



ESnet

The Energy
Sciences Network

OVERVIEW

ESnet Services

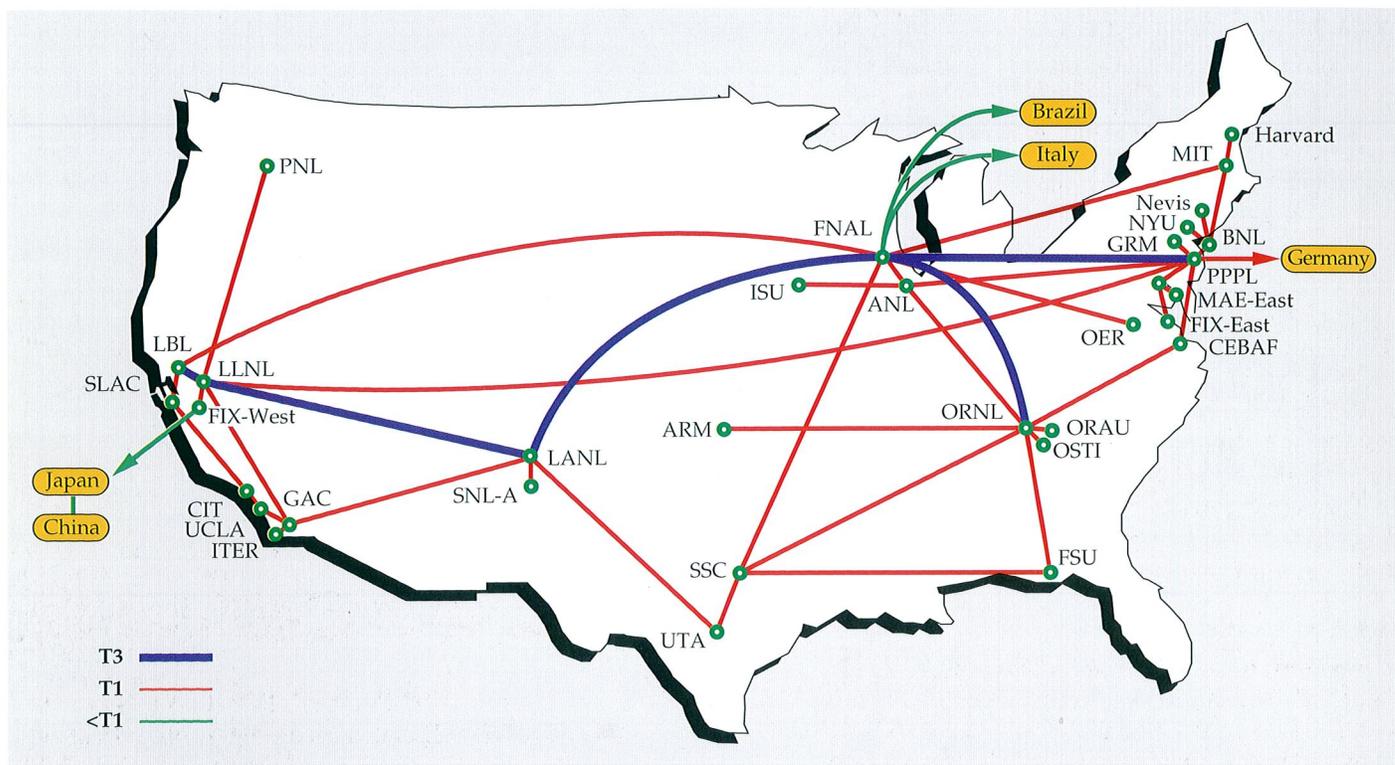


Figure 1: ESnet Backbone mid-1994

What Is ESnet?

The Energy Sciences Network (ESnet) is a nationwide computer data communications network managed and funded by the U.S. Department of Energy Office of Energy Research (DOE/OER) for the purpose of supporting multiple program, open scientific research. ESnet is intended to facilitate remote collaboration by researchers and to support needed information access and dissemination among scientific collaborators by providing

- widespread access to research facilities,
- state-of-the-art communications for collaborators, and
- on-line information and related services.

