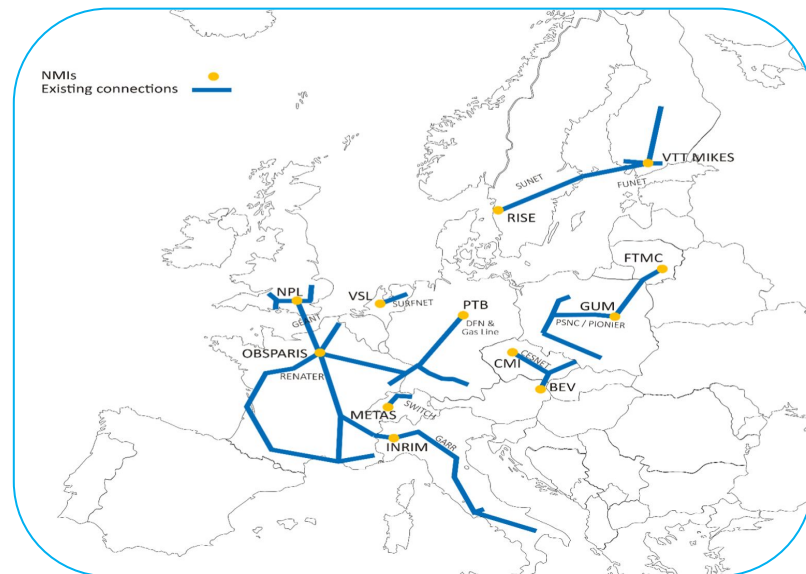
Optical Time and Frequency Networks - OTFN

Beginning of 2024

NRENs providing and further building optical time and frequency networks to support their National Metrology Institutes (NMI) in providing precise time and frequency signals

- Deployment differences
 - Frequency band, architecture and equipment choice
 - Different user groups
- Growing demand – more NRENs are getting involved urged by more user groups
- Several ongoing TF EU project (CLONETS, CLONETS-DS)

Redefinition of SI unit of the second in 2030 urges the usage of optical network infrastructure



GN5-1 Network Development OTFN incubator project

Initiated as a GN5-1 WP6 NETDEV incubator project to.

- Build a unified network **based on existing national infrastructure**
- Invest in coordination between NRENs and NMIs to build a sustainable community
- Identify long-term operational funding beyond 2027

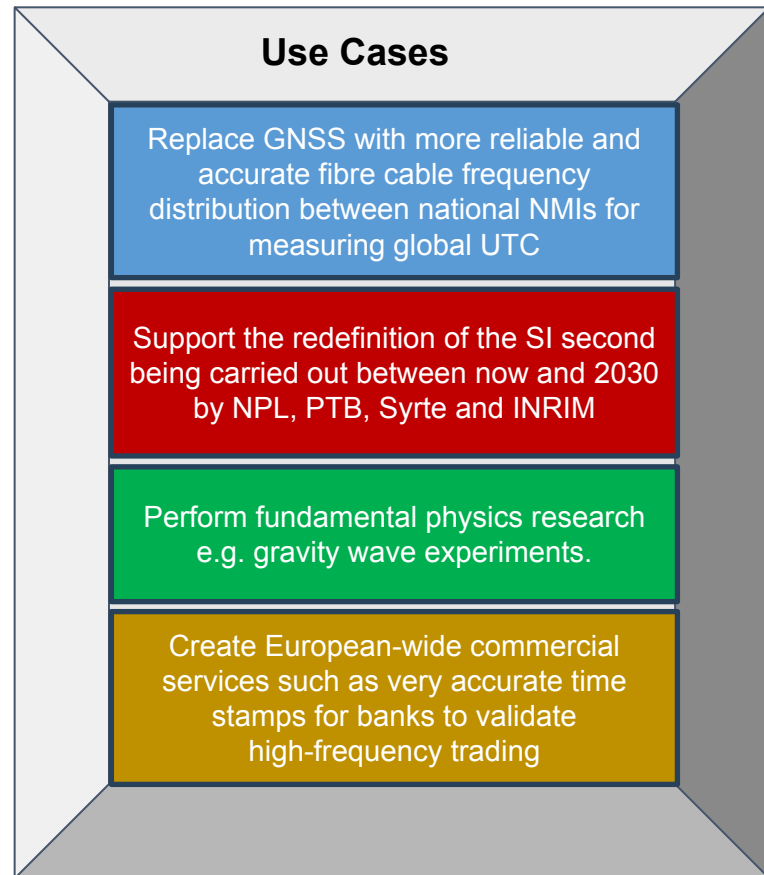
The T/F incubator project completed in January 2024:

- recommended using GÉANT funds to build some fibre links in GN5-2.

