THE ITALIAN RESEARCH & EDUCATION NETWORK | Consortium GARR

Open Optical Networking for R&E

From Alien Waves to a Disaggregated Optical Network

ITNOG3 - Bologna

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Outline

- GARR overview and update
- Disaggregation and Open Line Systems (OLS)
- Opportunities and challenges
- USE Cases
- Conclusions

GARR in a nutshell

- Italian R&E Network
  - A Community Network for R&E collaboration
  - A Communication Network with top performances
- Providing:
  - High-bandwidth transparent symmetric connectivity
  - Advanced services
  - E-Infrastructure support

GARR is the network built by the Italian Research and Education community to satisfy the users' needs

GARR: fibre footprint & optical Network

IRU fiber footprint **15000 km**

- **~9.000 Km** of backbone
- **~6.000 Km** of access links

About 1000 user sites interconnected

- **> 1 Tbps** aggregated access capacity
- **> 2 Tbps** Backbone Capacity

DWDM/OTN/ROADM Network

- (2011) Huawei 1/10 G
- (2015) Infinera 10/40/100 G
- (2017) Alien Waves 100G between Core PoPs

Core IP/MPLS network

- Juniper MX960/480/80

Metro/Aggregation

- Cisco ME3600/3400
- CPE Cisco 2900 series

Alien Wave Press Release

COMUNICATO STAMPA

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Una rete 5 volte più veloce con la tecnologia aliena

Grazie alla tecnica delle "alien wavelengths" GARR ha realizzato circa 3.000 km di rete ottica di ultima generazione riusando l'hardware esistente

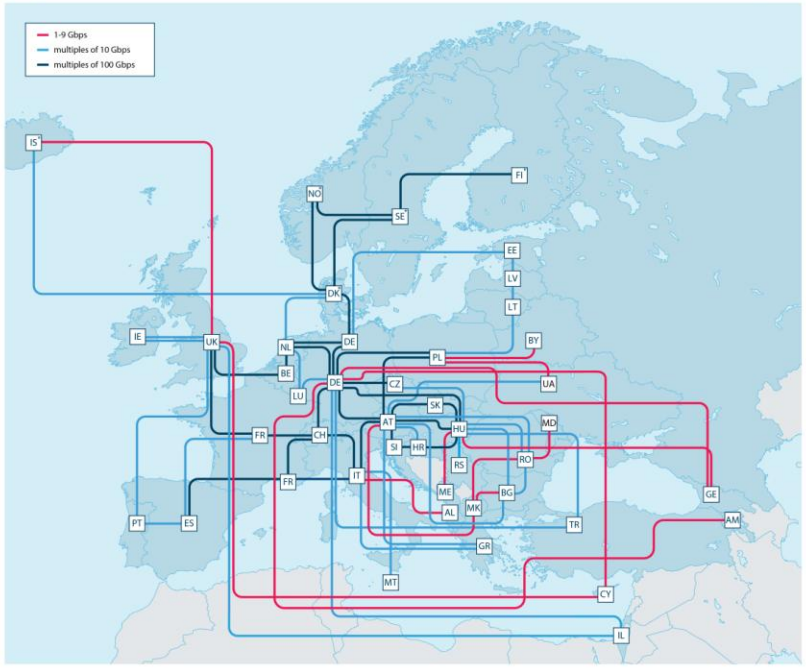
Roma, 06/11/2017 – La rete nazionale della ricerca GARR ha annunciato il risultato di un'innovazione tecnologica che ha permesso di accrescere le prestazioni della rete della ricerca italiana di circa 5 volte arrivando a capacità potenziali fino a 8 Terabit al secondo. Grazie al lavoro degli esperti GARR, sono ora in funzione quasi **3.000 km di fibra ottica** che collegano ad altissima velocità i principali nodi della rete a Roma, Bologna e Milano utilizzando la tecnica delle "lambda aliene" (alien wavelengths) che consente notevoli risparmi in termini economici e dei tempi di realizzazione.

È la prima volta che in Italia si realizza con questa tecnologia un'infrastruttura pienamente operativa su tratte di lunga distanza: il più lungo dei quattro collegamenti messi in campo è infatti di oltre 1.000 km. La tecnica delle lambda aliene è così chiamata perché rende possibile il trasporto dei segnali luminosi su una piattaforma ottica diversa da quella che li ha generati e permette di far parlare tra loro apparati differenti, massimizzando le prestazioni.

https://www.garr.it/it/news-e-eventi/comunicati/1011-una-rete-5-volte-piu-veloce-con-la-tecnologia-aliena

@European Scale

GÉANT's pan-European **research and education network** interconnects Europe's National Research and Education Networks (NRENs).
Together we connect over **50 million users** at 10,000 institutions across Europe.



