

NRENs and GÉANT: Europe's Research & Education Community Road towards ICT Convergence

The Future Internet is Present in Europe

Vasilis Maglaris

Professor of Electrical & Computer Engineering, NTUA
Chairman, NREN Policy Committee - GÉANT Consortium

maglaris@netmode.ntua.gr

e-IRG Workshop

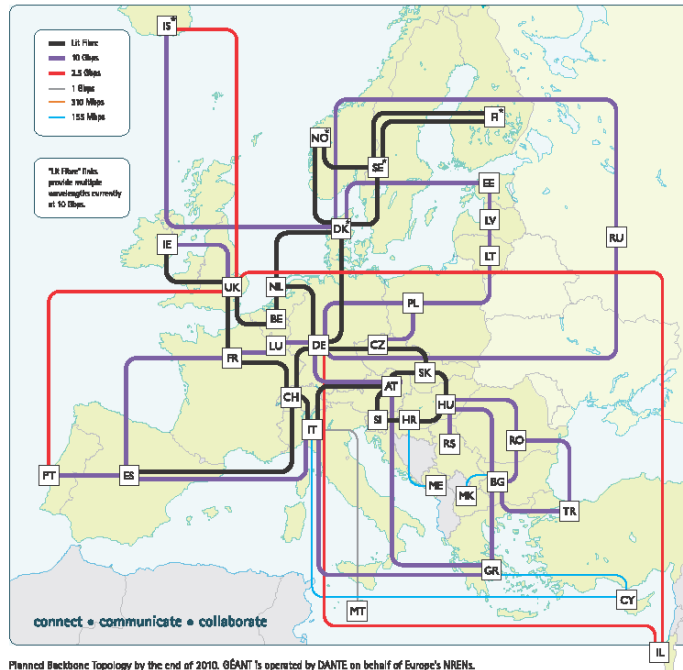
April 5th 2011

Budapest, Hungary



The GÉANT Service Area

GÉANT the pan-European
research and education network
Transforming the way users collaborate



GÉANT is co-funded by the European Commission within its 7th REID Framework Programme.

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GÉANT COST: 40 M€/year (equally shared by EC and NRENs)

- Not just the GÉANT backbone
- Federated services via **37 NRENs** and **4000+ Campuses** to **50 M+ users**

Total European R&E Networking Cost:
International (GÉANT) / National (NREN) /
Campus Costs follow the 1/10/100 rule

GÉANT★ At the Heart of Global Research Networking

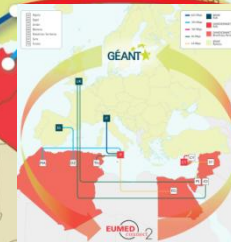
- GÉANT Coverage
- ALICE2-RedCLARA Network
- EUMEDCONNECT2 Network
- TEIN3 Network
- BSI Network
- UbuntuNet Alliance



