



# ***The US LHCNet Project***

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October 2006**

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# Who We Are



- ◆ A transatlantic network designed to support the **LHC** and the U.S. HEP community
- ◆ Funded by the US **DoE** and **CERN** and managed by **Caltech** in collaboration with CERN
- ◆ Evolved from a network between US and CERN which dates back to 1985
- ◆ Our mission is to deliver a reliable network service to support the upcoming **LHC** experiments at CERN
- ◆ Designed to support the LHC three-tiered model and to deliver data directly to/from the **US Tier 1's (FNAL and BNL)**



# LHCnet Services



- ◆ **We offer Layer 3 services (IP) and we peer with all major US research networks**
- ◆ **Layer 2 dedicated paths between CERN and the US Tier1's**
- ◆ **Layer 1 protected services coming soon**
- ◆ **Redundant services using multiple paths across the Atlantic**
- ◆ **Many layers of redundancy (equipment redundancy, path diversity, collaborations with other research networks)**
- ◆ **Integrated monitoring with MonALISA \***

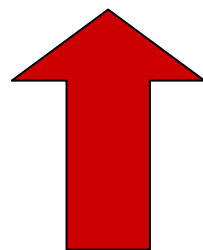


# US LHCNet Working Methods

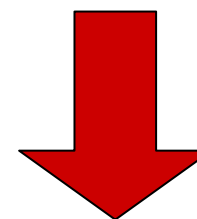


**LHCNet**

## Production Network



*Develop and build  
next generation  
networks*



*High performance  
High bandwidth  
Reliable network*

### Pre-Production

N x 10 Gbps transatlantic testbed  
New Data transport protocols  
Interface and kernel setting  
HOPI / UltraScience Net /  
Ultralight / CHEPREO /  
LambdaSation  
Lightpath technologies  
Vendor Partnerships

*HEP & DoE  
Roadmaps*



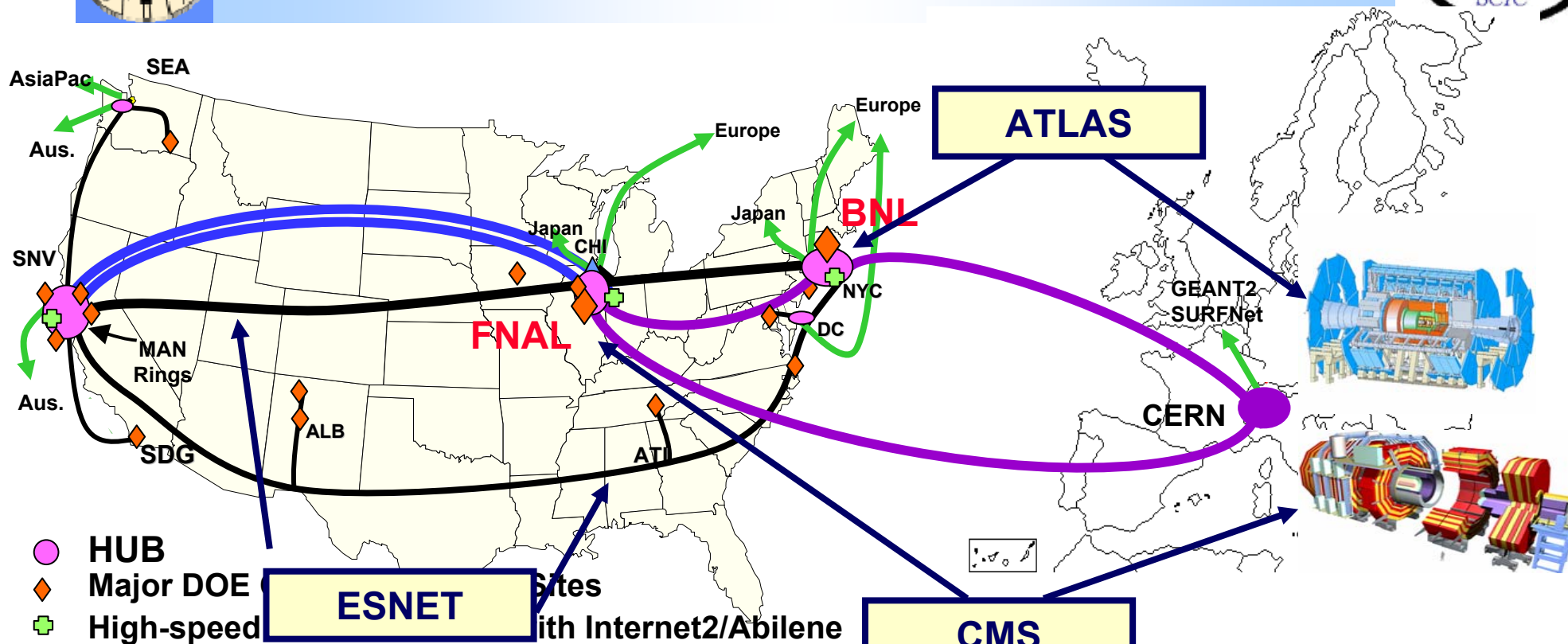
*Testbed for Grid  
Development*

### Networks for Research

D0, CDF, BaBar, CMS, Atlas  
GRID applications  
PPDG/IVDGL, OSG, WLCG,  
DISUN  
LHCOPN  
Interconnection of US and  
EU Grid domains  
VRVS/EVO