GÉANT's pan-European network is funded by the GÉANT Project (GN4-2). This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 731122. The map shows topology as at August 2017. The GN4-2 partners are listed below.

AL Albania, BG Bulgaria, DE Germany, FI Finland*, HR Croatia, IS Iceland*, LV Latvia, NL Netherlands, RO Romania, SI Slovenia, UK United Kingdom, AM Armenia, CH Switzerland, DK Denmark*, FR France, HU Hungary, IT Italy, ME Montenegro, NO Norway*, RS Serbia, MD Moldova, UA Ukraine, AT Austria, CY Cyprus, EE Estonia, GE Georgia, IE Ireland, LT Lithuania, MK F.Y.R Macedonia, PL Poland, BY Belarus*, SK Slovakia, BE Belgium, CZ Czech Republic, ES Spain, GR Greece, IL Israel, LU Luxembourg, MT Malta, PT Portugal, SE Sweden, TR Turkey

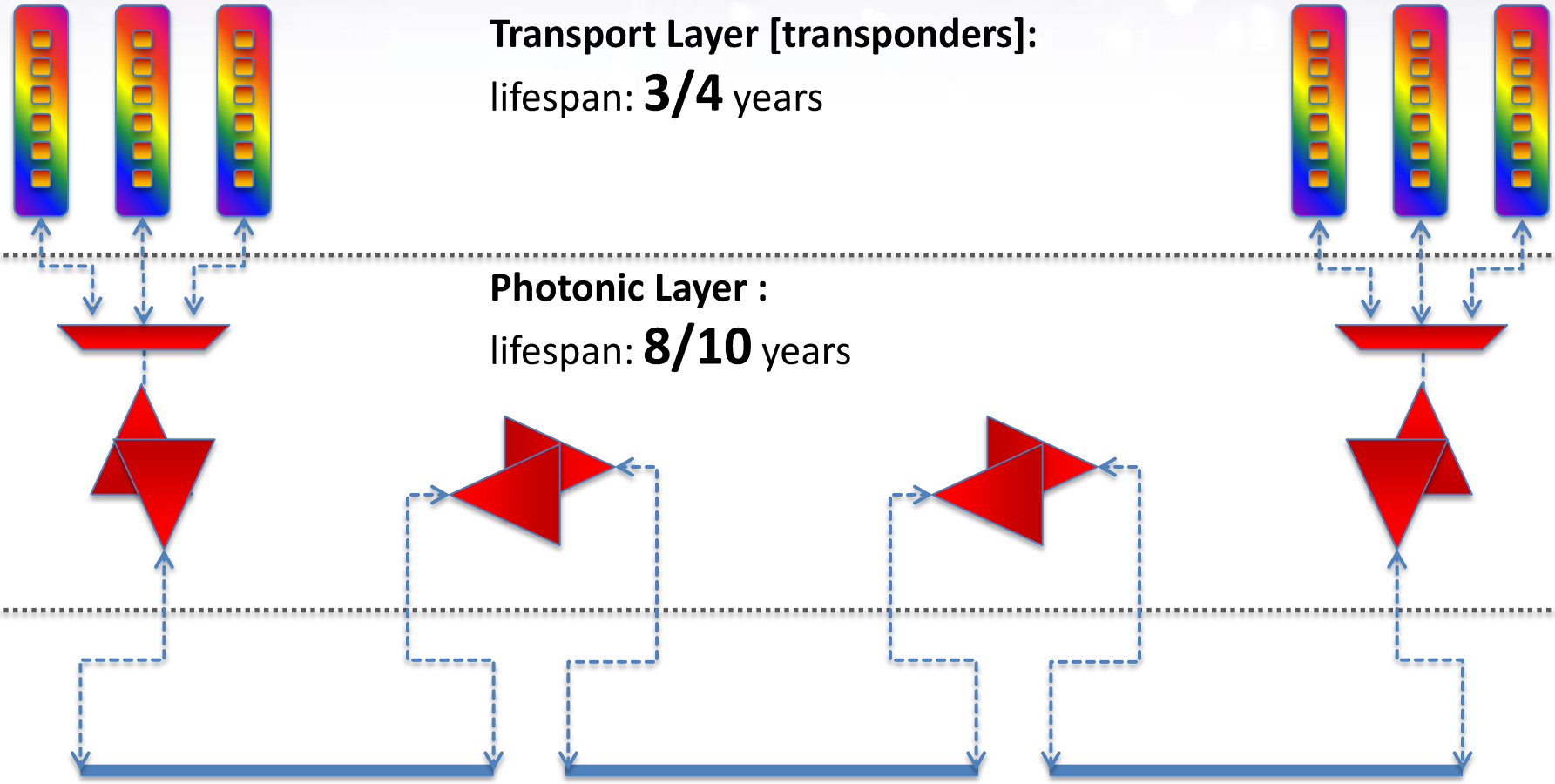
*Connections between these countries are part of NORDUnet (the Nordic regional network)

