



# GN4-3 and CLONETS

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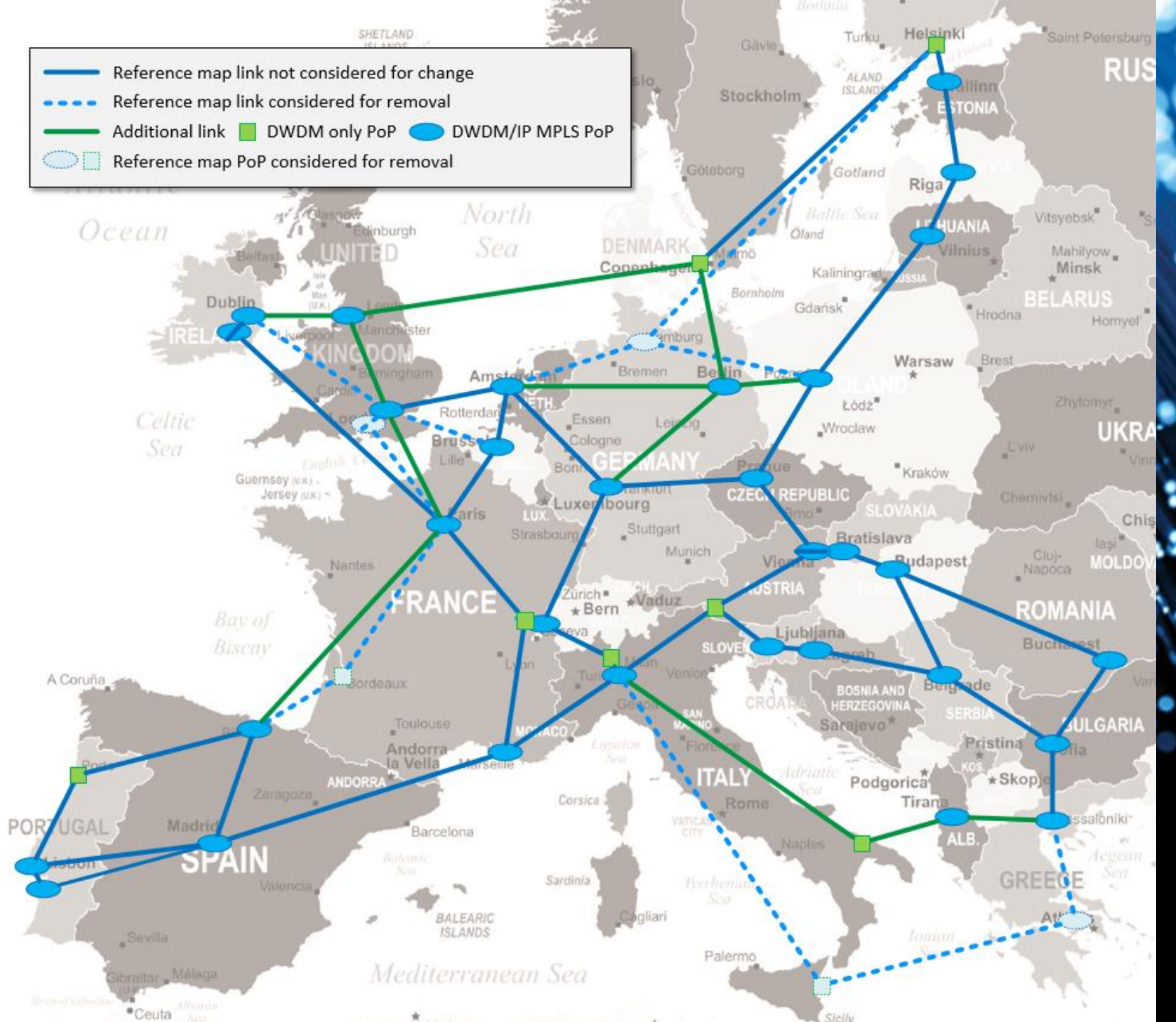
## Fibre IRU – the opportunity

