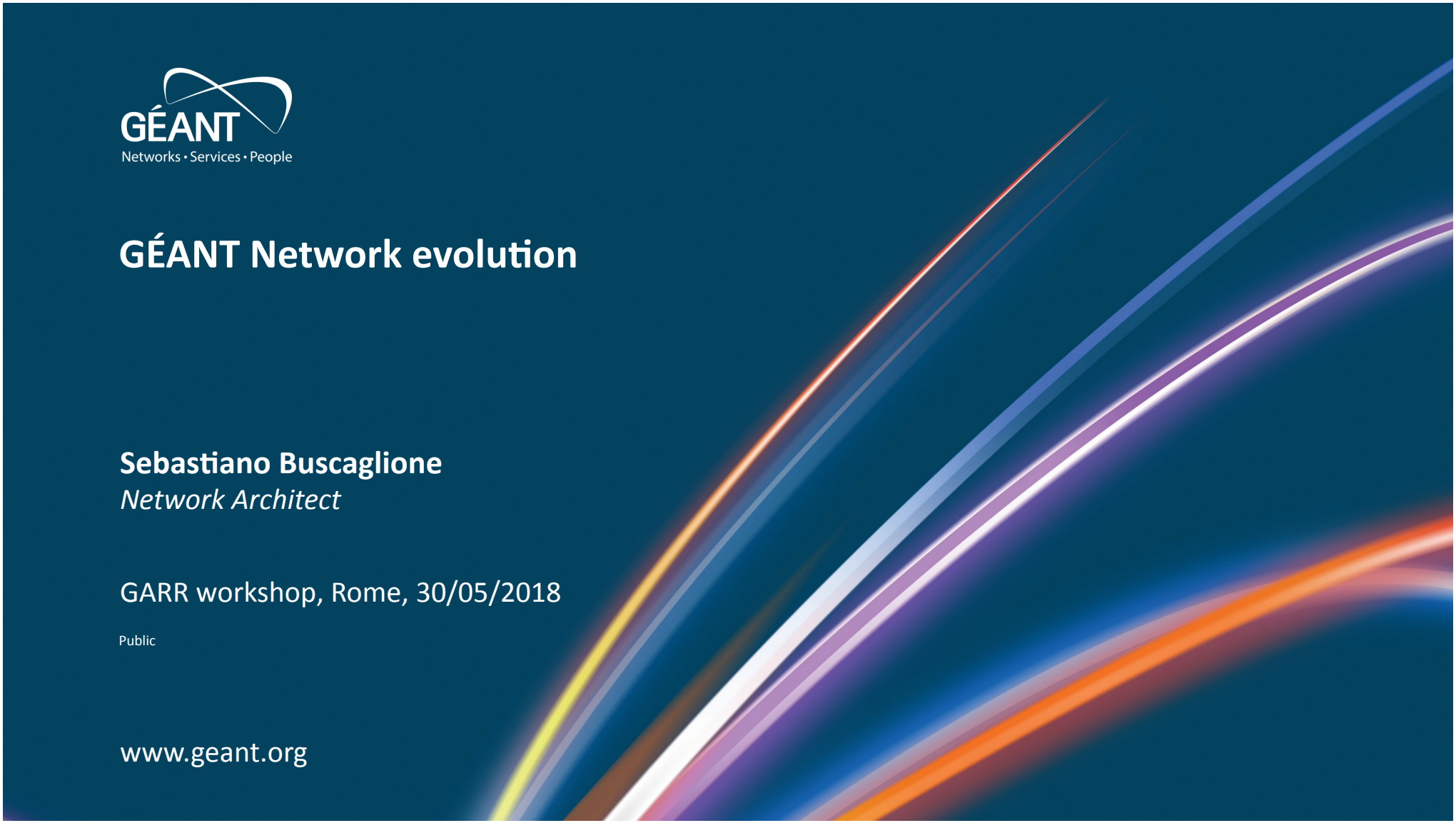

GÉANT Network evolution

Sebastiano Buscaglione
Network Architect

GARR workshop, Rome, 30/05/2018

Public

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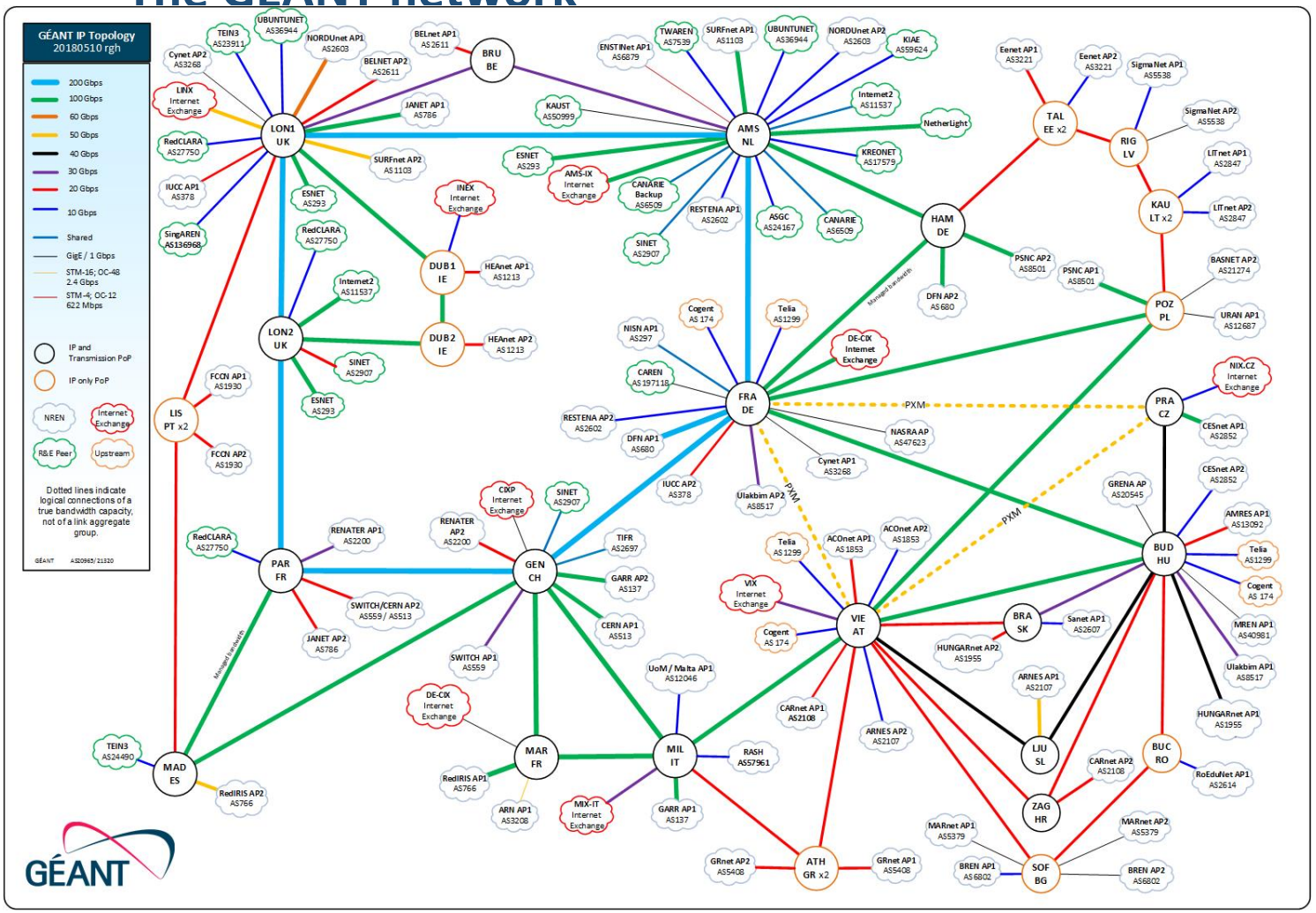
Overview of the session