Funded by the European Union

geant.org

- **European Project GN4-2 (JRA1-T1): Evolving the Shared Optical Infrastructure**
- **Cross Border Fiber** and **Alien Waves** over NREN infrastrucure to offload and complement GEANT network footprint
- Technological and Operational discussion for Alien Waves deployment and evolution of **optical inter-networking** among NRENs

Decoupling transport service from optical infrastructure



Transport Layer [transponders]:

lifespan: **3/4** years

Photonic Layer :

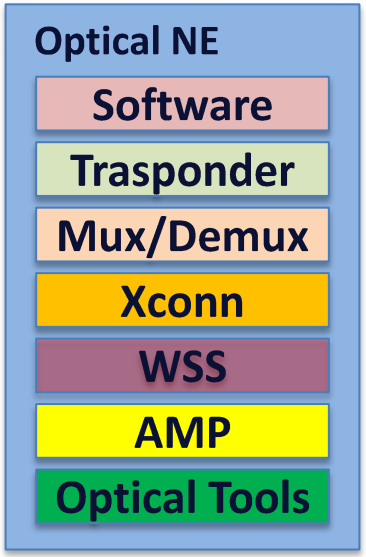
lifespan: **8/10** years

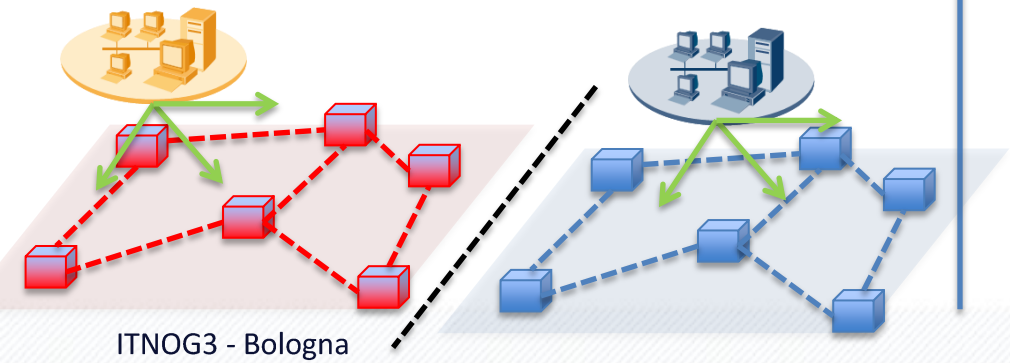
Fiber Layer:

lifespan: **15/20** years

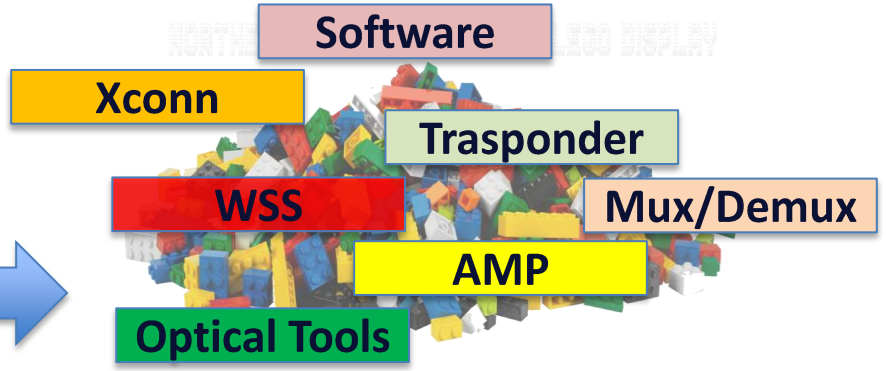
Innovation in Optical Network architecture