ESnet is a "backbone" network, that is, a network to interconnect other networks, in particular the local

area networks (LANs) of the directly connected sites. See Figure 1.

ESnet began initial deployment of its T1 (1.3 to 1.5 Mbps) circuit-based backbone in late 1989. It became fully operational with an initial configuration in early 1990, including 19 major OER-supported sites directly connected to the backbone. Today over 30 sites are directly connected at speeds as high as 45 Mbps. Growth in network traffic since January 1990 is shown in Figure 2. Connectivity to numerous other scientific and educational locations is provided through extensive interconnections with other networks that comprise the global Internet.

Multiple network layer protocols are supported including the Internet Protocol (IP), DECnet Phase IV, and the Open Standards Interconnection ConnectionLess Network Protocol (OSI CLNP).

How is it managed?

ESnet is an on-going activity whose success depends heavily on the cooperation and collaboration of the DOE Energy Research (ER) community. Although responsibility for the implementation and operation of ESnet resides at the National Energy Research Supercomputer Center (NERSC) located at Lawrence Livermore National Laboratory in Livermore, California, the guidance and collaboration that makes the network a success comes from many sources outside of NERSC. ESnet is, in terms of number of sites actively participating, one of the largest collaborations in DOE.

ESnet activity is guided by the ESnet Steering Committee (ESSC), comprising members appointed by each represented program, currently with one or more representatives from each of five Energy Research

Programs. The ESnet Coordinating Committee (ESCC) coordinates both the participation of, and information dissemination to, the individual institutions which benefit from the use of ESnet. The current ESnet program plan, prepared by the Steering Committee, is available from the National Technical Information Service as report DOE/ER-0486T (March 1991). An updated program plan is expected to be completed by Fall of 1994 and will be available on-line on the ESnet Network Information Center (NIC). A list of ESSC members is available via ESnet's World-Wide Web (WWW) as well. See the section titled "For More Information."

Who may use it?

Network activity in support of DOE/OER sponsored collaborations constitutes the current principal authorized usage of ESnet. The five major OER programs supported are: Applied Math Sciences, Basic Energy Sciences, Health and Environmental Research, High Energy and Nuclear Physics, and Fusion Energy. Usage in support of other activities, such as interagency collaboration or foreign country access may also be authorized usage.

ESnet has served the Energy Research community almost exclusively since its inception. However, as the integration of networked data communications services into the daily life of researchers, scientists, and other personnel has continued to grow, a number of other program areas within DOE have expressed growing interest in availing themselves of the services of ESnet.

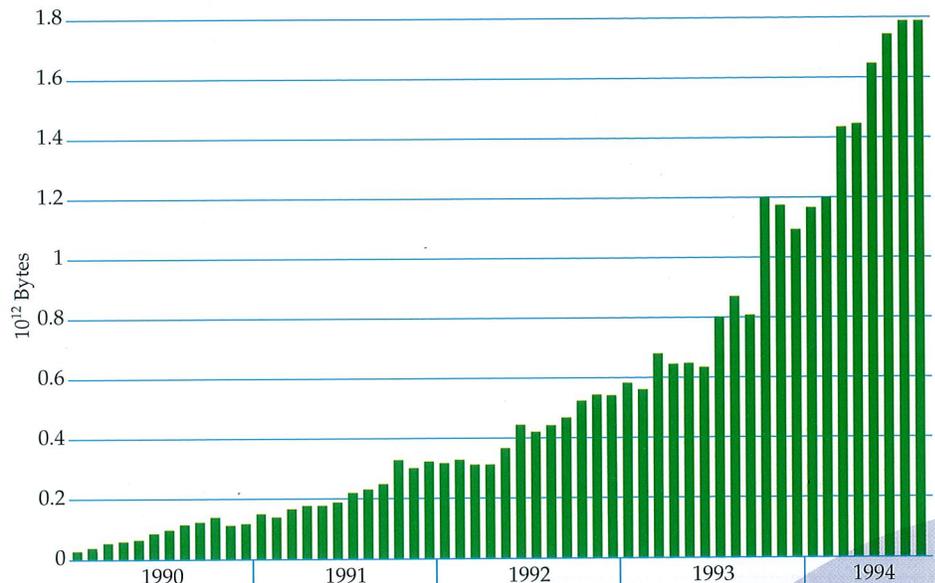


Figure 2: ESnet bytes accepted per month

What is its impact?