- Overview of the current GÉANT network
- Network infrastructure evolution strategy
  - The transmission layer
  - The IP/MPLS layer
  - Topology

The GÉANT network



- Providing international connectivity to European NRENs
- PoPs in most European countries
- High performance lossless environment optimised for science
- Uses a combination of Dark Fibre and Leased capacity for its trunks

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The GÉANT network - continues

- **Made of two main networks**
  - Infinera based DWDM/OTN
  - Juniper based IP/MPLS
- **Provides a wide range of services**
  - **GÉANT IP**
    - Global R&E internet reach
    - Commodities internet access
    - Cloud connectivity
    - LHCONE
  - **GÉANT VPNs**
    - L3VPNs
    - Carrier of Carriers VPN (MD-VPN)
    - L2-P2P VPN (GN+ and BoD)
  - **GÉANT Lambdas**
    - 10 or 100G OTN based P2P links

Traffic and growth

Network Traffic 2017

Average volumes were 3.13PB per day for the IP/MPLS network, average daily rate of 289Gbps

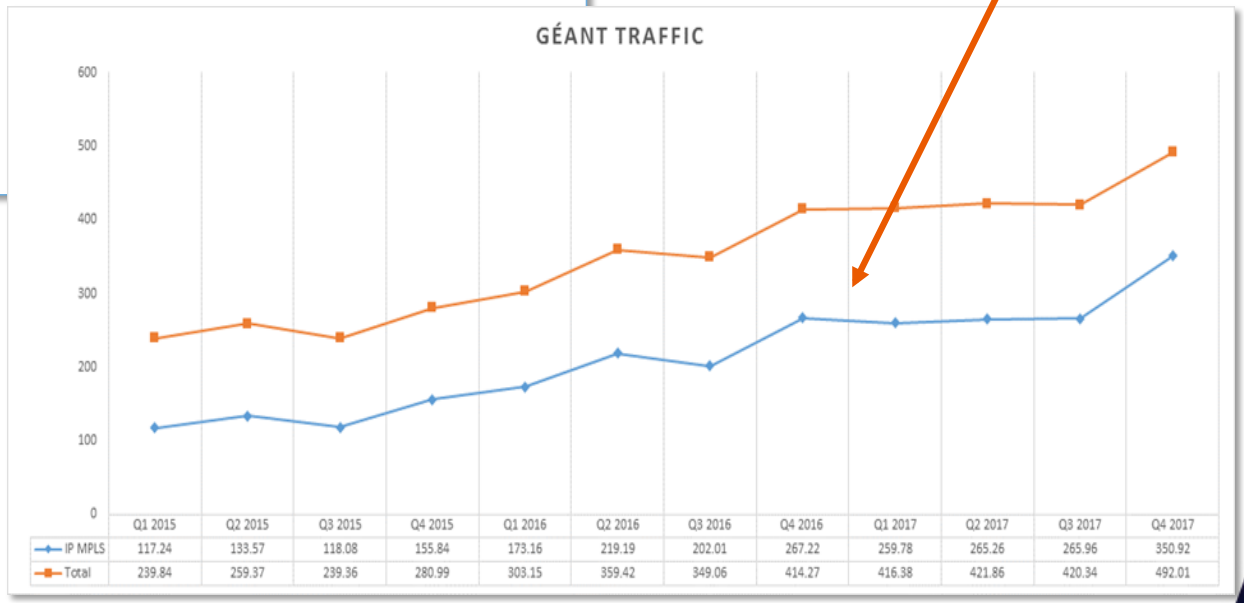
Average volumes including Lambdas are 4.79PB day or an average data rate of 444Gbps

Science traffic growth: 43%

Internet traffic growth : 26%

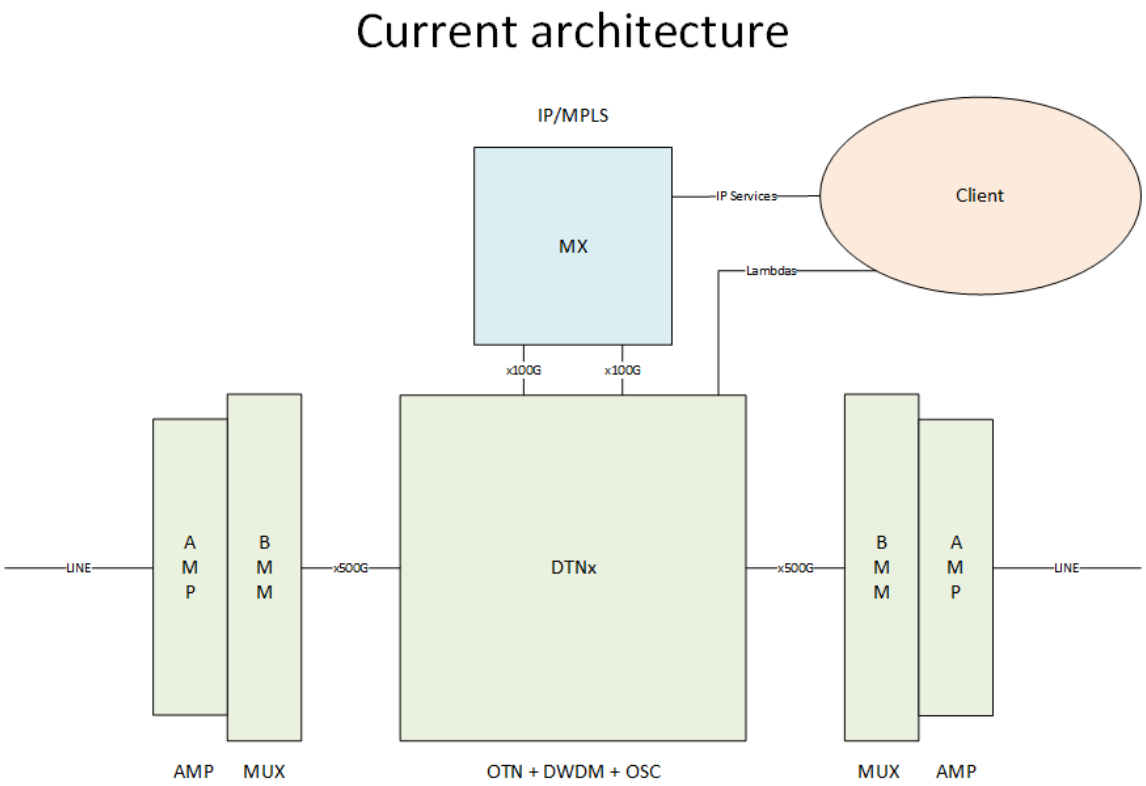
IP/MPLS grow rate 58% YoY over 2 years

Growth of science traffic almost 2x internet service growth. Solution tailored for ISPs might not be enough for GÉANT.