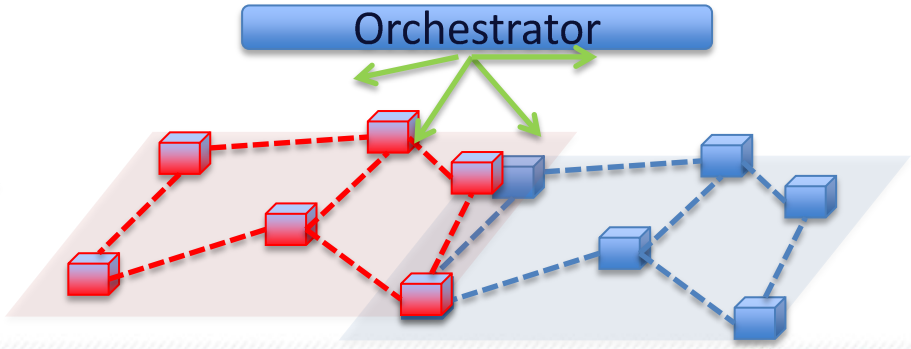
Integrated – closed





Disaggregated – open





Network model comparison

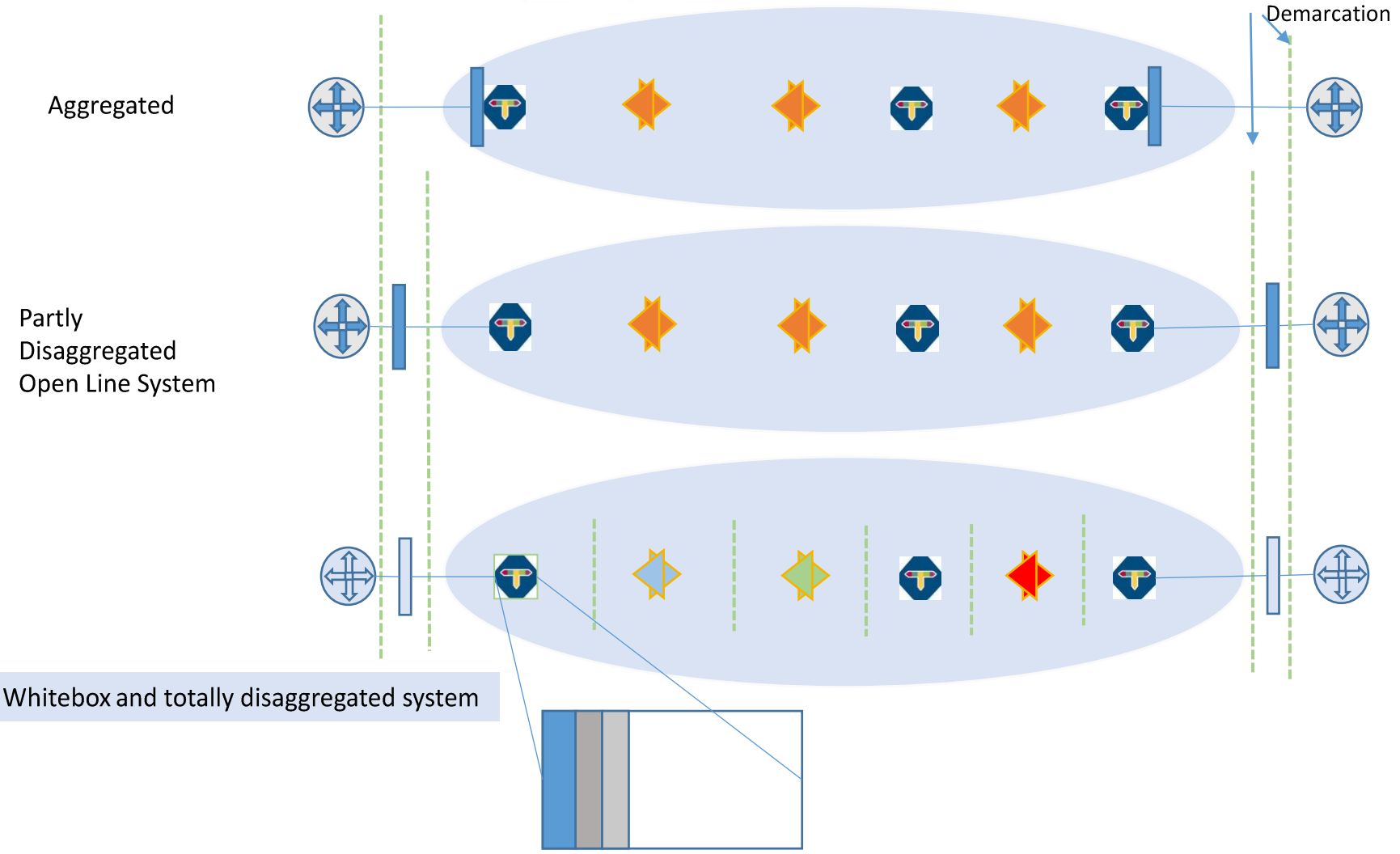
Aggregated Network

- Optimization via vendor specific solutions
- Turn-key solutions
- ‘One throat to choke’
- Integrated Network design, validation and troubleshooting
- Large scale cost benefits

