T/F distribution in fiber optics and the European initiatives

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Infoshare - SIKT
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Agenda

- User needs
- National T&F connections in Europe
- International T&F connections in Europe

Group of users

Navigation

Transport

Power Grids

Finance

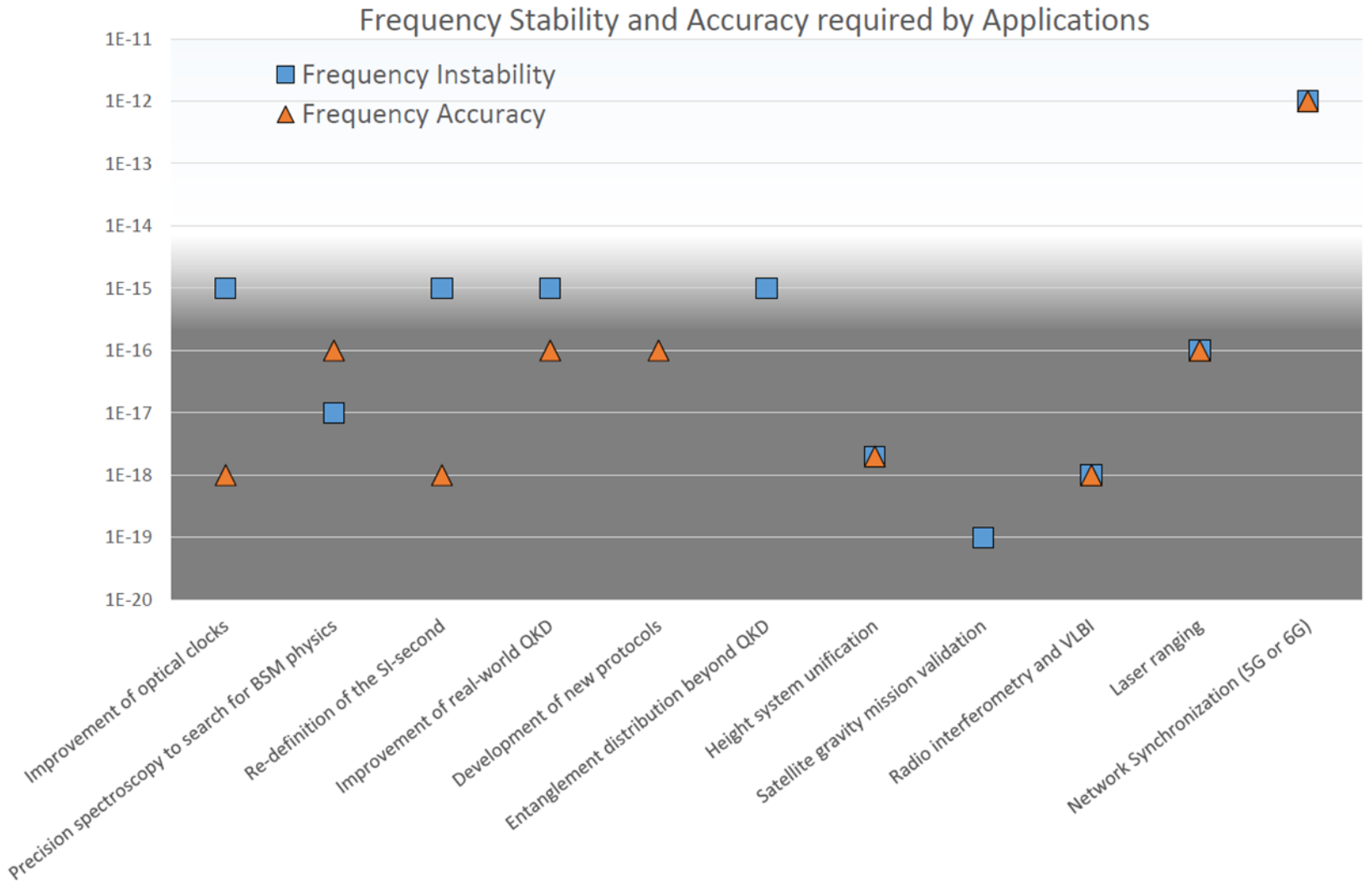
Science

Defence

Telecommunication (ICT)

