

# Research and Educational Networking in Europe and Worldwide

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DANTE

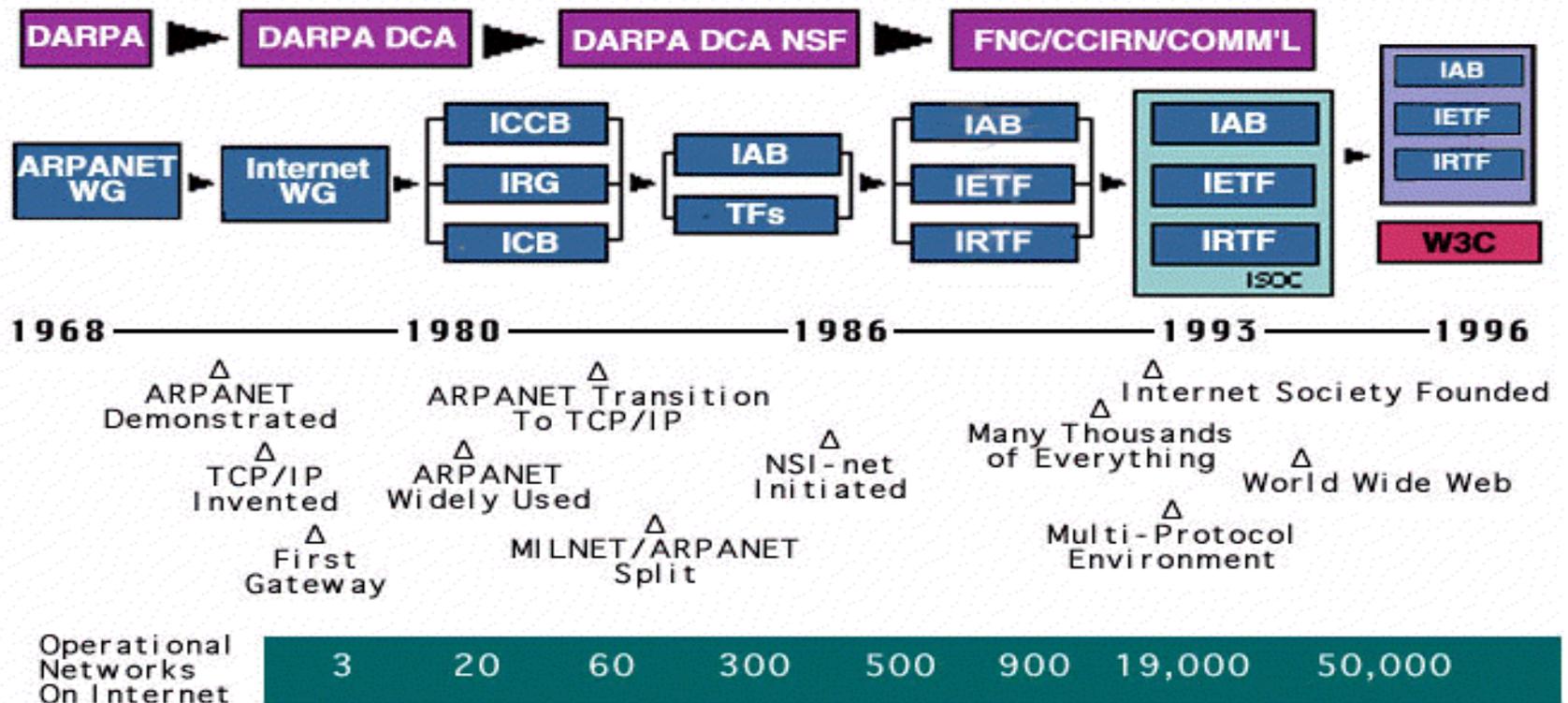
# Extremely fast development

- Collective memory quite short
- Allowing myself, to look at the history of networking
- Personal impressions - not historian

