

Time and Frequency service monitoring and management

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Agenda

- User needs
- Ways of implementing T/F signal distribution
- T/F service monitoring and management
- International T/F connections in Europe

Group of users



Transport



Navigation

Power Grids



Finance



Defence



Security

Telecommunication
(ICT)



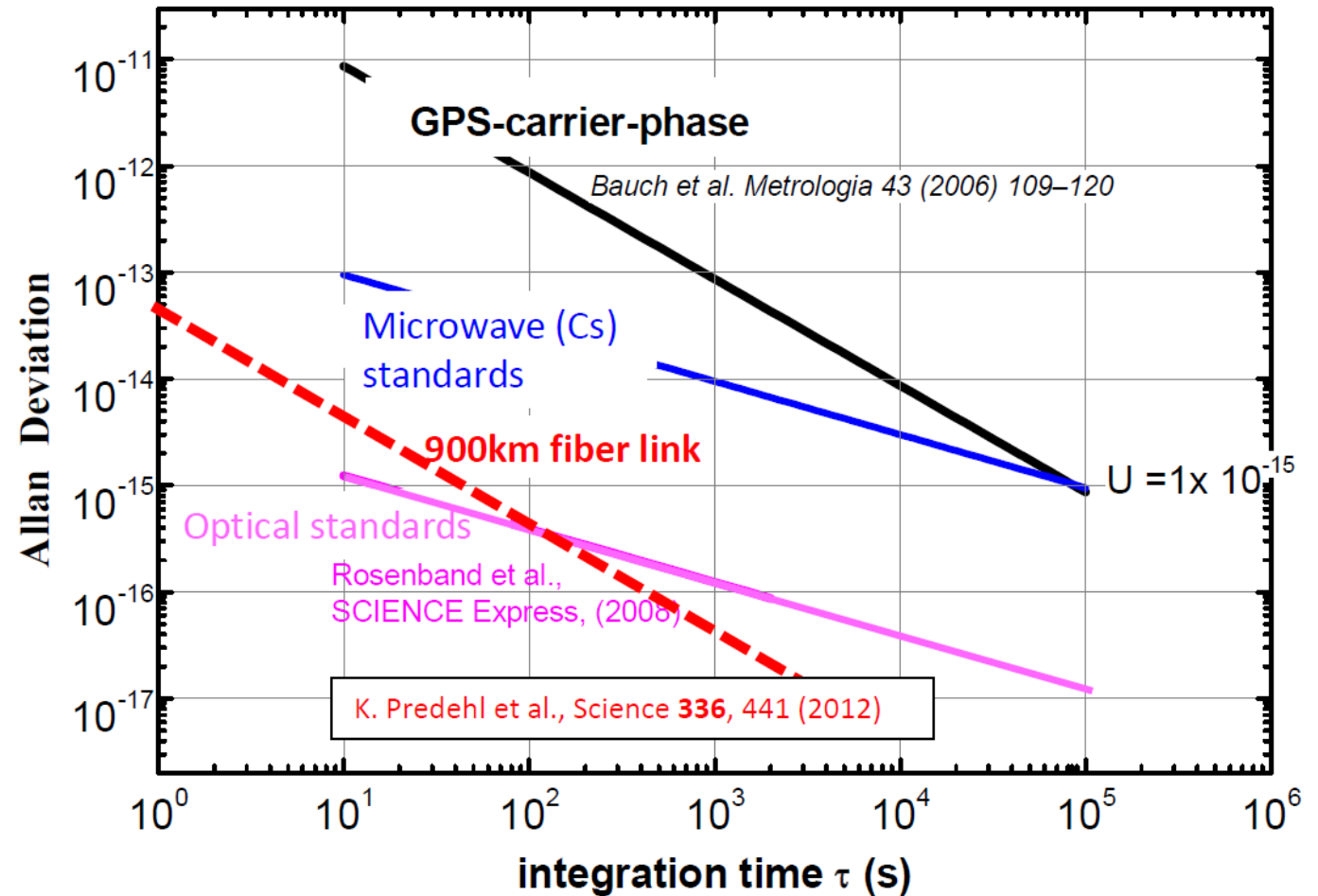
Science



Satellite transmission vs fibre transmission



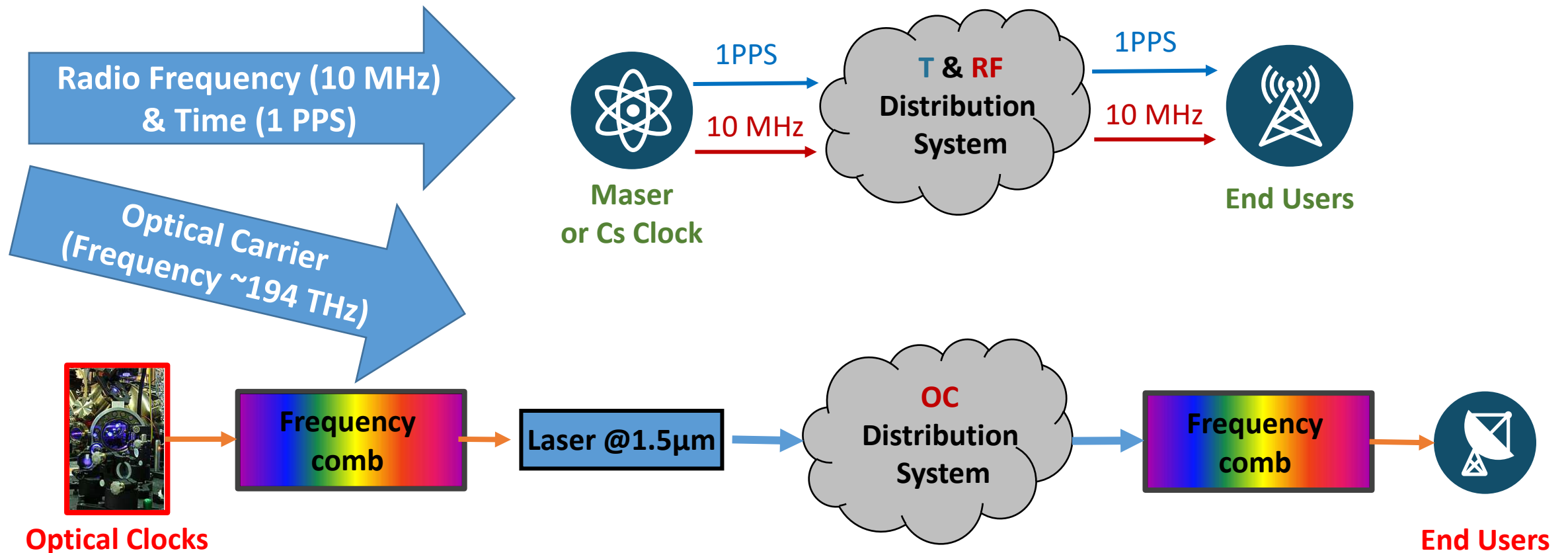