Security

User needs - frequency

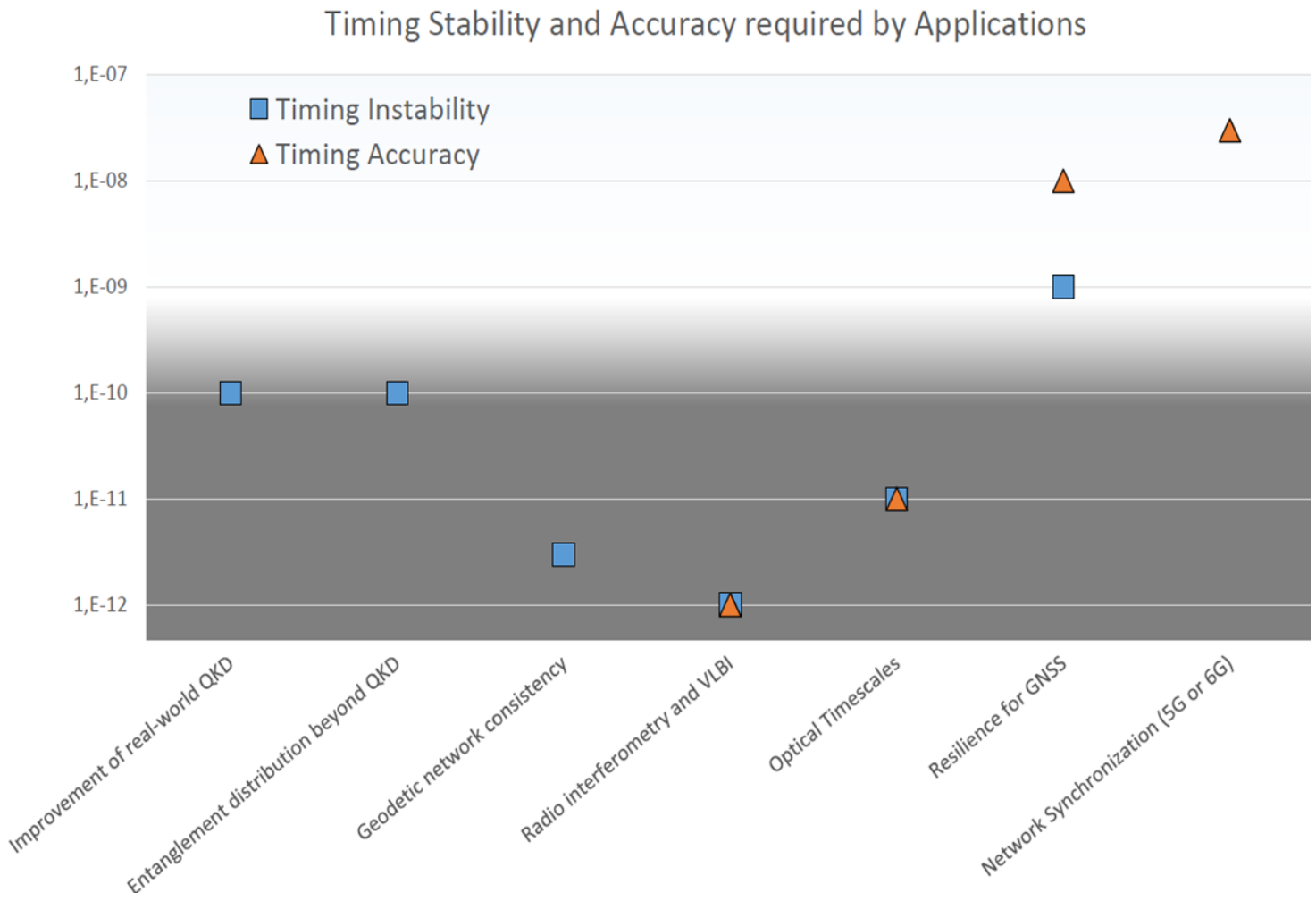


Commercial technologies

Limit of commercially available technology

Achievable with optical frequency and time distribution via optical fibre

User needs – time