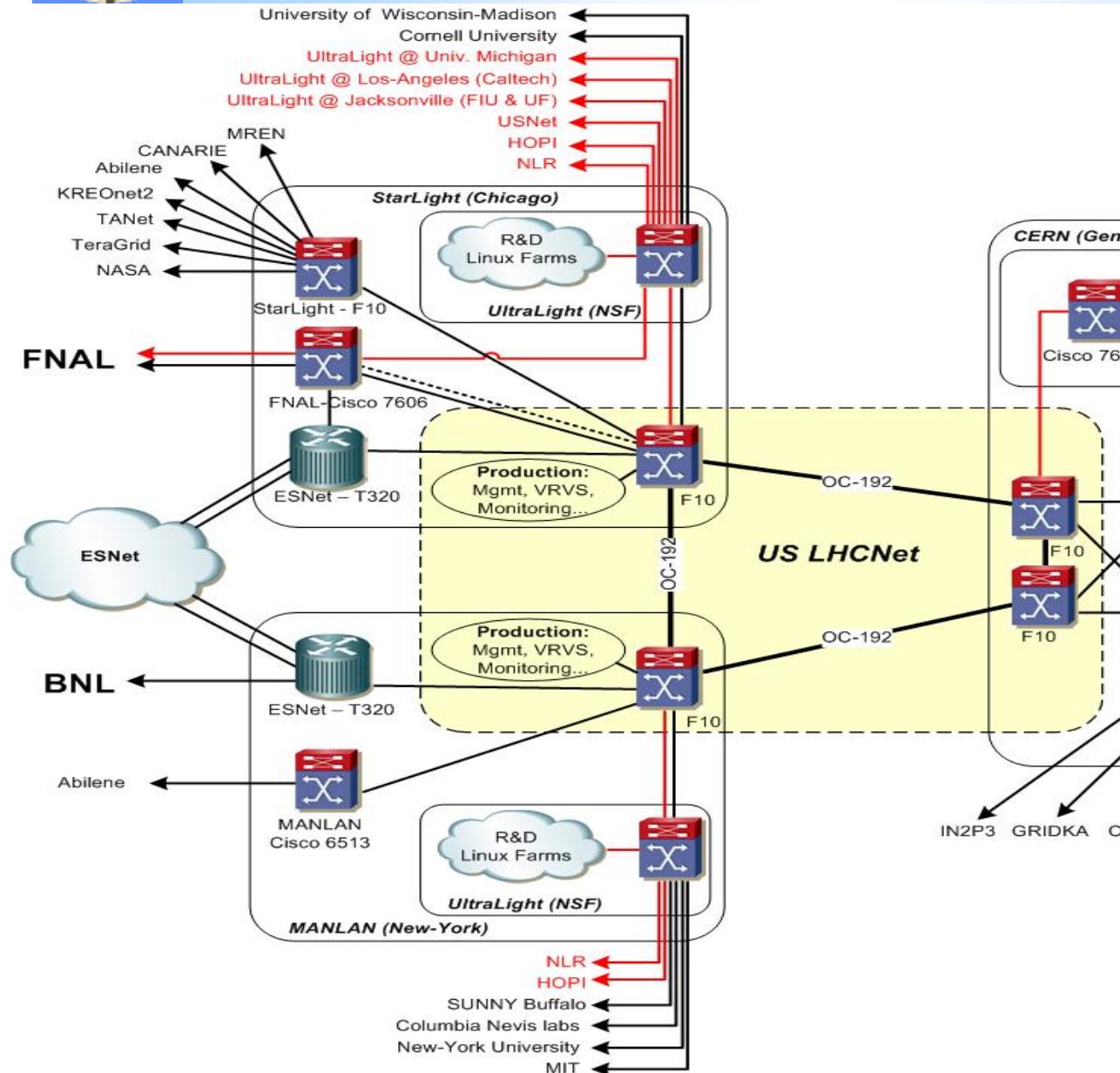
# US LHCNet



- ◆ Connections to ESnet Hubs in New-York and Chicago
- ◆ Redundant "light-paths" to BNL and FNAL
- ◆ Redundant 10 Gbps peering with Abilene
- ◆ Access to USNet/HOPI for R&D



# LHCNet configuration (October 2006)

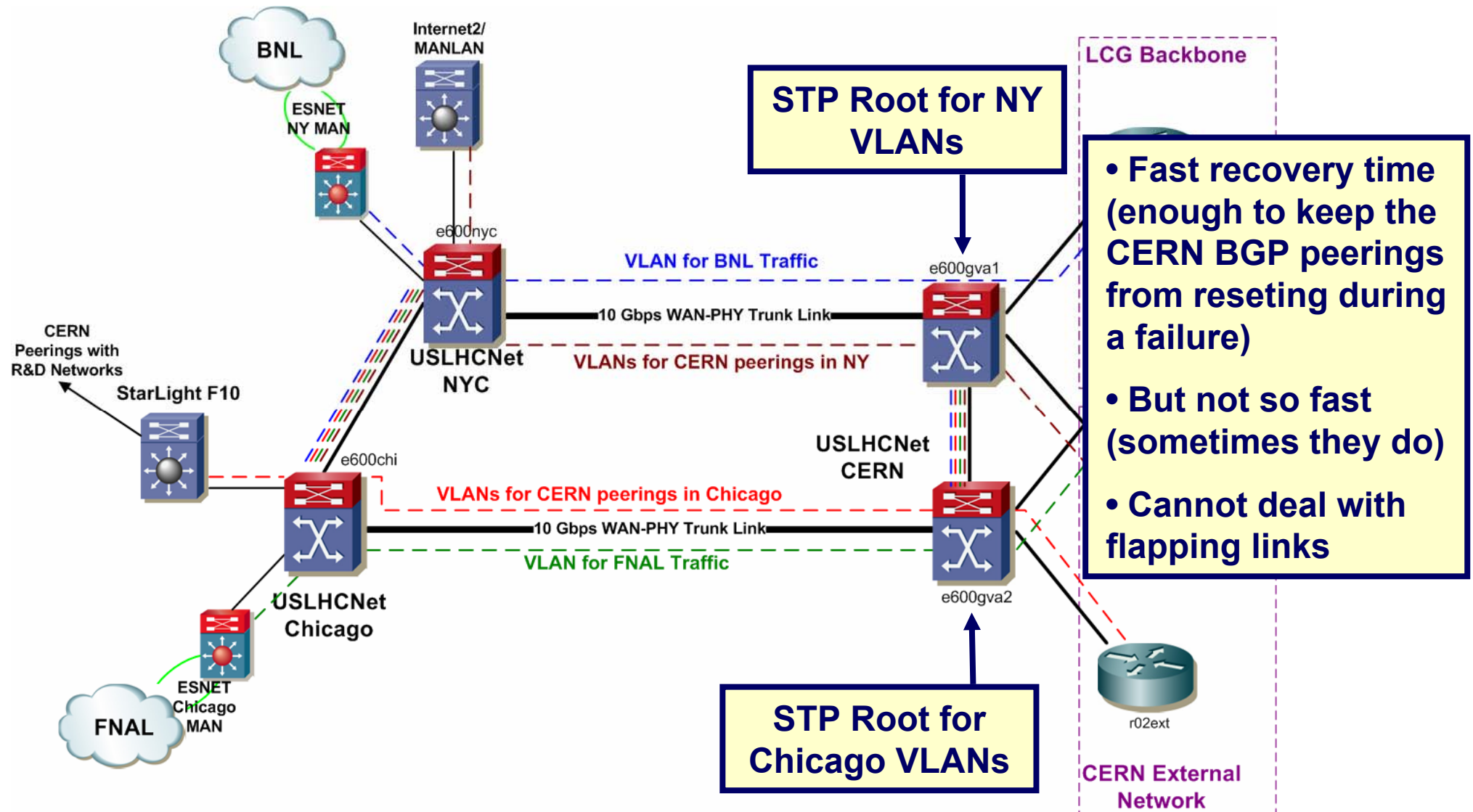


- ◆ Co-operated by Caltech and CERN engineering teams
- ◆ Force10 platforms, 10GE WANPHY
- ◆ New PoP in NY since Sept. 2005
- ◆ 10 Gbps path to BNL since April 2006
- ◆ Connection to US Universities via UltraLight (NSF & university funded) backbone



