

*U.S. Department of Energy*



*Office of Science*

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Advanced Scientific Computing Research Program

# High Performance Networks & Associated Research

**Dan Hitchcock**

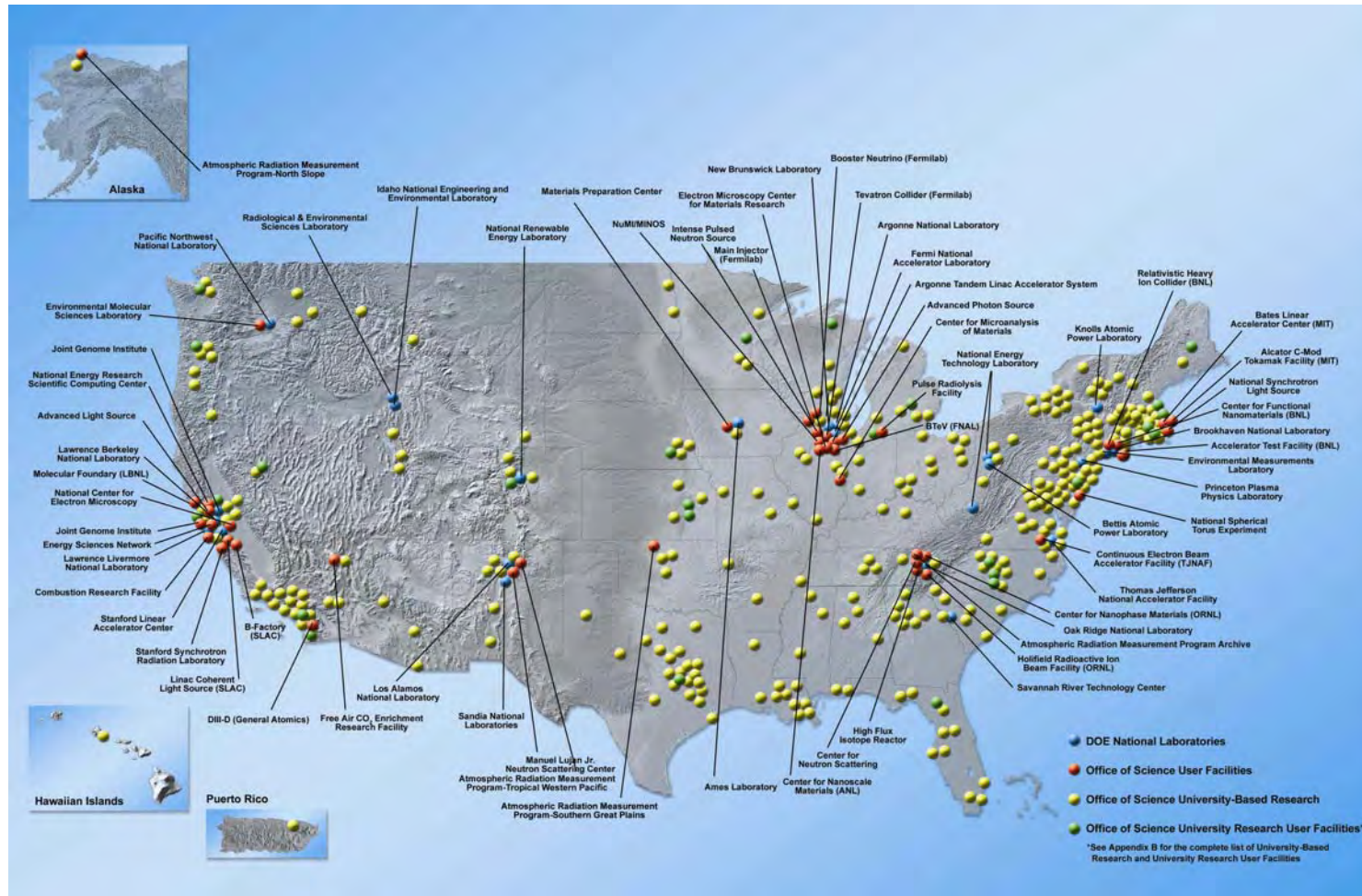
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301-903-6767