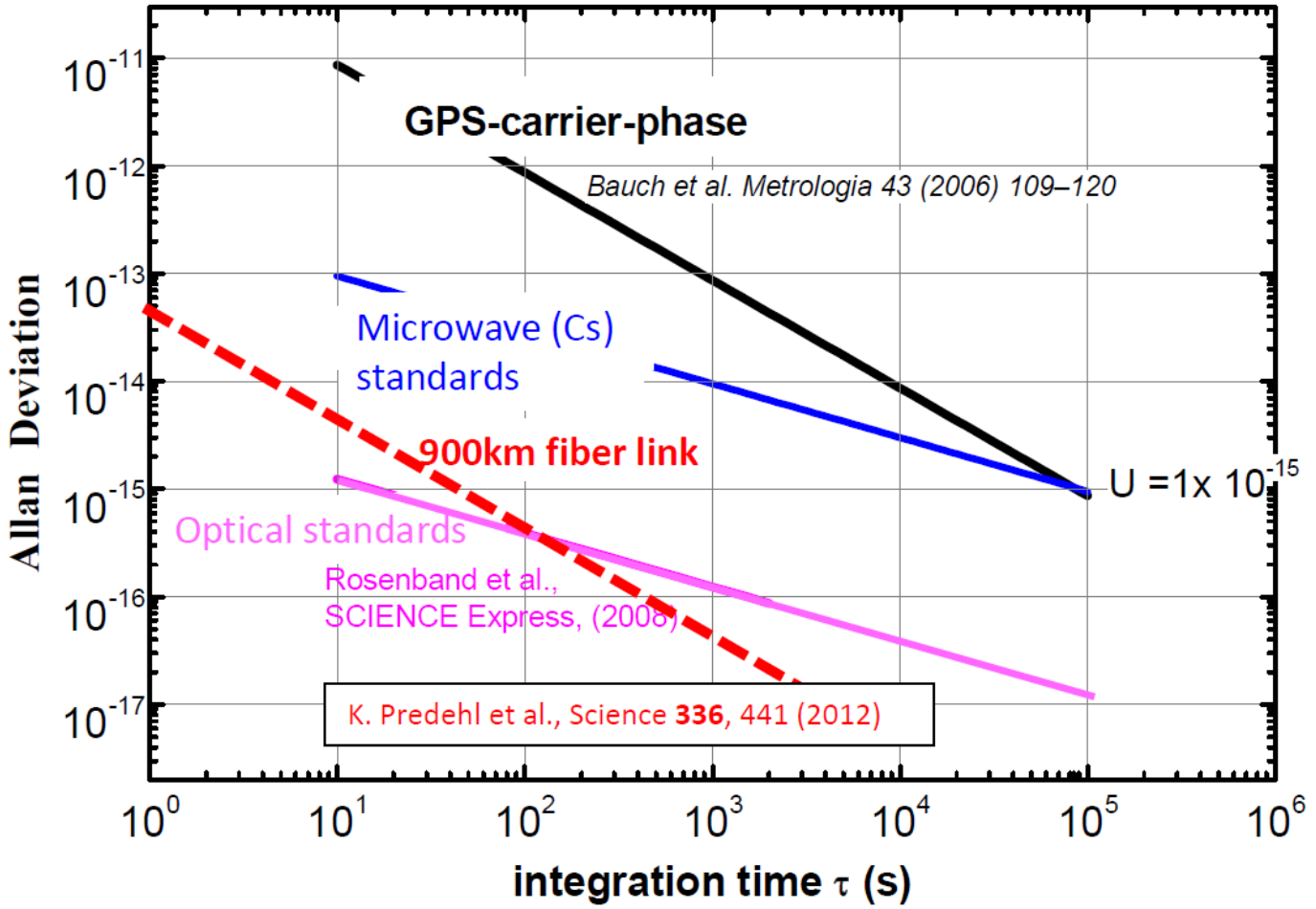
Commercial technologies

Limit of commercially available technology

Achievable with optical frequency and time distribution via optical fibre

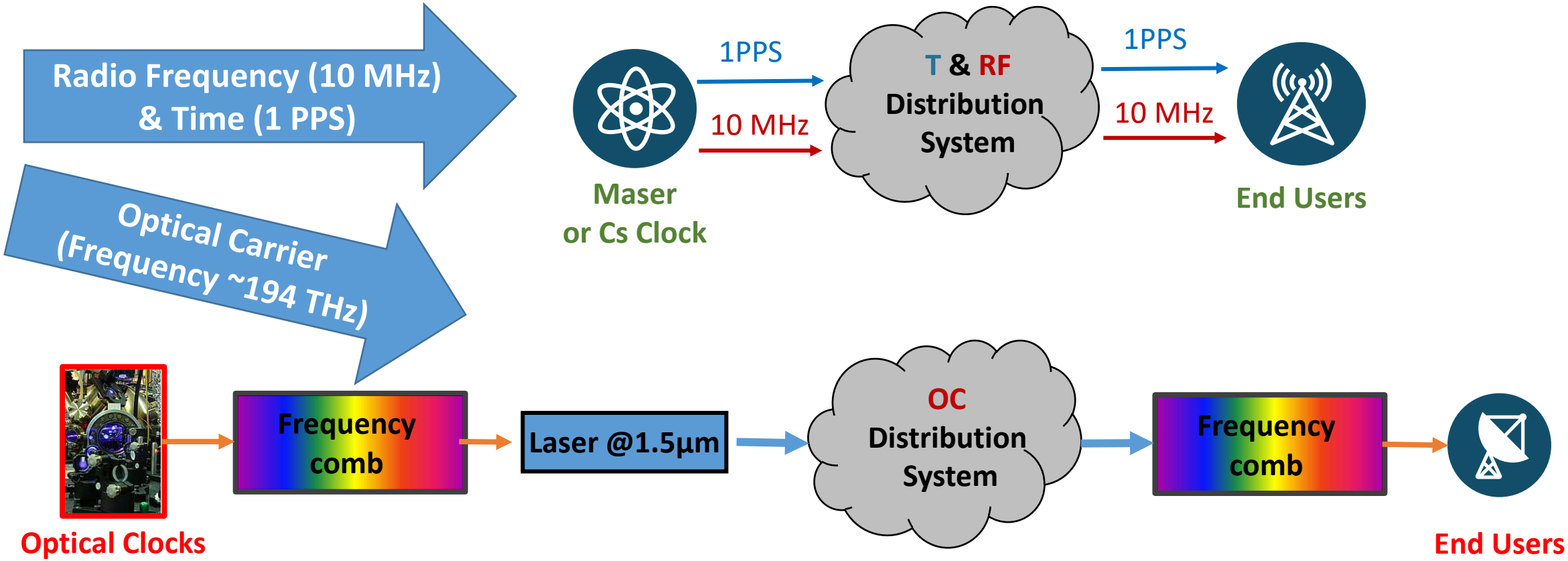
Satellite transmission vs fibre transmission