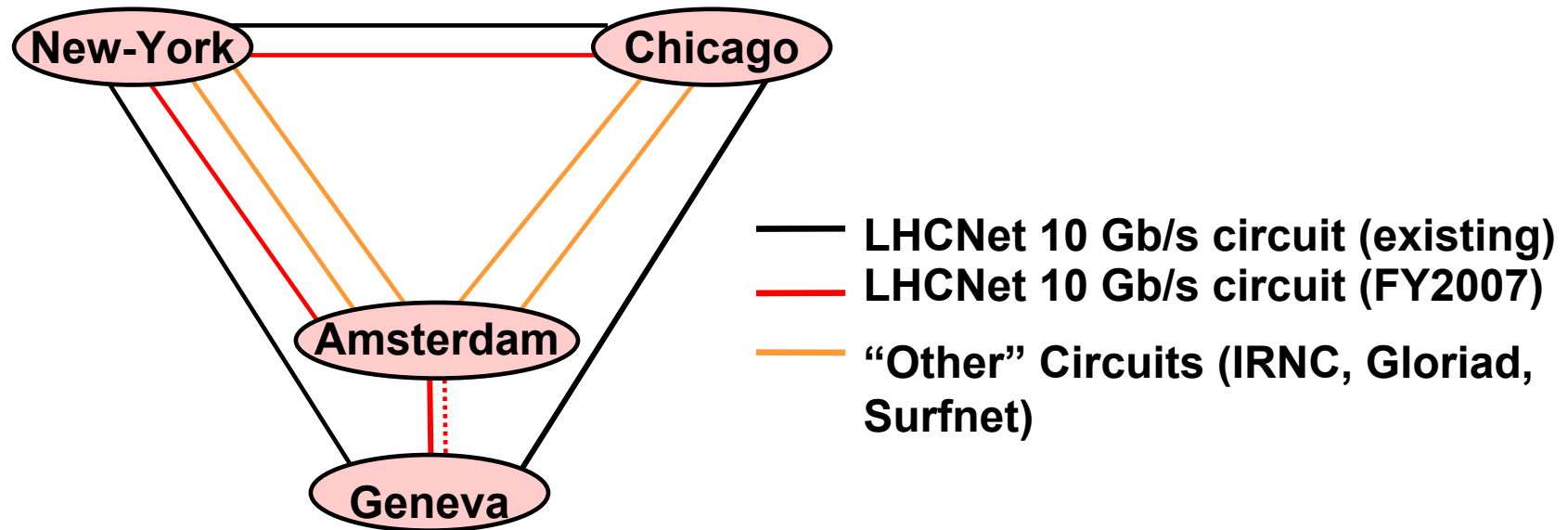


# RSTP Backup and Load Sharing





# Future backbone topology

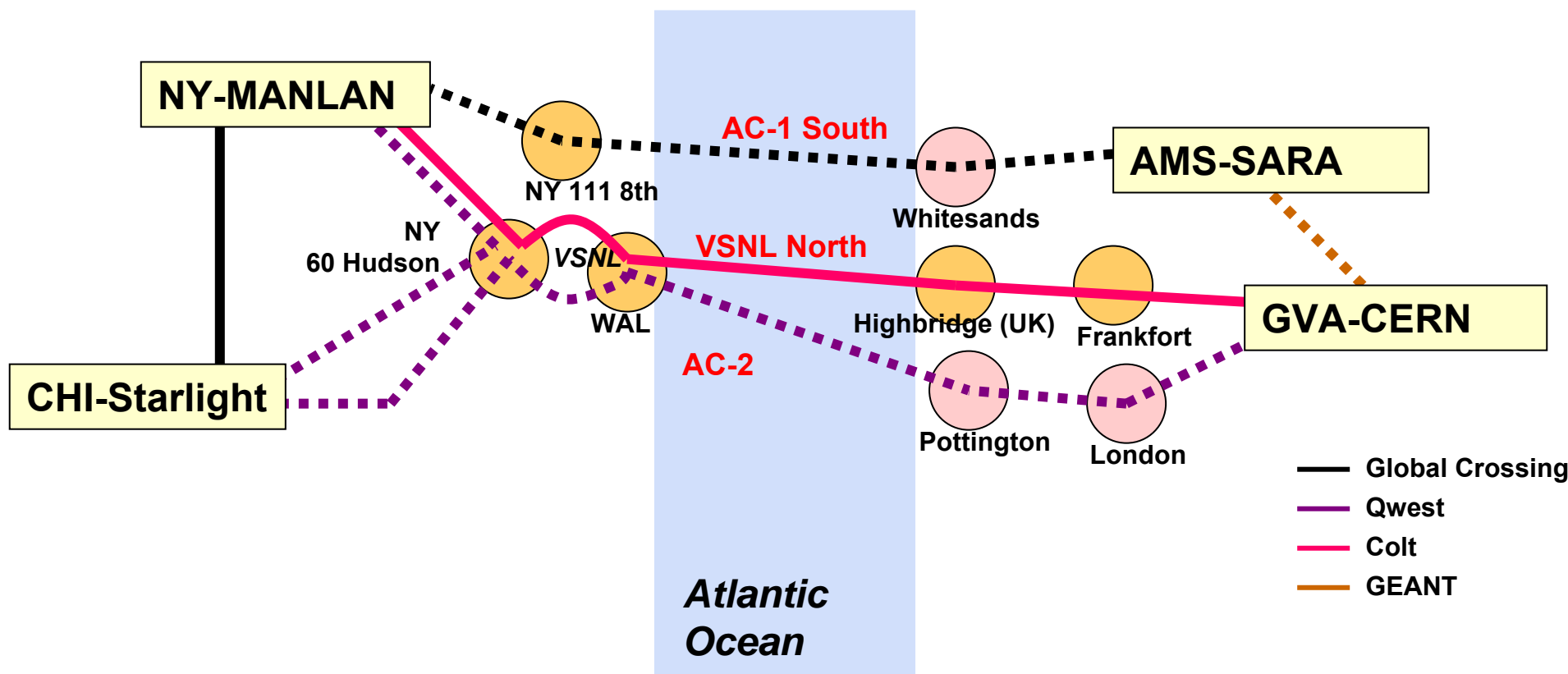


- ◆ **GVA-CHI-NY triangle**
- ◆ **New PoP in Amsterdam**
  - ❑ **GEANT2 circuit between GVA and AMS**
  - ❑ **Access to other transatlantic circuits ➡ backup paths and additional capacity**
  - ❑ **Connection to Netherlight, GLIF (T1-T1 traffic and R&D)**





