



Research and Education Networks

From pioneers to pathfinders

CERN Academic training

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Research Networking History

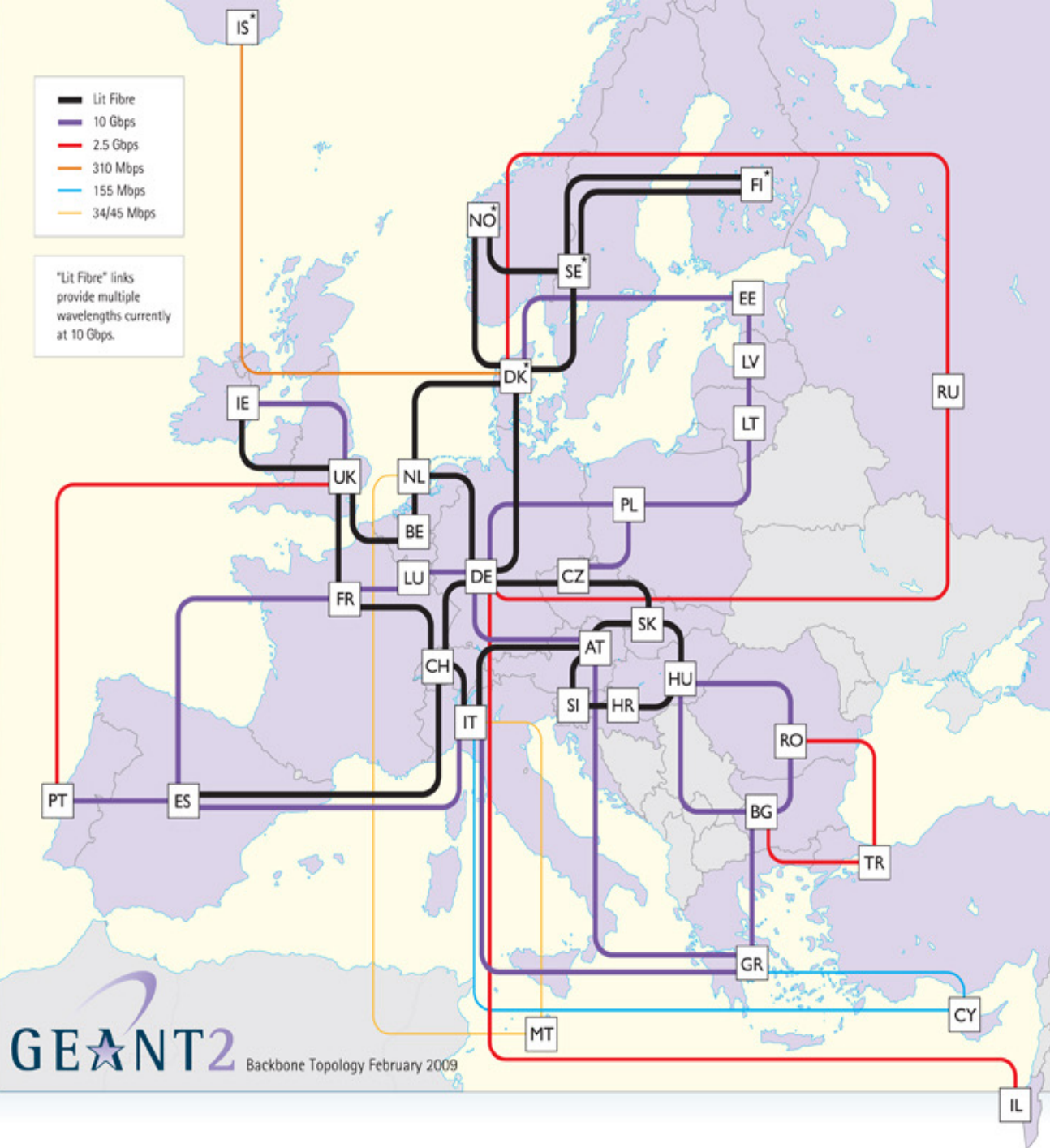
- In the 70s only small ad-hoc arrangements
- In the 80s some integration of initiatives
 - Expensive leased lines (telephone costs)
 - Operating at 300bps
 - Start of (super)computing centers for research
- End of the 80s the first networks for research are operational
 - In Europe X.25 based
 - In US NCP and UUCP based
 - Early 90s capacity has grown to 8Mbps

Research Networking History (continued)

- Services were developed to support researchers
 - Terminal access, file transfer and e-mail
- Knowledgeable users having the skills and ambitions was the key to making working solutions
- Telecommunications monopolies could see little economic reasons for developing such services for research and education

Research Networking History (continued)

