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EUROPEAN PARLIAMENT

*Scientific Technology  
Options Assessment*

**STOA**

# **Computer networks for research and education:**

## **A European success story – New challenges for policy makers**



April 2, 2008



# Research Networking & the Vision of the GÉANT2 Project

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***EARNEST Workshop on Computer Networks for Research & Education:  
A European Success Story – New Challenges for Policy Makers***

**Scientific Technology Options Assessment - STOA**  
**European Parliament, Brussels, April 2<sup>nd</sup> 2008**

# R&E Networking Model in Europe



- **A 3-tier Federal Architecture**, partially subsidized by National and EU Research & Education funds:
  - The Campus Network (LAN/MAN) > 3,500 Institutions, >30 M Users
  - The 34 NREN's (MAN/WAN)
  - The Pan-European Interconnection: **TEN34** → **TEN155** → **GÉANT** (GN1 in FP5) → **GÉANT2** (GN2 in FP6): **Hybrid Optical Backbone (+ Cross Border Fibers)** → **GÉANT3** (GN3 ? in FP7)
- **Total GN2 Cost: 40 M€/year** (co-funded by the EC and NREN's)

**GN2 EC Subsidy < 10% of total European R&E Networking Cost**

- **GÉANT Governance:** NREN Policy Committee
- **Project Management:** Exec, DANTE

# European NREN's – GÉANTn: A Growing Success Story - *Why?*



- Century old Telecom (+ 40 years ARPAnet - Internet) experience: Proven strong *“Network Externalities”* → Sharing tradition
- Industry needs for *Next Generation Network* proofs of concept, synergy with R&E community: The ARPAnet paradigm @ the US of America, inspiring the *“US of Europe”*
- **Foresight** of National + EU funding authorities, triggered by NREN planning – SERENATE, EARNEST Studies
- A decade (+) of success in serving R&E needs of the Continent → Smoothing-out *“digital divides”* & enabling powerful education communities (educators, students, pupils?)
- **Solidarity** – human networking within the NREN community
- Stable **Governance**: NREN Policy Committee (NREN PC)

# The NREN Policy Committee



- |   |  |
|---|--|
| <ol style="list-style-type: none"><li>1. Austria (<b>ACOnet</b>)</li><li>2. Belgium (<b>BELNET</b>)</li><li>3. Bulgaria (<b>ISTF</b>)</li><li>4. Croatia (<b>CARNet</b>)</li><li>5. Czech Republic (<b>CESNET</b>)</li><li>6. Cyprus (<b>CYNET</b>)</li><li>7. Germany (<b>DFN</b>)</li><li>8. Estonia (<b>EENet</b>)</li><li>9. France (<b>RENATER</b>)</li><li>10. Greece (<b>GRNET</b>)</li><li>11. Hungary (<b>HUNGARNET</b>)</li><li>12. Ireland (<b>HEANet</b>)</li><li>13. Israel (<b>IUCC</b>)</li><li>14. Italy (<b>GARR</b>)</li><li>15. Latvia (<b>LATNET</b>)</li><li>16. Lithuania (<b>LITNET</b>)</li><li>17. Luxembourg (<b>RESTENA</b>)</li><li>18. Malta (<b>UoM</b>)</li><li>19. Netherlands (<b>SURFNET</b>)</li></ol> | <ol style="list-style-type: none"><li>20. Nordic Countries – Denmark, Finland, Iceland, Norway, Sweden (<b>NORDUNET</b>)</li><li>21. Poland (<b>PSNC</b>)</li><li>22. Portugal (<b>FCCN</b>)</li><li>23. Romania (<b>RoEduNet</b>)</li><li>24. Russia (<b>JSCC</b>)</li><li>25. Slovakia (<b>SANET</b>)</li><li>26. Slovenia (<b>ARNES</b>)</li><li>27. Spain (<b>RedIRIS</b>)</li><li>28. Switzerland (<b>SWITCH</b>)</li><li>29. Turkey (<b>ULAKBIM</b>)</li><li>30. United Kingdom (<b>UKERNA</b>)</li></ol> <p><u>PLUS NON-VOTING MEMBERS:</u><br/>Delivery of Advanced Network Technologies to Europe Ltd. (<b>DANTE</b>)<br/>Trans-European Research &amp; Education Networking Association (<b>TERENA</b>)</p> <p>PERMANENT OBSERVERS: <b>CERN, AMRES, MARNET</b></p> |
|---|--|

