

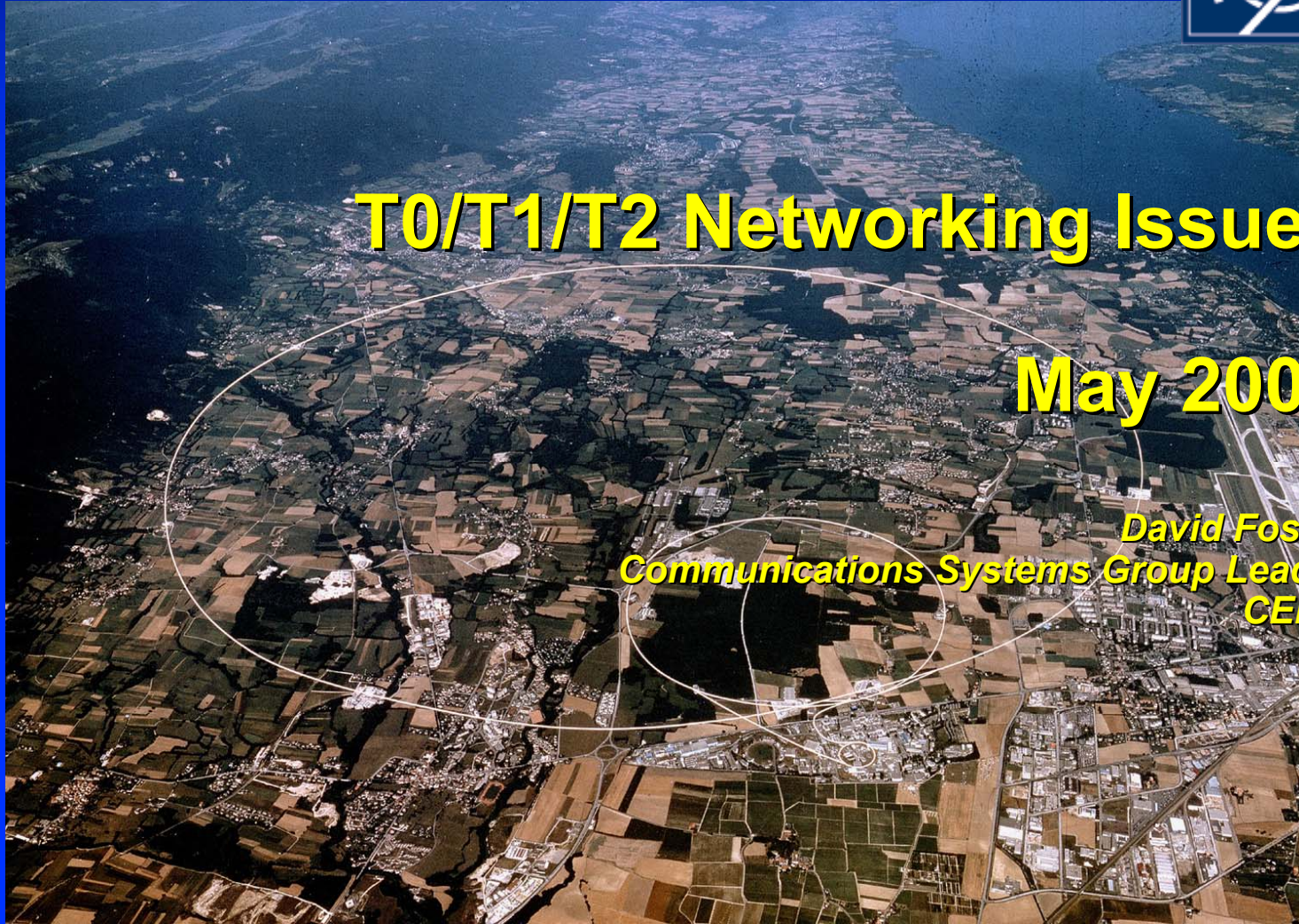
EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH
EUROPEAN LABORATORY FOR PARTICLE PHYSICS



