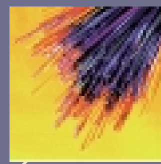
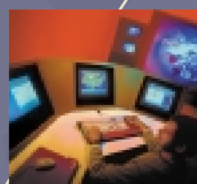
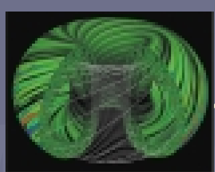
The National Energy Research Scientific Computing Center

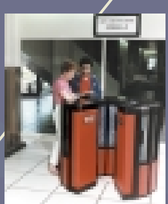
The Energy Sciences Network

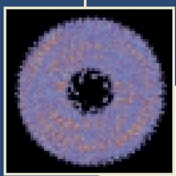
25 YEARS OF LEADERSHIP











Greetings.

In 1974 the staff of the Controlled Thermonuclear Research Computer Center, NERSC's original name, began a revolution in computing. Their new vision was to provide a supercomputer to a user community spread over the nation, instead of only to local users, and they set about creating and adapting technology to do so. Over the years, the staff of NERSC and ESnet have delivered on that original concept, and continued to set the standards for the supercomputer centers and research networks that followed.

Twenty-five years ago, the word "supercomputer" was not yet in current use, and we were just scientists; "computational scientist" was not yet a respectable or even understandable term. Computer science was only beginning to gain recognition as an independent discipline. In those early days, scientists ordinarily sat in a computer center, keypunching decks of computer cards for batch submission, and then waiting for fan-folded stacks of printout. That was what it meant to use a computer center. Interacting with a large computer via a printing teletype or a "dumb" terminal was still a novelty for most of the country's scientists.

The idea that interactive scientific computing could be provided to a national community from a central facility was truly revolutionary. The early NERSC center achieved that goal and built the modern aesthetic of supercomputing, which allows scientists to interact with the machines as though they were in the same room, visualizing and manipulating results immediately. The aesthetic was so strong that for a while a delay was put in the connections for local users to give them the same level of access as users on the other side of the country. That arrangement ensured that the pressure for better service for the entire national community would be the dominant influence on the center.

The concept worked. Numerical simulation in plasma physics and fusion research advanced quickly and set a new standard for scientific discovery. These scientists were the vanguard of the supercomputer revolution. When NERSC broadened its mission to serve a larger scientific community in the late 1980s, new discoveries and advances over the entire spectrum of scientific research ensued.

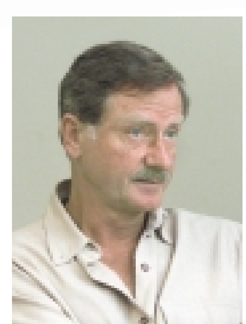
Another important result from the center was development of the Cray Time Sharing System. CTSS became the standard at other centers, and when the National Science Foundation centers in Illinois and San Diego were established, they also adopted the NERSC (then called the MFECC) model of a supercomputer center, including CTSS.

In its 25-year history NERSC has witnessed a stunning change in the technology of computing. In 1974 the speed of a supercomputer was measured in megaflops and its memory was large if it had 64,000 words. Today our measures are teraflops for speed and terabytes for memory — million-fold increases over the standards of 25 years ago. The history of computing technology is not NERSC's history, though. NERSC's story is about invention and scientific discovery, and it is the story of the computer scientists and scientists of the center whose accomplishments created its influential past and are creating its future.

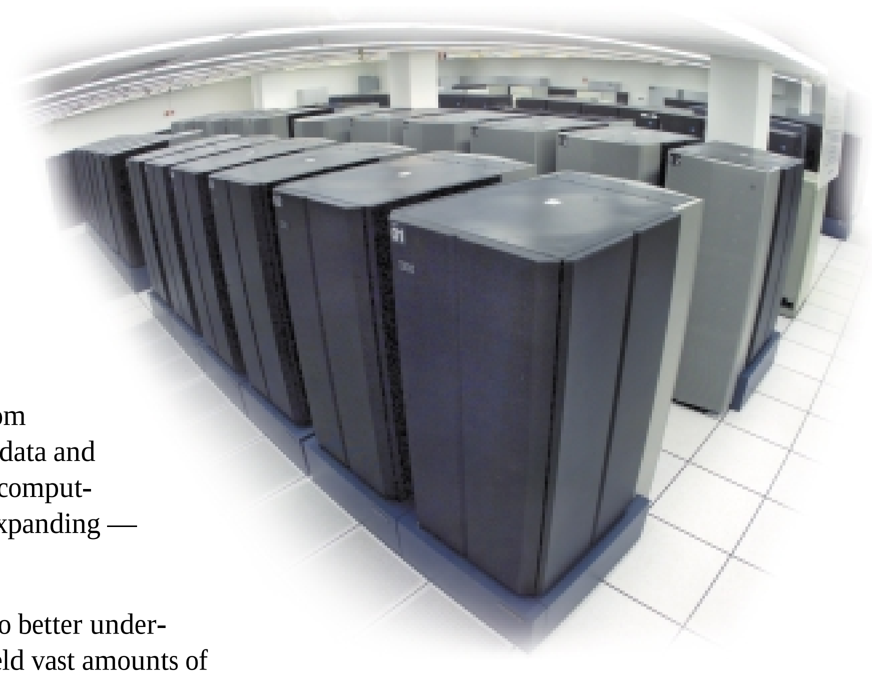
Bill McCurdy
Associate Laboratory Director for Computing Sciences
Ernest Orlando Lawrence Berkeley National Laboratory

