

GARR Services and Infrastructure

Architecture for High Throughput Networks

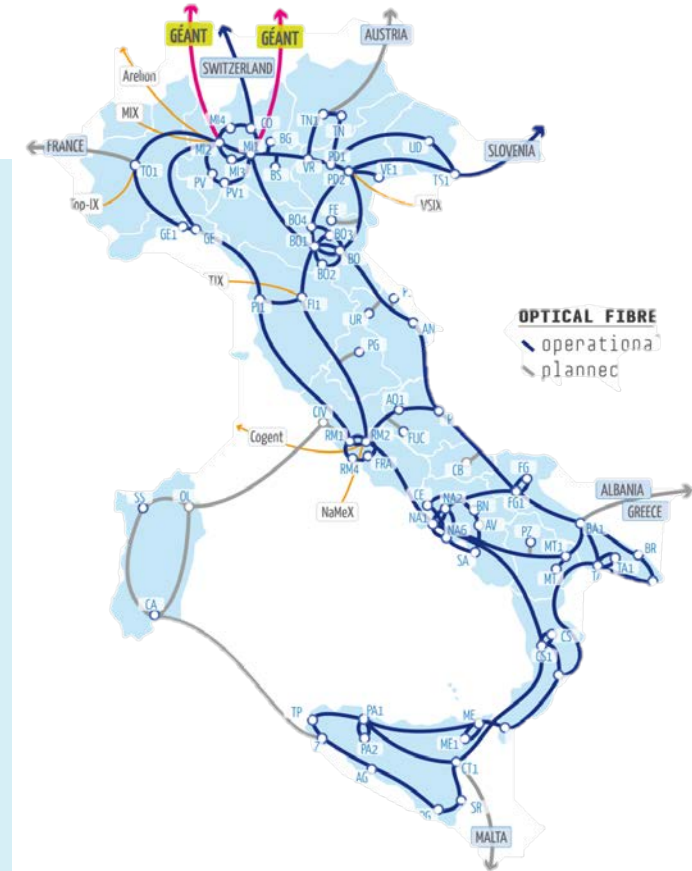
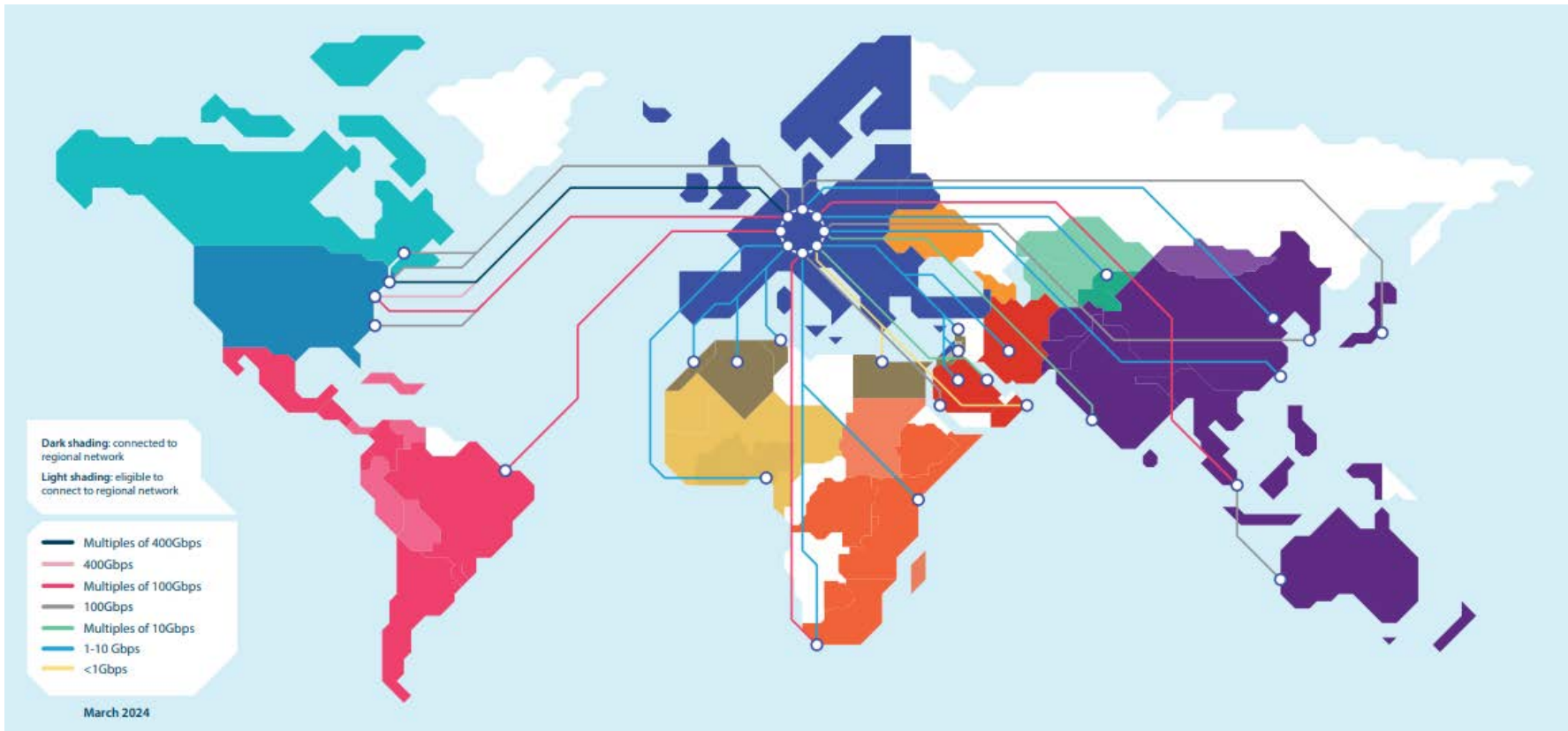
S.TOMASSINI – E. TAMIRO

USCVIII - General Assembly // GARR Services and Infrastructure // Padova, 15-10-2024

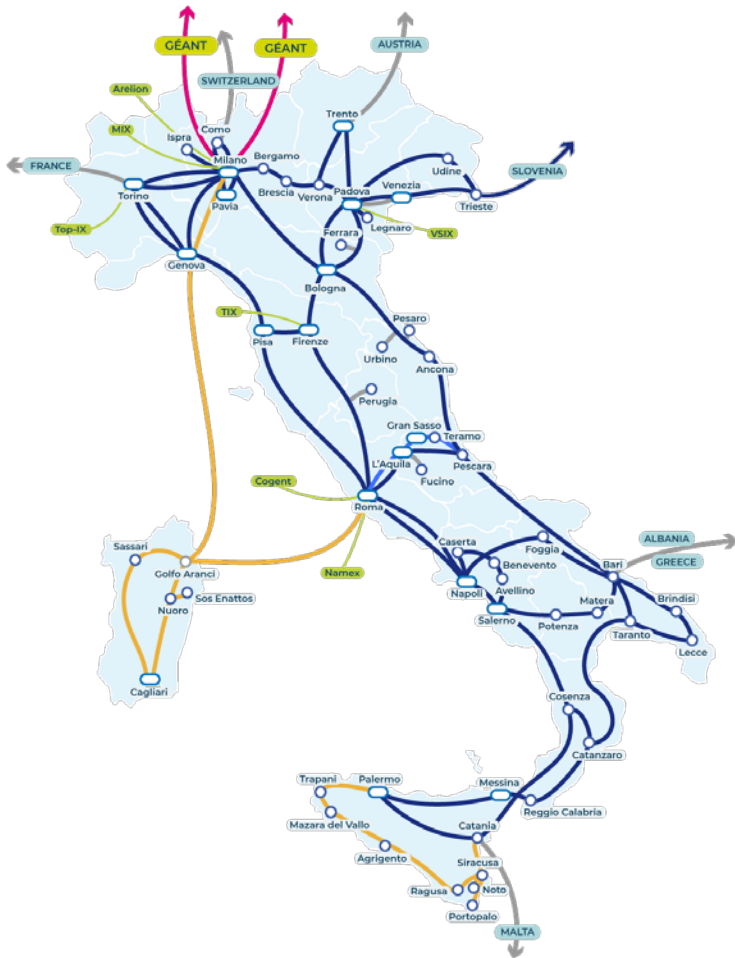
GARR and its characteristics

Italian Legislative Decree n. 218 of 25 November 2016 art. 10 paragraph 5, defining GARR as

"the only national research network and part of the GEANT European research network".



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

About 1000 connected sites belonging to several organisations

-  100 Universities
-  350 Research Institutes and Laboratories
-  60 Biomedical Research Institutes
-  65 Music Conservatories, Art Academies, Libraries, Museums & other Cultural Institutions
-  More than 100 PoPs

Some numbers

- ➔ 2x300G GÉANT
- ➔ 300G LHCONE (VPN)

CERN – CNAF
1,6 T Optical VPN

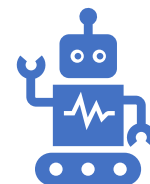
- ➔ 100G MIX
- ➔ 100G NAMEX
- ➔ 30G Arelion-Cogent
- ➔ 10G-1G-1G TOPIX-TIX-VSIX

