



# European Research and Academic Networking - on the Edge of Technology

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CUC2005, Dubrovnik

November 2005



Connect. Communicate. Collaborate

# Overview

- Brief history
  - Worldwide
  - Political framework in EU
  - European networking
- GÉANT 2 Consortium
- International engagement
- Technology
- New services
- Conclusion



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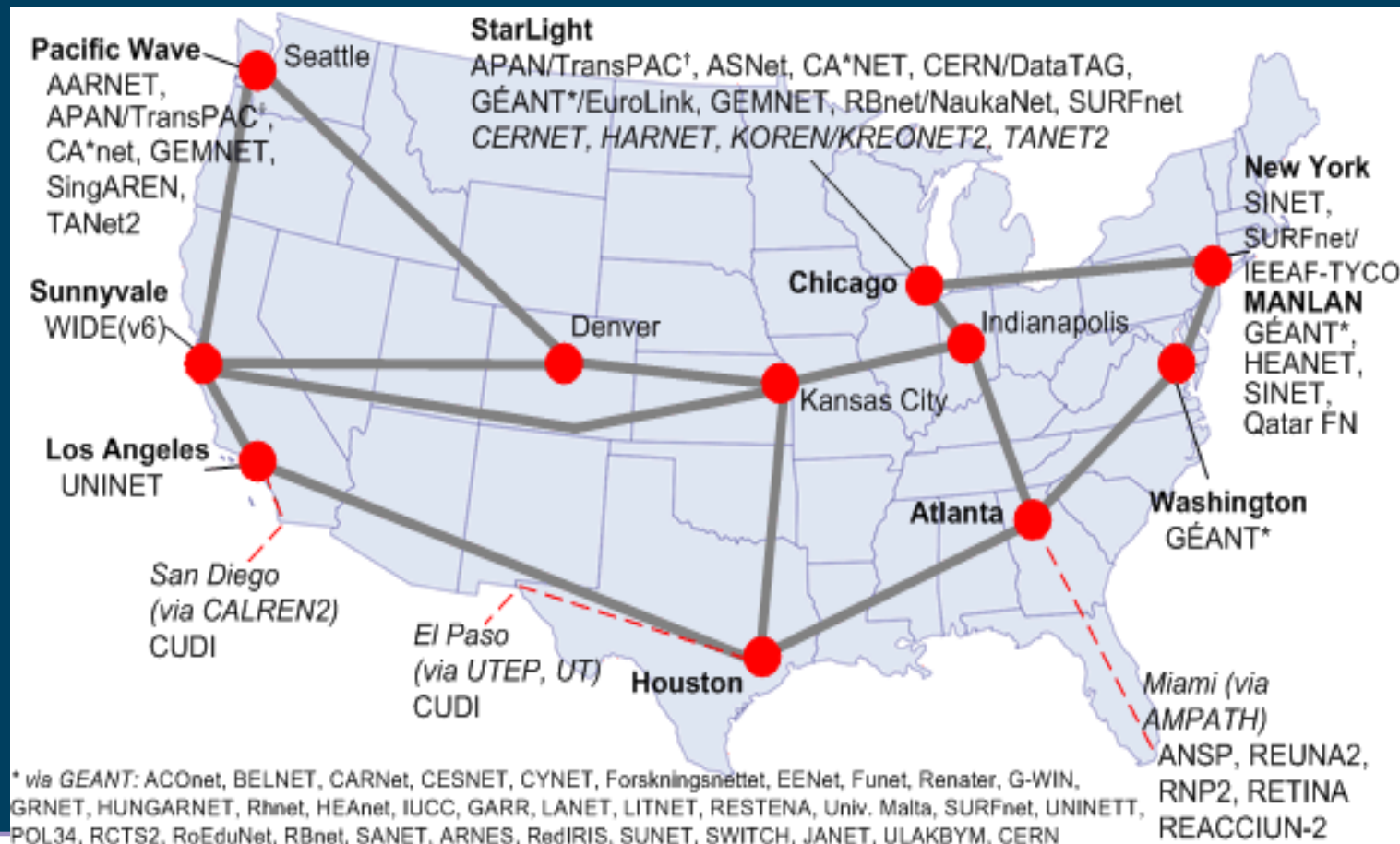
# Similar developments

- USA - Abilene, NLR
- Canada - CA\* Net 4
- Asia - Super SINET - Japan
- Europe - GÉANT



# Abilene International Peering

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\* via GEANT: AConet, BELNET, CARNet, CESNET, CYNET, Forskningsnettet, EENet, Funet, Renater, G-WIN, GRNET, HUNGARNET, Rhnet, HEAnet, IUCC, GARR, LANET, LITNET, RESTENA, Univ. Malta, SURFnet, UNINETT, POL34, RCTS2, RoEduNet, RBnet, SANET, ARNES, RedIRIS, SUNET, SWITCH, JANET, ULAKBYM, CERN

<sup>†</sup> via APAN/TransPAC: WIDE/JGN, IMnet, CERNet/CSTnet/NSFCNET, KOREN/KREONET2, PREGINET, SingAREN, TANET2, ThaiSARN



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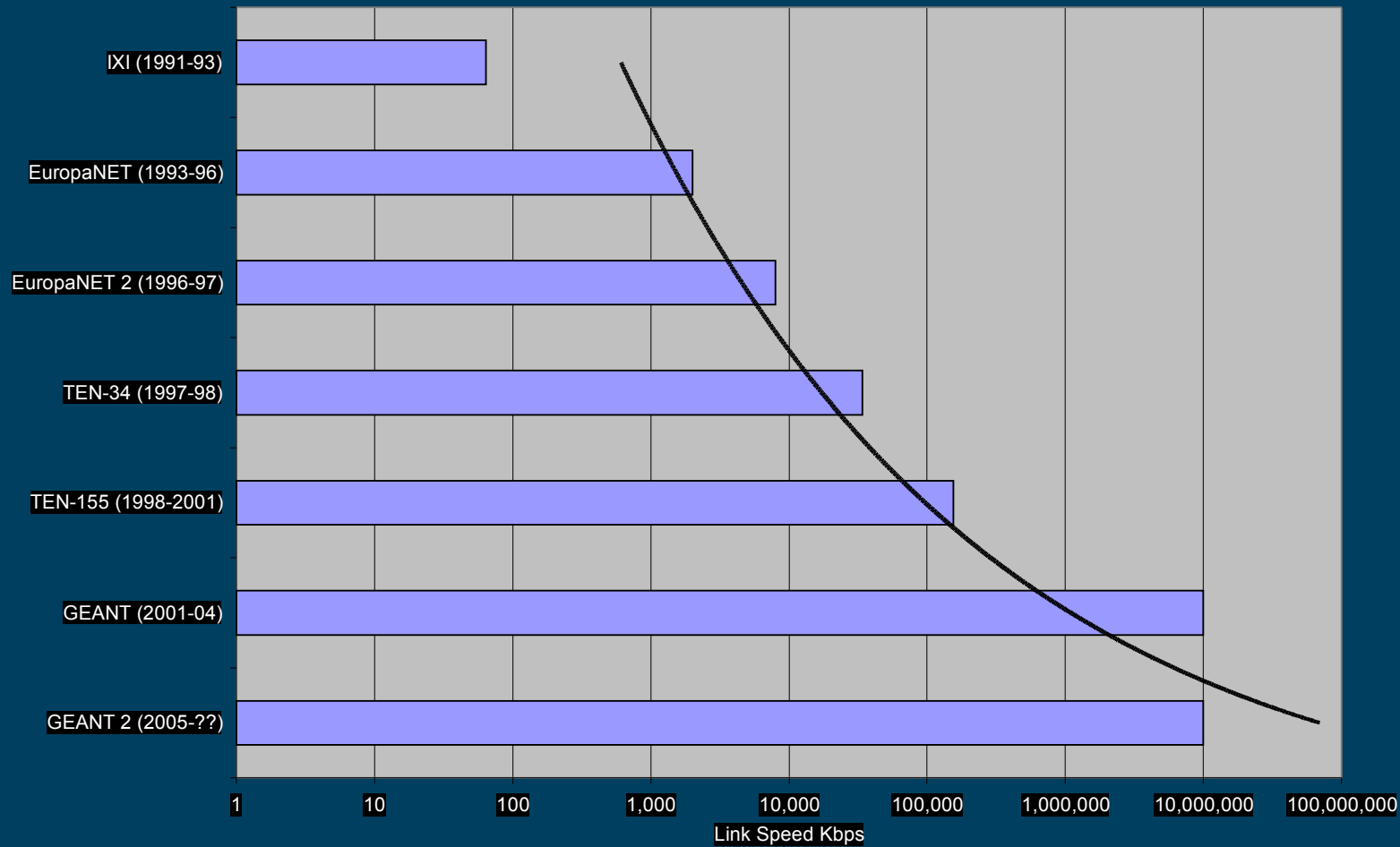
# European framework

- Growing importance of EU Framework Programmes
- Development of the NRENs
- EU Enlargement
- Market developments
- Technology development
- **World's best research network infrastructure**



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Pan-European Network History (Log Scale)