ASCAC Meeting: March 15-16, 2006

# Networks Support Science Mission

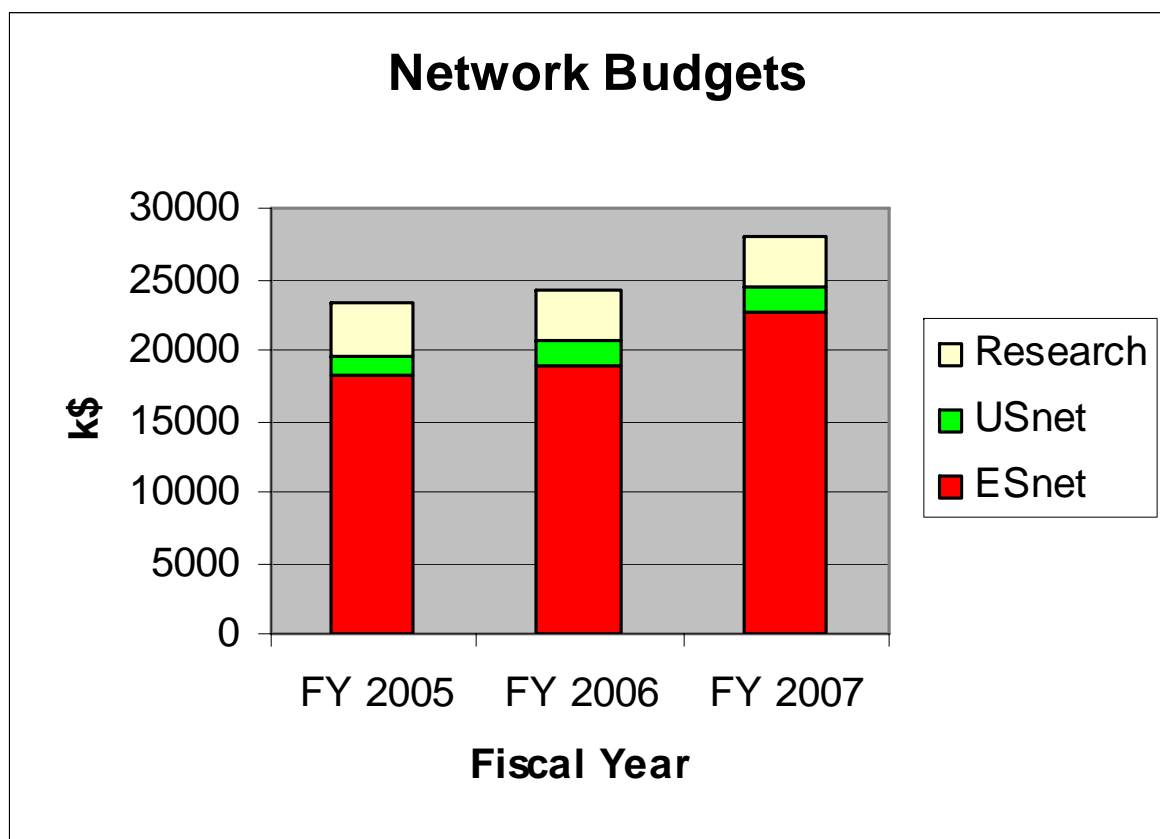
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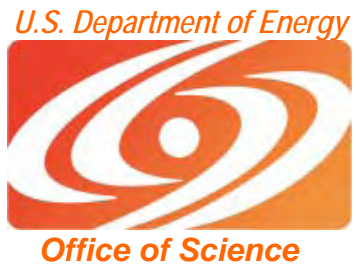