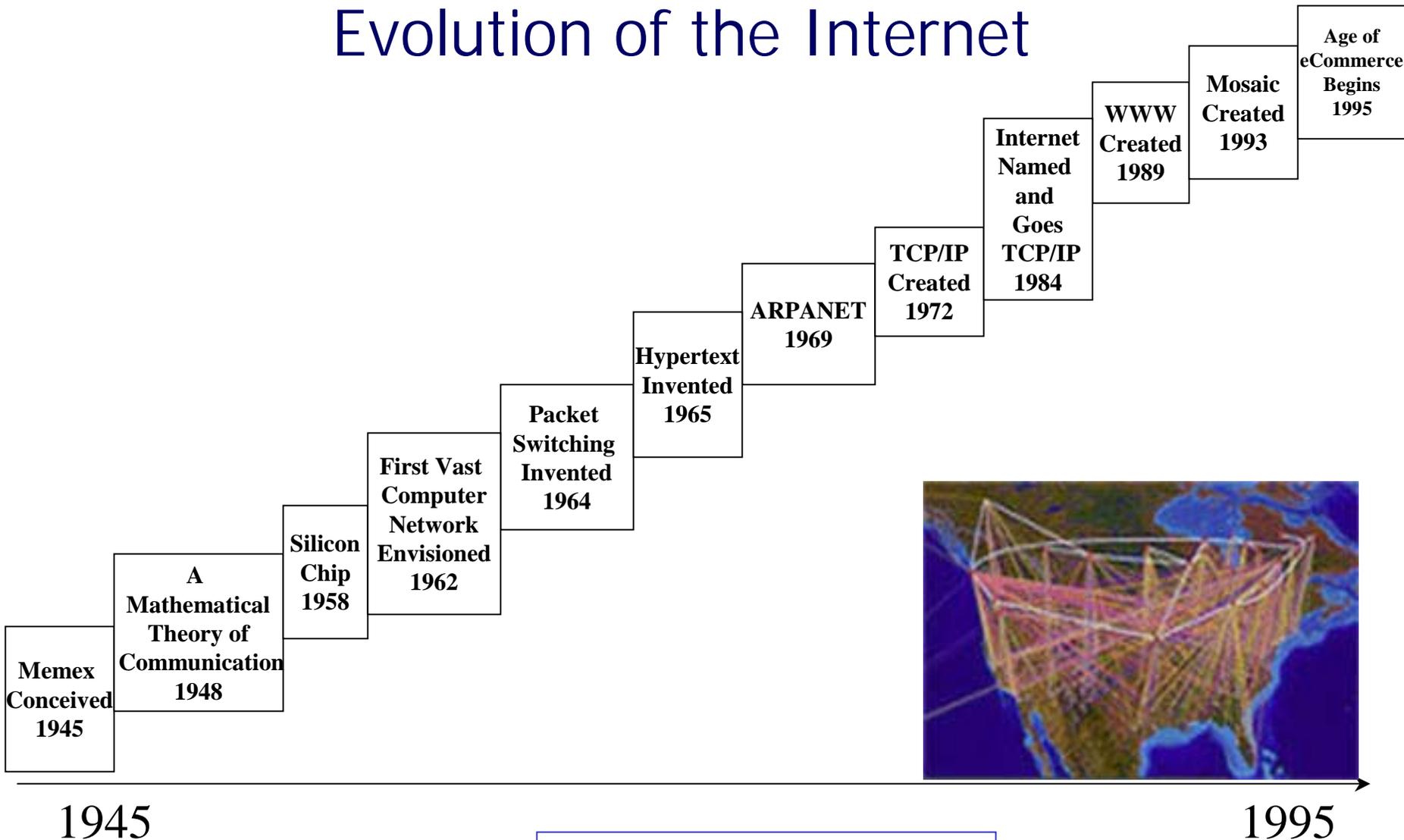
## Some history

- DARPA 1970
- ARPANET 1973
- BITNET / EARN 1981 - 1996

# Internet History



# A Brief Summary of the Evolution of the Internet



GARR Conference 05





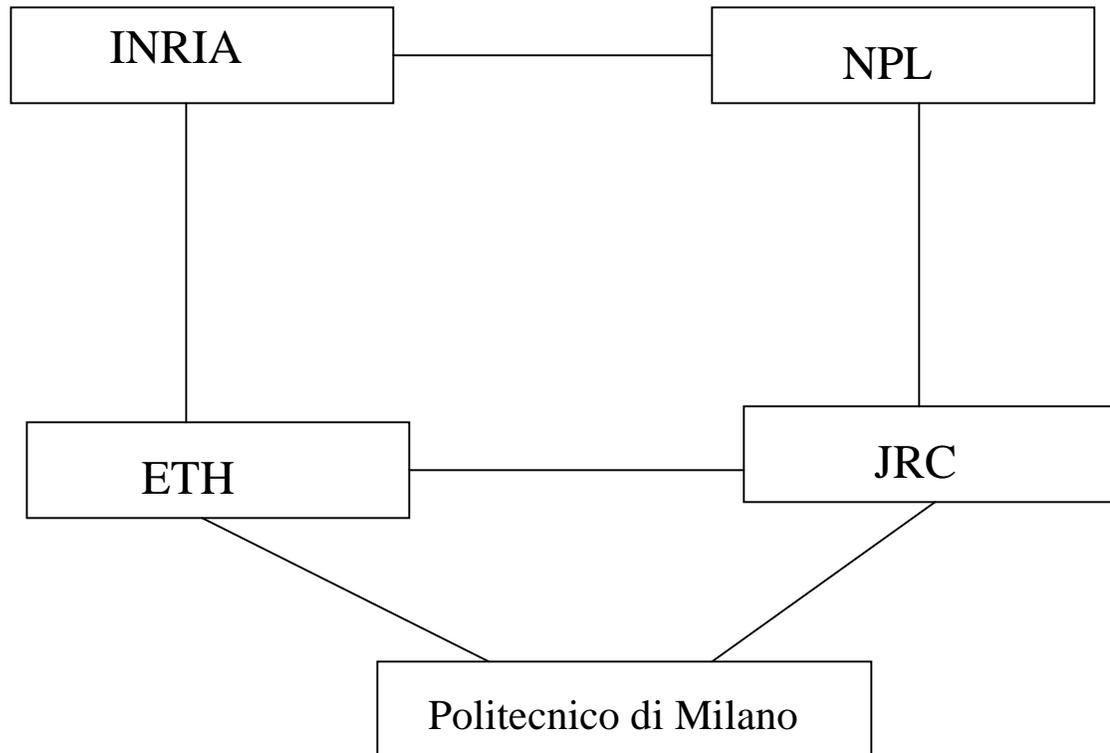
# National Networks

- CIGALE / CYCLADES (INRIA) 1972
- NPL Network
  - Design started 1966 operational 1973
  - Based on Honeywell DDP 516
  - Designed as potential WAN
  - LAN implementation
  - Packet switching
  - Home made layered protocols

# Early International European Networks

- European Informatics Network 72 - 77
  - Nodes in London, Paris, Zurich, Ispra (EC), Milano
  - Datagram network
  - Developed own protocols
  - Base for some ISO protocols
  - Killed by PTTs (EURONET - X.25)

# European Informatics Network



# COSINE

- An EUREKA project
- RARE coordinated the activity
- Pan-European infrastructure
- IXI started 1990 - X25 services at 64 kbps
- MHS, Paradise (X500)
- Additional IP services in 1992

# EBONE

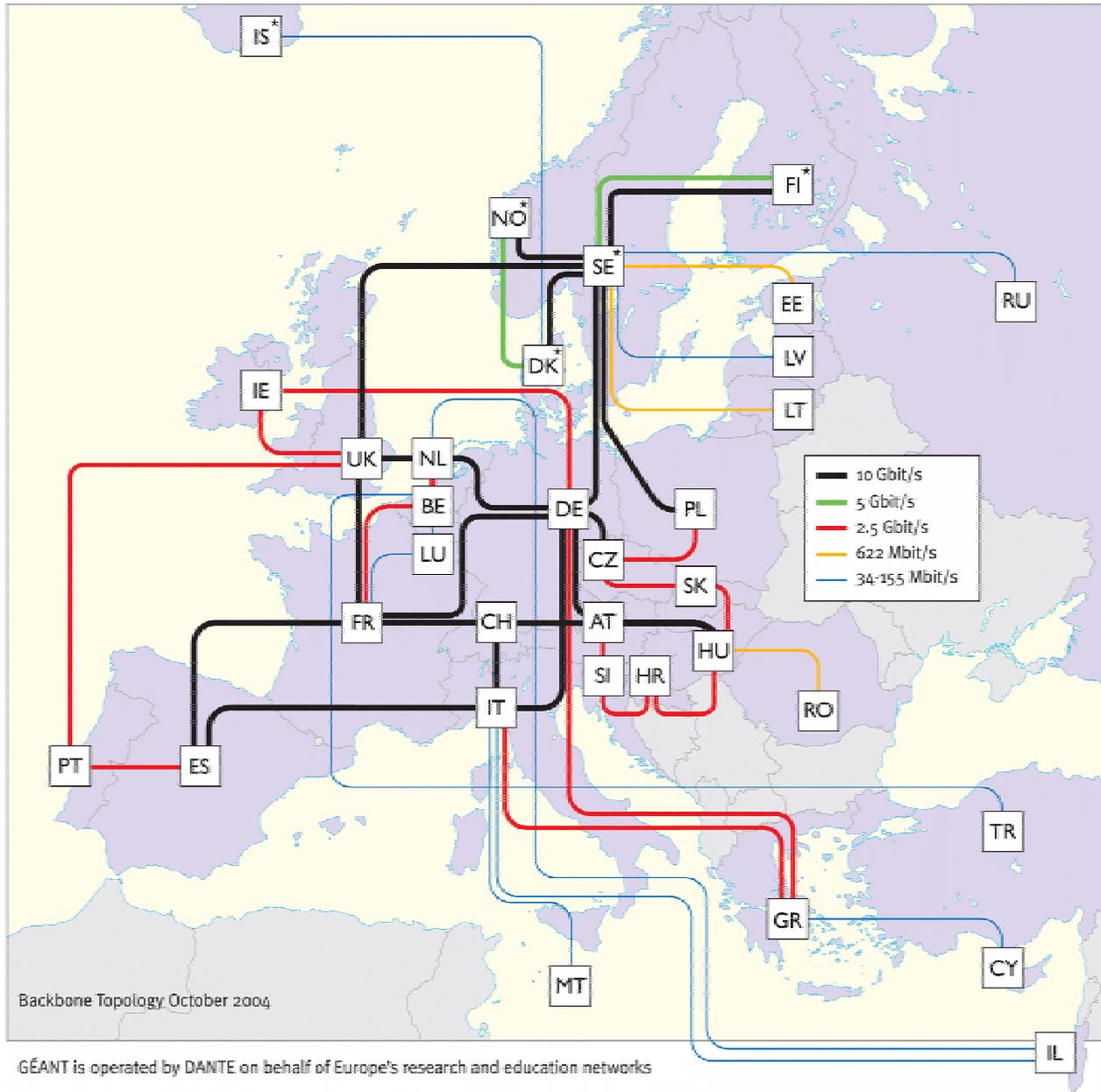
- IP backbone set up by large TCP/IP users
- EBONE93 - backbone and interconnect
- Gateways between EuropaNet and EBONE
- **Protocol Wars**