# GÉANT 2 Consortium

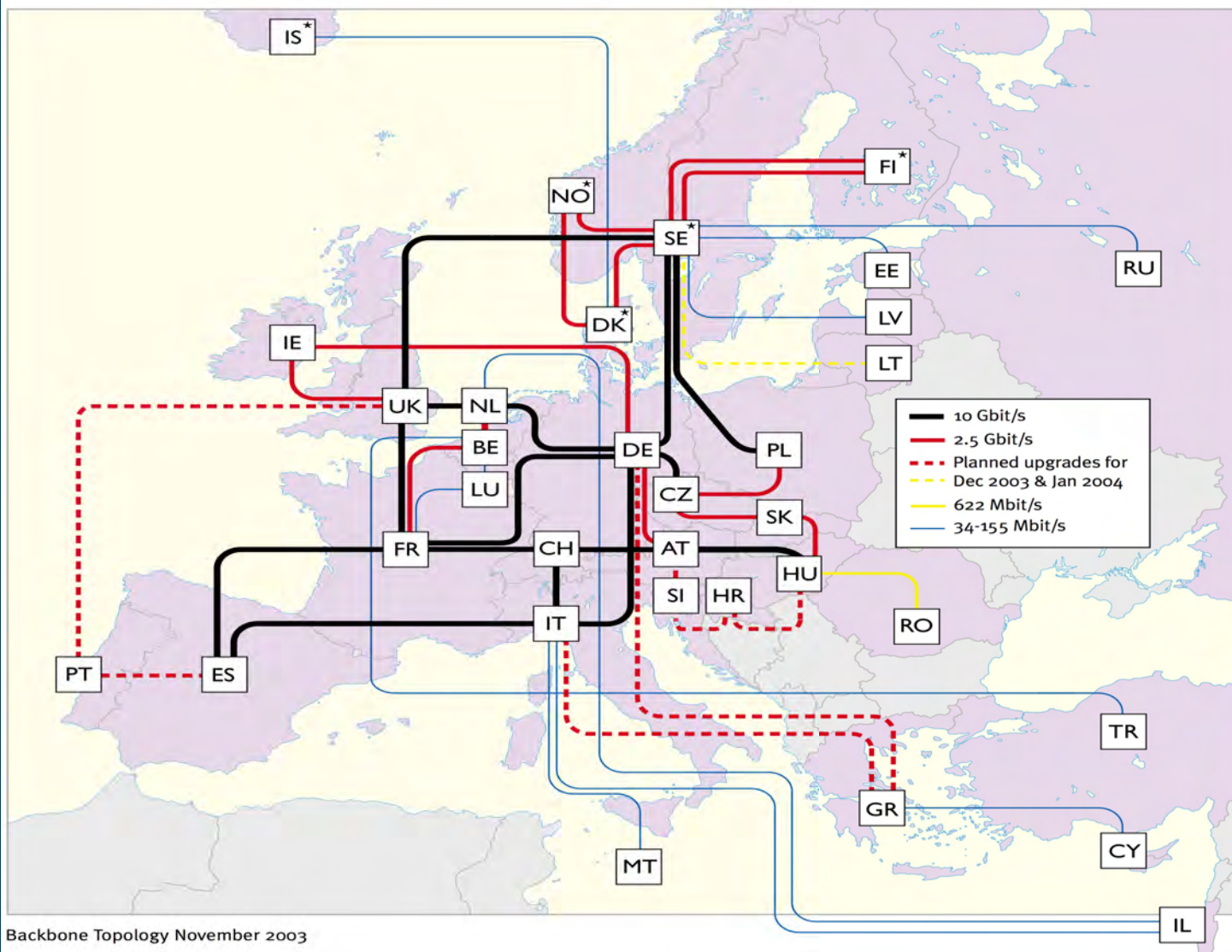
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- |                  |                     |   |                  |
|------------------|---------------------|---|------------------|
| • AUSTRIA        | ACOnet              | • NORDIC countries                                | NORDUnet         |
| • BELGIUM        | BELNET              | • POLAND  | PSNC             |
| • BULGARIA       | ISTF                | • PORTUGAL  | FCCN             |
| • CYPRUS         | CYNET               | • ROMANIA   | RoEduNet         |
| • CROATIA        | CARNet              | • RUSSIA  | JSCC             |
| • CZECH REPUBLIC | CESNET              | • SLOVAKIA  | SANET            |
| • ESTONIA        | EENet               | • SLOVENIA  | ARNES            |
| • FRANCE         | RENATER             | • SPAIN   | RedIRIS          |
| • GERMANY        | DFN                 | • SWITZERLAND                                     | SWITCH           |
| • GREECE         | GRNET               | • TURKEY  | TUBITAK- ULAKBIM |
| • HUNGARY        | HUNGARNET           | • UK  | UKERNA           |
| • IRELAND        | HEAnet              | • DANTE   |                  |
| • ISRAEL         | IUCC                | • TERENA  |                  |
| • ITALY          | GARR                |   |                  |
| • LATVIA         | LATNET              | • Belarus, Bosnia, Lichtenstein, Moldova, Ukraine |                  |
| • LITHUANIA      | LITNET              |   |                  |
| • LUXEMBOURG     | RESTENA             | • Latin America                                   |                  |
| • MALTA          | University of Malta | • EUMEDCONNECT, South Africa                      |                  |
| • NETHERLANDS    | SURFnet             | • SILK  |                  |
|                  |                     | • SEEREN 2  |                  |
|                  |                     | • TEIN 2  |                  |