T0/T1/T2 Networking Issues

May 2005

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CERN Networking for LCG



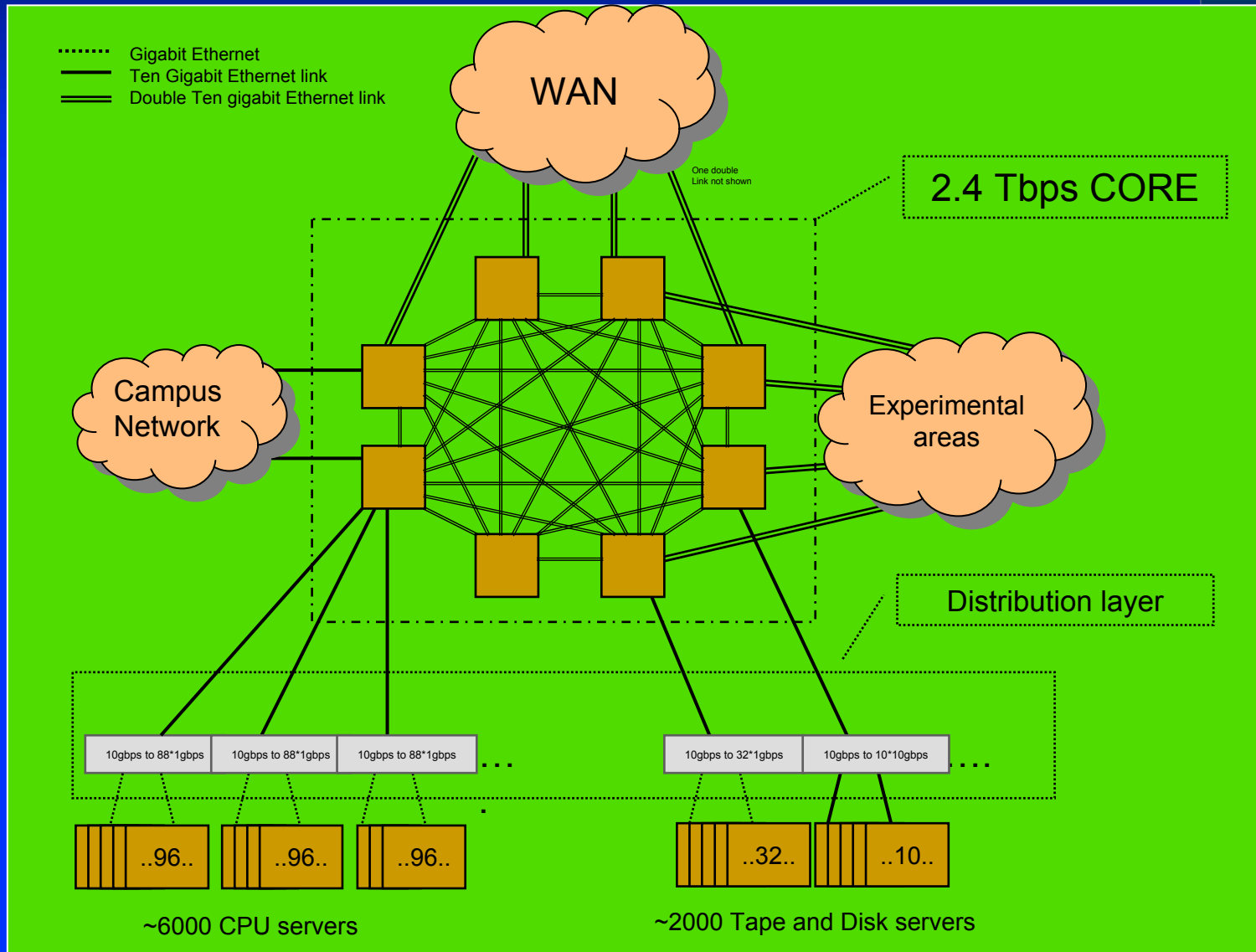
■ LCG will require

- Several thousands of Gigabit ports in the computer center
- Hundreds of Ten Gigabit Ethernet connections in the computer Center
- 10+ Ten Gigabit Ethernet links to T1's (WAN)
- 8+ Ten Gigabit Ethernet links to the Experiments

■ Challenges

- Operation of the system as ONE entity
- Ensure security and protection of the system
- Good monitoring to understand how the network is being used.
- T1/T2 Campus Infrastructures

LCG cluster network





The future ???