# DANTE Related Networks - 1

- From 1993 to 1997, EuropaNET was developed. It connected **18** countries at speeds of 2Mbps and used IP technology.
- From 1997 to 1998, TEN-34 was connecting **18** countries, but now at speeds of 34Mbps and using both IP and ATM technology.

## DANTE Related Networks - 2

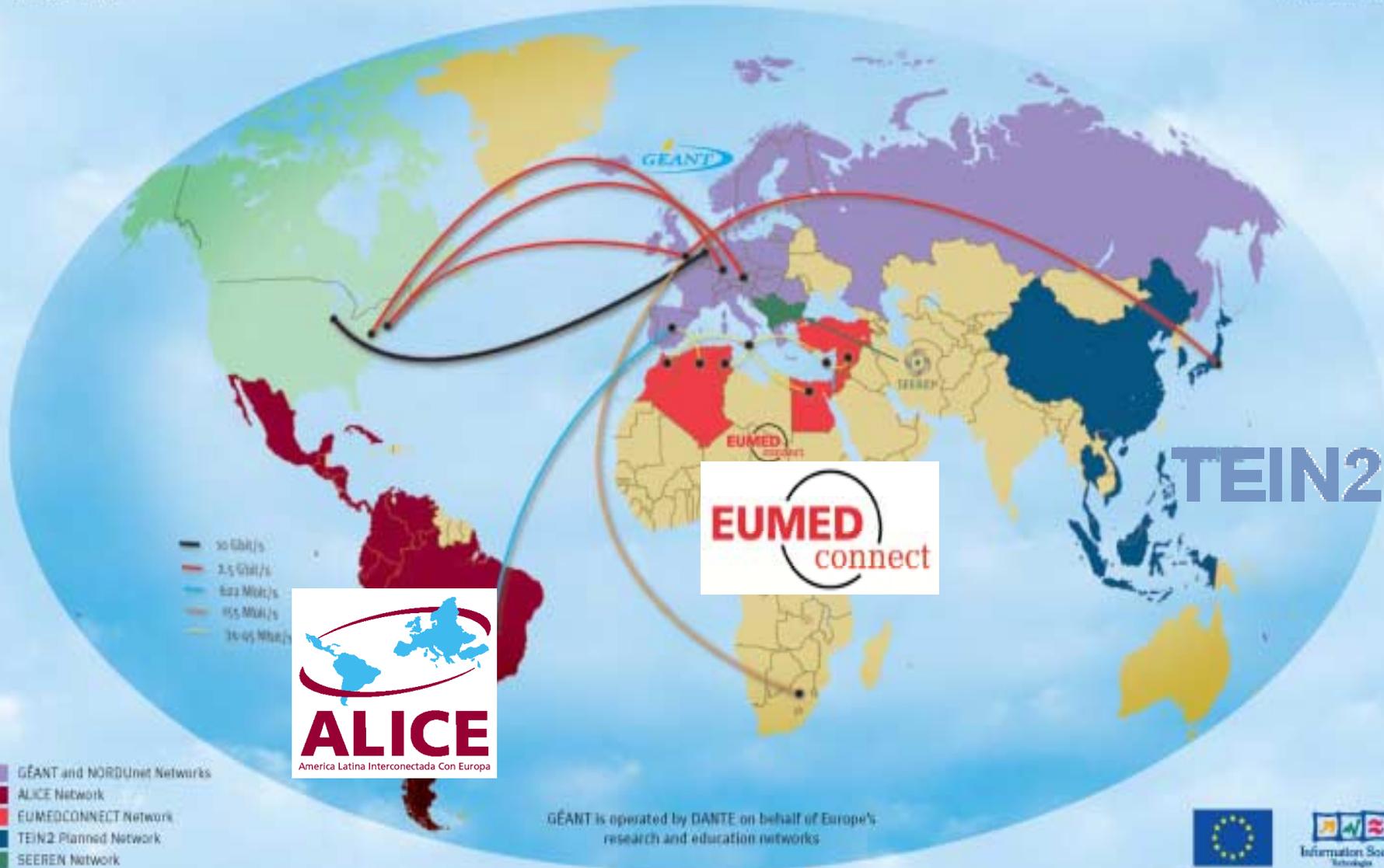
- From 1998 to 2001, TEN-155 was connecting **19** countries at speeds of between 155 and 622 Mbps, again using IP and ATM technologies.
- From 2001 until 2004, the GÉANT network connects **32** countries at speeds of between 2.5 and 10Gbps. It uses DWDM technology and offers IPv4 and IPv6 native services in dual-stack mode.