JOHN KILLEEN
CTRCC-NMFECC
Director
1974-1989

DIETER FUSS
NMFECC-NERSC
Director (acting)
1989-1991



LEADING THE WAY

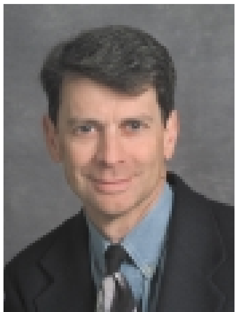


A team of scientists in Tennessee, Iowa, New York, California and England studying the behavior of magnetic fields develop a computer model which shows how the magnetic properties of iron atoms change as the temperature increases. The resulting simulations provide new information about the behavior of magnetic fields.

Physicists in Berkeley, California, trying to determine whether our universe will continue to expand or eventually collapse, gather data from dozens of distant supernovae. By analyzing the data and simulating another 10,000 supernovae on supercomputers, the scientists conclude that the universe is expanding — and at an accelerating rate.

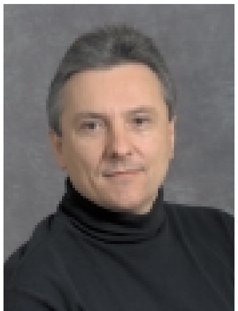
Researchers in Princeton, New Jersey, seeking to better understand how hot gases can be fused together to yield vast amounts of energy, create computer simulations which build on data from experiments and give them new insights into physics.

By harnessing the computing and networking power of the U.S. Department of Energy's National Energy Research Scientific Computing Center and the Energy Sciences Network, these scientists, along with thousands of others across the country, are proving the value of computational science as a complement to theoretical



BILL McCURDY
NERSC Director
1991-1995

HORST SIMON
NERSC Director
1996-present



JIM LEIGHTON
ESnet Head
1986-present

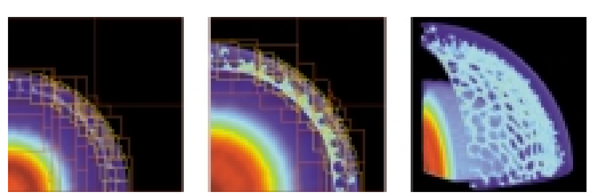
and experimental science. Additionally, computer simulations developed using the resources of NERSC and ESnet are giving scientists unprecedented understanding of such complex problems as combustion, protein folding, global climate changes and the behavior of subatomic particles.

Located at Lawrence Berkeley National Laboratory in Berkeley, California, NERSC and ESnet are national facilities serving the needs of researchers at DOE facilities and universities across the nation. Together, NERSC and ESnet represent the most powerful combination of open computing and networking in the country. As separate facilities, they have pioneered many of the technologies and capabilities taken for granted in today's world of high-performance computing and communications.

NERSC's Cray T3E supercomputer marked the center's move to massively parallel processing.

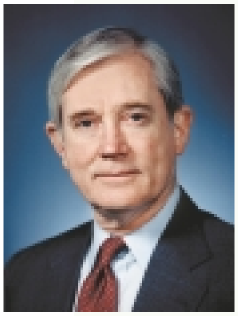
Funded by the DOE's Office of Science, NERSC's mission is to accelerate the pace of scientific discovery by providing high-performance computing, information and communications services. Our primary goal is to make possible computational science of scale, in which large, interdisciplinary teams of scientists attack fundamental problems in science and engineering that require massive calculations and have broad scientific and economic impacts.

To provide the computing power necessary to perform such calculations, NERSC has deployed leading-edge supercomputers throughout the center's existence. Most recently, NERSC installed the first phase of an IBM SP-3 system, which will eventually provide more than 2,048 processors for scientific computing with a top speed of 3 teraflops, or three trillion calculations per second. The first phase of that IBM system, with 512 processors for computing, has a peak performance of 410 gigaflops. NERSC also operates a 696-processor Cray T3E-900, and in the summer of 1999 accepted the first three of four planned Cray SV1 computers. NERSC's High Performance Storage System for storing and retrieving archival data, has a capacity of more than 500 terabytes, or five hundred trillion bytes of data.



AL TRIVELPIECE

Director, Oak Ridge National Laboratory



On Jan. 1, 1973, I took a two-year leave of absence from the University of Maryland and joined the Atomic Energy Commission as Assistant Director for Research in the Controlled Thermonuclear Research Division. Shortly after that, I initiated a review of the research program's activities. This led to a report, "Review of the Research Program of the Division of Controlled Thermonuclear Research," which was presented at a meeting in April at Massachusetts Institute of Technology. This report recommended, "the creation of a CTR computer center with its own special-purpose dedicated computer."

This recommendation in turn led to the establishment of a panel, chaired by Bennett Miller, to explore this possibility. The report of the panel, "The Application of Computers to Controlled Thermonuclear Research," pointed out that entire magnetic fusion program had the collective computing capability of one Control Data Corp. 6600 computer. It was clear that to make effective progress in understanding the properties of plasmas as produced in some of the experimental devices of that time would require several CDC 7600 equivalents. It was also clear from the budgetary circumstances that this would be impossible.