New Optical Standards
needs fibre links
for frequency transmission



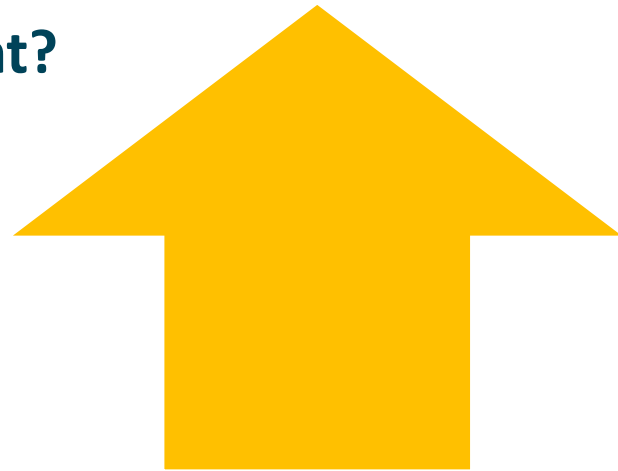
T&F -> simple acronym – not easy decisions (1)



What kind of signal will be transmitted?



How to implement?



Dark Fibers

the best option but also the most expensive



Dark Channels

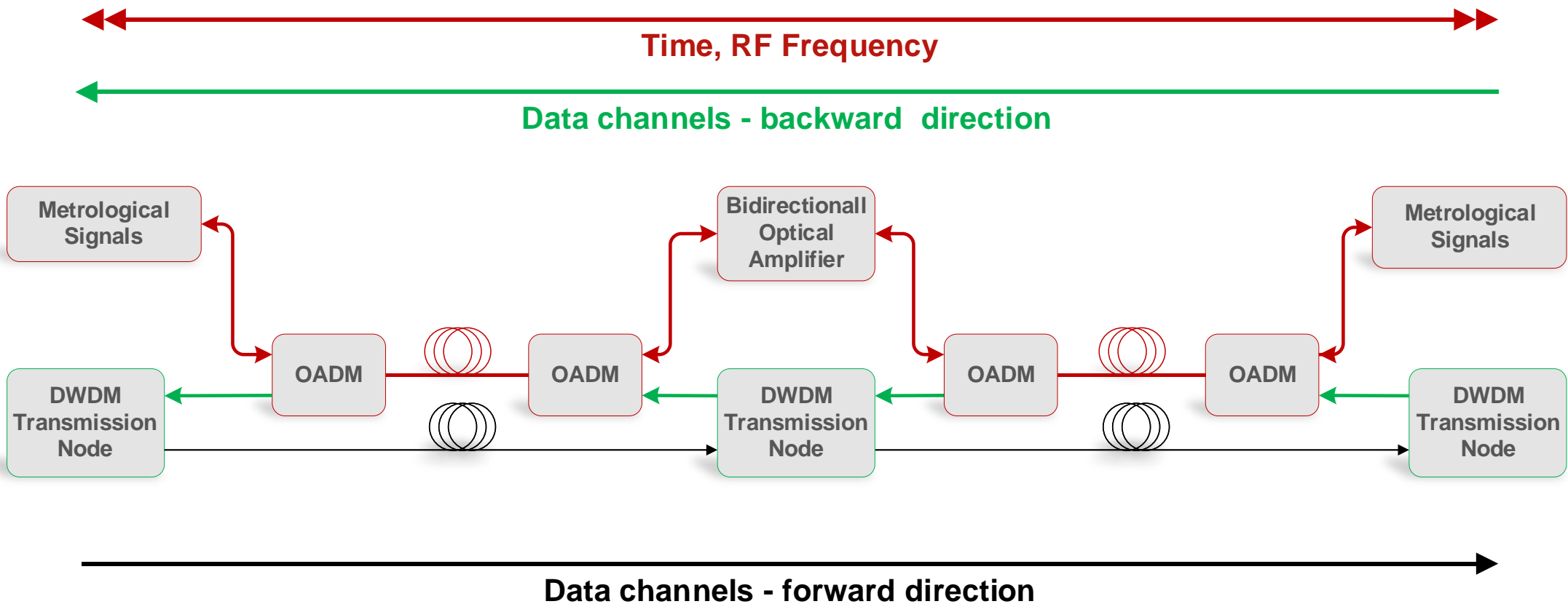
does not require renting additional fibers, but requires difficult integration with transmission system (DWDM)

If Dark Channel which band? C or L?