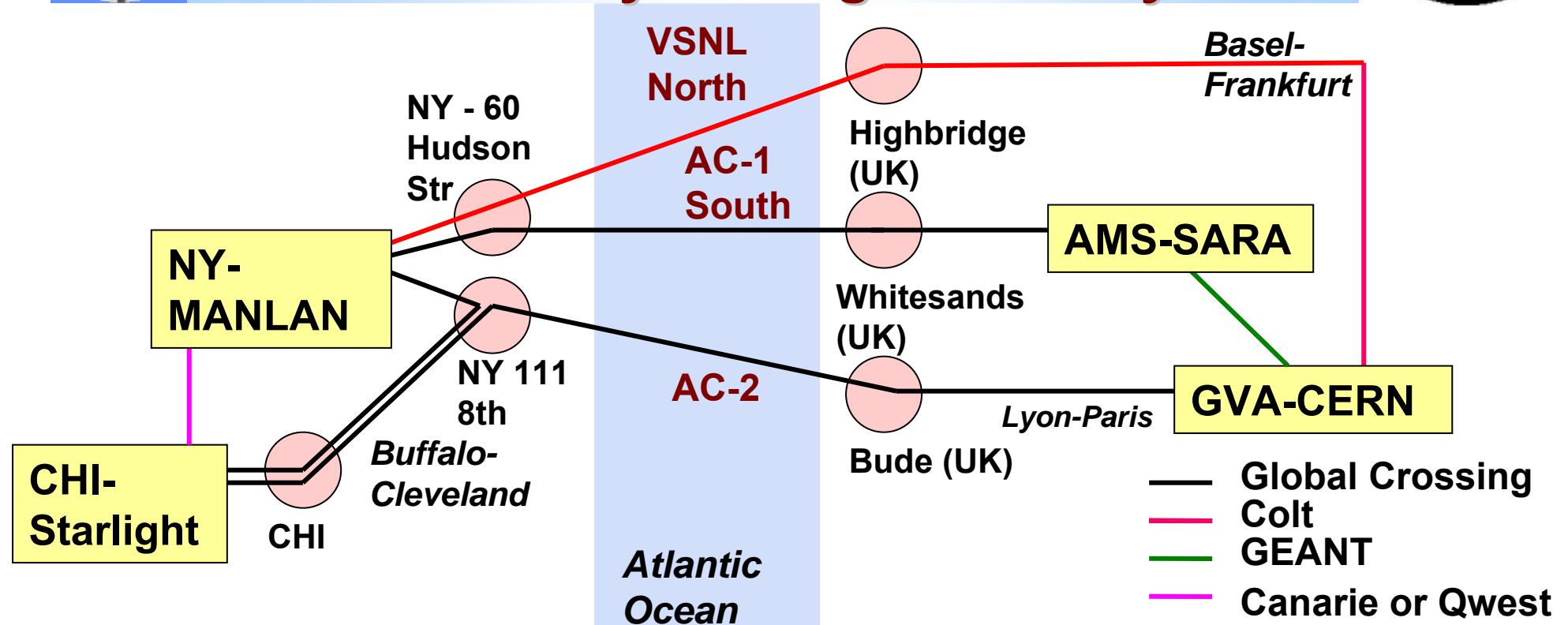
# New Topology deployment



- In Production
- In Production
- November 1st
- January 2007
- January 2007



# Multiple Fiber Paths: Reliability Through Diversity

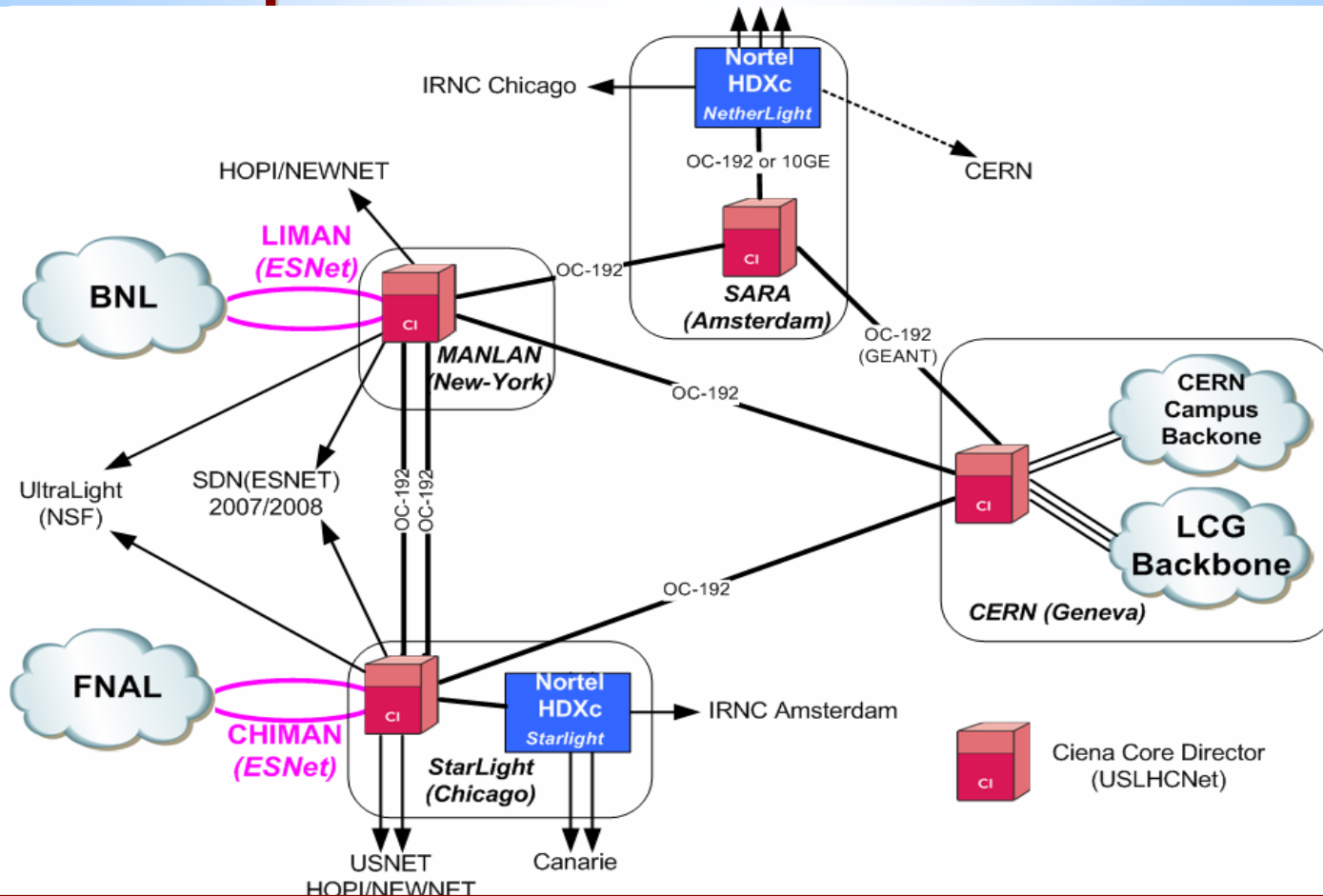


- ◆ Unprotected circuits (lower cost)
- ◆ Service availability from provider's offers:
  - ◆ Colt Target Service Availability is 99.5%
  - ◆ Global Crossing guarantees Wave Availability at 98%
- ◆ Canarie and GEANT: No Service Level Agreement (SLA)

**LCG Availability  
requirement: 99.95%**



# Next Generation LHCNet: Add Optical Circuit-Oriented Services



## Based on CIENA “Core Director” Optical Multiplexers

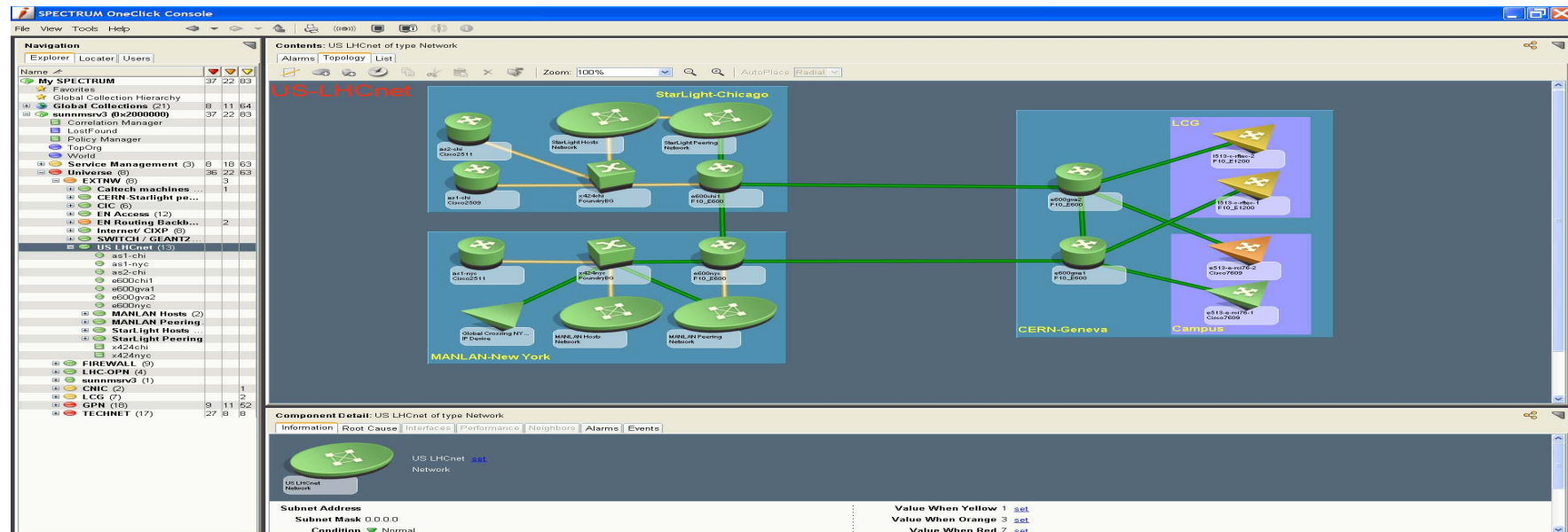
- Robust fallback, at the optical layer
- Circuit-oriented services: Guaranteed Bandwidth Ethernet Private Line (EPL)
- Sophisticated standards-based software: **VCAT/LCAS**.