However, there was another possibility. Would it be possible to have one 7600 equivalent at one lab connected to the other labs with what would at that time be considered wide bandwidth? One of the arguments at the time was that this would allow several individuals interested in tokamak transport problems to simultaneously work on the same code. This would in principle allow a better comparison of experimental results between the various plasma experiments.

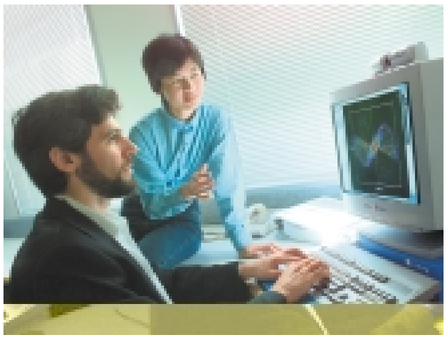
What was amazing to me was that this "revolutionary" idea got funded. One of the individuals who played a backroom role that proved to be essential was Johnny Abbadessa, controller of the AEC during this period. He liked the idea of multi-site users of one computer and provided essential backing in some of the difficult discussions with the Office of Management and Budget. The request for proposals to become the center led to submissions by the labs engaged in fusion research as to their capabilities and dedication. After due process, Livermore was selected to be the site of the Controlled Thermonuclear Research Computer Center (CTRCC). Sid Fernbach led the Livermore program at the beginning. A lot of hard work by more people than I can give credit to in this space did an outstanding job in turning an idea into reality.

I left the AEC in 1975 to return to teaching at the University of Maryland. Time passed. The CTRCC became the Magnetic Fusion Energy Computer Center. By some quirk of fate I ended up as the Director of the Office of Energy Research (now Science) in the Department of Energy in 1981. One of my early concerns was the lack of high-performance computing support of some of the other programmatic activities in ER. I created some uproar by allocating 5 percent of the time available on the fusion computer system for projects in ER other than fusion. The idea of having a high performance computing resource available for ER programs took hold and led indirectly to NERSC. I am pleased to have had the opportunity to be at the right place at the right time to help this outcome along. I hope that the future events leading to some version of the Strategic Simulation Initiative come to pass. This is important to the long-range efforts that the Department of Energy has set out for itself in various areas of science and technology development.

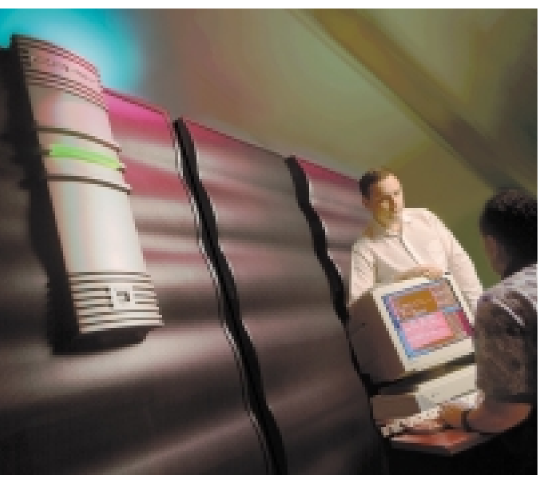
But as I told Bob Hirsch, who was the director of the fusion program at the AEC, "I believe that the ability of the members of the fusion and plasma physics communities to communicate with each other over the network will prove to be more valuable than the ability to work collectively on plasma transport codes in tokamaks". I still believe it.

Congratulations to everyone who has had a hand in keeping this idea alive for 25 years. I believe that the best is yet to come!

MORE THAN MACHINES



Although supercomputing centers and networks are often described in terms of their hardware, NERSC and ESnet's successful leadership is really a continuing story of our staff applying the latest technologies to provide more advanced services and solutions. NERSC has evolved the role of the scientific computing staff member away from the application-specific parallel programmer towards the computational technology expert. Our Scientific Computing staff collaborate with strategic users to port and develop scientific applications, as well as to evaluate, integrate, and create new hardware with users to enhance the speed of their applications, answer questions, and conduct on-line, video and classroom training.



Two groups within NERSC, the Center for Computational Sciences and Engineering and the Applied Numerical Algorithms Group, are national leaders in developing specialized algorithms for studying problems in fluid dynamics. Their applications of adaptive mesh refinement capabilities are advancing computer simulations used to study such problems as combustion and weather.

NERSC also benefits from the expertise of clients and scientists from other organizations. The NERSC Users Group meets regularly and provides guidance regarding NERSC services and the direction of future development. In early 1999, the Department of Energy announced a new policy for allocating NERSC's computing resources. The new policy broadens the role of scientific peer review in evaluating applications and provides for two additional panels — the NERSC Policy Board, which helps guide overall development of the center, and the Program Advisory Committee, which brings increased scientific peer review to the program and allocation of resources.

COMPUTER SCIENCE RESEARCH

To stay at the forefront of high-performance computing and the underlying technologies, NERSC participates in computer science research as both a consumer of state-of-the-art technologies and an activist in communicating the needs of scientists to computer science R&D organizations. In the consumer role, we continually evaluate and test next-generation software and hardware, such as new mass-storage systems, compilers, languages and visualization tools, for potential introduction into NERSC systems. Our users' needs for high-performance computational robustness, reliability and efficiency provide a solid testbed for new ideas and designs. In our activist role, we strive to influence the direction of technology development and shape the national technology agenda by focusing on technologies that are two or three generations in the future.