NREN and NII

The High Performance Computing and Communications (HPCC) Program was signed into law in late 1991. The basic goal of this program is to bolster the global competitiveness of the U.S. in the areas of computing and communications. The role of ESnet as DOE's contribution to the National Research and Education Network (NREN - a national internetwork capable of gigabit speeds by 1996) has been planned in concert with the provisions of the bill. The program has recently expanded to include a broader concept called the National Information Infrastructure (NII), or the "Information Superhighway" which emphasizes applications that will make use of the underlying NREN facilities. ESnet represents DOE's contribution to NREN and will be a major component of its support for NII production-level applications.

AGENCY EFFECTIVENESS

ESnet is becoming a core infrastructure component for research activities within DOE. As the agency works to streamline its operations, it is becoming clear that cooperation and collaboration are key elements to becoming more efficient. The importance of this ability to carry out research independent of geography has been recognized for some time within the research community. The very high cost of major experiments has established the need to centralize major research facilities and provide widespread access to the resources, as well as facilitate communication among the resulting collaboration's distributed personnel, in many cases on an international basis.

Collaborations are recognized as a vital element of facilitating the new directions emphasized by DOE, including both internal collaborations as well as collaborations with organizations and personnel external to the agency, domestically and internationally.

What interconnections are provided?

A major component of the networking service provided by ESnet is broad interconnectivity to the global research and education community. This interconnectivity is provided in a variety of means, including direct connection of "backbone sites" as well as indirect connections through other R&E networks.

Figure 3 shows the immediate (or directly connected) IP networking neighbors of ESnet. Other networks which are not direct neighbors to ESnet can also be reached by using the direct neighbors or still other networks as intermediaries.

ESnet backbone sites

The following is a list of sites directly connected to the ESnet backbone as of 1994.

ANL:	Argonne National Laboratory, Argonne, IL
BNL:	Brookhaven National Laboratory, Upton, NY
CIT:	California Institute of Technology, Pasadena, CA
CEBAF:	Continuous Electron Beam Accelerator Facility, Newport News, VA
DOE:	DOE Office of Energy Research, Germantown, MD
FIE:	Federal Information Exchange, Germantown MD
FIX-E:	Federal Interagency eXchange-East, University of Maryland, College Park, MD,
FIX-W:	Federal Interagency eXchange-West, NASA Ames Research Center, Mountain View, CA
FNAL:	Fermi National Accelerator Laboratory, Chicago, IL
FSU:	Florida State University, Tallahassee, FL
GA:	General Atomics, La Jolla, CA
GRM:	Grumann Aerospace, Princeton, NJ
HARVARD:	Harvard University, Cambridge, MA
ISU:	Iowa State University, Ames, IA
ITER:	International Thermonuclear Experimental Reactor Project, La Jolla, CA
LBL:	Lawrence Berkeley Laboratory, Berkeley, CA
LLNL:	Lawrence Livermore National Laboratory, Livermore, CA
LANL:	Los Alamos National Laboratory, Los Alamos, NM
MIT:	Massachusetts Institute of Technology, Boston, MA
NEVIS:	Nevis Laboratory, Columbia University, Irvington, NJ
NYU:	New York University, Upton, NY
OER:	U.S. DOE, Office of Energy Research, Germantown, MD
ORAU:	Oak Ridge Associated Universities, Oak Ridge, TN
OSTI:	Office of Science and Technology Information, Oak Ridge, TN
ORNL:	Oak Ridge National Laboratory, Oak Ridge, TN
PNL:	Pacific Northwest Laboratory, Richland, WA
PPPL:	Princeton Plasma Physics Laboratory, Princeton, NJ
SNLA:	Sandia National Laboratory, Albuquerque, NM
SNLL:	Sandia National Laboratory, Livermore, CA
SLAC:	Stanford Linear Accelerator Center, Palo Alto, CA
SSC:	Superconducting SuperCollider, Waxahachie, TX
UCLA:	University of California, Los Angeles, CA
UTA:	University of Texas, Austin, TX