Communicate. Collaborate

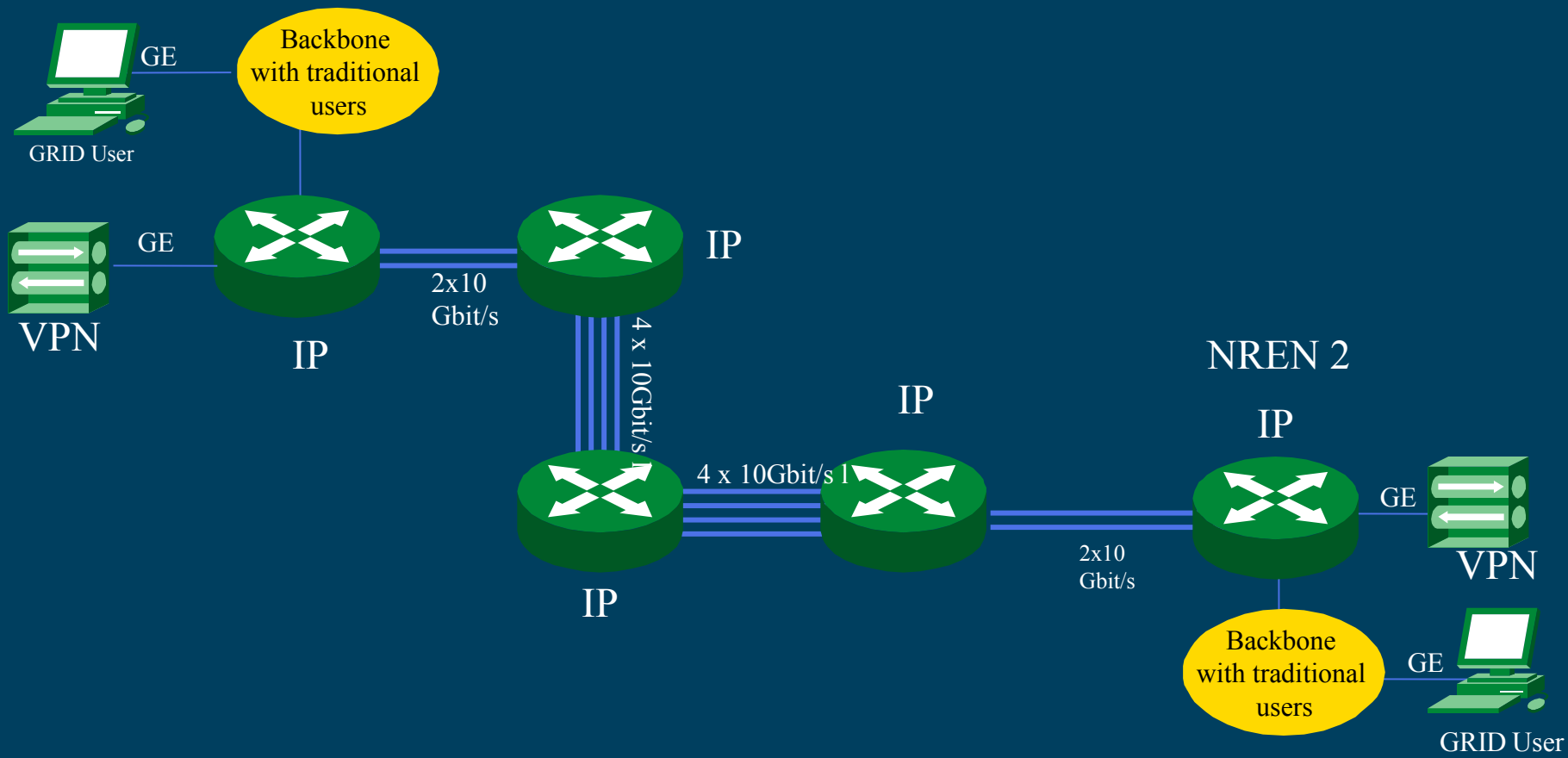




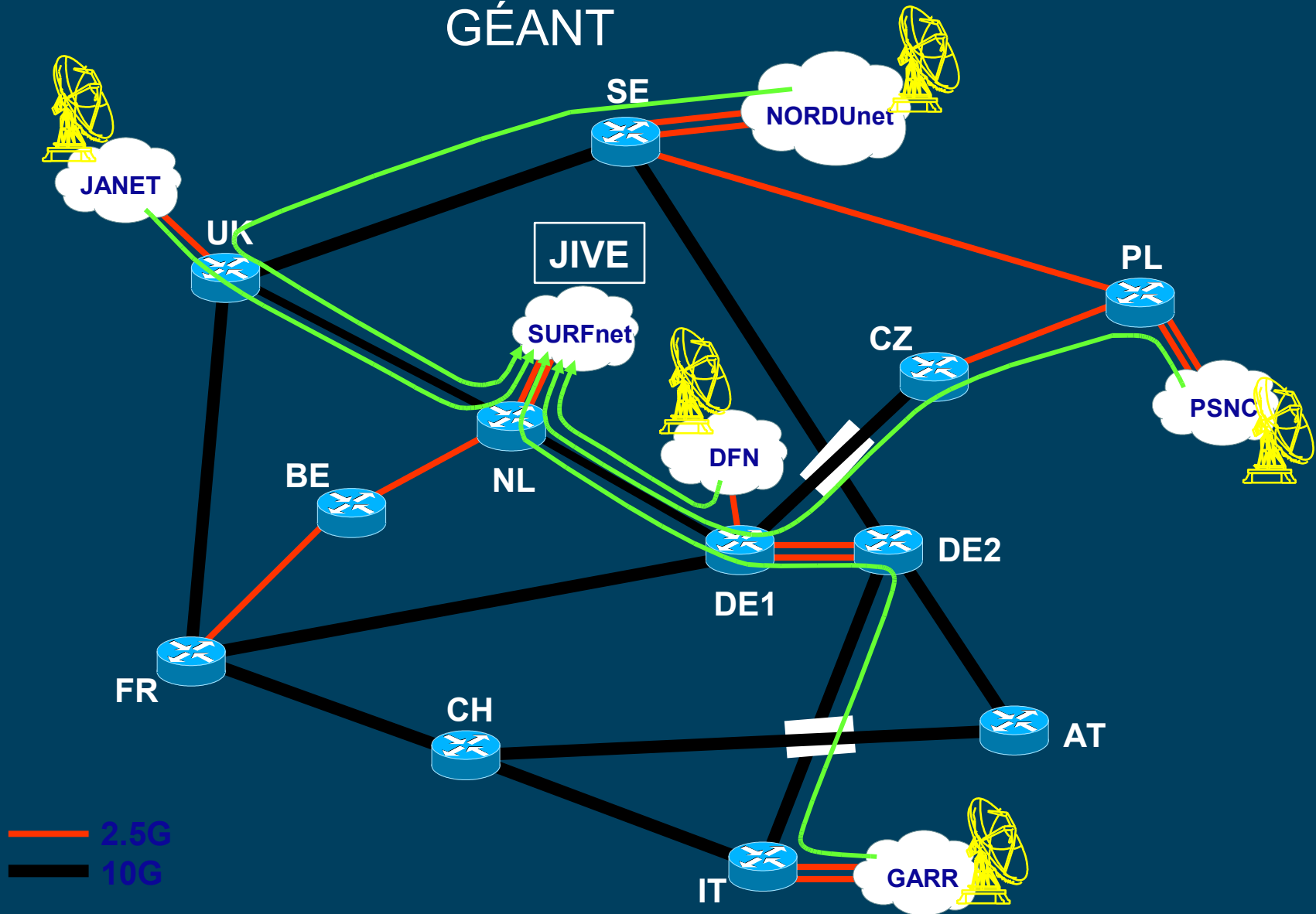


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## NREN 1

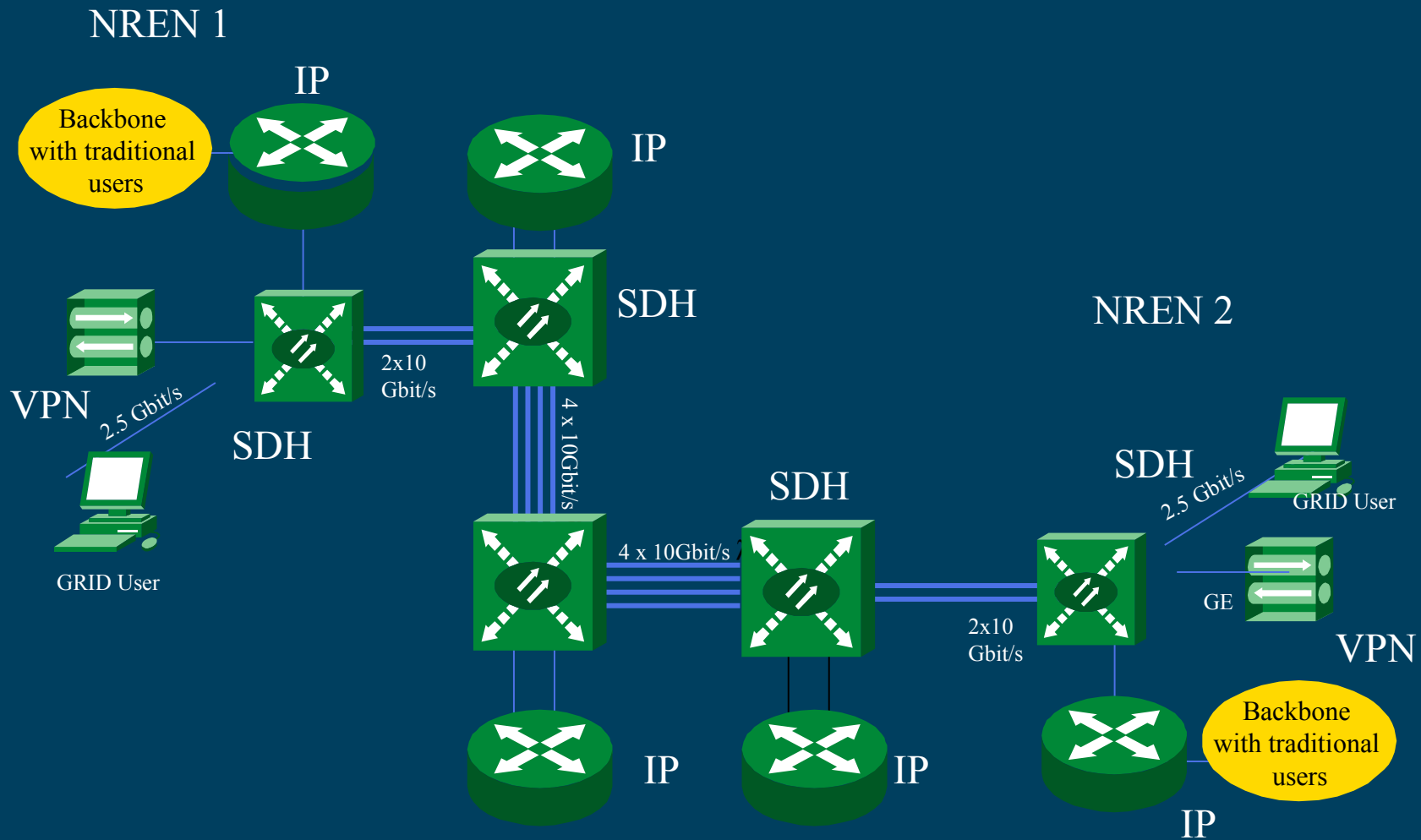


# EVN Traffic Flows over GÉANT



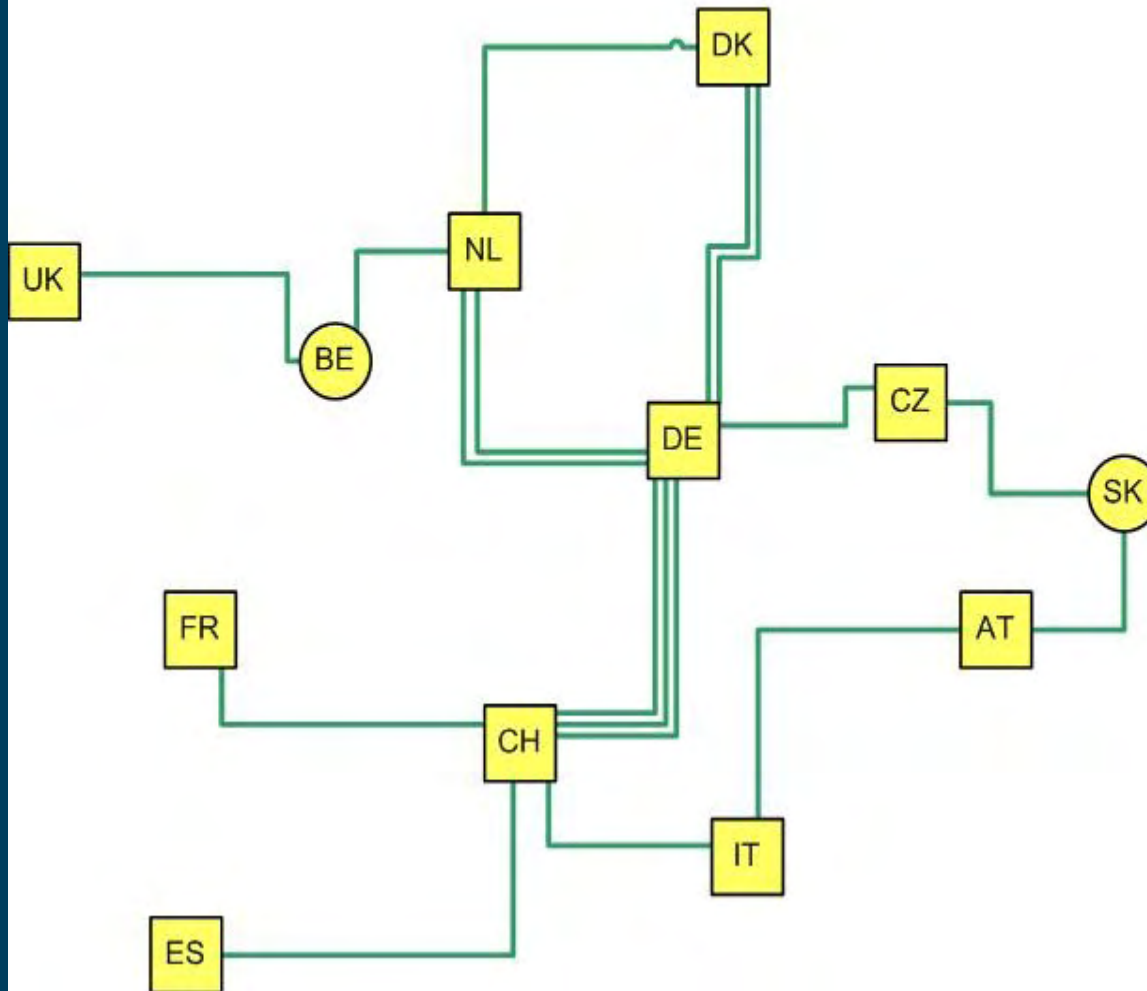


