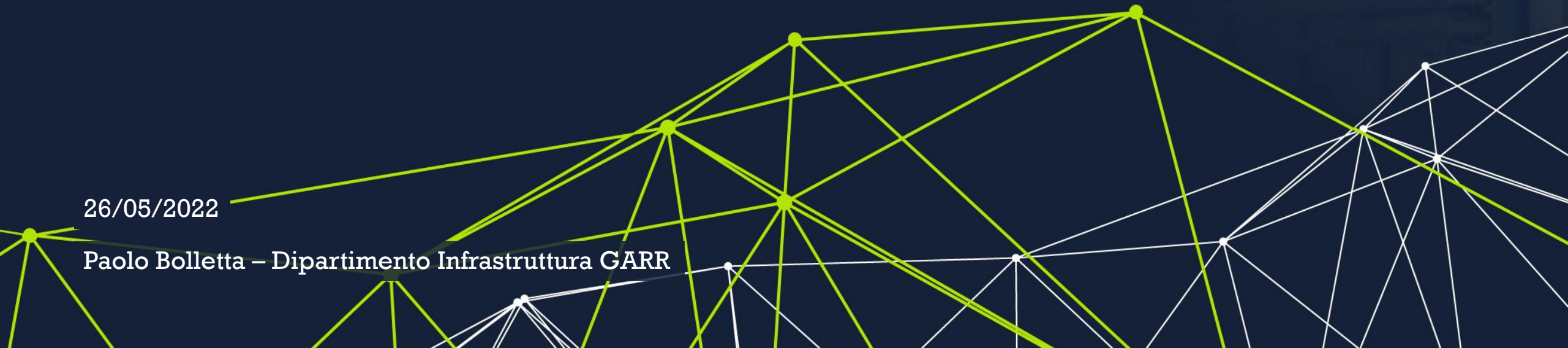
RETE GARR

Consortium GARR | THE ITALIAN EDUCATION & RESEARCH NETWORK

Accendiamo la fibra!

UPDATE GARR-T E EVOLUZIONE RETE OTTICA



26/05/2022

Paolo Bolletta – Dipartimento Infrastruttura GARR

Outline

Architettura GARR-T

Tecnologie

- Rete Trasmissiva
- Rete Pacchetto
- Sistemi di controllo e Gestione

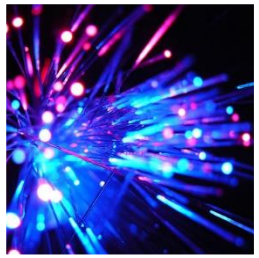
Siti Satellite: Illuminiamo la Fibra!

Condivisione di Spettro

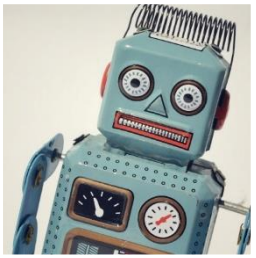
Pilot DCI CNAF-CERN

Conclusioni

GARR-T punti di partenza …



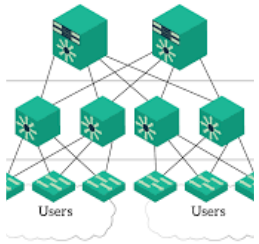
Terabit/s



Programmabilita' e Automazione

Capillarita'