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



Bidirectional time and frequency transfer in unidirectional DWDM

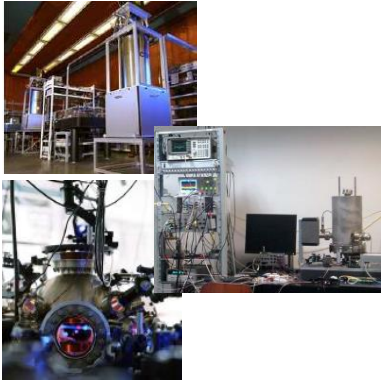


T&F service distribution techniques

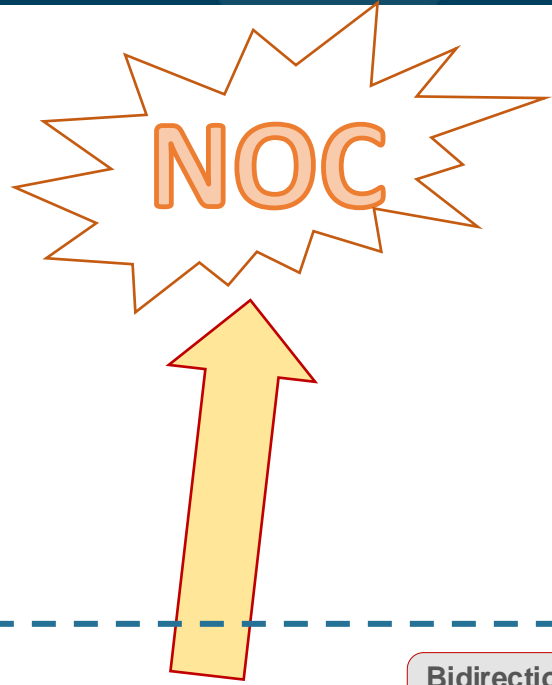


Technology	Advantages	Disadvantages
Optical Carrier	<ul style="list-style-type: none">• Best ultrastable frequency service performances• Has been operated in different setups (dark channel and dark fibre)	<ul style="list-style-type: none">• Limited number (but more demanding) of end-users because frequency 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	<ul style="list-style-type: none">• Distributions Time and Frequency services• Wavelength is fixed but can be chosen all over C-Band to fit any ITU channel	<ul style="list-style-type: none">• Even greater performances might be required for the most demanding end-users (optical clock comparisons)
White Rabbit PTP	<ul style="list-style-type: none">• Easy to use• A wide range of potential end-users• Time and Frequency service• Affordable prices	<ul style="list-style-type: none">• Performances only slightly better than GPS