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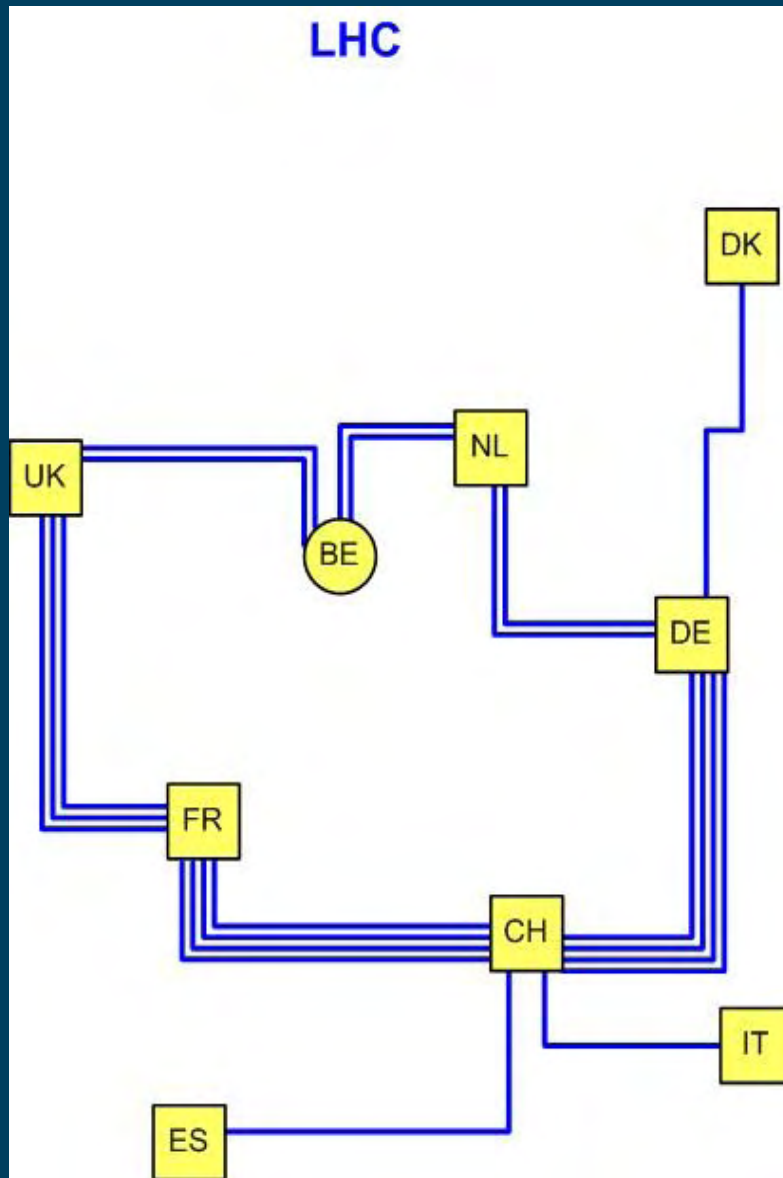


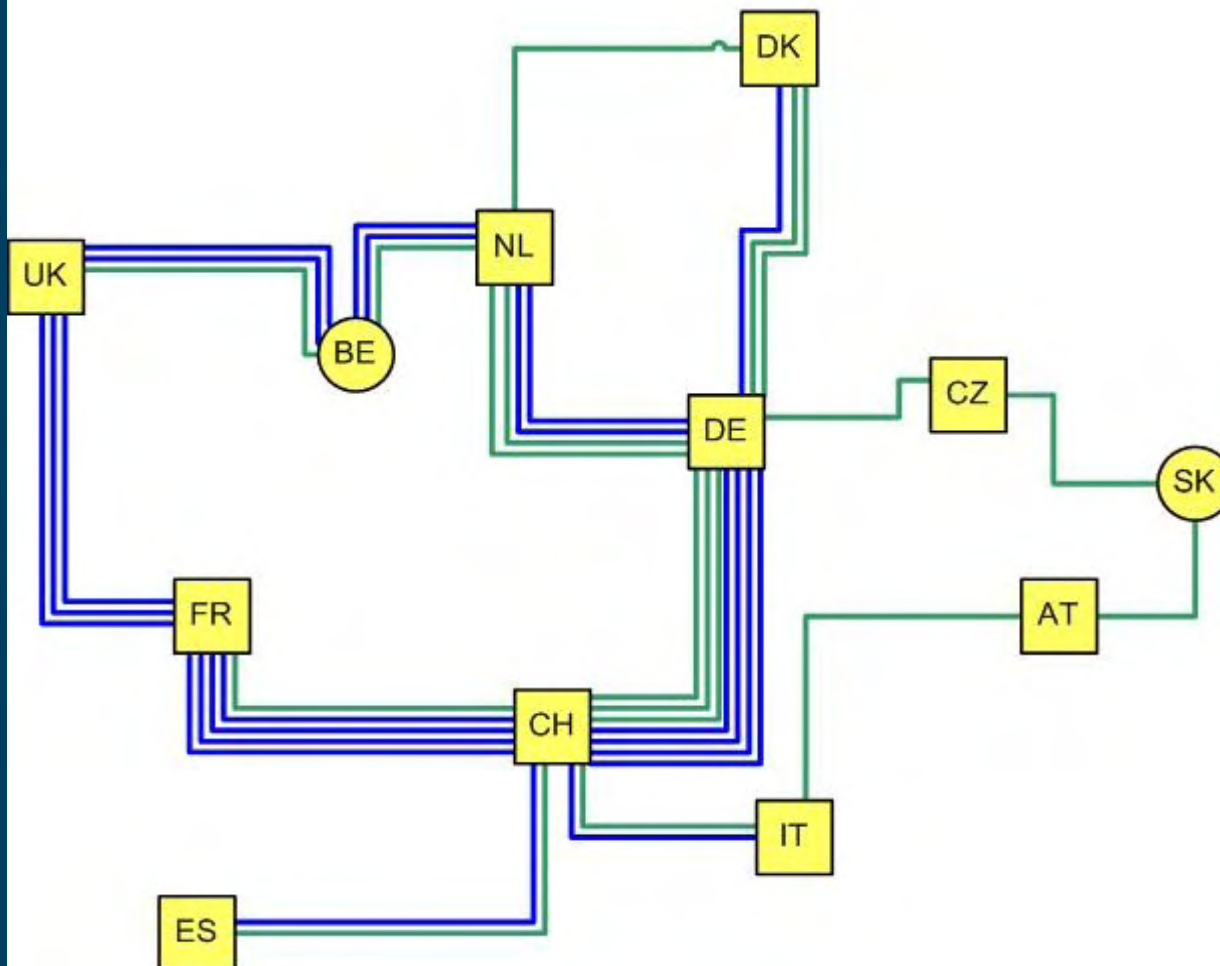
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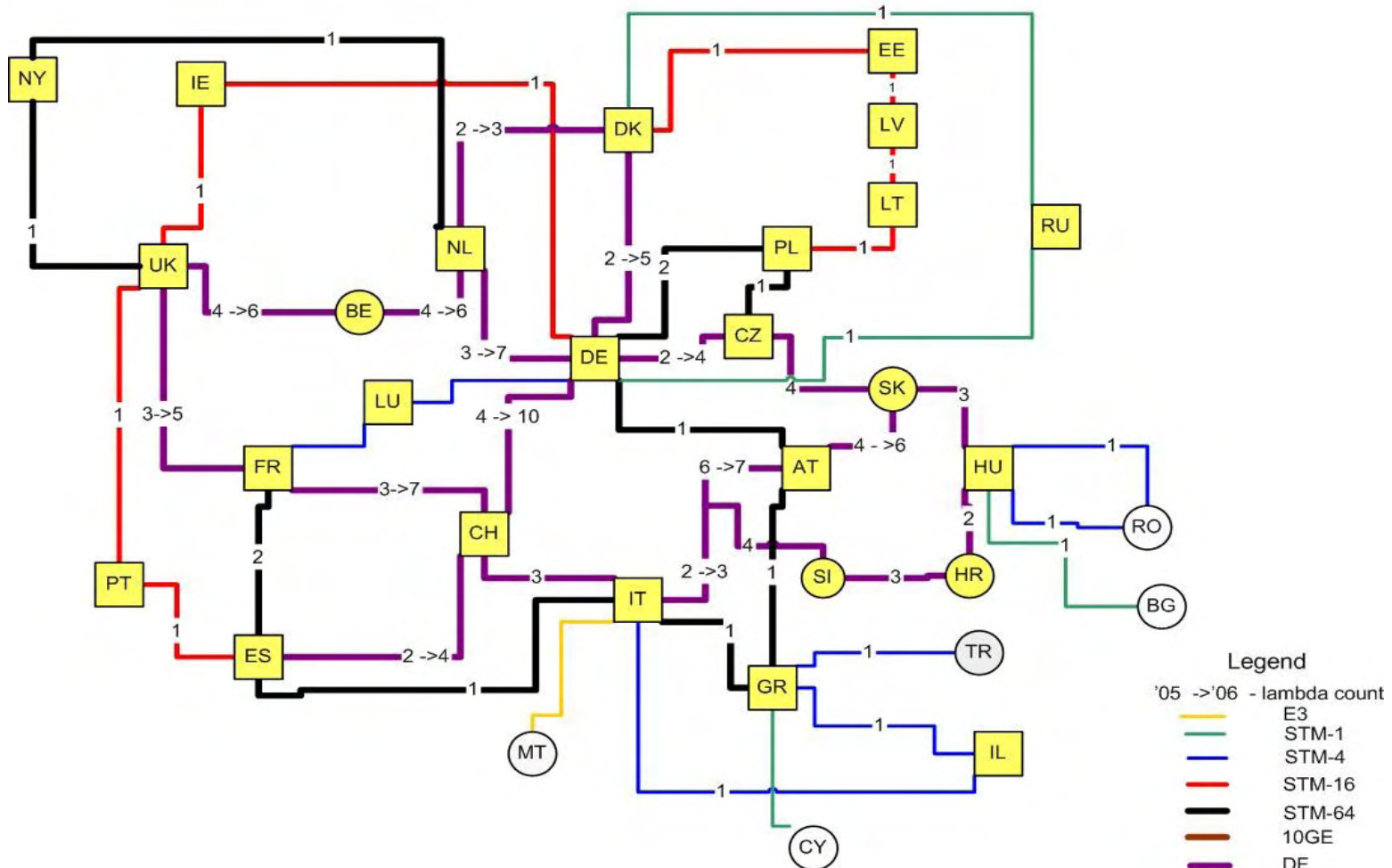