- ➔ 2x100G Peering Microsoft
- ➔ 200G Peering Google
- ➔ 2x200G Peering Amazon

GARR-T cornerstones



Terabit/s



Automation and programmability

Widely spread



Next-gen Control and Monitoring



Resiliency



High end services

Resources optimization

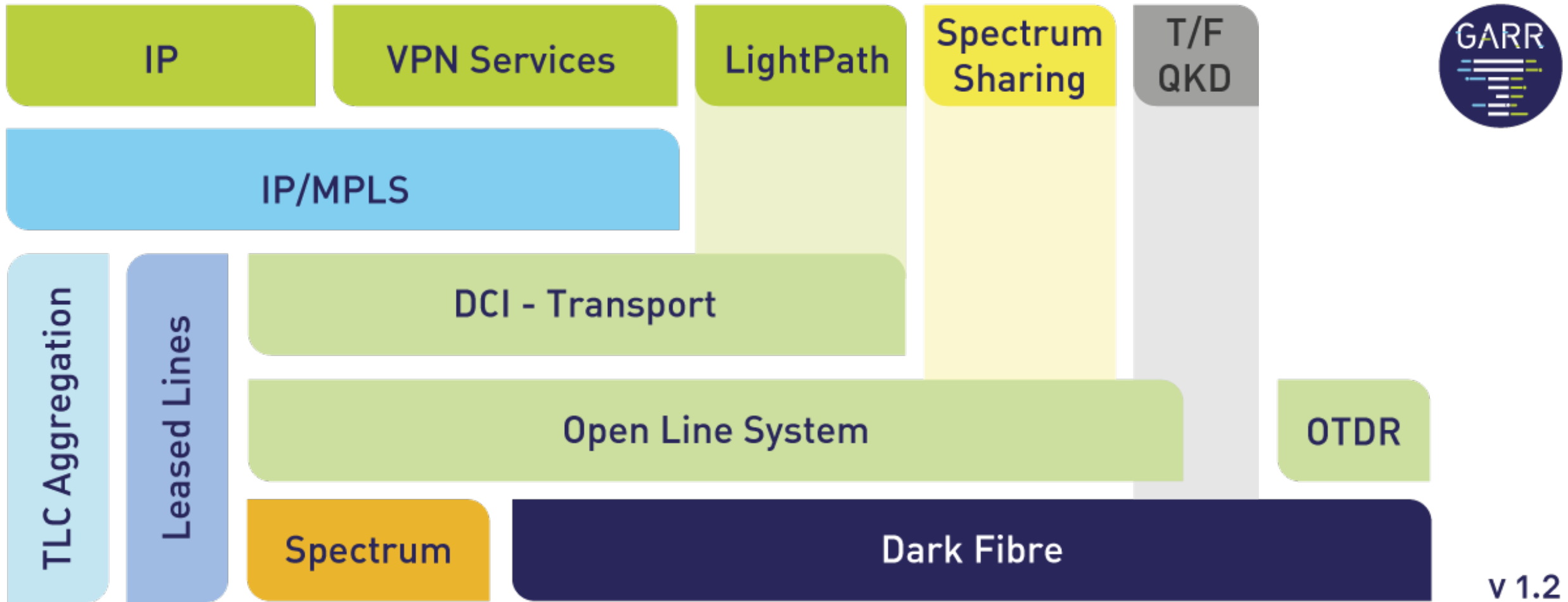


Lower Power and Space footprint



Source: Paolo Bolletta, GARR – TeRABIT Conference 25-06-2024

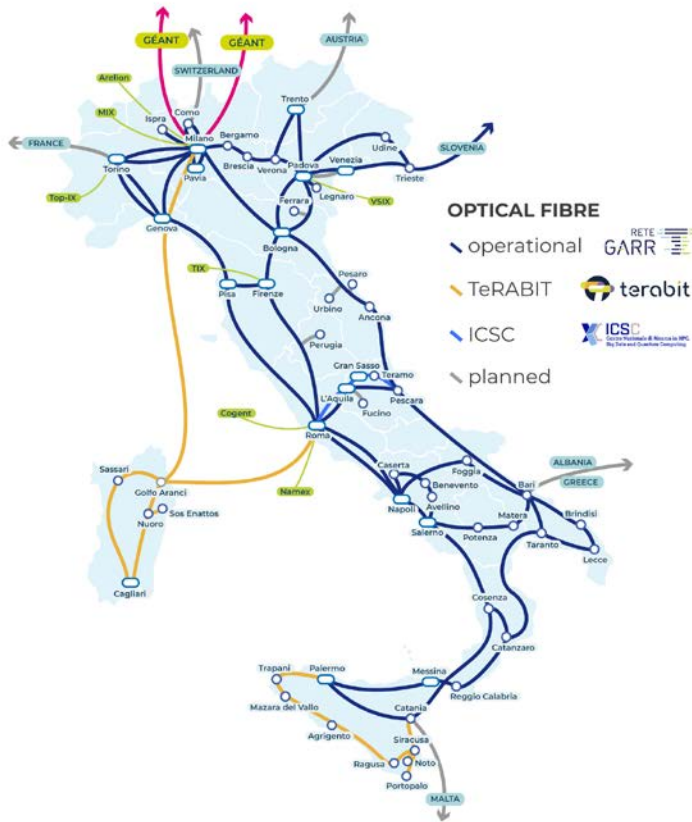
GARR-T Architecture



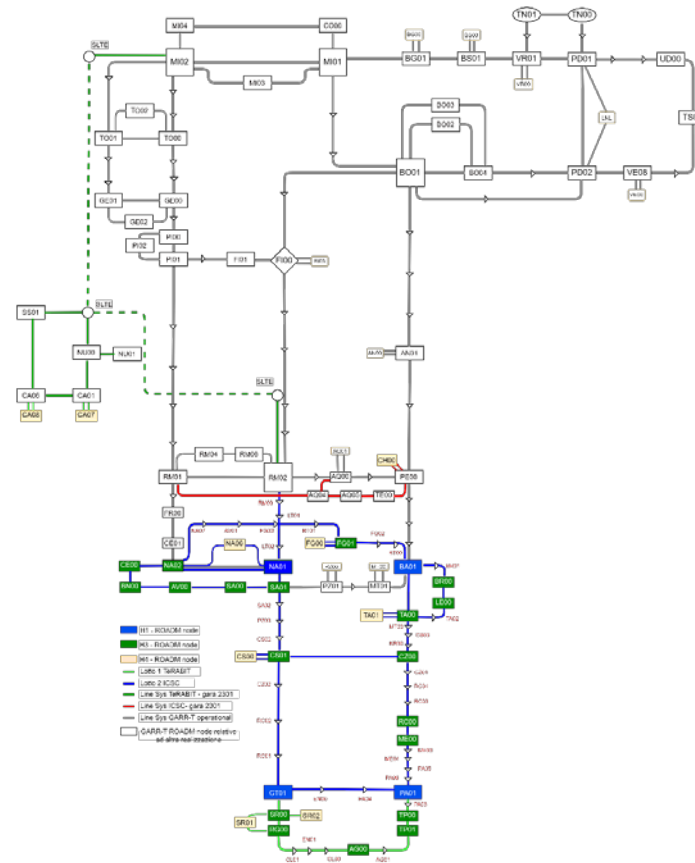
Source: Paolo Bolletta, GARR – TeRABIT Conference 25-06-2024

GARR-T new deployments (PNRR) - network overview

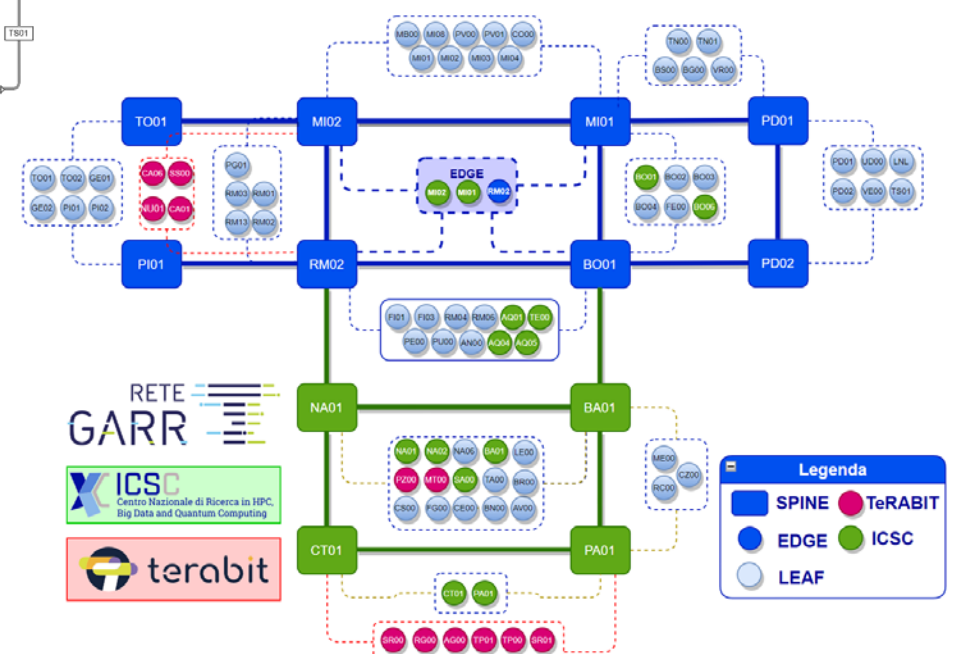
Backbone topology



Optical Transport Layer



Packet Layer



Source: Paolo Bolletta, GARR – TeRABIT Conference 25-06-2024

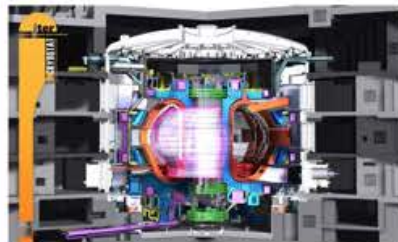
Global traffic forecast – driven by big data movers

LHC

- 200 sites across the globe
- 50% of GÉANT global traffic
- High Luminosity HLC from 2029



Map courtesy of Google.com



ITER – Fusion Research

- Several PBs of data per year
- To be copied from France to multiple locations globally



Astronomy

- Square Kilometre Array
 - Detectors in 100 Gbps capacities required
- Chile:
 - Cherenkov Telescope Array
 - ESO – Very Large Telescope

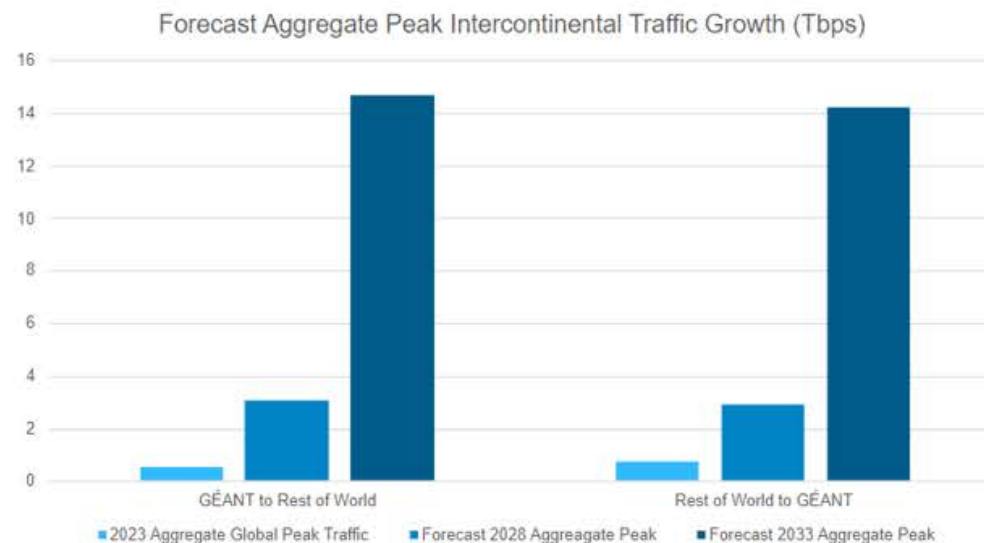


Earth Observation

- Distributing Copernicus data worldwide

Global traffic forecasting allows for:

- Average growth of general-purpose R&E traffic at 35% per annum and corresponding peaks
- Significant “step changes” in traffic due to major science collaborations and science infrastructures



Source: Helga Spitaler – GEANT – LHC-LHCONE Meeting-53

Network services and their use

Network access

- **1000 user sites** directly connected to the GARR backbone (IP connectivity, L2VPN, L3VPN, Optical VPN). GARR NOC manages and controls the access service for sites with different complexity (Universities, CNR, INFN, ENEA, INAF, INGV, IRCCS, IZS, research centres, cultural institutes, museums, schools)

Network services

- LIR for IPv4 and IPv6 network allocation
- NIC for domain name registration (.it e .eu)



Gestione della rete
Network management

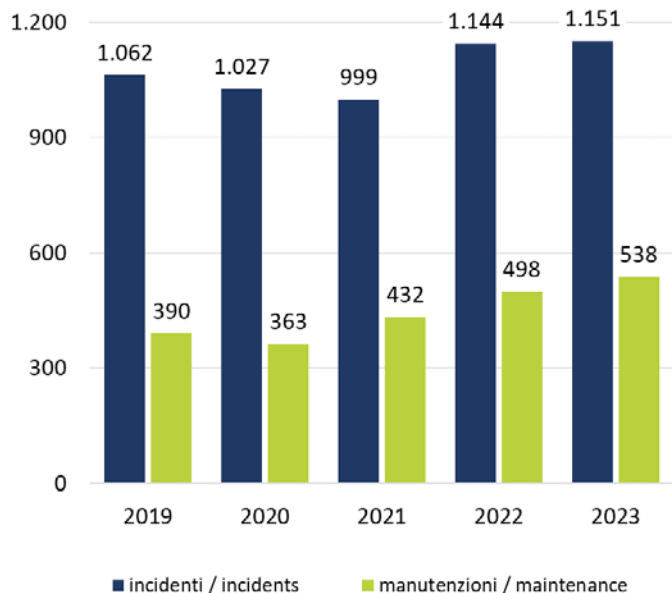


Indirizzi IP
IP address

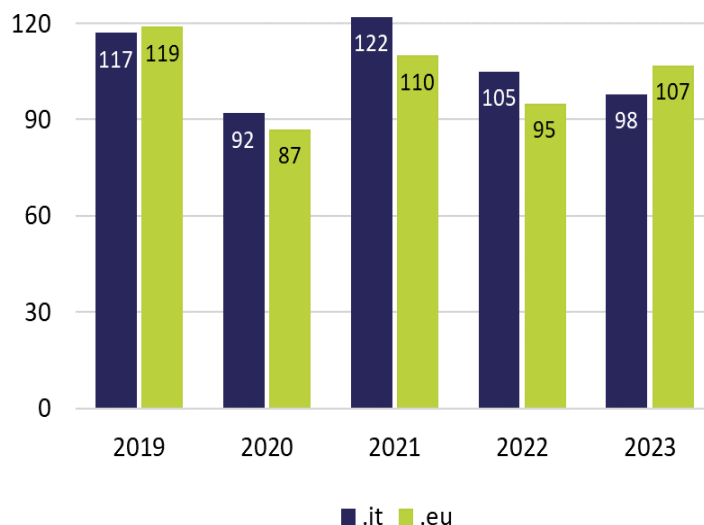


Nomi a dominio
Domain names

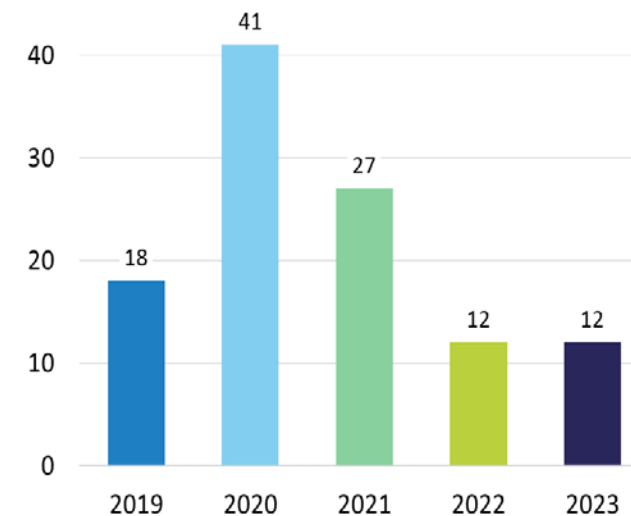
Incidenti e manutenzioni
Incidents and maintenance