# World Class Research Networking

GÉANT: The world's most advanced international research network

GÉANT Global Connectivity October 2004



TEIN2

GÉANT is operated by DANTE on behalf of Europe's research and education networks



## Additional connected networks

- SEEREN interconnects the national research and education networks
  - Albania
  - Bosnia-Herzegovina
  - Macedonia,
  - Serbia and Montenegro
- Behind GÉANT members:
  - Russia, Belarus, Ukraine, Moldova , Vatican

## Additional connected networks - 2

- Clara
- EUMEDCONNECT
- North American Networks
- Asian Networks
- TEIN2 Project
- South Africa - using a tunnel

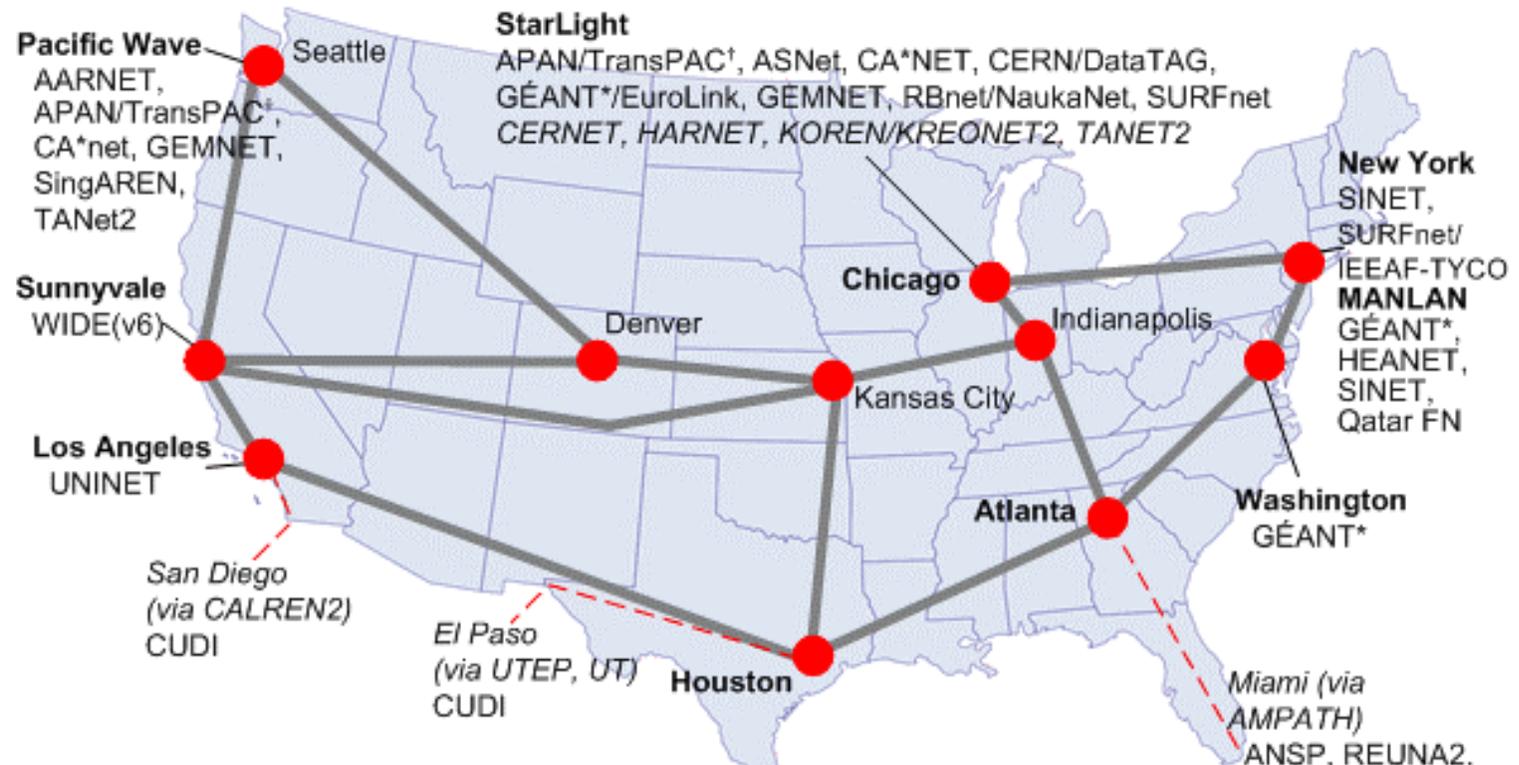
# USA

- Black April 95 - NSFNet discontinued
- Commercial ISP supposedly taking over
- GigaPoPs
- US research networking community now extremely happy with this development:
  - Independent of bureaucrats
  - Excellent results
  - Internet2 - Abilene

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

232 Institutions

# Abilene International Peering



\* via GEANT: ACOnet, BELNET, CARNet, CESNET, CYNET, Forskningsnettlet, 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