- Coming faster than we imagine ... ???

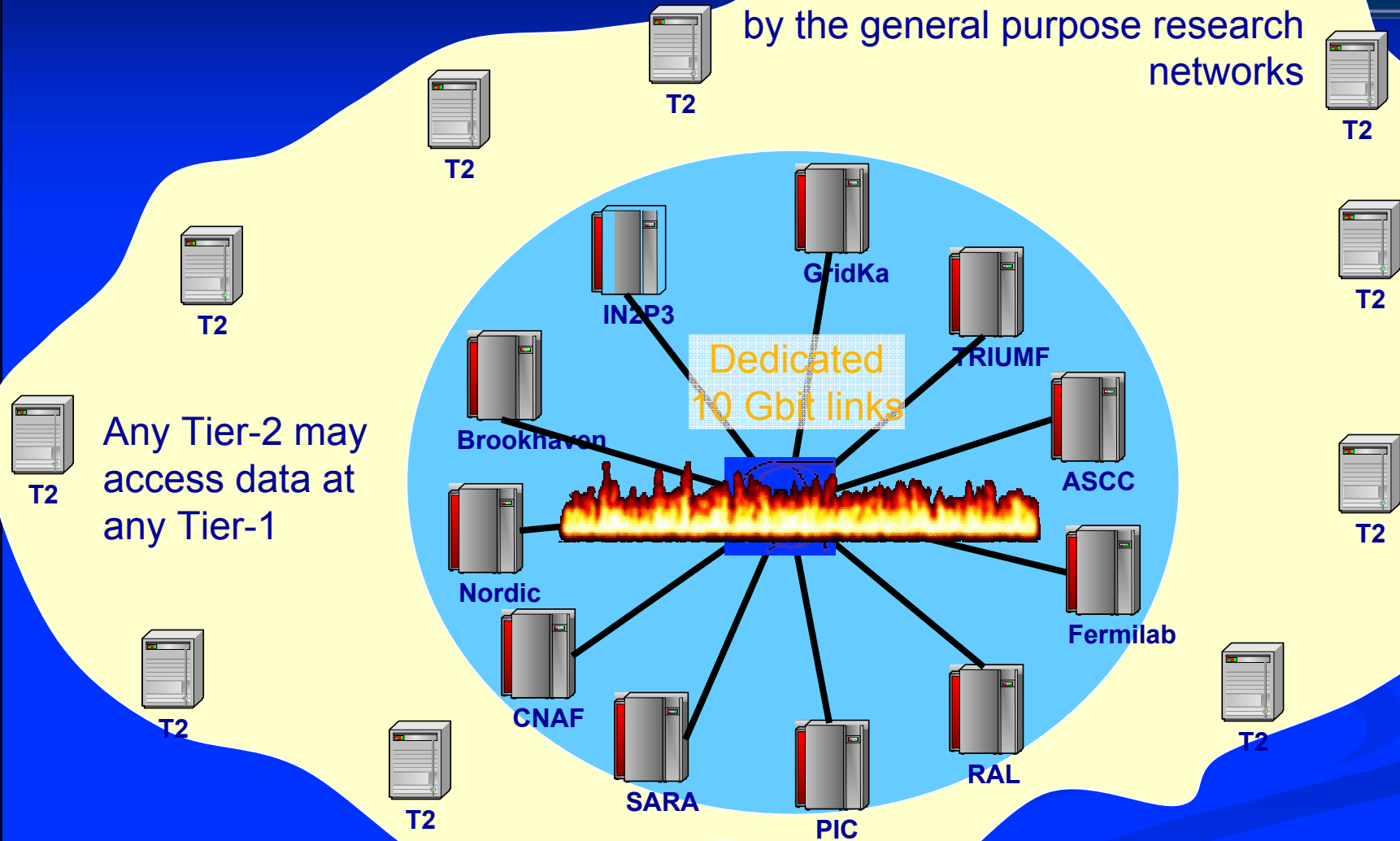


- 3 Core
 - 1 TFlop??
 - Liquid Cooled
 - Networked, 20G Disk
 - <\$300 ??
-
- And then there is the PS3