# FY 2007 Budget Request Supports Office of Science

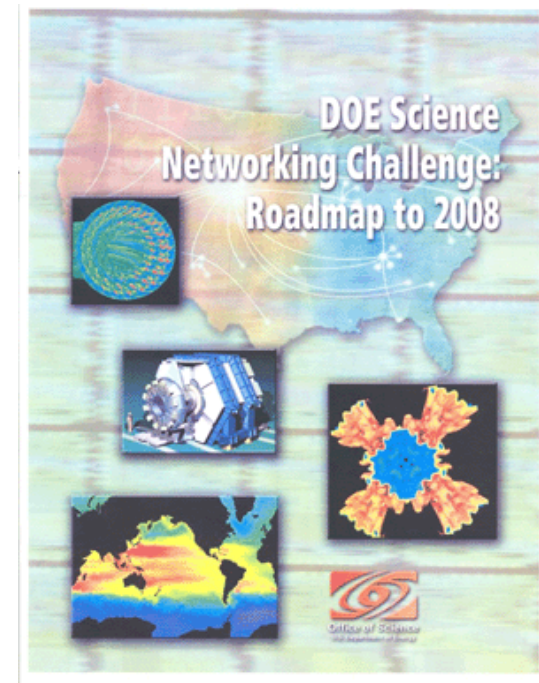
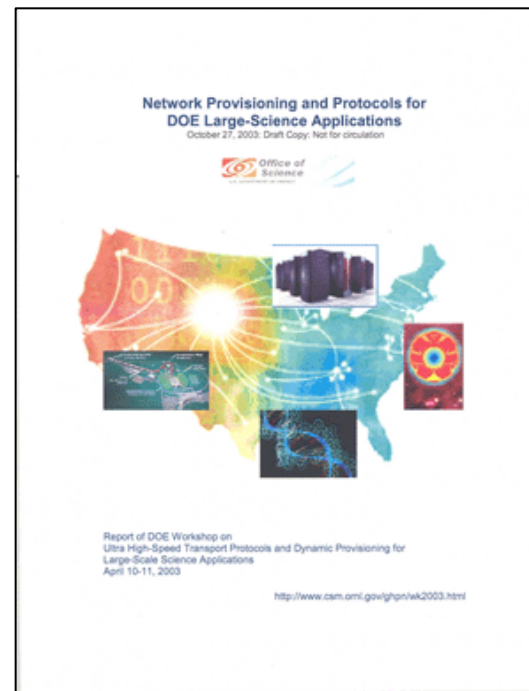
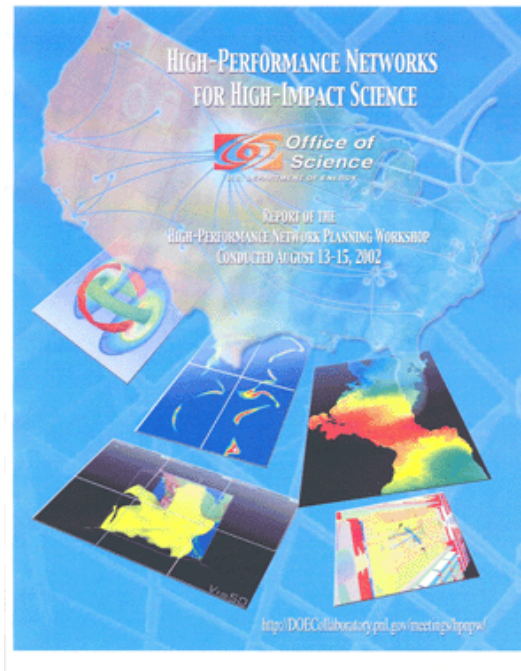
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# Networking Workshops

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# Ultra Science Net Ultra High-Speed Network Testbed

