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

*GÉANT operates on a non-profit cost-recovery basis.*
Some Indicative costs

• Amplifier sites

<table>
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<tr>
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<th>Install /ILA</th>
<th>Rental /ILA/Annum</th>
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<tbody>
<tr>
<td>Average cost</td>
<td>€754.88</td>
<td>€6,485.78</td>
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</table>

• Fibre

15Yr DF Contract quotes fibre pair

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<tr>
<th>Route</th>
<th>NRC €</th>
<th>ARC €</th>
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<tbody>
<tr>
<td>Milan-Paris (MIL-PAR)</td>
<td>1,348,080</td>
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<tr>
<td>Paris-London (LON2-PAR)</td>
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<td>London-Amsterdam (AMS-LON1)</td>
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<td>Amsterdam-Hamburg (AMS-HAM)</td>
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<td>Hamburg-Poznan (HAM-POZ)</td>
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<td>Poznan-Prague (POZ-PRA)</td>
<td>1,481,928</td>
<td>167,351</td>
</tr>
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</table>

• 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 44th 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.