New Optical Standards
needs fibre links
for frequency transmission



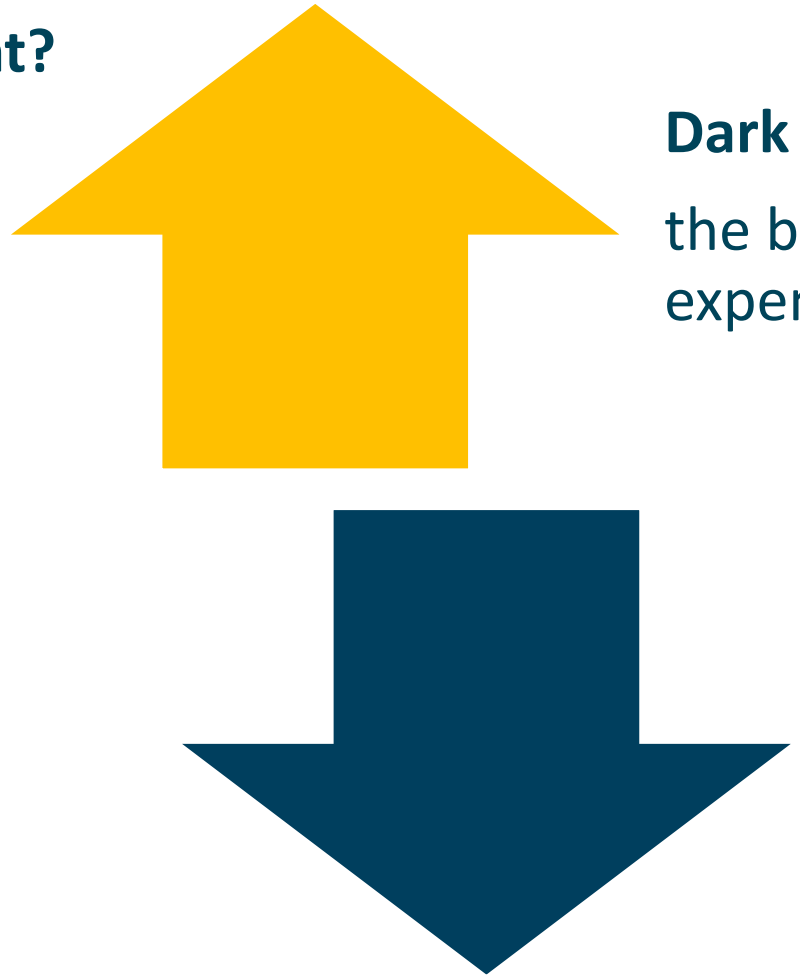
T&F -> simple acronym – not easy decisions (1)

What kind of signal will be transmitted?



T&F -> simple acronym – not easy decisions (2)

How to implement?



Dark Fibers

the best option but also the most expensive

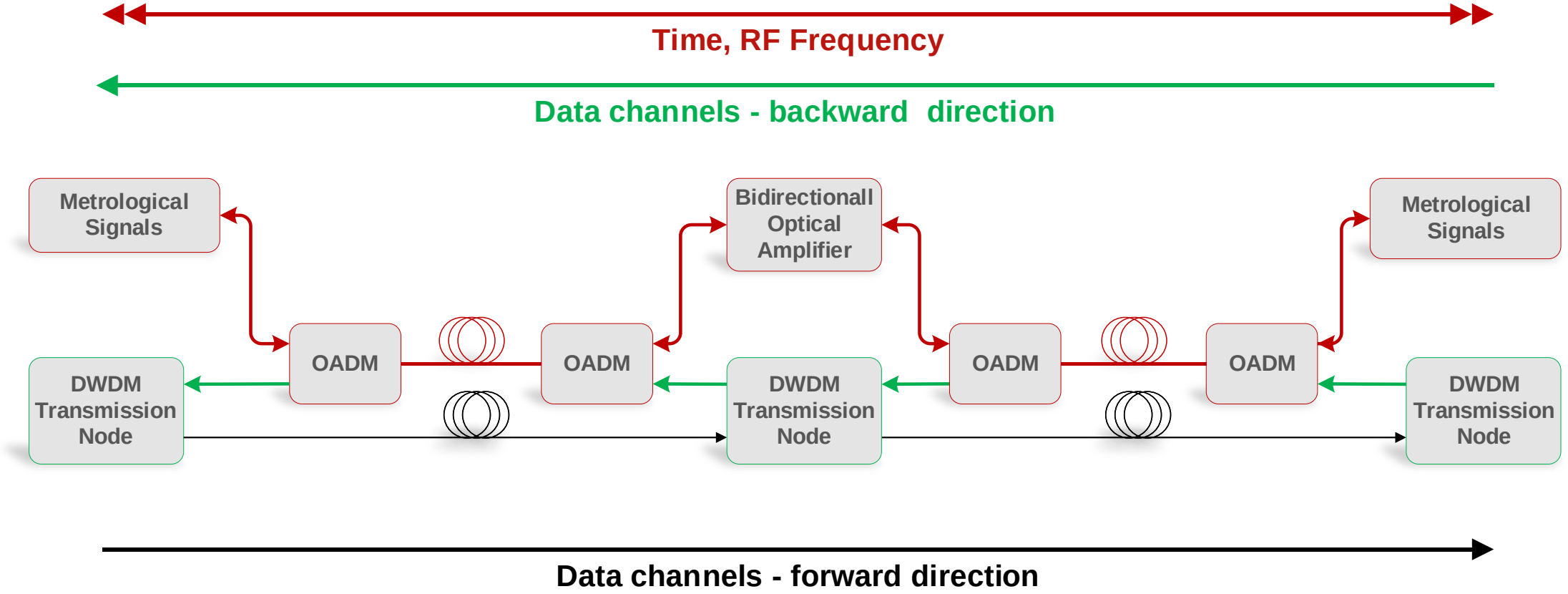
Dark Channels

does not require renting additional fibers, but requires difficult integration with transmission system (DWDM)