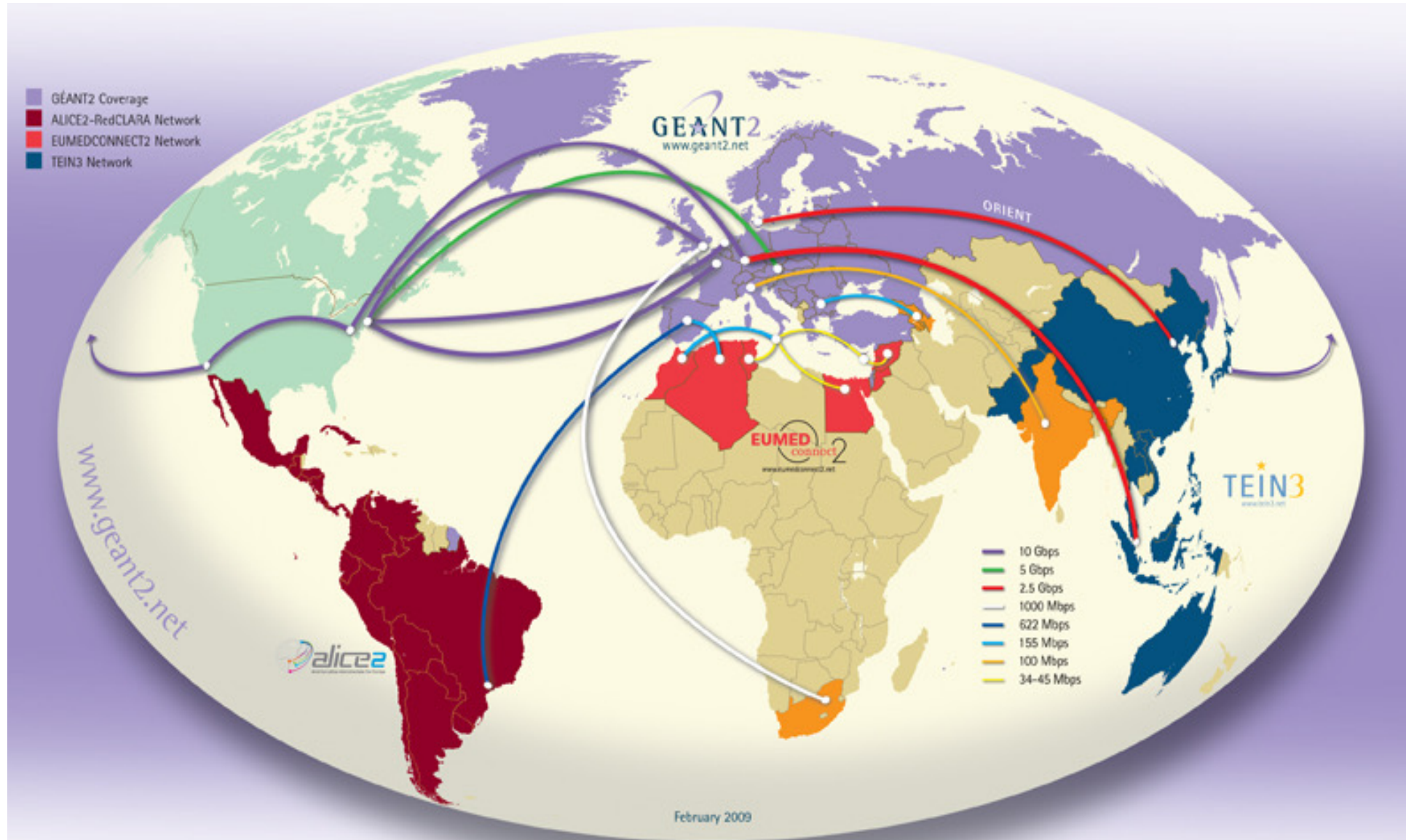
- Pre-1990: various disconnected networks: OSI, DECnet, UUCP, IBM. Academic networks EARN and RARE; EUnet
- 1990 merger of RARE and EARN into Terena. End of protocol wars.
- 1992 – 1997: Europanet multiprotocol service network (Dante)
- 1997 – 1998: TEN-34 34 Mbps network service
- 1998 – 2000: TEN-155 Network based on STM-1 circuits
- 2000-2004: GN1 project GÉANT network service
- 2004-2009: GN2 project GÉANT network + other services Research and Network Activities
- 2009-2013: GN3 project GÉANT network + more services Research and Network Activities



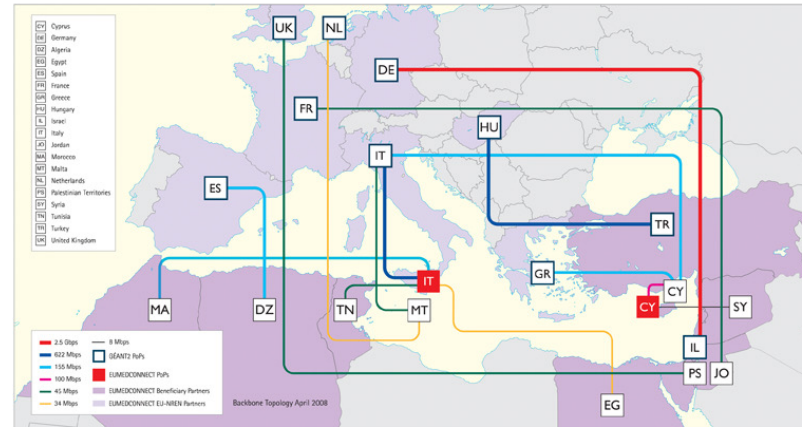
GEANT 2009

- 38 European Countries
- First Dark Fibre links
- Hybrid network:
 - IP Packet routed
 - Switched point-to-point - Circuits
 - Dedicated wavelengths - Lambdas

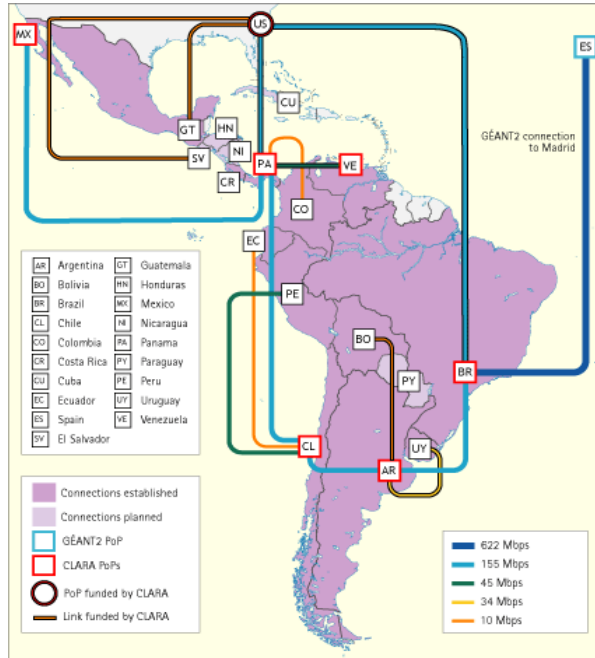
GÉANT global connectivity



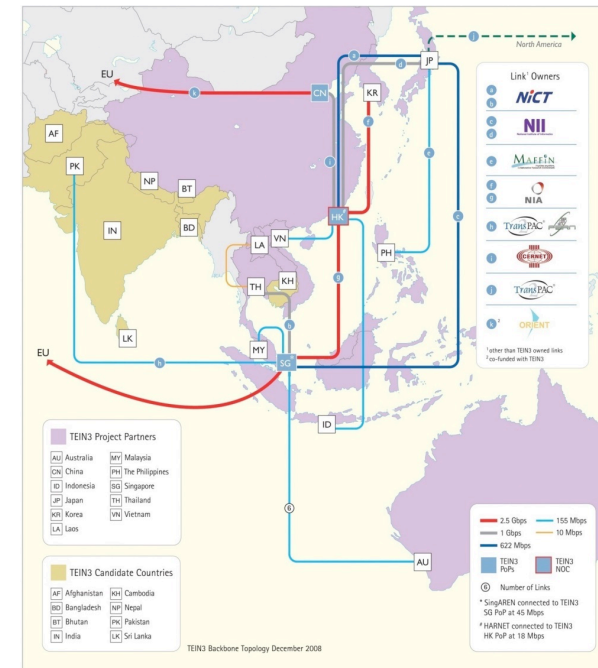
ALICE Project: RedCLARA Topology October 2007