With the move to Berkeley Lab, NERSC offered joint appointments to several UC Berkeley Computer Science faculty members who are conducting scientific and high-performance computing research. These appointments provide a bridge for combining and leveraging the complementary intellectual resources of the campus and the Laboratory.

REALIZING THE POTENTIAL OF CLUSTERS

Another area of intense activity is the development of cluster computing with commodity processors and open software based on the Linux operating system. Small clusters are ideal for parallel code development, special-purpose applications, and small- to medium-sized problems. Large clusters show promise of replacing MPPs for certain applications. NERSC's Future Technologies Group is working closely with other research organizations and vendors to assess and develop new tools to more fully realize the potential of PC clusters for scientific computing.

ALL THE RIGHT CONNECTIONS

The Energy Sciences Network, or ESnet, is a high-speed network serving thousands of U.S. Department of Energy researchers and collaborators worldwide. Managed and operated by the ESnet staff at Berkeley Lab, ESnet provides direct connections to more than 30 DOE sites at speeds up to 622 megabits per second. Connectivity to the global Internet is maintained through "peering" arrangements with more than 100 other Internet service providers. Funded principally by DOE's Office of Science, ESnet allows scientists to use unique DOE research facilities and computing resources — independent of time and location — with state-of-the-art performance levels.

Early success led to a broadening of NERSC's mission

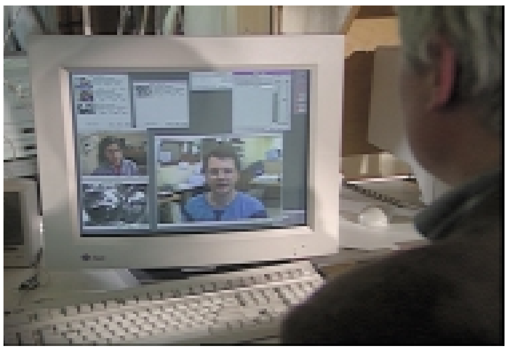
JAMES DECKER

Deputy Director, Department of Energy, Office of Science

The NMFECC — NERSC's predecessor — was the creation of Al Trivelpiece when he was the Director of Research for the Office of Fusion Energy, and of his Deputy, Bennet Miller. Several years later, when I directed that same office, since renamed the Division of Applied Plasma Physics, I assumed responsibility for managing Al and Bennet's creation. When Al returned to the Department of Energy as Director of Energy Research, he selected me as his special assistant and gave me the task of studying how to provide the same kind of supercomputer support that fusion enjoyed to the other research programs in ER. At the same time, there was concern about the future of the supercomputer industry in the United States and the lack of access to supercomputers by the scientific community. I was selected by the President's Science Advisor to chair an interagency committee charged with putting together a report recommending a U.S. program addressing both the needs of researchers and the state of the industry. The result of both of these tasks included a recommendation that the NMFECC role be expanded to include other areas of research.

We began with a pilot program that allocated 5 percent of NMFECC's resources to other ER research programs. The pilot was an unqualified success. In fact, it was oversubscribed by a factor of 20 — so we changed the mission of the NMFECC from supporting fusion alone, to supporting all of ER's research programs. At that time, it was the only supercomputer center dedicated to civilian scientific users; neither NSF nor DOD had similar centers. In 1990, the NMFECC was renamed NERSC, and when what later became the Office of Advanced Scientific Computing Research was formed, I was named its first director, once again managing NERSC in its broader role. I have continued my interest in its progress since becoming the Deputy Director of Energy Research in 1986.

Looking back over my nearly 25 years of involvement with NERSC, I think that it has been an outstanding success. It has made significant contributions to all of our research programs. Through ESnet, it has made a wide range of collaborations possible and continues to do so. It has also made substantial contributions to scientific computing and reliable high speed communications. In the future, I expect that the importance of computing, and of NERSC, to the Office of Science can only increase. Many of the problems we are interested in solving are of such complexity that they can only be addressed through scientific simulation, and NERSC must be a major player in developing the tools and techniques to solve them.



Collaborative services are key components of ESnet's service.

In fact, ESnet performance levels have grown with user demands by a factor of more than 10,000 since its inception in the mid-1980s. Measurements of traffic accepted by the network from researchers show growth by a factor of more than 400 since 1990.

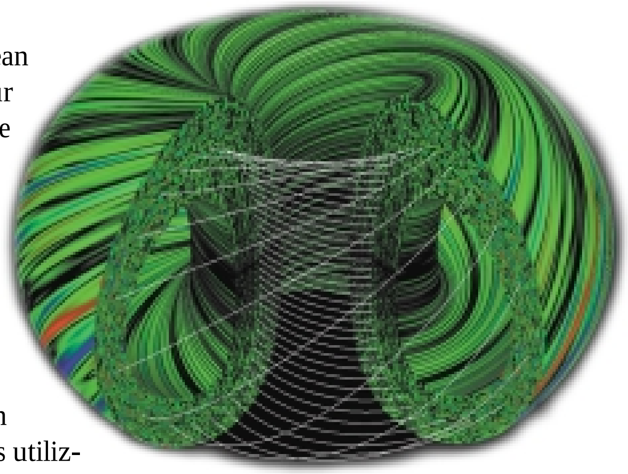
ESnet derives its effectiveness from the extensive cooperation it enjoys with its user community. It is one of the most widely based and successful cooperative efforts within the Department of Energy, perhaps within the federal government. The extensive participation by technical and scientific personnel on a DOE-wide basis results in extremely effective leveraging of both effort and resources.