Domini registrati
Domain names registered



Nuove reti IPv4 e IPv6 assegnate
New IPv4 and IPv6 networks allocated

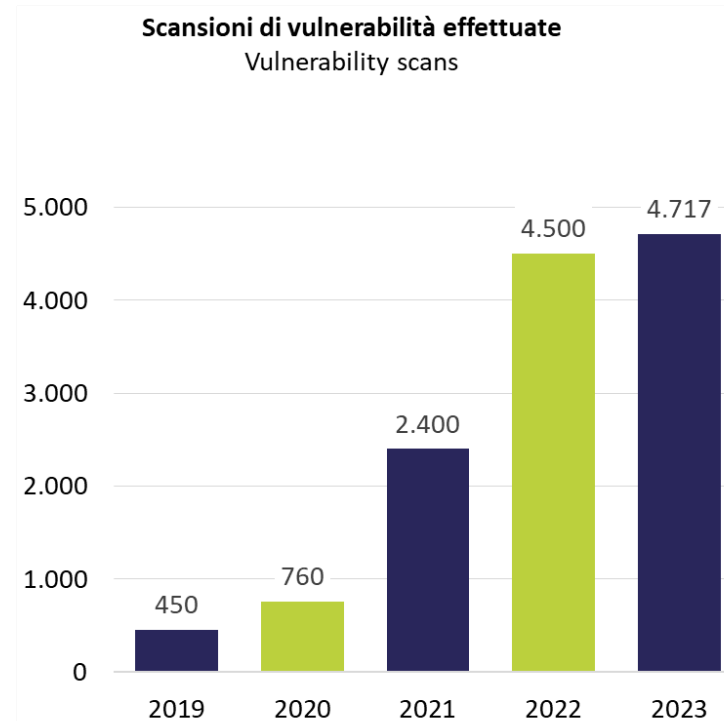
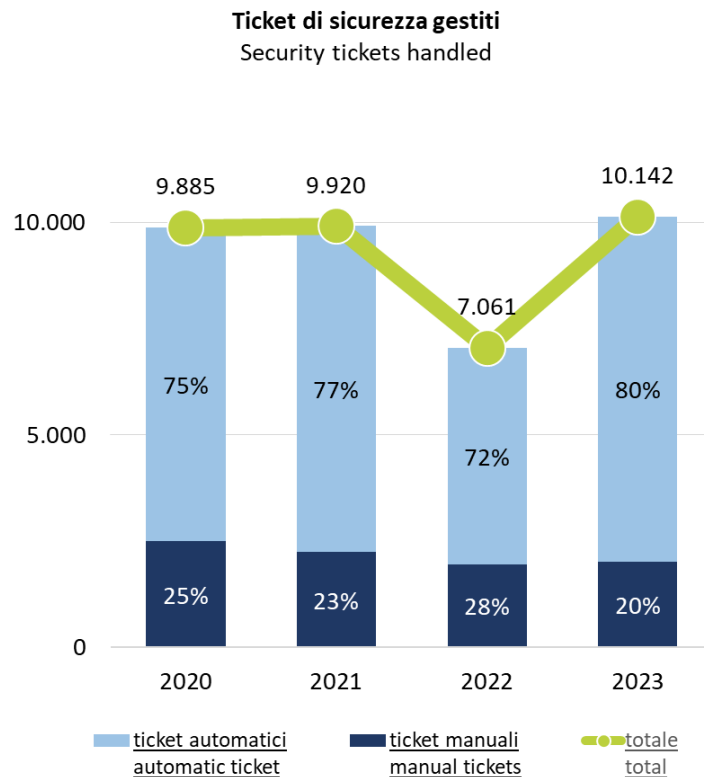


Annual Report 2023 [<https://u.garr.it/AnnualReport2023>]

GINS - GARR Integrated Networking Suite [<https://gins.garr.it/>]

Network services and their use

- GARR CERT Computer Emergency Response Team: incident management and scans (GARR victim/origin node)



Gestione e prevenzione
Management and prevention



Scansioni di vulnerabilità
Vulnerability scans

Network services and their use

- IDEM - Italian Federation of Universities and Research Institutions for Authentication and Authorization

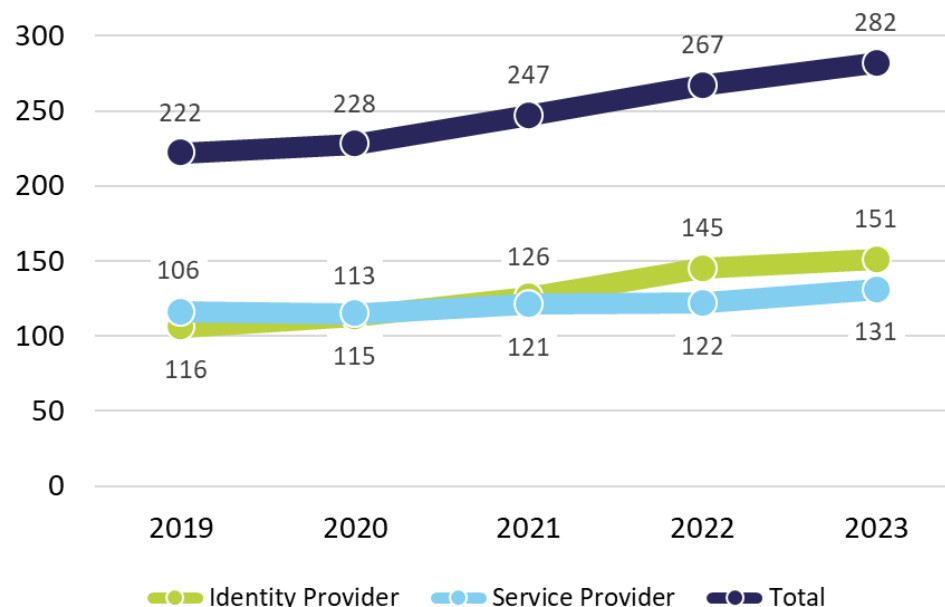
IDEM is a member of the eduGAIN world federation inter-service and allows its users to use thousands of resources made available by federations from all over the world

Current data (September 2024):

- 158 IdP in the IDEM federation
- 133 registered resources



Adesioni alla Federazione IDEM Joining to IDEM Federation



Application

eduID.it

101 institutes and 686 students



Identity Management (IDEM)

Simplifies the management of credentials so that users can have all the benefits of a single password to remember.

IDEM is part of international federation **EduGAIN** and in this way makes thousands of resources accessible worldwide.

The development and management of eduGAIN are financed through the GÉANT project and team members are technologists from GARR, PSNC, RENATER, DFN, SURF, SRCE, RENAM, CESNET, JISC, GRNET, KIFU, SWITCH, AMRES.



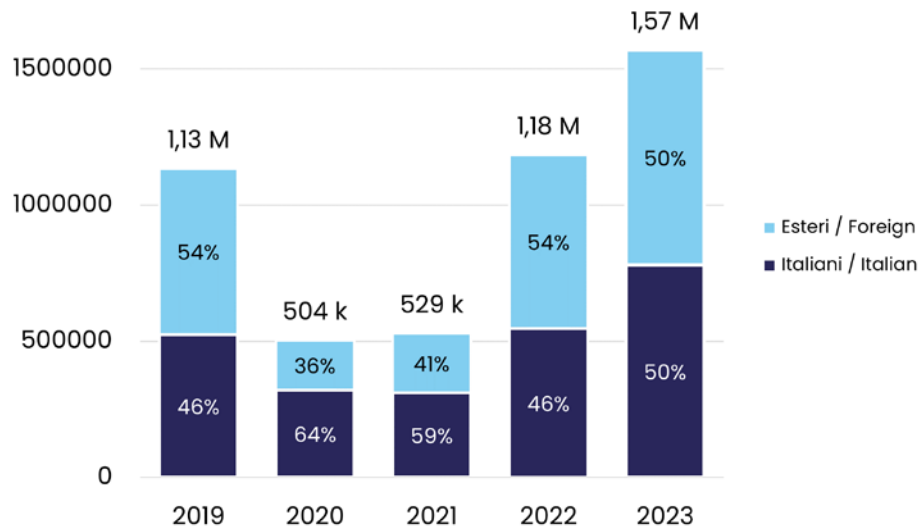
Eduroam and certificates

- EDUROAM
Confederation of all national federations, GARR manages the Italian federation
- Digital Certificates (personal, server) released by
Certification Authority Sectigo through GEANT Trusted Certificate Service



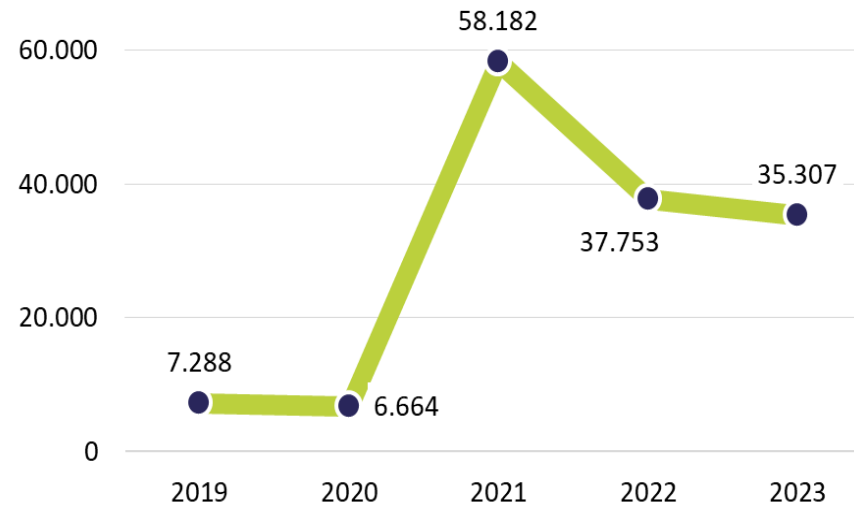
Eduroam: dispositivi connessi attraverso la federazione italiana

Eduroam: connected devices through the Italian federation



Certificati digitali rilasciati

Released digital certificates

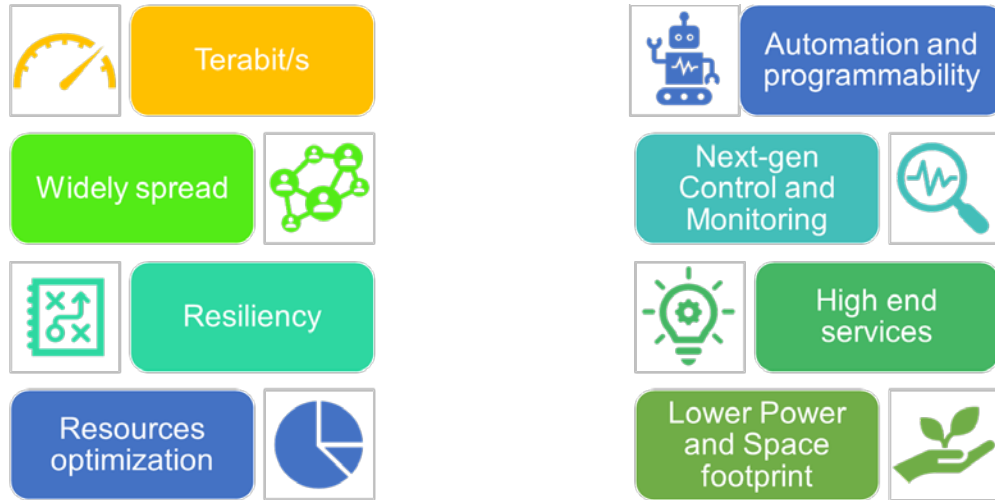




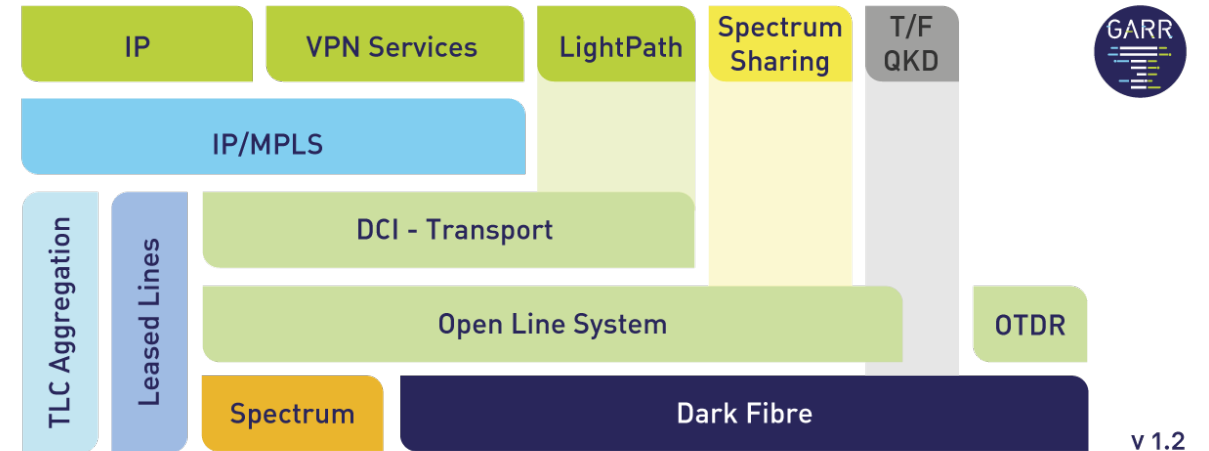
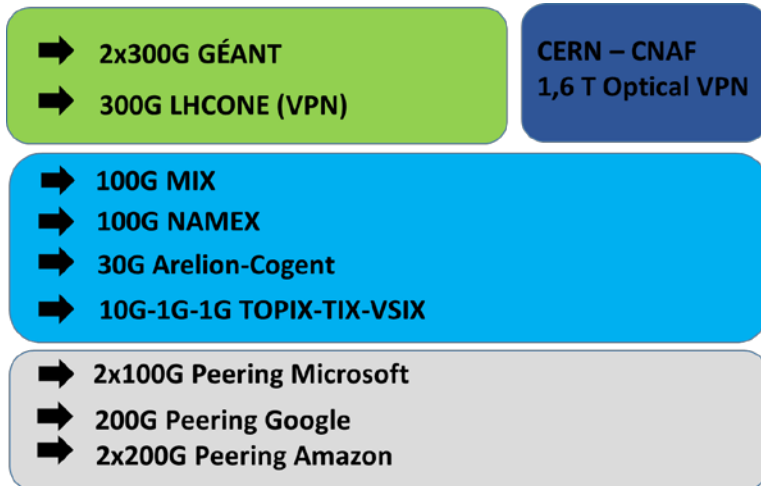
Personal Storage: (GARRbox)

Personal Cloud for file storage and sharing, designed specifically for the Italian research and education community. It enables data synchronization among different devices and the resource sharing with other users.