T0/T1/T2 Interconnectivity



T2s and T1s are inter-connected by the general purpose research networks



Any Tier-2 may access data at any Tier-1

Dedicated 10 Gbit links

LHC T1 Networking



- **Needs to provide high bandwidth production connections to the T0**
 - For the first time for HEP the WAN is an integral part of the computing system.
 - Dedicated 10Gb/sec links
- **Is the combination of a number of initiatives:**
 - GEANT networking deployed in Europe – Geant-2
 - SURFNET, SARA
 - UKERNA, RAL
 - RENATER, IN2P3
 - DFN, FZK
 - NORDUNET, Nordic T1
 - RedIRIS, PIC
 - GARR, Bologna
 - Dedicated transatlantic and transpacific links
 - TRIUMF
 - ASCC
 - FNAL, BNL
 - Networking Initiatives
 - NetherLight, UKLight, GLIF, Gloriad, Ultralight and many others interconnecting China, Asia Pacific, North America, South America etc ...



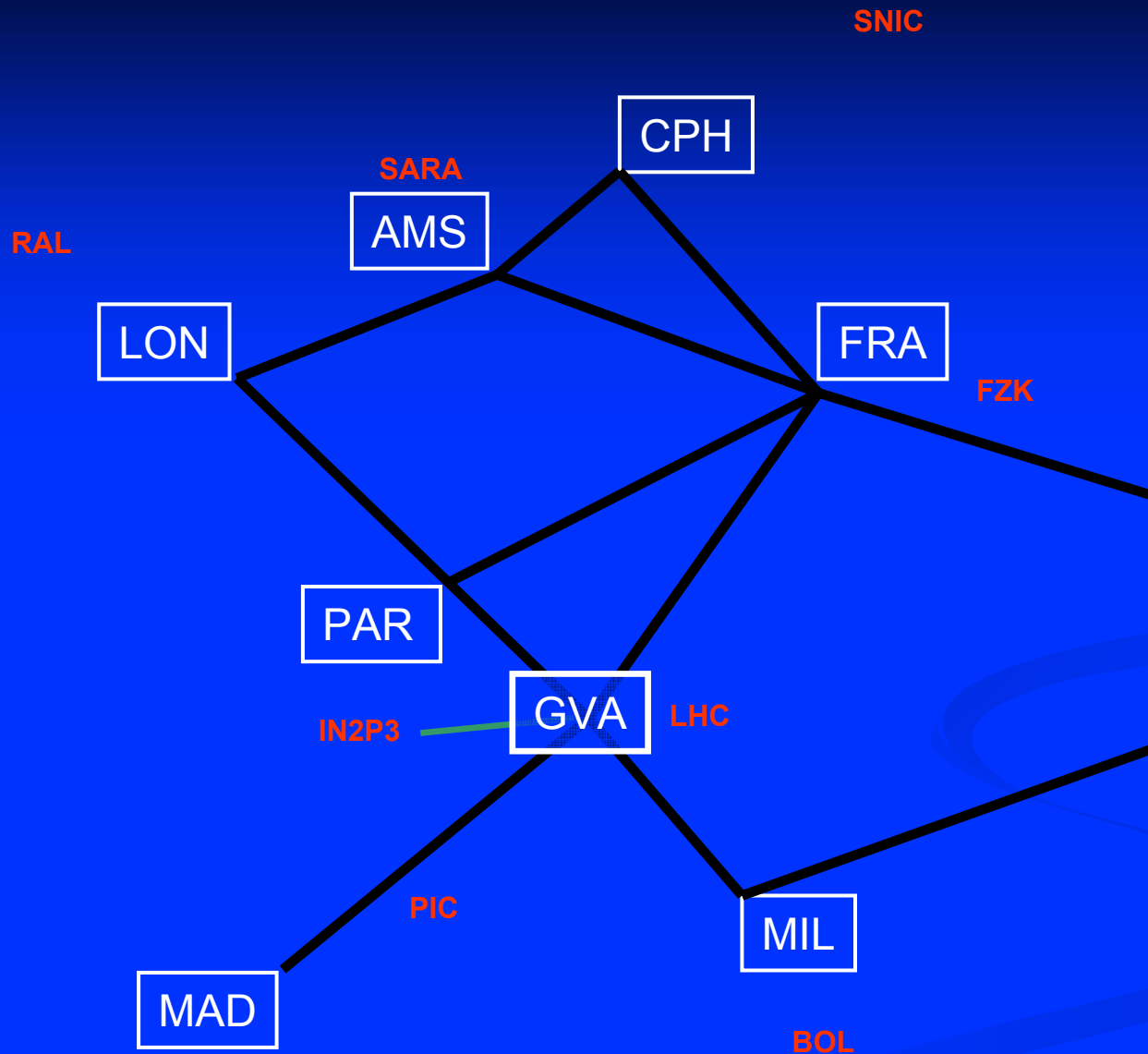
LHC T2 Networking

- Needs to provide connectivity between T2's and T2 to T1. No particular access pattern is assumed.
 - T2's are expected to have good (1Gb/sec -> 10Gb/sec) access to national and international research networks
 - Geant
 - ESnet
 - Abilene
 -

GÉANT2 Topology



- Up to 15 of 30 consortium partners will be connected to DF
- Selection of preferred providers expected to be completed on 9.5.2005 in Pisa
- On 31.3. all DF routes relevant to the 7 European T1s have been selected