An essential element of DOE research is the collaboration of teams of researchers located around the world. ESnet enhances the effectiveness of these scientists' work by providing interconnections to other research sites and networks in the United States and around the world.

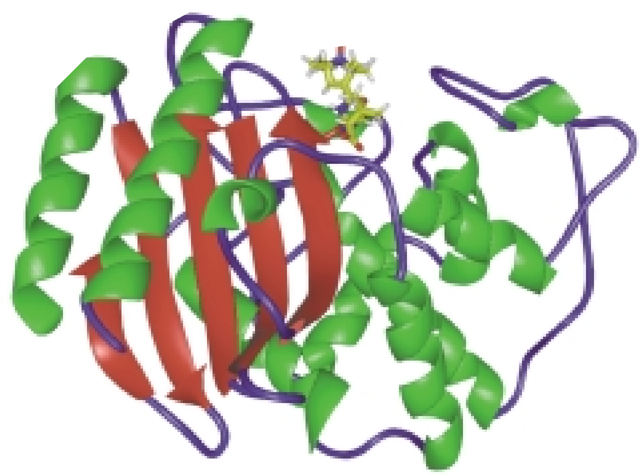
In addition to high-speed network connections, ESnet provides additional services in support of DOE research efforts. The flagship service is the ESnet Virtual Collaboration Services, or VCS — a collection of integrated collaboration services and tools designed for ease of use. Tools include an MCU (Multipoint Control Unit) for multiple participant video-conferencing, an audio bridge, a data-conferencing tool and an Mbone bridge for multi-casting.

The user-driven, collaborative framework of ESnet, with its ongoing combination of reliable services coupled with state-of-the-art capabilities, uniquely positions it to contribute to the development of leading-edge technologies. ESnet is also strategically positioned to participate in interagency, national and international research and development projects, such as Internet Protocol version 6 (IPv6), Asynchronous Transfer Mode (ATM), streaming video, multicast, virtual private networks and differentiated services on the Internet. In fact, in August 1999, ESnet was assigned the first production address using the IPv6 protocol.

SHAPING THE FUTURE



Virtually unlimited sources of clean energy. Accurate blueprints of our genetic makeup which allow once incurable diseases to be eradicated. Insight into how human activities affect our global climate and how we can protect our planet. Knowledge of the most fundamental building blocks of our universe. Once the stuff of science fiction, research in these and other fields by scientists utilizing the resources of NERSC and ESnet holds the promise of dramatically changing our world. By providing the scientific community with more powerful and more useful computing and networking resources, NERSC and ESnet will continue to accelerate scientific discovery.



By the end of the year 2000, NERSC will have on line a 2,048-processor IBM SP-3 supercomputer, with a theoretical peak capacity of 3 teraflops. Named in honor of Berkeley Lab Nobel Laureate Glenn Seaborg, the IBM machine will be one of the world's most powerful computers for unclassified research. NERSC selected the IBM system for its ability to handle large-scale scientific problems. To ensure that the next-generation NERSC system is well-suited to the demands of a production supercomputing center, NERSC and IBM are developing and testing a benchmark known as "ESP," or Effective System Performance. This set of tests will measure how well any highly parallel machine will deliver under a realistic workload. Additionally, The SP's architecture will also allow NERSC to run a variety of different-sized computations simultaneously, thereby providing faster turnaround of results for users across the country.

The new Berkeley Computing Facility is scheduled to open mid-2000 in Oakland.

In summer of 2000, Berkeley Lab will open its new computing facility in Oakland. The LBNL Computing Center will house NERSC's computing and data storage resources, as well as computers used by the Lab's scientific programs and administrative organizations. The 27,000-square-foot center will provide a state-of-the-art facility for the 2,048-processor IBM SP-3 supercomputer and also accommodate future systems.

Looming large on the computational science horizon is data intensive computing, stemming from increasing rates of data generation from both computer simulation and experiments. For example, the high energy physics community is bringing on line new experiments which have predicted data generation rates of about 10 terabytes per year in 2002 and 1 petabyte per year in 2005. Both the climate research and bioinformatics communities predict similar growth in data from various projects. These projected data rates are forcing a reevaluation of storage and bandwidth requirements, and are leading to new tools in scientific data management.

The Mass Storage Group at NERSC will continue to provide the storage media and baseline technology for large amounts of data. This group has increased the tertiary storage capacity at NERSC at an exponential rate, and kept available storage capacity ahead of the demand. At the same time that raw capacity was increasing exponentially, NERSC transitioned its storage management system completely to HPSS. As a developer site, NERSC is able to influence the HPSS consortium to provide tools for the requirements of the data intensive applications.

In summer 1998, NERSC began laying the foundation for large-scale data transfers from high energy and nuclear physics experiments expected to generate up to 1.5 terabytes of data per year. Massive amounts of data from simulations produced at NERSC were poured into Brookhaven National Laboratory at an average of 50 gigabytes a day. In all, about half a terabyte was transmitted by NERSC, demonstrating that unprecedented quantities of data could be entered, processed and stored as planned.