	Q1 2015	Q2 2015	Q3 2015	Q4 2015	Q1 2016	Q2 2016	Q3 2016	Q4 2016	Q1 2017	Q2 2017	Q3 2017	Q4 2017
IP MPLS	117.24	133.57	118.08	155.84	173.16	219.19	202.01	267.22	259.78	265.26	265.96	350.92
Total	239.84	259.37	239.36	280.99	303.15	359.42	349.06	414.27	416.38	421.86	420.34	492.01

The current PoP architecture



Problems with current architecture:

- DTN-X chassis running out of slots in central PoPs
- OTN layer adds significant cost
- OTN useful for protection switching and multi-hop but traffic is 70% unprotected and next hop
- Proliferation of IP/MPLS cross connects to OTN
- DTN-X chassis are DC powered full racks
- Locking to Infinera innovation curve for transponders technology where market is very active

A solution – Data Centre Interconnects

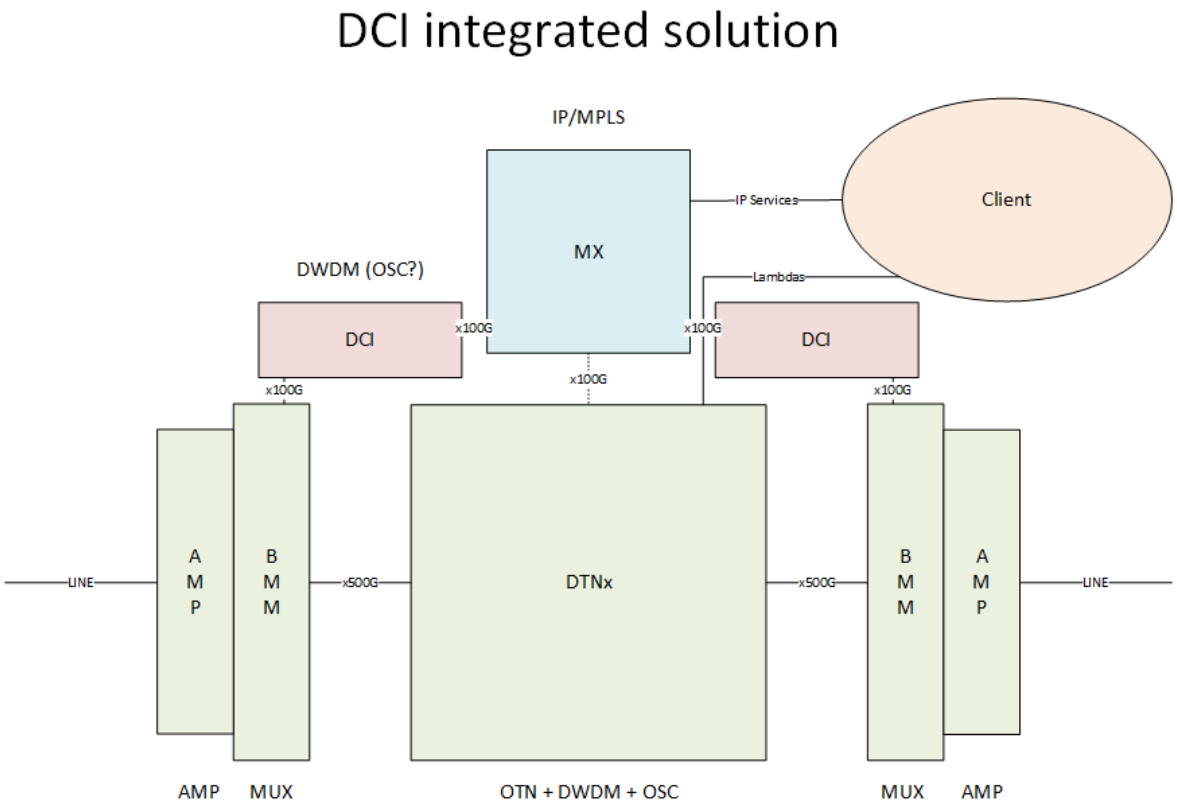
- Point to point connectivity over a fibre link
- Data centre style 1 RU stackable form factor.
- Over **6 times reduction in cost** over traditional telecoms equipment architectures
- Significant increase in **density** and reduction in **power consumption**
- Modular – easy to scale up
- Next gen of **commodity pluggable optics** have excellent performances
- Easy **upgrade path** to new technology

Loss of equipment integrity – not designed to be highly available as per ETSI etc.

- **No internal hardware redundancy**
- **No in-service upgrades**
- **Restricted temperature operation**

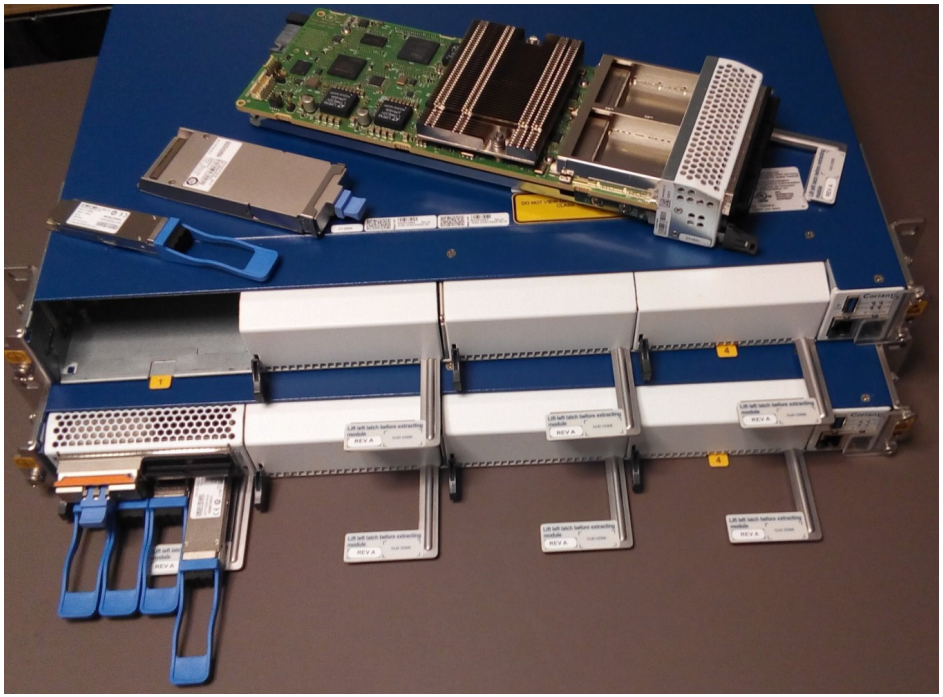
The transmission layer – phase 1 (2018 – 2020)

- Plan to integrate DTN-X with DCIs and use DCI to provision high capacity IP/MPLS trunks
- DCI (Data Centre Interconnect) boxes available to provision capacity over a DF link at low cost
- Keep DTN-X for link management and lambda provisioning greatly simplifying DCI role and minimising risk
- Integration of DCI allows for growth offset and generate spares to be used for Lambda services growth
- DCI are typically AC powered 1RU
- DCIs can be easily re-used after line system re-procurement in 2020/2021