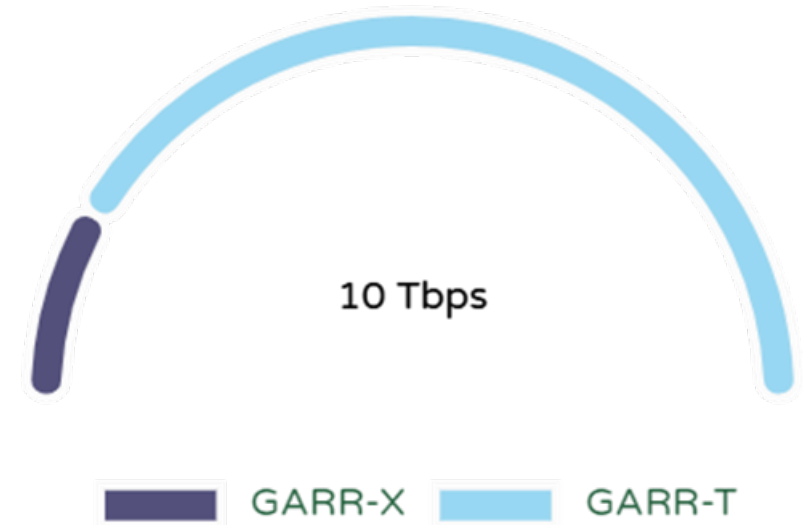
A picture of GARR Network ...



Source: Paolo Bolletta, GARR - TeRABIT Conference 25-06-2024



Increased capacity for end user services



Network Operations Center (NOC)

- **Manages** the network from the operational point of view
- **Solves** network outages
- **Works together** with the **APM** in order to deliver GARR Services and to keep site connectivity at its best

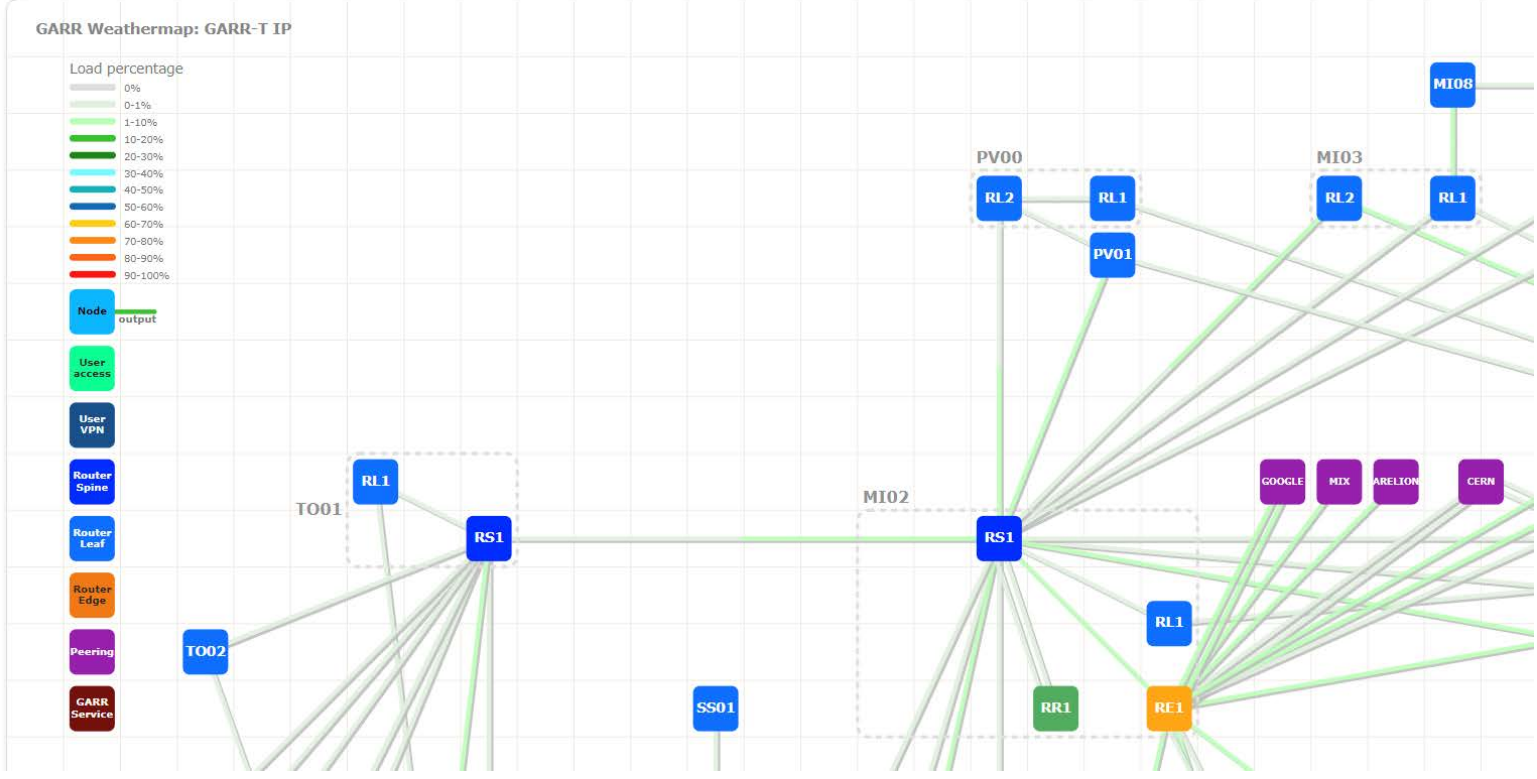
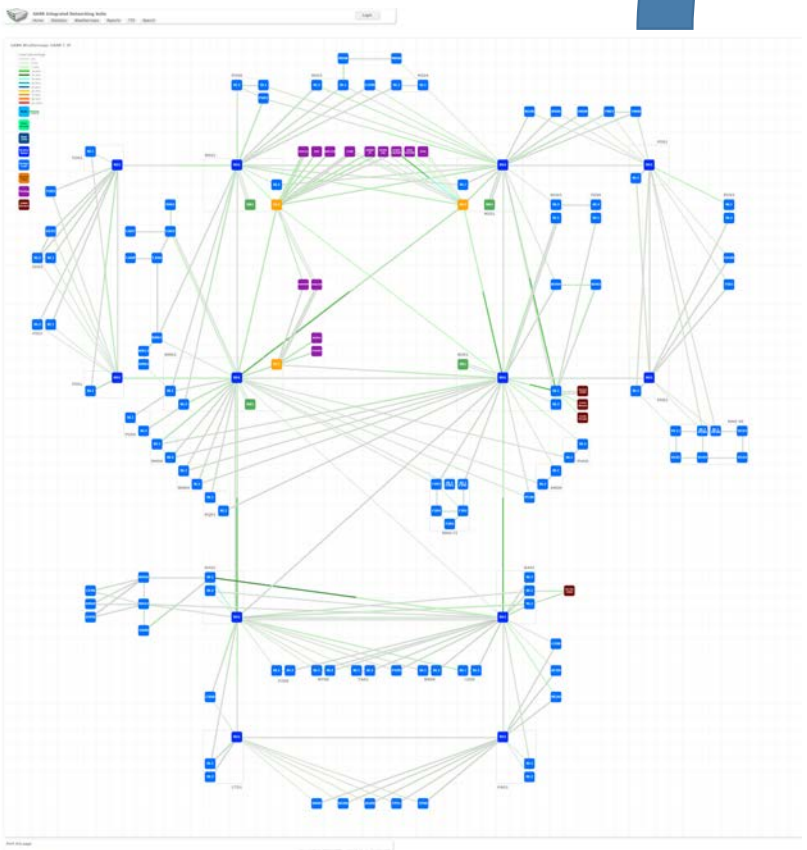
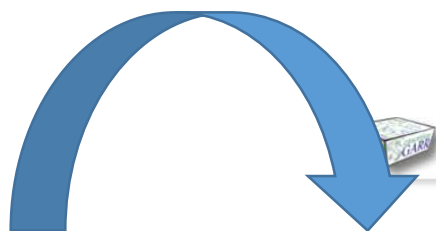




GARR Integrated Networking Suite (GINS)

Set of tools used for:

- **Diagnosing** and tracing network and service outages
- **Publishing** online statistics for both the backbone and the individual organisations.





Looking Glass

Host:

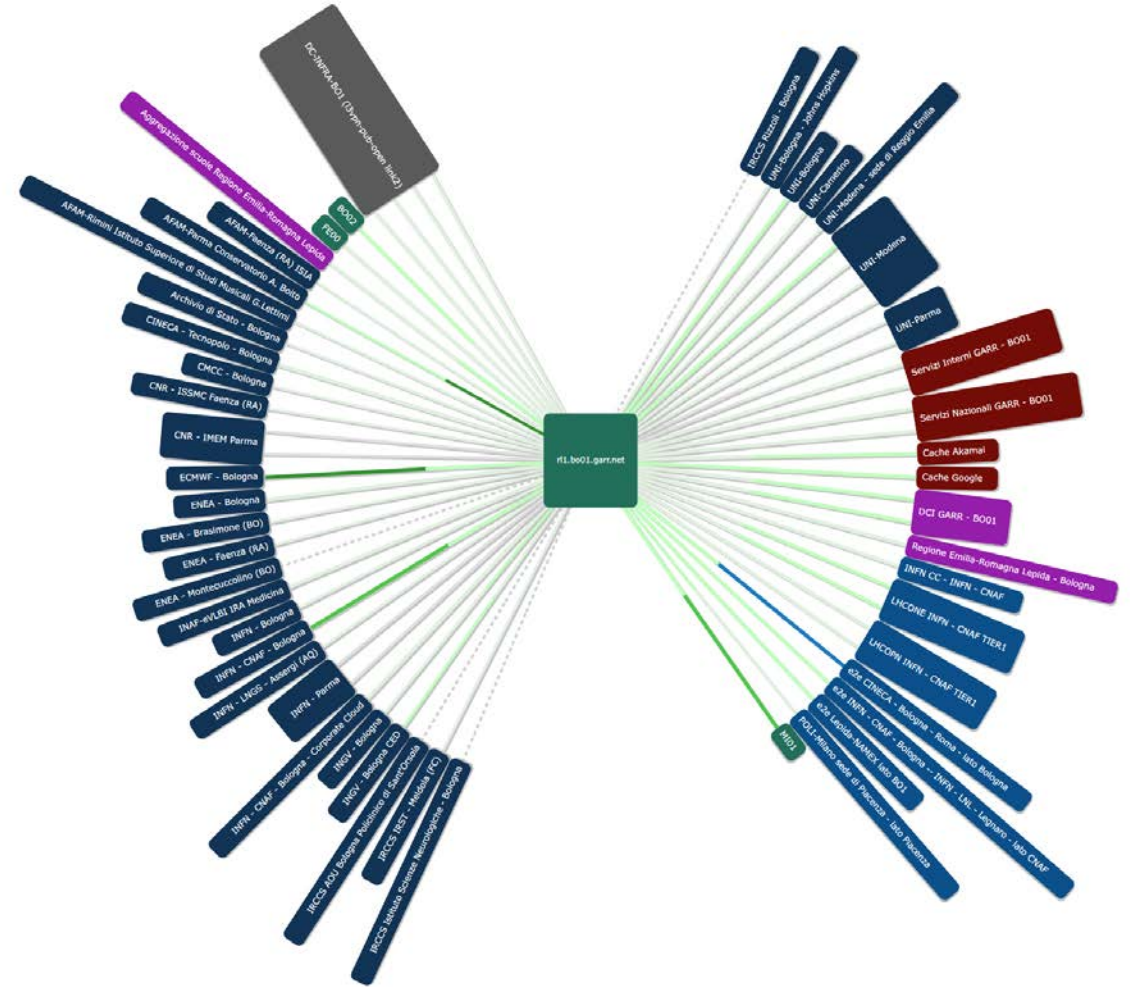
Command:

- ping ADDRESS
- traceroute ADDRESS
- show bgp summary
- show route ADDRESS[/PREFIX]
- show bgp neighbor ADDRESS

Argument:

use my address as argument

```
show route 193.206.128.54
inet.0: 946490 destinations, 4479392 routes (945395 active, 53035 holddown, 421323 hidden)
+ = Active Route, - = Last Active, * = Both
193.206.128.52/30 * [BGP/170] 2d 00:33:07, localpref 100, from 185.191.182.1
AS path: I, validation-state: unverified
> to 185.191.180.159 via ae10.1, Push 5121
to 185.191.180.56 via ae12.1, Push 19, Push 5028(top)
[BGP/170] 2d 00:33:07, localpref 100, from 185.191.182.2
AS path: I, validation-state: unverified
> to 185.191.180.159 via ae10.1, Push 5121
to 185.191.180.56 via ae12.1, Push 19, Push 5028(top)
[BGP/170] 2d 00:33:07, localpref 100, from 185.191.182.3
AS path: I, validation-state: unverified
> to 185.191.180.159 via ae10.1, Push 5121
to 185.191.180.56 via ae12.1, Push 19, Push 5028(top)
inet.2: 3187 destinations, 8161 routes (3186 active, 0 holddown, 1 hidden)
+ = Active Route, - = Last Active, * = Both
193.206.128.52/30 * [BGP/170] 2d 00:33:07, localpref 100, from 185.191.182.1
AS path: I, validation-state: unverified
> to 185.191.180.159 via ae10.1
to 185.191.180.56 via ae12.1, Push 19, Push 5028(top)
[BGP/170] 2d 00:33:07, localpref 100, from 185.191.182.2
AS path: I, validation-state: unverified
> to 185.191.180.159 via ae10.1
to 185.191.180.56 via ae12.1, Push 19, Push 5028(top)
[BGP/170] 2d 00:33:07, localpref 100, from 185.191.182.3
AS path: I, validation-state: unverified
> to 185.191.180.159 via ae10.1
to 185.191.180.56 via ae12.1, Push 19, Push 5028(top)
```

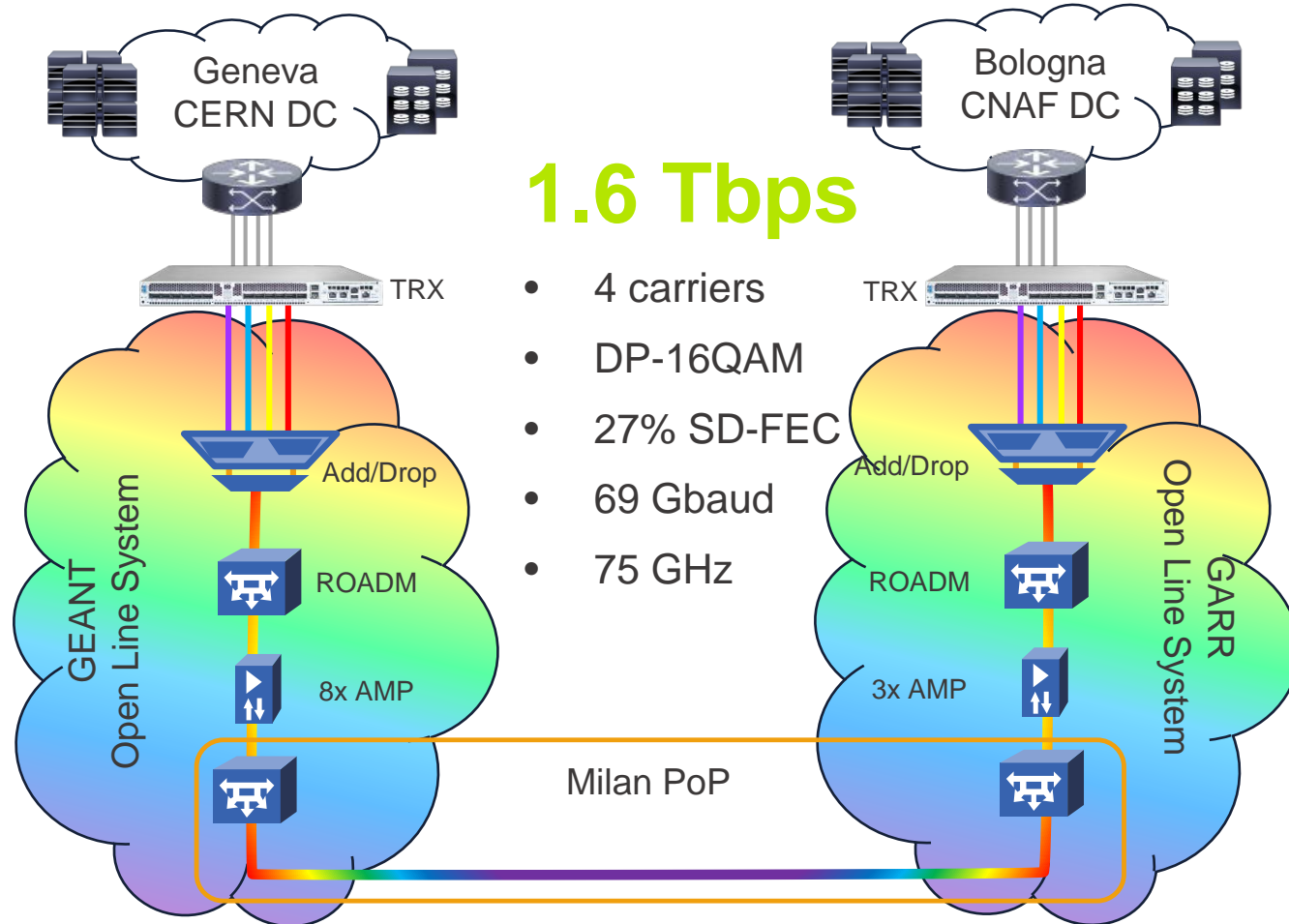




Dedicated connectivity

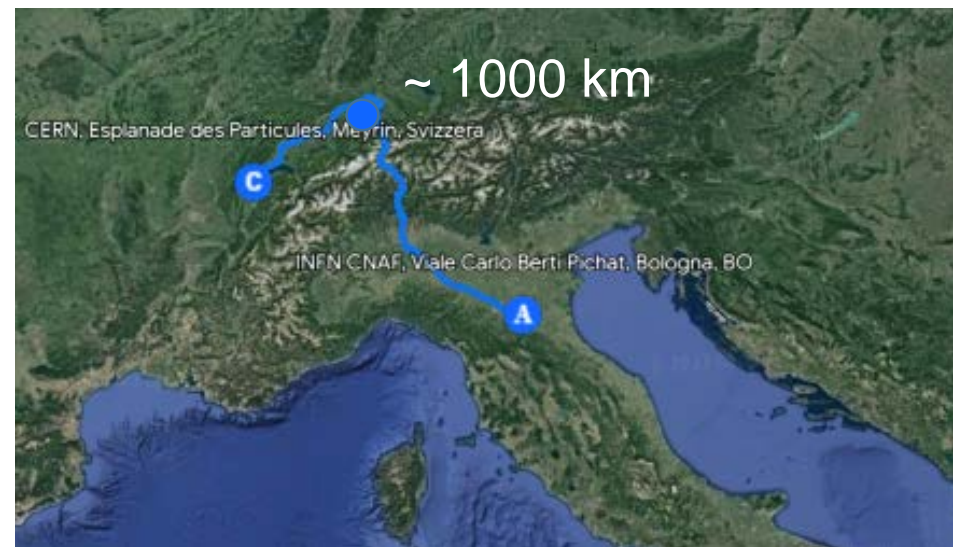
end-to-end connectivity services to establish direct physical or virtual connections between two or more locations.