# Capacity planning results

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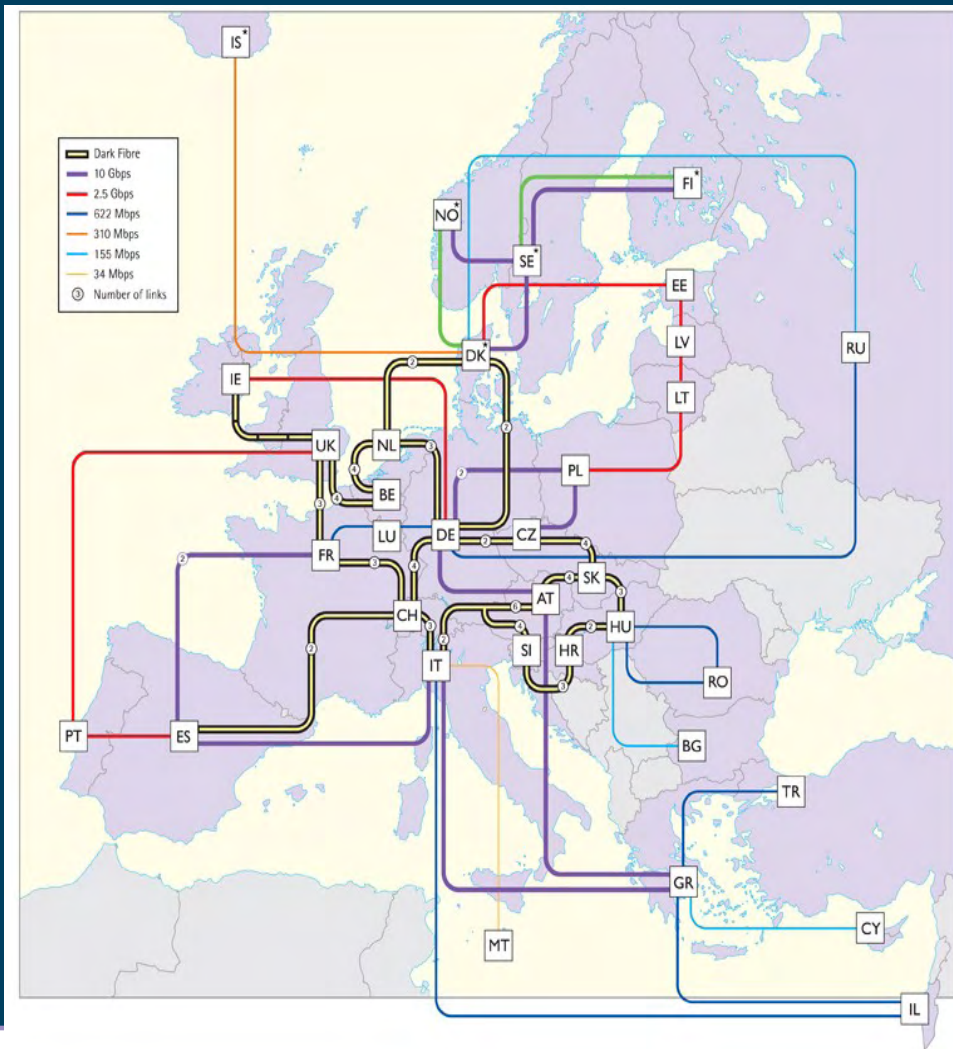




# GÉANT(1) → GÉANT2



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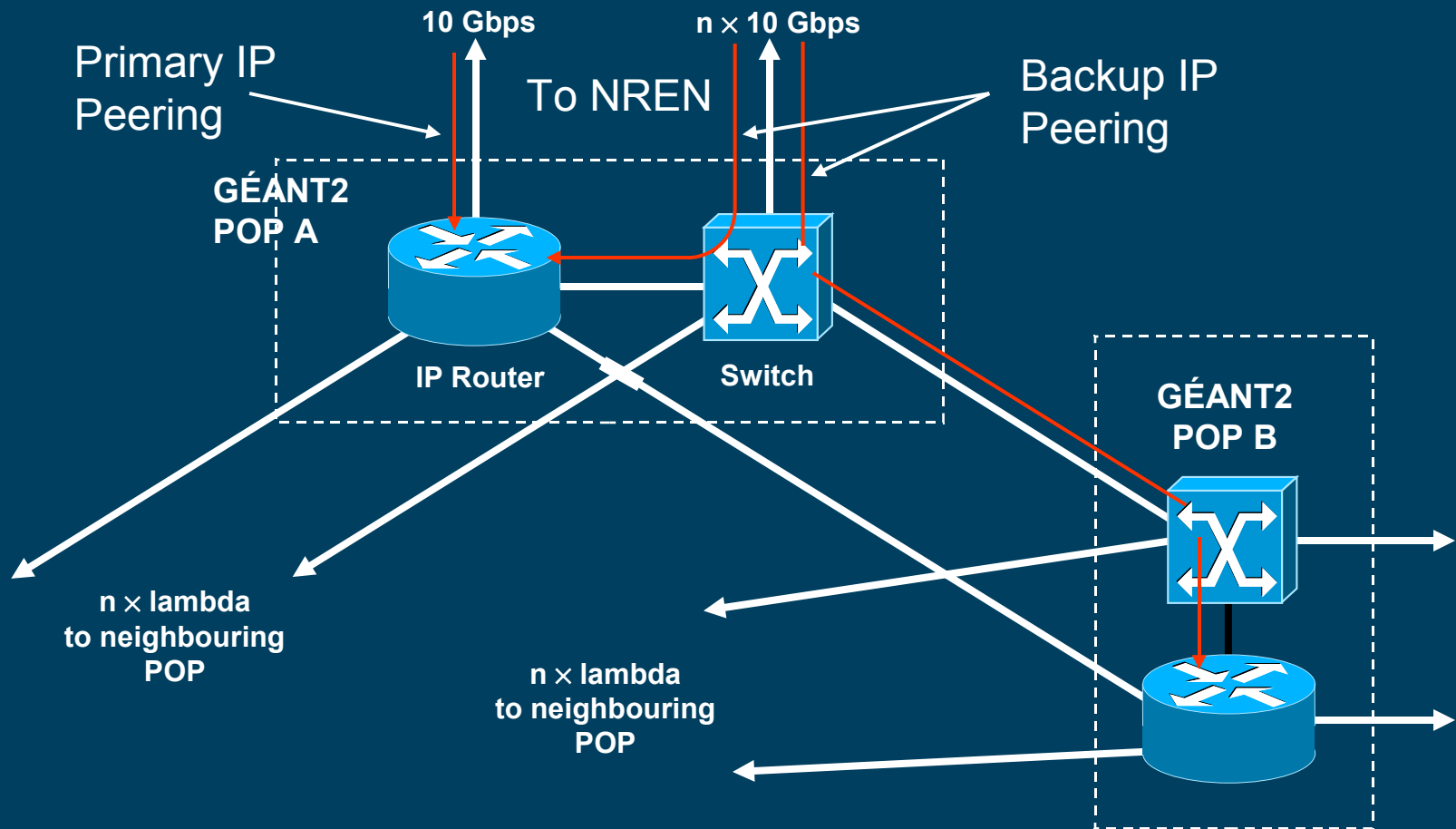
## Some Facts & Figures...

- 25 POPs (+4)
- to serve 30 NRENs (+1)
- 11600 km of fibre
- 140+ ILA sites
- 50+ x (own) 10G lambdas
- 9 x (leased) 10G lambda
- 8 x 2.5G (leased) "lambda"
- + some lower speed links
- Juniper T640, M160 & M40 routers in POPs with
- NREN accesses at up to 10Gbps (+ backup) + P2P
- 4 x 10G to North America
- POP in NY
- connections to other R&E networks as before...