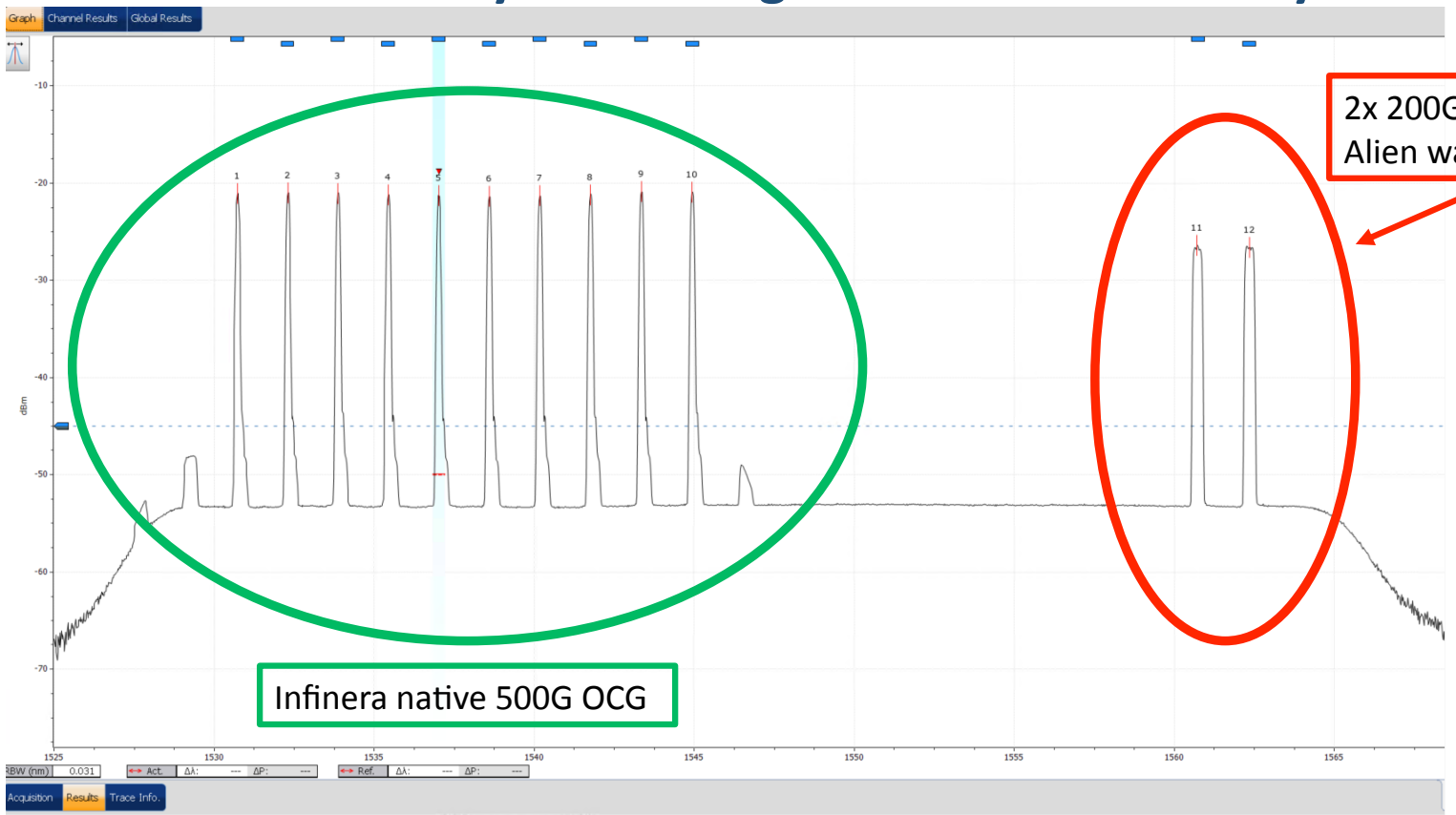
The transmission layer – DCI choice

- GÉANT has chosen the Coriant Groove G30 product.
- 1 RU stackable
- 4 sleds, each up to 4 x 100G
- Optics are based on Acacia CFP2 ACO
  - 200G up to 1000km with 16 QAM
  - 150G up to 2000km with 8 QAM
  - 100G up to 5000km with DP-QPSK
- Client side is QSFP28



Next generation to support AC1200 with 600Gbps using 64QAM

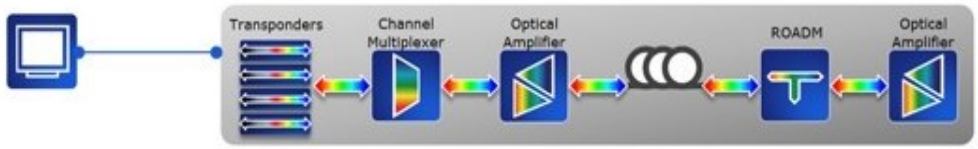
The transmission layer – testing alien waves on the system



The transmission layer – phase 2 (2020+)

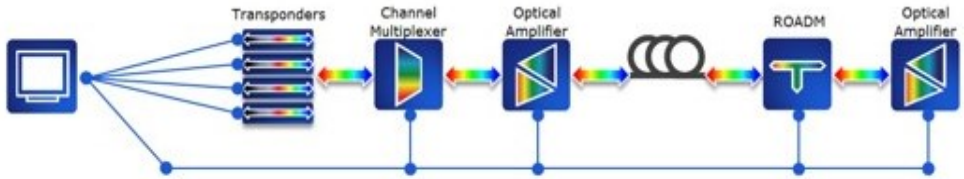
Re-procurement of dark Fibre and Line system in 2020 is an opportunity for change

- No Disaggregation: Entire transport network acts as one element



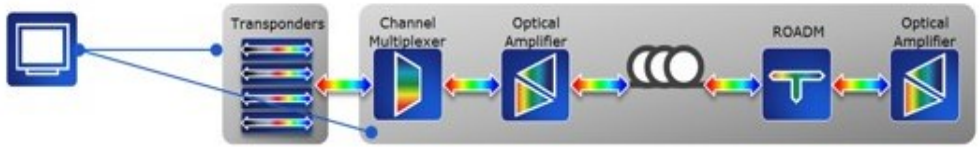
Current closed interop model

- Fully Disaggregated: Everything is a separate network element



Long-term vision. But open standards and management under development

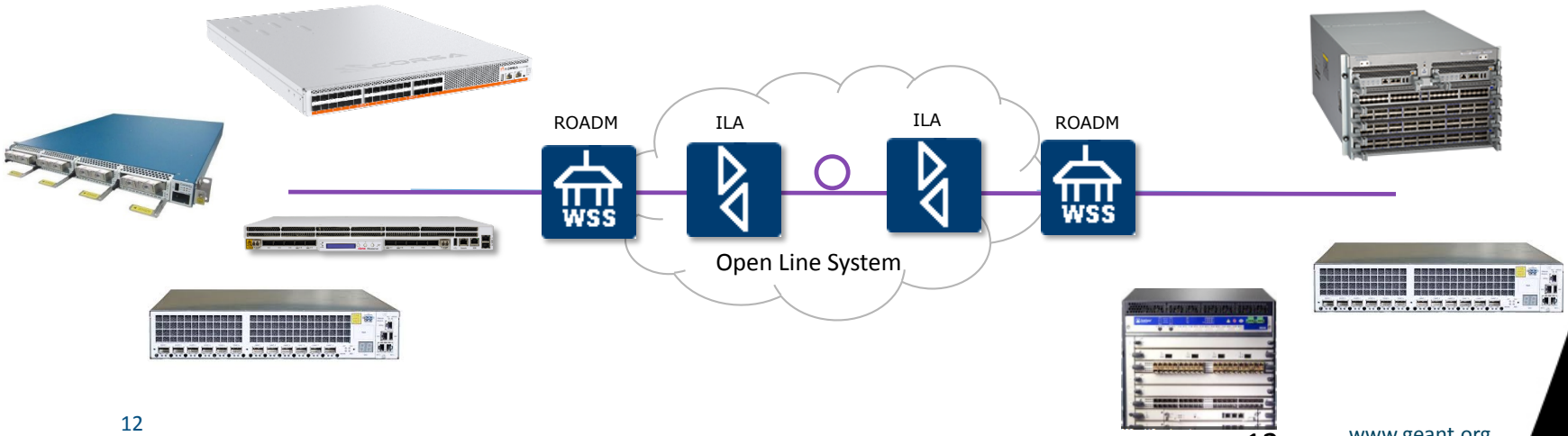
- Partially: Transponding is one element, OOLS is second.