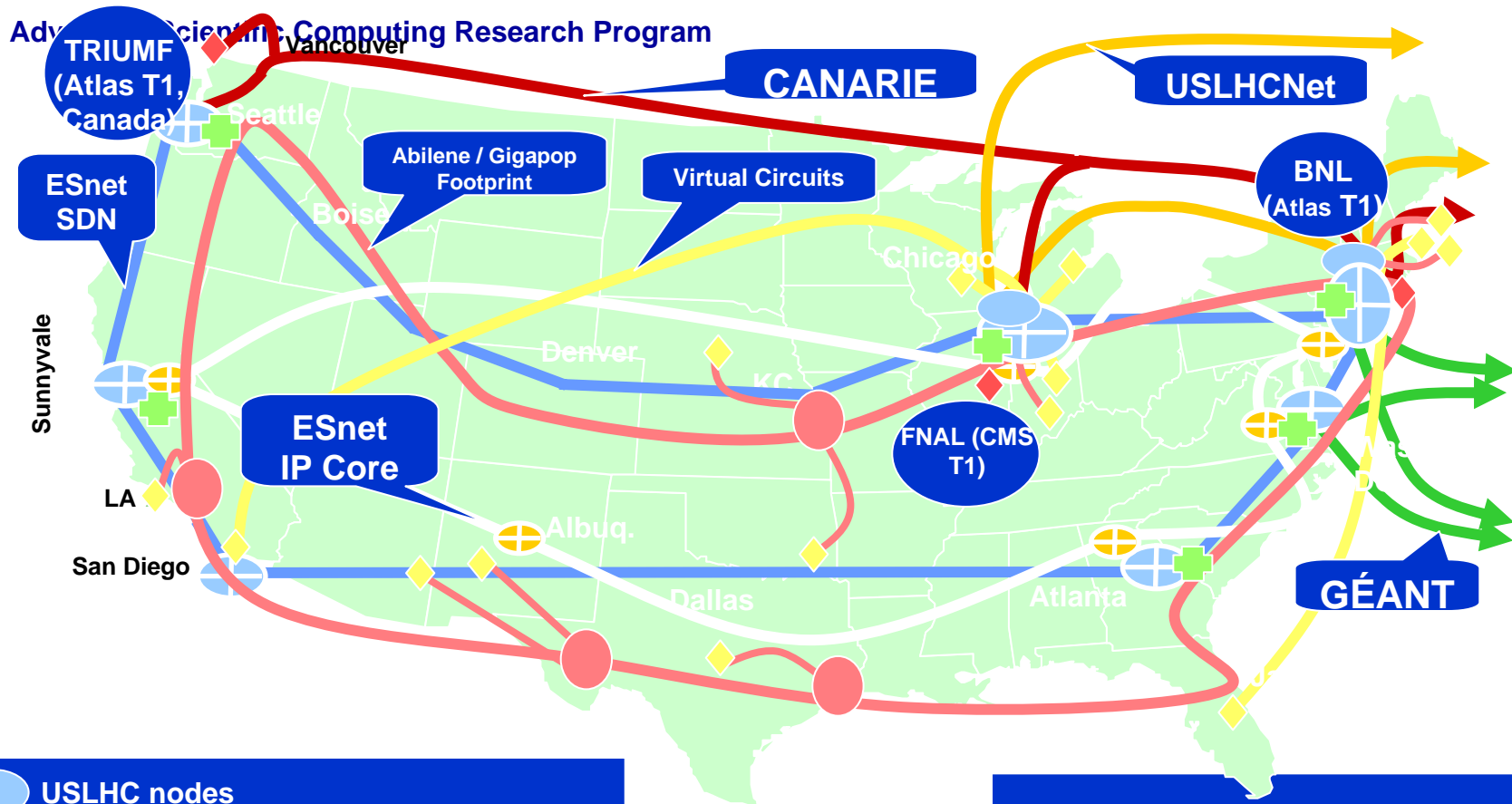
## Advanced Scientific Computing Research Program

- Goal
  - Explore advanced cost-effective optical network technologies that can be used to distribute petabytes-scale data, interconnect distributed terascale computing resources and instrument, and support distributed high-end applications
- Features:
  - 20 Gpbs with node at: ORNL, StarLight, FNAL, PNNL, Sunnyvale, Caltech, ANL\*, BNL\*
  - Circuit peering at Starlight with **Internet2 HOPI and EU GEANT**
- Capabilities
  - Guaranteed end-to-end VLAN circuits
  - On-demand and reservation bandwidth services
  - Transport protocols independent (non-IP)
  - Hybrid mode: Seamless co-existence with best-effort IP network
- Tech Transfer
  - LHCnet, Interet2 HOPI, ESNat Science Data Network, LHC & ATLAS tier1 network technologies





# Requirements Grow Rapidly Networks for LHC



- USLHC nodes
- Abilene/GigaPoP nodes
- ESnet IP core hubs
- ESnet SDN/NLR hubs
- Cross connects with Internet2/Abilene