Goal of GN5-2 funding:

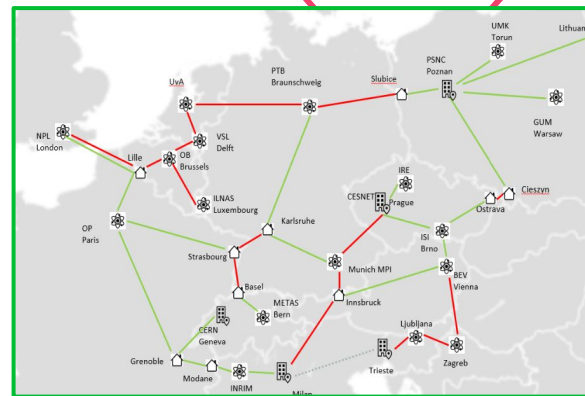
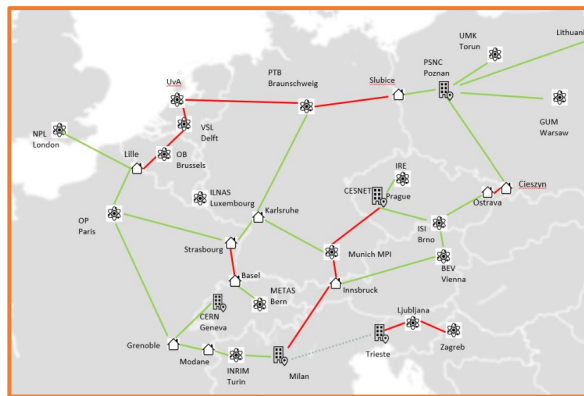
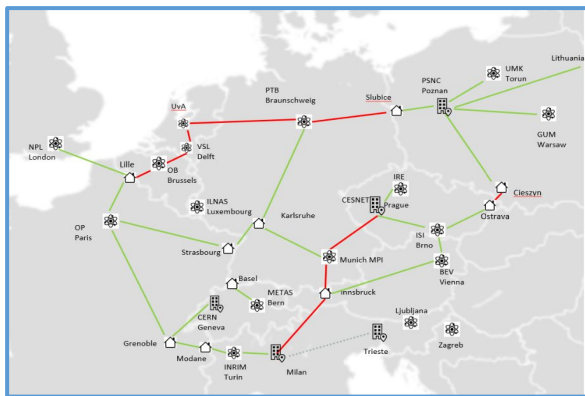
- Prepare a GÉANT funding proposal to build stage one of the core time-frequency network (C-TFN)

[OTFN Incubator Proposal](#)



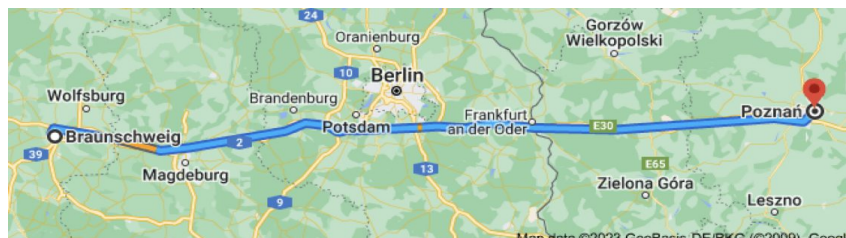
Design of the Core Time and Frequency Network (C-TFN)

C-TFN
Options



C-TFN PathFinder Link:

Explore technical and operational aspects of running such a C-TFN



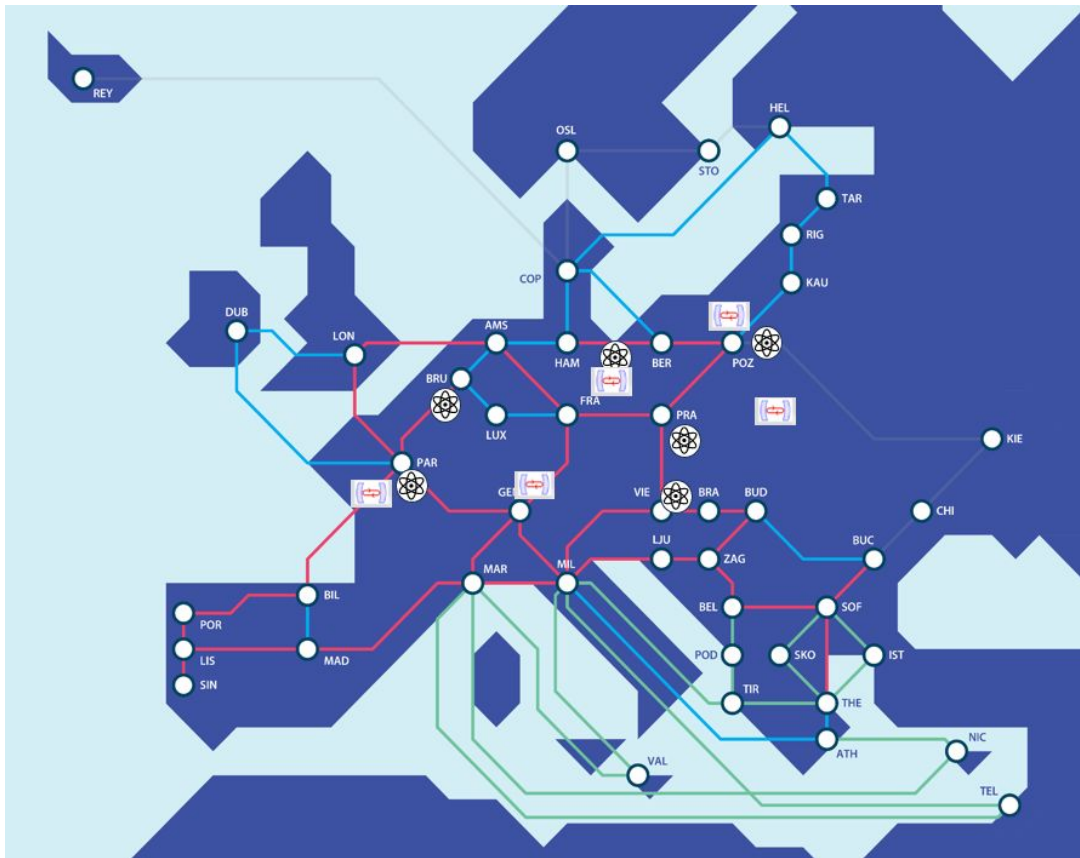
More information in the [GÉANT Core Time/Frequency Network \(GÉANT C-TFN\) Network Development Incubator Report](#)

Monitoring the Core TF Network (C-TFN)

Neither simple or easy!

Multiple technical considerations:

- TF management and monitoring parameters in addition to IP-network
 - Link state, delay, jitter / amplifiers / RLS state / comparators / flywheel performance
- Data from multiple domains required for the end-to-end view
- Differentiating services require additional computational elements
- What is a service? T/F signal or their comparison with the local sources?
- Heterogeneous TF equipment in NRENs



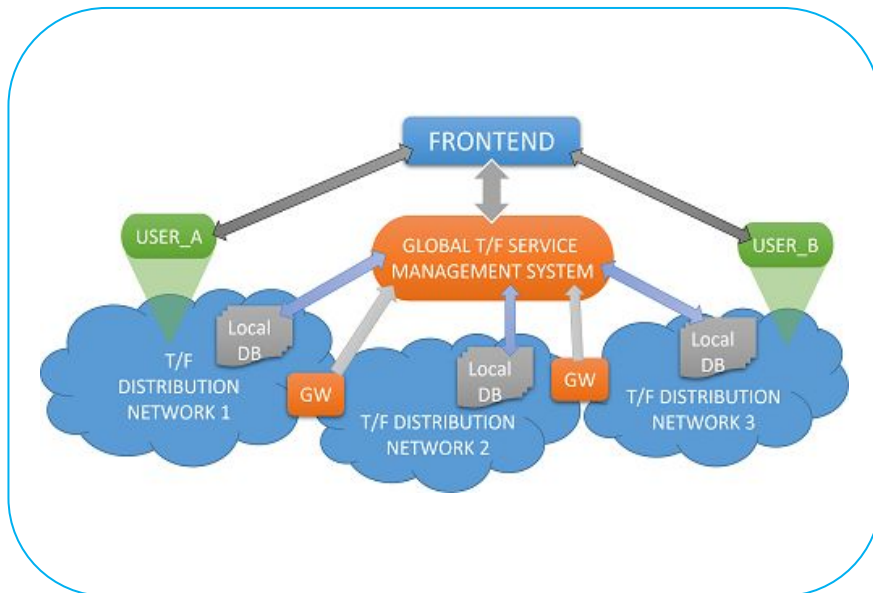
Monitoring the Core TF Network (C-TFN)

Groups and Roles

- GÉANT - managing the core network
- NRENs - managing NREN network and connectivity to user institutions and individuals
- NMIs - contributors of TF sources and C-TFN users
- Other organisations - users
- Researchers - users

Approach to C-TFN monitoring:

- Building upon already existing TF infrastructure and services
- Respecting management domain boundaries
- Providing appropriate views to different user groups
- The first monitoring system based on existing service - TimeMap



