About GÉANT but just personal remarks, not official

You have heard about CESNET (and other NRENs)

Also you have heard about GÉANT
  - So why another presentation?
  - Part of it is tradition but there are other reasons too...

New optical equipment for GÉANT DWDM network
  - Development is pretty fast, speeds are really high

Similarities between NRENs and commercial networks and data centres
  - Good or bad?
Evolution of network(s)

Capacity only, leased lines
- Rather expensive but problems solved by capacity/line provider

Dark fibre arrived
- Something new for many organizations
- Missing experience with real fibre but clear advantages: price and capacity/speed

Dark fibre and DWDM equipment
- Rather big difference from routing and switching equipment

Then 'only' higher speeds and more wavelengths?
- In a way yes but new projects with specific needs want to use fibres
- **GÉANT and dark fibre and DWDM**
  
  - **Started with first period/phase 2005 [1]**
    - Alcatel equipment, good for what it was
    - Similar to other equipment – rather ’fixed’ configurations, coherent receivers not available, the same goes for ROADM (OK, ’primitive ROADM available, some vendors would be unhappy with this description)
  
  - **Then second phase came in [2]**
    - Another procurement 2011/2012, winner was Infinera with DTN-X platform
    - Different from previous equipment – high speed coherent
    - Also Infinera is rather specific vendor with their opto-electro-opto conversions on the chip
    - Openess and disaggregation miles away
  
  - **New procurement in 2019**
    - In addition to Infinera, GÉANT deployed new coherent equipment Coriant Groove G30 on some fibres
    - Coriant Groove G30 can be purchased by NRENs
    - Coriant was acquired by Infinera – so one vendor in the whole network again:-)
GÉANT and dark fibre and DWDM

2019 – new equipment designed for data centres available

- Coriant Groove G30 and others, like Ciena Waveserver and almost every vendor started to produce such equipment
- Small 1 rack unit boxes (‘pizza’) but really powerful, 100/150/200G speeds normal
- 600G interfaces in 2018/2019 available, with 800G equipment from Ciena
- But also ‘openess’ and ‘white boxes’ and ‘dissaggregation’ are mentioned in last few years

Do we need ‘openess’ and ‘white boxes’ and ‘dissaggregation’?
Some historical remarks

- **2004 – ethernet switch for Google (Pluto)** [3]
  - Coriant Groove G30 and others, like Ciena Waveserver and almost every vendor started to produce such equipment

- **2004 – Czech Light optical equipment** [4]

- **Facebook and Pack6 and other equipment** [5]
  - Facebook and Telecom Infra Project will be mentioned later in this presentation

- **2019 – open 400GE switches and 200G open transponders**
Today

Open WiFi Access Points, Edgecore and Open Compute Project. 5G? LTE?

Also Passive Optical Networks
- AT&T Open XGS-PON 1RU OLT specification contributed to the OCP Telco Working Group
- Open Source Access Manager Hardware Abstraction (OSAM-HA) software

Facebook – Wedge and Backpack switches. Distributed network system Fabric Aggregator. Next-generation data center fabric design F-16

Facebook and Pack6 and other equipment
- Facebook and Telecom Infra Project will be mentioned later in this presentation

2019 – open 400GE switches and 200G open transponders
Open Source for **Hardware** too

The physical future of open source. Some interesting examples:

- **Wedge 40G - 2015**
- **Wedge 100G - 2016**

**Facebook**

"WEDGE"

ToR (top of rack) or "Leaf" switches with 40 Gbps & 100 Gbps ports.
Open ROADM [6]

- Open ROADM Multi-Source Agreement (MSA) defines interoperability specifications for ROADM i.e. ROADM switch as well as transponders and pluggable optics
- AT&T, Ciena, Cisco, Fujitsu, Rostelecom, Saudi Telecom Company, Juniper Networks, Deutsche Telekom, Infinera/Coriant,...
- Czech Light® SDN ROADM
Open Cables [7]