Evoluzione gestione e monitoraggio



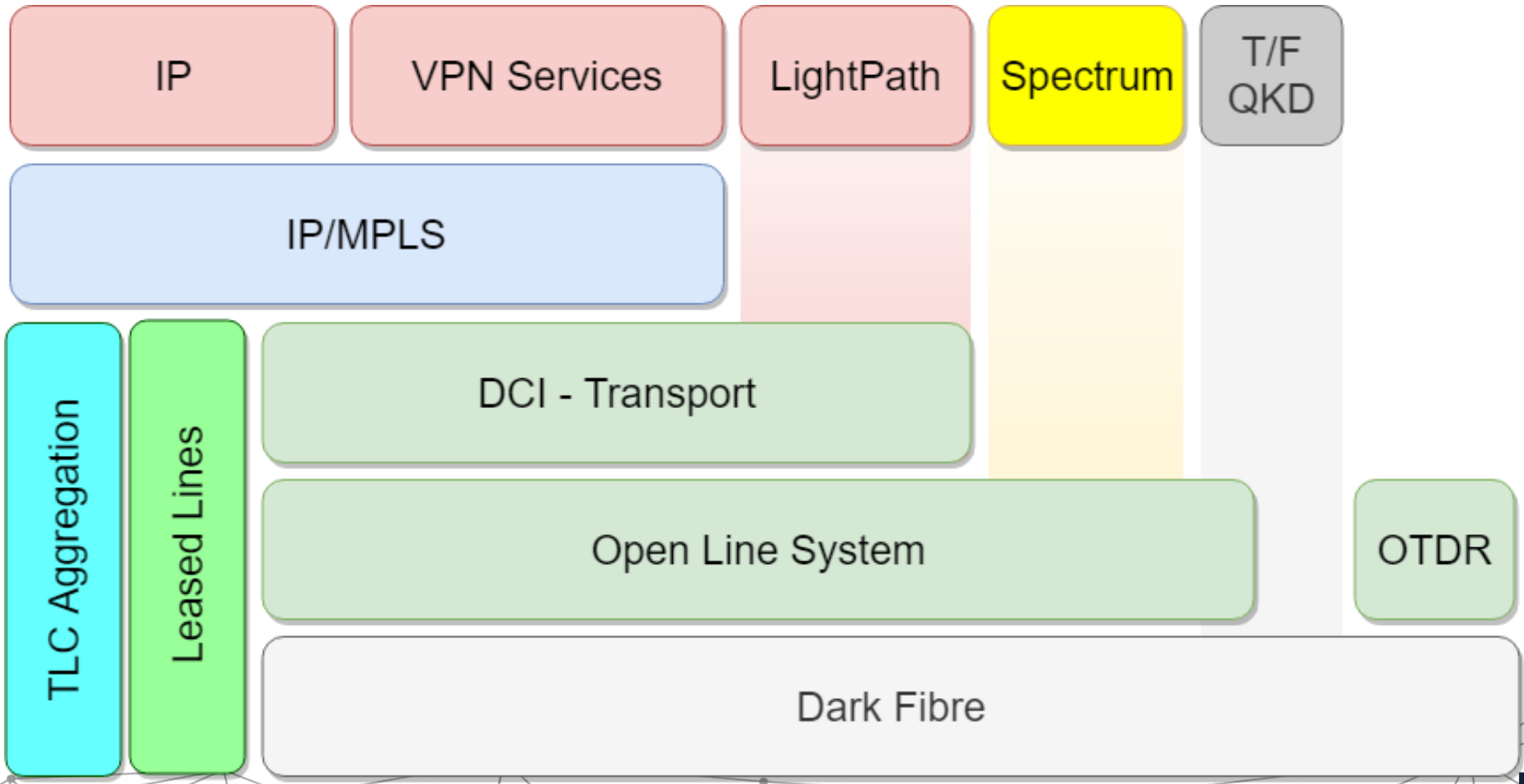
Resilienza

Evoluzione servizi

Ottimizzazione uso risorse

Minore impatto spazi e consumi

Architettura rete GARR-T

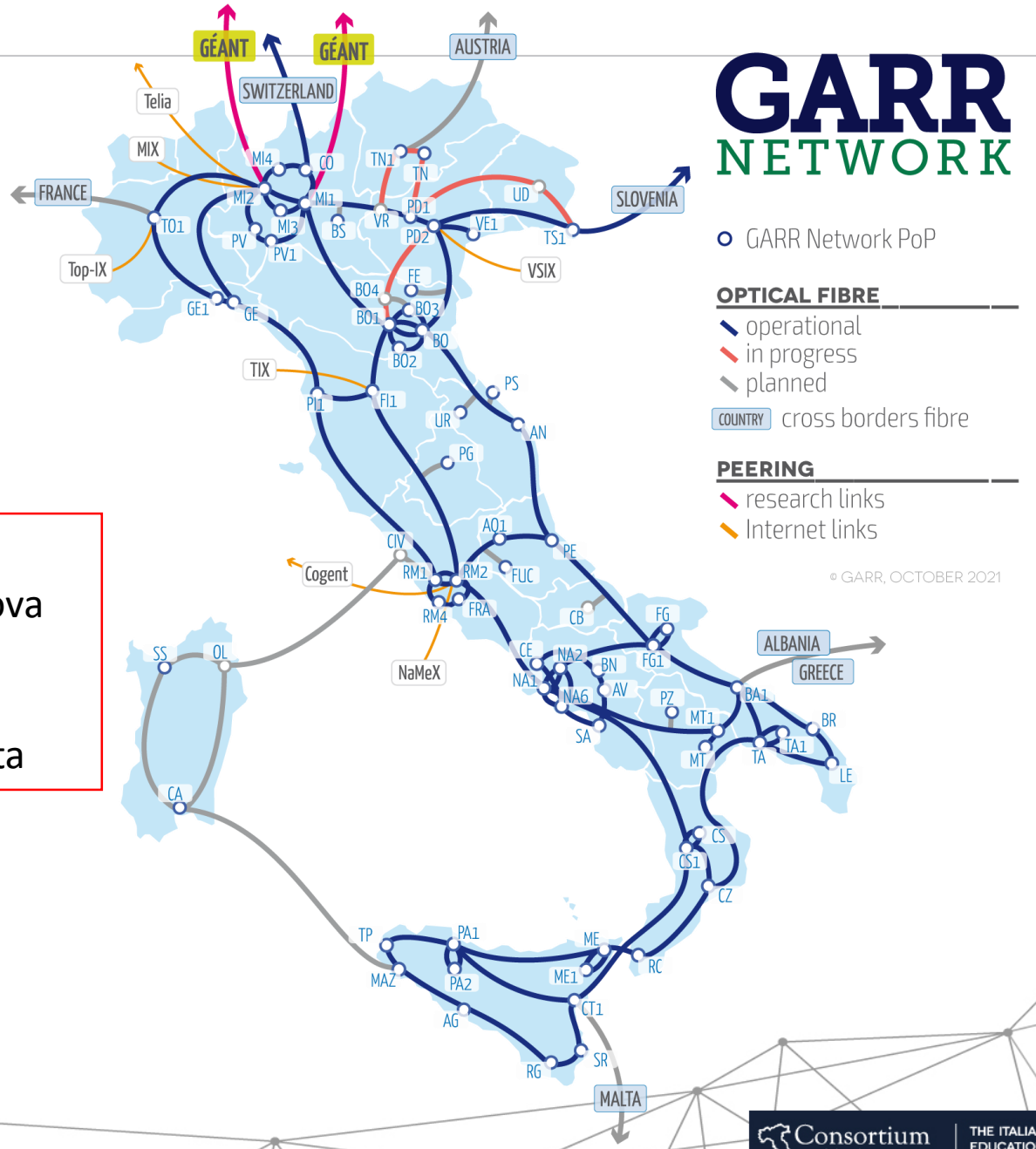


GARR-T

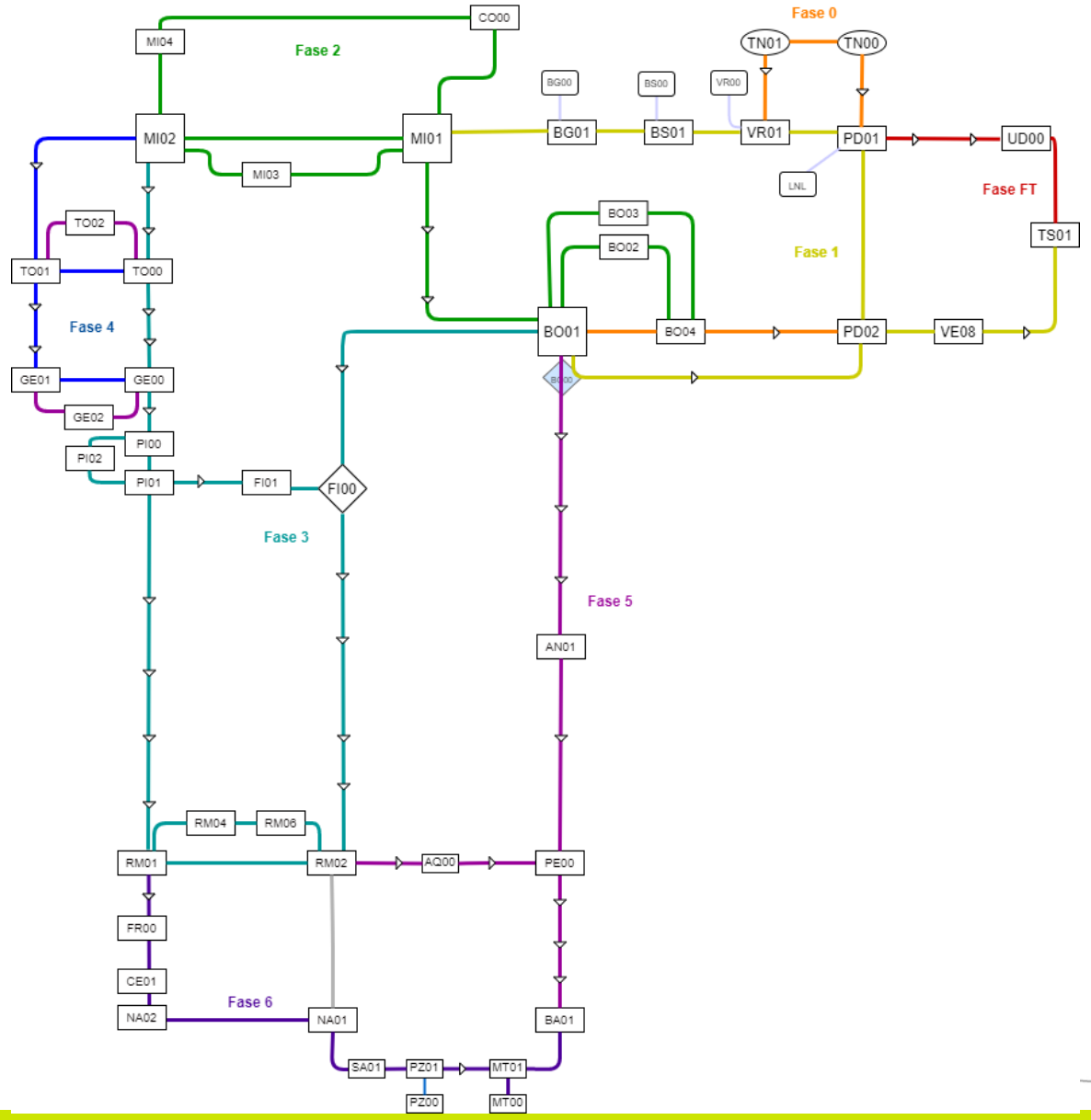
- **Infrastruttura fibra ottica:**
  - Richiusura magliatura nord-est
  - Nuovi anelli metropolitani
  - Ottimizzazione dorsali lunga distanza
  - Infrastruttura temporanea per migrazione