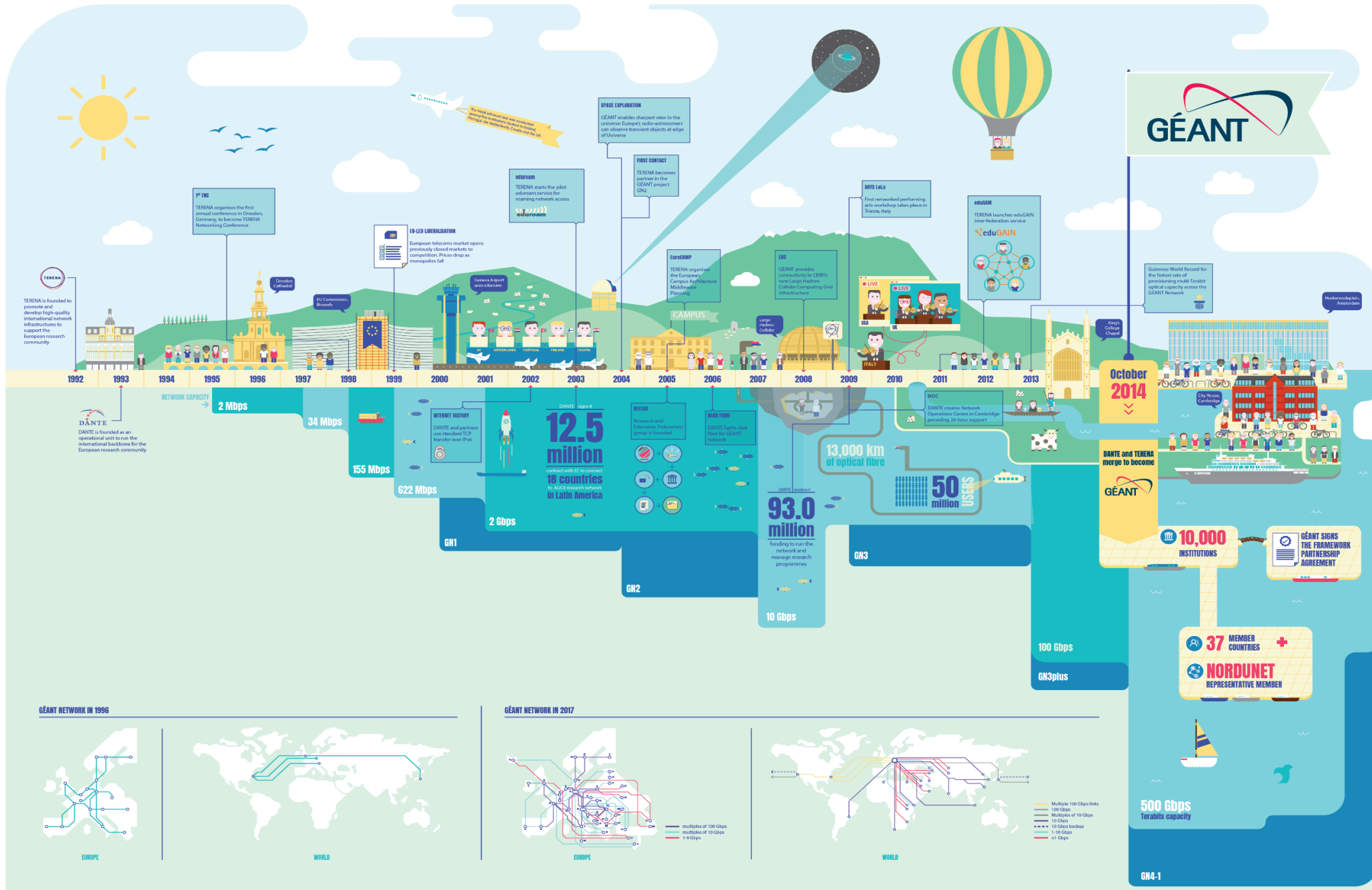


TEIN3 Topology January 2009



EUMEDCONNECT Topology April 2008





Membership Association

GÉANT Association supports and represents over 40 NRENs across Europe.

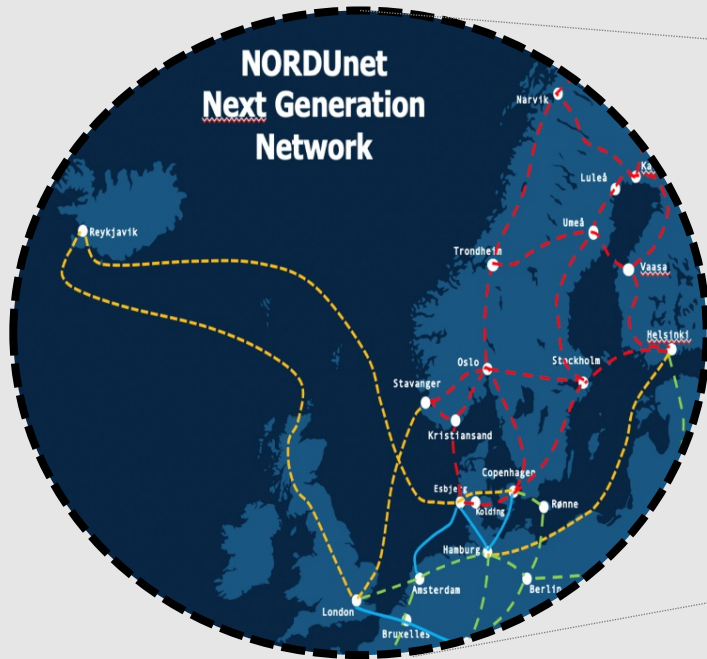
Together they support over 10,000 institutions and 50 million academic users.