In August 1999, NERSC and Oak Ridge National Laboratory began developing a distributed high-performance storage system testbed called Probe to help meet that future data demand. Probe uses award-winning technology to support the gigabyte-per-second and petabyte-scale capacity needed in global climate modeling, human genome mapping and high energy physics. Probe, based at ORNL and Berkeley Lab, will be used to study ways to contain the cost of large storage systems, reduce long-distance network traffic and help scientists understand complex relationships by improving the performance of visualization applications.

NERSC is also developing tools for scientists to manage their data more effectively. The Scientific Data Management (SDM) Group is presently involved in various projects including tertiary storage management for high energy physics applications, data management tools, and efficient access of mass storage data. An important aspect of a scientific investigation is to efficiently access the relevant subsets of information contained within much larger datasets. The main problem is that the time to access a subset from a large dataset stored on a mass storage system may take many minutes to hours. This slows down the effectiveness of data analysis to the point that much of the data is never analyzed. Increasing access time of such subsets from hours to minutes is the key to effective analysis.

The NERSC SDM group has developed optimization algorithms for reorganizing the original datasets to match their intended use. Further, the SDM group has designed enhancements to current storage server protocols to permit control over physical placement of data on storage devices. At the analysis level this involves the application of clustering algorithms and organization of data into bins. The work of the SDM group is unique among supercom puting centers and we are not aware of a comparable research effort elsewhere.

As the Human Genome Project continues to decipher the secrets of our genetic makeup, scientists around the world are gaining new insight into our understanding of the biology of health and of disease. Computational tools are crucial in making the discoveries possible. To streamline the retrieval of key information from the ever growing banks of data, NERSC's Center for Bioinformatics and Computational Genomics (CBCG) provides tools for the analysis of biological sequences in the areas of sequence analysis, protein structure and function prediction, and large-scale genome annotation, as well as tools for access to biological information through database integration and data mining.

GIRDING FOR THE DATA GRID

In the last two years the vision of a computational grid has gained a large number of followers. The grid is envisioned as a unified collection of geographically dispersed supercomputers, storage devices, scientific instruments, workstations and advanced user interfaces.

The most significant aspect of the grid for NERSC is the data grid. The petabyte datasets discussed above are community resources to be shared by geographically distributed researchers. Therefore NERSC is investigating research issues related to large datasets distributed over a wide area network. In particular, NERSC is

Advancing the State of Plasma Physics Research

STEVE JARDIN

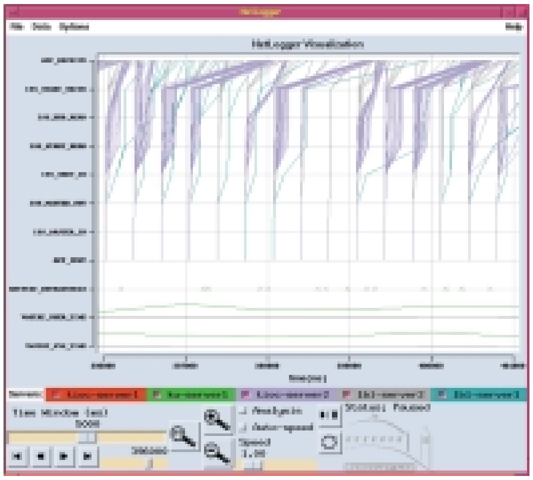
Princeton Plasma Physics Laboratory
Chair, NERSC Program Advisory Committee

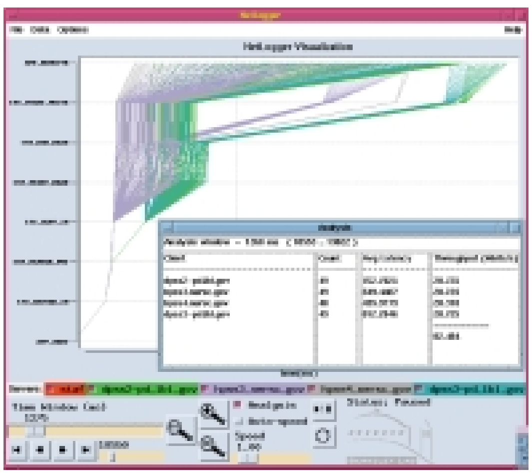
The 25th anniversary of NERSC is of special significance to me because my professional career began at about the same time as NERSC (then MFECC) was being founded. Our research group at the Princeton Plasma Physics Laboratory (PPPL) was at that time, and still remains now, one of the biggest users of NERSC. Of course, many things have changed dramatically since those early days.

I remember well when each user in our group was allocated 7 minutes of computer time per day on the 36Mhz CDC 7600 NERSC "supercomputer" and we had microfiches mailed across the country to get our output. But that was the cutting edge then, and NERSC has managed to stay at the cutting edge of supercomputing during its entire lifetime. This has enabled groups like ours to remain at the cutting edge of computational physics during this same period.

Many of us think that one of the greatest things about NERSC is how they are always able to keep the computing environment seemingly unchanged as it evolves in major ways. The NERSC staff has always been very sensitive to the sometimes conflicting needs of their users to perform productive work even as the major upgrades they were demanding are in progress. As new generation computers, networks, and file storage systems were brought in, the transitions have been made in such a seamless manner that our production work was virtually uninterrupted.