T/F service monitoring and management



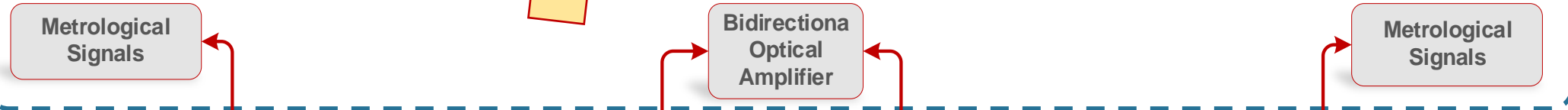
Metrology signal sources



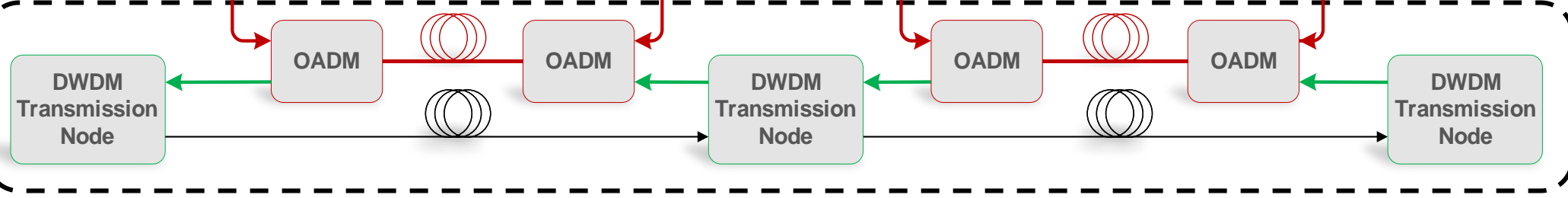
End users



The metrology signal transfer system



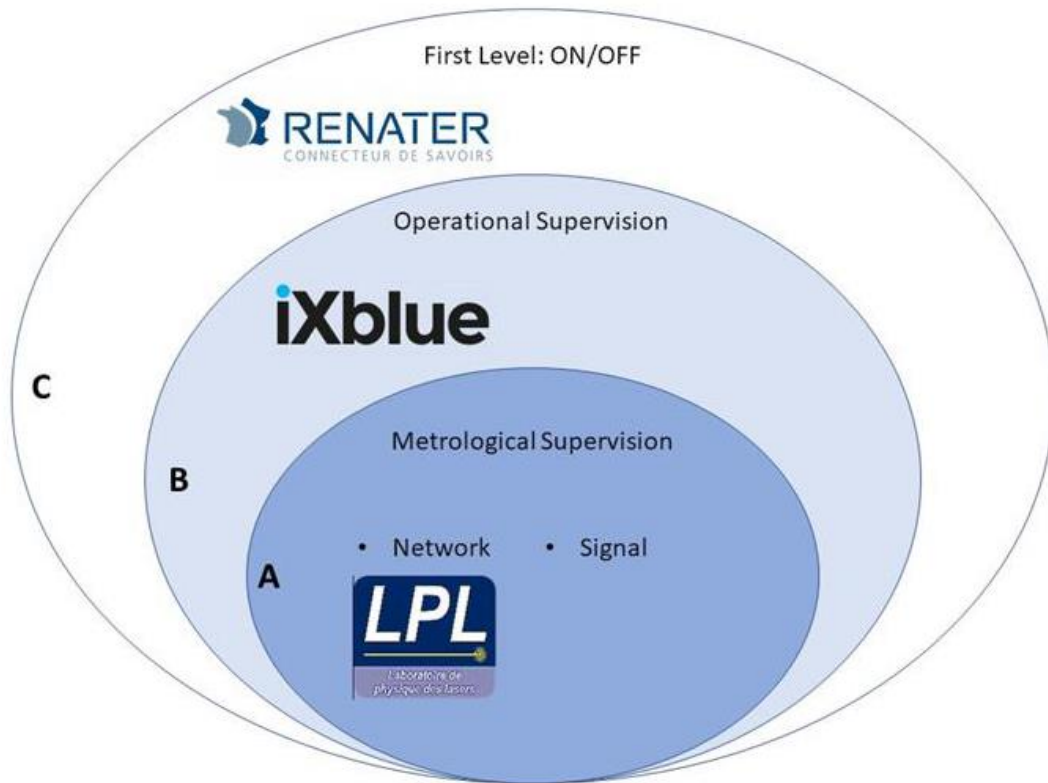
The telecommunication data transmission system



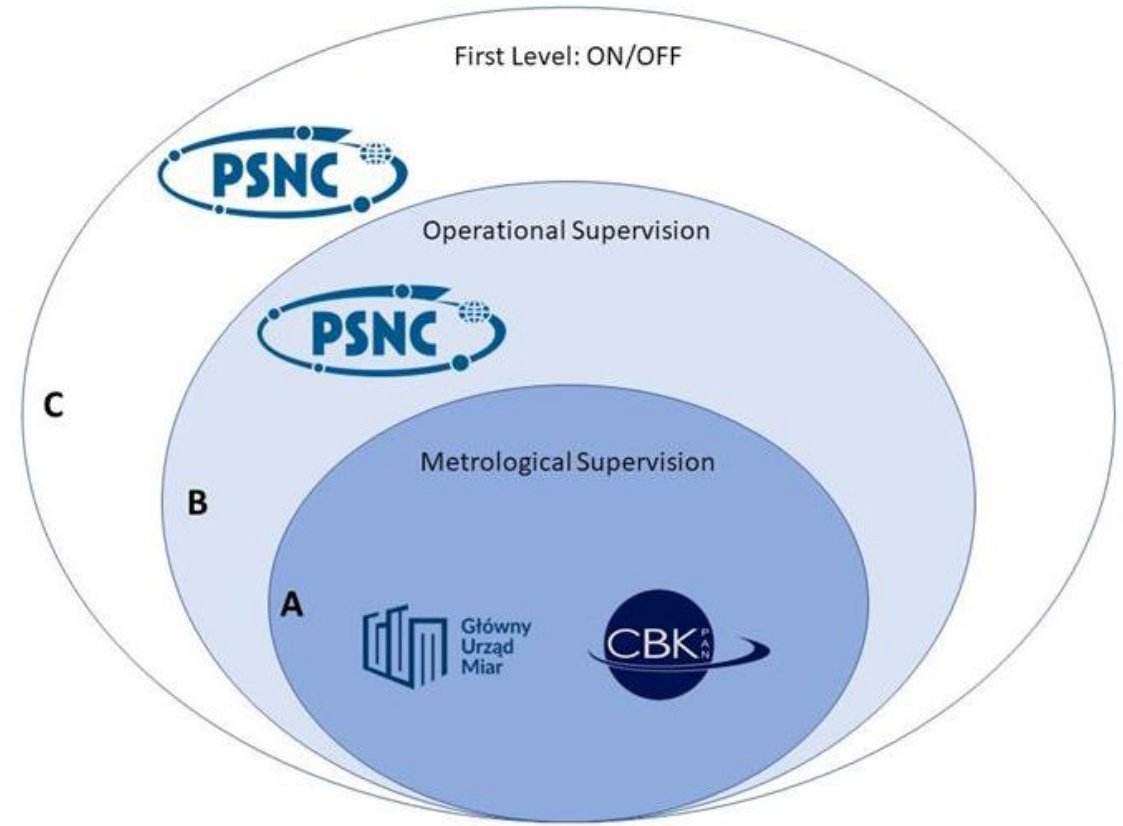
Levels of responsibility for metrological networks - examples