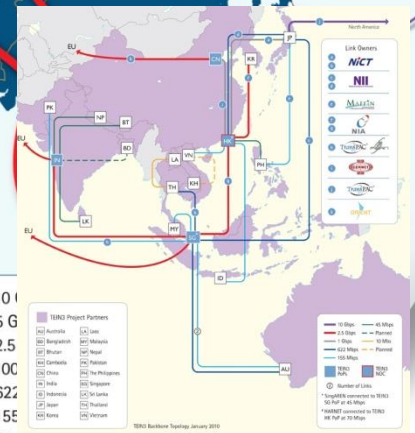
GÉANT★

ORIENT

BSI



• AfricaConnect



GÉANT and sister networks enabling user collaboration across the globe

December 2009

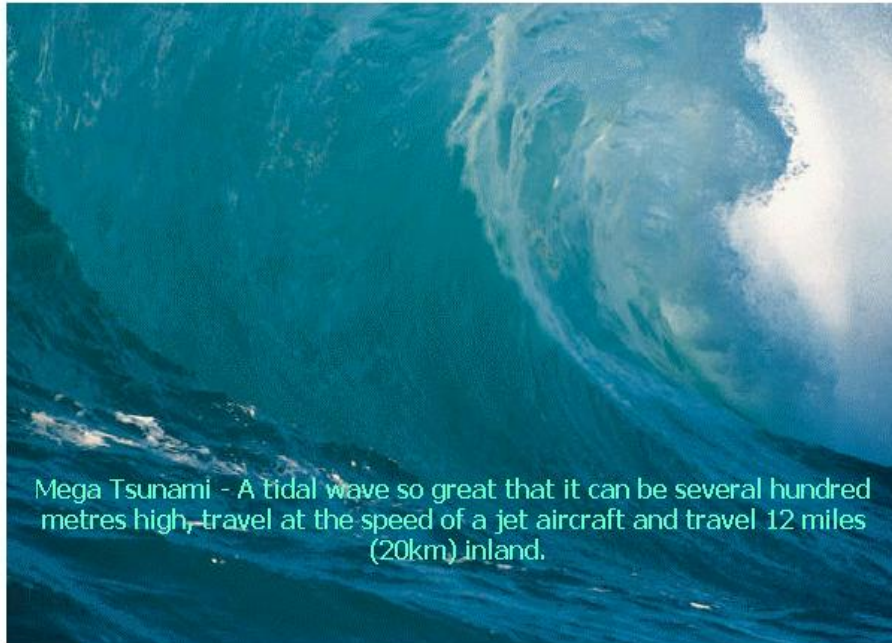
connect • communicate • collaborate

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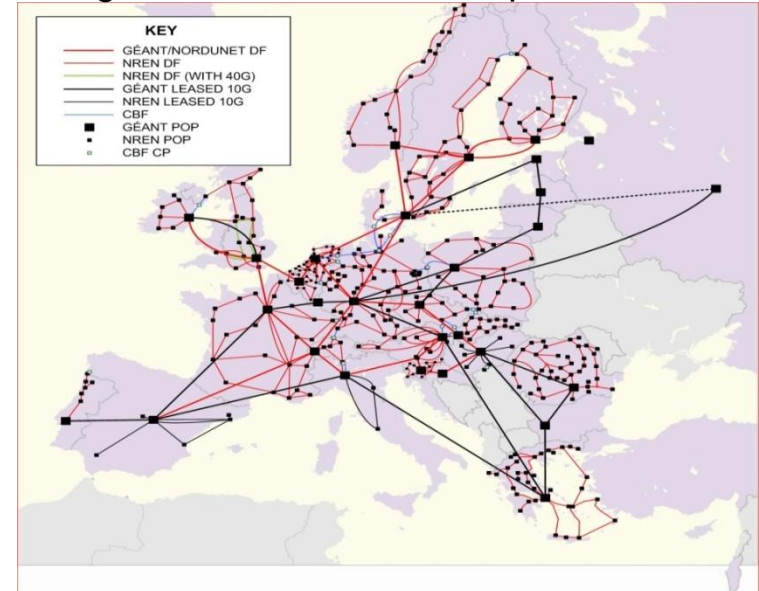


The Key Challenge for NRENs - GÉANT: A Tsunami of Global High-End Requirements



Mega Tsunami - A tidal wave so great that it can be several hundred metres high, travel at the speed of a jet aircraft and travel 12 miles (20km) inland.

10 Gig+ NREN – GÉANT Footprint, June 2009

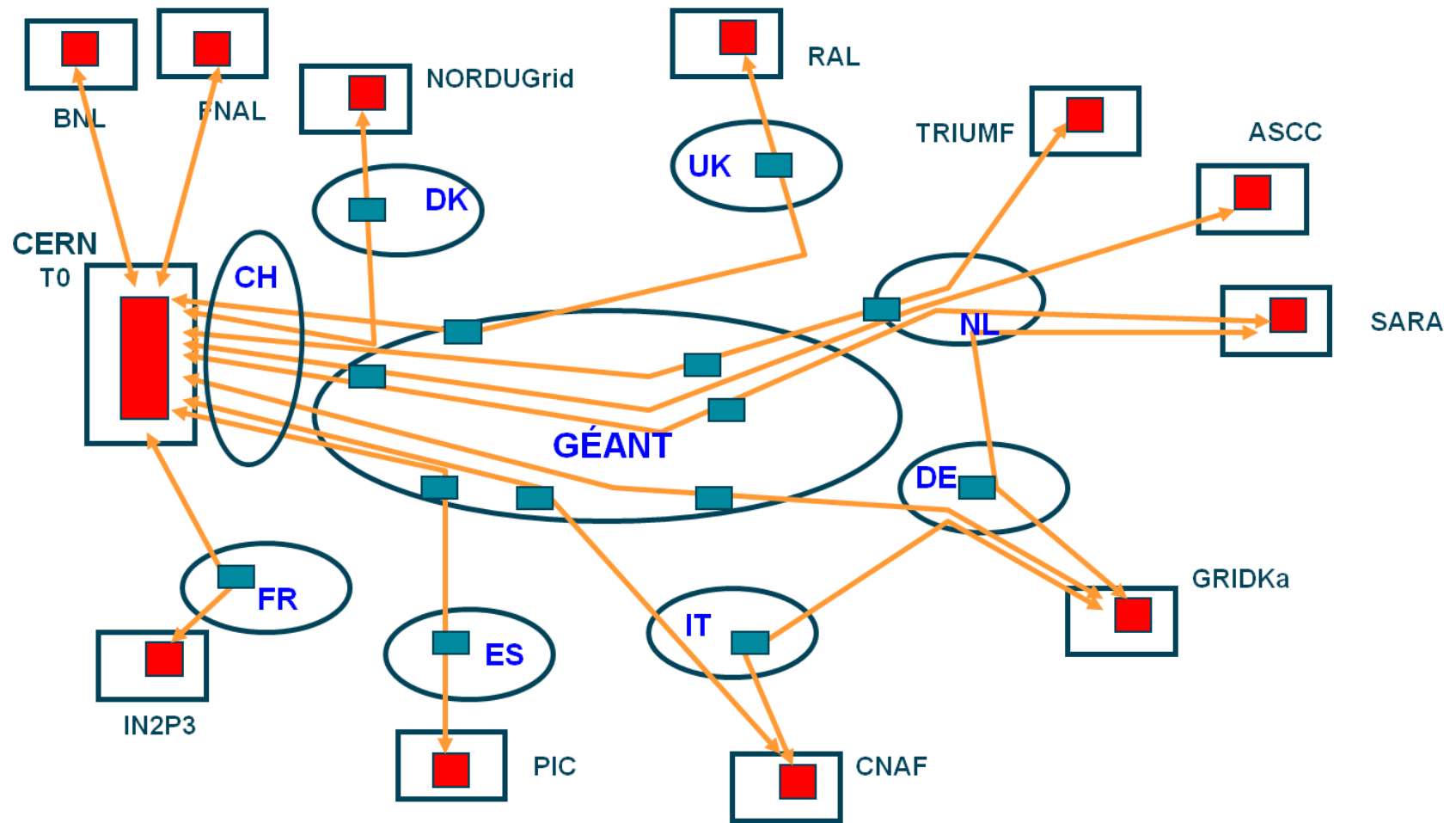


High-End Users (HPC, CERN, ITER,...) require stable production services:

- Provisioning 10-40-100 Gbps networks (DWDM over dark fiber, leased λ)
- Meeting robustness, reliability, security requirements
- Enabling multi-domain e2e monitoring & on-demand hybrid resource allocation
- Managing converging e-infrastructures as a High Performance Computing & Networking (HPCN) Cloud → **Future Internet (FI) Services & Applications**