# USLHCNet NOC

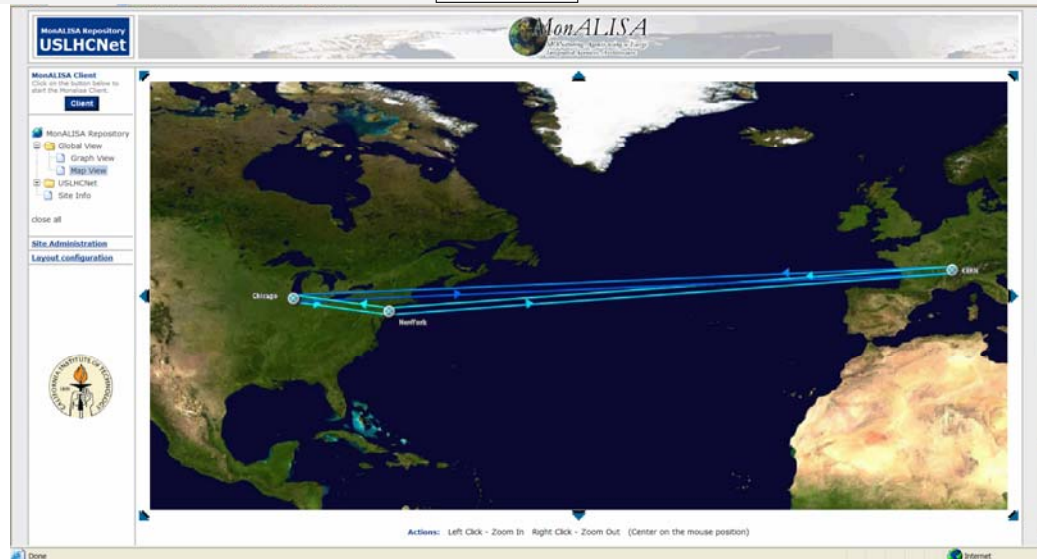
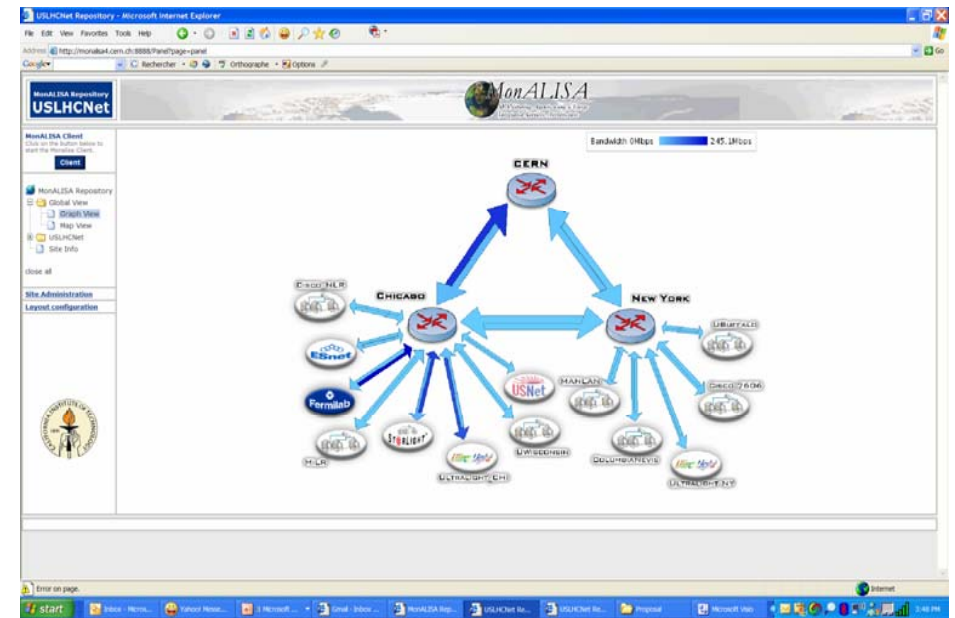
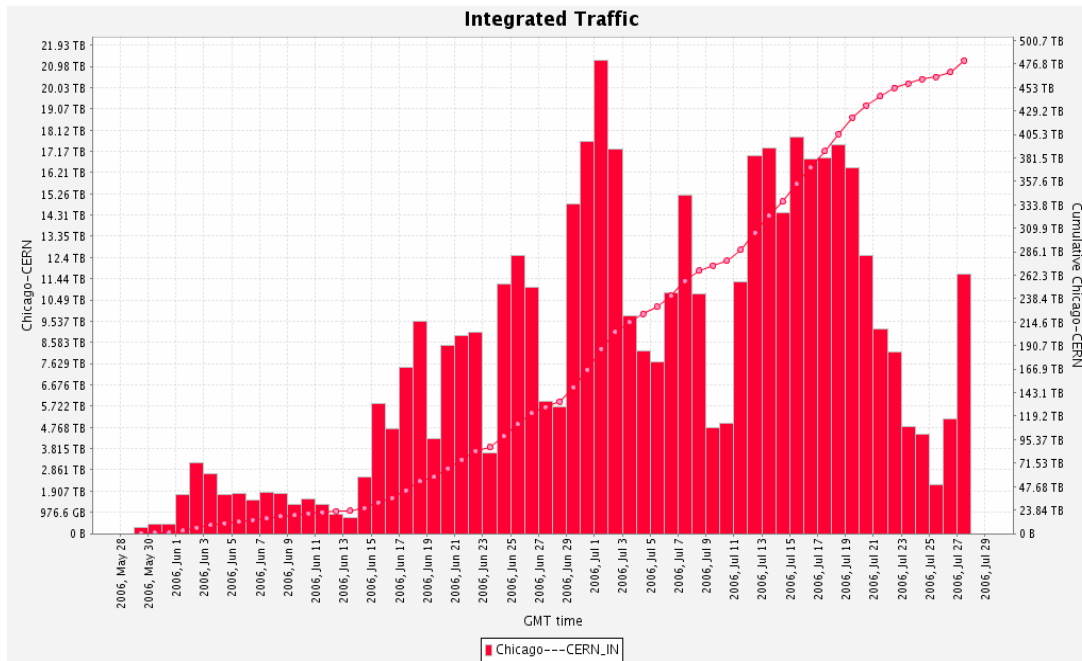


- ◆ **The CERN Network Operation Center (NOC)**
  - ❑ Delivers the first level support 24 hours a day, 7 days a week.
  - ❑ Watch out for alarms
  - ❑ A problem not resolved immediately is escalated to the Caltech network engineering team.
- ◆ **USLHCnet engineers “on call” 24x7**
  - ❑ On site (at CERN) in less than 60 min
  - ❑ Remote hand service at MANLAN and StarLight is available on a 24x7 basis with a four hour response time.