FRANCE



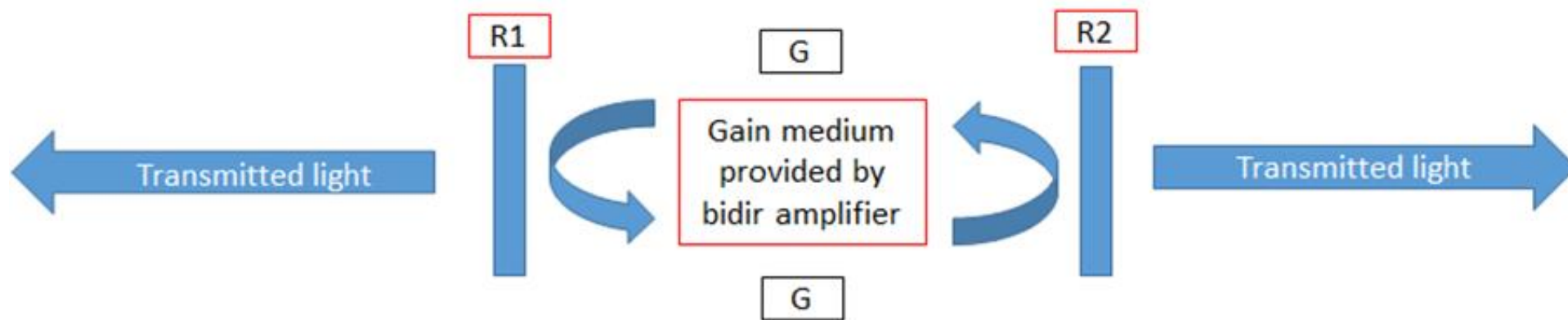
POLAND



What might surprise network administrators (1)

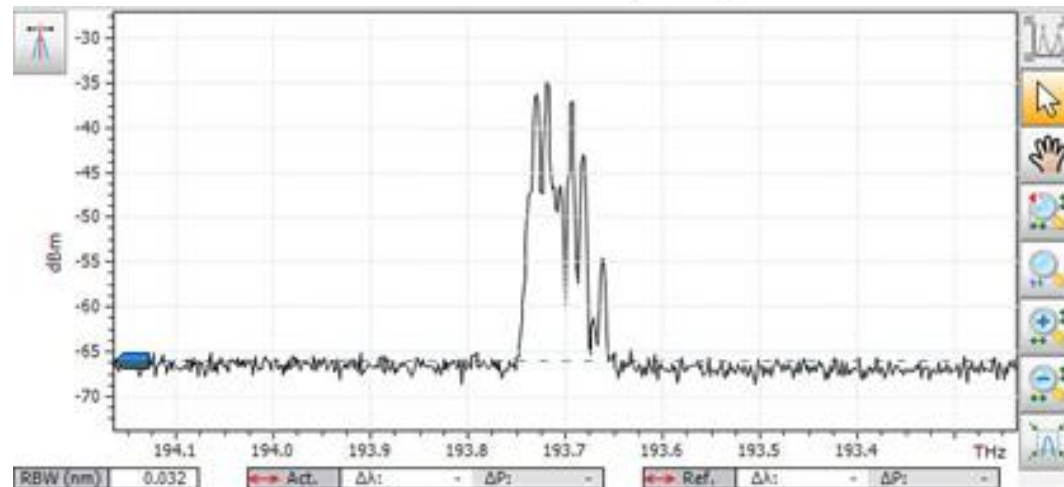


Reflections and Rayleigh scattering in two-way systems can be a serious problem



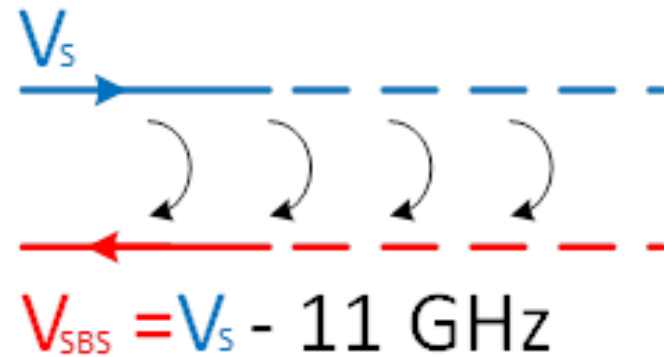
Amplifier lasing
(oscillating) issue

$$2G > R1+R2$$



Light generated by oscillating amplifiers is extremely chaotic both in terms of optical spectrum, and also in time domain.