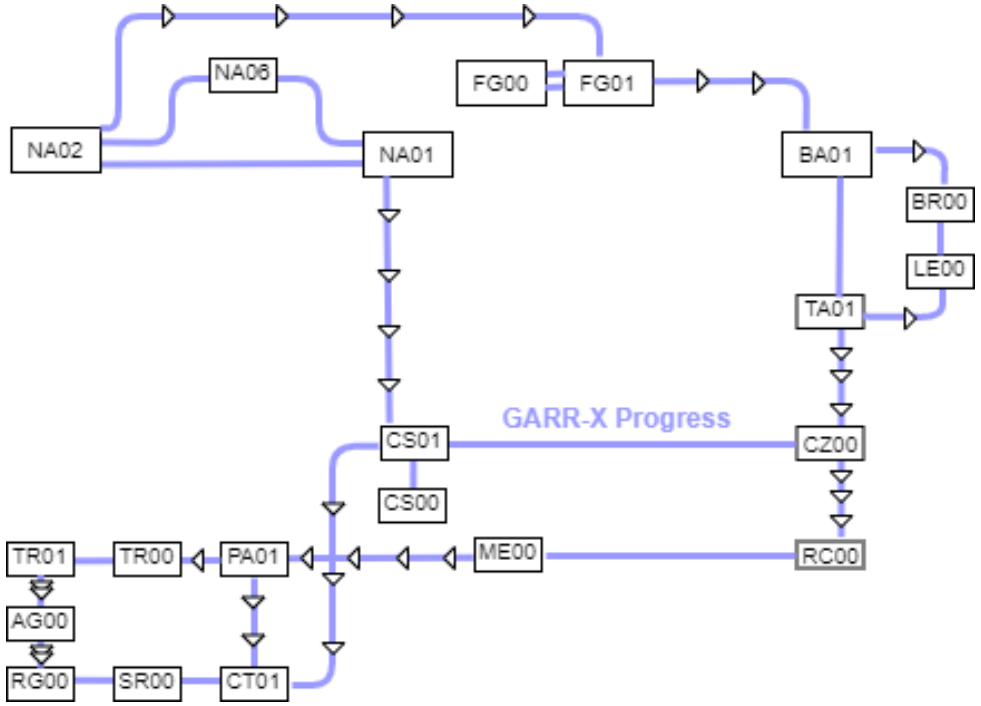
- **Rete trasporto ottica:**
  - Sostituzione piattaforma GARR-X (2011) con nuova piattaforma trasmissiva
  - Rete Trasmissiva GARR-X Progress già basata su piattaforme di nuova generazione sarà preservata

- **Rete a pacchetto:**
  - Completa sostituzione apparati a pacchetto su tutti i Punti di presenza GARR



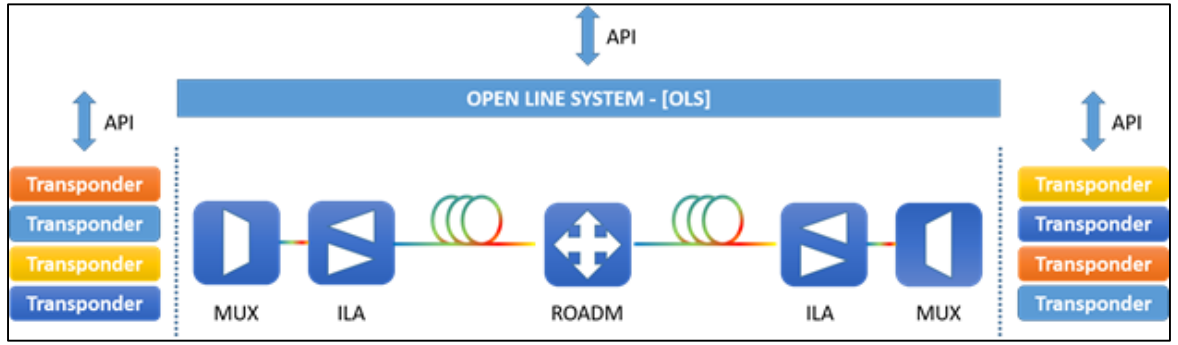
GARR-T infrastruttura fibra ottica di lunga distanza

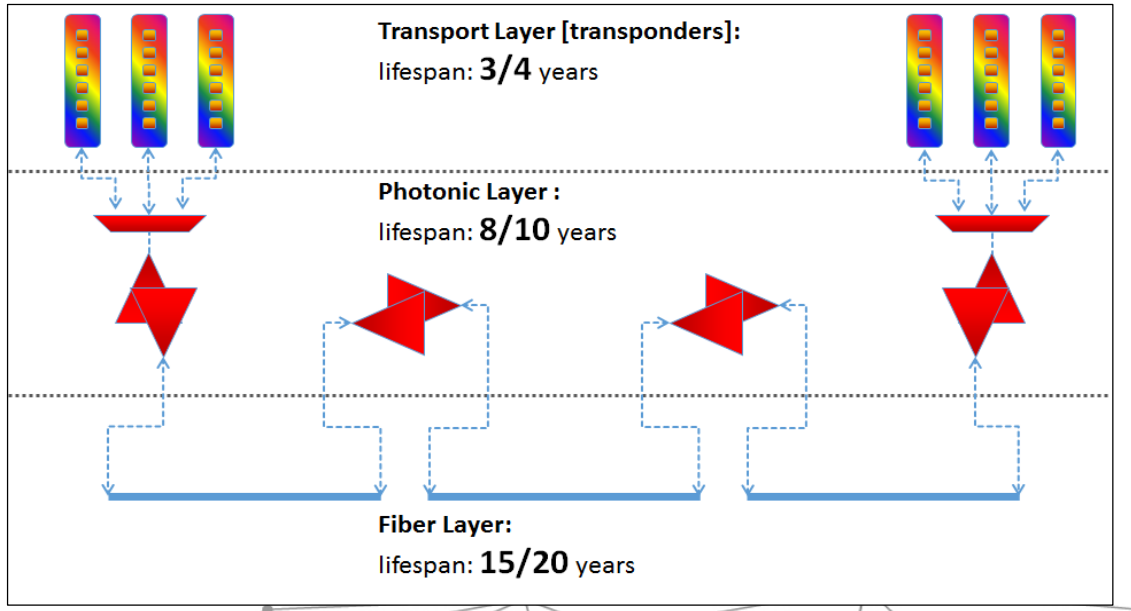




Rete Trasporto Ottica
Open Line System: rete parzialmente disaggregata

- **Open Line System:** elementi fotonici di linea come amplificatori, mux/demux, ROADMs, OTDR, WSS.
- **Elementi di Rice/Trasmissione (DCI/Transponder):** interfacce di Rice/Trasmissione del segnale ottico
- **Interfacce Programmabili**
- **Elementi di Controllo, Gestione e Monitoraggio**