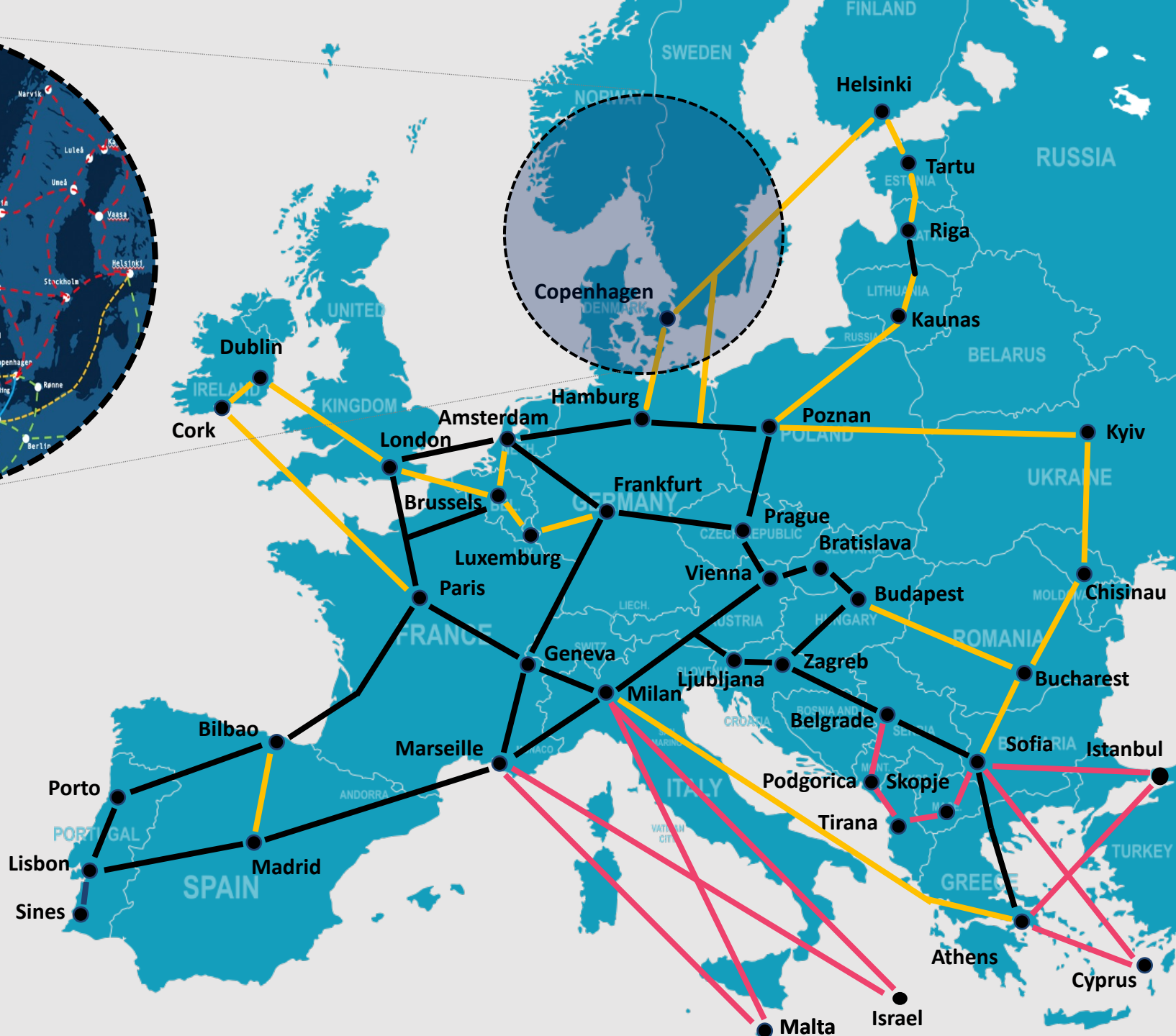
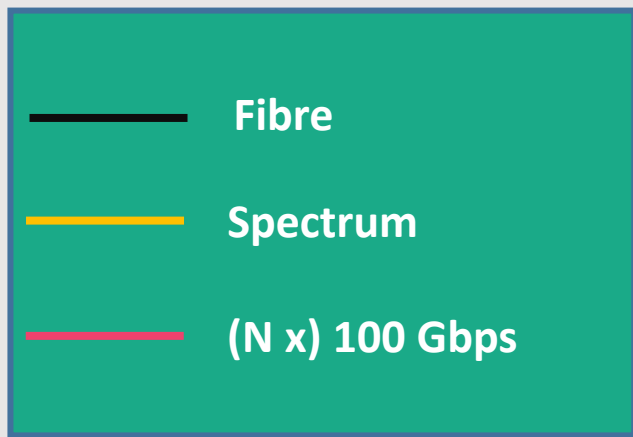
The GÉANT Community