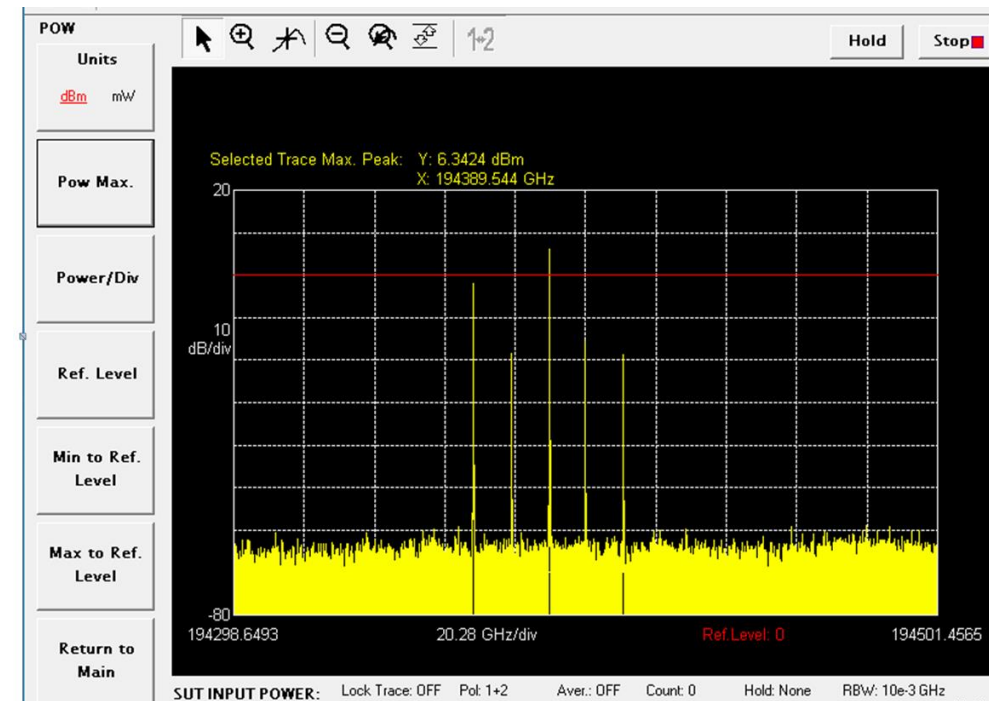
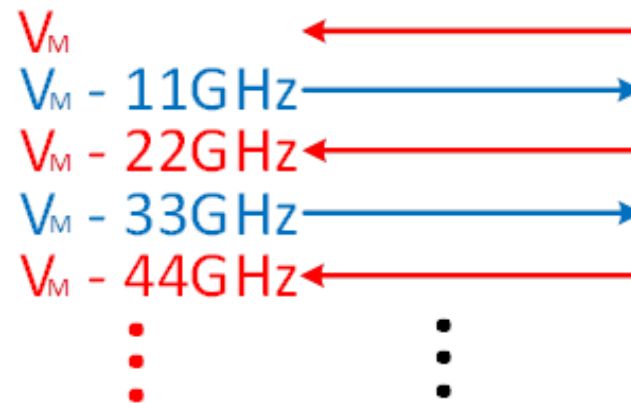
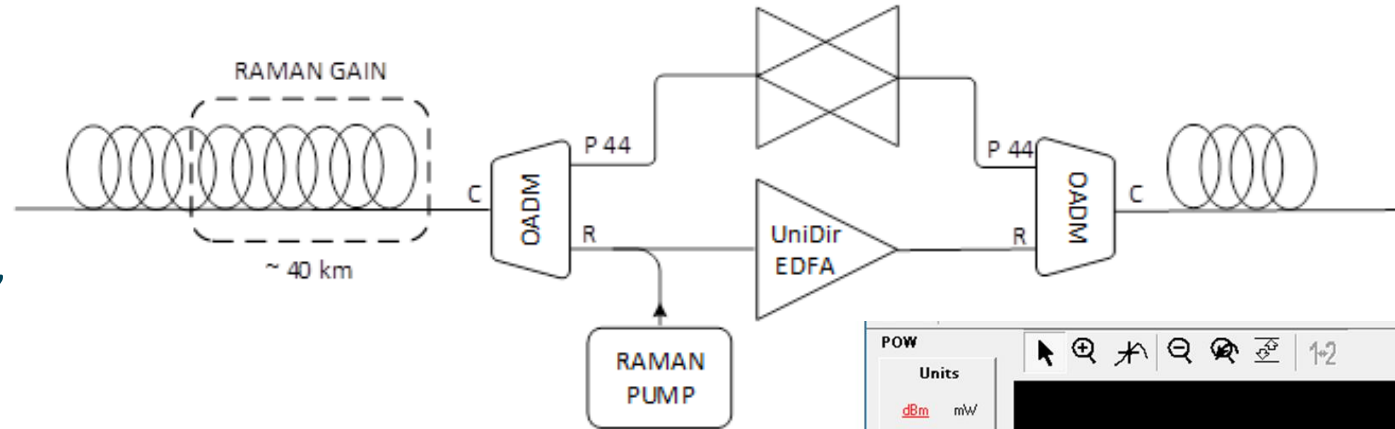
Stimulated Brillouin Scattering (SBS)



- Stimulated Brillouin Scattering is very narrowband (10 MHz) process and so generally not observed in modulated data signals.
- In particular, it is a limitation on the maximum optical power of OC signals, however ...

What might surprise network administrators (3)

... high optical signal copropagated with Raman pump can cause so-called „optical comb” (due to SBS, Rayleigh)



What might surprise network administrators (4)

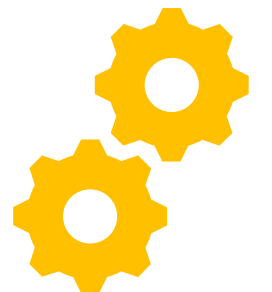


Other issues:

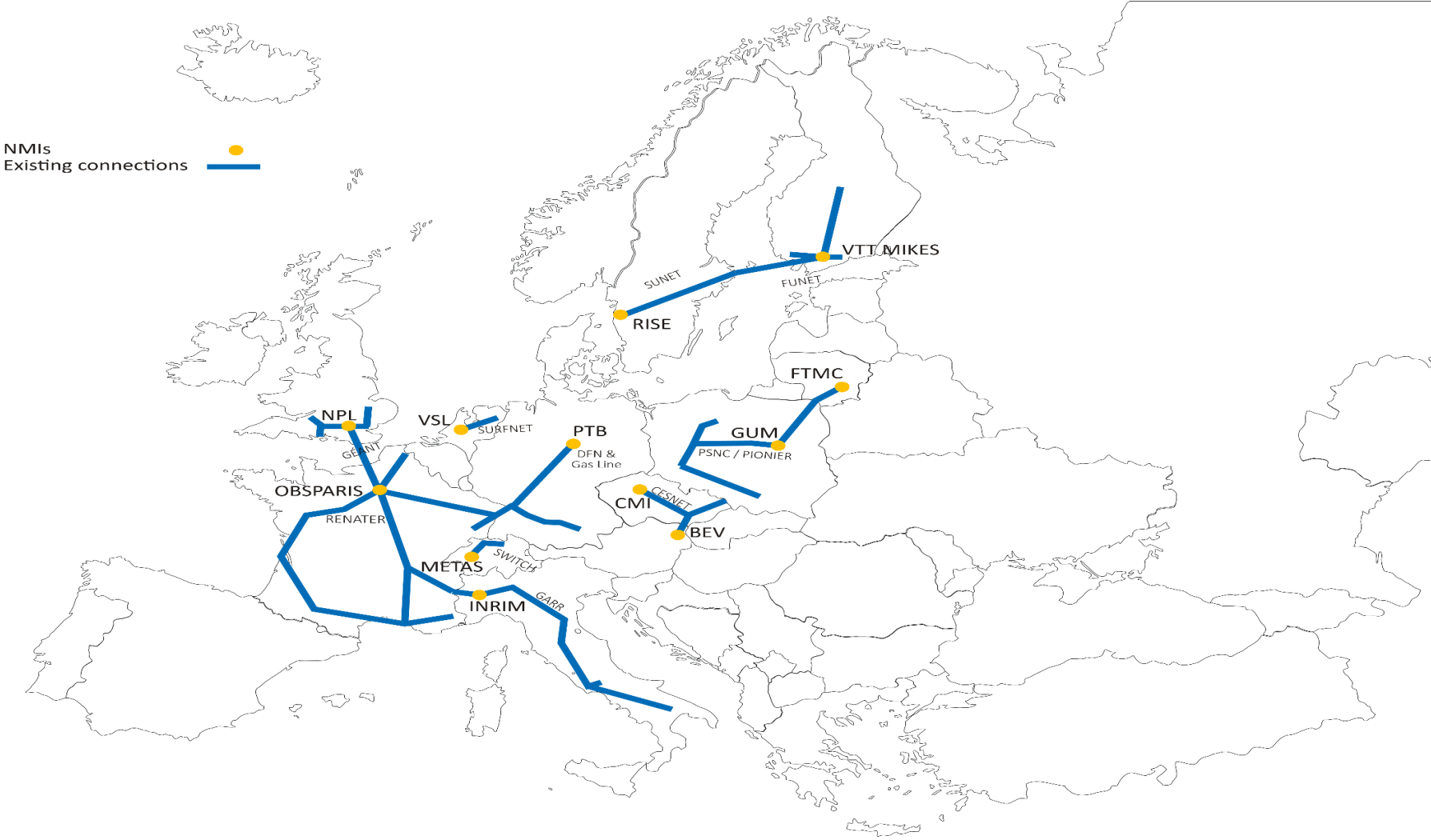
- Changing the level of Raman gain also changes the gain of metrology signals.
- The need to calibrate the time transfer (total line delay) - without this the time signal is useless. The calibration procedure is usually well described but requires in different devices but usually requires a time interval counter which is not "standard equipment of networkers"

In summary:

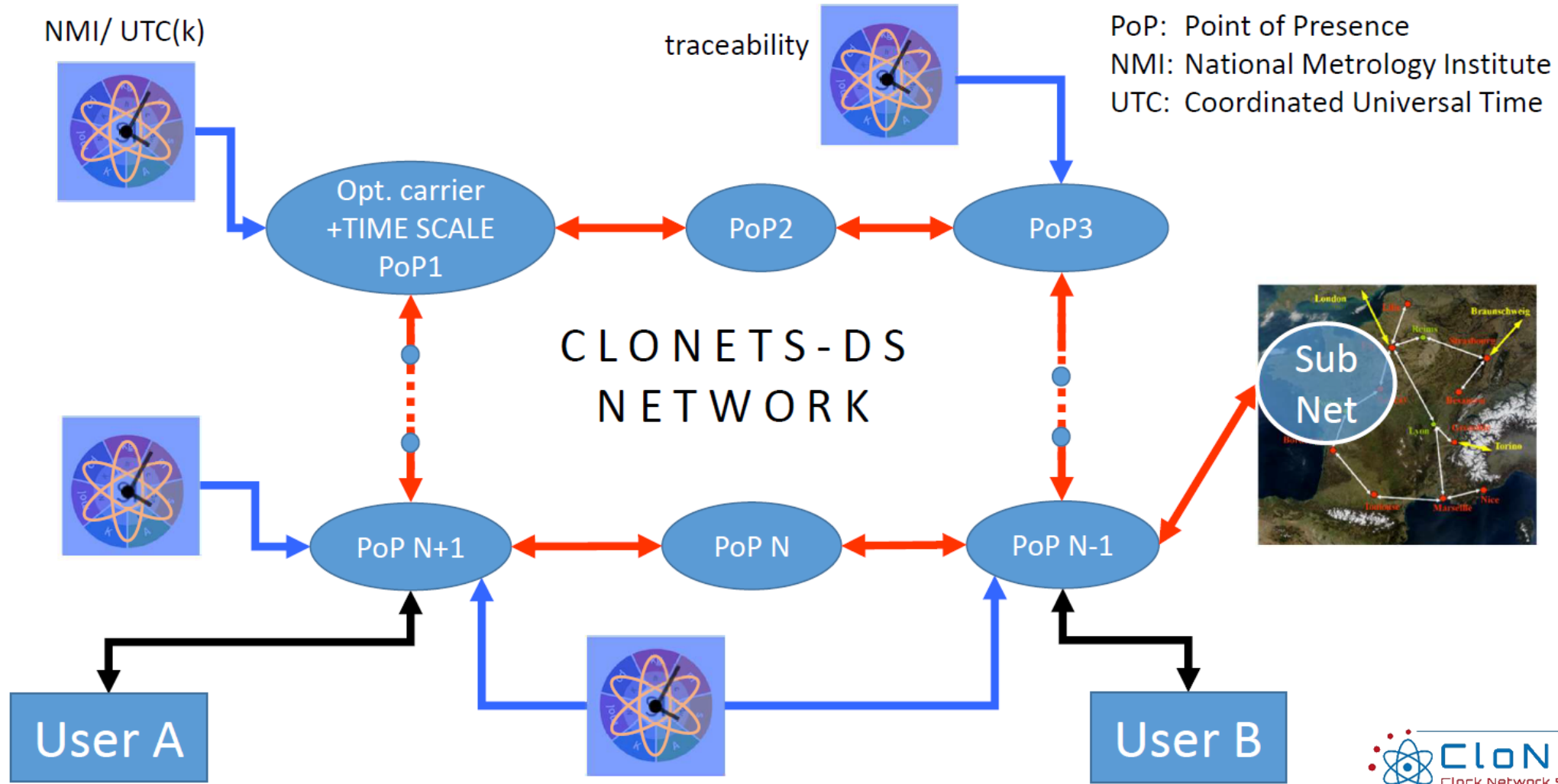
There is a need for close cooperation between "metrologists" and "networkers" in the management of T/F transfer services