CERN – CNAF Data Centre Interconnection



1.6 Tbps

- 4 carriers
- DP-16QAM
- 27% SD-FEC
- 69 Gbaud
- 75 GHz

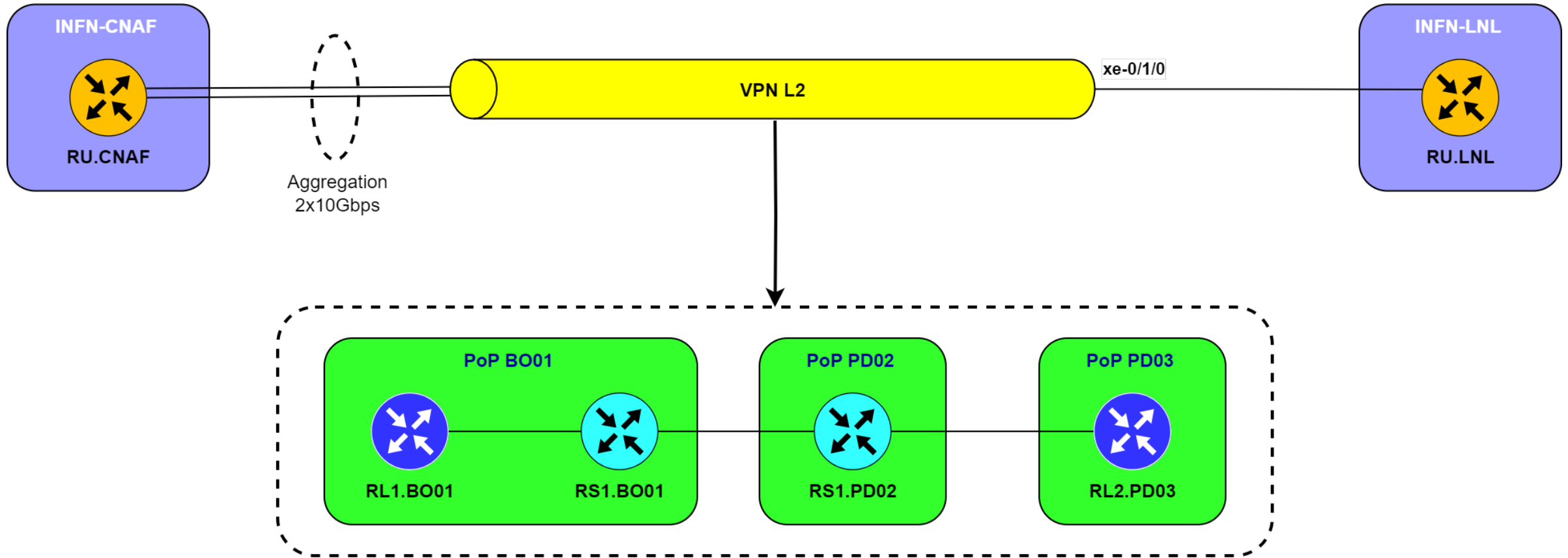


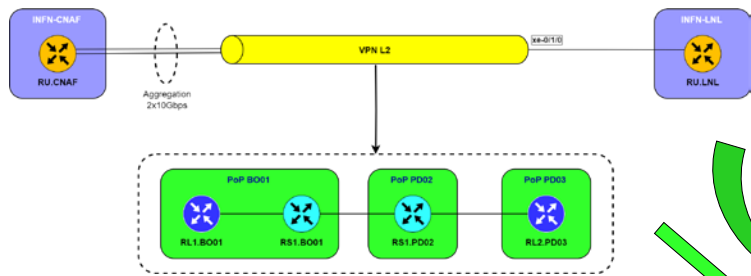
Live @WLCG-DC24



Source: Paolo Bolletta, GARR – TeRABIT Conference 25-06-2024

VPN CNAF-LNL





GARR Integrated Networking Suite

Service info

Service: e2e INFN - CNAF - Bologna -- INFN - LNL - Legnano - Lato LNL

Service name: LNL - Legnano - lato LNL

Service type: VPN

Network type: 11,0 Gbps

Bandwidth: 11,0 Gbps

Web page: http://www.infn.it

Site

Name: INFN - Laboratori Nazionali di Legnano

Address: Viale dell'Università, 2

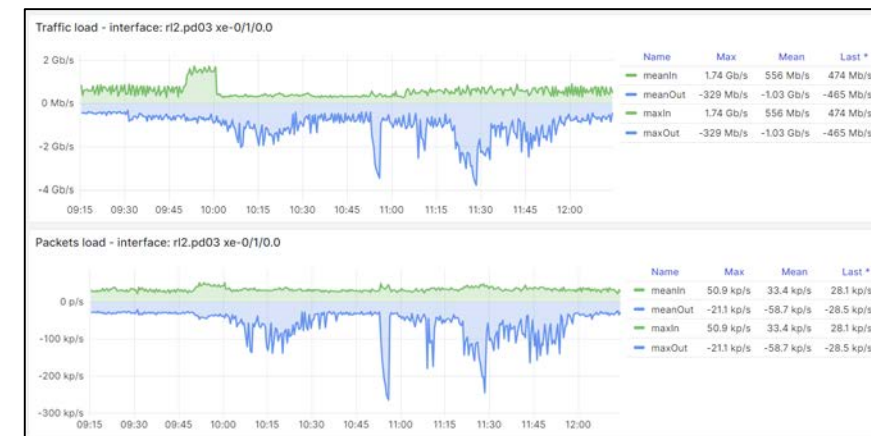
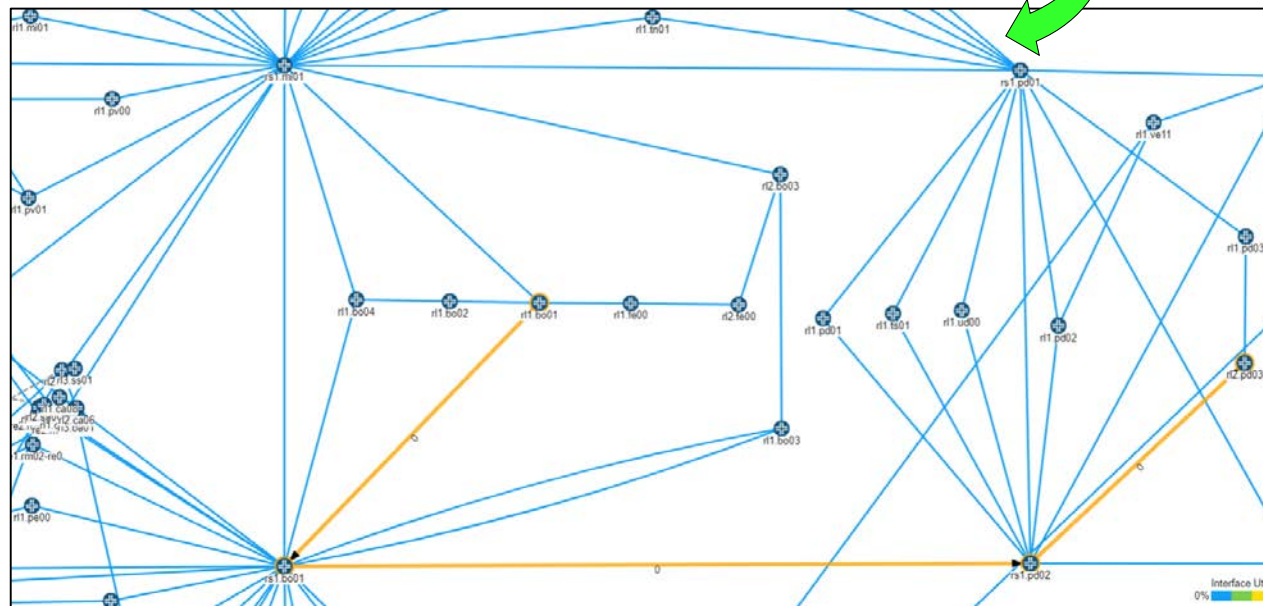
City: Legnano

Region: VENEZIA

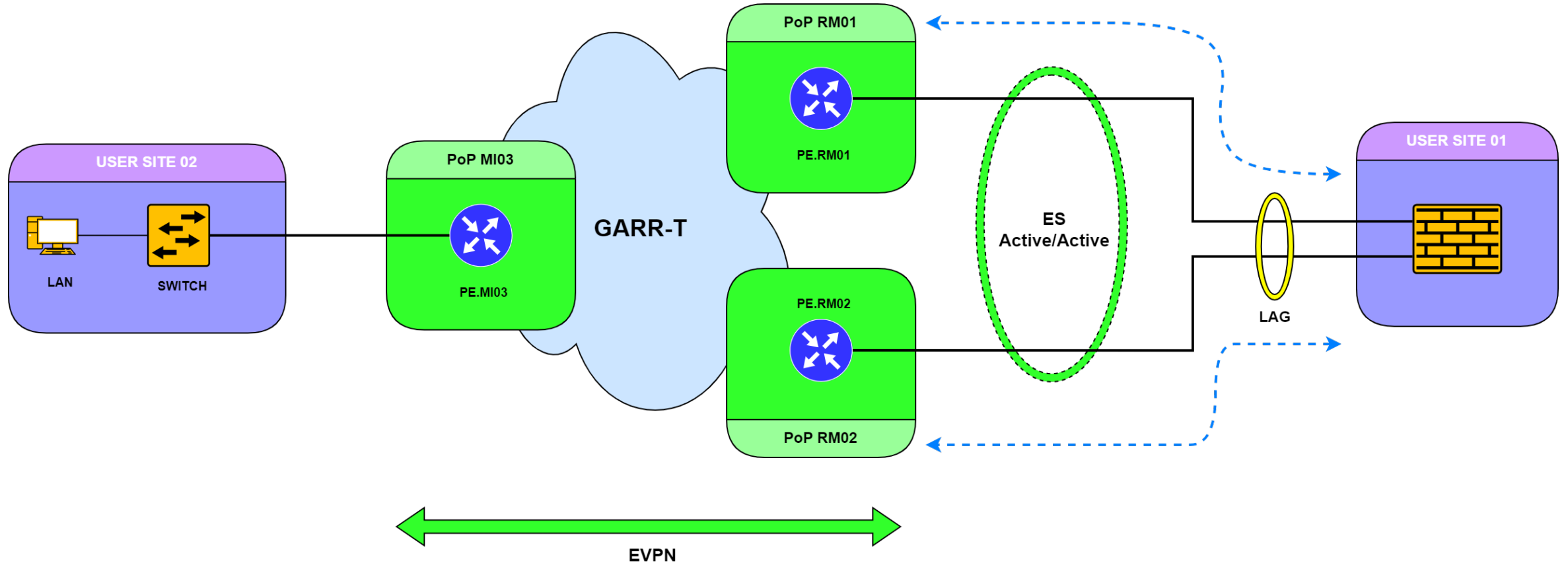
Network links

Name	Use	BW	Side A	Side B	Service as	Target options
e2e INFN - CNAF - Bologna -- INFN - LNL - Legnano - Lato LNL	end-to-end	10,0 Gbps	INFN - LNL - Legnano (PD)	PD03-Legnano r12.pd03.ge.net (MX204) xe-0/1/0.0	Hierarchy: 1	interface

Aggregate traffic load



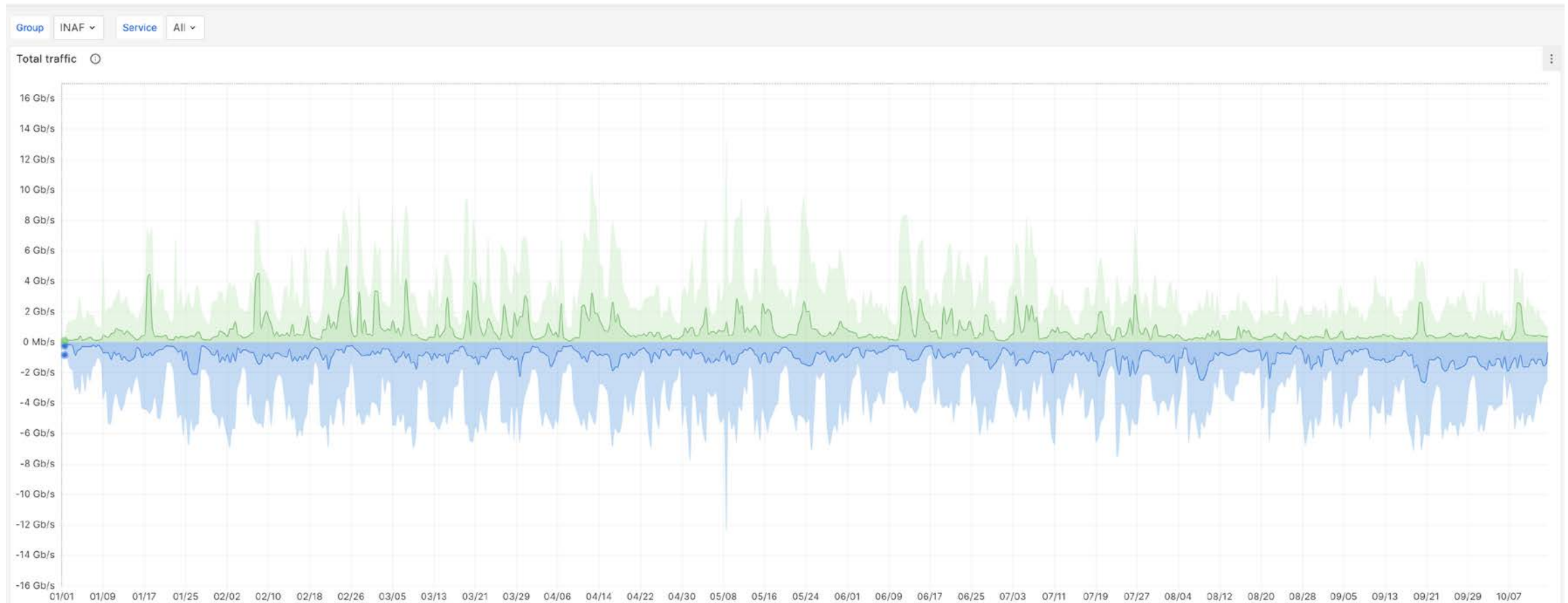
EVPN Active/Active



INAF and GARR

GARR-T Network as a solution to meet
INAF requirements for High Speed Network Connectivity

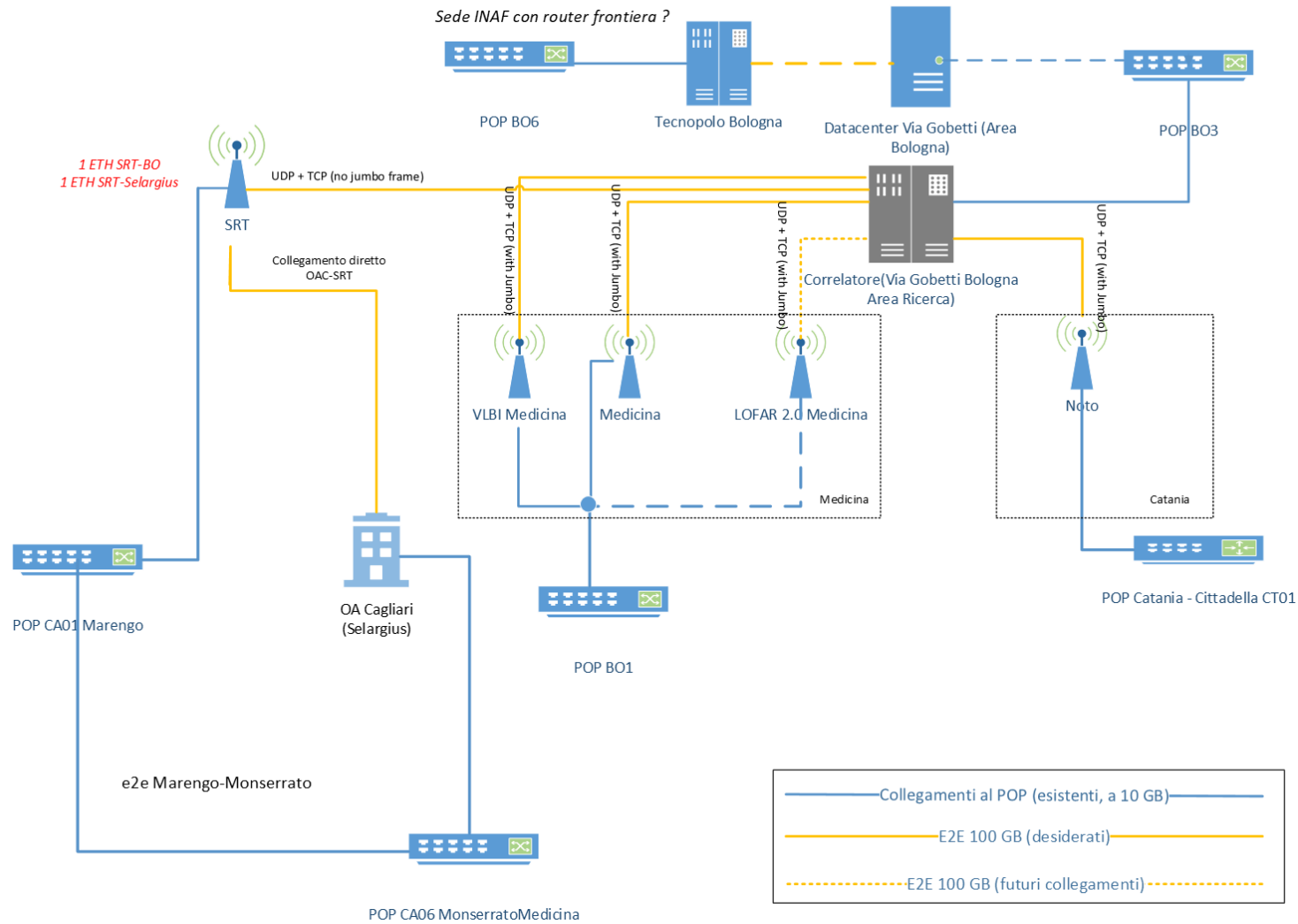
INAF total traffic: this year so far



Name	Last *	Min	Max	Mean
IN mean	398 Mb/s	88.3 Mb/s	5.03 Gb/s	794 Mb/s
OUT mean	-621 Mb/s	-2.62 Gb/s	-137 Mb/s	-889 Mb/s
IN peak	1.10 Gb/s	128 Mb/s	13.5 Gb/s	3.41 Gb/s
OUT peak	-2.52 Gb/s	-12.5 Gb/s	-817 Mb/s	-4.11 Gb/s