LHC Tier0 – Tier1 Optical Private Network





ITER Proposed Connectivity





Convergence & NRENs

- All **IP** networking: CPE - Local access (wireless/wired), Optical MANs – Backbones, tunnels...
- Holistic seamless services: Ubiquity, roaming, (delegated) access control, (flow based) virtualization
- Federated control & management planes: **Multi-domain NOCs, composite services**
 - Towards a ubiquitous, secure, scalable multi-domain PaaS (Platform as a Service), beyond **BGP** & **SS7** legacy protocols
- NRENs – GÉANT: An instantiation of converging Next Generation Networks → **Future Internet** platforms

NRENs – GÉANT: Innovators in the Years of Convergence via the GN3 Project



- GN3 SA1/JRA1: Optical networking (OPNs, 100 Gig...), concatenation of L1, L2, L3 (virtual) circuits across domains
- GN3 SA2/JRA2: Multi-domain **laaS** (Infrastructure as a Service), monitoring, bandwidth on demand, hosting of virtualized resources aka NRENs/GÉANT & FEDERICA, Internet2 & GENI
- GN3 SA3/JRA3: Composite **federated end-user services**, roaming profiles – Eduroam, coordinated access control - Edugain, sharing of Virtual Conferencing facilities (+ Data Centers → R&E clouds?) across Europe
- GN3 SA4: Software **governance** for a complex service-oriented orchestration
- GN3 NAs: Supporting the **NREN ecosystem (CAMPUS ???)**



Sustainability of FI Experimental Platforms

- A concern in the times of crisis but FI Research is a **high-risk strategic investment**
- Advanced Internet-based e-Infrastructures perceived as **creative commons** and a **stimulus to recovery**: Obama's initiative & EU FI PPP...
- **Some problem areas:**
 - **Subsidiarity** between Federal (EC) & National policies
 - Selection of Projects based on periodic peer reviews (spirals), **old boys networks**
 - **Synergies** with major vendors (Cisco, Juniper, NEC, HP...) and Cloud SPs (IBM, Google, SAP...); **IPRs & openness**
 - Emphasis on attracting **end-users**: EU Living Labs & FIRE Integrated Projects Open Calls (up to 250 K Euros/year per “user”)



Sustainability Factors (1/2)

- Sustainability depends on active endorsement of **diverse user communities** (beyond ICT researchers)
- **Users** need to understand (and appreciate) the benefits and economic incentives in using multifaceted, holistic FI platforms
- Priorities, requirements and budgetary constraints of users need to guide **planners/providers** of FI platforms (e.g. user-friendly open interfaces, policies for QoS delivery reproducibility of experiments)



Sustainability Factors (2/2)

- FI converged platforms should attract users by developing – deploying user friendly tools, based on **efficient resource allocation algorithms** (e.g. Virtual Network Embedding), **monitoring schemes** (slice and substrate oriented) and **novel information models** (e.g. ontologies assisting users to locate and compose virtualized resources in a distributed FI environment)
- **Operational costs** should be assured, required for seamless infrastructure support (and hardware – software upgrades)
- Well defined **SLAs** and broadly acceptable **pricing models** are required, in line with legacy Service Provider practices



Federation is tightly related with Sustainability

The FI will be a shared multi-domain ecosystem where:

- Users should be able to run their applications/experiments by dynamically **selecting diverse slivers** within a slice (basket) of the federated FI facility
- Federated FI facilities should be able to upgrade their scope by incorporating additional testbeds, thus attracting a wider user base: Need for **open, scalable federation architectures** (bases: PlanetLab **SFA**, Panlab **Teagle**)
- Synergies with established advanced **R&E e-Infrastructures** should be exploited:
 - In the US **Internet2, NLR** are used as backbone facilities for GENI infrastructures – e.g. OpenFlow testbeds, VINI...
 - In Europe, **NRENs - GÉANT** can provide support for advanced connectivity services amongst European virtualized infrastructures
 - In Asia-Pacific advanced R&E networks provide virtualized platforms, interconnecting FI testbeds
- Plan towards a **global federated environment for FI experiments**