TimeMap

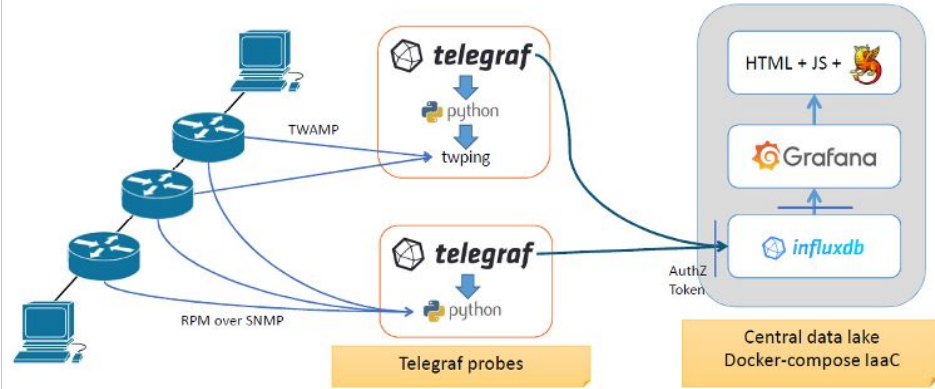
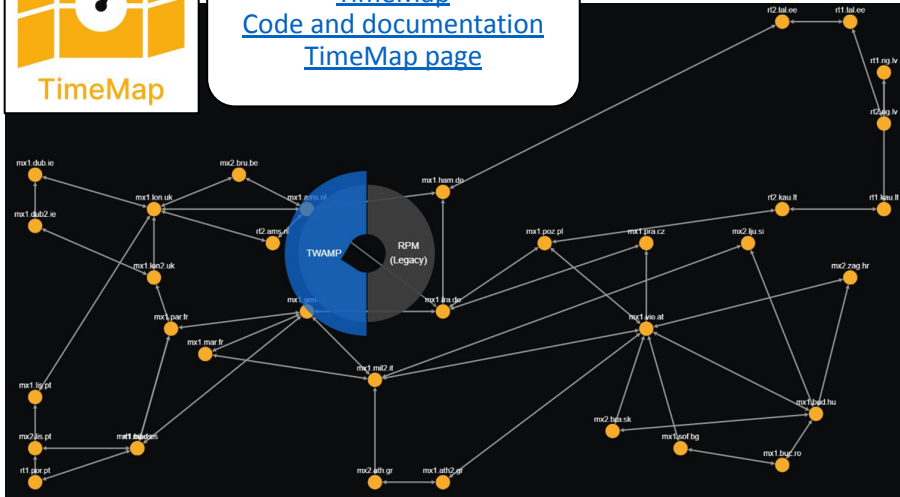
Per-segment latency and jitter monitoring
TWAMP-based tool (RFC 5357)

EduGAIN access

Deployed in the [GÉANT backbone network](#)



[TimeMap](#)
[Code and documentation](#)
[TimeMap page](#)



TimeMap Architecture

C-TFN TimeMap

Leverages TimeMap's easy and quick modular design

Follows TimeMap's architecture

Deployed on a pilot link PSNC-PTB

Designed to receive TF and IP network monitoring
data from multiple sources and domains

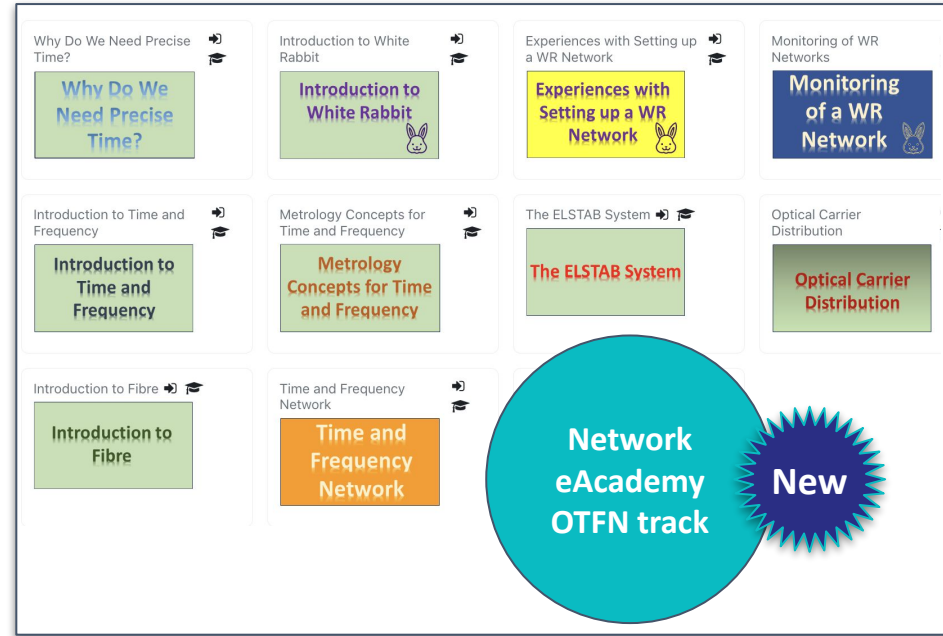
Extendable to provide per-user group view