Disaggregated Network

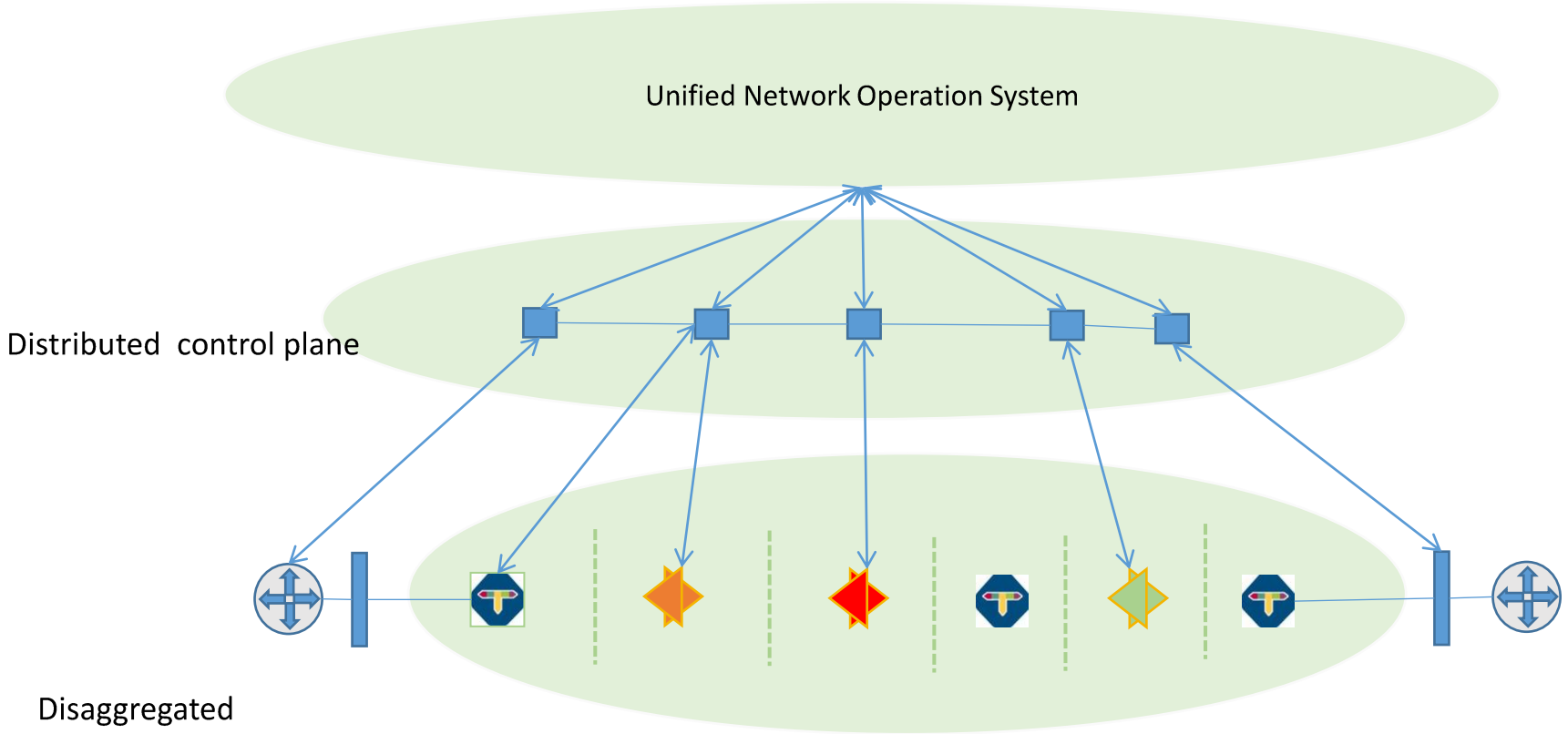
- Maximize network customization
- Unchain and speed-up innovation lifecycle
- Decouple service from infrastructure
- Allow smooth evolution
- Avoid function replication