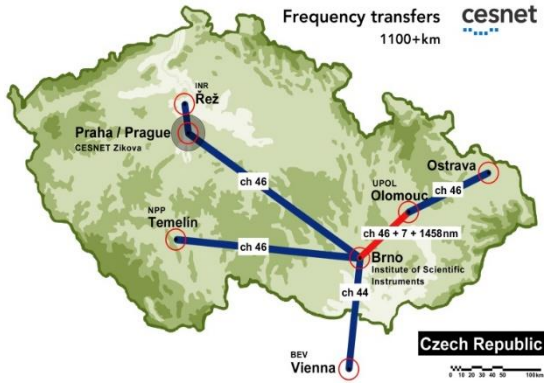
If Dark Channel which band? C or L?

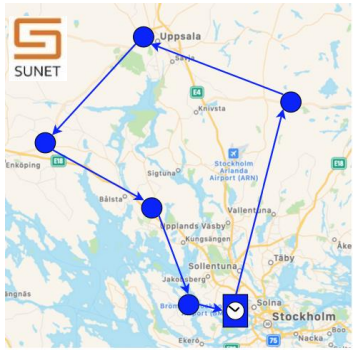
T&F -> simple acronym – not easy decisions (3)

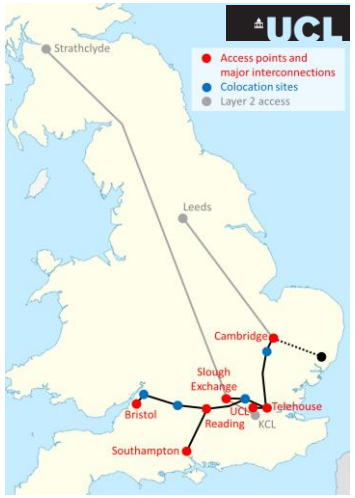
Bidirectional time and frequency transfer in unidirectional DWDM

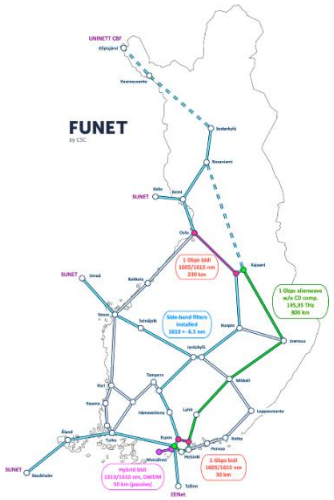


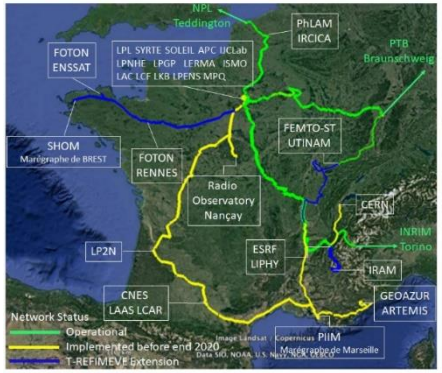
National T&F connections in Europe – examples (1)

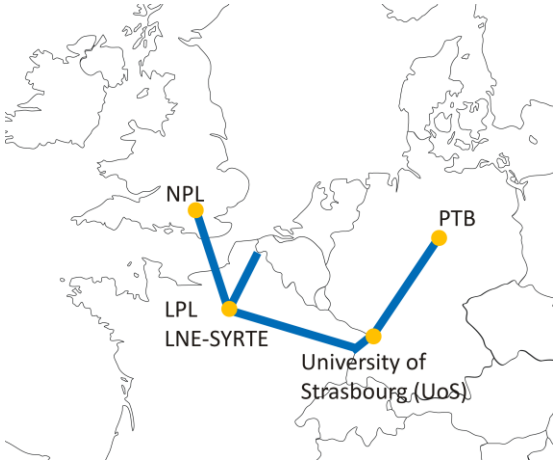


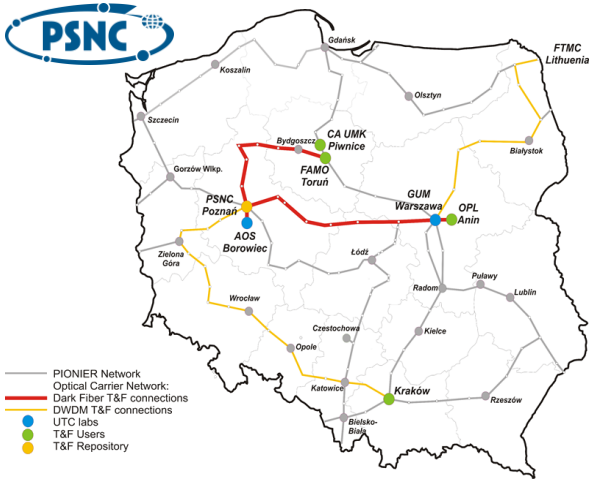












National T&F connections in Europe – examples (2)