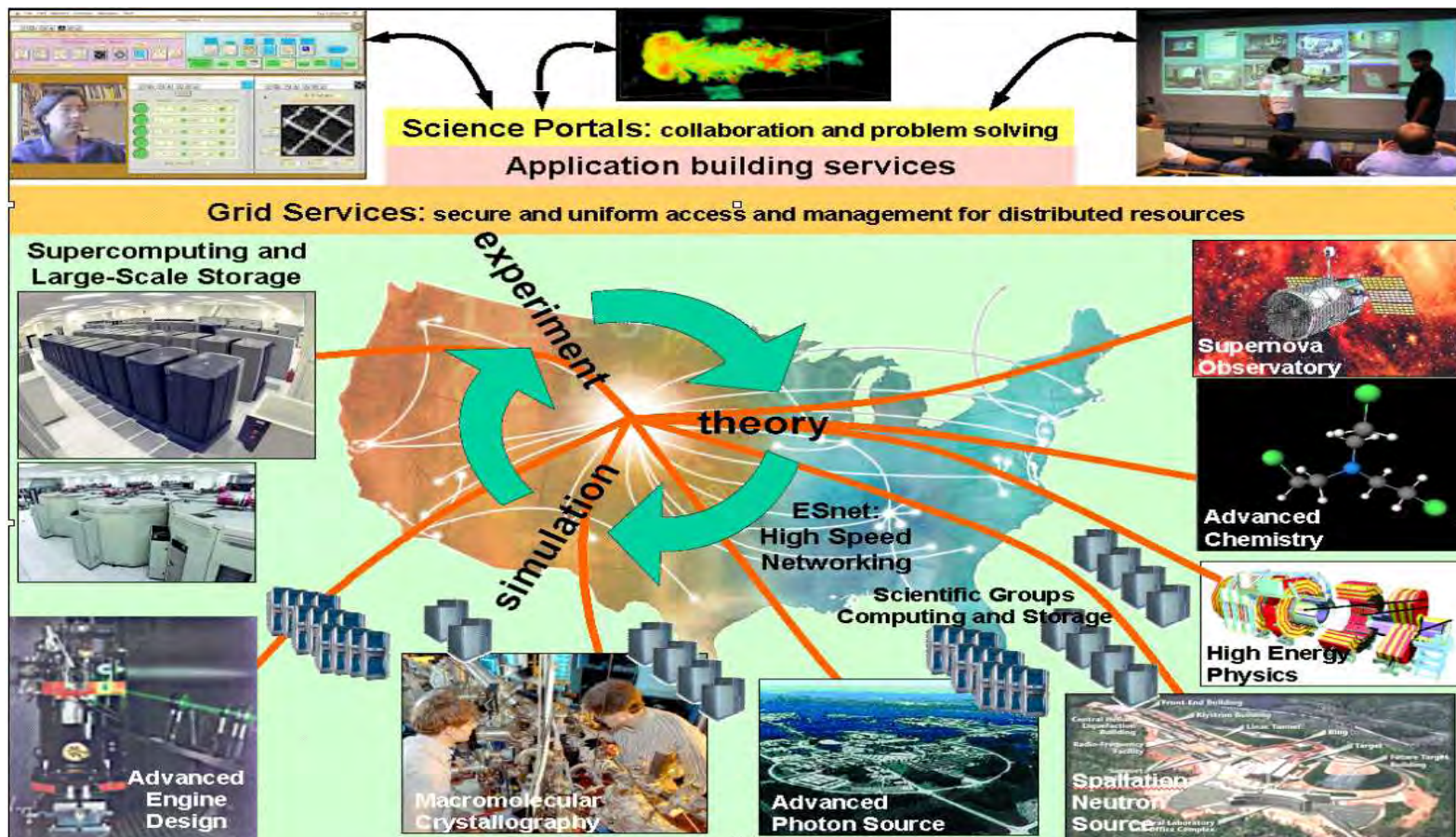
- Tier 1 Centers
- Tier 2 Sites

- Direct connectivity T0-T1-T2
  - USLHCNet to ESnet to Abilene
- Backup connectivity
  - SDN, GLIF, Virtual Circuits