Disaccoppiamento tra line system e transponder consente di indirizzare correttamente il ciclo di vita delle soluzioni

Supporto di soluzioni eterogenee e multivendor

GARR-T apparati rete trasporto ottica

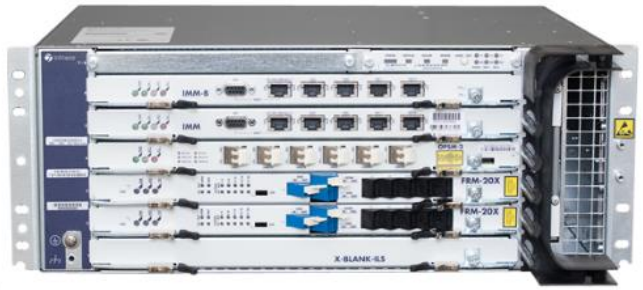
Open Line System: FlexILS Infinera
- Extended C-band (4.8 THz)
- FlexGrid (12.5 GHz granularity)
- Alien e Spectrum Sharing by design
- Trasparente a tipologia di modulazione e baudrate
- Nodi adattabili a installazioni DataCenter
- Embedded OTDR

DCI: Groove G30
- 1 RU pizzabox fino a 2.4Tbps per chassis
- Interfacce network tunable
- Modulazione flessibile 100Gbps fino a 600Gbps
- Interfacce client 100GEth e 400GEth
- Supporto multi-chassis

Infinera

Open Line System

FlexILS



Data Center Interconnect

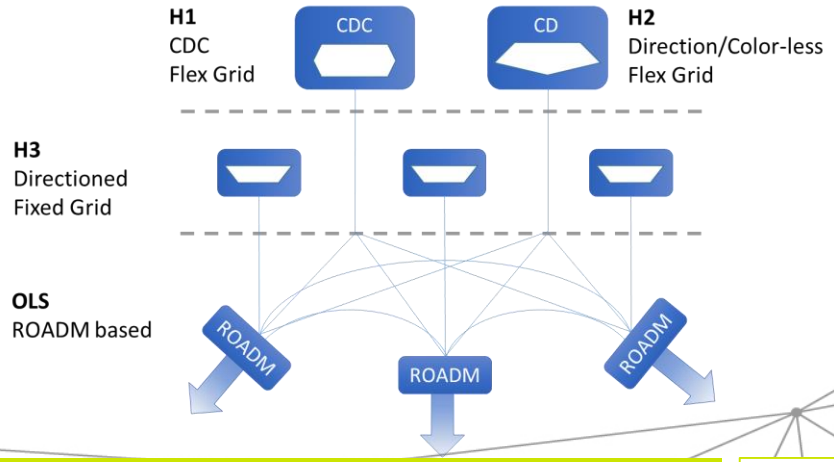
Groove G30

CHM1T

CHM2T

400G

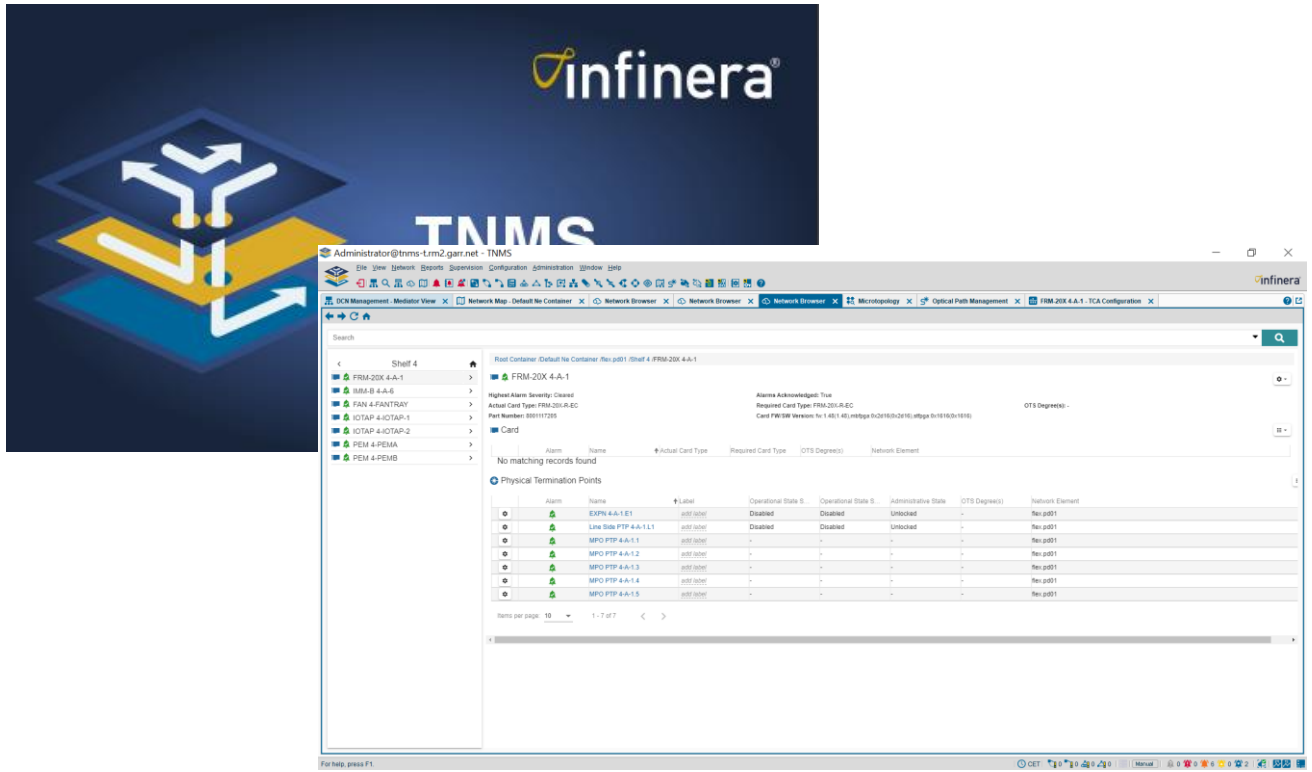
1.2T



GARR-T Controllo e gestione rete ottica

FCAPS Network Management System

- TNMS



Transcent SDN Controller API

- REST and RESTCONF / YANG based interfaces using JSON data
- Data models following ONF T-API 2.x
  - Inventory/topology/services
- TMF models based REST interfaces for Alarm Management and Performance Management

Open Networking Foundation

< REST CONF />

Rete gerarchica a pacchetto: Spine, Leaf, Edge

Gli apparati con funzione **LEAF** realizzano lo stadio di accesso della rete:

- accessi utente 100/10/1 Gbps;
- supportano feature avanzate per i servizi.

Gli apparati con funzione **SPINE** realizzano lo stadio di trasporto della rete:

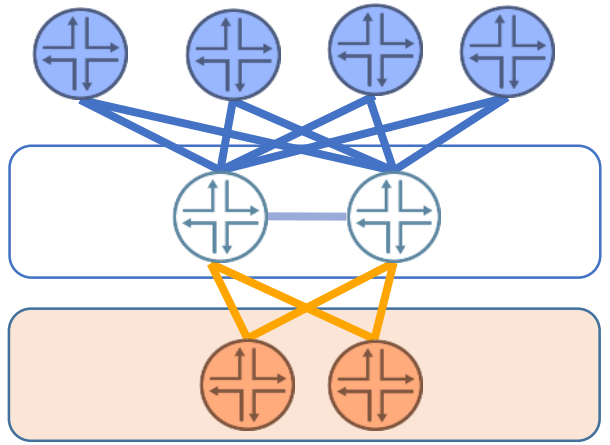
- link a elevata capacità di banda, 400/100 Gbps e multipli;
- non necessarie funzionalità per raccolta utenti e servizi di edge, per routing internet e transiti.