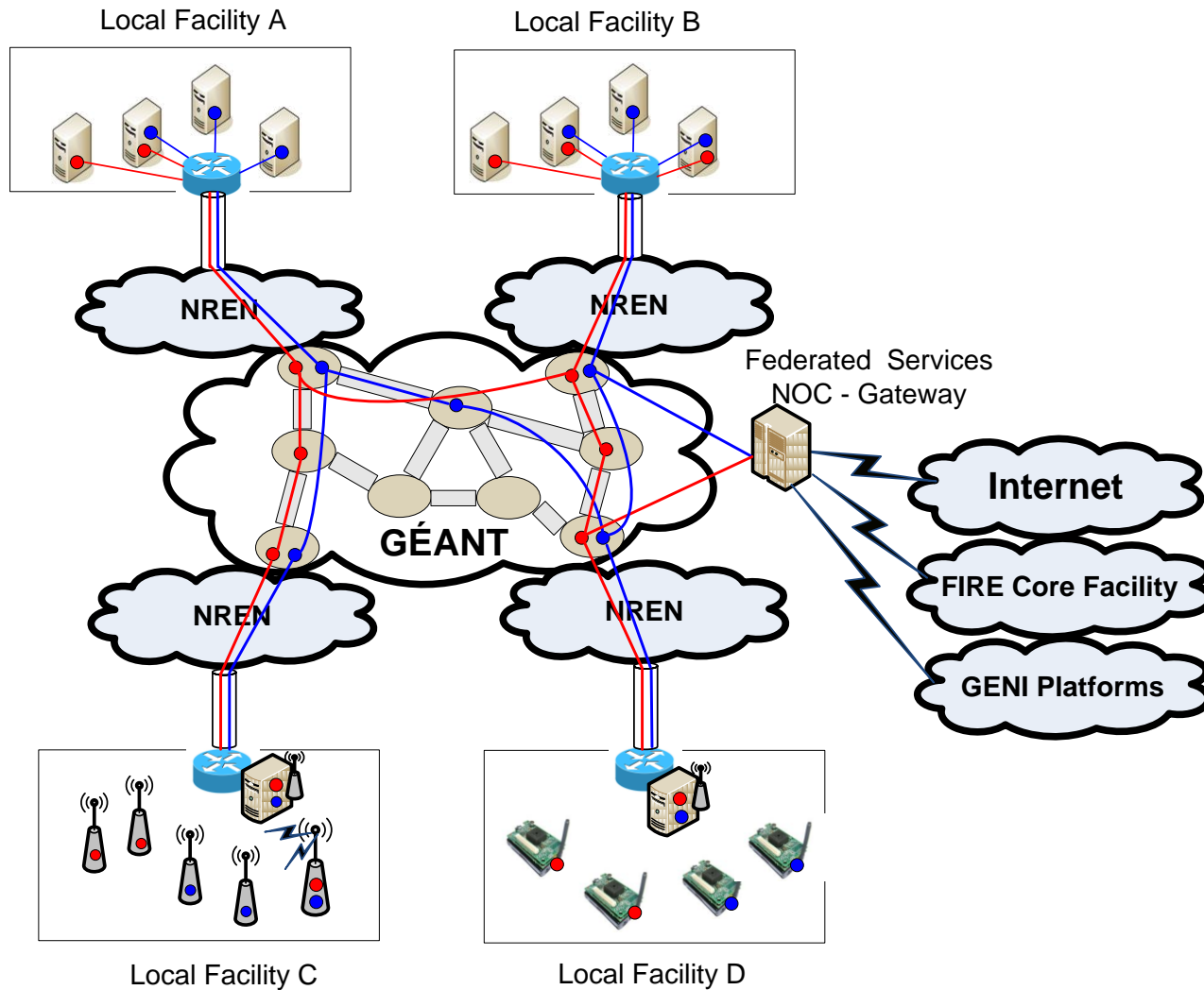


Future Internet Experimental Research: An Opportunity for NRENs

- **Requirements:**
 - Sharing optical backbones & housing for FI experiments
 - Emulating real-world conditions
 - In isolation from production traffic (slicing, virtualization)
 - Interconnection of local testbeds (e.g. OpenFlow, wireless labs)
- **NRENs as infrastructure providers & innovation brokers:**
 - In **Europe**: FI Private-Public Partnership (PPP) & FIRE → provisioning of NREN – GÉANT facilities (e.g. FEDERICA)
 - In the **US**: GENI experimental platforms → provisioning of Internet2, NLR, ESnet, RON facilities (e.g. VINI)
 - In **APAN**: SINET (JP), CERNET (CN), KOREN (KR), AARNet (AU),...