Country	Type of architecture	T&F service implemented	Scope
France	Dark channel @194,4 THz	Frequency service (OC)	More than 2 000 km
Switzerland	Dark channel @190,7 THz	Frequency service (OC)	More than 200km
Czech Republic	Dark channel @ 194.4 and 194.6 THz	Time and Frequency (RF and OC) services	More than 1400 km of bidirectional channels and 2 100 km in DWDM
Poland	Dark fibre / DWDM	Time and Frequency (RF and OC) services	More than 1 100 km in dark fibre and about 1 600 km in DWDM

… and many others

T&F service distribution techniques

Technology	Advantages	Disadvantages
Optical Carrier	• Best ultrastable frequency service performances • Has been operated in different setups (dark channel and dark fibre)	• Limited number (but more demanding) of end-users because frequency combs are required to use the distributed signal • Most of equipment is designed to work @ 194.4THz (C-Band) • Requires highly trained personnel.
ELSTAB Active cancellation with electronic delays	• Distributions Time and Frequency services • Wavelength is fixed but can be chosen all over C-Band to fit any ITU channel	• Even greater performances might be required for the most demanding end-users (optical clock comparisons)
White Rabbit PTP	• Easy to use • A wide range of potential end-users • Time and Frequency service • Affordable prices	• Performances only slightly better than GPS

Development of the T/F network in Poland (1)

PIONIER LAB
https://pionier-lab.pionier.net.pl/

Development of the T/F network in Poland (2)

Point of access for optical carrier

Source of optical carrier

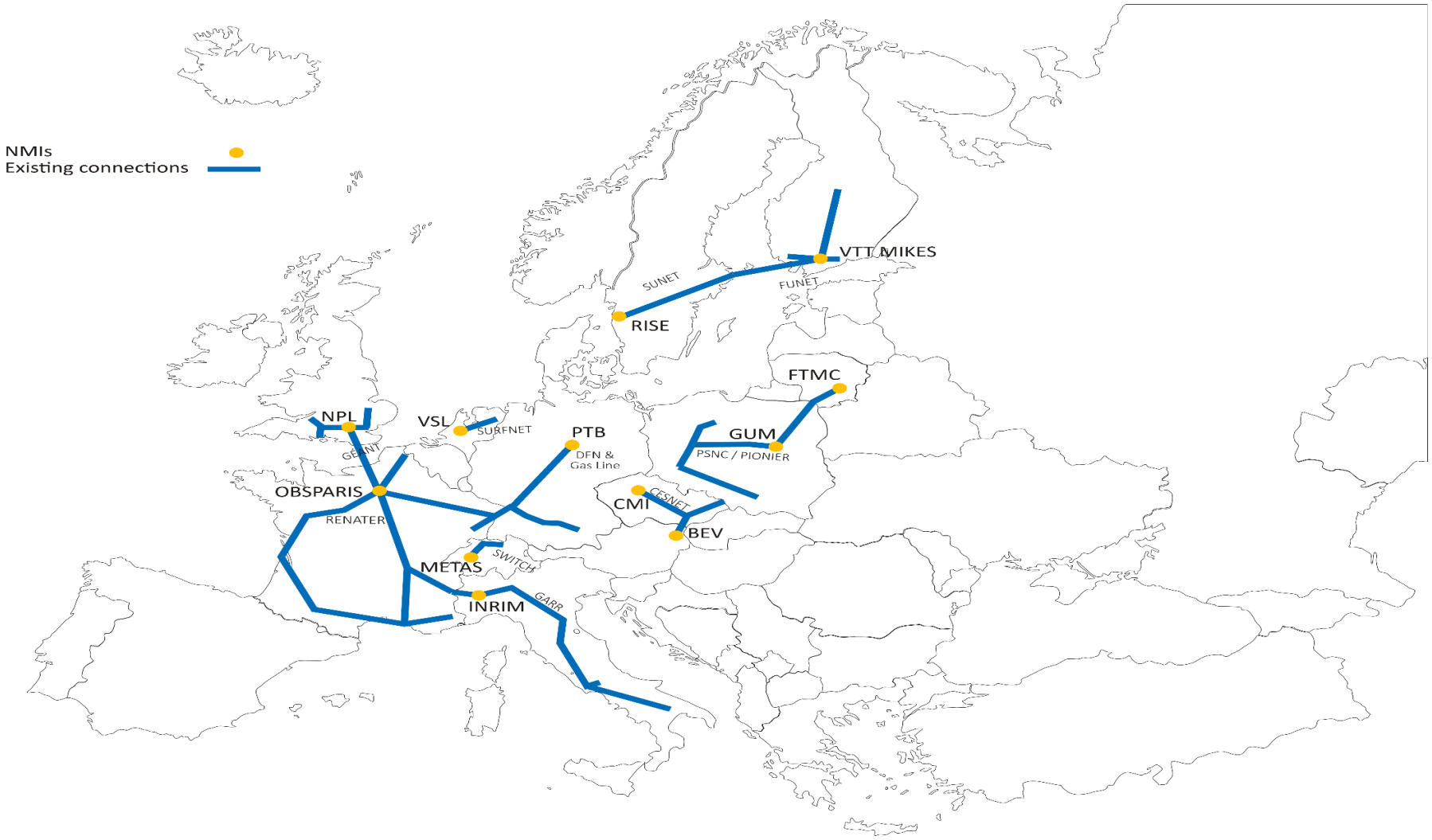
Optical carrier distribution links

The PIONIER network

NLPQT NATIONAL LABORATORY FOR PHOTONICS & QUANTUM TECHNOLOGIES

http://nlpqt.fuw.edu.pl/en/

T&F connections in Europe



CLONETS-DS project

The proposed project aims to **establish a pan-European time and frequency reference system as a European Research Infrastructure to serve the European science community**. It is based on transmitting ultra precise time and frequency information via optical fiber.