Disaggregation in data plane



Kurosh Bozorgebrahimi, UNINETT and JRA1-T1

control and management plane

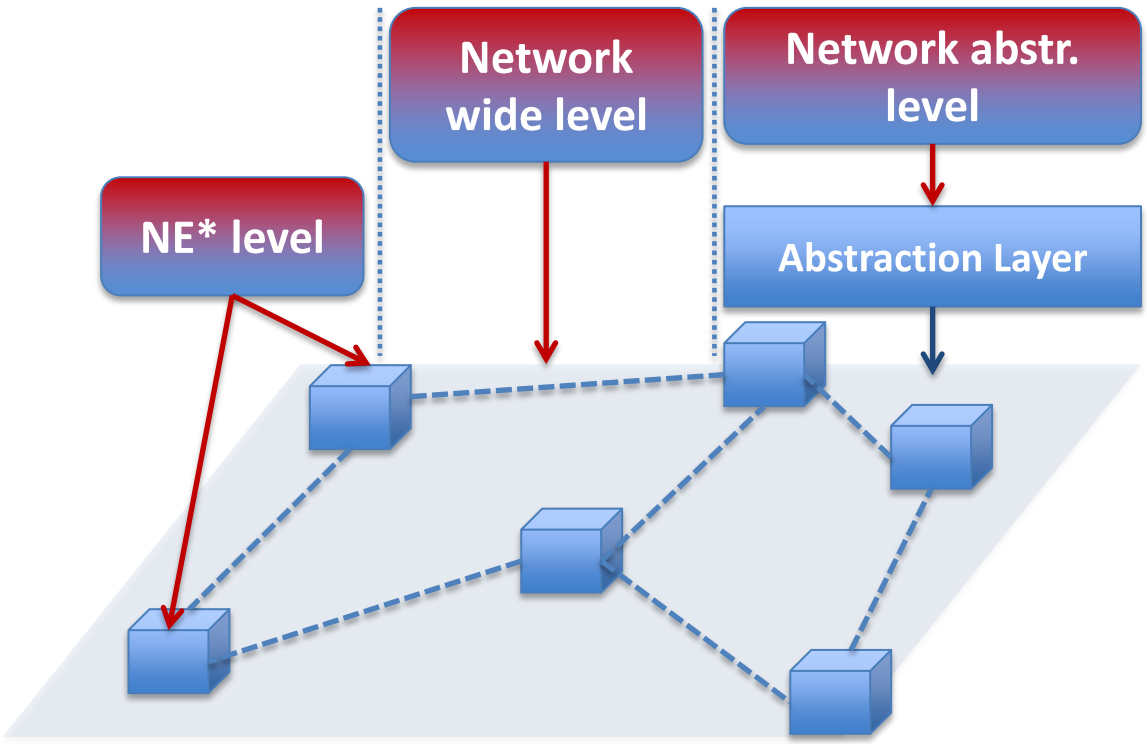


Kurosh Bozorgebrahimi, UNINETT and JRA1-T1

Open approach to API/NBI

APIs and NBIs are mandatory for integration and net operations in a multivendor environment

Network and equipment are logically 'aggregated'



APIs:

- REST
- NETCONF
- RESTCONF

Data Model (YANG) equipment:

- ONF Core model
- OPEN ROADM
- OpenConfig

Data Model (YANG) network :

- ONF Transport API
- IETF TEAS TE Topology

Scope and target of these data models are not overlapped and span between different applications