GARR and INAF

Initial design elements



40Gbps to receive 3.8% of the data production

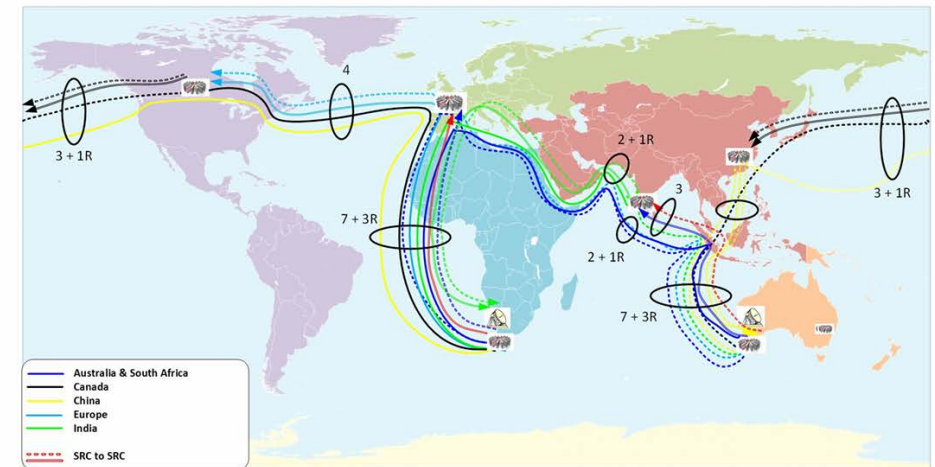
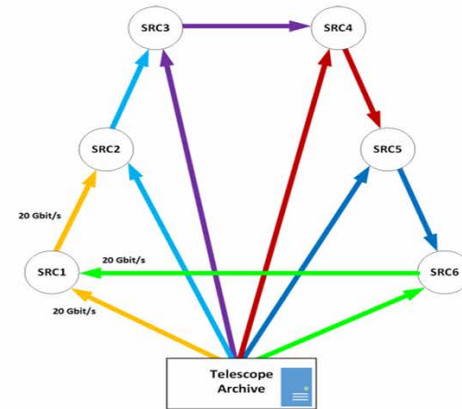
Data challenge: if today there was a test, it would be successfully passed

**Long distance, disk to disk
data transfers at 6Gbps**

IPv6 mandatory!!

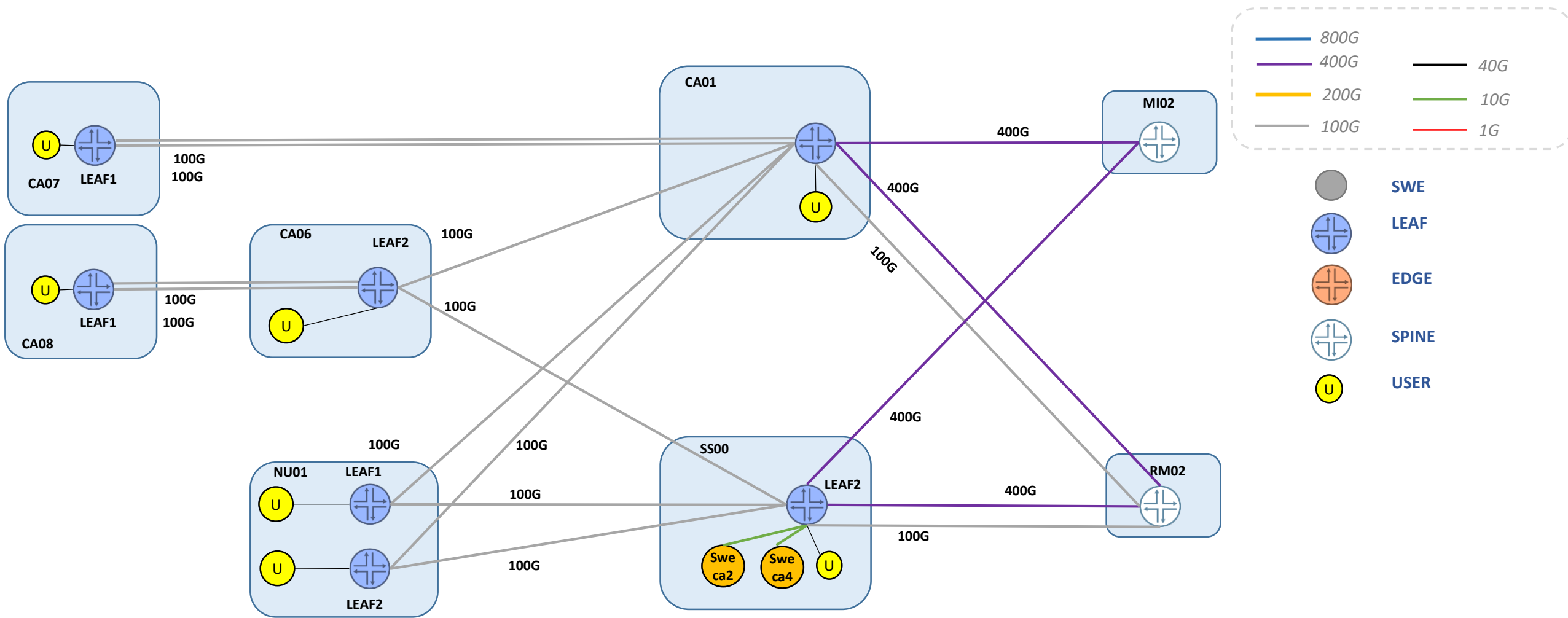
Global Data Flows if the SRC Re-distribute data 2nd Replica

- Each SRC accepts its fraction of the Observatory Data Products and re-distributes to another SRC.
- SRC has 20 Gbit/s flow from the telescope & a second continuous 20 Gbit/s flow from another SRC.
- Each SRC sends out a 20 Gbit/s flow.
- Makes substantial use of the shared academic network.

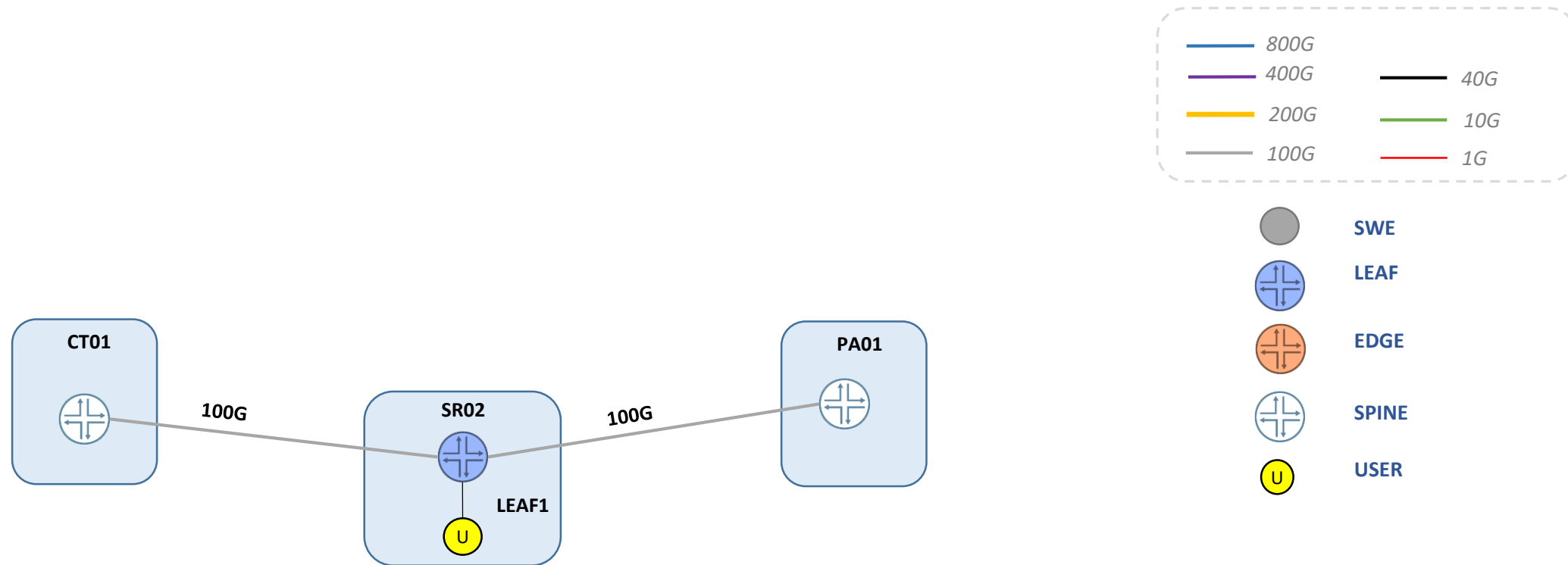


Source: Richard Hughes-Jones GEANT, Jonathan Churchill RAL - LHCONE Meeting – Catania 9 April 2024

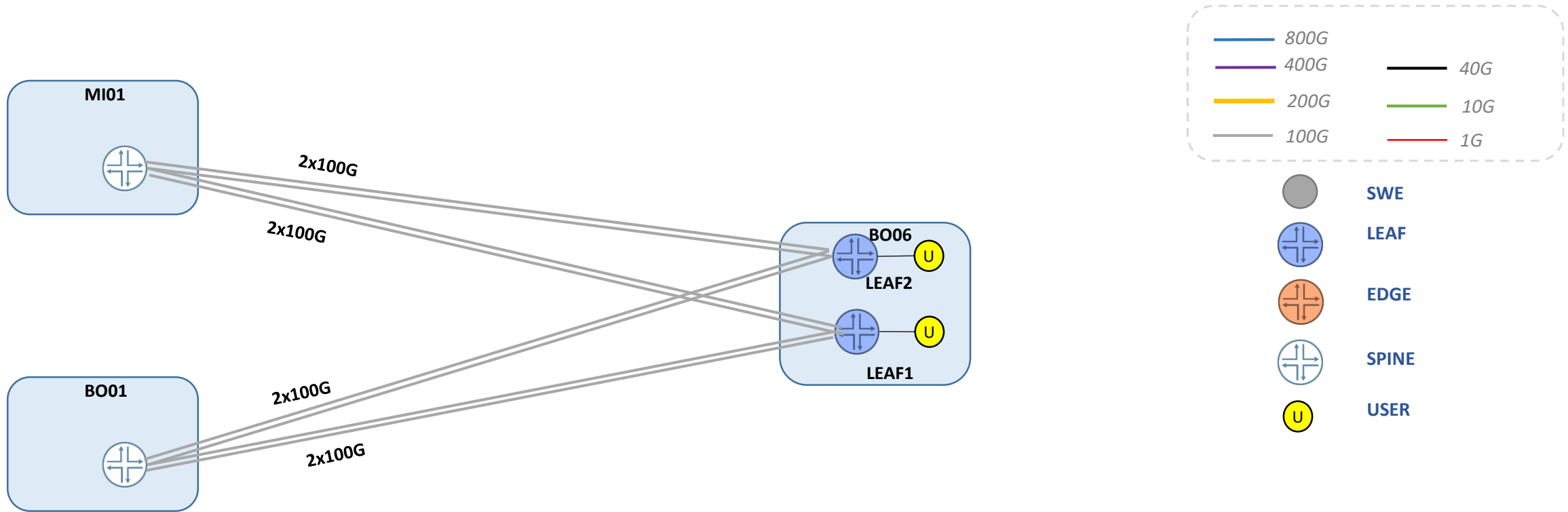
Sardinia network evolution



New GARR PoP SR02 (INAF-IRA-Noto)



New GARR PoP BO06 (Tecnopolo)