GÉANT2 DF Topology

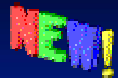
as relevant to
LHC

up to 6
further
Central
European
locations

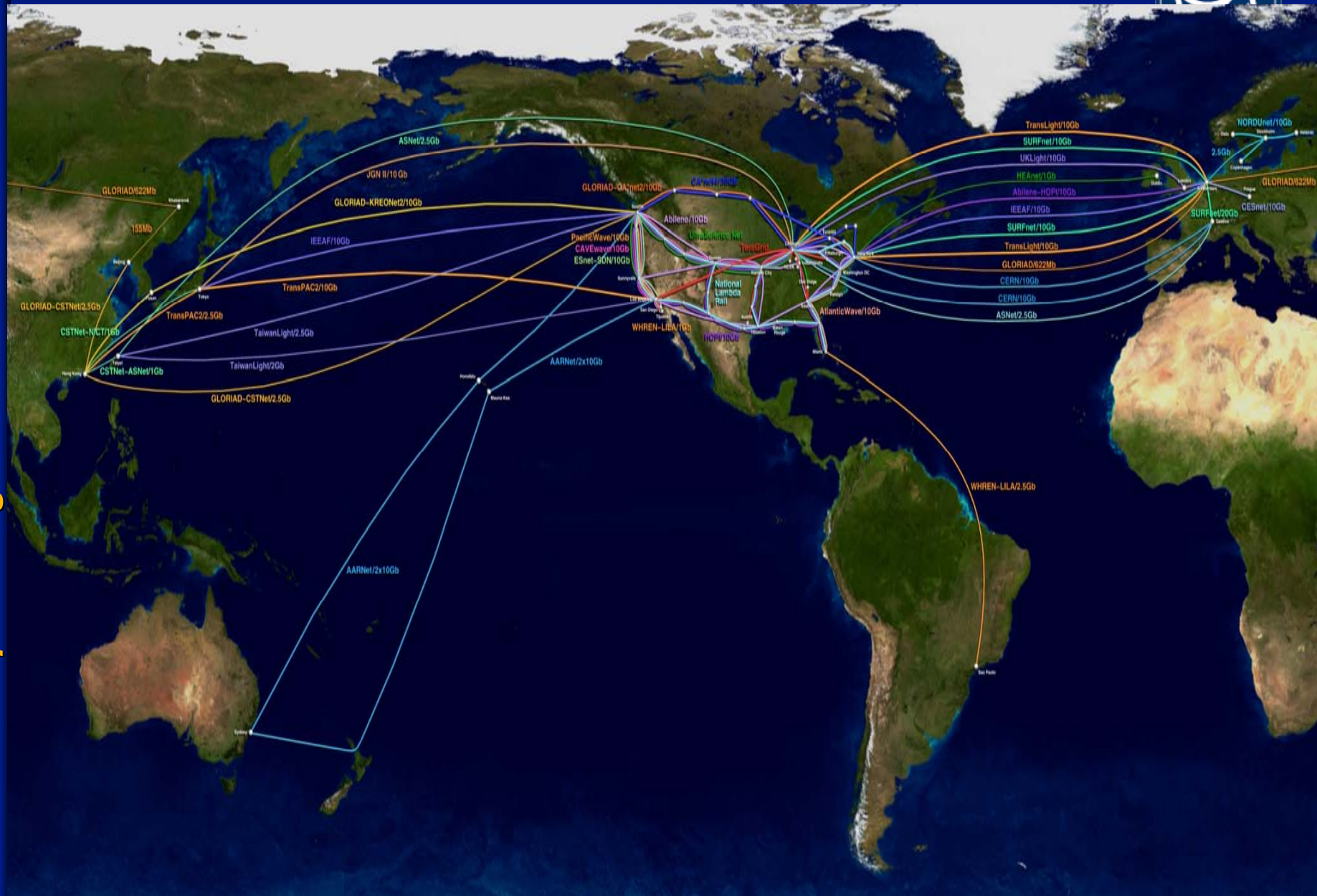


Cost Model

- **GÉANT2 does not have prices, it shares cost**
- **The NRENs on the dark fibre cloud subscribe to a GEANT+ service - about 2 M€ per NREN per year**
 - 10Gb/s IP and 10Gb/s worth of p2p services
- **This subscription finances the DF backbone**
 - Extra wavelengths for projects at marginal cost
- **Opportunities for more direct connections (T2-T1) than first thought?**