- In funding cycle 2019-2022, the IRU budget to upgrade the optical network is 50M€
- European Commission have set the following objectives
  - *Go beyond the state-of-the-art by restructuring the backbone network through exploration and **procurement of long-term IRUs and associated equipment to increase the footprint**, stimulating the market in cross-border communications infrastructure **whilst decreasing the digital divide and reducing costs***
  - *Improve the **minimum service level** of the smaller European NRENs and their users by ensuring connectivity speeds of **100 Gbps** (where technically and economically feasible)*

*Can this new network infrastructure be leveraged to carry T/F?*

# GÉANT new topology

- This is an evolving map and a number of options are being considered
- Both the solid blue and green links are under consideration.
- Some of the links may be built on NREN fibre, so T/F support will need to be discussed with those NRENs





## GÉANT's new optical transmission equipment

- GÉANT currently uses Infinera DWDM equipment, we choose a new optical equipment vendor this year
- Equipment will be rolled out in 2020-2022 as we move to our new fibres.
- I will be leading the choice of optical equipment vendor. We will short-list 6 vendors and put them on a framework contract for the whole NREN community to purchase from.
- Then GÉANT will pick one of the vendors to build our own network.
- We plan to add a requirement to support bidirectional time/frequency signals to the invitation to tender.
- *A short (around 100 word) statement of metrology technical requirements from CLONETS can be included in the Tender.*
- During the competitive dialogue phase of vendor negotiations I will ask the vendors to propose how they could carry bidirectional T/F signals using their equipment based on the metrology requirements