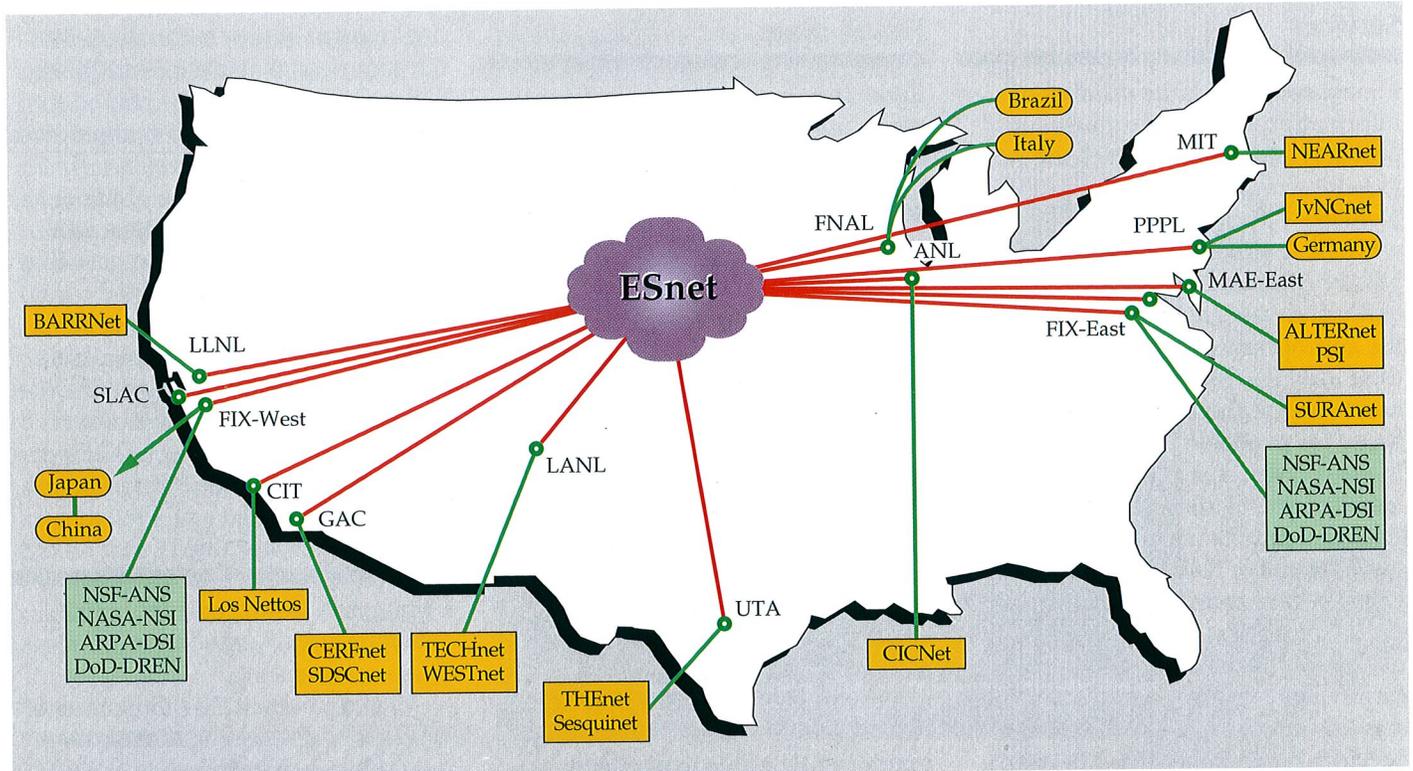


Figure 3: ESnet direct IP neighbors map

Other federal agencies

ESnet currently provides access to two Federal Interagency eXchange (FIX) points to allow efficient exchange of data with other federal agencies including ARPA, DoD, NASA, and NSF. The FIX-West interconnect point is located at the NASA Ames Research Center, near San Francisco, California, and FIX-East is located at the University of Maryland, near Washington, DC.