# NREN's & GÉANTn: e-Science Enablers + Networking R&D Platforms



- NREN's – GÉANT2/3 provide cost effective **e2e switched & light path connectivity** within the Dark Fiber Cloud (DWDM footprint)
  - + Global **IPv4 – IPv6 coverage** and **Hybrid** networking services
  - + Multi-domain Network management, resiliency & support
- *e-Science* (GRID) Virtual Organizations obtain, production quality hybrid networking, beyond leasing individual circuits, wave-lengths or dark fibers
- *e-Infrastructures* as equalizers, reduce the **DIGITAL DIVIDES** in Europe & globally: **Big Science affordable via virtual e-Science**
- NRENs – GÉANT stimulate **Network Research** & enable novel concept evaluation - **emulations** in a global production environment via virtualization of facilities & services

# Bandwidth Requirements per User

SERENATE Study Final Report, 2003

*Cees De Laat, David Williams et. al.*



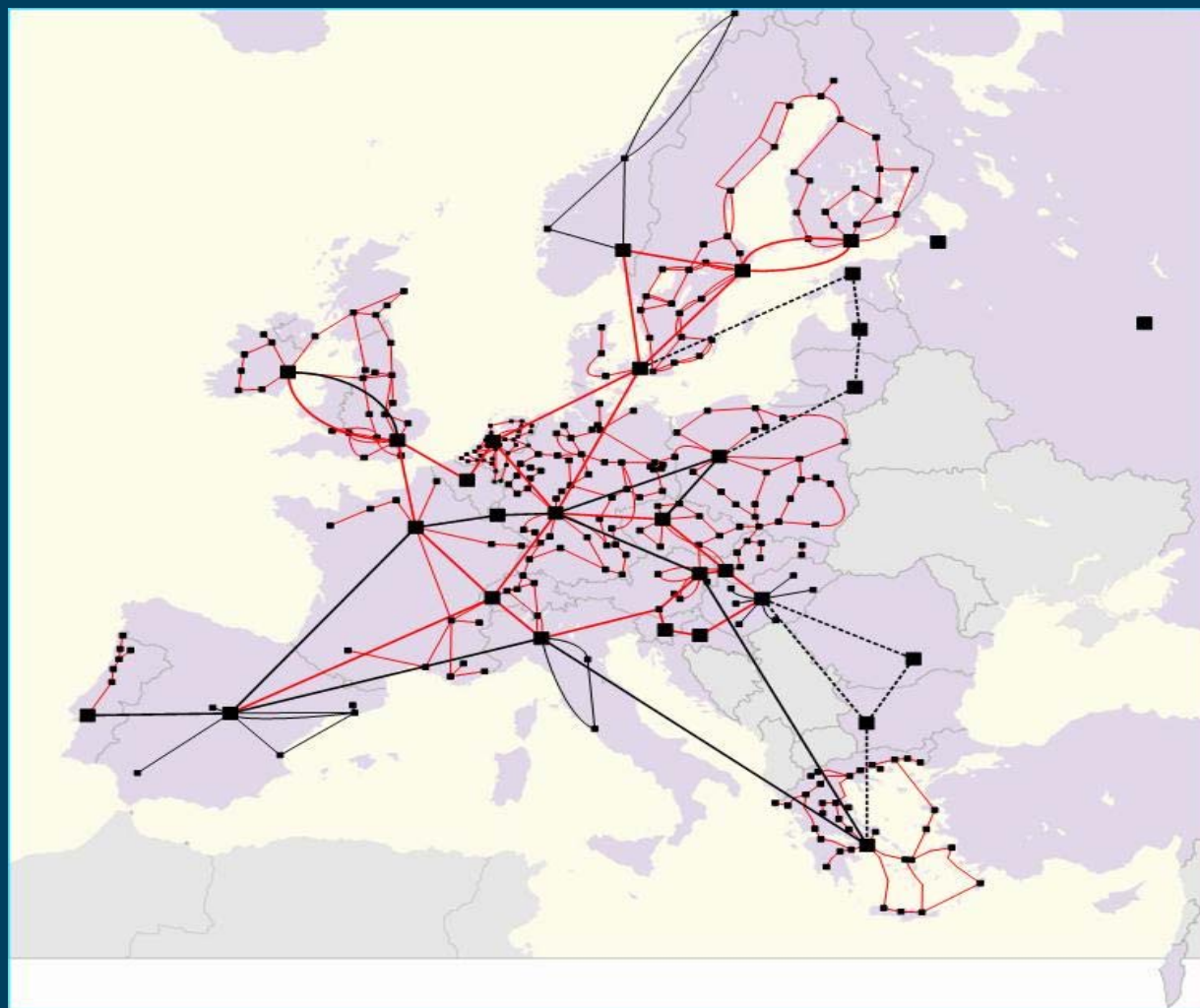
# of users



ADSL

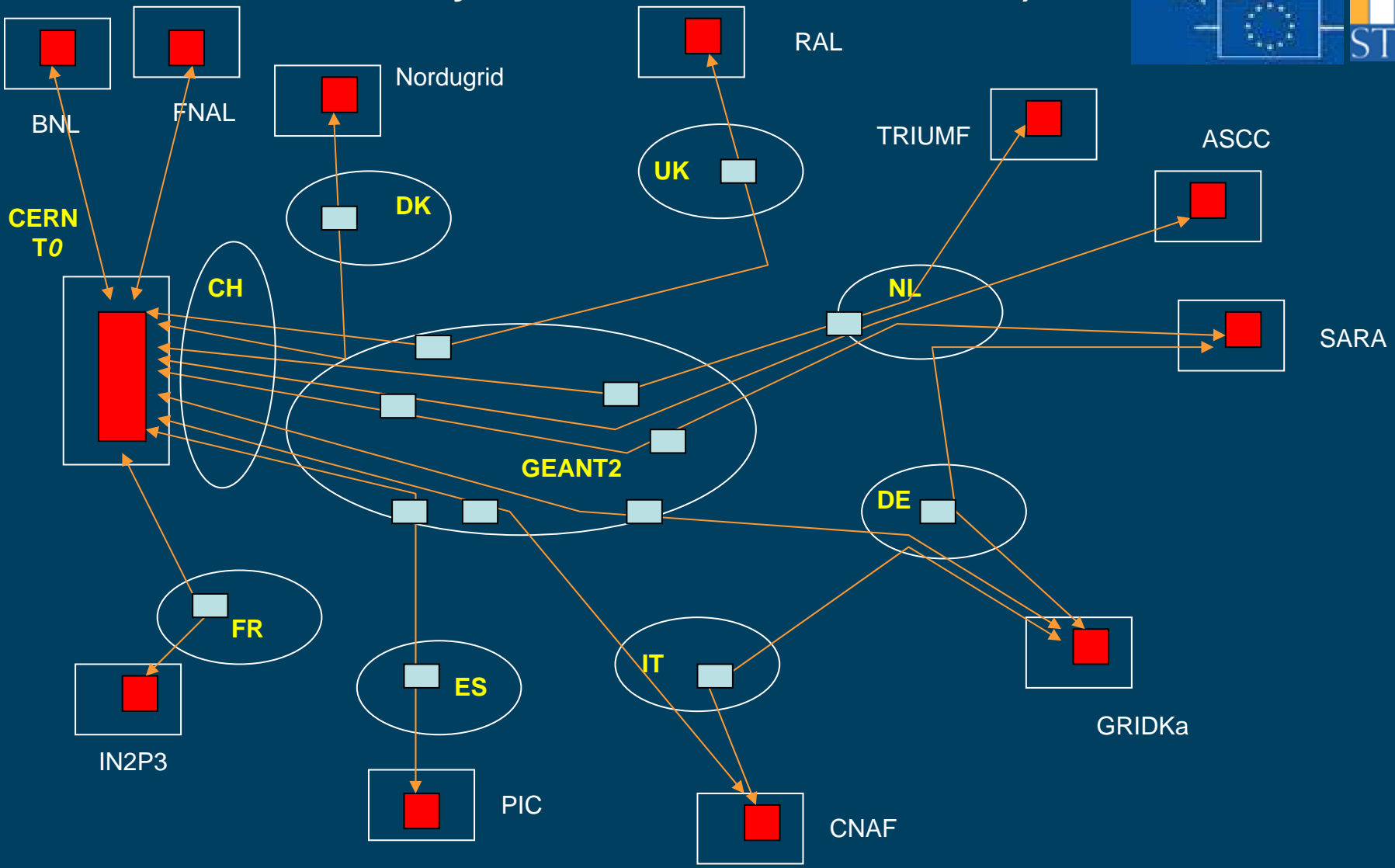
GigE

# European R&E 10 Gig+ Footprint, March 2008 (based on data by *DANTE* & *NRENs*)



Enables  
end-to-end  
**Hybrid Networking** &  
Optical Private  
Networking (**OPNs**) for  
**e-Science Projects**