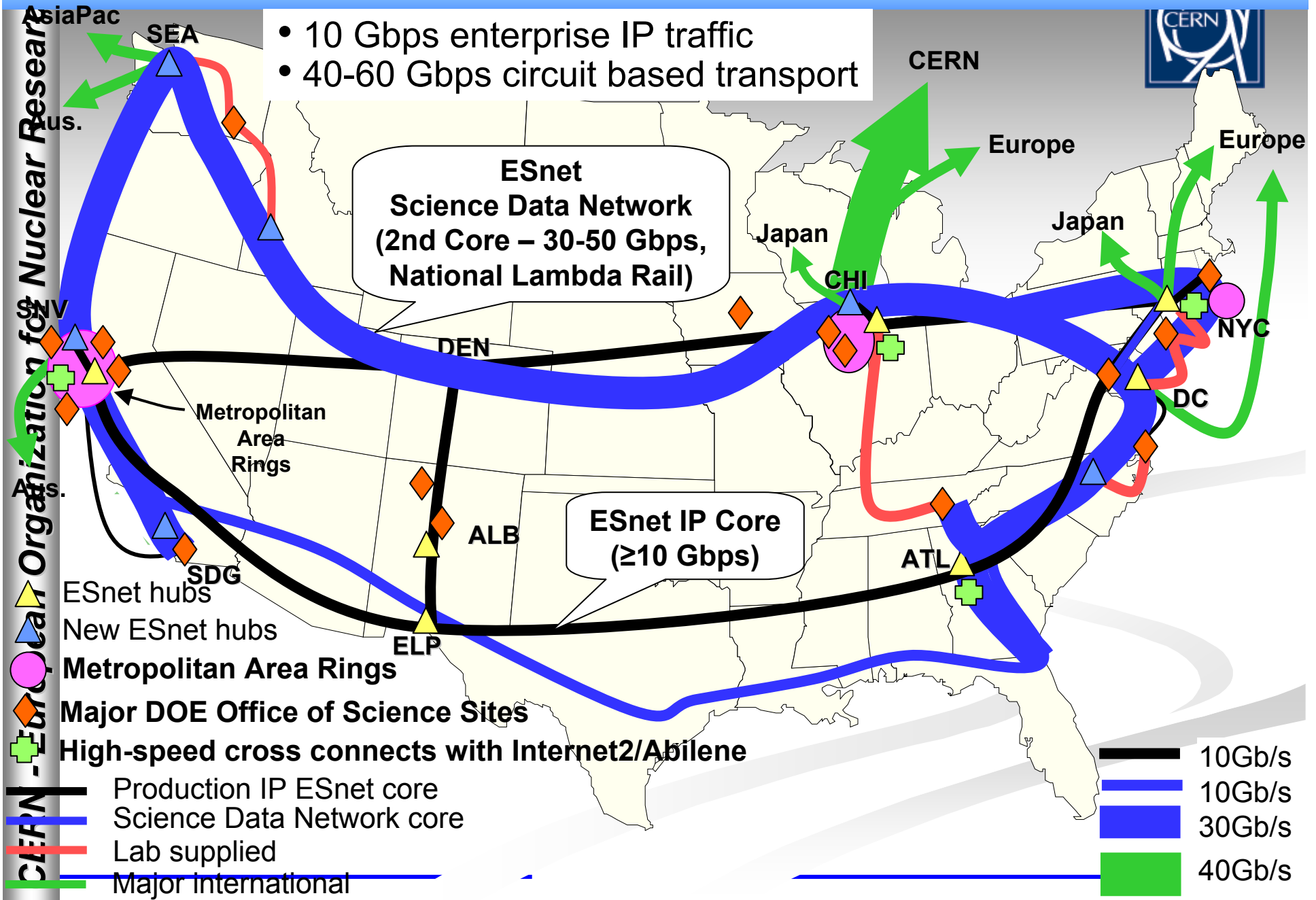


GLIF MAP From GLIF



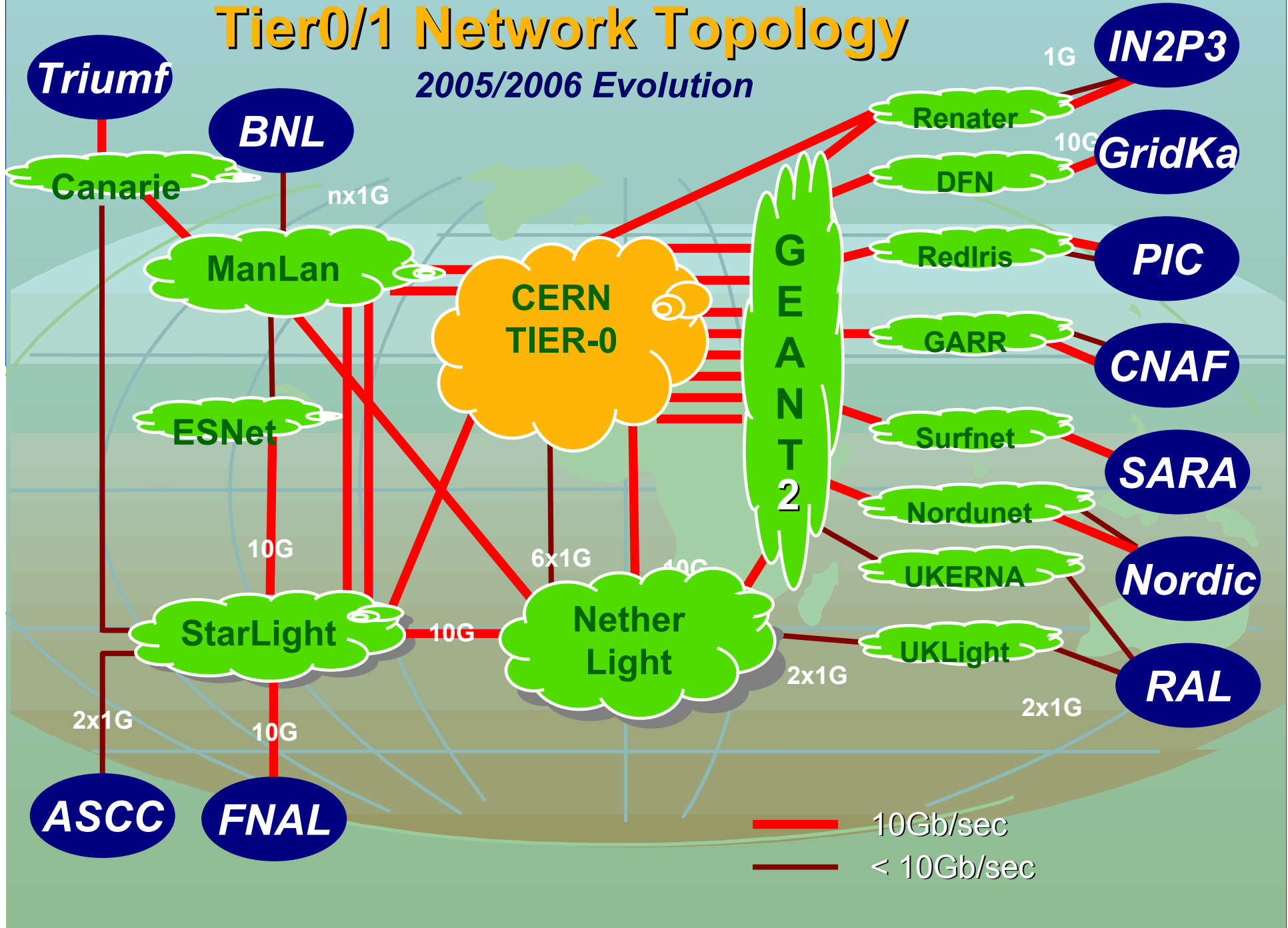
ESnet Goal – 2007/2008

- 10 Gbps enterprise IP traffic
- 40-60 Gbps circuit based transport



Tier0/1 Network Topology

2005/2006 Evolution



Basic Network Issues



- **Collections of circuits are not a network.**
 - GEANT will provide diverse backup routes for dedicated circuits.
 - DOE/CERN will provide circuits to New York (BNL) and Chicago (Fermilab) with additional transit between New York and Chicago.
 - The backup connectivity for TRIUMF (Canada) and ASCC (Taipei) is still being discussed.
- **Testbeds and Production are not the same thing**
 - Many issues to be resolved that need funding, testbeds are important.
 - We need to evolve a clear plan for production infrastructures for LHC.
- **The LHC Network design is being discussed.**
 - The sub-group of the Grid Deployment Board, "T0/T1 Networking" is preparing an architecture document.
 - Aims to reach agreement on how the IP network on the dedicated circuits will be designed.