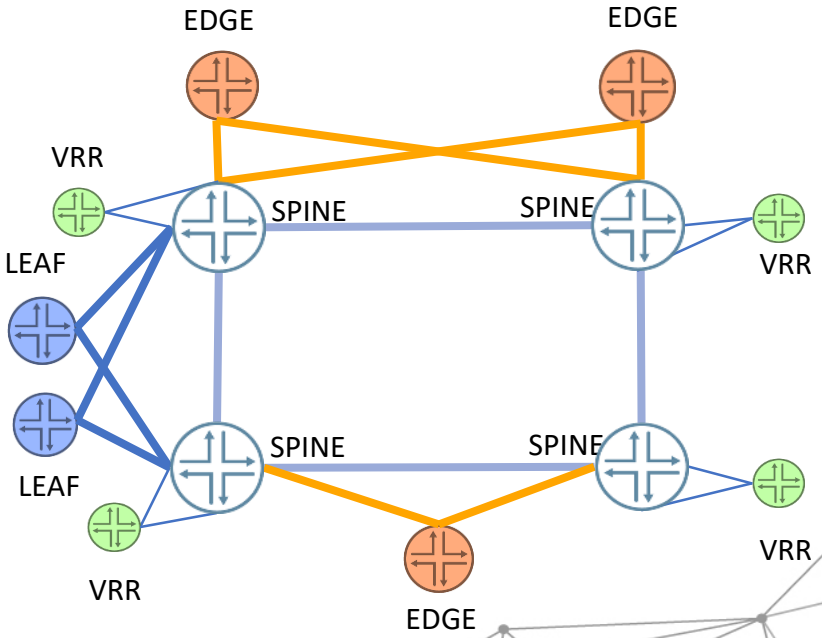
Gli apparati con funzione **EDGE** realizzano lo stadio di interconnessione con le reti esterne:

- interconnessione con reti esterne, Geant, upstream provider e IX, capacità 100/10 Gbps, collegati a SPINE differenti;
- funzionalmente sono identici alle LEAF.

vRR, funzione di Route Reflector trasferita su apparati dedicati.

CLOS

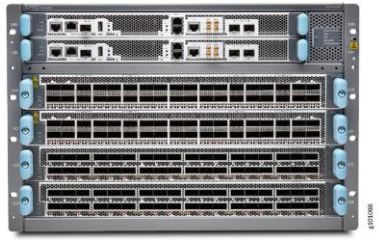




GARR-T Apparati previsti rete a pacchetto

Apparati	Tipo	Spazio (RU)	Consumo (kw)	Interfacce	Performance
MX204	fixed	1	0,3	100GE/40GE/10GE/1GE	400 Gbps
MX10003	fixed	3	2,0	100GE/40GE/10GE	2.4 Tbps
MX480	modulare	8	4,1	100GE/10GE-1GE dual rate	9,0 Tbps (espansione)
PTX10001-36MR	fixed	1	1,8	400GE/100GE/10GE	9.6 Tbps
PTX10004	modulare	7	7,3	400GE/100GE/10GE	9,6 Tbps (espansione)
JRR200	fixed	1	0,5	10GE/1GE	

SPINE



PTX10004

PTX10001-36MR

LEAF

MX480

MX10003

MX204

VRR

JRR200

Totale 130 nuovi apparati

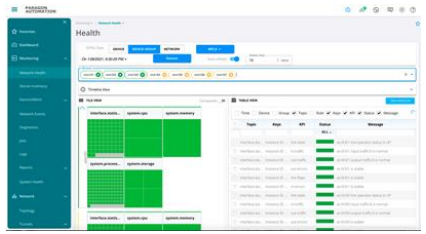
GARR-T Automazione rete a pacchetto

PARAGON AUTOMATION

INSIGHT HEALTHBOT sistema di **monitoring** avanzato e **troubleshooting** con nuove modalità:

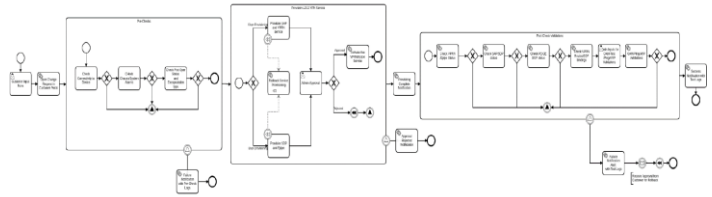
acquisizione dati con **telemetria** (sensori);

event driven network.



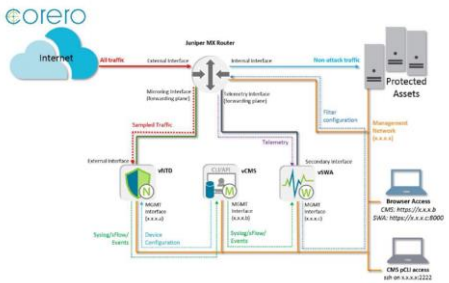
ANUTA ATOM sistema change management e operatività basati su workflow:

- inventory;
- cambi configurazione;
- cambi release apparati;
- provisioning servizi e altro.

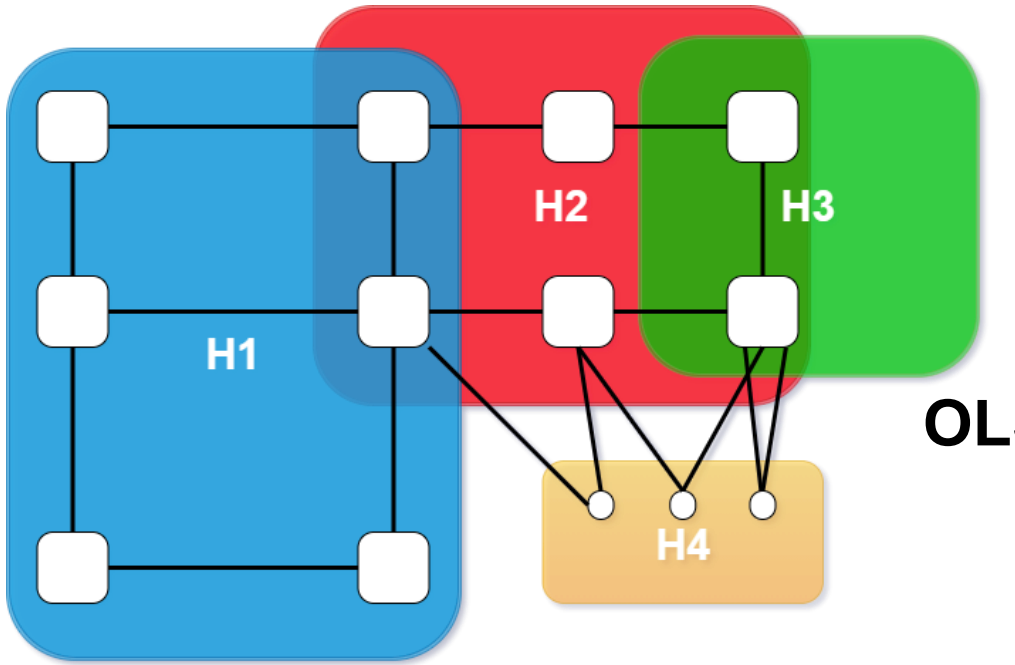


- **NORTHSTAR** sistema di pianificazione e gestione Traffic Engineering (TE):
  - **PATHFINDER, Controller** per la gestione (configurazione, visualizzazione, monitoraggio) del TE.
  - **Planner** per l'analisi offline della rete e analisi di tipo what-if e simulazione dei fault.