Building Skills and Capabilities

A new OTFN Training Track in the [Network eAcademy](#)

Learning Units:

- Why Do We Need Precise Time?
- Introduction to Time and Frequency
- Introduction to White Rabbit
- Experiences with Setting Up WR Network
- Monitoring of White Rabbit Networks
- Introduction to Fibre
- Optical Carrier Distribution
- Prevention of Line Lasing
- The ELSTAB System
- Time and Frequency Network
- Metrology Concepts for Time and Frequency



Collaboration: SIG-TFN

Special Interest Group for Time Frequency Networks (SIG-TFN) created to support collaboration around C-TFN

Two working groups within the SIG-TFN:

- T/F Sustainability
- C-TFN technical specification

Next SIG-TFN meeting:

- [16-17 october 2024, Amsterdam](#)

More information:

- [SIG-TFN Connect article](#)
- [SIG-TFN Web page](#)

Join the mailing list: sig-tfn@lists.geant.org



Quantum Technologies



Quantum Technologies

Beginning of 2024

EU supports building Quantum Communication Infrastructure (QCI)

NRENs activities focused on national EC-funded [EuroQCI](#) projects

High interest, limited availability for joint work

Topics of common interest:

- Equipment features, availability and procurement
- Services
- Building skills and competences
- Discussions, collaboration

Announcement for cross-border QCI calls



DECLARATION ON A QUANTUM COMMUNICATION INFRASTRUCTURE FOR THE EU

All 27 EU Member States

have signed a declaration agreeing to **work together** to explore how to **build a quantum communication infrastructure (QCI)** across Europe, boosting European capabilities in **quantum technologies, cybersecurity and industrial competitiveness**.

@FutureTechEU #EuroQCI



[Image Source](#)

Quantum Technologies in GN5-1 Network Development WP

Exploring Quantum Technologies (QT) for NREN Use cases

Supporting NRENs in their QT deployments and EuroQCI projects

- Open Quantum Group meetings and infoshares
- Knowledge hub on the [QT wiki](#)
- Infoshares:
 - [QKD Long-Distance Trials](#) (7/2024),
 - [NREN QKD Networks: 25 Sept 2024, 14:00 CEST](#)

White Paper [QKD Concepts and Considerations](#)

- Deployment and implementation aspects and components
- Security

QT track in the Network eAcademy

<https://wiki.geant.org/display/NETDEV/QT>



Quantum eAcademy

Quantum Algebra: QuBits



Quantum Algebra: Operator Multiplication: Variants



Quantum Algebra: Mathematical Operators



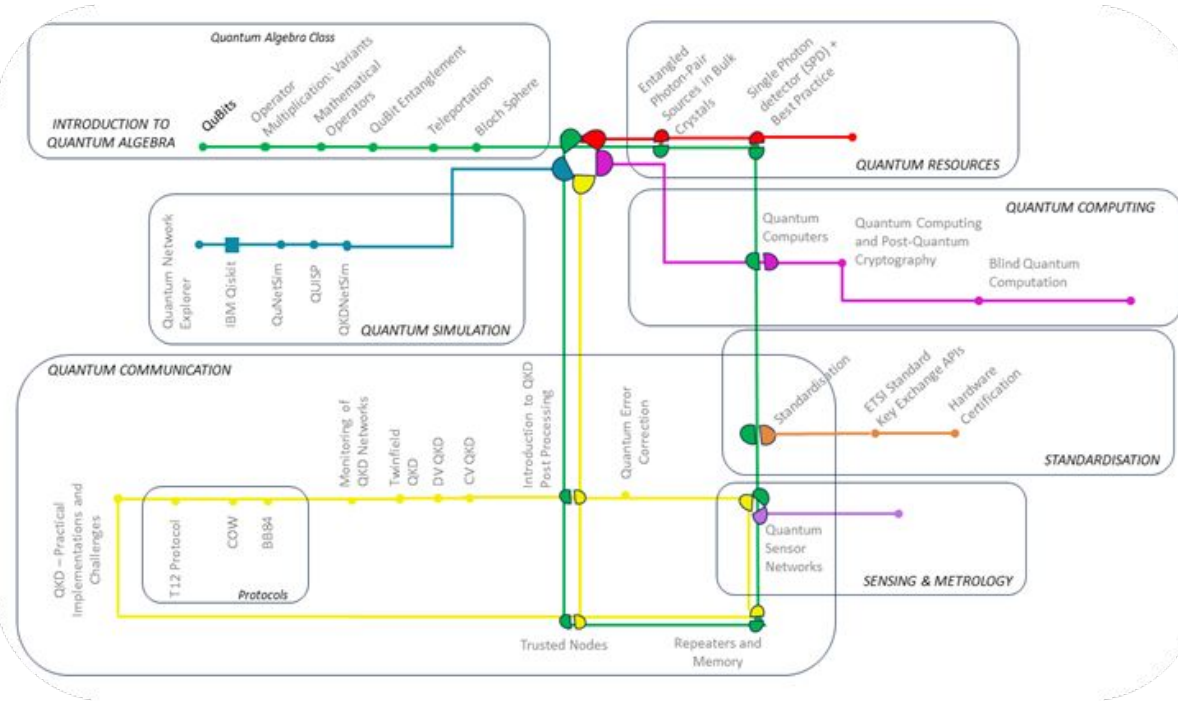
Quantum Algebra: QuBit Entanglement



Quantum Algebra: Teleportation



CC BY-NC-SA
license
eduGAIN
access (or
social media)