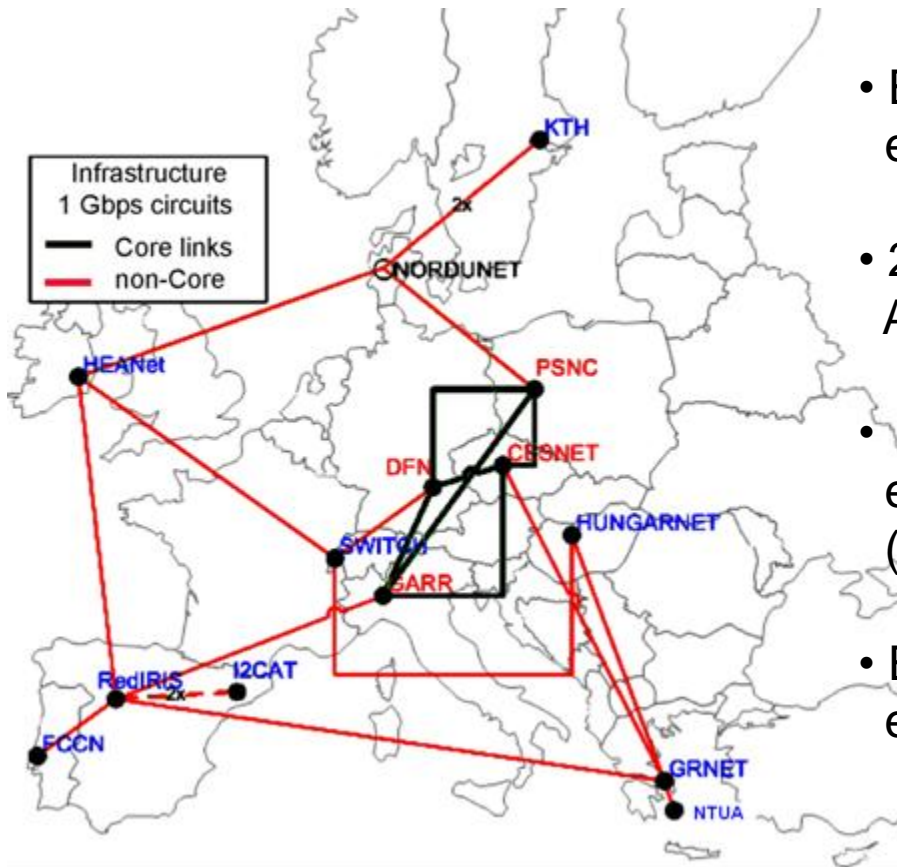
Virtualization over GÉANT - NRENs



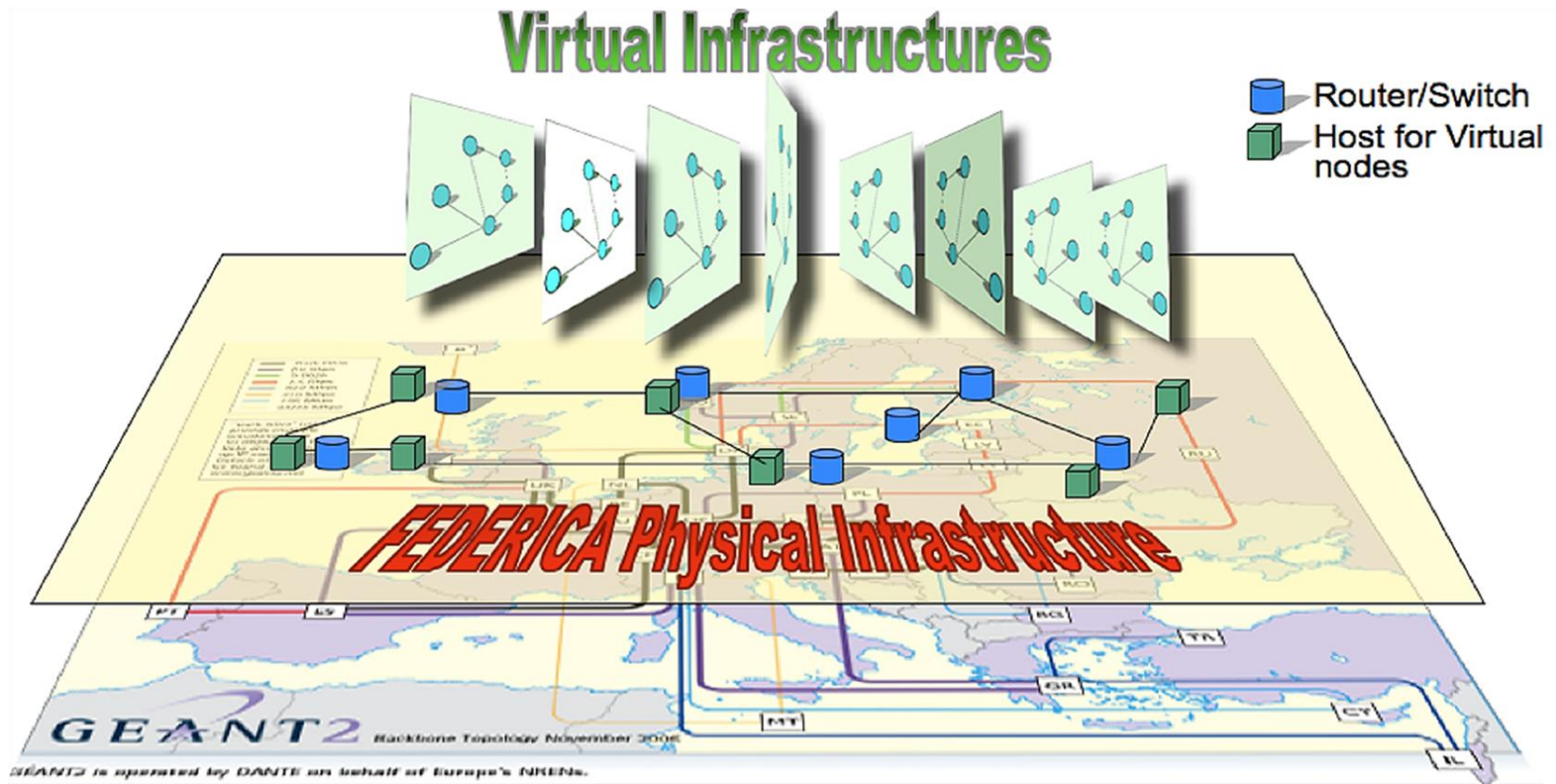
A Research Infrastructure Project: **FEDERICA**

Federated **E**-infrastructure **D**edicated to **E**uropean **R**esearchers
Innovating in **C**omputing network **A**rchitectures

- EC FP7 – Capacities (DG INFSO-F, e-Infrastructures/GÉANT Unit)
- 20 Partners (NRENs, DANTE, TERENA, Academic & Research Institutions, Industry)
- Provide FI researchers with virtualized experimental facilities as user slices (Infrastructure as a Service)
- Enable emulations in a controlled environment → reproducibility