# LHC TIER0 – TIER1 Optical Private Network - OPN, (Scenario based on work by *Roberto Sabatino* DANTE CTO)

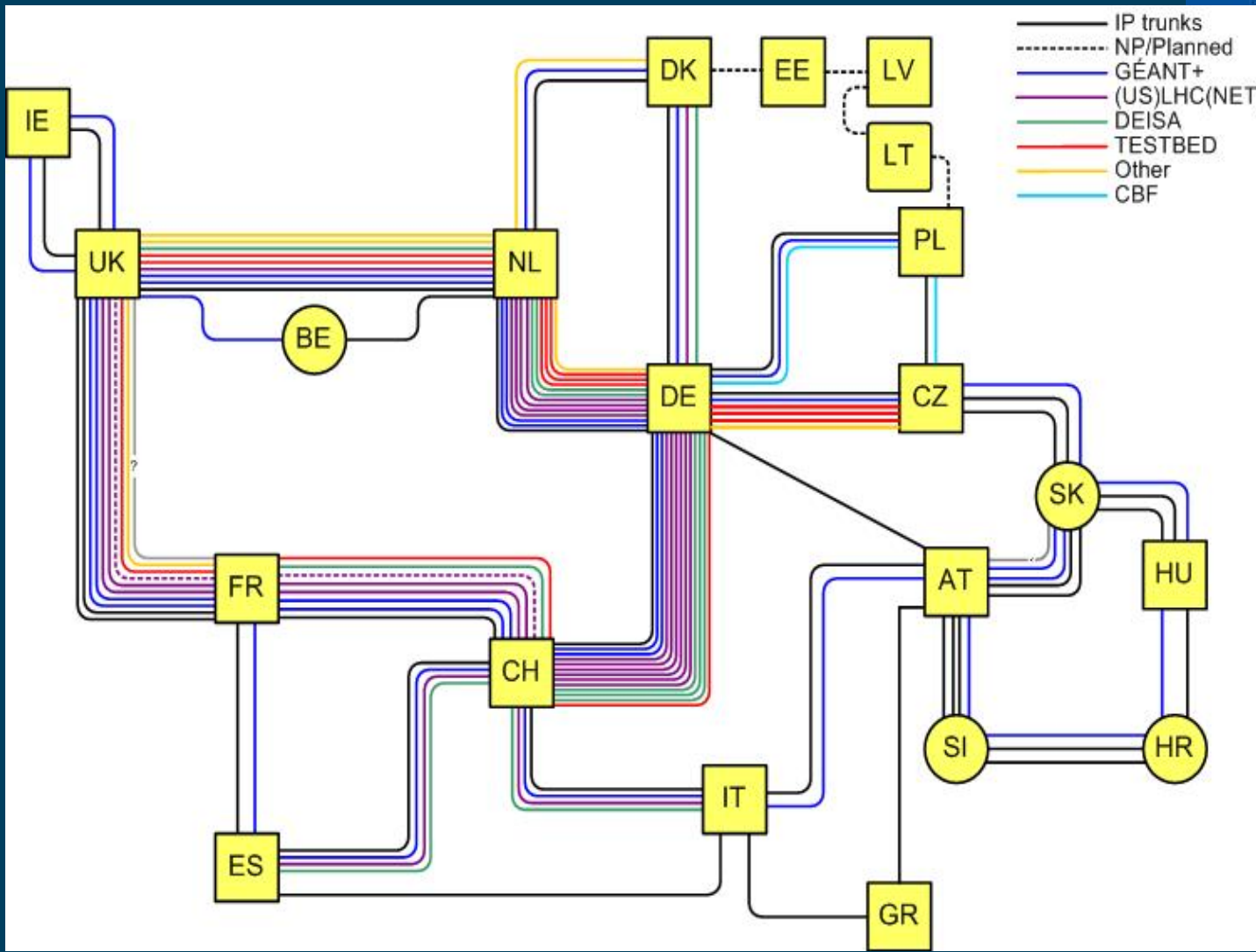


NTUA – NATIONAL TECHNICAL UNIVERSITY OF ATHENS



# Wavelengths on GÉANT2 - February 2008

(based on presentation by *Hans Döbbling* DANTE G.M.)



# Is there Life after GÉANT2 ?



- Advances in networking & ICT technologies:
  - Enable **terabit** optical networking
  - Introduce revolutionary backbone network design trends
  - Point towards converged ICT infrastructures & services, virtualization
- **Time is ripe for Europe to profit from its long-term investment on R&E Networking**
- GÉANT is a yardstick for global initiatives
  - USA, Internet<sup>2</sup>: Accelerated hybrid networking development (HOPI → DCN, Dynamic Circuit Network)
  - DICE Group (GÉANT2/3 via *DANTE*, *Internet2*, *Canary*, *ESnet*)
- Growing **global role & commitments** of the GÉANT community