CORERO sistema di rilevamento e mitigazione DDoS già in produzione.

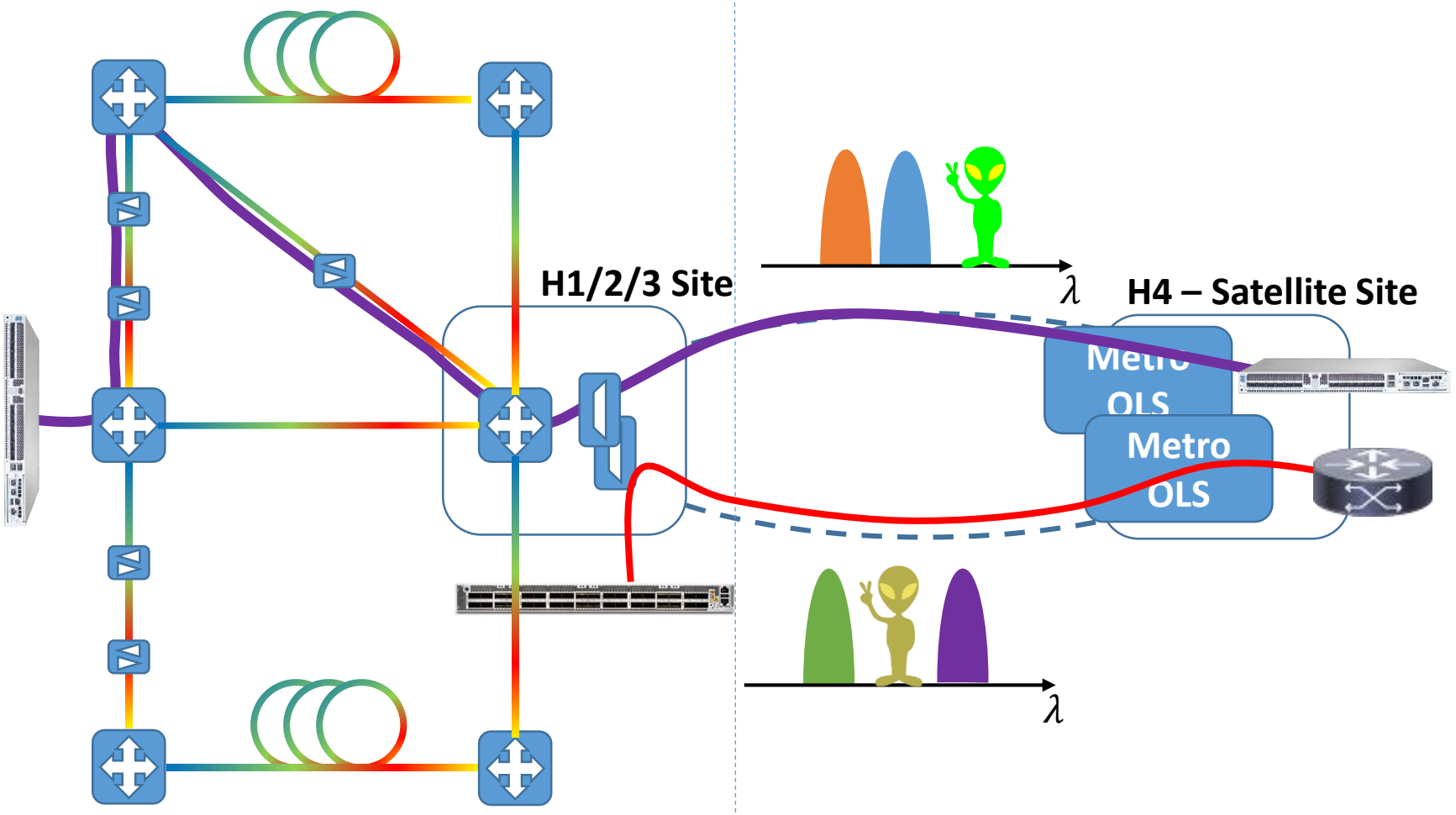


Gerarchia e complessita' nodi



	H1 (edge+spine+leaf)	H2 (spine+leaf)	H3 (leaf)	H4 (leaf)
PKT	[9, 17] kW	[3.5, 8] kW	[0.3, 5] kW	0.3 kW
	[12, 30] RU	[4, 19] RU	[1, 11] RU	1 RU
OLS+DCI	[4.5, 5] kW	[1.6, 2.9] kW	[1, 2.3] kW	[0.5, 1] kW
	[38, 40] RU	[15, 27] RU	[15, 22] RU	3 RU

Optical Network **Satellite** Sites (illuminiamo la fibra!)



- H4 nodes review
- Metro OLS elements integrated in the LH network
- Unique photonic domain
- PoP sites or High end user sites
- Same functions of the optical core network
- Scalable and low footprint
  - 4-8 RU
  - 1-1.5 kW