*Network Element

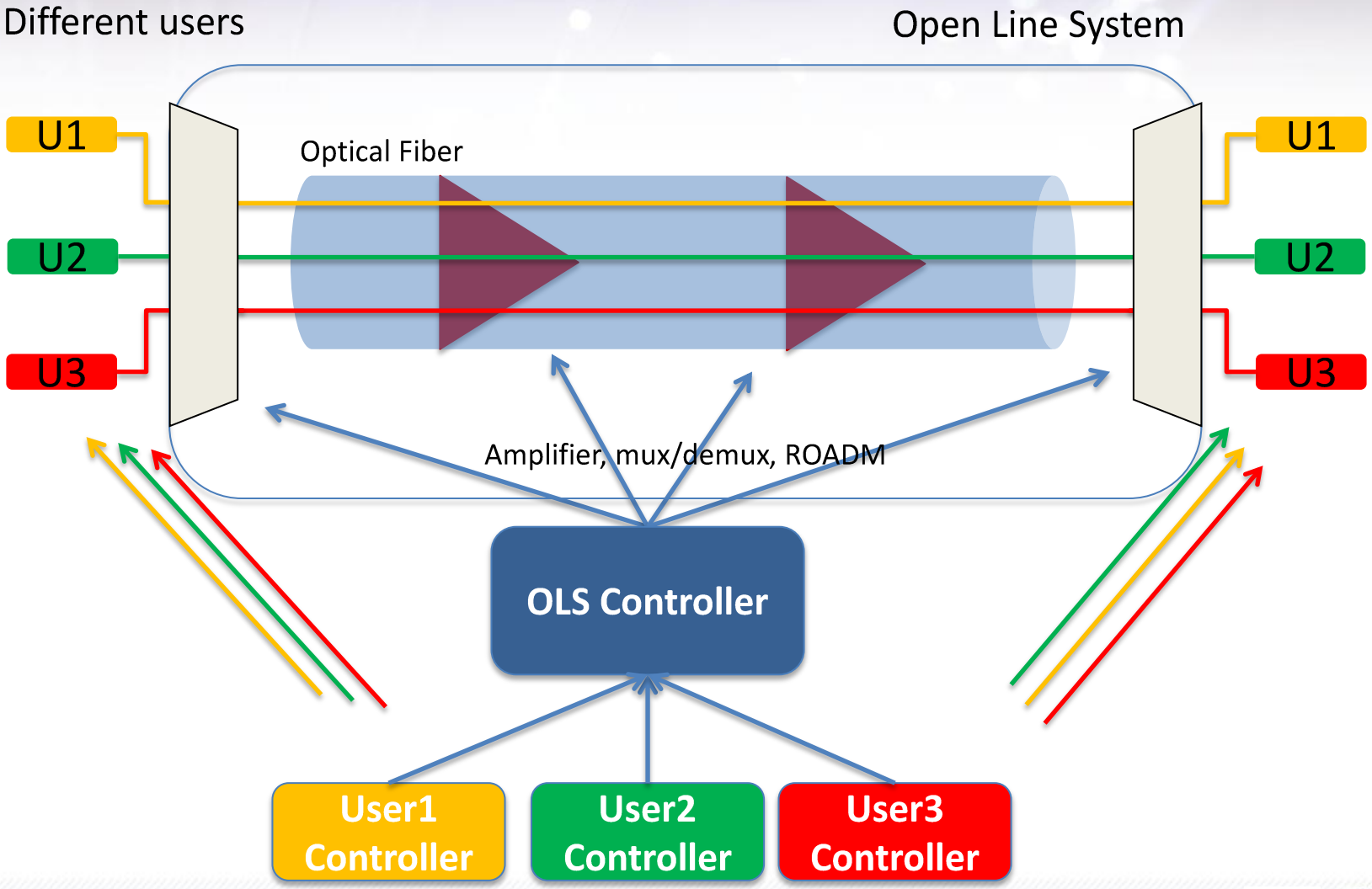
Disaggregation and OLS opportunities

- Resolve vendor lock-in
- Enable mix-and-match approach
- Decouple photonic layer from transport layer
  - Transponders become obsolete more rapidly with respect to the line system
  - Enable to share the infrastructure: Fiber+LineSystem
- Avoid functions replication and enable to setup nodes effectively tailored
- Speed-up innovation capabilities, replacing only the required components
- Enable inter-domain networking at the optical layer