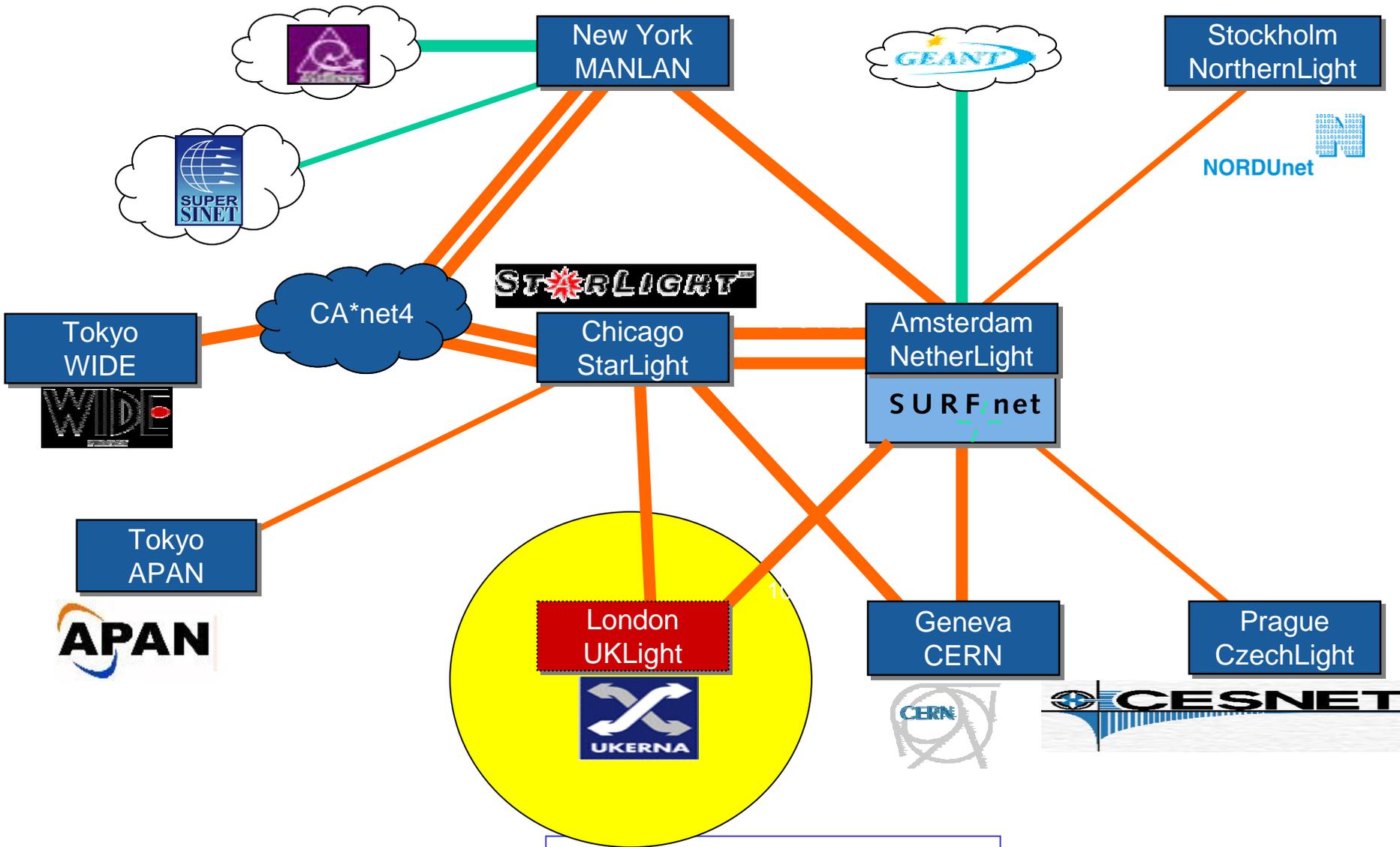
† via APAN/TransPAC: WIDE/JGN, IMnet, CERNet/CSTnet/NSFCNET, KOREN/KREONET2, PREGINET, SingAREN, TANET2, ThaiSARN