Medium term solution. Open access, single management plane for OLS

The transmission layer – Why an Open Line System

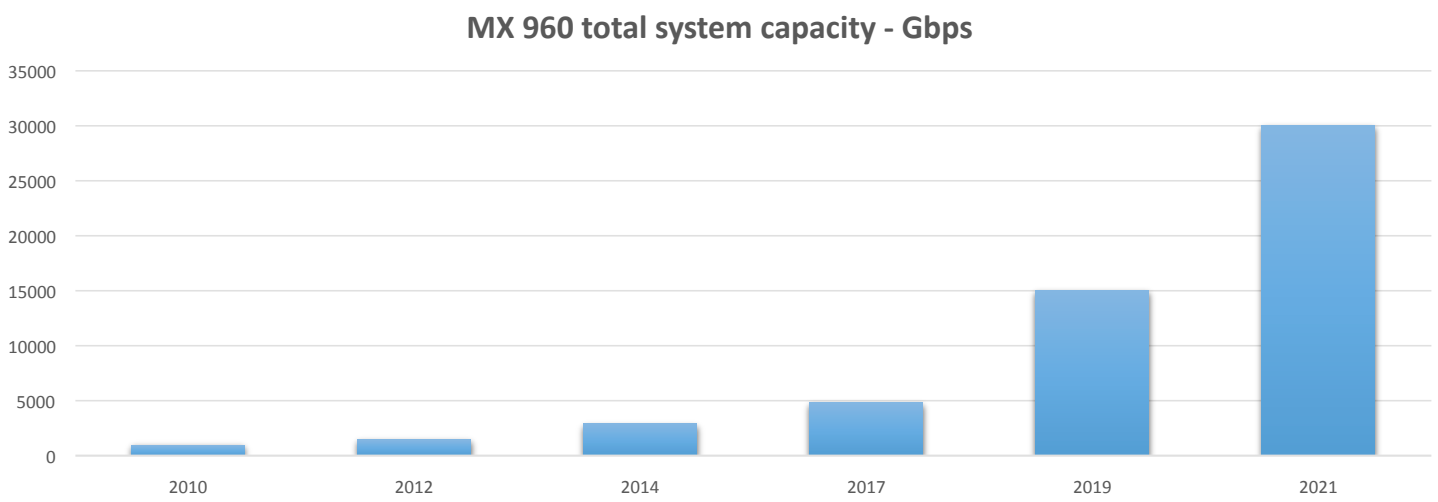
- Technology is moving faster in the packet and transponders than the amplifiers and WSS.
- Alien waves allow transponders from multiple vendors to operate on a single line system.
- Still benefit from a single vendor providing end-to-end optical management: Channel & span equalization, DCN connectivity (OSC), ALS, Alarm reporting ect.



The IP/MPLS layer – Upgrading MXs

Good upgrade path on MX960/480 means we can keep the system in place for a little longer than expected

Flex Ethernet coming on MPC10 will solve elephant flow issue on 100G links



30x in 10 Years

Slot capacity evolution:
MPC3 – 1x100G → MPC4 – 2x100G → **MPC7 4x100G** → MPC10 15x100G **FlexE**

The IP/MPLS layer – OPEX optimisation / MX204

Maintenance cost could be optimised for small PoPs in GÉANT

MPC2 going to next day support later 2017

MX 204

4x QSFP – 1x100G or 4x10G

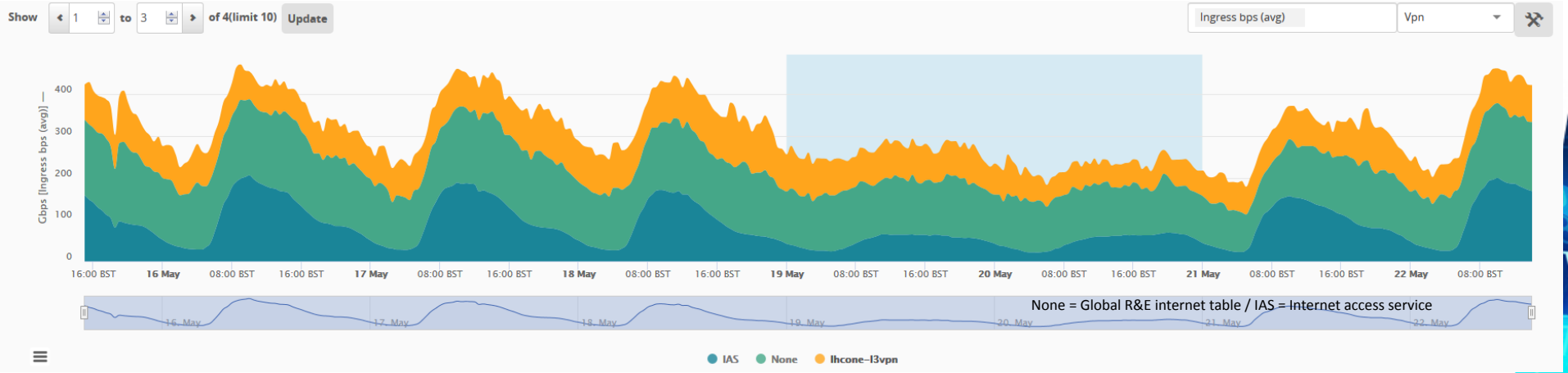
8x SFP – 1G or 10G

400G total switching capacity
Enhanced QoS
PTP support
Dual PSU
Single routing engine