# Everything is Integrated in the Future

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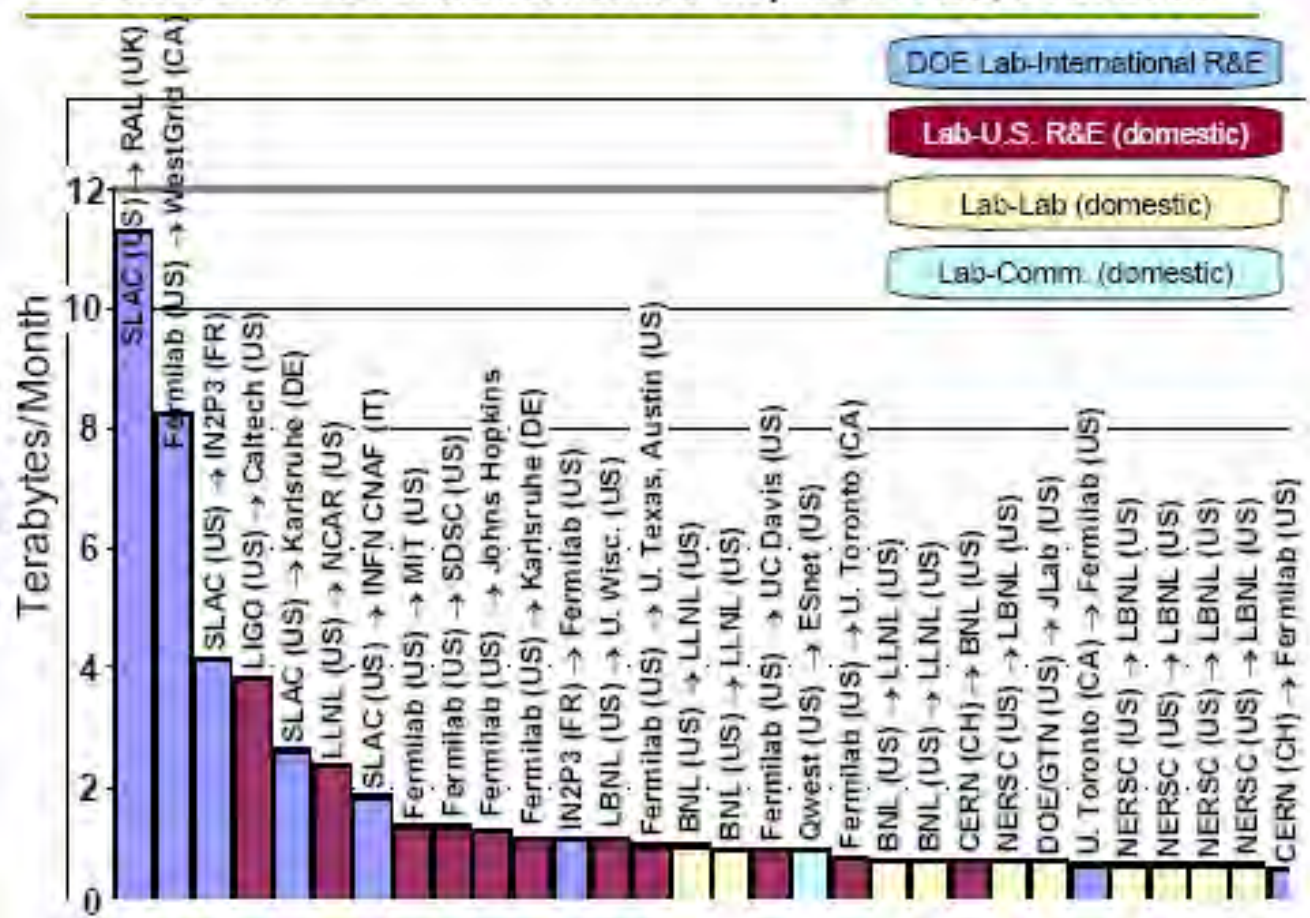