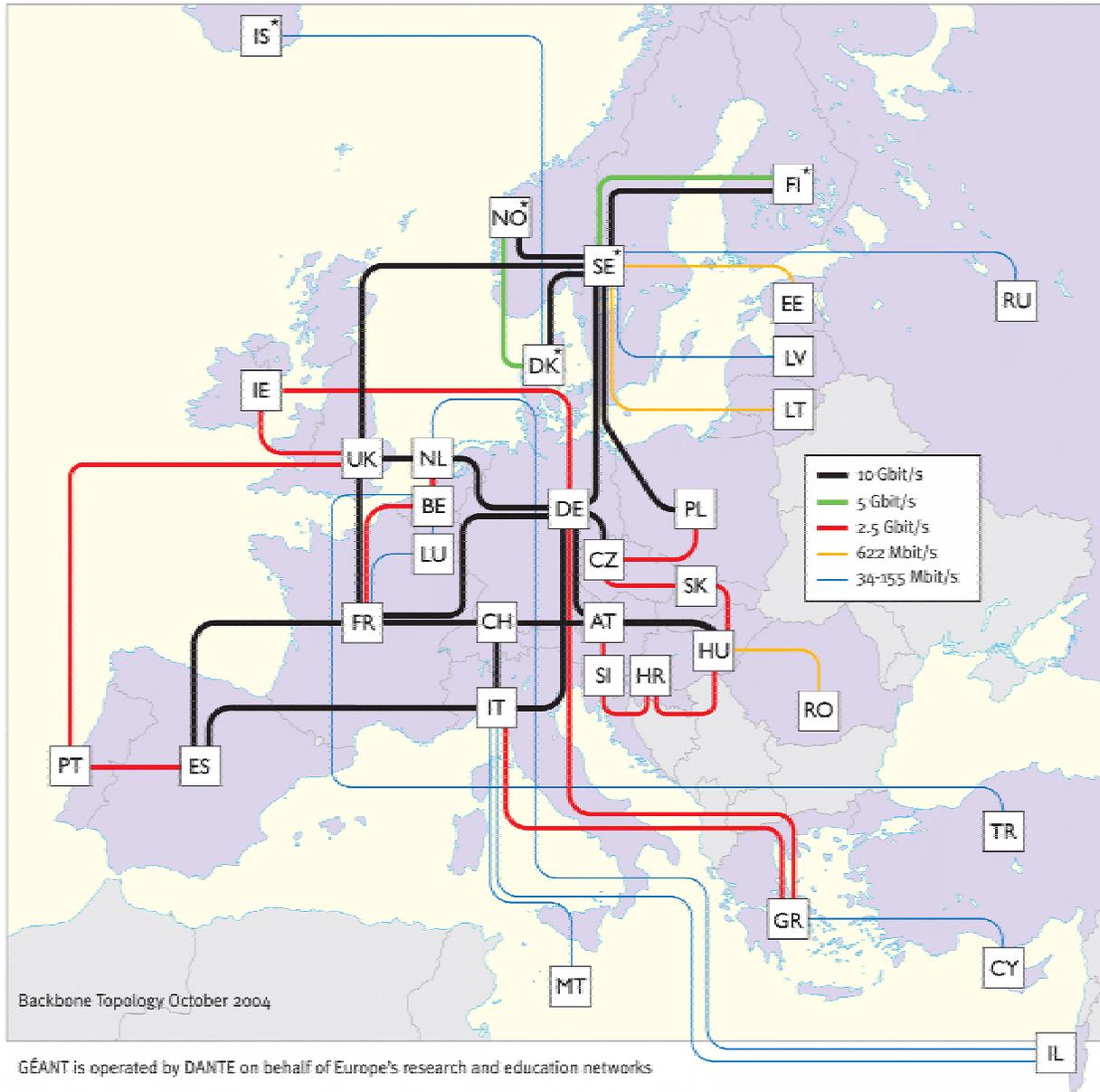


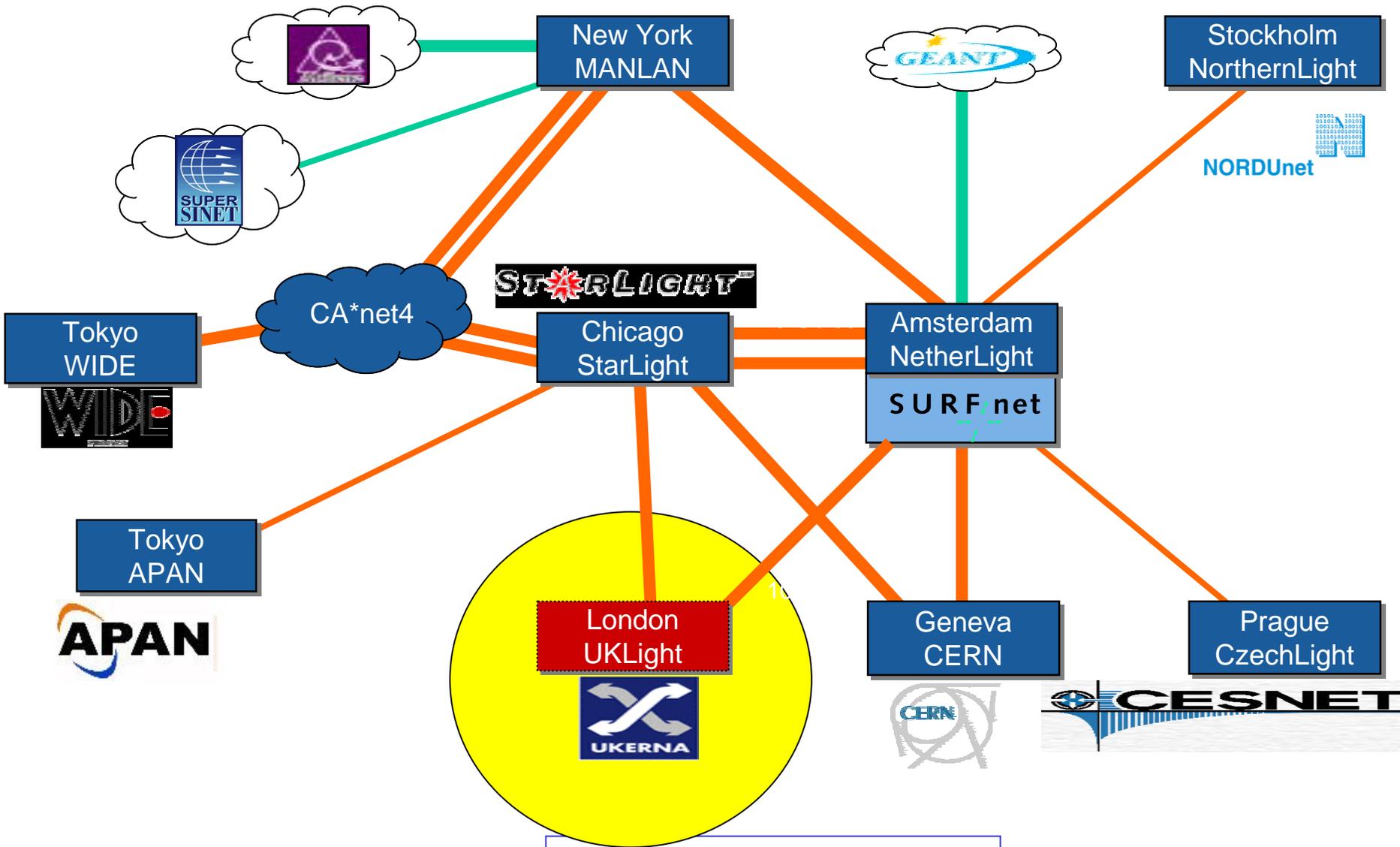
# National LambdaRail Architecture











# GÉANT 2 - New Paradigm

- GÉANT - emphasis on core network
- NREN connecting to PoPs
- Change in the approach: **End-to-End QoS**
- Whole “chain”
- Responsibility of the whole community
- Close co-operation

# Technology

- Investigation of Transmission Costs
- Skepticism *re* 40 Gbps
- OEO cross connects interesting
- “All Optical” some way off
- Emphasis on AAA and Control issues

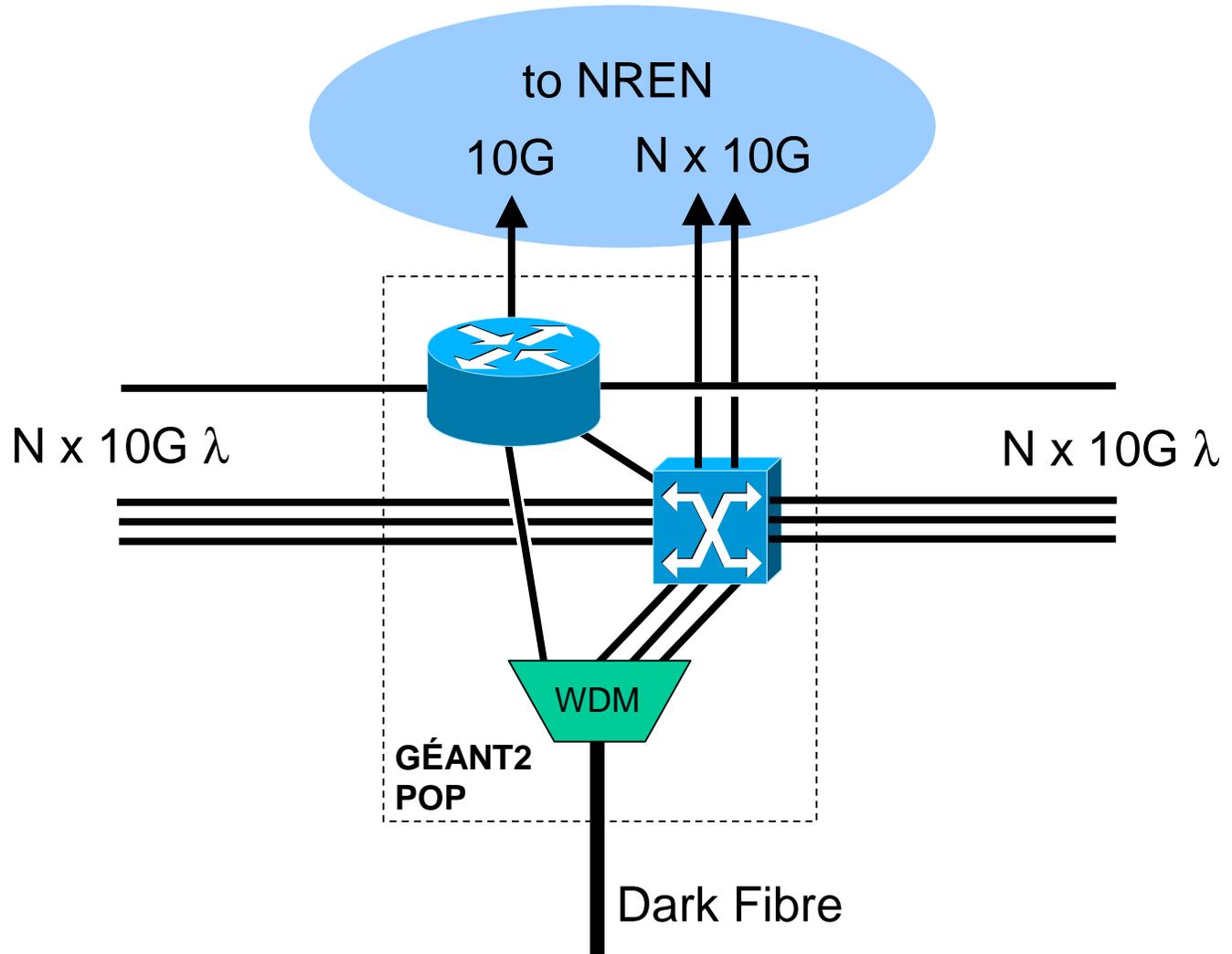
# GÉANT 2 Architecture

- Based on:
  - Dark fibre with multiple 10 Gbps lambdas
  - Leased 10 Gbps lambdas, if fibre not economic
  - Some lower bandwidth SDH links to the very expensive areas