NREN

GÉANT, cesnet, PSNC, RENATER CONNECTEUR DE SAVOIRS

Academic & Research

cnrs, Université Sorbonne Paris Nord, ISI CAS Institute of Scientific Instruments The Czech Academy of Sciences, AGH, UNIVERSIDAD DE GRANADA, UNIVERSITÄT BONN, UCL, TUM

NMI

PTB, INRiM ISTITUTO NAZIONALE DI RICERCA METROLOGICA

Industry

MenloSystems, orolia, PIK TIME SYSTEMS®, iXblue

[Project - CLONETS-DS (https://clonets-ds.eu/)](https://clonets-ds.eu/)

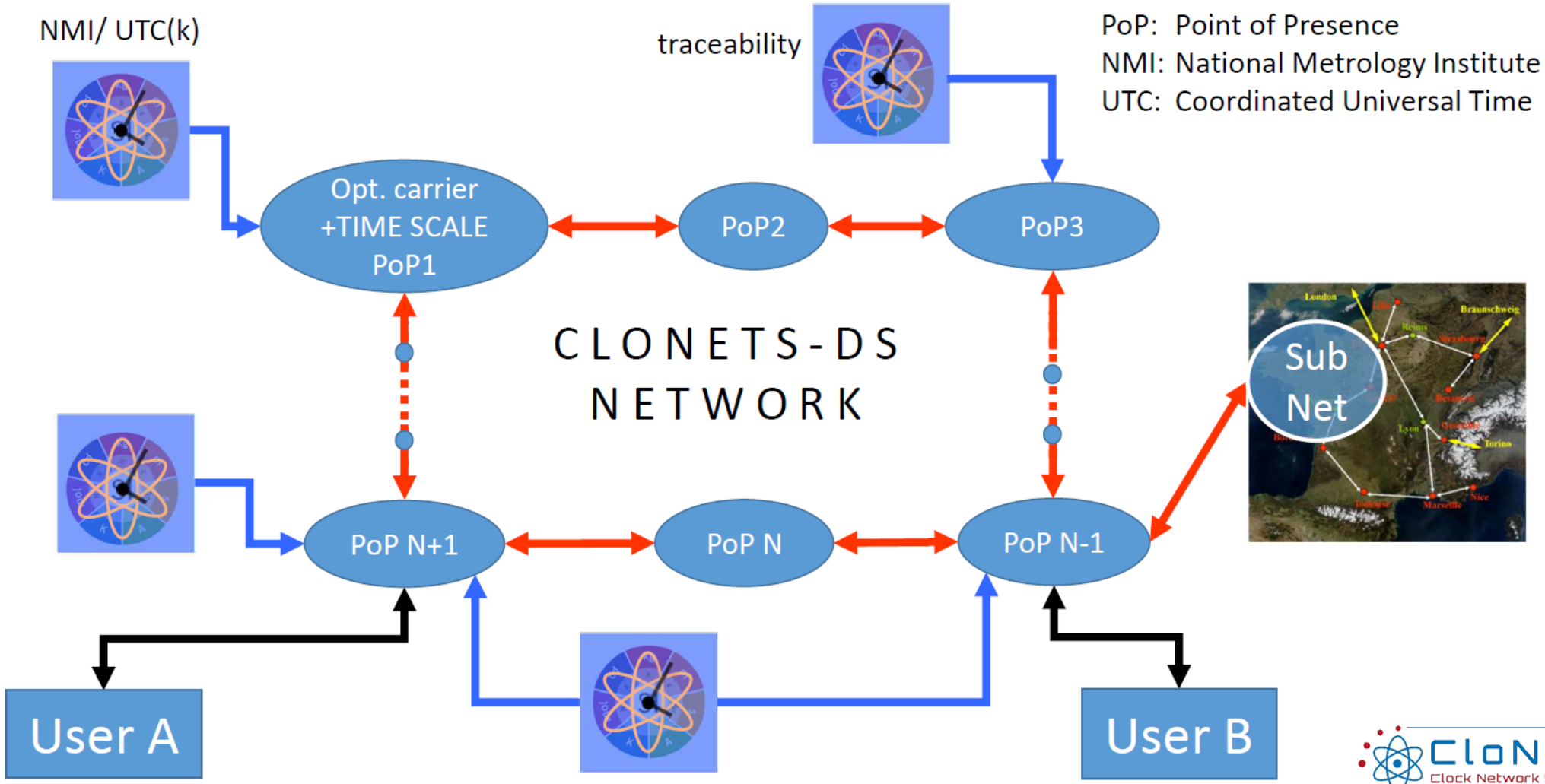
CLONETS-DS - European Infrastructure

Main objectives of the project:

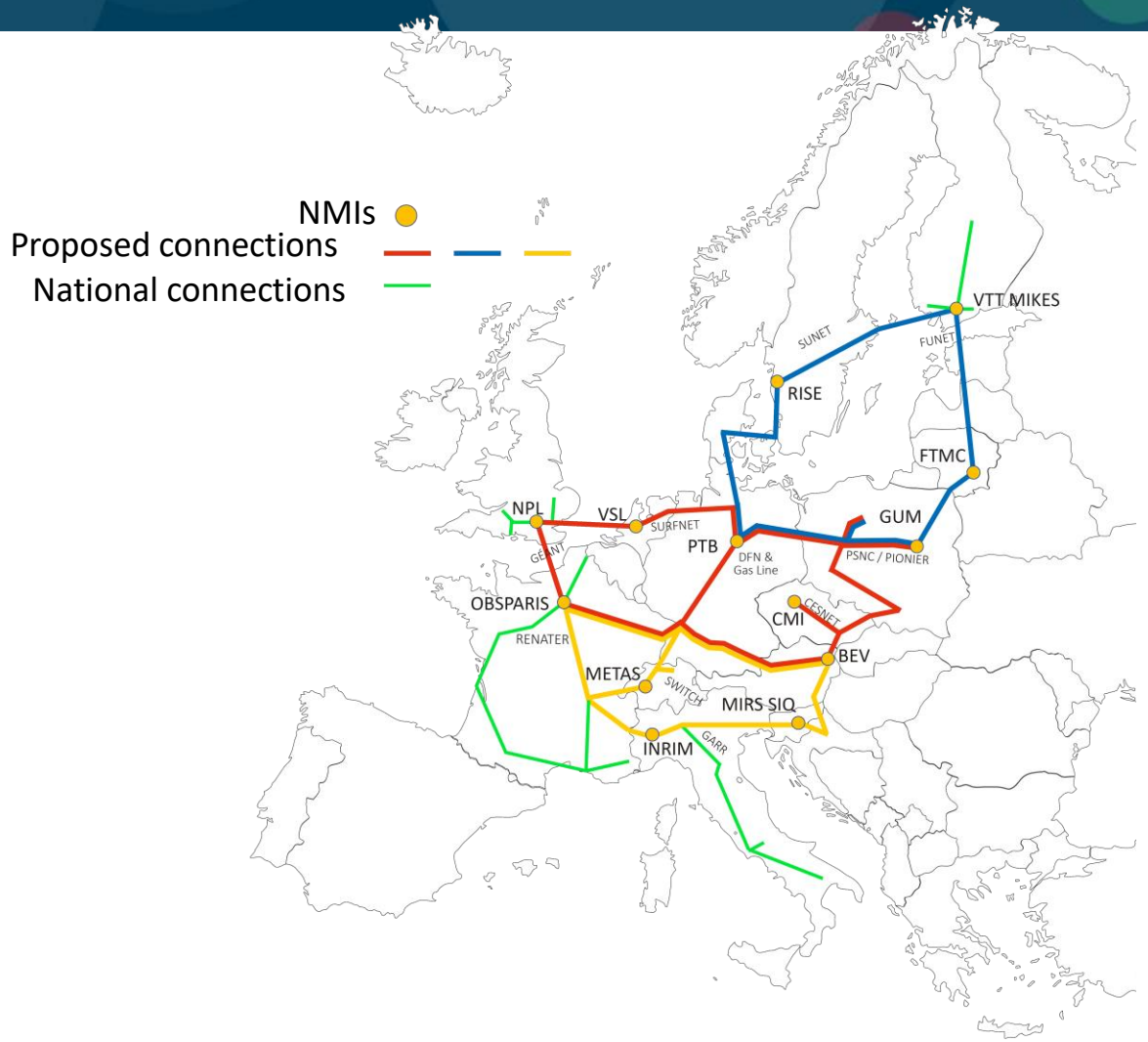
- **Identify the needs of the scientific community for ultra-precise time and frequency measurement** in various scientific fields, such as: fundamental physics, metrology (including optical clock comparisons), applications in geodesy, Very Long Baseline Interferometry (VLBI), telecommunications and navigation.
- **Define a network architecture that supports T&F transfer services** at the highest level of stability and accuracy, while allowing parallel usage by different scientific communities and multiple users at the same time.
- **Defining roadmaps and strategies to implement the proposed research infrastructure.** This will include a costing model, future governance structure, as well as plans for efficient development, usage of the infrastructure, and estimation of potential future economic and social impacts.
- **Inclusion of the T&F network on the ESFRI roadmap**.
- Implementing time and frequency services into the European research and development community.

CLONETS DS
Clock Network Services Design Study
https://clonets-ds.eu/

The CLONETS-DS vision of a network



CLONETS-DS - Planned network topology



Benefits:

- allows the incorporation of national implementations
- allows the implementation of different techniques
- no constraint regarding dark channel or dark fibre
- no predetermined provider (NREN, GEANT, company...)
- open, expandable, adaptable structure
- easy implementation of novel concepts

CLONETS DS
Clock Network Services Design Study

https://clonets-ds.eu/

Thank you

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