# GEANT2 At the Heart of Global Research Networking



★ Connect ★ Communicate ★ Collaborate

# GÉANT3: A factory of (virtualized) networking resources & services (1/2)

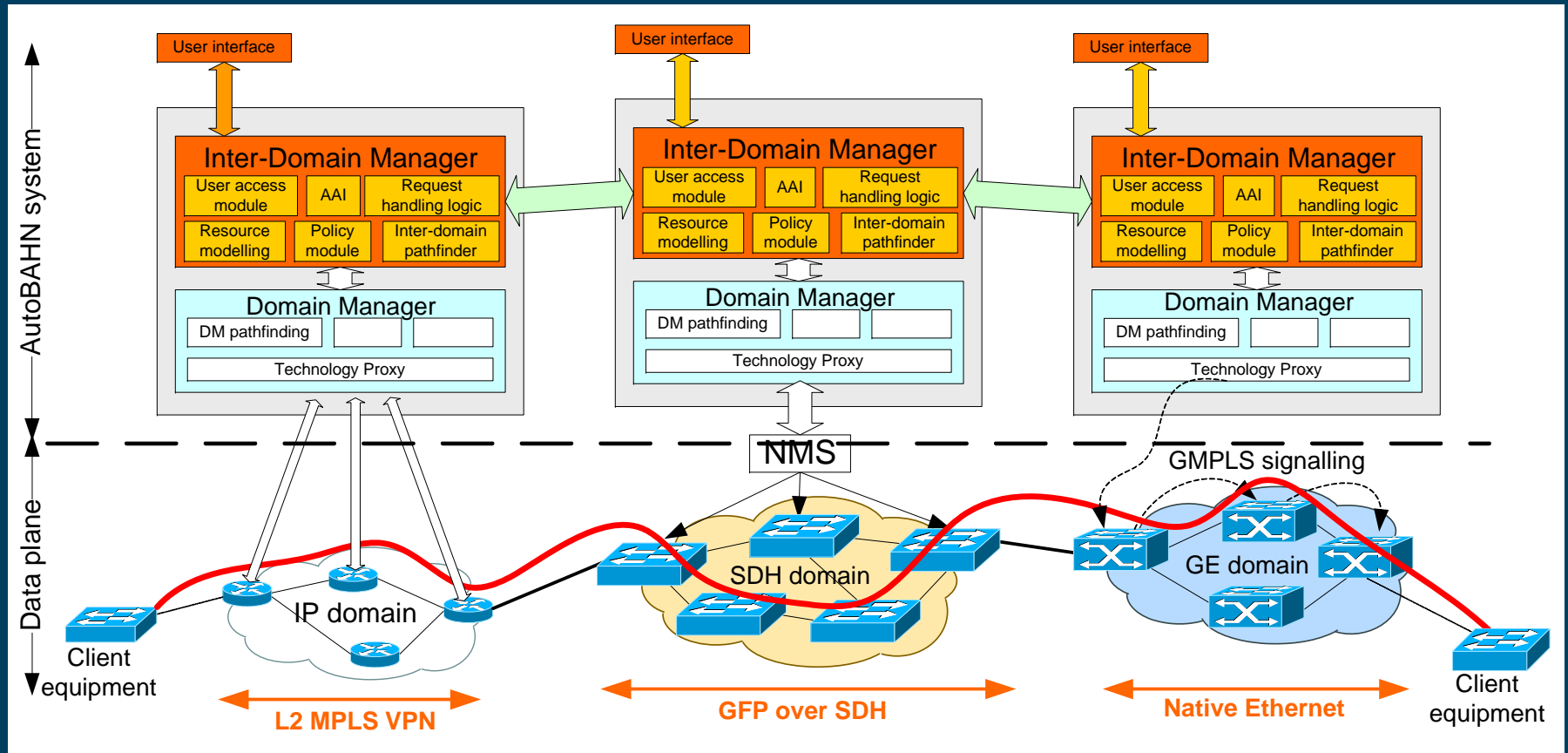


- Extending the service portfolio to production quality multi-domain hybrid networking
  - Campus, NRENs, GÉANT3...
  - Innovate to resolve the multi-domain automated control impasse:

*Note that there have been up to now only TWO inter-domain control plane (signaling) success stories: SS7 (telephony) & BGP (Internet)*

- Translating into a common view an enriched set of per-domain information, feedback to standardization bodies (IETF, OIF, OGF)

# Example of Multi-Domain Services: AutoBAHN, GÉANT2 Automatic Bandwidth Provisioning (based on a presentation by *Afrodite Sevasti*, GRNET)



# GÉANT3: A factory of virtualized networking resources & services (2/2)



- Extend the NREN – GÉANT Services to provision of integrated IT services that include:
  - Multi-domain hybrid networking services
  - Storage (?)
  - Computing (?)
- Converging e-Infrastructures
  - Relationship with Grid – Supercomputing
  - Towards **cloud** computing aka. Google, Amazon, IBM...?
  - Now more than ever the **NETWORK IS THE COMPUTER**