80% OPEX reduction

70% less power

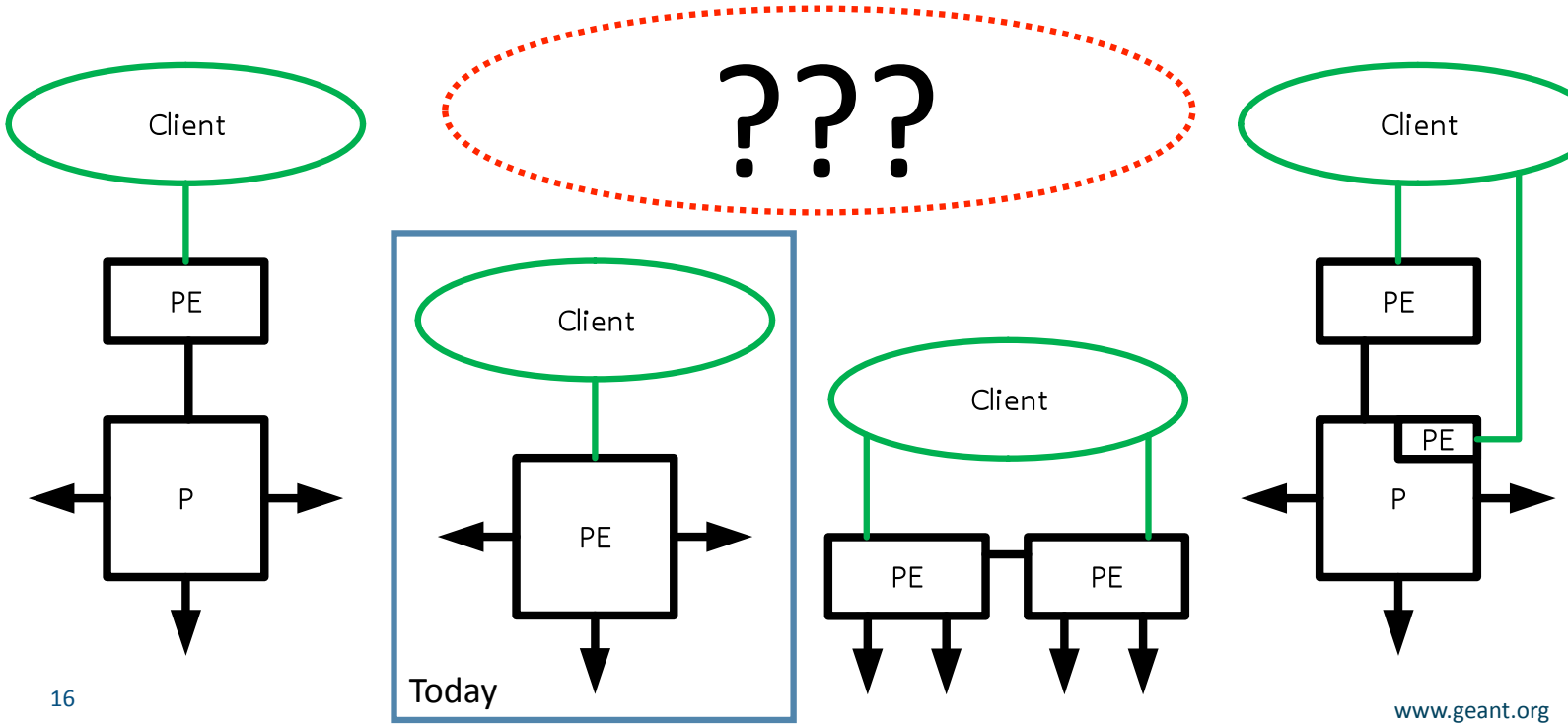
The IP/MPLS layer – disaggregating the layer



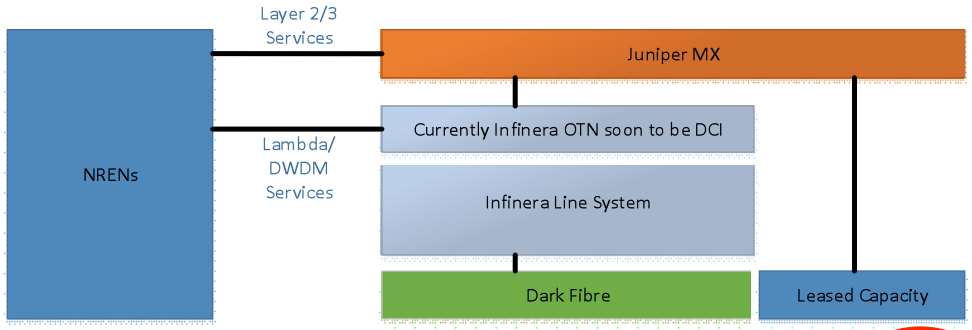
- Current cost per bit paid on IP/MPLS is based on the requirements of the most complex service/s but flow requirement are very diverse
- Merchant silicon and white/brite boxes challenging main vendor (ASICS) dominance on ISP market – lower cost high density routers/switches
- At lower capacity/scale, aggregation is key, **at higher scale, disaggregation makes sense**
- Software and hardware disaggregation also possible

The IP/MPLS layer – various architectures possible

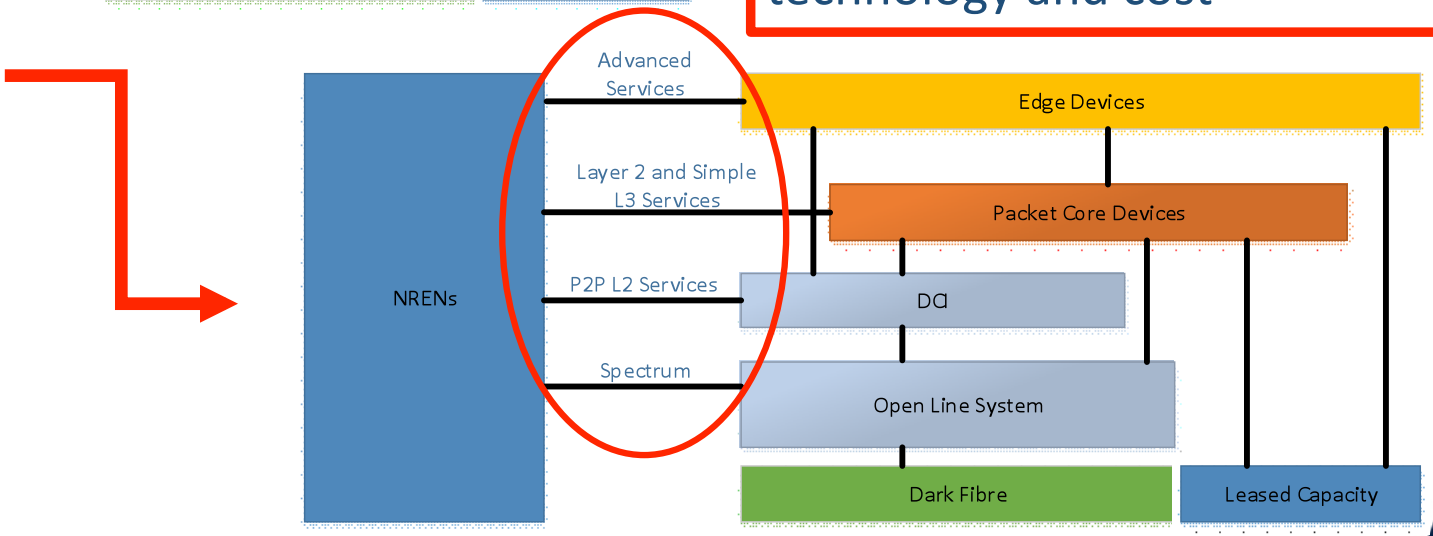
Keeping an open mind on options for the IP/MPLS layer architecture