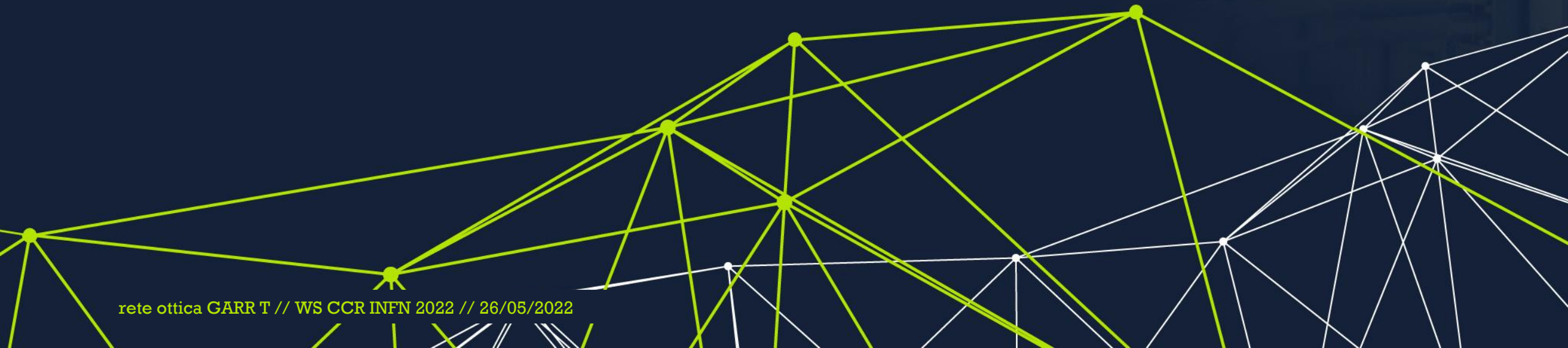
Long Haul Network scale

Metro Network scale 5-30 km

GÉANT
Networks • Services • People

Consortium GARR
THE ITALIAN EDUCATION & RESEARCH NETWORK

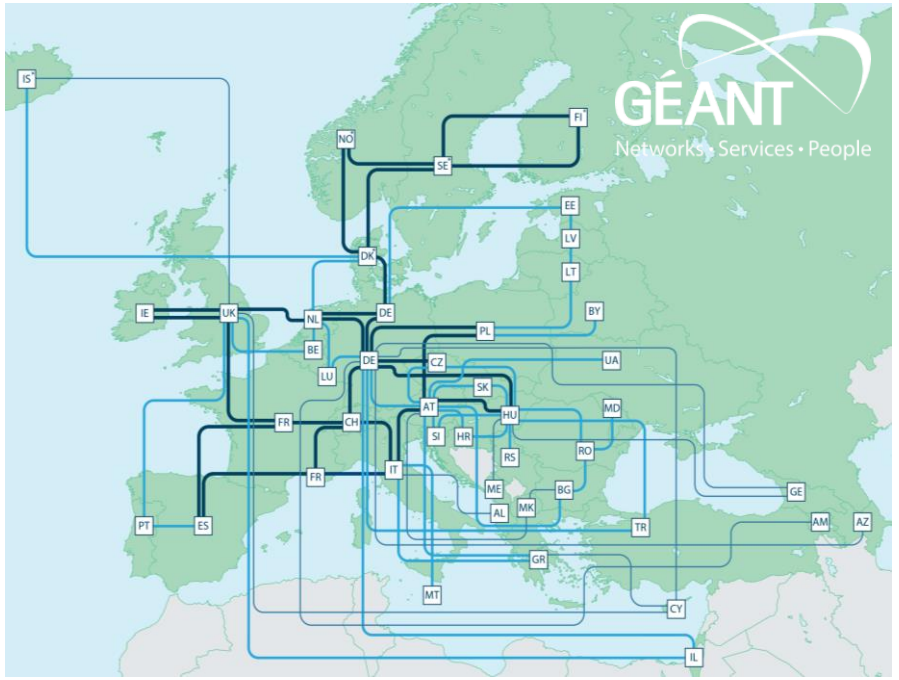
Spectrum Sharing at European Scale



rete ottica GARR T // WS CCR INFN 2022 // 26/05/2022

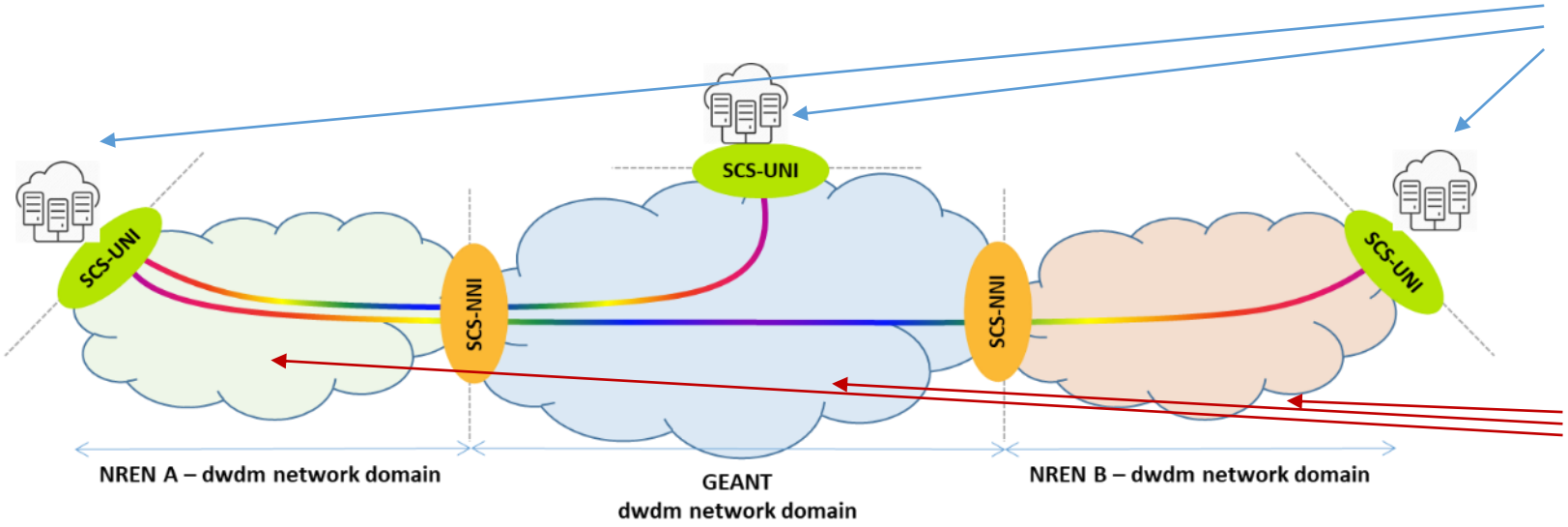
GEANT network and The Spectrum Connection Service (SCS) team

- 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.
- A new Spectrum Connection Service service has been proposed in the GÉANT Network Evolution Plan
- The service development team in GN4-3 is WP7-T2 (started in January 2019)
- The participating NRENs are:



AMRES Akademska mreža Srbije · Consortium GARR · GÉANT · grnet · cesnet · KIFÜ · RENATER · UNINETT

SCS Reference Model



Actors:

- **Spectrum Service Users-Consumers**
  Own the equipment that generates the coloured, coherent optical signals, behind the SCS-UNI
- **Spectrum Service providers**
  Own and operate the DWDM line system in their domain

Interfaces:

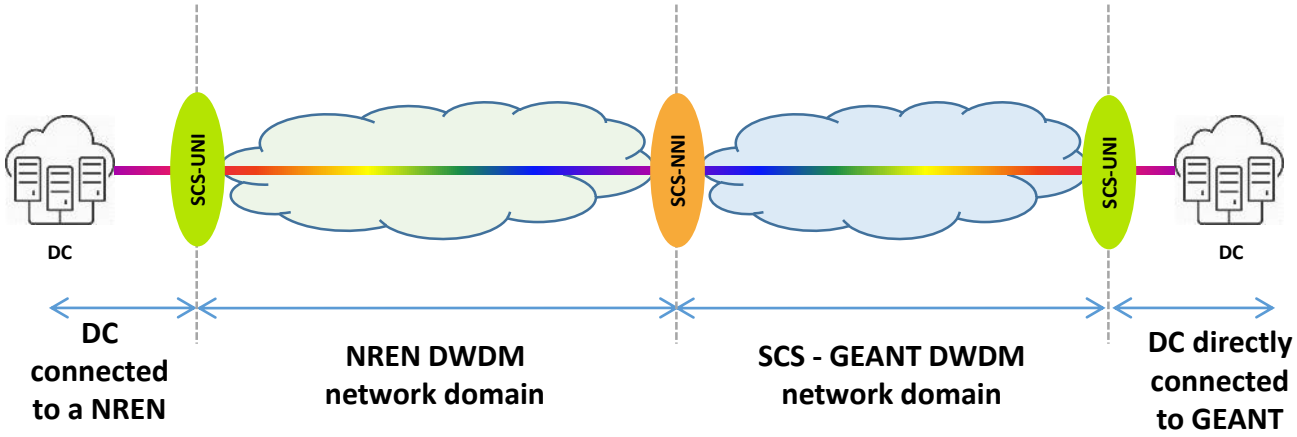
SCS-UNI: The User-Network Interface.