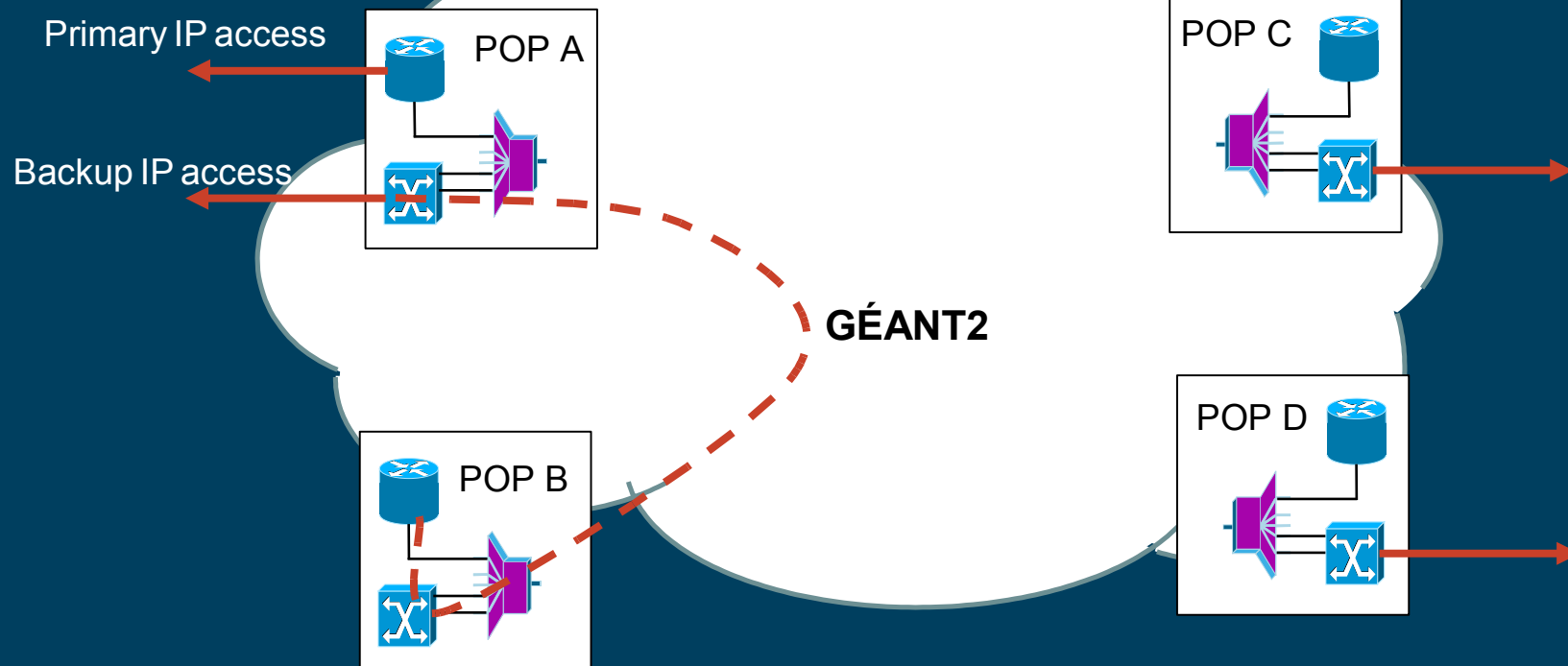
# GÉANT2: A hybrid infrastructure



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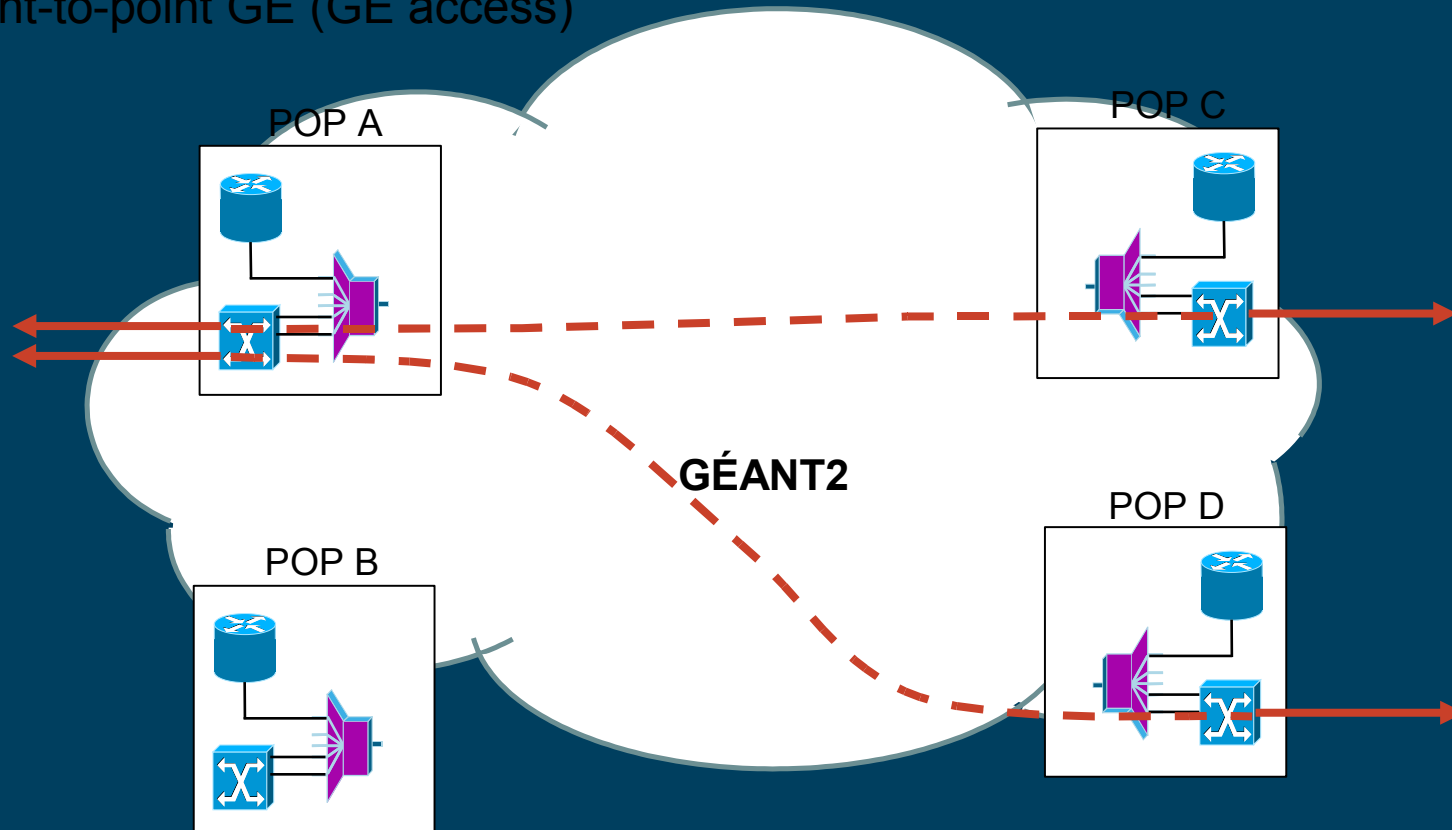




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# Circuit Services over GÉANT2

Point-to-point GE (GE access)



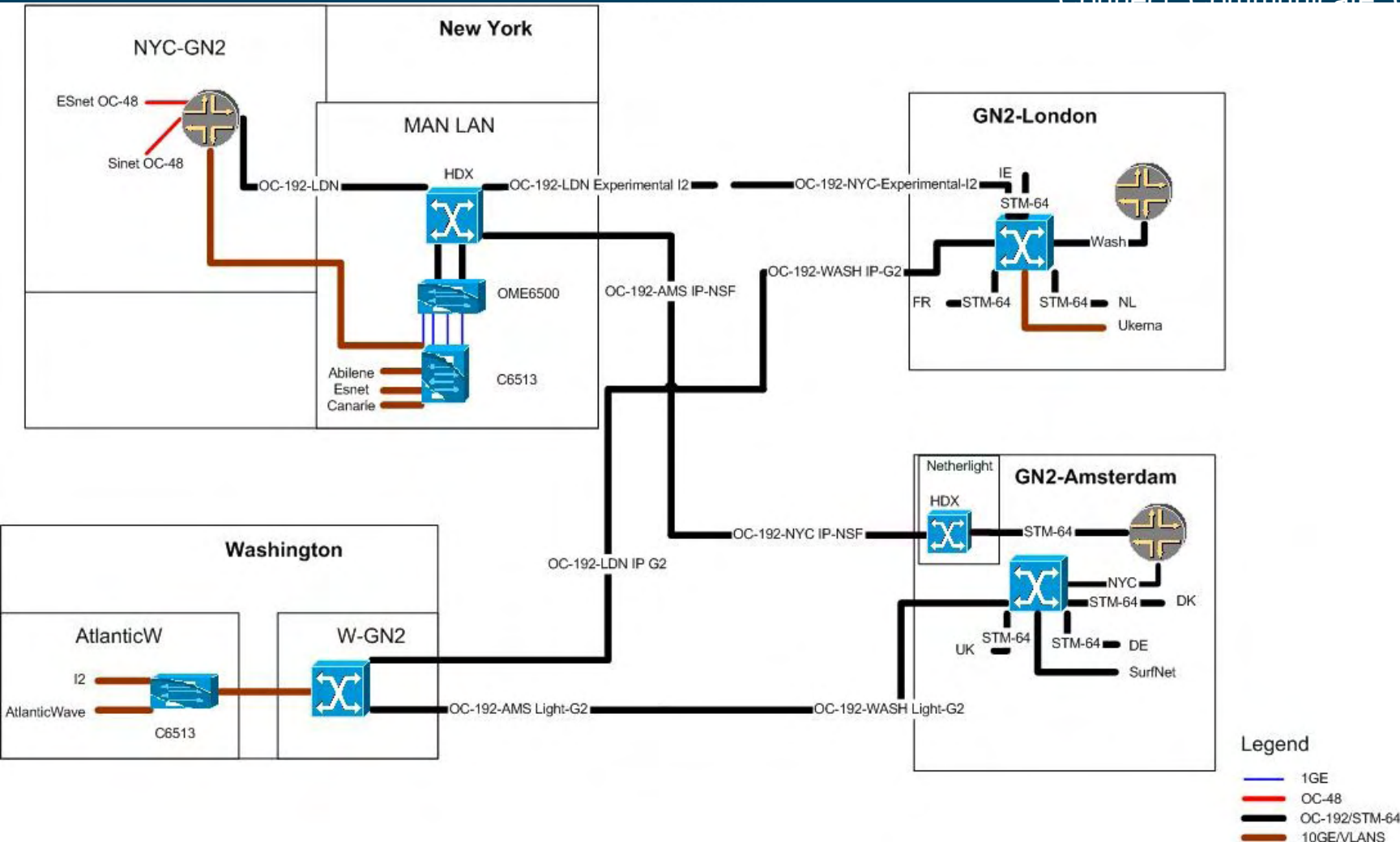
## Features:

- uses GFP/VCAT
- GE port per instance
- more dynamic
- sub 1G possible

# Transatlantic



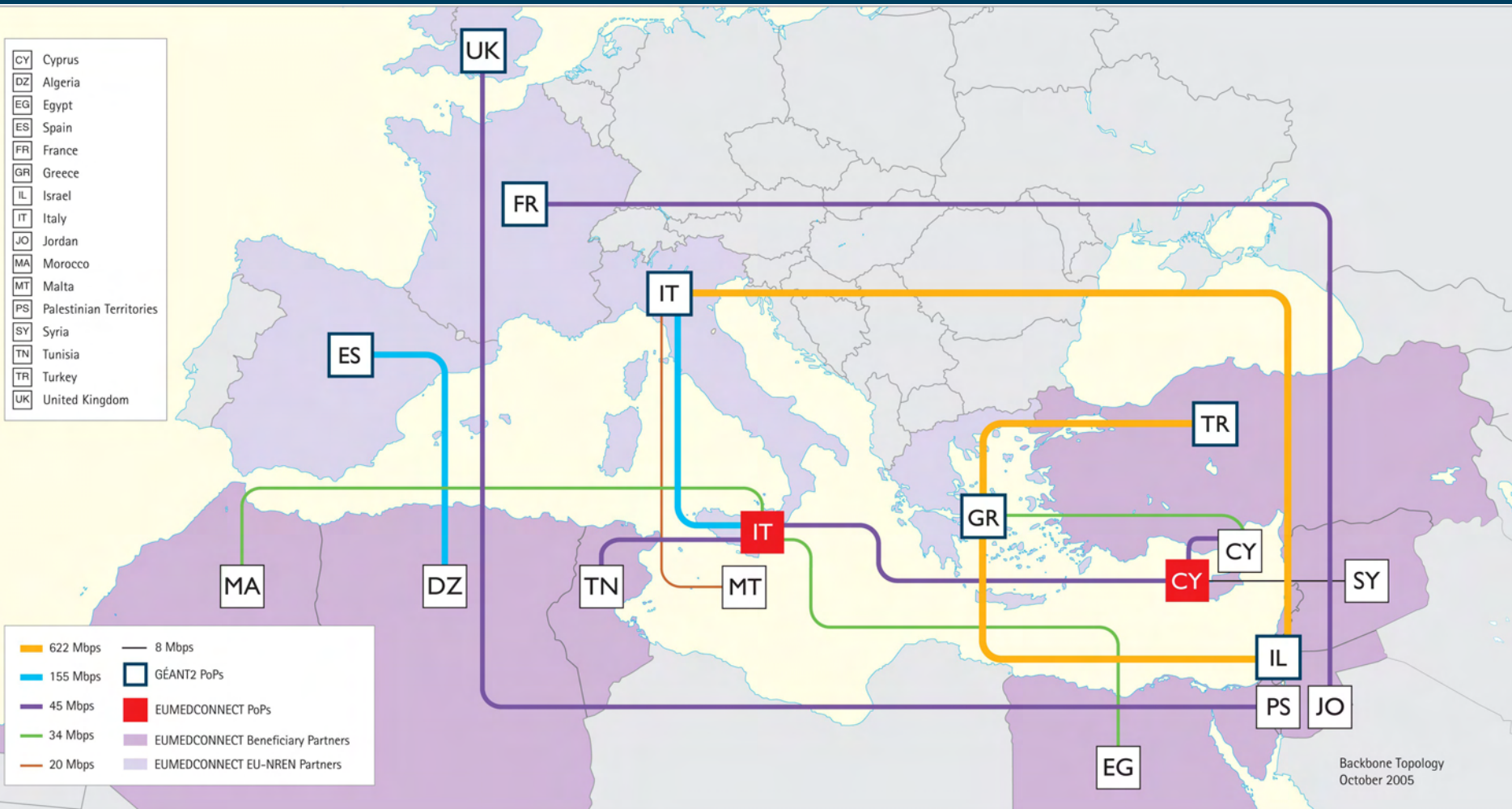
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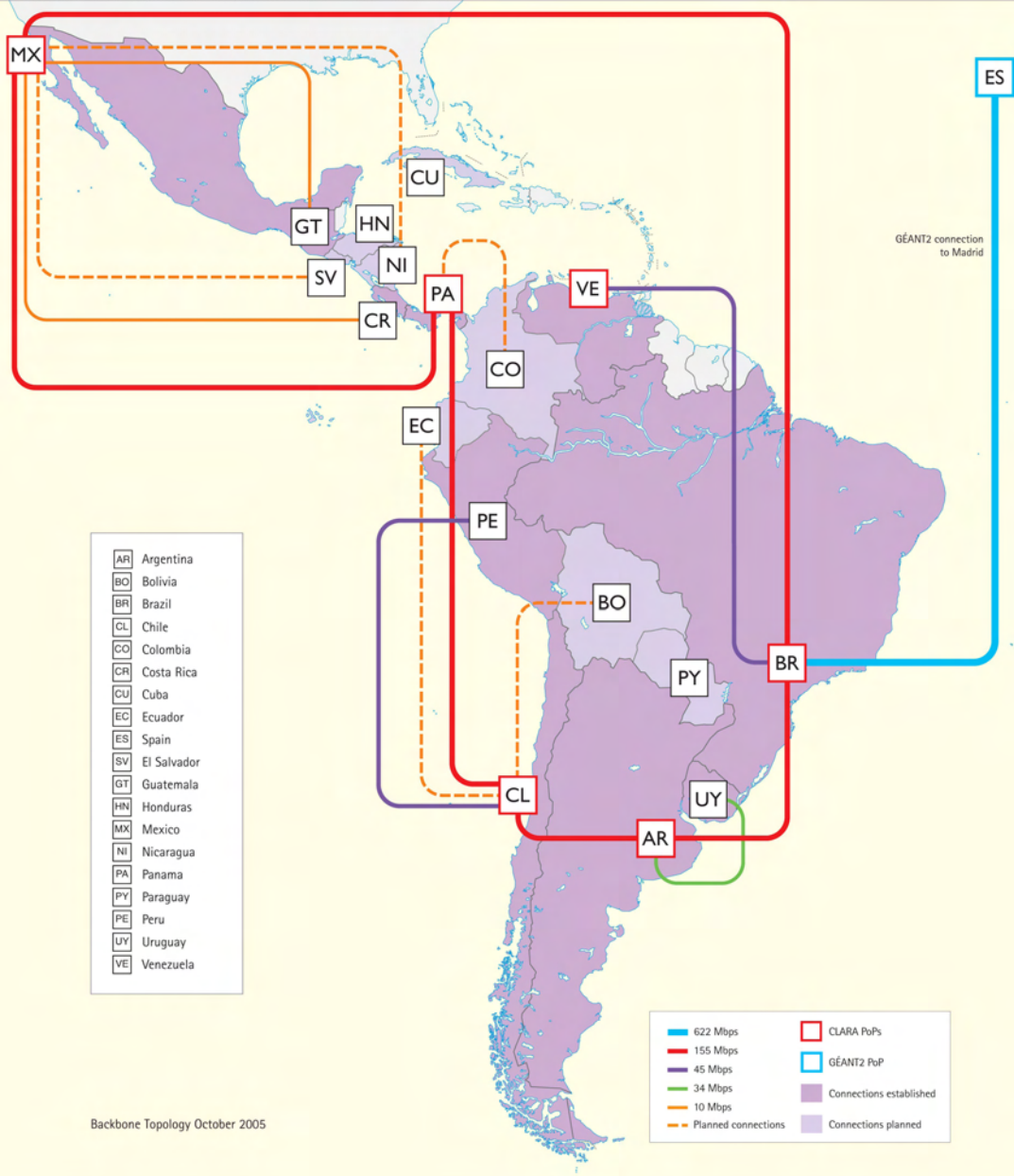




# EUMEDCONNECT

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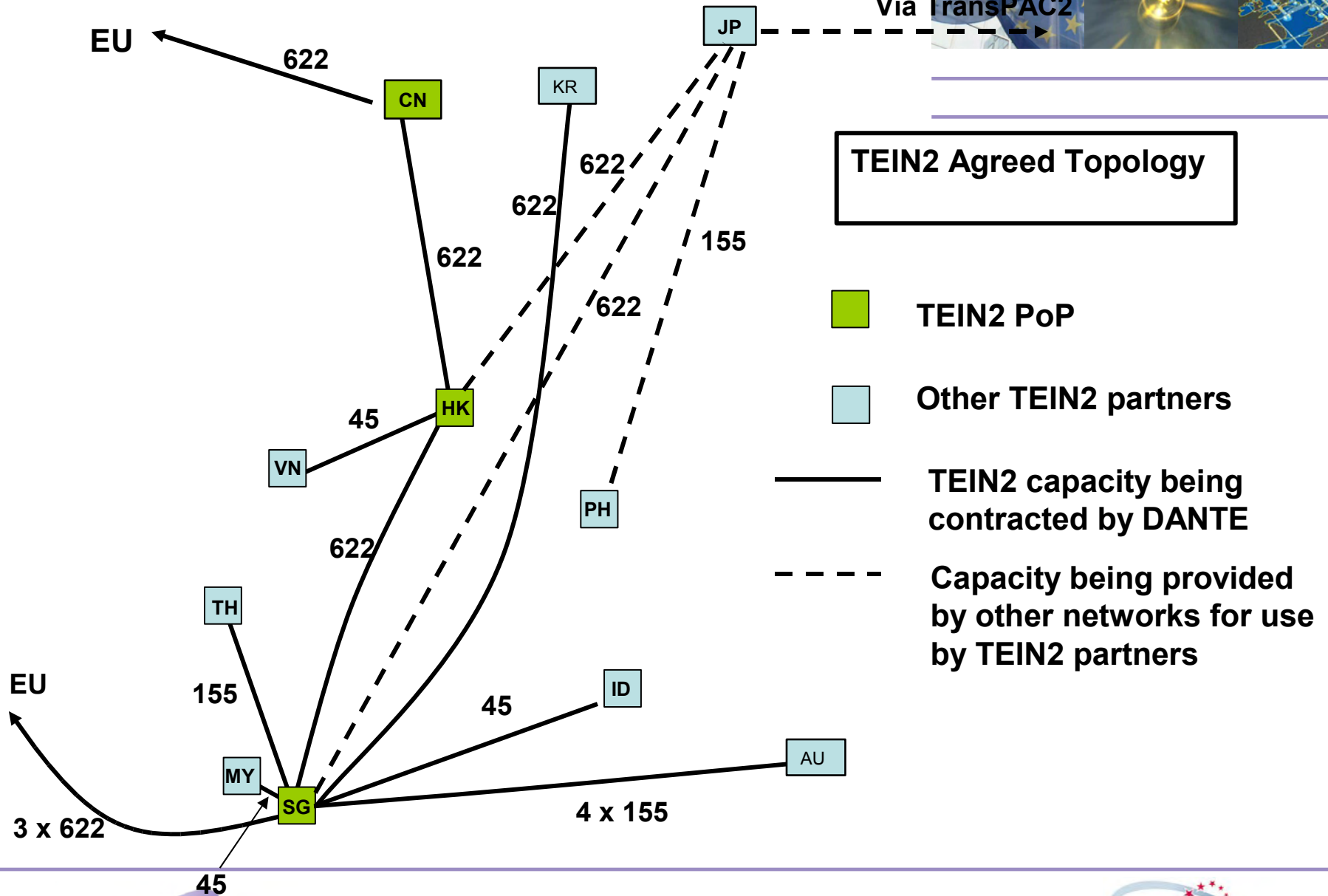
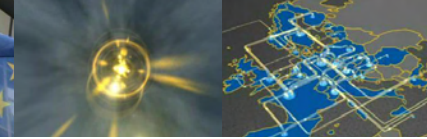


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## ALICE Topology October 2005



North America  
Via TransPAC2





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QuickTime™ and a  
TIFF (Uncompressed) decompressor  
are needed to see this picture.