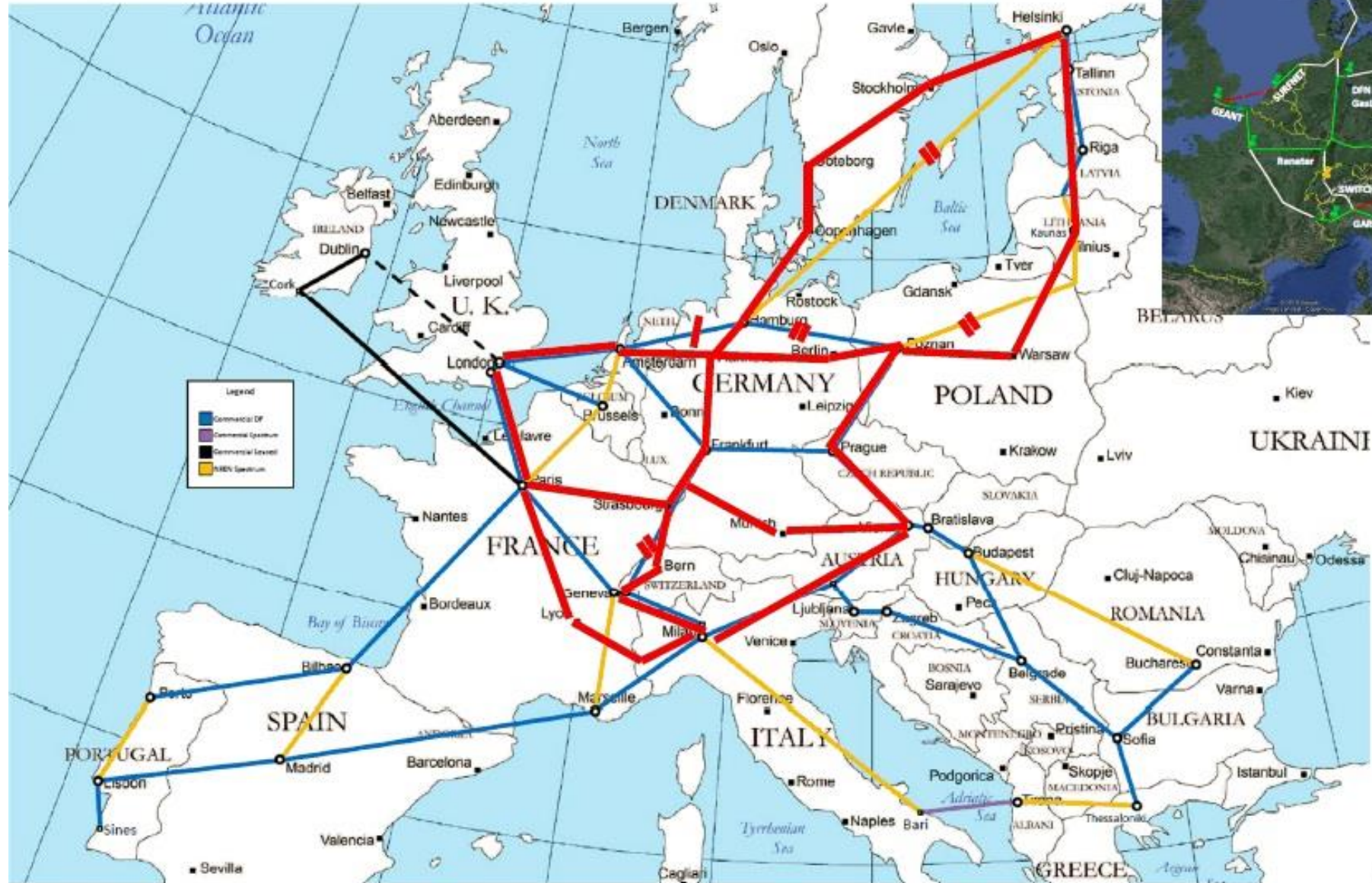


## Metrologists requirements

- The proposal would be to connect with the highest priority with fully bi-directional links: **Milan-Paris-London-Amsterdam-Berlin-Poznan-Prague-Milan**
  - *INRIM will manage to connect in Milan via the LIFT project (GARR, about 10 existing nodes)*
  - *OP will manage to connect in Paris via REFIMEVE project (RENATER, about 10 existing nodes)*
  - *NPL will manage to connect in London via its own rented fiber or via JISC*
  - *PTB will manage to connect in Berlin via its own rented fiber or via DFN*
  - *GUM will manage to connect in Poznan via the OPTIME project (PSNC, about 10 existing nodes)*
  - *UFE will manage to connect in Prague via CESNET (about ? existing nodes)*
- *With a second order of priority, the proposal is to provide :*
  - *extension towards Northern countries (Denmark, Finland,...), one day towards Russia ?*
  - *extension towards Spain, Portugal*
  - *extension towards Slovenia, Bosnia, Romania...*



# Overlay of GÉANT and CLONET maps





# Optical Time and Frequency Network (OTFN) in GÉANT

OFTN task objectives are:

- WP leaders: Ivana Golub (PSNC) and Tim Chown (JISC), Task leader: Xavier Jeannin (RENATER), Technical lead: Guy Roberts (GÉANT) other OTFN task participants: Nicolas Quintin (RENATER), Wojbor Bogacki (PSNC), Krzysztof Turza (PSNC), Josef Vojtech (CESNET), Ernst Heiri (SWITCH), Vladimir Smotlacha (CESNET)
- Review CLONETS results and adapt for GÉANT needs.
- Carry out proof-of-concept pilot services before use GÉANT network.
- Create an engineering design to allow T&F to be disseminated over the next generation of GÉANT transmission network.
- Select optical components to allow T&F to be distributed. E.g. add-drop multiplexers to allocate spectrum for time/frequency distribution for dedicated bidirectional single path optical amplifiers.



## Building a new GÉANT network service

- OTFN team we see two options that we could offer the metrologists: ‘dark channel’ and ‘full service’.
  1. ‘dark channel’ service between amplifier huts. In this case the metrologists will be responsible for everything on their side of an Add-Drop filter.
  2. ‘full-service’ solution as offered by RENATER, CESNET, PSNC and SWITCH. This means providing rack space, power, bi-directional amplifiers which are operated by the NREN/GÉANT.
- NRENs have decided that ‘full service’ is the best solution for metrologists. The optical skills and a 24 hour network maintenance infrastructure are part of the NRENs core expertise and also NRENs would like to have ultimate control to cut the T/F signal in case of lasing effects in the bi-directional amplifiers.
- In either case there will be considerable design work involved in building a monitoring system, building up the skills in our Operations Centre, writing procedures, etc. I estimate this will take at least a year to be defined and agreed.
- GÉANT runs our network on a cautious process-driven basis. The network is very complex and needs to be able to be extremely reliable and able to be fixed in a couple of hours by an operator with few skills in the middle of the night.