Each major procurement at NERSC has enabled us to tackle new problems that would previously have been impossible. It is remarkable how far computational plasma physics has developed during the 25 years of NERSC. The mathematical models that we now use have increased dramatically in their resolution and realism. Computational physics has now firmly established itself as an essential ingredient in plasma physics research, and it is difficult to imagine how this transition would have occurred were it not for our long and fruitful association with NERSC.





helping develop middleware for the data grid, DPSS and NetLogger. DPSS provides high-performance data handling and architecture for building high-performance storage systems from low-cost commodity hardware components.

One recent project which builds on DPSS, and which can be considered a prototype application of data-grid technology, is the China Clipper project, named for the 1930s commercial air service which spanned the Pacific Ocean and opened the door to the reliable, global air service taken for granted today. In this project, high energy physics data generated at the Stanford Linear Accelerator (SLAC) are shared among storage systems at SLAC, NERSC and Argonne National Lab. One of the early successes was a sustained data transfer rate of nearly 60 megabytes per second from SLAC to the data archive in Berkeley.

In the expanding field of distributed computing, a new toolkit called NetLogger, developed by computer scientists at Berkeley Lab, is making it easier to track down the problems and eliminate the chokepoints in such widely distributed systems. NetLogger has proven to be invaluable for diagnosing problems in networks and in distributed systems code and is being adopted by researchers at other national laboratories and universities. The toolkit's approach is novel in that it combines network, host and application-level monitoring, allowing users to monitor exactly what is happening inside a distributed application — from the time a request for data is sent and received to the time the data are starting to be read, the point at which the read is completed, and the time when processing begins and ends.

NETWORKING THE FUTURE

Hand-in-hand with many of the advancements being propelled by NERSC will be enhanced network services and capabilities. ESnet will continue researching, developing and implementing new technologies to serve its broad-based community of scientists. Among the capabilities ESnet is working to foster are remote experimental operations, distributed parallel computing, remote/shared code development, remote and distributed data access, collaborative engineering, scientific visualization, and teleconferencing and videoconferencing.

ESnet will continue to help develop, assess and implement leading-edge telecommunications capabilities and services. Current projections call for an additional growth factor of more than 1,000 within the next five years to support DOE's role in proposed new interagency programs, including the ability to network at terabit-per-second (1,000 million megabits/second) levels. ESnet is already well along in its plan to accommodate such performance levels.

NERSC and ESnet
A chronology of 25 years of leadership

THE 70s

1973

In June, Alvin Trivelpiece, deputy director of the Controlled Thermonuclear Research (CTR) Program of the Atomic Energy Commission, looking to significantly expand the use of computers to aid in reaching the goal of fusion power, solicits proposals for such a computing center.

Proposals are submitted by Los Alamos Scientific Laboratory, New York University, Princeton Plasma Physics Laboratory, Lawrence Livermore Laboratory and Oak Ridge National Laboratory.

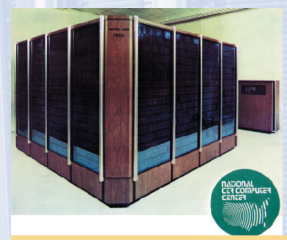
In October, Lawrence Livermore Laboratory is named as the site for the new center.

1974

John Killeen is named as project manager for the new CTR Computer Center in March. The center, later to be renamed NERSC, is part of Livermore's Computation Department, headed by Sid Fernbach.

In July, local researchers begin running jobs on a borrowed Control Data Corp. 6600 computer (serial no. 1), a machine described as "on its last legs." Remote access is provided via four acoustic modems, which were manually answered and had a capability of 10 characters per second. A primary goal is to secure a new machine.

The Atomic Energy Commission is abolished and the Energy Research and Development Administration is created.



1975

The RJET, or Remote Job Entry Terminal, is delivered to Princeton Plasma Physics Laboratory in February to allow direct connection to the center computer. The terminal, based on a PDP-11 minicomputer, can produce text or graphical data, and is also equipped with a card reader for data input. Access is by a leased line with a capability of 4,800 bits per second.

In August, four terminals are added at PPPL, using specially designed hardware and software. The four dial-up modems on the CDC 6600 are replaced with 16 self-answering modems.

A new CDC 7600 computer is installed at the center in Livermore in September and connectivity is provided by the 16 dial-up ports on the 6600. File management is provided by a CDC 6400 machine.

1976

Access is provided via leased 56-kilobits-per-second lines and remote access terminals are added at UCLA and UC Berkeley. This is the beginning of the Magnetic Fusion Energy Network (MFEnet), which will eventually become the Energy Sciences Network, or ESnet.

Remote access results in the CDC 7600 being run at full capacity. Additional time is purchased on a CDC 7600 at Lawrence Berkeley Laboratory. Jobs are driven by car to Berkeley in the evening, run overnight and then returned to Livermore in the morning.

Cray Research produces its first CRAY-1 computer, which is four times as fast as the CDC 7600 and has more memory.

A seventh access terminal, located at Science Applications International in La Jolla, is added to the network.

The CTR Computer Center is renamed the National Magnetic Fusion Energy Computer Center (NMFECC).

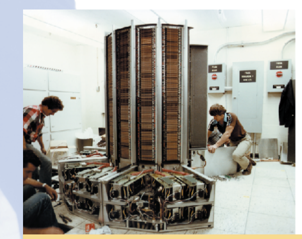
MFEnet begins providing data links between the fusion energy research sites and the Livermore facility.