Regional networks

The following is a list of regional networks with which ESnet is currently interconnected: BARRNet (San Francisco Bay Area Regional Research Network), CERFnet (California Education and Research Federation Network), CICNet (Committee on Institutional Cooperation Network), JvNCnet Northeast Research

Regional Network, Los Nettos (Los Angeles Regional Network), NEARnet (New England Academic and Research Network), Sesquinet (Texas Sesquicentennial Network), SURAnet (Southeastern Universities Research Association Network), TECHnet, THEnet (Texas Higher Education Network), and WESTnet.

Commercial networks

Connections to commercial networks are also available, including ALTERnet and PSI (Performance Systems International).

International connections

A large and growing number of research activities within DOE now make use of international collaborations. An example is the International Thermonuclear Experimental Reactor (ITER), which has contributing mem-

bers from the U.S., Japan, Europe, and Russia. Communications among these members is essential to the success of the project.

ESnet currently supports direct international connectivity to Japan, Germany, Italy, and Brazil. A number of program requirements for access into the Former Soviet Union, particularly Russia have been identified. Access to a number of Russian networks is currently available through indirect connections. Plans for additional access into Russia are currently being defined.

Services

ESnet provides a large number of information and other on-line support services, most of which are provided via replicated servers called Network Information Centers (NICs) with the Internet host names of NIC.ES.NET and NIC2.ES.NET. Generally end-users must have access to the appropriate client software on their local PC, Macintosh, or workstation to access these services, although many are available via Telnet or FTP. In most cases, client software is installed and available for use on the NIC, and may be accessed via the NIC's Telnet or X-window interfaces. Client source code is also available on the NIC for users to download and use on their local computing platforms. More information about ESnet services may be found in the ESnet Services Brochure, UCRL-TB-114841.

Future plans

ESnet is currently in the process of being upgraded to a next generation capability. Over the next five years, the plan is to upgrade the capability of the network to include access rates of $N \times 1.5$ Mbps, 45, 155, and 622 Mbps; an increase of up to 400-fold over the current access rates. This upgrade is being done in concert with HPCC goals and will include a collaborative effort with a national communications vendor. This working relationship with industry will help enhance U.S. competitiveness in the area of emerging high-speed data communications technology. By making new technology available to ESnet on an early availability basis for initial "shakedown" and subsequent incorporation into a production network environment, the selected vendor will be able to accelerate the

deployment of new technology into the commercial marketplace. Other U.S. vendors will also be helped because of the increased market place acceptability that will result.

Interest in making use of ESnet to support research areas within DOE, but outside of ER, has been growing. The first steps are the establishment of internal formal agreements to make ESnet more broadly available. Expansion and enhancement of ESnet is anticipated in response to the requirements of these new DOE program areas.

Video conferencing

ESnet provides support for both "meeting room" and "desktop" class video conferencing.

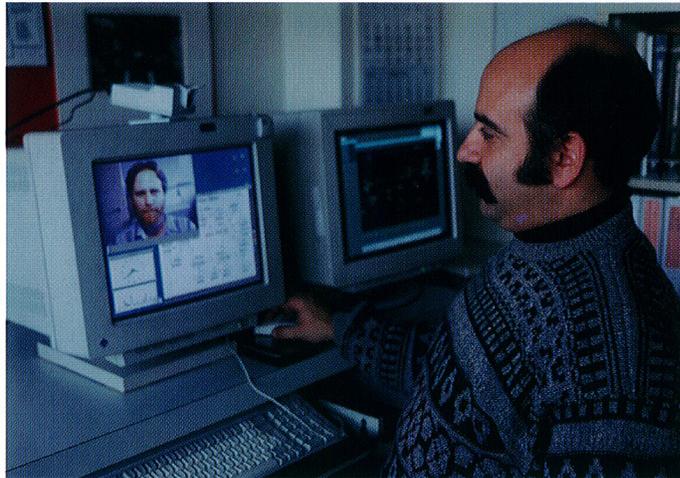
Meeting room video conferencing is typically done using a small to medium size meeting room specifically equipped to serve as a mini-studio, including cameras, microphones, and monitors. Communications are currently done using ISDN (Integrated Services Digital Network) circuits on a dial-up basis at speeds ranging from 64Kbps to T1 in 64Kbps steps, with typical conferences using 128Kbps to 384Kbps. ESnet provides a large MCU (Multi-point Control Unit), which essentially serves as a meeting director for conferences with three or more sites participating. The MCU is capable of supporting multiple multi-way conferences simultaneously. ESnet also provides an on-line reservation system which allows users to check availability and reserve video resources needed for planned video conference sessions.