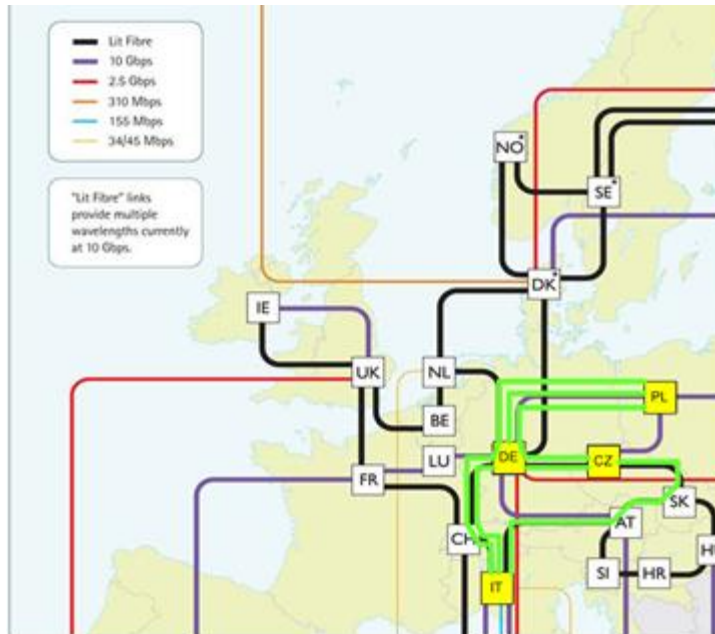


The FEDERICA Concept

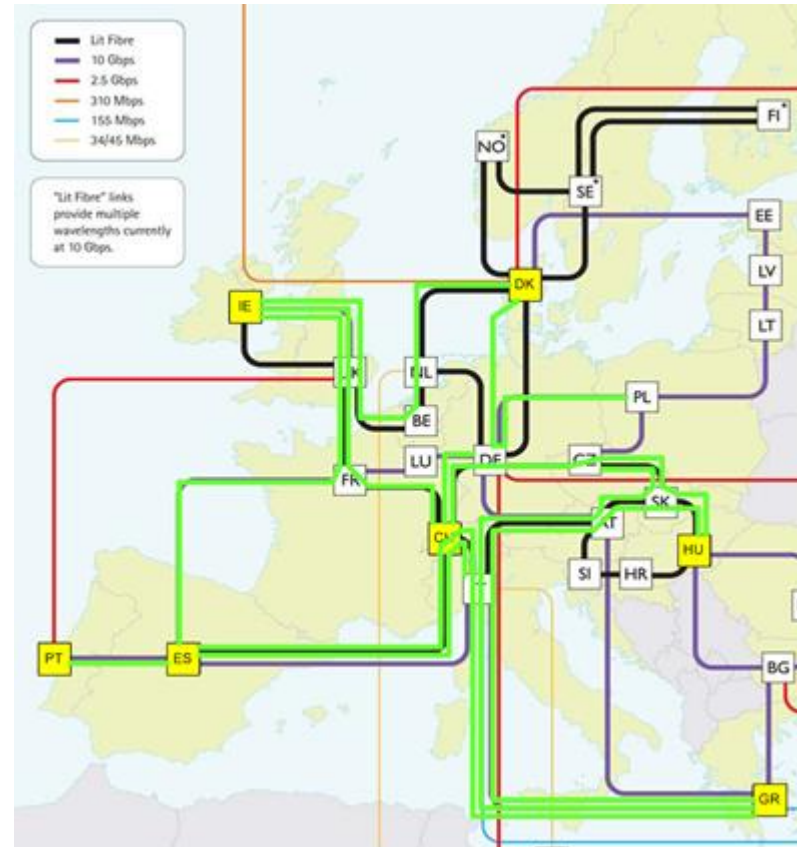


GEANT2 and NRENs Infrastructure

FEDERICA usage of GÉANT+ 1Gbps Circuits



Core Site Connectivity



Non-core Site Connectivity

Selected FEDERICA User Slices

OneLab/PlanetLab Europe: The proof of concept slice
(ELTE *Hungary*, KTH *Sweden*)

OpenFlow: The protocol experiment slices (Friedrich -
Alexander University *Germany*, KTH *Sweden*, GARR
Italy, Stanford University *USA*)

G3 system: The monitoring test slice (CESNET *Czech Republic*)

Phosphorus: The scalability study slice (i2CAT *Spain*,
PSNC *Poland*)

The FEDERICA Consortium

(FEDERICAII Proposed Additions in *Red/Italics*)

National Research & Education Networks

CESNET	Czech Rep.
DFN	Germany
FCCN	Portugal
GARR (<i>coordinator</i>)	Italy
GRNET	Greece
HEAnet	Ireland
NIIF/HUNGARNET	Hungary
NORDUnet	Nordic countries
PSNC	Poland
Red.es	Spain
<i>RENATER</i>	<i>France</i>
SWITCH	Switzerland

Small Enterprise

Martel Consulting	Switzerland
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NREN Organizations

TERENA	The Netherlands
DANTE	UK

Universities - Research Centers

i2CAT	Spain
<i>IBBT</i>	<i>Belgium</i>
KTH	Sweden
NTUA (ICCS)	Greece
<i>Univ. of Essex</i>	<i>UK</i>
UPC	Spain
PolITO	Italy