# GÉANT3 & its Global Peers: Help shape the Internet of the future



- GÉANT3 will be a key player in European & Global initiatives on the **Network of the Future**
  - US Initiatives
    - GENI <http://www.geni.net/> (clean slate)
    - VINI <http://www.vini-veritas.net/> (on Internet2, NLR)
  - Japanese Initiatives
    - AKARI <http://akari-project.nict.go.jp/eng/index2.htm>
  - European Initiatives
    - FEDERICA <http://www.fp7-federica.eu/> (on GÉANT2, NRENs)
    - FIRE ICT Projects <http://cordis.europa.eu/fp7/ict/fire/>

# Summarizing the GÉANT3 Vision



- To create an innovative **multi-domain hybrid networking** environment, using advanced transmission & switching technologies
- To enable R&E users through their Organizations with **flexible and scalable production quality services** via their constituent NRENs
- To be an enabler for Global R&E networking supporting international e-Science initiatives, creating a **Global Virtual Village** to house researchers & educators around the world
- To contribute to standards as a key participant in European & Global efforts towards the **Network of the Future**

# *ICT e-Infrastructures:* A CONCERTED EUROPEAN EFFORT



Research Networking & HPC/GRID communities common mission:

Provision of leading edge *e-Infrastructures* for Research & Advancement of HPCN technologies as **European added value**