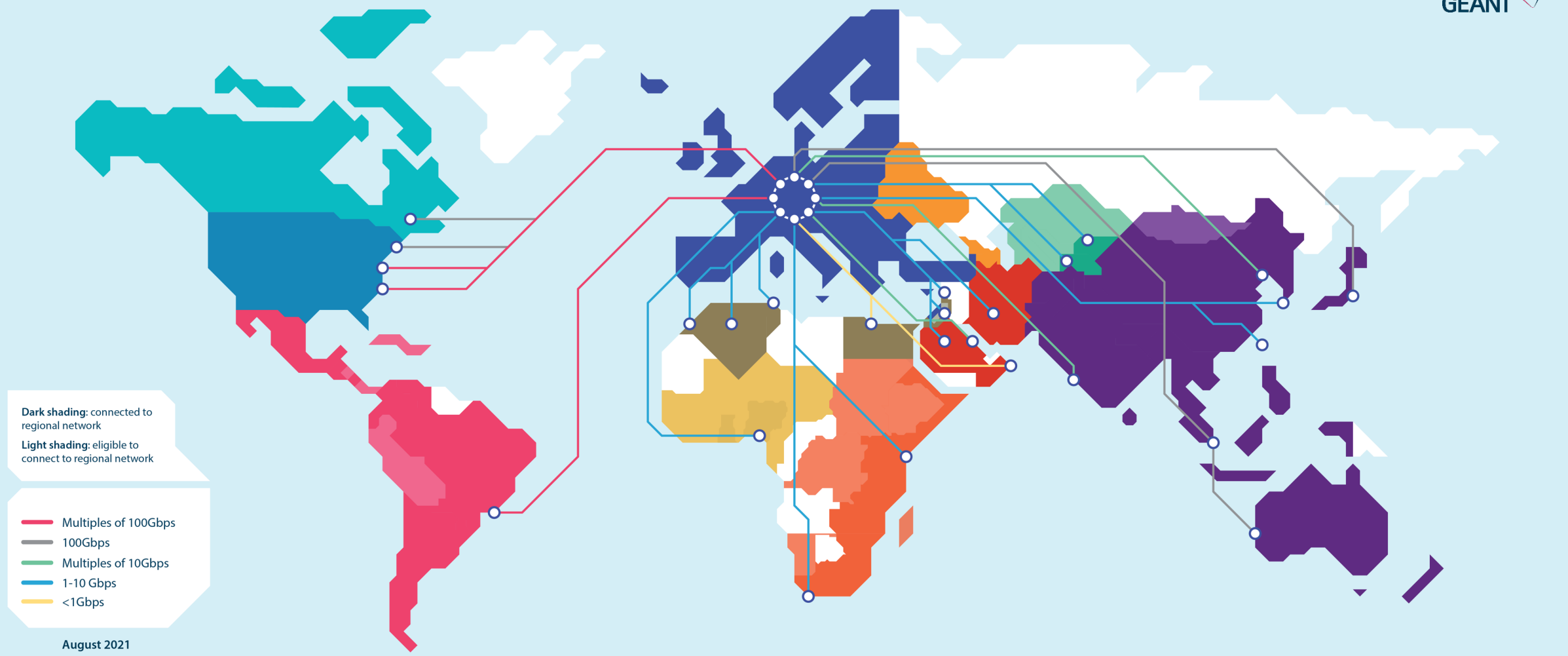
Well placed to serve EuroHPC - all current PRACE HPC sites are already using GÉANT and the NRENs