T&F connections in Europe



The CLONETS-DS vision of a network



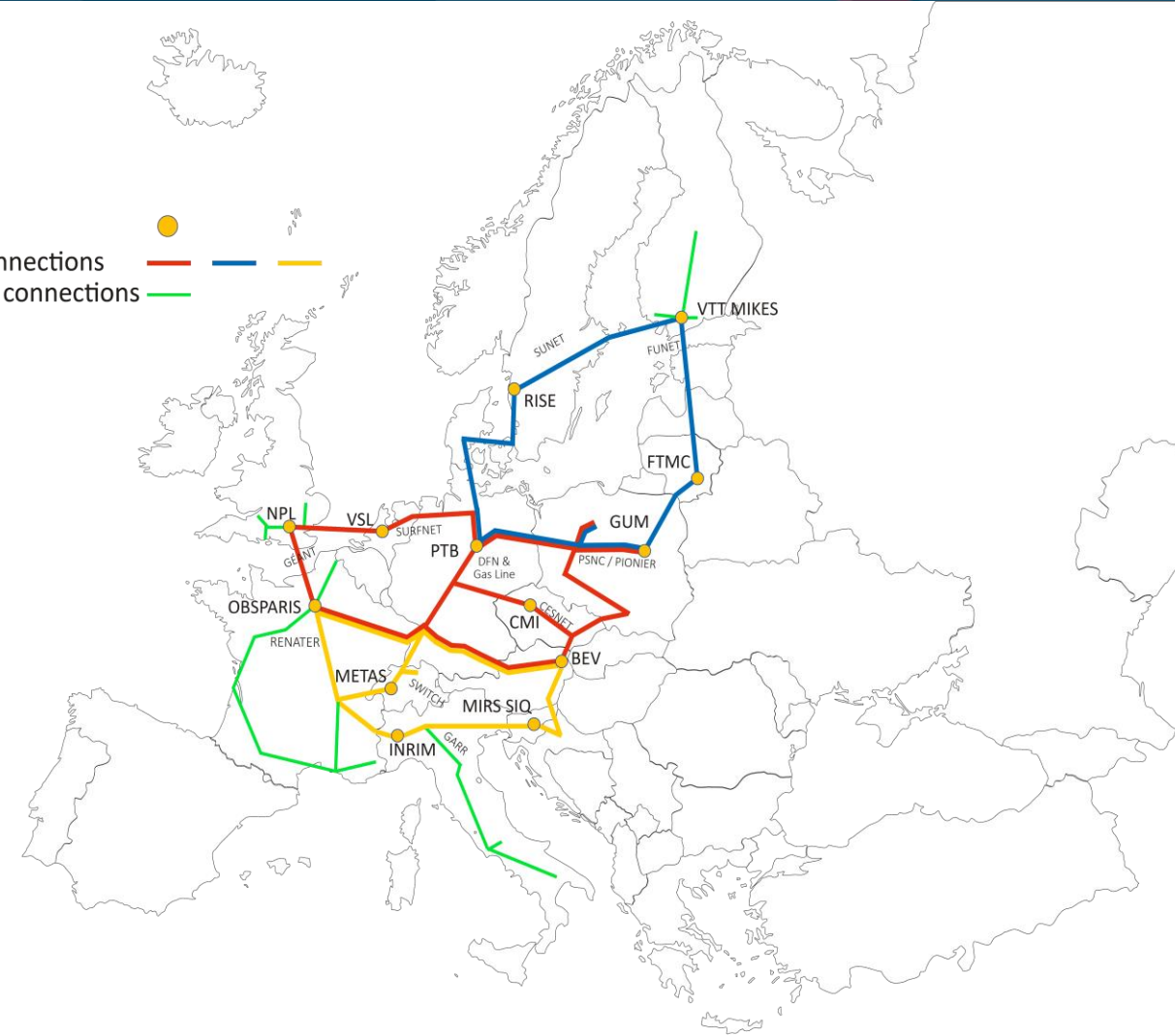
CLONETS-DS Results – RINGs topology



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

NMIs
Rings connections
National connections



Thank you

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