- Open Cables. Started in subsea networks. But the principle is same – different equipment has different lifetime

- Wetplant and Dryplant. Submarine Line Terminating Equipment SLTE (dry) from wet cable: disaggregation in the industry...
Few words about TIP

Initiative launched by Facebook

- CESNET participates in optical activities (OSNR)

Voyager box. Open transponder. 1st generation

Cassini box. Open transponder. 2nd generation
Few words about GTS

Still looking for 'Bandwidth on Demand' features
- Started in GLIF good few years ago
- Not easy discussions about best approach to 'BoD'

Real implementations rare (or non existent?)
So - The 'open' trend is here. Period.

- Major networks, including hyper scale datacentres around the globe, heavily involved
- On all levels: physical, optical, switching, routing...

Let me remind one colleague and his presentation from 2007:

Open Photonic Devices in CEF Networks

Stanislav Sima
CESNET

Why open lighting for Research and Education Networks?

1. Freedom in REN design (fibres are not sufficient)
2. Use full advantage of advanced products of photonic industry by programmable devices
3. Very cost effective, comparing to legacy approach
4. Availability of transmission parameters to monitoring and management (impairment detection etc.)
5. Fully open to improvements during network life cycle
6. Research, development and testing of new network principles is not limited to upper layers
7. High speed transmissions using multiple lambdas (for example 5x20 Gb/s)

The Quilt's 2007 Spring Member Meeting and Workshop
Lessons learned (for me and our optical team)?

Procurement/tender must be 'open' – and not to be living in the past

Perhaps openness and disaggregation is not so important for some people (perhaps some are afraid of them, similar situation like with dark fibre so many years ago) – but price and flexibility is

So better price and equipment and flexible solutions/services

Support of new projects like CLONETS, TiFOON, Quantum (and others) is taken for granted

I feel really positive about next generation of GÉANT optical backbone! [8]
References

[8] https://wiki.geant.org/display/SIGNGN/2nd+SIG-NGN+Meeting

And of course other online resources...
Acknowledgement

Colleagues from CESNET – as always of course!

Colelagues from GÉANT (Guy Roberts, Mian Usman)

Apologies to anybody I forgot to mention
THANK YOU FOR YOUR KIND ATTENTION!

QUESTIONS?
Oh yes – did you know that the Earth is flat?

And multimode optics (patchcords and transceivers) is better than singlemode?

Old G.652 or G.653 fibre can transmit terabits without much problems over few(many) kilometres.

New multimode fibre OM4/OM5 can support 100Gb/s over 150m.

But with more parallel lanes i.e. more fibres required (10x10G or 16x25G or even more).

Also MM OM3/4/5 fibre is more expensive than SM G.652 fibre.

Therefore 100GE as 10x10G over OM4 is much more expensive than 1x100GE over singlemode fibre (at least 10x more from fibre perspective).

Sure - MM transceivers are cheaper (e.g. 2x or 5x) but reach VERY limited (25-100x worse) compared to SM transceivers.

Also different connectors/cables - do you remember RJ-45 straight/crossover? So with optics and 3 different types (A, B, C) it is much worse...also nightmare to clean properly and make easy loopbacks to verify your connections.

So ‘cheap’ MM technology can be pretty expensive!

If possible use singlemode optics (methods to improve MM performance do exist but 100G over 10km over MM is not realistic and not needed).
GÉANT – LESSONS LEARNED

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<th>Housing Type</th>
<th>No. of Fiber</th>
<th>Mode and Grade</th>
<th>Housing Color</th>
<th>Boot Type</th>
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<td>SS Single mode Standard</td>
<td>GR Green</td>
<td>TN No boot</td>
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<td></td>
<td>PF</td>
<td>24*</td>
<td>SH Single mode High Grade</td>
<td>YE Yellow</td>
<td>T1 Ribbon fiber (12 fber or less)</td>
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<td>MS Multimode Standard</td>
<td>BE Beige</td>
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