 - Will indicate what type of equipment will be required. "Who should put what, where"
- **Some technology investigations are underway**
 - The use of long-distance WAN-PHY links given the OC192 interface costs.
 - UCLP
 - GFP and VCAT technologies.



Basic Operational Issues



■ Many parties are involved in operations support

- At the network layer there are a number of partners with different spheres of influence
 - GEANT, NREN's Commercial links, T0 and T1 Centers
- At the grid layer there are operations centers, Regional Operations Center (ROC), Grid Operations center (GOC), Core Infrastructure Center (CIC) etc.
- For the end user there is Global Grid User Support (GGUS)
- Performance Enhancement and Response Teams (PERT) are emerging in some NRENs



■ The process for resolving end user problems has yet to be fully defined.

■ We still need to decide on a monitoring strategy

- and deploy appropriate monitoring tools.

Far-reaching Issues



- There is tremendous momentum behind world-wide networking initiatives but it is important that this continues.
- What we want to do today ... “requirements”
 - A typical approach to size needs according to current understanding.
- What we can do tomorrow ... “opportunity”
 - Affordability of high capacity end-end networking
 - CPU-Memory-Disk
 - Bus-NIC
 - NIC-Campus
 - Campus-WAN
 - Opportunity for “business transformation” and conceive of new ways of collaborating and sharing resources.
 - Current grid use is largely off-line batch like.
 - Continued advancement in “on-demand” end-end networking will provide for increasingly cost effective, real-time and interactive usage.
- World class networking available for everyone will bring dramatic changes and opportunities
 - Digital divide issues need to be addressed to make cost effective access to high performance networking accessible to everyone.
 - Pervasive high performance networking is needed to realise the vision of pervasive high performance grid services