Disaggregation increase options



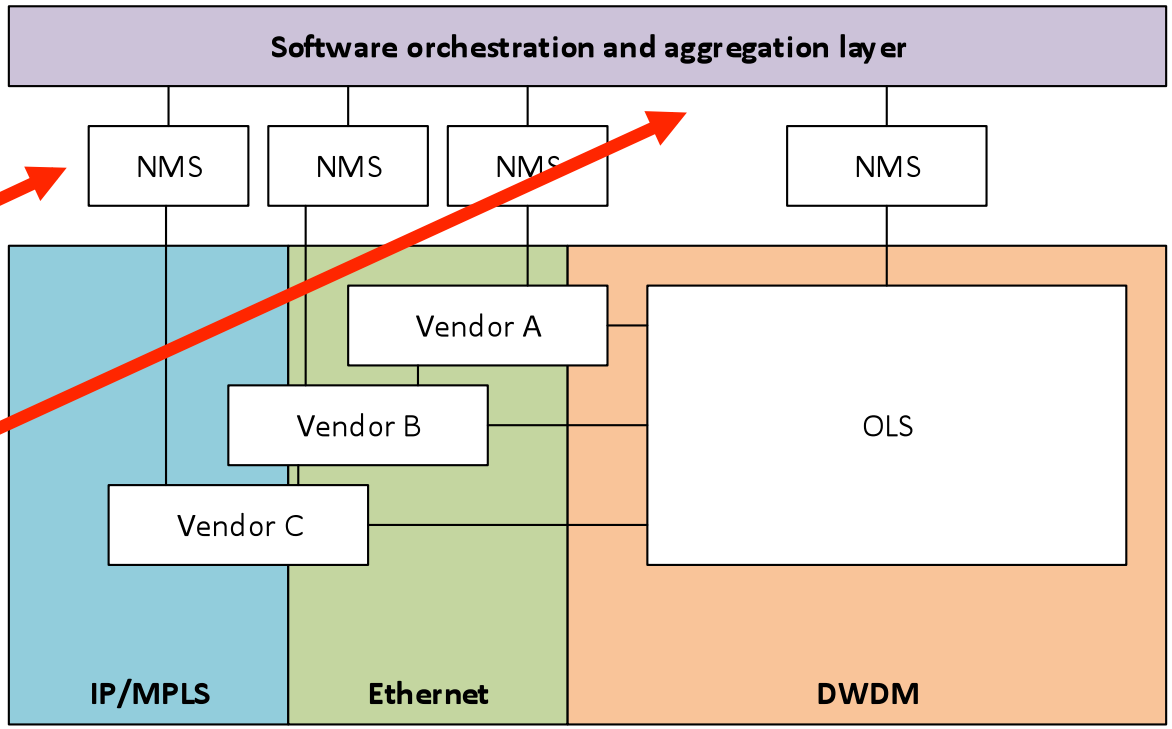
Increase the options for connectivity between clients and network allows for new services and better mapping of services requirements to technology and cost



Managing a disaggregated system

Disaggregation and modularisation of infrastructure will results in the use of specialised equipment from different vendors each having is own management system.

Aggregation of information and orchestration will have to be provided by upper software layer.



GÉANT topology - Today

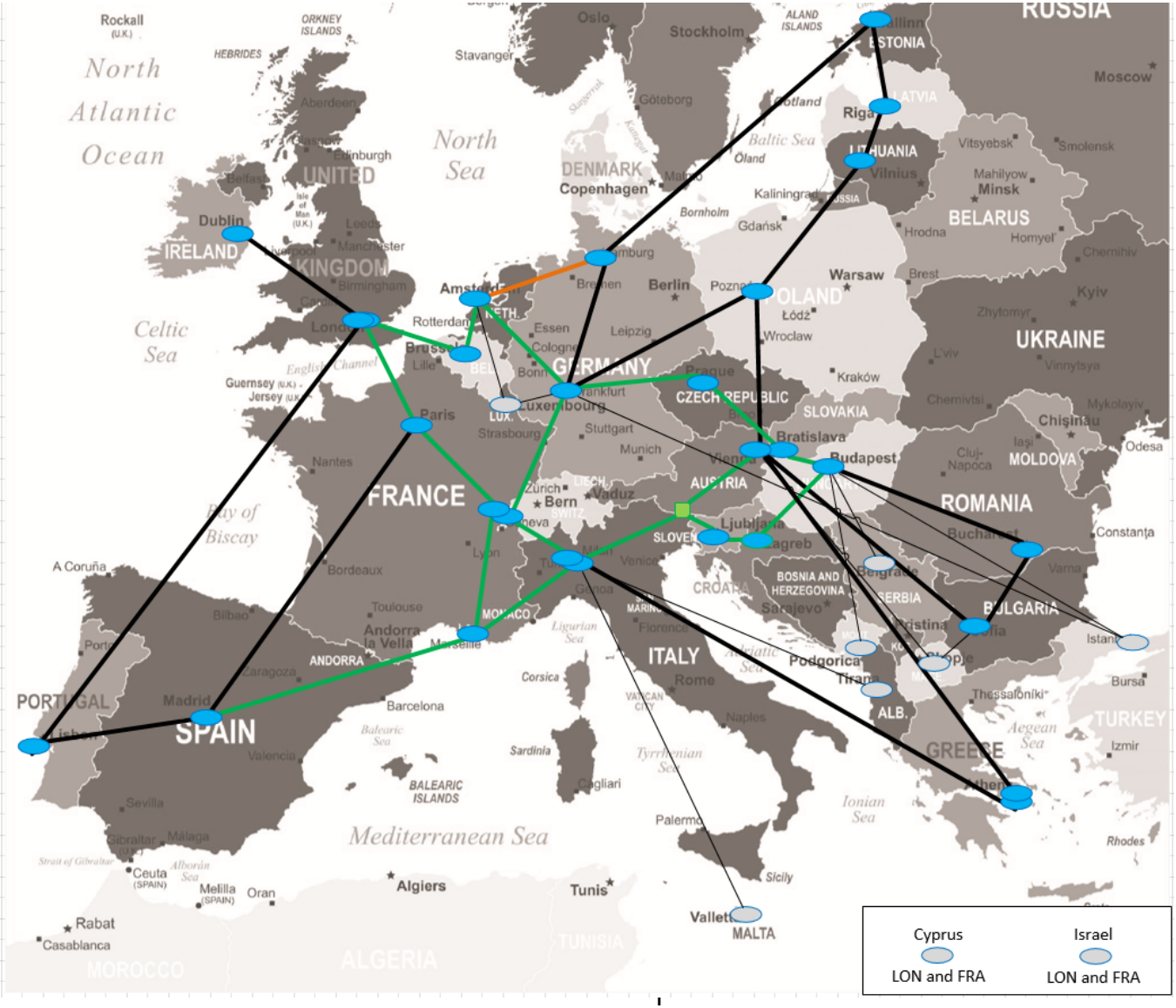
- 2018 design has been in place since 2012…. With very little change
- Currently based on DF and lease capacity with short procurement cycles and driven by short term requirements
- Regional connectivity hub and spoke with central part of the network