END POINT:
 AMBITION FOR INFRASTRUCTURE
 AT THE END OF THE PROJECT





Canada & USA



Latin America



Europe



North Africa & Eastern Mediterranean



West & Central Africa



Eastern & Southern Africa



Central Asia



Asia-Pacific

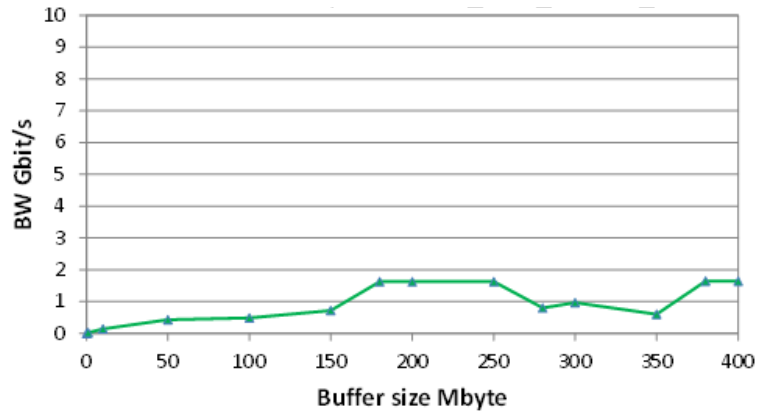


Other R&E Networks

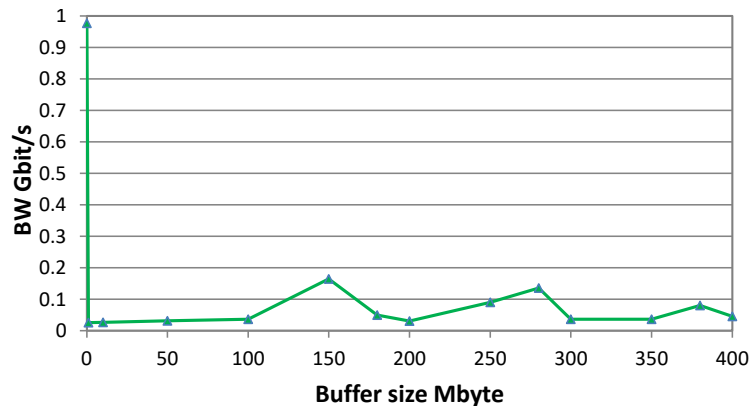
Optimised for research data transfers

Public Internet

Geneva to Canberra

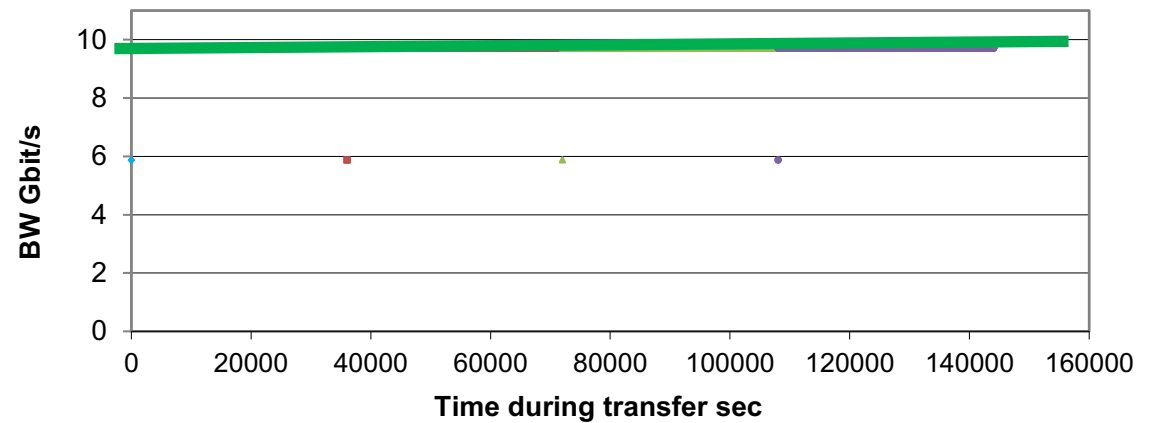


Geneva to Canberra



GÉANT and R&E partners

Geneva to Canberra GÉANT + R&E networks US to Australia



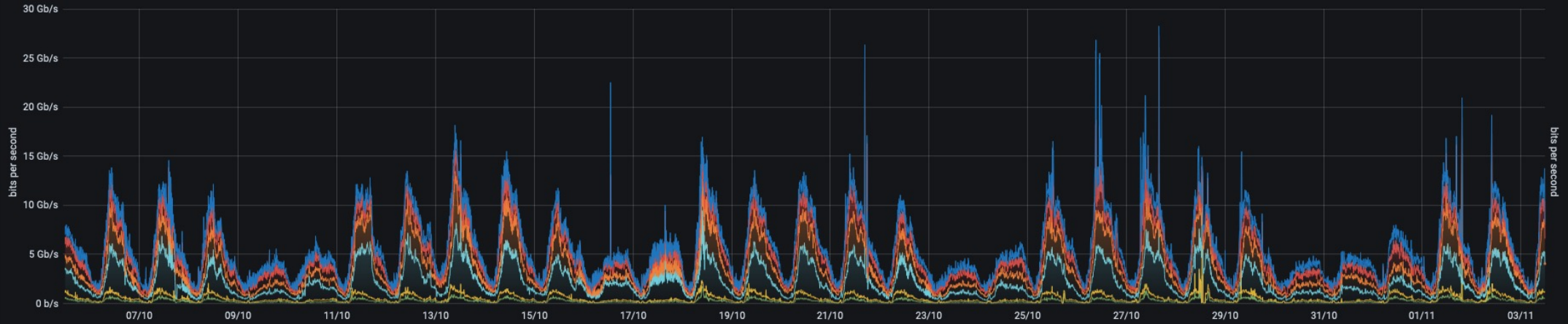
R&E networks are designed for different goals than the Internet

Comparative Times for a 100TByte data transfer.

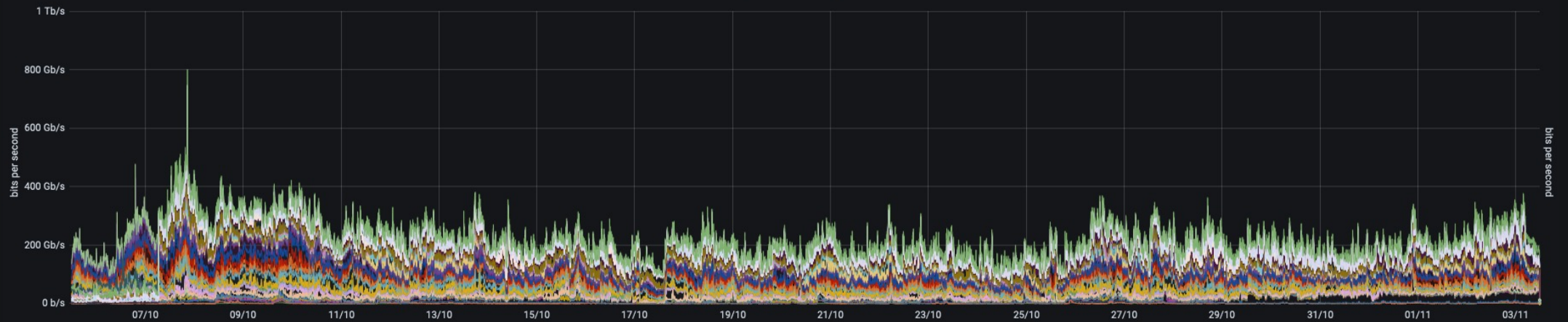
File Size (TB)	Data rate (Gbit/s)	Time taken (Hours)	Time Taken (Days)	
NREN	100	9.27	34.0	1.4
ISP A	100	1.72	183.2	7.6
ISP B	100	0.11	2864.3	119.3