Meeting room video conferencing

Desktop video conferencing is an emerging capability which uses an individual's office, workstation monitor, mini-camera and microphone as the studio. For many implementations, the compressed video data is transmitted over the network as IP packetized data. Because of the large (and continuous) streams of data that can be generated and simultaneously sent to several other network sites, the ESnet Mbone (Multicast backbone) has been implemented as a virtual network to minimize the amount of duplicate traffic transmitted (traffic intended for several remote locations can be sent as one data stream). This experimental service allows users to participate in real time with colleagues around the globe from their office.

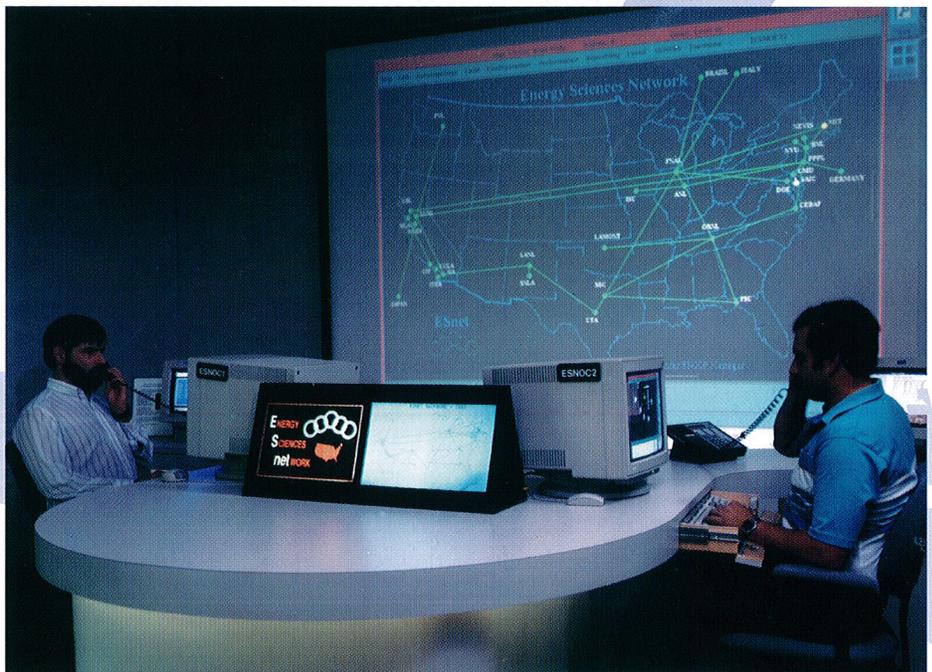
problems will be properly tracked. Requests for information on ESnet can be directed to info@es.net. Problems can be reported to trouble@es.net.



Desktop video conferencing

Network Operations Center

The ESnet Network Operations Center (NOC) provides 24 hour/day monitoring and control capabilities for the various network components that comprise ESnet. The Operations Center is operated by the ESnet staff and the NERSC Supercomputer Operations personnel. The NOC staff continuously monitor the ESnet backbone facilities to verify the network's integrity and to routinely gather statistics for troubleshooting and long term planning. Electronic mail boxes for network information, network operations, and trouble calls are provided. An on-line trouble ticket system exists such that all reported



The ESnet Network Operations Center

For More Information

General Contact

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e-mail:

Internet: info@es.net
DECnet: 42158::INFO
X.400: /s=info/p=ESnet/a= /c=us/

On-line Information

Telnet: nic.es.net anonymous login
FTP: ftp.es.net anonymous login
Gopher: gopher.es.net
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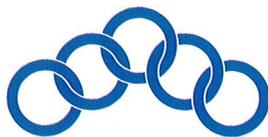
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NERSC



Lawrence Livermore
National Laboratory



United States
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