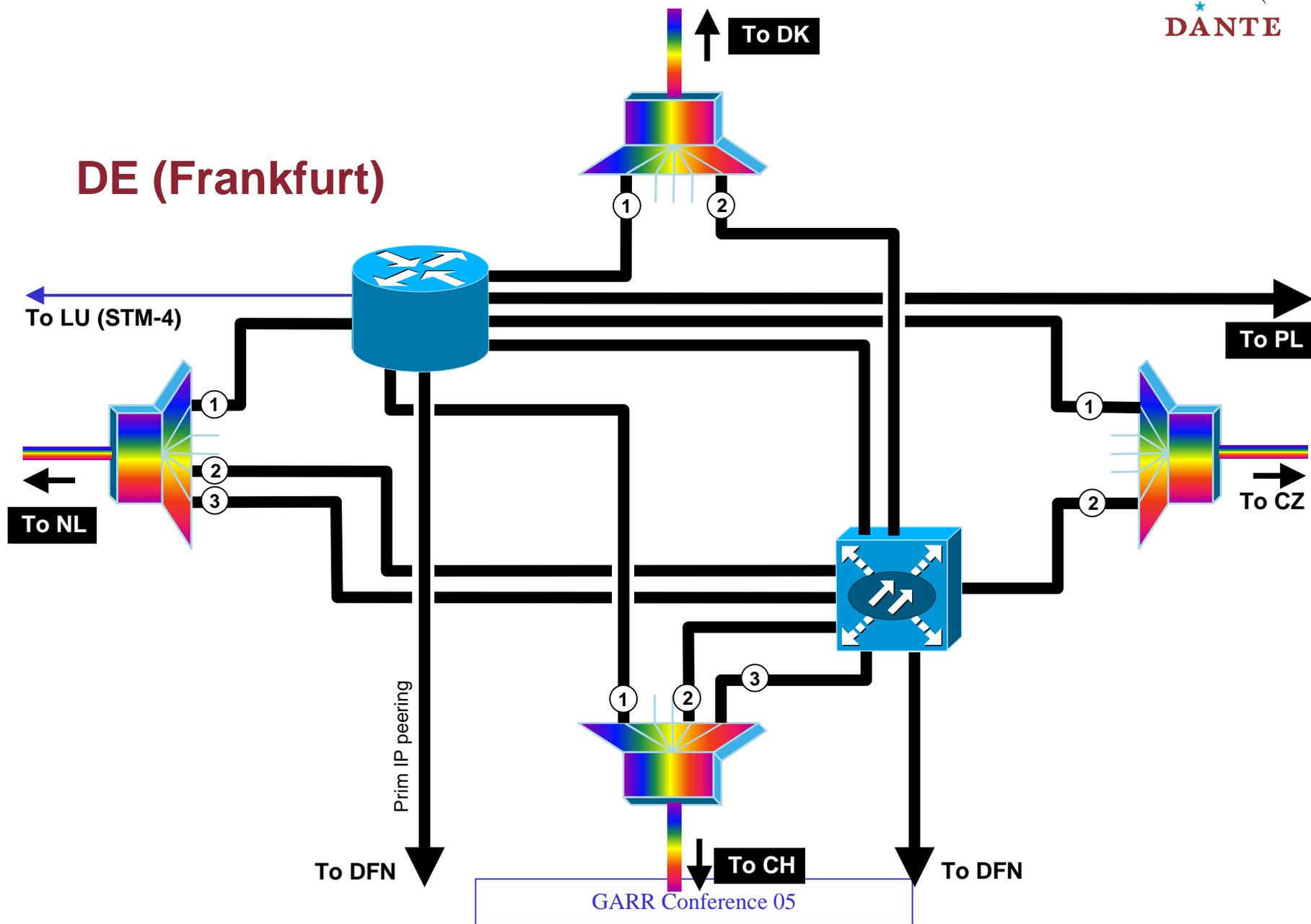
# Subscriptions

- All NRENs on “fibre cloud” subscribe to 10 Gbps IP service and 10 Gbps p2p service (to any point on the cloud)
- NRENs outside get basically 10 Gbps (or less) IP service
- Additional p2p accesses at marginal costs - for lighting additional lambdas in the system
- Topology independent - flat contributions