# ESnet Traffic Characterization

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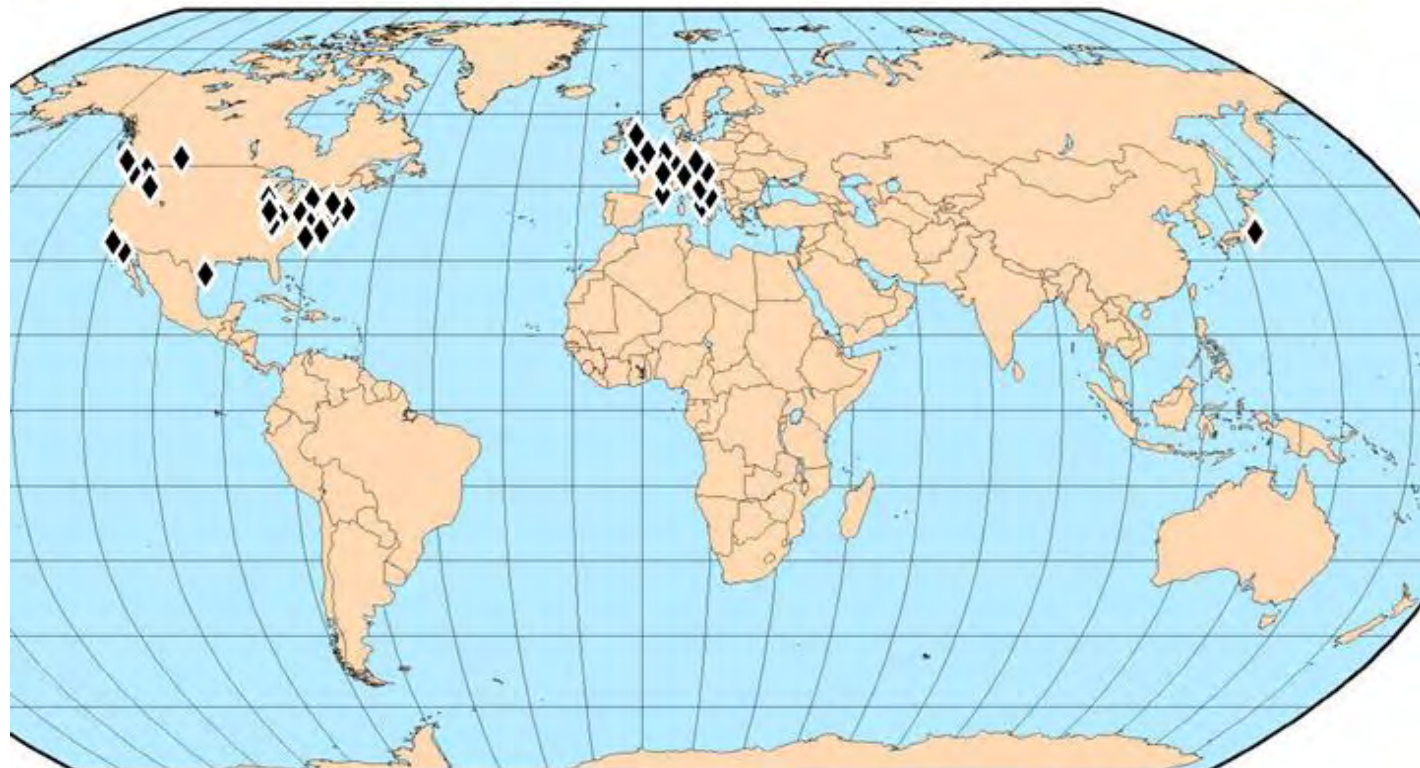
Source and Destination of the Top 30 Flows, Feb. 2005



# ESnet links US to the World

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## Footprint of SC Collaborators - Top 100 Traffic Generators



◆ Universities and research institutes that are the top 100 ESnet users

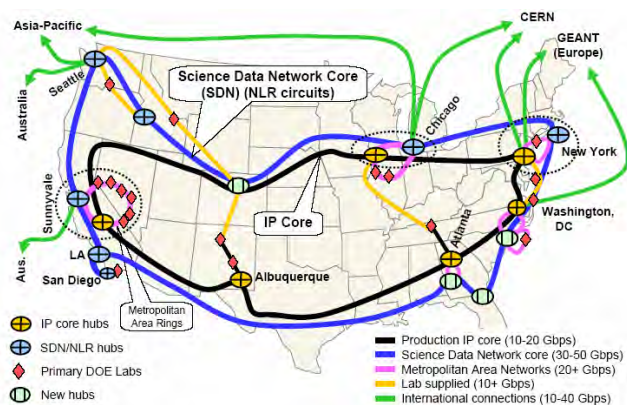
- The top 100 data flows generate 30% of all ESnet traffic (ESnet handles about  $3 \times 10^9$  flows/mo.)
- 91 of the top 100 flows are from the Labs to other institutions (shown) (CY2005 data)

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# Disruptive Changes in Networks for Science