# Monitoring: <http://monalisa.caltech.edu>



- ☐ Operations & management assisted by agent-based software (MonALISA)
- ☐ 500 TB of data sent from CERN to FNAL over the last two months





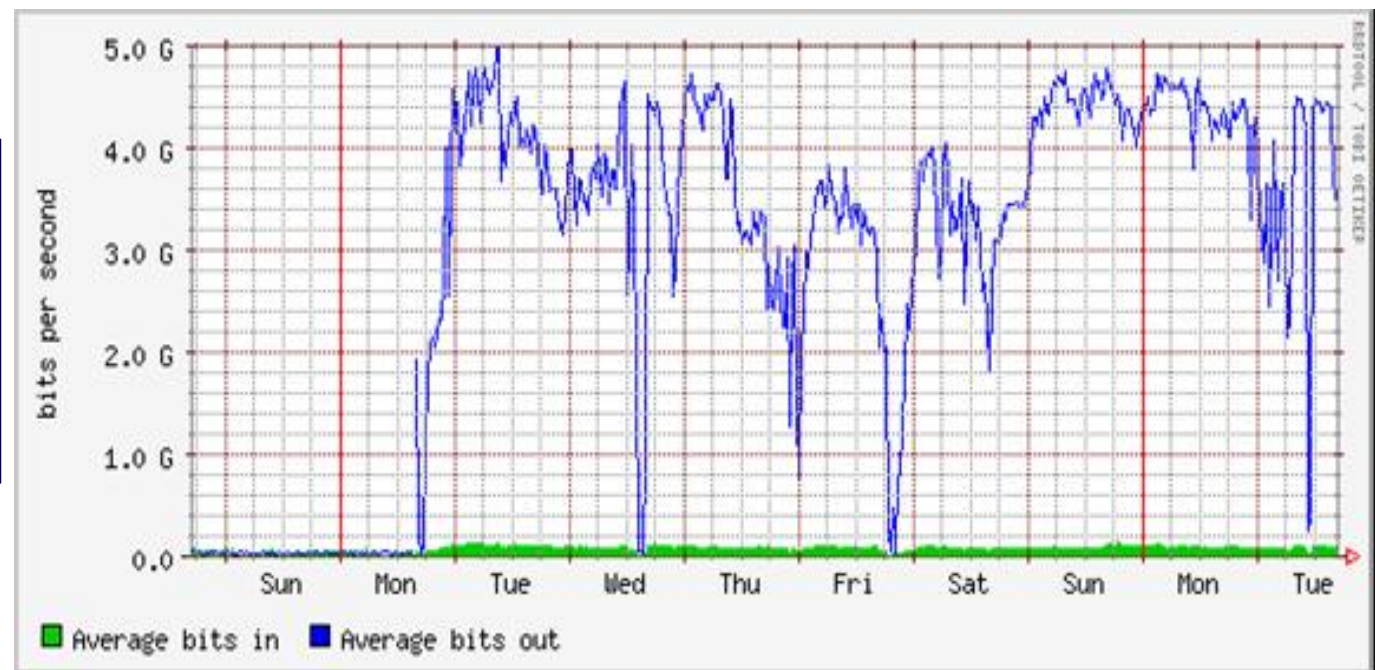
# LHCNet Utilization during Service Challenge



## ◆ Service challenge

- ❑ Achieving the goal of a production quality world-wide Grid that meets the requirements of LHC experiments
- ❑ Prototype the data movement services
- ❑ Acquire an understanding of how the entire system performs when exposed to the level of usage we expect during LHC running

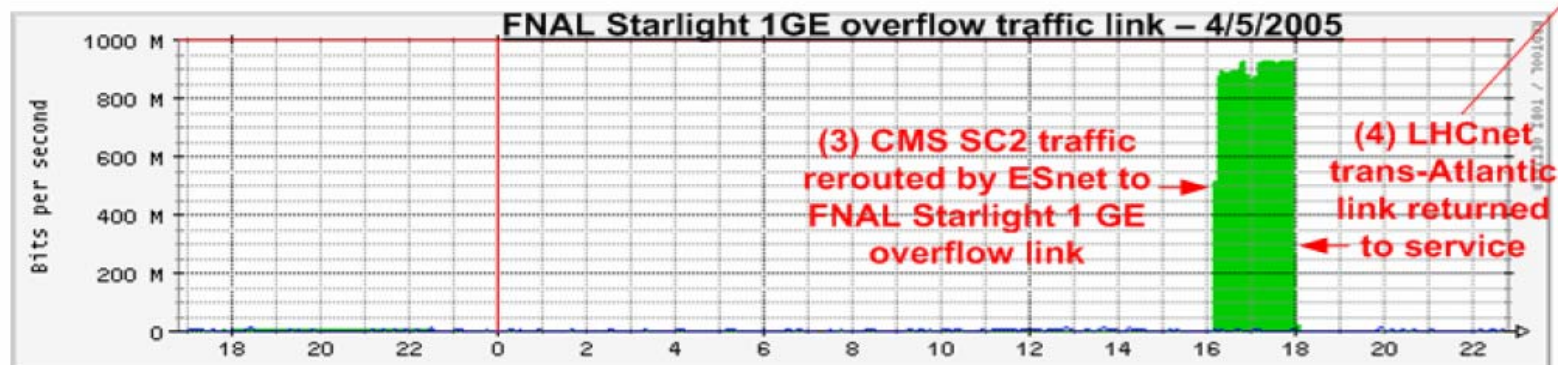
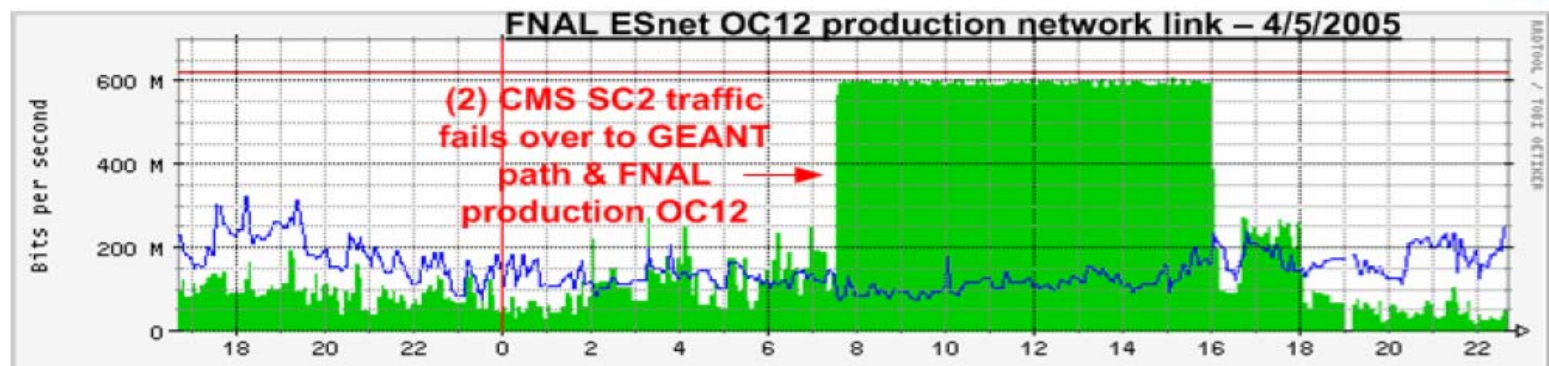
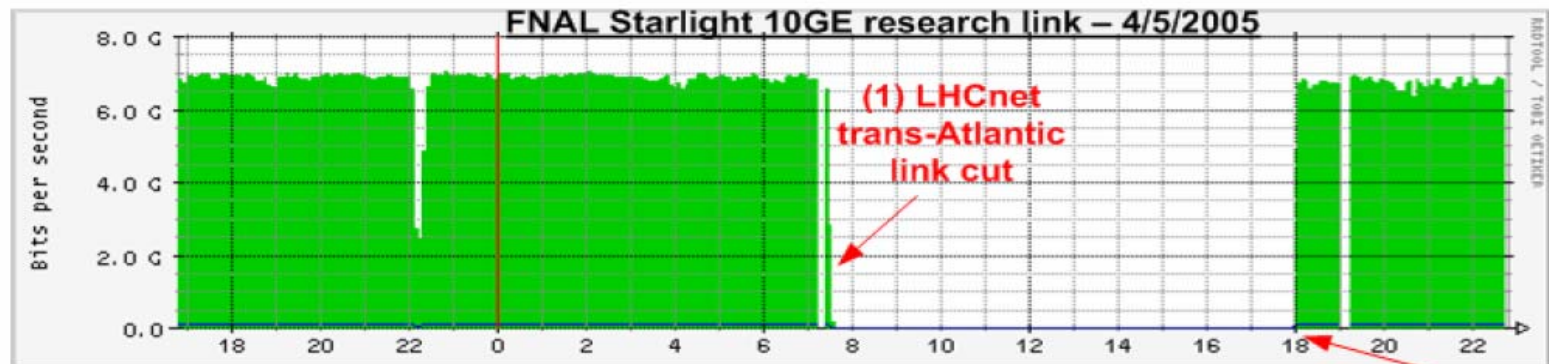
- ◆ CERN-FNAL traffic during SC3 (April 2006)
- ◆ Disk-to-Disk