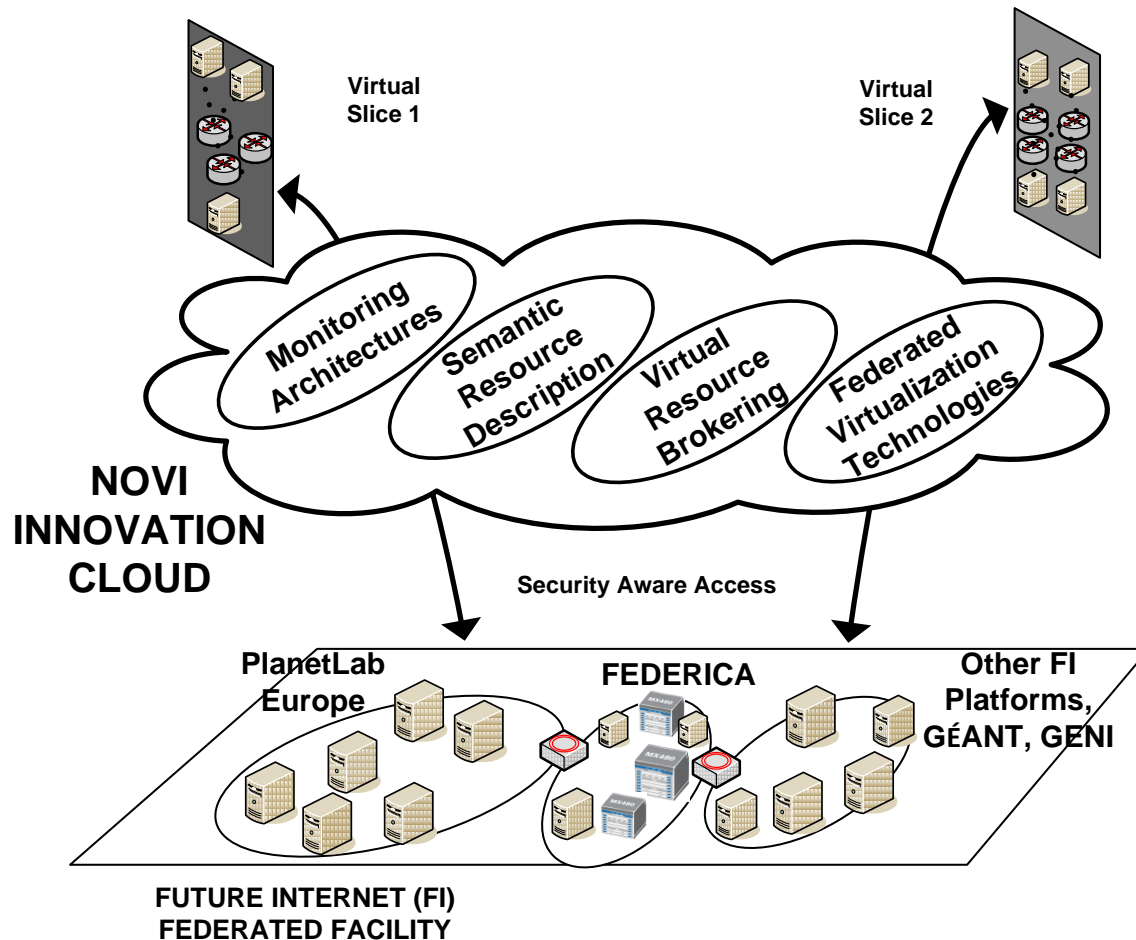
System Vendors

Juniper Networks	Ireland
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A FIRE Research Project: *NOVI*

*N*etworking innovations *O*ver *V*irtualized *I*nfrastructures



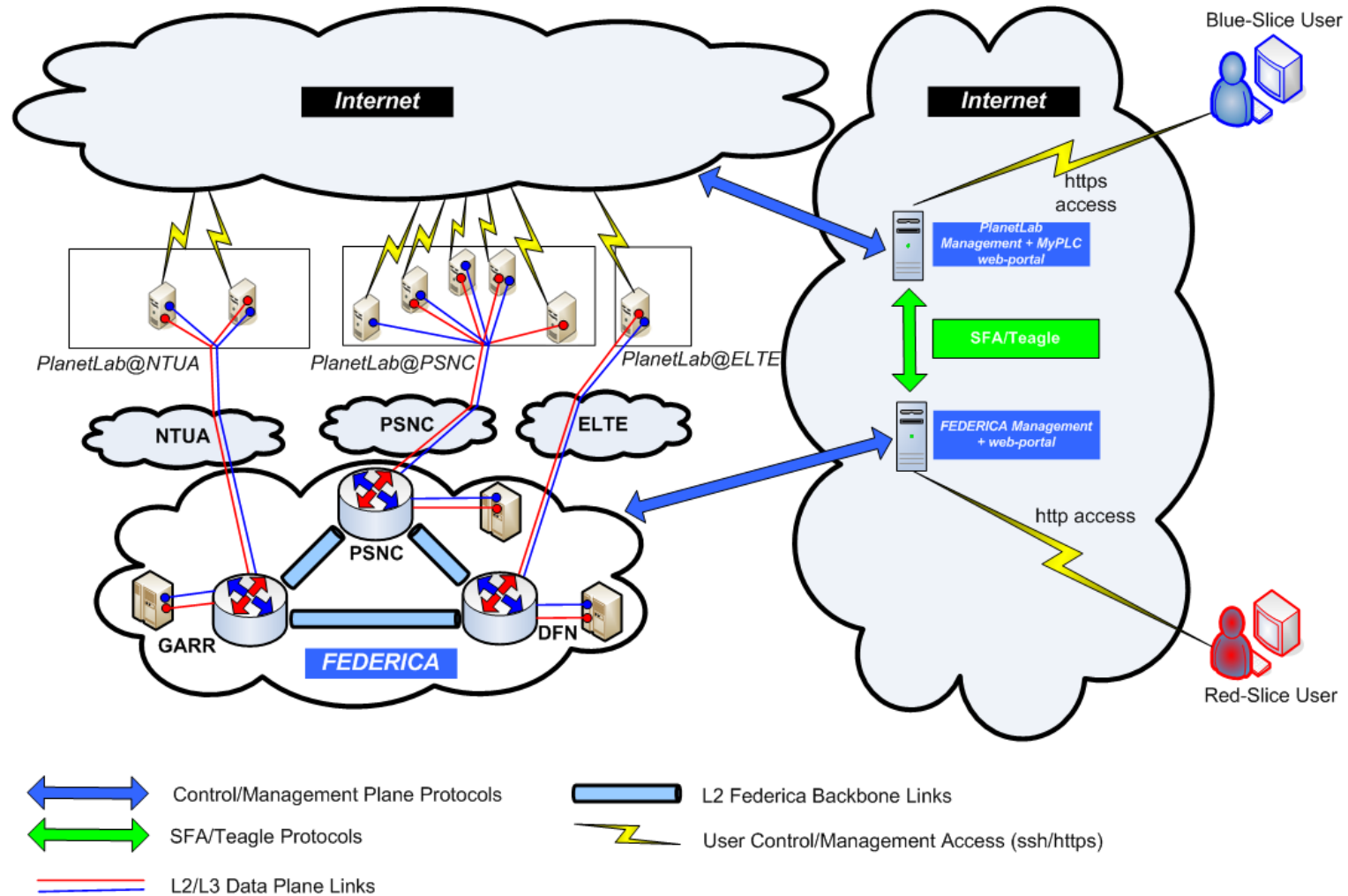
- EC FP7 – Cooperation (DG INFSO-F, FIRE Unit)
- 13 Partners (NRENs, Academic & Research Institutions, Industry)
- 30 Months (starts Sept. 2010)