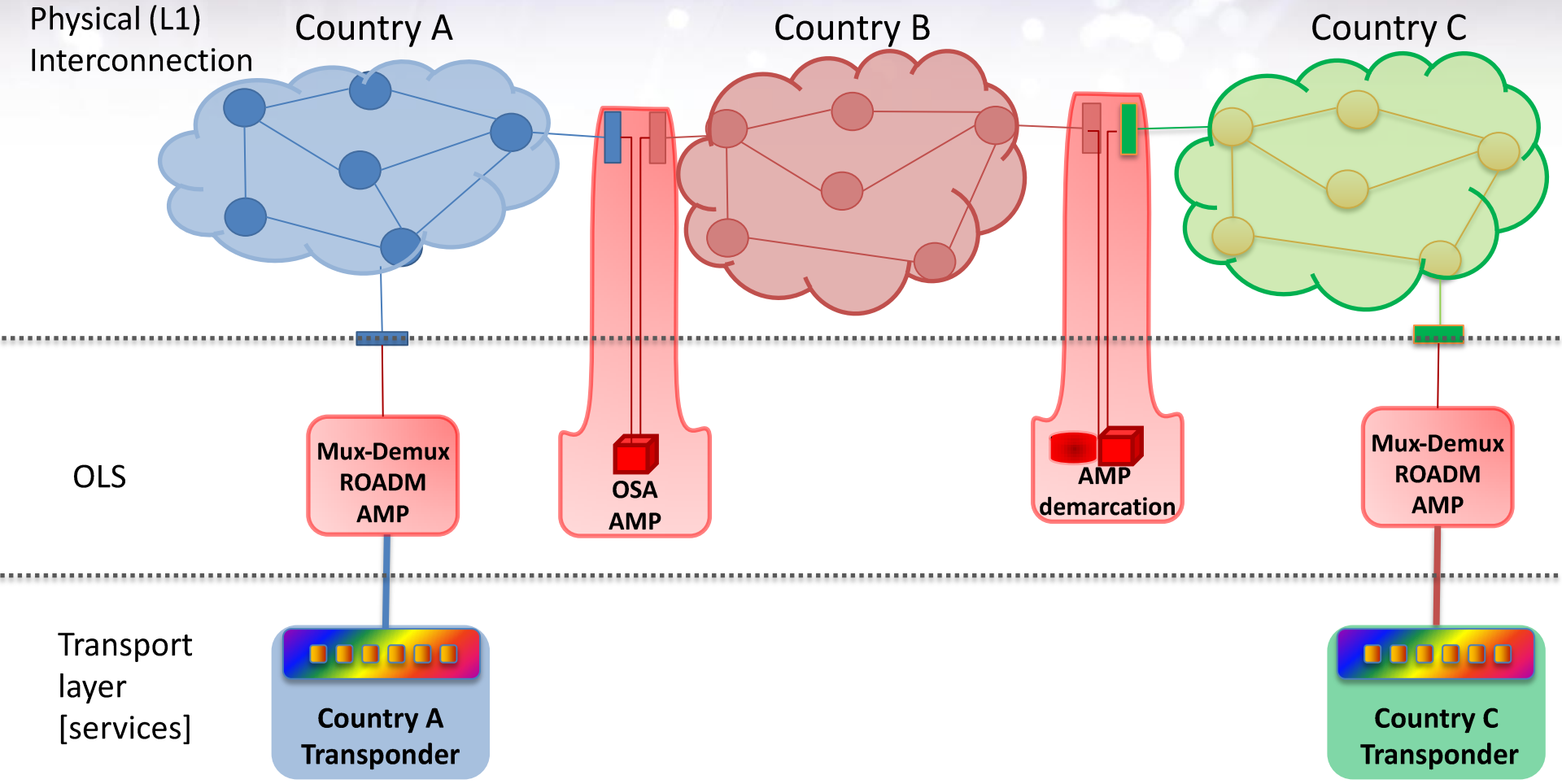
Disaggregation and OLS challenges

- Extreme modularity
- Lack of Management and control plane integration
- Planning and Design tools not available
- Operations and troubleshooting: who is in charge?
- Software integration and management is critical

[USE CASE] Sharing spectrum and infrastructure



[USECASE] InterDomain Optical Neworking



Conclusion

- **O**pen **L**ine **S**ystem as next step in GARR optical network evolution
  - Decouple Services from Photonic Layer
  - Flexible solution (mix & match)
  - Enable Automation and Programmability
  - Smooth evolution
- Fully disaggregated model seems to be not sustainable
- Approach effectiveness depends on its actual diffusion

ELISA: Considering NG of GARR Network

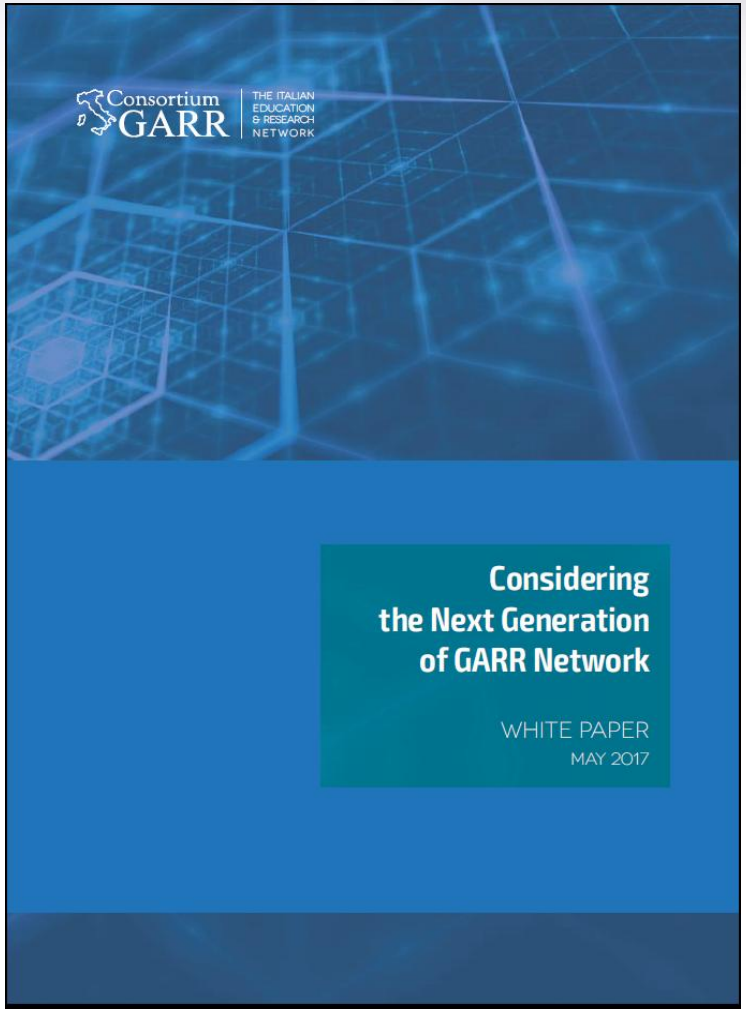
***E**volved **L**ayered network **I**nfrastructure with **S**oftware/services **A**rchitecture*

(Evoluzione rete con Livelli Software Avanzati)

GOAL of ELISA project:

design our future network taking the inherent opportunities offered by the new paradigm shift

We wrote a white paper on our current vision and ideas



https://www.garr.it/documenti/3474-garr-white-paper-maggio-2017

Q&A

Acknowlegments:
GARR
Elisa Project
GEANT GN4-2 JRA1-T1