Not all traffic is equal

Aggregate - GWS Upstreams - ingress

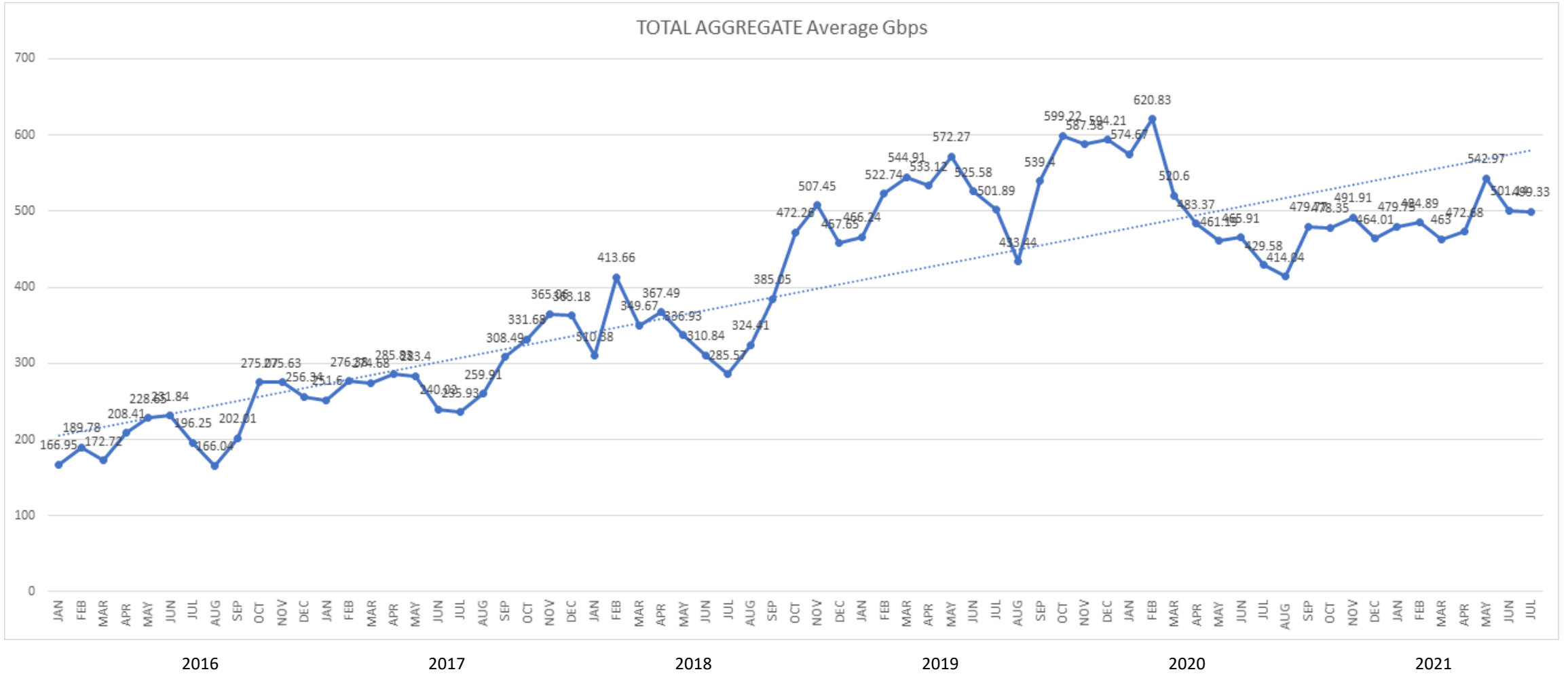


Aggregate - LHCONE - ingress



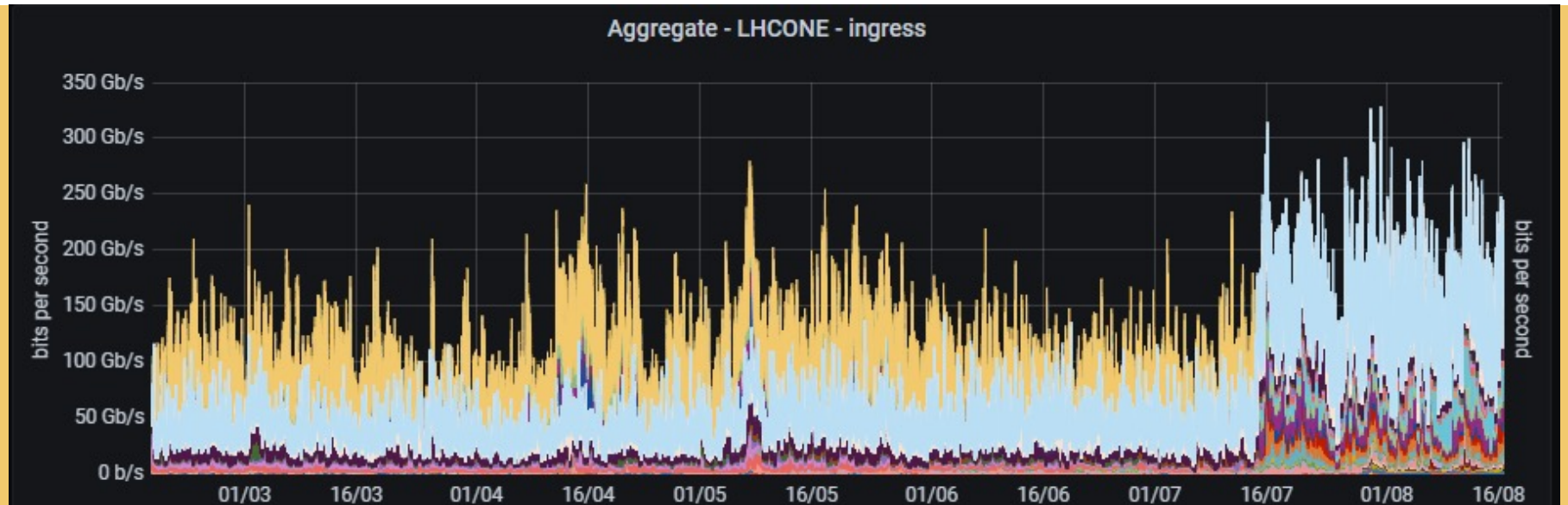
GÉANT Network – Traffic Growth

TOTAL AGGREGATE Average Gbps



Big Science Traffic Growth

The R&E traffic continues to grow - LHCONE traffic peaks over 300Gbps now increased from peaks of less than 200Gbps 6 months ago





GÉANT Services



Network

GÉANT IP
 GÉANT Plus
 GÉANT Lambda
 GÉANT Guaranteed Bandwidth
 GÉANT Open
 GWS
 L3VPN
 MD-VPN
 Commercial Peering
 ExpressRoutes



Network Support

Operations Centre
 perfSONAR
 perfSONAR PMP
 WiFiMon
 NMaaS
 Software Tools
 e.g. BRIAN



Security

FoD
 RTBH (Remote Trigger to Black Hole)
 DDoS C&A
 TCS
 TRANSITS
 eduVPN



Trust & Identity

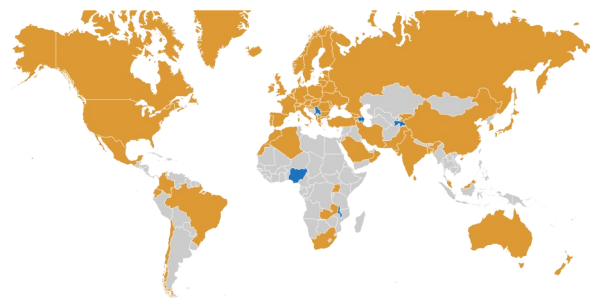
eduroam
 eduGAIN
 eduTEAMS
 InAcademia
 FaaS
 Registry Services