# Circuit failure during SC2

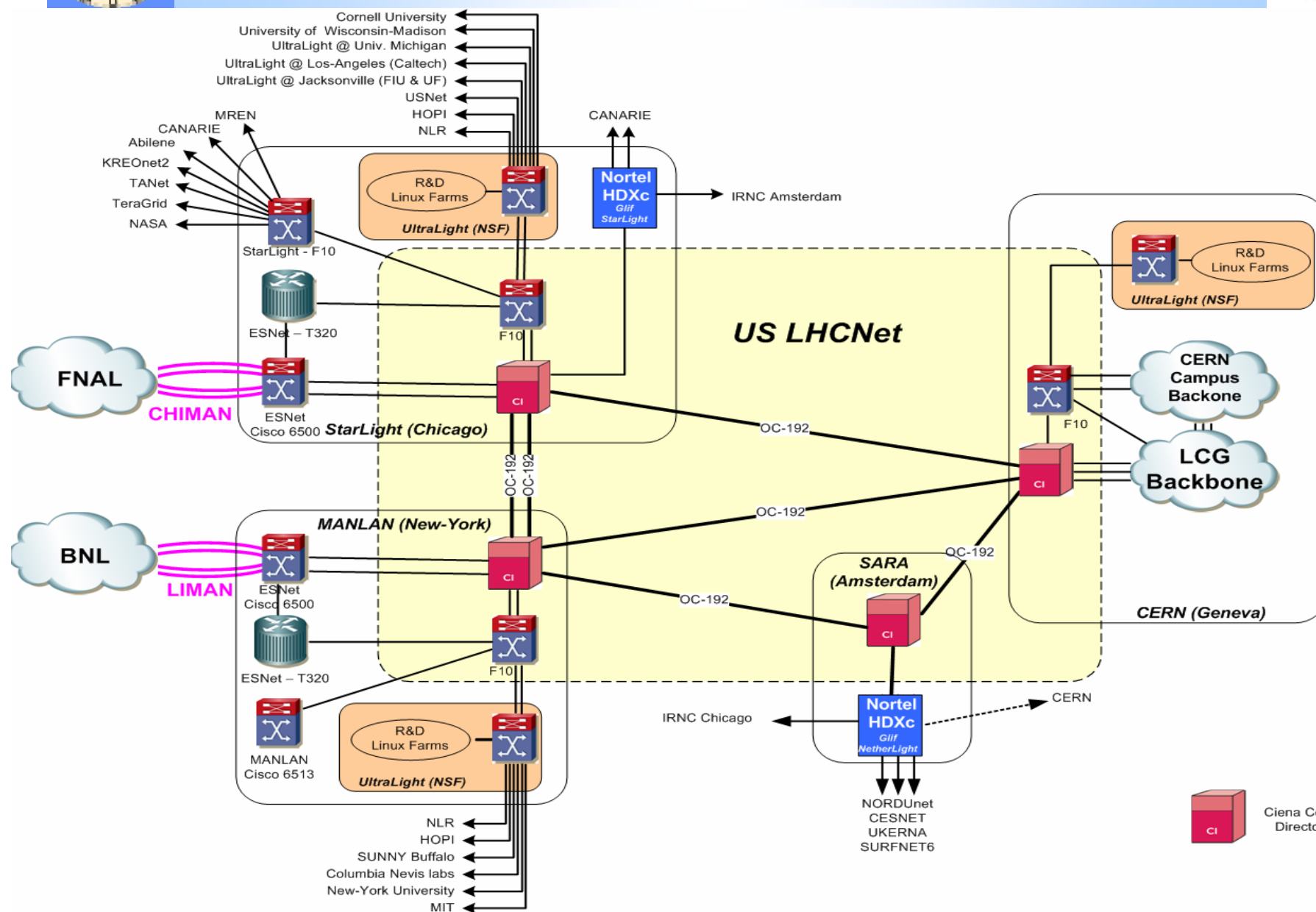




# **Additional Slides**

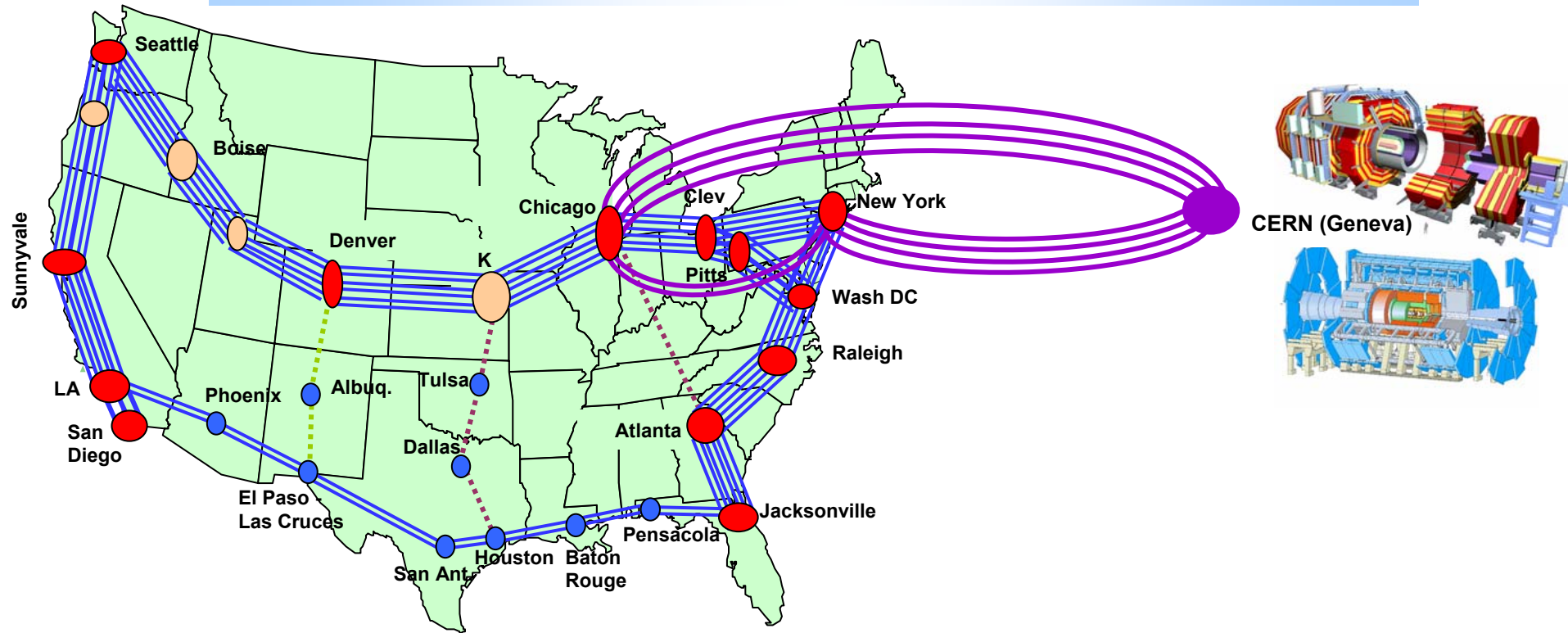


# LHCNet configuration (2007)





# LHCNet connection to Proposed ESnet Lambda Infrastructure Based on National Lambda Rail: FY09/FY10



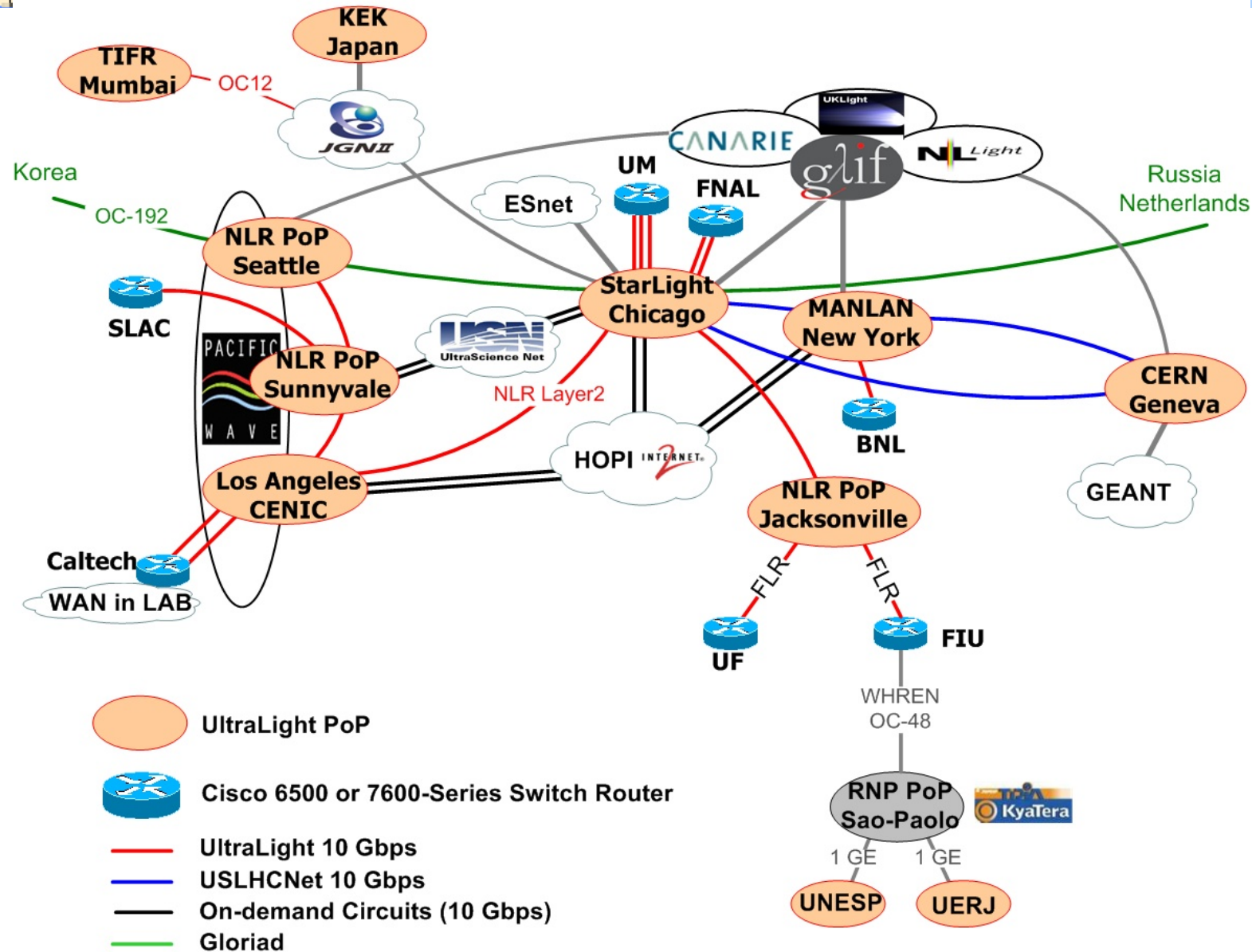
- NLR regeneration / OADM sites
- NLR wavegear sites
- ESnet via NLR (10 Gbps waves)
- LHCNet (10 Gbps waves)

◆ LHCNet: To ~80 Gbps by 2009-10  
◆ Routing + Dynamic managed  
circuit provisioning





# UltraLight





# Pre-Production Activities



- ◆ **Prototype data movement services between CERN and the US**
- ◆ **High speed disk-to-disk throughput development**
  - ❑ **New end-systems (PCI-e; 64 bit cpu; New 10 GE NICs)**
  - ❑ **New data transport protocols (FAST and others)**
  - ❑ **Linux kernel patches; RPMs for deployment**
- ◆ **Monitoring, Command and Control Services (MonALISA)**
- ◆ **“Optical control plane” development**
  - ❑ **MonALISA services available for photonic switches**
  - ❑ **GMPLS (Generalized MPLS); G.ASON**
  - ❑ **Collaboration with Cheetah and Dragon projects**
- ◆ **Note: Equipment loans and donations; exceptional discounts**





## Milestones: 2006-2007



- ◆ **May to September 2006: Service Challenge 4 - completed**
- ◆ **August 2006: Selection of telecom provider(s) from among those responding to the call for tender - completed**
- ◆ **October 2006: Provisioning of new transatlantic circuits**
- ◆ **Fall 2006: Evaluation of CIENA platforms**
  - Try and buy agreement
- ◆ **End 2006: 1<sup>st</sup> Deployment of Next-generation US LHCNet**
  - Transition to new circuit-oriented backbone, based on optical multiplexers.
  - Maintain full switched and routed IP service for a controlled portion of the bandwidth
- ◆ **Fall: Start of LHC operations**



