High Performance Networks & Associated Research

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Networks Support Science Mission
FY 2007 Budget Request Supports Office of Science

Advanced Scientific Computing Research Program

Network Budgets

Fiscal Year

FY 2005 FY 2006 FY 2007

Research
USnet
ESnet

k$
Networking Workshops

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ESnet Connects SC Assets to Scientists worldwide (since 1987)

ESnet Science Data Network (SDN) core

Japan (SINet)
Australia (AARNet)
Canada (CA*net4)
Taiwan (TANet2)
Singarex

CA*net4
France
GLORiad
StarTap
(Russia, China)
Taiwan (TANet2)
Korea (Kreonet2)
UltraLight

SINet (Japan)
Russia (BIMP)

CERN
(USLHCnet)
CERN+DOE funded

GÉANT
- France, Germany,
Italy, UK, etc

ESnet IP core: Packet over SONET Optical Ring and Hubs

ESnet IP core

International (high speed)
10 Gb/s SDN core

10G/s IP core

2.5 Gb/s IP core

MAN rings (= 10 G/s)

OC12 / GigEthernet

OC3 (155 Mb/s)

45 Mb/s and less

AMPATH
(42 end user sites)

Office Of Science Sponsored (22)
NNSA Sponsored (12)
Joint Sponsored (3)
Other Sponsored (NSF LIGO, NOAA)
Laboratory Sponsored (6)

commercial and R&E peering points

ESnet core hubs

Abilene high-speed peering points with Internet2/Abilene

JGI
LBNL
SLAC
NERSC
SDSC

Lab DC Office

USN

NCI

DOE-ALB

OSC GTN

NNSA

International

MAN rings

Abilene

Abilene high-speed peering points with Internet2/Abilene

AMPATH
(S. America)

AS/400

SNV SDN

SNV

SNV SDN

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- **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, ESNet Science Data Network, LHC & ATLAS tier1 network technologies
Requirements Grow Rapidly
Networks for LHC

- 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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Science Portals: collaboration and problem solving
Application building services

Grid Services: secure and uniform access and management for distributed resources

Supercomputing and Large-Scale Storage

ESnet: High Speed Networking
Scientific Groups Computing and Storage

Advanced Engine Design
Macromolecular Crystallography
Advanced Photon Source

Supernova Observatory
Advanced Chemistry
High Energy Physics
Spallation Neutron Source
ESnet Traffic Characterization

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Source and Destination of the Top 30 Flows, Feb. 2005
ESnet links US to the World

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 3x10^9 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
Future ESnet Proposal

Advanced

New points of presence
Science Data Network Core
Expanded IP Core

New hubs
CERN
GEANT (Europe)
New York
Washington, DC

Increased operating cost due to increased complexity
Routers where needed, switches elsewhere

IP core hubs
SDN/NLR hubs
Primary DOE Labs
New hubs

10-50 Gbps circuits
Production IP core
Science Data Network core
Metropolitan Area Networks
Lab supplied
International connections

ASCAC Meeting: March 15-16, 2006
ESnet External Review
Feb 21-23

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• 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

• 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