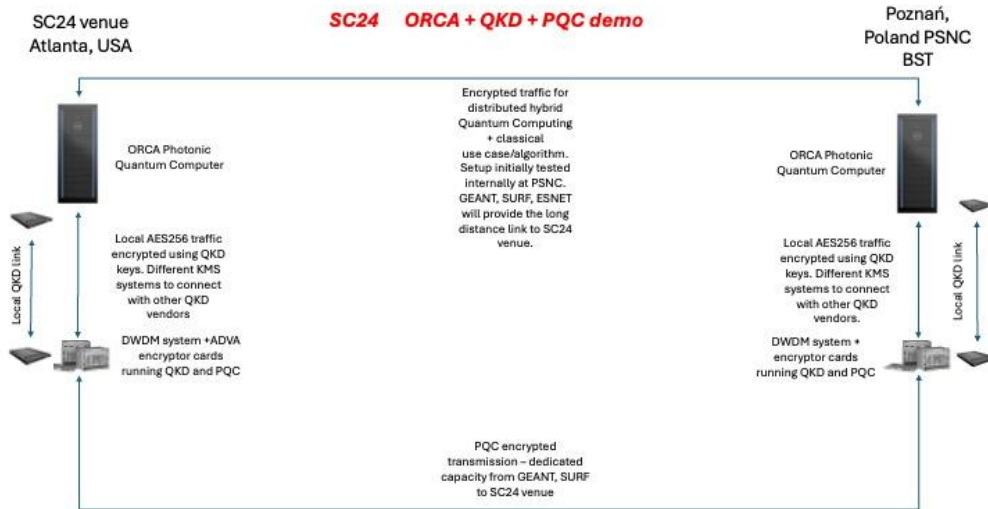
Technical and Operational Considerations for Cross-Border QCI Interconnection

Ongoing work on:

- Architectural considerations of connecting national QCIs
- Interoperability of different quantum solutions
- Interoperability of Quantum Key Management Systems (KMSs)
- EU-wide KMS service
- Exploring physical layer challenges for connecting Optical Ground Stations (OGS) to QKD satellites
- Classical and Quantum Networks Coexistence
- Mapping roles and responsibilities: NRENs, GÉANT, non-R&E orgs



SC24 Demo: Where Classical and Quantum Networks meet



Initiated by PSNC, prepared in collaboration of:

- ESnet, GÉANT, iCAIR / Northwestern University, Internet2, PSNC, SURF

Demonstration of:

- quantum-classical computing testbeds
- interconnected with dedicated classical direct link
- secured with PQC and QKD technology encryption

Two path connect remote ends:

- PSNC, Poznan/Poland
- SC24 venue, Atlanta/USA

Quantum processing of biomedical images in collaboration with Nvidia and ORCA

Fibre Sensing



Fibre Sensing (FS)

Beginning of 2024

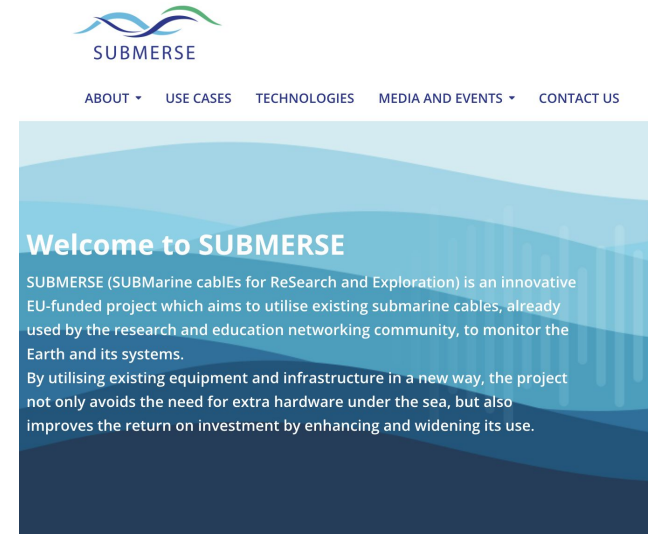
Growing interest among NRENs to support their users providing infrastructure with fibre sensing capabilities

Use cases in monitoring:

- Cable network infrastructure
- Earth (seismic) activity
- Sea life (Wales)
- Sea transport (Ships)

NREN Interest:

- Explore DAS, SOP, SOP OTDR, SOP OFDR technologies
- Define FS architecture and how it fits existing networks
- Ecosystem from data harvesting to R&E usage
- Best practices of deploying and managing FS networks
- Validating and building upon the SUBMERSE project results



WELCOME TO SUBMERSE

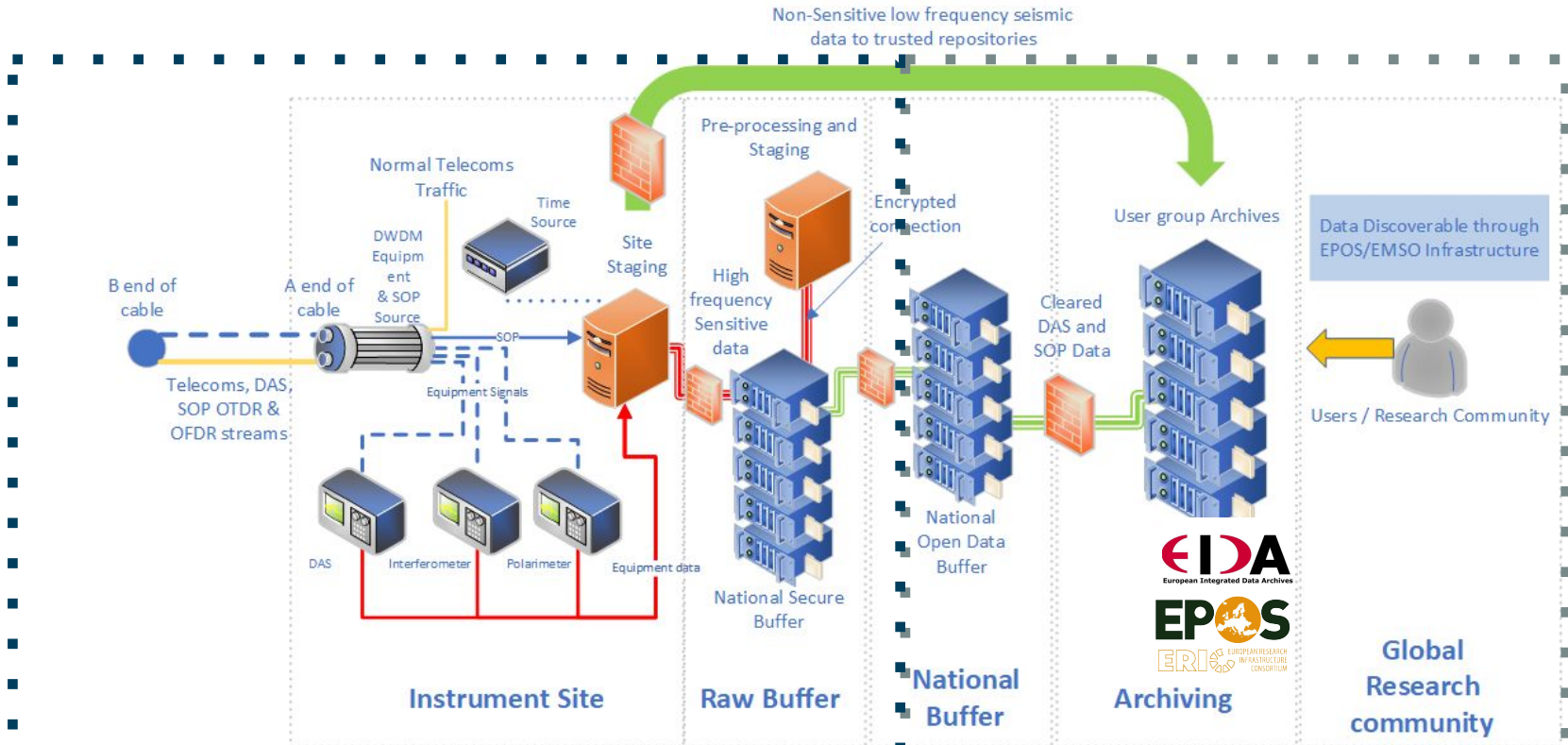
SUBMERSE (SUBMarine cablEs for ReSearch and Exploration) is an innovative EU-funded project which aims to utilise existing submarine cables, already used by the research and education networking community, to monitor the Earth and its systems.

By utilising existing equipment and infrastructure in a new way, the project not only avoids the need for extra hardware under the sea, but also improves the return on investment by enhancing and widening its use.