- It defines the 'end' of the SCS service region. Beyond is the customer's network outside of the region controlled by the SCS service

SCS-NNI: The Network-Network Interface.

- It defines the boundary between two networks that are participating in the SCS service
- Meta data relating to the service may be transferred between NREN service providers relating the service transiting the SCS-NNI. For example: service name, service owner, service spectral width, target optical power levels etc

Generic Use Case: Data Centers Interconnection by SCS



- Indipendent photonic domains: one NREN and Géant
- Two Data Center as end-sites, providing DCI boxes to generate optical signal
- No 3R regeneration-> max 1000km path.
- Focus on APIs to provision, manage and monitor the connection
- Simulation tools test
- Candidate use case: CNAF (IT) Tier1 to CERN Tier0, through GARR and Géant SCS service providers

CNAF – CERN Data Center Interconnection

LHCOPN-LHCONE meeting #46

S.Campana (CERN)

https://indico.cern.ch/event/983436/contributions/4226012/attachments/2213578/3746895/LHCOPN-LHCONE-Mar2021.pdf

Summary of Network Needs

In the flexible scenario, we expect the largest T1s (KIT, IN2P3, CNAF, RAL, BNL, FNAL) to be connected with CERN and the T2s (at least at regional level) through a ~1Tbps network

For the other T1s we expect ~500Gbps.

The numbers from the flexible scenario are coherent with what was presented at the LHCONE/LHCOPN meeting in early 2020.

The minimal scenario is coherent with the numbers presented at the ESNET planning of summer 2020.

LHCOPN-LHCONE meeting #48

S.Zani (INFN)

https://indico.cern.ch/event/1110783/contributions/4700636/attachments/2417802/4137815/DCI-CERN-CNAF-LHCOPN-2022.pdf

Main motivations to start a pilot project on an optical direct link between CERN and CNAF

HL-LHC connectivity requirements for TIER1s: More than 1Tbps in 2027 (S.Campana Presentation at LHCONE/OPN meeting 23/3/2021)

- A direct link with CERN without traversing too many **router interfaces** should be a **cheaper** solution for High Bandwidth link.
- A programmable transponder based interconnection infrastructure could be used to **dynamically resize the T0 –T1 Link** on the needs.
- A DCI interconnection could be used as the underlay network for a Data Lake spanning between CERN and CNAF
- High bandwidth end to end **optical channels for specific purposes** could be deployed in few seconds.
- More efficient use of the physical network infrastructure, sharing spectrum available on NREN backbones.

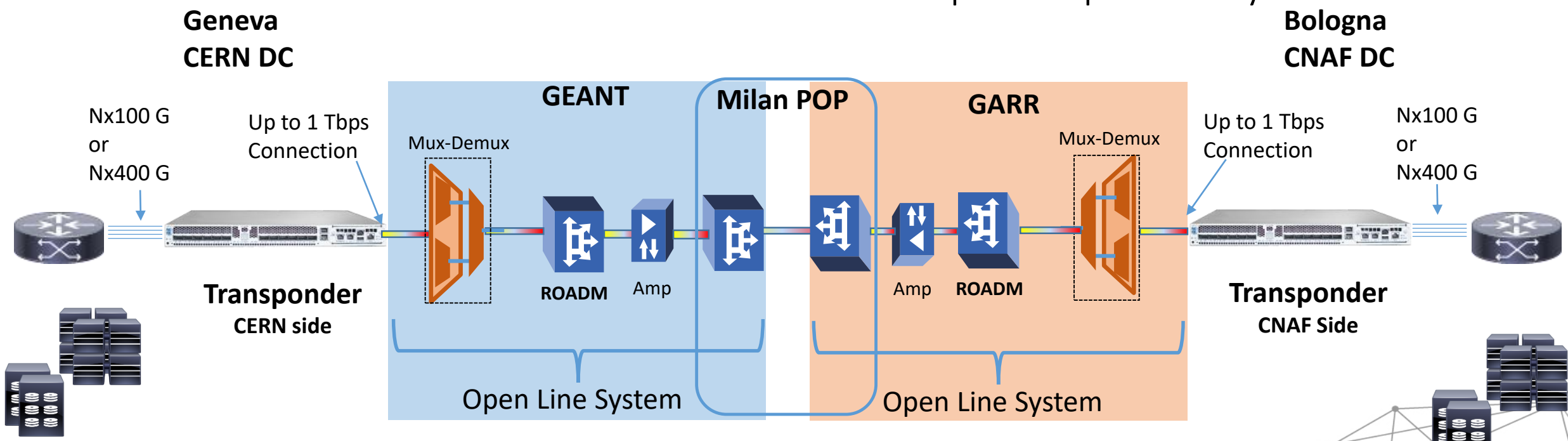
Pilot Activity

Service Main Features

1. e2e transparent optical interconnection
2. no restoration o protection
3. flexible DCI ownership

Areas of investigation

1. End Points (DC, L2/L3 interconnections)
2. UNI
3. NNI
4. Reliability
5. Monitoring and Control
6. Impact on Optical Line System



ROADM: Reconfigurable Add/Drop Multiplexer

Pilot Steps (1/2)

Activity started in late 2021

Prerequisites

- Configuration and tuning of the GARR Open Line system between Bologna and Milan GARR/GEANT POP. [07/2022]
- GARR is procuring DCI for CERN node [already ordered, delivering] and CNAF node [to be ordered by 07/2022]
  - 2x Transponders per site *(To be ready for preproduction)*
    - Infinera Groove G30 (CHM2T DCI Metro)
    - 2 Transceivers QSFP28 (100G-Ethernet)
    - 1 QSFP-DD 400G Ethernet
- NNI interconnection in Milan [defined and agreed between GEANT and GARR, to be deployed]

START

Pilot First Step

- Access to the GEANT spectrum sharing service and tuning activity:
  Different interconnection schema are under evaluation
- Transponders will be connected to the Datacenters LANs of the sites (CNAF and CERN) at the beginning at 2x100G to perform first tests. ***-Hope to have the first link up before the end of 2022-***

Pilot Steps (2/2)

Pilot Next Steps

- Grow in terms of capacity adding 100G Ethernet ports and activating 400G Ethernet interfaces when it will be possible.
- Integrations with monitoring and control tools

Up to → Pre Production

- Check the reliability of the interconnection
- Validate monitoring and operational management

Opportunities and Challenges [DC]

- L2 Stretching of specific networks between the DCs
- IP Fabric stretching
- Direct L1 Interconnection as part of the full capacity capability of a DC

Opportunities and Challenges [Network]

- Definition of best practices and limits related to Spectrum Connection Service
- PKT layer offload and overall network scalability enhancement
- Develop monitoring and control tools

Conclusioni

Architettura:

- Open
- Disaggregazione e Disaccoppiamento
- Resilienza
- Automazione e Programmabilita’

Tecnologie:

- Scalabilita’
- Impatto sostenibile

Pilot e nuove applicazioni:

- Sviluppo tool e servizi avanzati
- Sviluppo competenze
- Capillarita’

Thanks!

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images credits: Flaticon.com