## Understanding the cost of developing an new T/F service

- Costs common to all solutions
  - Amplifier rack space
  - Amplifier power
  - Local fibre tails
  - Professional services for bidirectional amplifier system installation
  - 24 hour Operations Centre support manpower
  - Support team training
- Costs for DF
  - Dark Fibre IRU and annual maintenance fee
- Costs for Spectrum
  - Cost of usage of GEANT/NREN spectrum (especially if C-band is used)
  - Fibre ADMs equipment and installation

***GEANT operates on a non-profit cost-recovery basis.***



## Some Indicative costs

- Amplifier sites

	Install /ILA	Rental /ILA/Annum
Average cost	€754.88	€6,485.78

- Fibre

15Yr DF Contract quotes fibre pair			
		NRC €	ARC €
Milan-Paris	MIL-PAR	1,348,080	188,598
Paris-London	LON2-PAR	1,348,383	14,831
London-Amsterdam	AMS-LON1	335,600	42,016
Amsterdam-Hamburg	AMS-HAM	670,163	56,932
Hamburg-Poznan	HAM-POZ	1,203,627	80,024
Poznan-Prague	POZ-PRA	1,481,928	167,351

- Professional services

For a building a new route: Commission of each ILA site: €7k per site



## Which part of the spectrum?

- Wavelength choice for metrologists: C-band channel 44. + guard bands.
- RENATER – wavelength 1542nm 44<sup>st</sup> ITU channel.
- GARR – currently using 1540 – 1545nm (C-band)
- Some NREN network operators prefer L-band or edge of C-band. This is seen as safer as it keeps a distance away from the data traffic in the C-band. Also it leaves the C-band spectrum free for traffic.
- CESNET – currently using 1540 – 1545nm (C-band), but are considering L-band or S-band.
- SWITCH – around the 1582nm range likely. Solution will be working by end of this year.
- 1625nm suffers from bending losses and EDFA does not work well. 1580-1590nm range helps this.
- PSNC – current preference is dedicated dark fibre – do not share spectrum.
- ADVA equipment has bi-directional mux ports using 1610nm for PTP solution.

***GÉANT considering 1580-90nm range. We have concerns about using the C-band for T/F.***



## Future funding

- The EC has indicated that they are looking to fund a Quantum Communication Infrastructure (QCI).

*“It is initially intended to deploy quantum key distribution (QKD) in various large-scale networks, with scalable communication nodes and **relying when possible on existing classical telecommunications infrastructure**. The QCI should, however, be made from the beginning modular, upgradable to a much broader range of applications, **such as time-base distribution (clock synchronisation)** and future interconnections between quantum computers (“quantum internet”). It is envisaged that the QCI could include both terrestrial fibre and satellite links. “*

- GÉANT/NRENs and metrologists should coordinate with EC to see if there are synergies here.



## Ongoing collaboration after CLONETS

- The GÉANT OTFN team will continue working until 2022
- GÉANT would like to have a *single point of communications with the metrology community* after the end of the CLONETS project.
- This contact point would be the ‘voice of metrologists’ to represent their interests with GÉANT discussion.



## Next steps and questions

- GÉANT fibre does not go all the way to the metrology sites so some dedicated fibre will be needed. Also, not all NRENs will be able to support T/F services.
- Optimal solution will likely need to be a blend of dedicated fibre and NREN/GÉANT spectrum.
- Preferred solution will depend on funding and close collaboration between metrologists and NRENs
- Significant costs will be incurred regardless of whether dedicated fibre or spectrum is used
- 24 hour operations centre and support contracts need to be in place
- Because of cost GÉANT will need to get governance agreement on how such T/F services will be funded.

## notes/actions

- CLONETs is still working to identify the highest-priority endpoints for time/frequency
- GÉANT would like CLONETs to define their requirements for T/F that we can add to our OLS ITSOP.
- Matthew Gordon to do some costing estimates for building and operating a T/F network based on a high-level design by CLONETS. Ring: Milan-Paris-London-Amsterdam-Berlin-Poznan-Prague-Milan. DF and spectrum.
- CLONETs to nominate a single point of contact for metrology community to liaise with OTFN team.
- Expect to receive a request from the metrologists asking if the Ams-Ber fibre can pass through Braunschweig.