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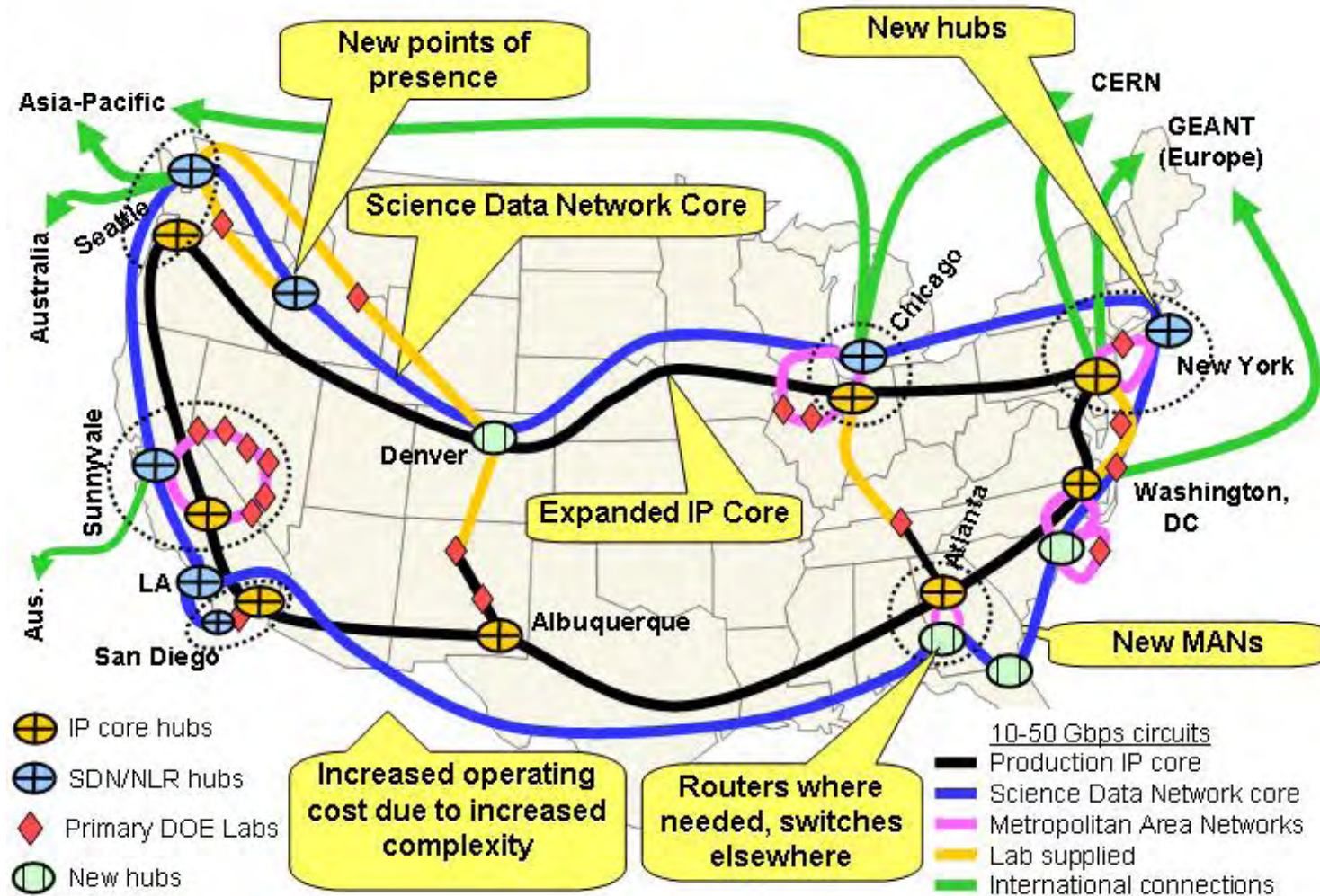
INTERNET. Leading & Emerging Regional Optical Networks FiberCo

- Alabama
- Arkansas
- California (CALREN)
- Colorado (FRGP/BRAN)
- Connecticut (Conn. Education Network)
- Florida (Florida LambdaRail)
- Georgia (Southern Light Rail)
- Indiana (I-LIGHT)
- Illinois (I-WIRE)
- Louisiana (LONI)
- Maryland, D.C. & northern Virginia (MAX)
- Michigan (MiLR)
- Minnesota
- New England region (NEREN)
- New York (NYSERNet, Cornell)
- North Carolina (NC LambdaRail)
- Ohio (Third Frontier Network)
- Oklahoma (OneNet)
- Oregon
- Pacific Northwest (Lariat - NIH BRIN, PNNL)
- Rhode Island (OSHEAN)
- SURA Crossroads (southeastern U.S.)
- Tennessee (OneTN)
- Texas (LEARN)
- Virginia (MATP)
- Wyoming



# Future ESnet Proposal

Advanced





# ESnet External Review Feb 21-23

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## Advanced Scientific Computing Research Program

- **Same, gigapops, network research, SC laboratories Process as used for other major SC projects**
- **Broad Committee representing scientific disciplines, universities**
- **Broad endorsement of ESnet approach**
- **Recognition of increased complexity and need for outreach to partners, especially Regional Optical Networks and end sites**



# Implications for Sites

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- **Hybrid Networks in site infrastructure**
- **Network “Peering” at Layers 1,2,3**
- **New Cybersecurity Challenges**
- **Defining Next Generation DMZ**





# Network Environment Research

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- **Inter-Domain Interfaces**
- **End-to-end performance**
- **Cyber security**
- **High-Performance Middleware**
- **Integrated testbeds and networks**