Cloud & RTC

IaaS+ Framework
 eduMEET
 Filesender

Federated Identities in Research and Education - Globally



70+

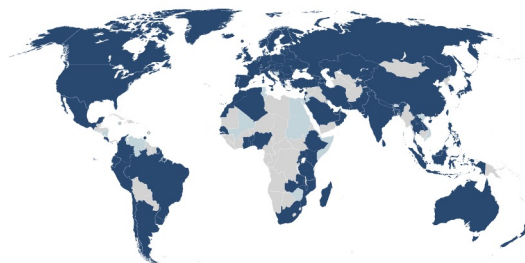
Countries

4400+

Institutions

3400+

Web
Services



106+

Countries

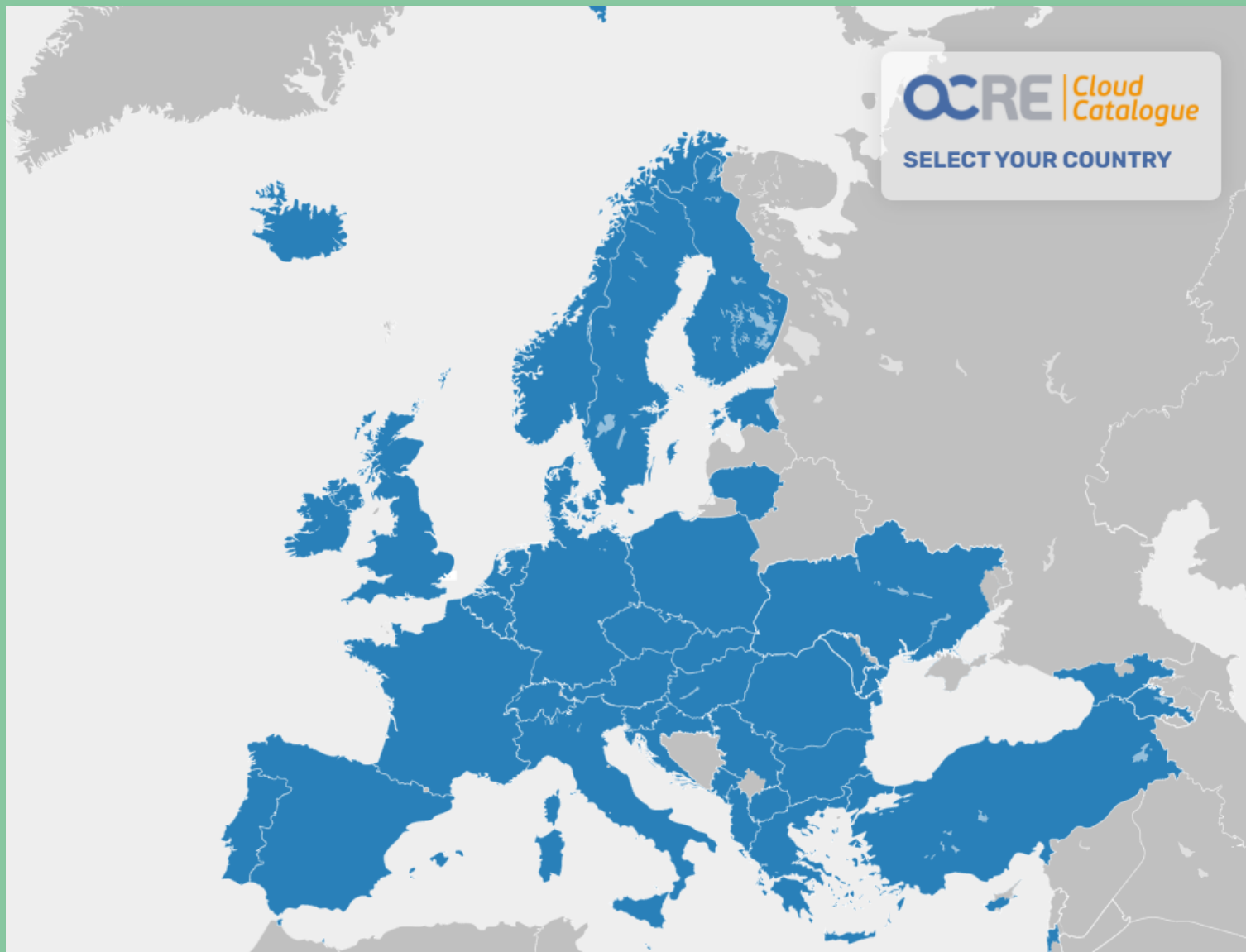
8600+

Institutions

32000+

eduroam WiFi
Locations

Procurement for Universities and Research Institutes in Europe



GÉANT brings down cost of cloud services

36 participating countries

R&E institutions act as a

Single Digital Market

Market response to tender – 1100 bids

Outcome - 473 cloud contracts

27 cloud platforms represented

39 suppliers (including hyperscale)

Platform tested using HNSciCloud

Community support

GÉANT is build upon a community. The GÉANT community invests in the research and development of network architectures, technologies and paradigms to develop into the services, processes, tools and network capabilities of tomorrow.



Community
Conference



Special Interest
Groups and
Task Forces



Research
Programmes
and Service
Development



Talent pool



Astronomy/Physics



Earth Observation



eInfras



Life Science



Arts and Humanities



Outreach





A European Research Networking Future – The Big 5

GÉANT Project

European Open
Science Cloud
(EOSC)

European HPC
Program
(EuroHPC)

Quantum
communication

Intercontinental



A GÉANT Safari Adventure - Our Big Five

GN5 : The Rhinoceros

- The 5th generation of collaborative GÉANT projects actively involving the European NREN community.
- Successfully grown over more than 20 years
- Consistently rated “excellent” in reviews conducted by EC external experts.
- Based on an 8-year partnership agreement with the EC
- Focus on Security, Trust, Identity
- Network growth towards 1 Tbps





A GÉANT Safari Adventure - Our Big Five

EOSC : The Elephant





A GÉANT Safari Adventure - Our Big Five

EuroHPC : The Lion

- NREN EuroHPC survey shows general NREN readiness and a good number of interactions nationally.
- However EuroHPC requires Tbps connectivity earlier than other research
- Complication lies in the funding environment.
- How to ensure there is sufficient extra funding to meet the terabit requirement is still unknown.





A GÉANT Safari Adventure - Our Big Five

Quantum : The Leopard

- All Member States now signed up to EuroQCI.
- Will be part of the European Connectivity Initiative/ Secure Connectivity Initiative.
- Quantum communication networks can be seen as the natural next step for the backbone development after the terabit aims of EuroHPC have been met
- There is uncertainty on the funding environment on an EU level





A GÉANT Safari Adventure - Our Big Five

International / Submarine : The Buffalo

- Most submarine initiatives nowadays are completely dominated by the big platforms
- No autonomy
- How to ensure European independence





Thank you

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