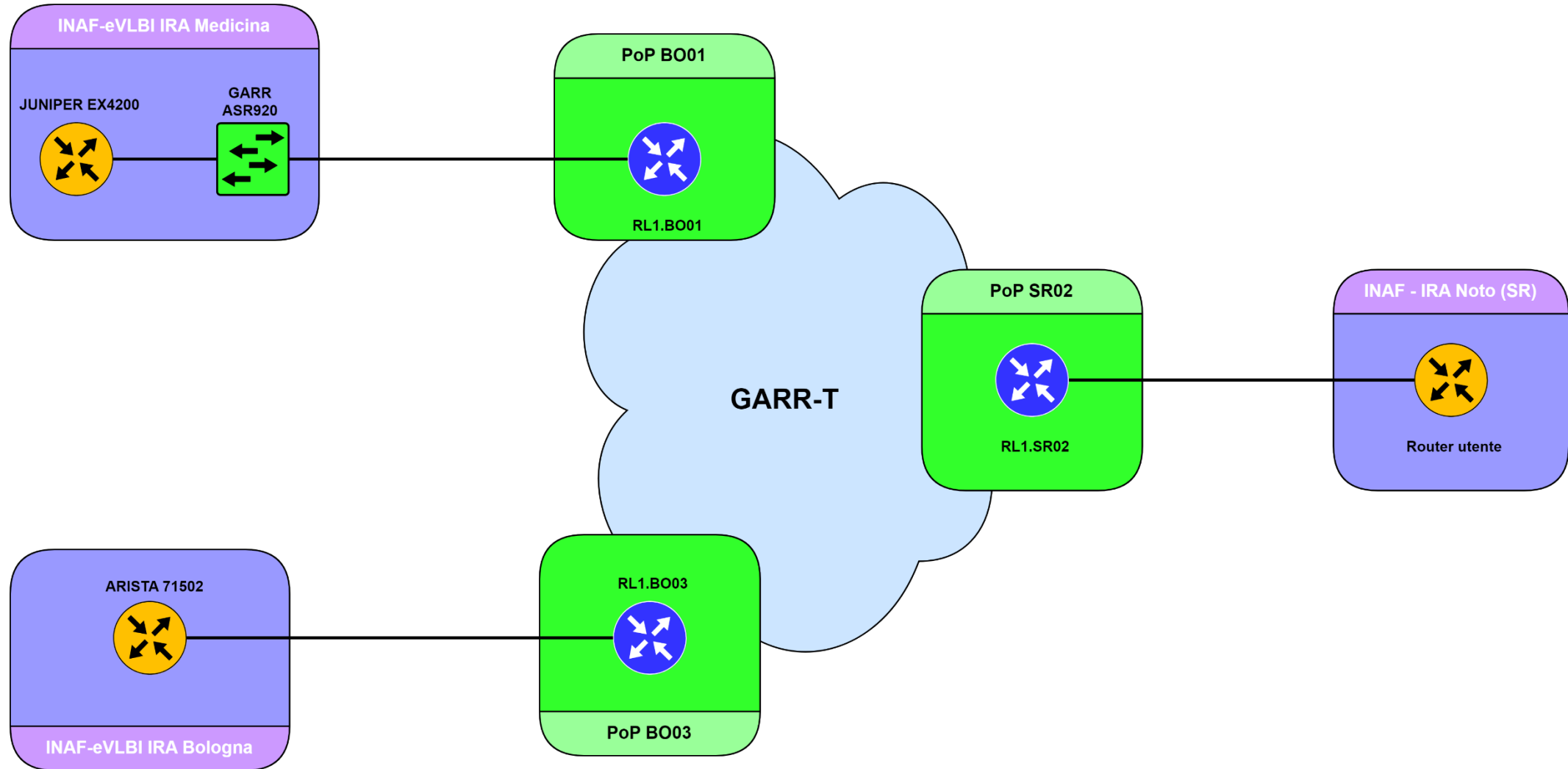
PoC For Routing Model

3 INAF sites involved in the PoC

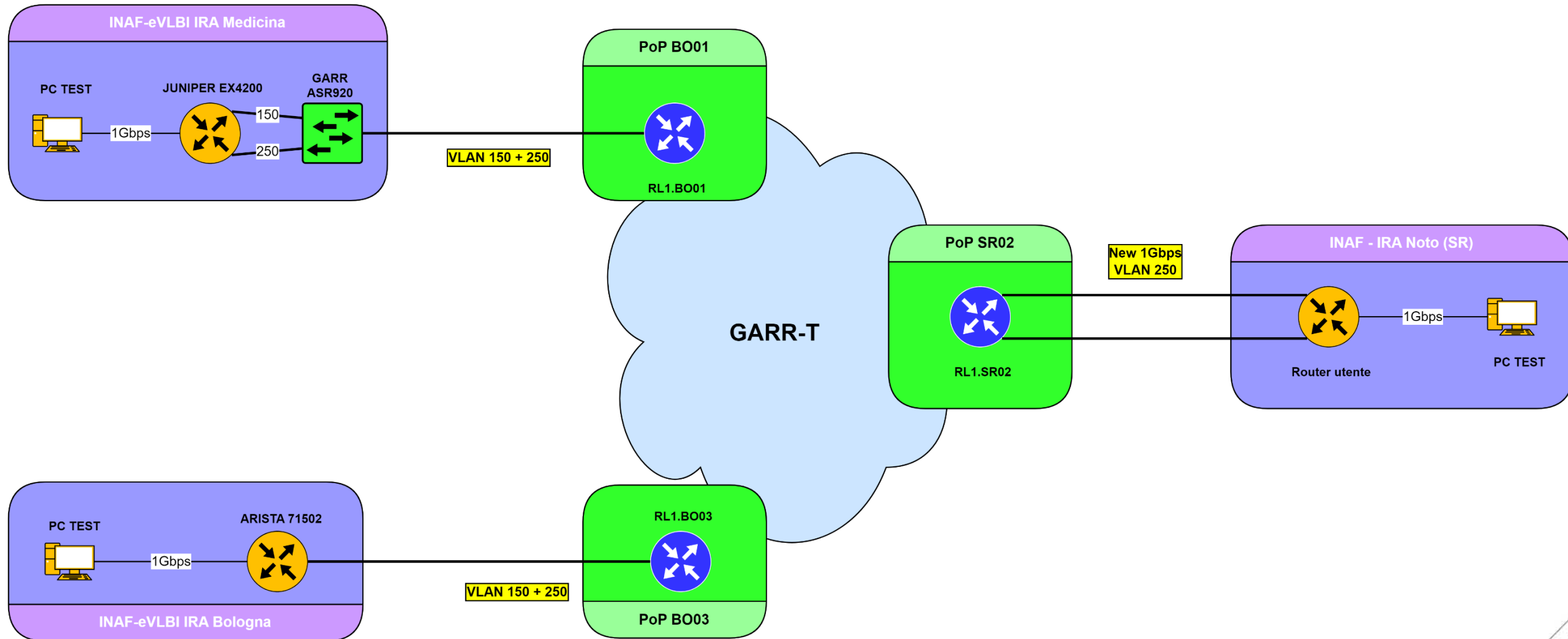
Thanks to ...

- **Salvatore Buttaccio**, INAF – IRA – NOTO
- **Giuseppe Maccaferri**, INAF – IRA – Medicina
- **Matteo Stagni**, INAF – IRA - Bologna

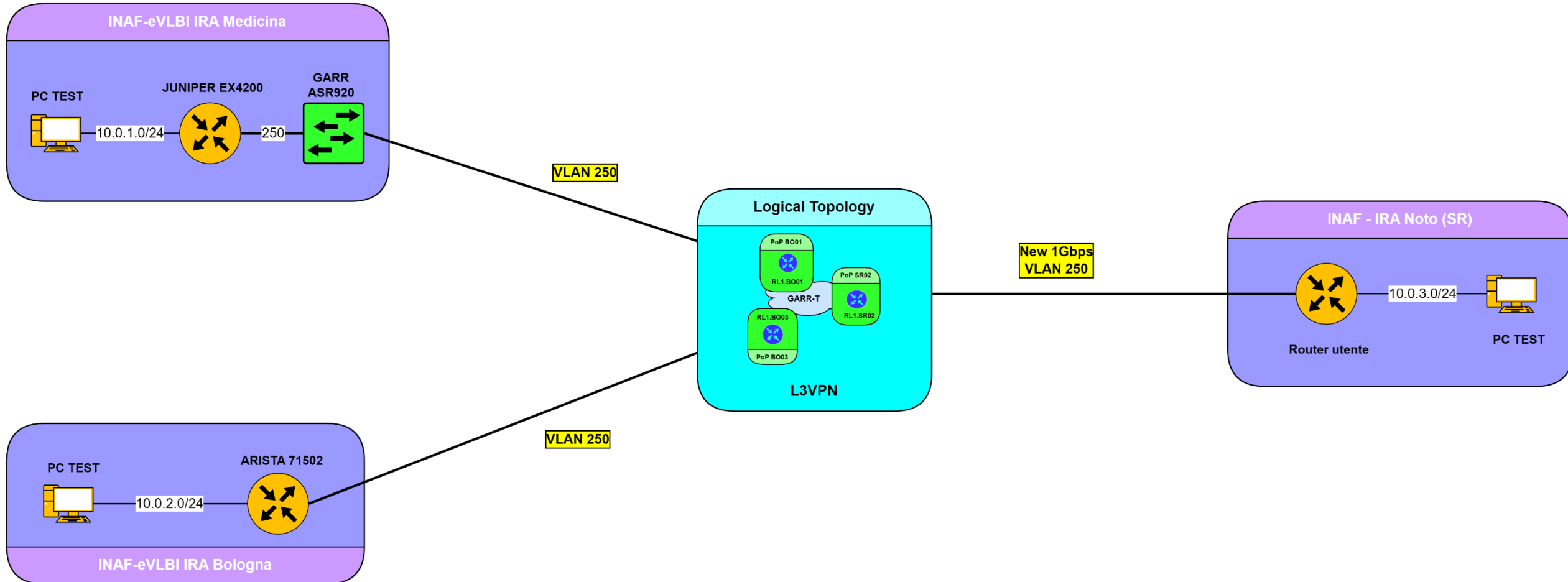
PoC For Routing Model – Current set up



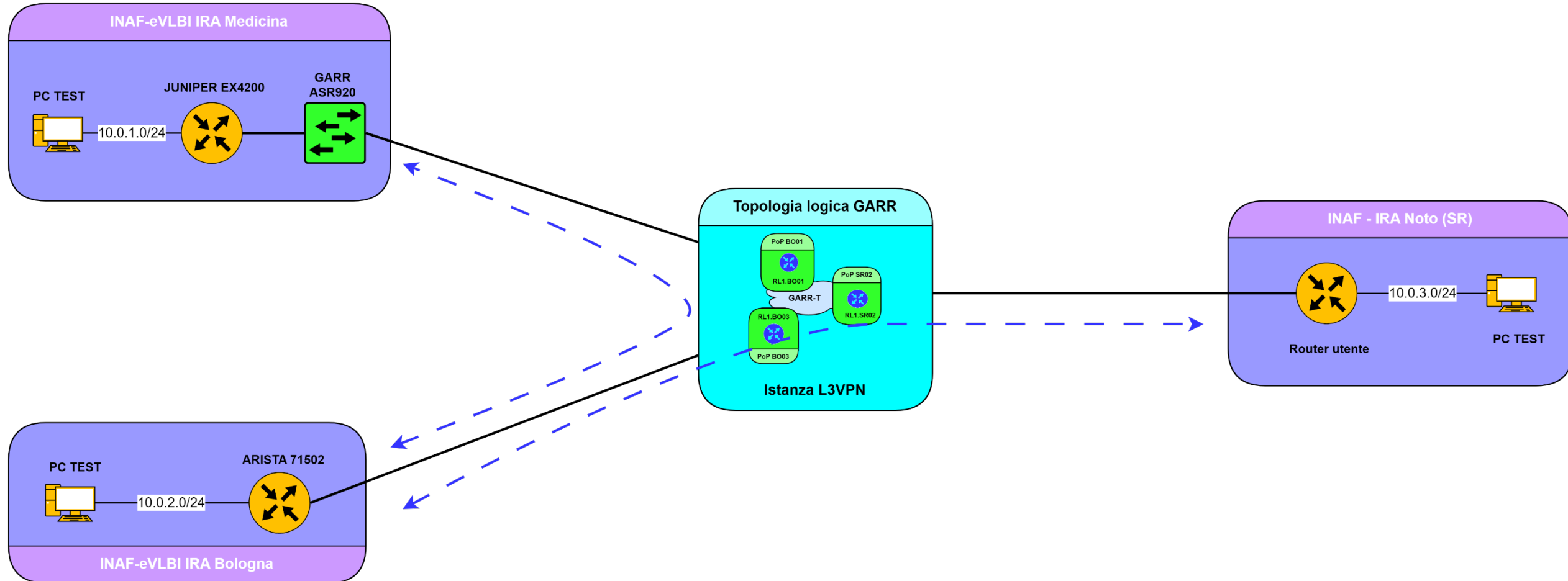
PoC For Routing Model – Actions to be taken on current set up



PoC For Routing Model – L3VPN



PoC For Routing Model – Routing and Performance Tests



Thank you

planning@garr.it