Fibre ‘core’ in green

Leased capacity in **black**

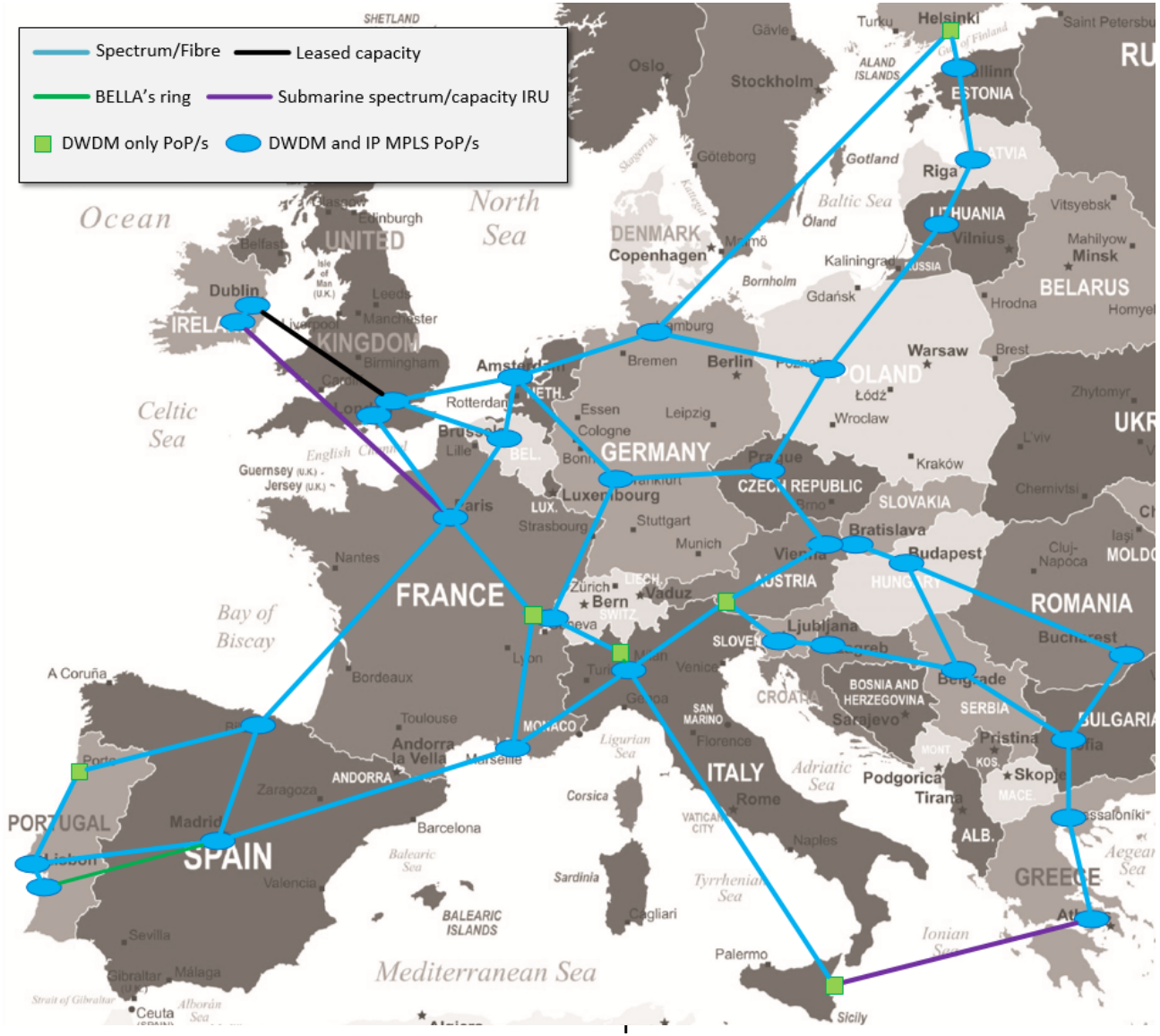
Spectrum in orange

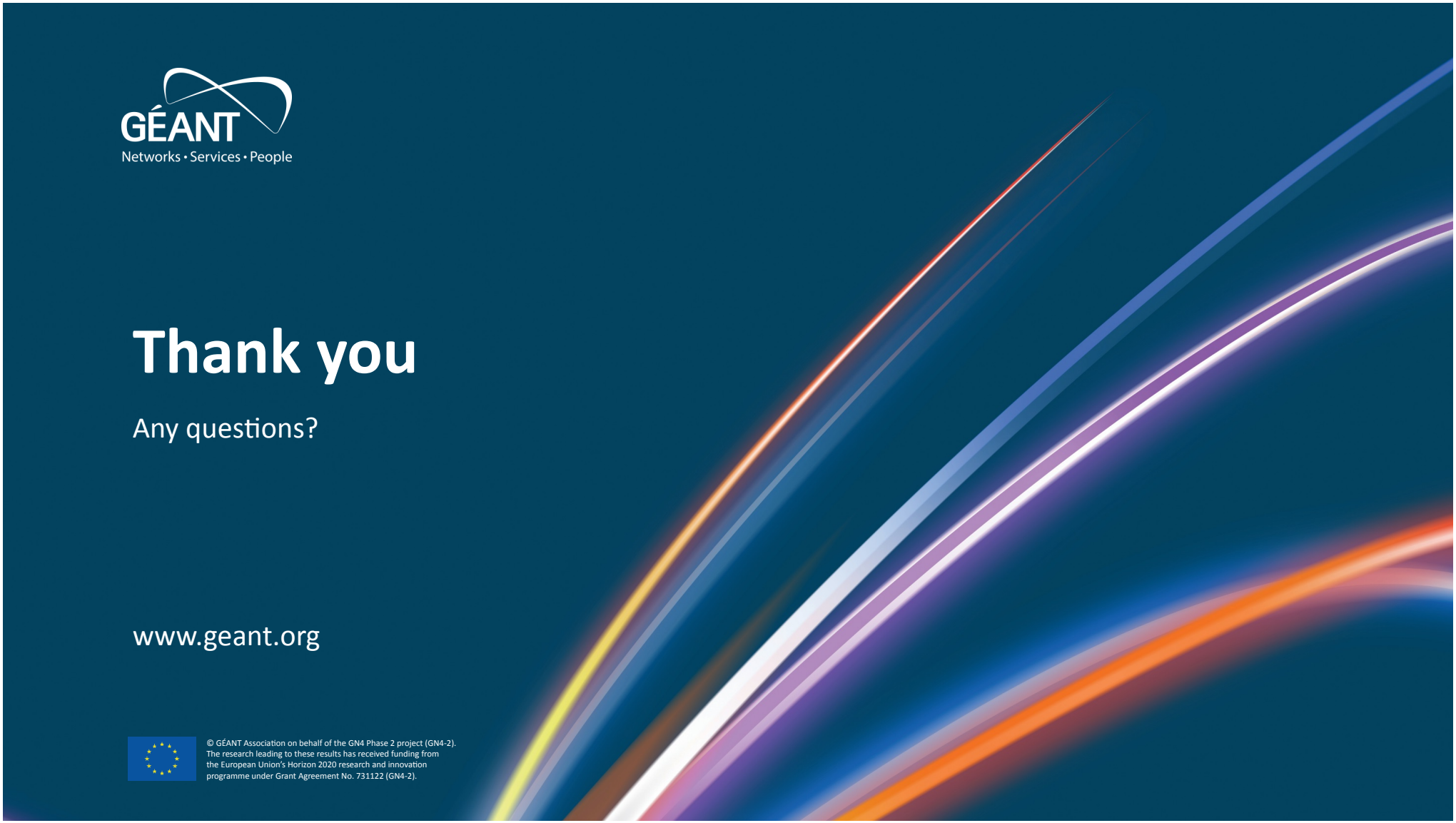
PoPs blue circle



GÉANT topology - Future

- New funding opportunities allows for procuring on longer term contracts - IRUs
- Optimised based on long term requirements
- Resulting topology considers an extension of fibre and spectrum to cover wider area of Europe
- Less hub and spoke with improvement or regional connectivity
- Fibre/Spectrum + OLS offers flexibility and allows for taking the most advantage of transponders evolution





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