Interest expressed by several NRENs who proposed a NETDEV incubator project:



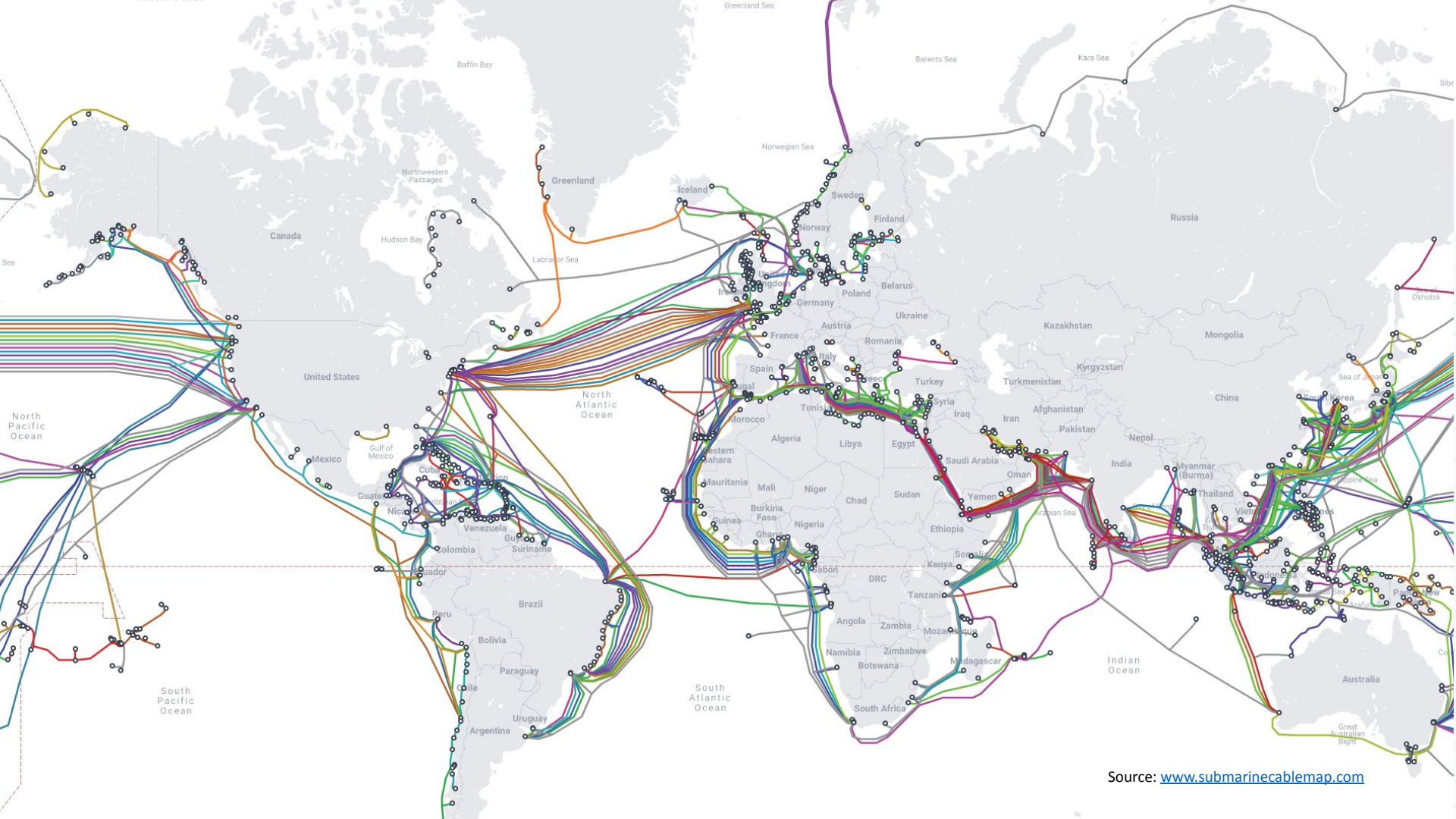
Fibre Sensing high level instrument architecture – per site



National Data Management policies

Image source: [Submerged Curiosity](#) C. Atherton, GÉANT

Open Science Data Management policies (FAIR)



Source: www.submarinecablemap.com

GN5-1 Network Development Fibre Sensing incubator project

Activities in scope

Short term:

- Fibre sensing technology and instrumentation
 - Demonstration
 - Best practices
- Selection of target user groups and their requirements
- Data acquisition and visualisation
- FS infra resources specification in a single-and/or multi-domain R&E environment

Mid term:

- Further technology investigation
 - Experiments and field trials
- Explore the options for building user-oriented FS-based services
- Design and best practices of FS data management

Long term:

- Setting up a large-scale sensing network over the GÉANT and NREN infrastructure
- Setting up data management infrastructure for fibre sensing
- Setting up an ecosystem of scientists and researchers gathered around FS

More information in the [project report](#)



Thank You!

netdev@lists.geant.org

www.geant.org



Co-funded by
the European Union