## Primary Milestones for 2007-2010



- ◆ **Provide a robust network service without service interruptions, through**
  - ❑ Physical diversity of the primary links
  - ❑ Automated fallback at the optical layer
  - ❑ Mutual backup with other networks (ESnet, IRNC, CANARIE, SURFNet etc.)
- ◆ **Ramp up the bandwidth, supporting an increasing number of 1-10 Terabyte-scale flows**
- ◆ **Scale up and increase the functionality of the network management services provided**
- ◆ **Gain experience on policy-based network resource management, together with FNAL, BNL, and the US Tier2 organizations**
- ◆ **Integrate with the security (AAA) infrastructures of ESnet and the LHC OPN**



## **Additional Technical Milestones for 2008-2010**



**Targeted at large scale, resilient operation with  
a relatively small network engineering team**

### **◆ 2008: Circuit-Oriented services**

- ☐ **Bandwidth provisioning automated (through the use of MonALISA services working with the CIENAs, for example)**
- ☐ **Channels assigned to authenticated, authorized sites and/or user-groups**
- ☐ **Based on a policy-driven network-management services infrastructure, currently under development**

### **◆ 2008-2010: The Network as a Grid resource (2008-2010)**

- ☐ **Extend advanced planning and optimization into the networking and data-access layers.**
- ☐ **Provides interfaces and functionality allowing physics applications to interact with the networking resources**



# Conclusion



- ◆ **US LHCNet: An extremely reliable, cost-effective High Capacity Network**
  - ◆ **A 20+ Year Track Record**
- ◆ **High speed inter-connections with the major R&E networks and US T1 centers**
- ◆ **Taking advantage of rapidly advancing network technologies to meet the needs of the LHC physics program at moderate cost**
- ◆ **Leading edge R&D projects as required, to build the next generation US LHCNet**