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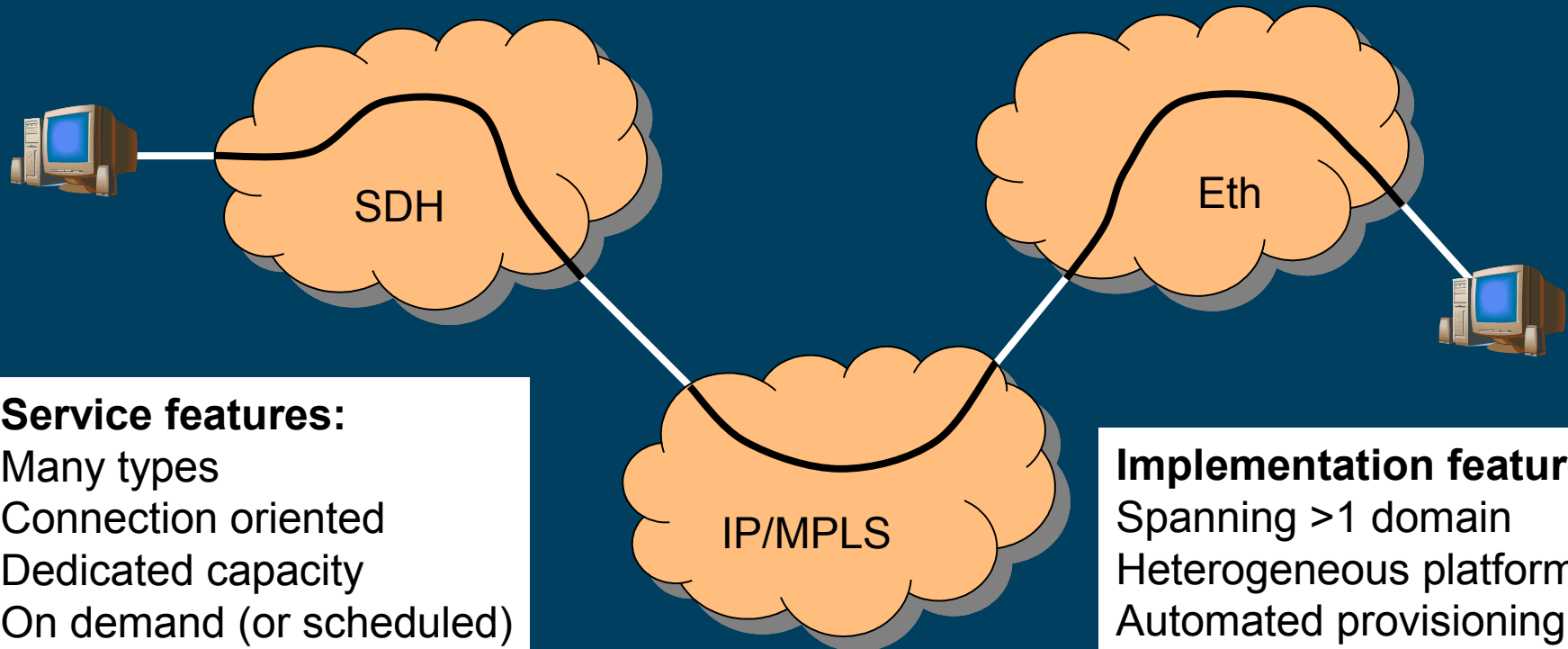
# New services

- Bandwidth on demand (BoD)
- Network monitoring
  - IP monitoring - perfSONAR
  - e2e circuit monitoring
- End-to-End Quality of service
- e2e - NOC

# BoD Service



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## Service features:

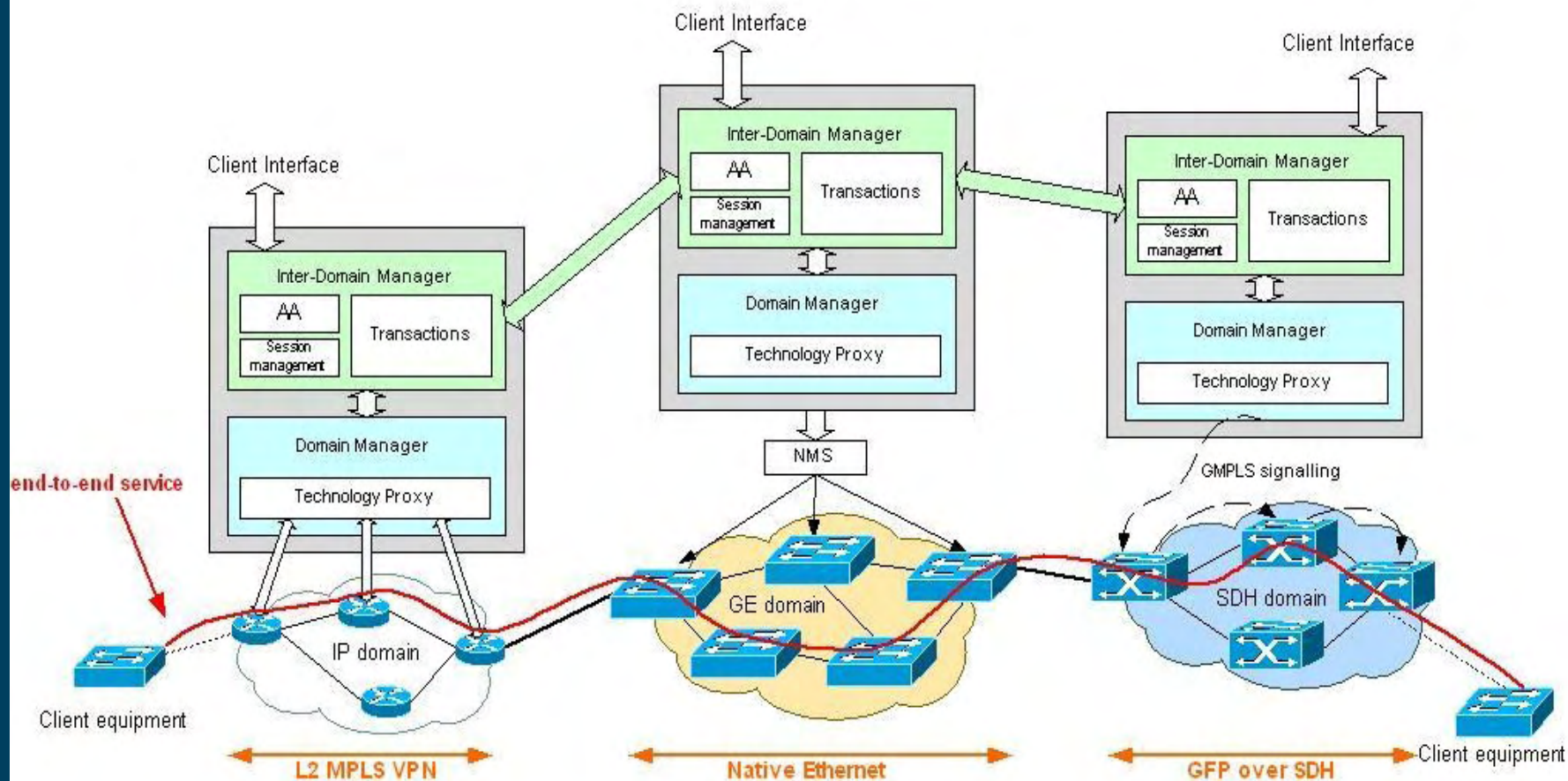
- Many types
- Connection oriented
- Dedicated capacity
- On demand (or scheduled)
- Short-lived

## Implementation features:

- Spanning >1 domain
- Heterogeneous platforms
- Automated provisioning

# BoD Architecture

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# Monitoring



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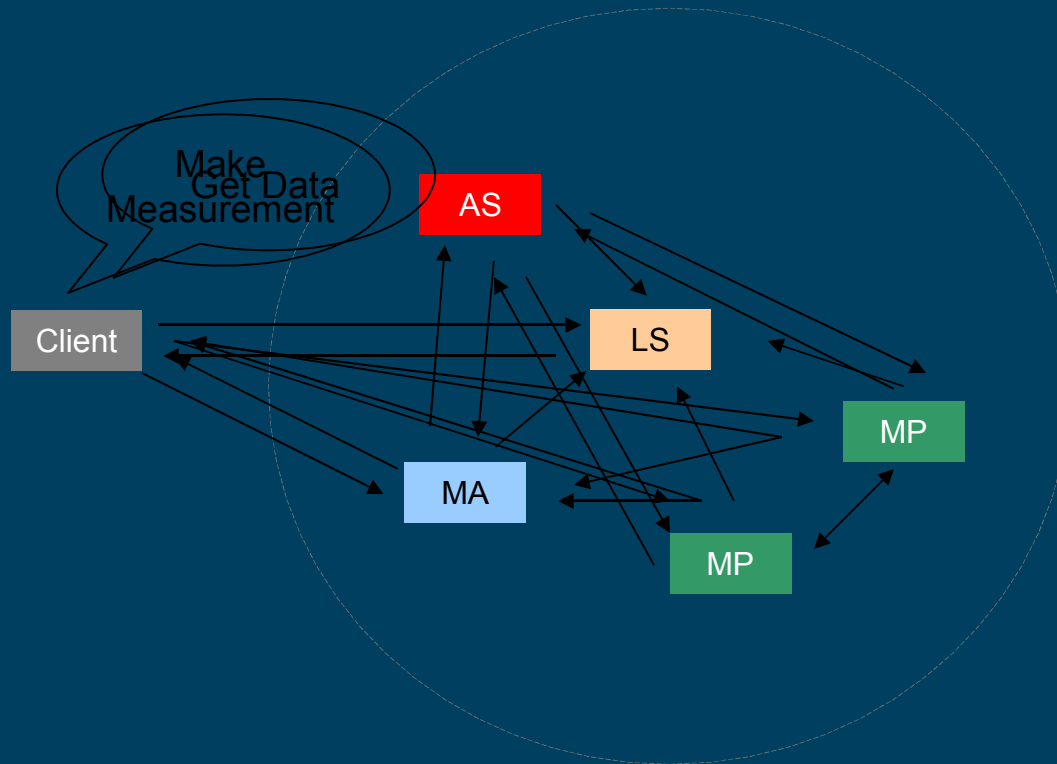
## Services identified by perfSONAR

- Base Services
  - Measurement Archive Service
  - Measurement Point service
  - Authentication Service
  - Lookup Service
- Additional Services
  - Resource Protection Service
  - Topology Service
  - Transformation Service

# perfSONAR Architecture 5



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|    |                             |
|----|-----------------------------|
| MP | Measurement Point Service   |
| LS | Lookup Service              |
| MA | Measurement Archive Service |
| AS | Authentication Service      |

\* This slide has animations





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# End-to-End Quality of service

- To deploy an initial set of Performance Monitoring devices
- To set-up and operate an E2E network performance help and advice service, called the PERT (Performance Enhancement & Response Team) - (8 \* 5)
- The localisation, diagnosis and resolution of end-system performance issues
- To enable and promote the use of multi-domain Premium IP (PIP)



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# Future developments

- Full transit to GÉANT 2 - January - February 2006
- Enlargement of the “fibre cloud”
- Increase capacity to the edge - repeated tendering
- Strengthening of the international connectivity
- Net - wide deployment of the advanced services

# Conclusions



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- Enormous development in the 15 years
- Stable organizational setup
- Technical progress
- Global impact
- **Best research network**