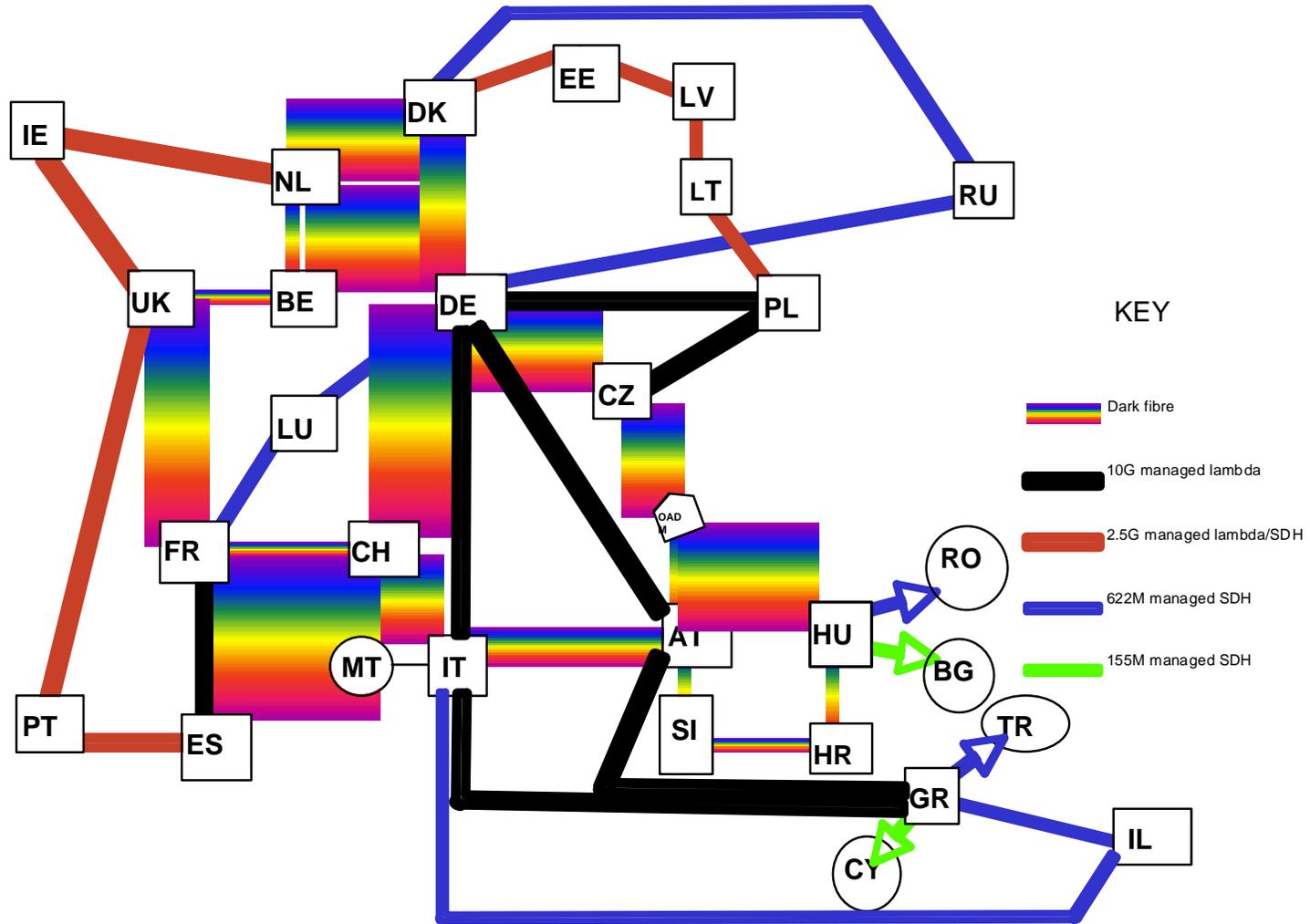
# A GÉANT2 Large Hybrid POP

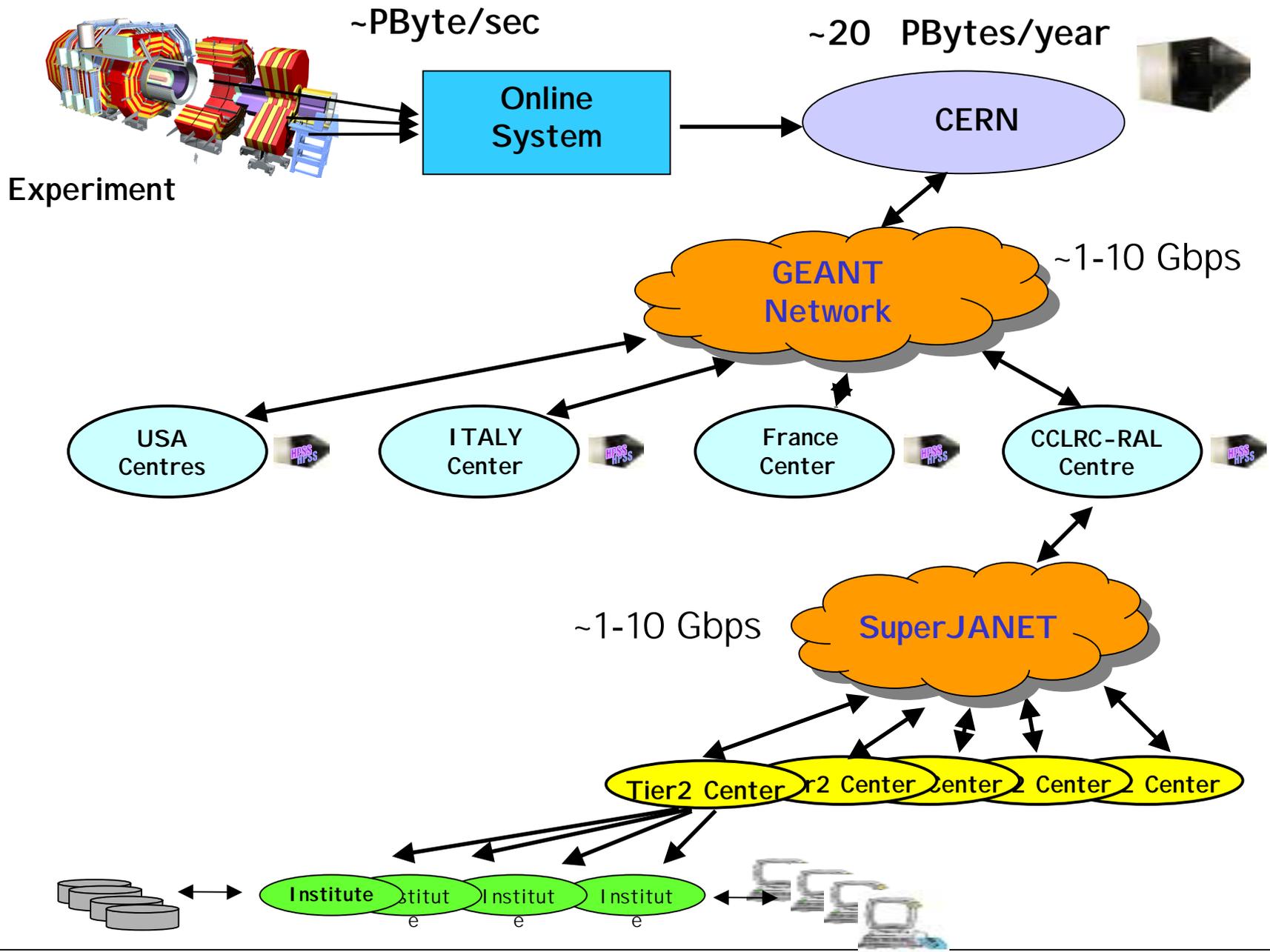


# DE (Frankfurt)



# Example of Overall Topology





# Schedule

- Procurement decisions mid 2005
- Gradual change from GÉANT to GÉANT 2
- Start of transition in Fall 2005
- 3 Years duration of the GN2 Project

# Conclusions

- R & E networks international from the very beginning
- The same spirit prevailing today even more
- To the benefit of the whole research community
- Our task - reduce the digital divide as much as possible