The NOVI Consortium

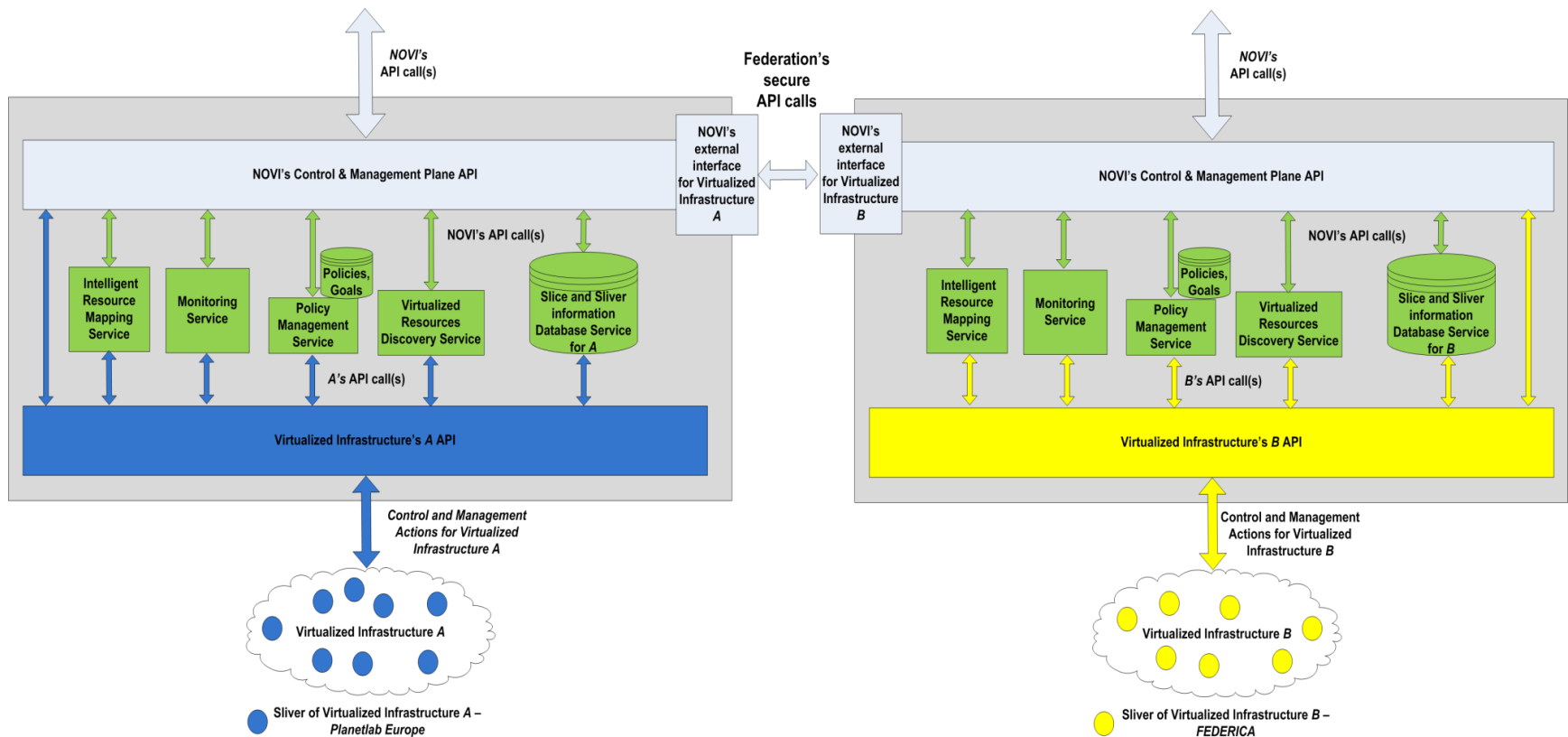
1. National Technical University of Athens - **NTUA** (Coordinator, *Greece*)
2. **Martel** GmbH (*Switzerland*)
3. Université Pierre & Marie Curie - **UPMC** (*France*)
4. Consortium **GARR** (*Italy*)
5. Universiteit van Amsterdam - **UvA** (*Netherlands*)
6. Fundació **i2CAT** (*Spain*)
7. **DFN** Verein (*Germany*)
+ Universität **Erlangen** - Nürnberg
8. Institut National de Recherche en Automatique et Informatique - **INRIA** (*France*)
9. Eötvös Loránd Tudományegyetem - **ELTE** (*Hungary*)
10. Poznan Supercomputing and Networking Center - **PSNC** (*Poland*)
11. **Cisco** Systems International B. V. (*Netherlands*)
12. **Fraunhofer** Gesellschaft zur Förderung der angewandten Forschung (*Germany*)
13. Universitat Politècnica de Catalunya – **UPC** (*Spain*)

Federated Platform for NOVI Experiments





Conceptual View of NOVI Federation





European FI Readiness

- Core connectivity available via **FI-ready** NRENs – GÉANT
- Skilled human potential & testbed facilities in academia, industry, operators (Converged Networks, Federated Clouds, Wireless & Sensor Networks, Internet of Things...)
- Co-financing from EU RTD Framework Programs (FP7, FP8?)
- **European Commission, DG INFSO, Directorate F**
 - **GÉANT & e-Infrastructures Unit** – **GÉANT, FEDERICA**
 - **FIRE Unit** - Experimental facilities: **OneLab2, Panlab2, (VITAL++, WISEBED...)** + **BonFIRE, OFELIA, TEFIS, CREW, Smart Santander**; Experimental Research: **NOVI...** ; Support Action: **FIREStation**
- **European Commission, DG INFSO, Directorate D**
 - **FI PPP + Future Internet Assembly, Future Internet Forum**: Close to market (3 years) **stimulus** projects: core facility + use cases with high social economic impact (*technical innovation?*)
- **Need for concerted planning at European & Global levels**



Related Public Web Pages

- http://ec.europa.eu/information_society/activities/foi/index_en.htm (link to **EU Future Internet** activities)
- <http://www.geant.net/pages/home.aspx> (link to **GÉANT**)
- <http://www.fp7-federica.eu/> (link to **FEDERICA** site)
- <http://www.fp7-federica.eu/documents/FEDERICA-DNA2.2.pdf> (link to **FEDERICA Deliverable on User Slices**)
- <http://www.fp7-novi.eu/> (link to **NOVI** site)
- <http://www.netmode.ntua.gr> (link to **netmode.ntua.gr** laboratory)