1977

The facility signs a contract for a CRAY-1. In April, the user magazine "Buffer" debuts.

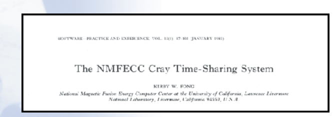
Steve Wozniak and Steve Jobs start selling the Apple II. Although not immediately apparent, personal computing has arrived.

In October, the U.S. Department of Energy assumes responsibilties of ERDA and other energy-related agencies.



1978

In May, the new CRAY-1 with a peak speed of 138 Mflops arrives.

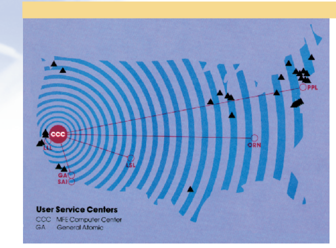

SOFTWARE—PRACTICE AND EXPERIENCE, VOL. 15(1), 87-101 (JANUARY 1985)

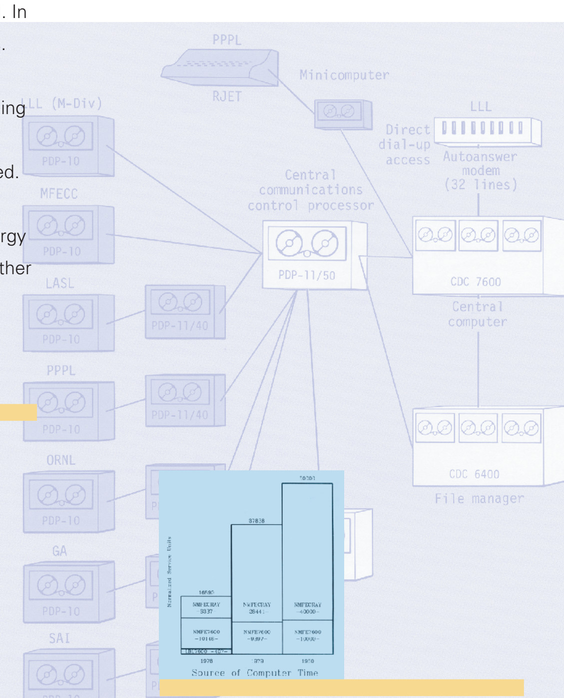
The NMFECC Cray Time-Sharing System

KIRBY W. FONG

National Magnetic Fusion Energy Computer Center at the University of California, Lawrence Livermore National Laboratory, Livermore, California 94550, U.S.A.

NMFECC undertakes a major software project to convert the 7600 operating system (LTSS or Livermore Time Sharing System), utilities and libraries to the new CRAY-1. The resulting system is called the Cray Time Sharing System (CTSS) and begins use in June, with 24-hour reliability provided in September. The CTSS allows interactive use of the CRAY-1 and is adopted by six other computer centers.





1979

The center's number of users reaches 1,000. NMFECC forms its own Operations Group.

As part of the center's move to its new building, four major computers and network equipment with a total value of $25 million are moved in November. Downtime is less than four days.

The Automated Tape Library system is delivered.

NATIONAL MFE COMPUTER CENTER

NERSC@25
NATIONAL ENERGY RESEARCH SCIENTIFIC COMPUTING CENTER

ESnet@25
ENERGY SCIENCES NETWORK

25 YEARS OF HIGH-PERFORMANCE COMPUTING AND NETWORKING LEADERSHIP

THE 80s

1980

The NMFECC staff makes the move to the center's new building, completing the transition from World War II-era barracks buildings to a dedicated facility at LLNL.

American Satellite Corp. is selected to replace the land-based access lines. In past years, problems with the telephone-company-owned lines had caused disruptions in service to the center.

1981

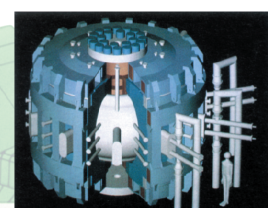
The new satellite links go on line, providing seamless connections to the center.

A second CRAY-1 is installed at the NMFECC.

1982

MIT is among three sites added to the center network. Universities account for 27 percent of NMFECC's computing resources, an increase of 3 percent over the previous year. The major users — Los Alamos, Lawrence Livermore and Oak Ridge national laboratories, General Atomics and Princeton Plasma Physics Lab — use 64 percent of the resources, with the remainder going to other labs.

Silicon Graphics Inc. is founded.



1983

The Department of Energy's Office of Energy Research asks the NMFECC to expand its services to include researchers in other fields. This will result in 13 additional sites joining the network.

Thinking Machines is founded.

1984

To accommodate the additional users, now numbering 3,500, a CRAY X-MP is added to the NMFECC. The arrival of the new machine and addition of 500 new users produces a heavy workload for the consultants, rocketing the number of contacts from 25 to more than 100 per day.

MFEnet staff meet with their counterparts at computing facilities in Japan, England and West Germany with an eye toward establishing international connections.

1985

The center acquires the first CRAY-2 supercomputer, the most powerful computer in the world at the time. The four-processor machine, along with the two-processor X-MP, allows multiprocessing of codes, which greatly accelerates the speed of computing. The CDC 7600 is retired.

DOE's Office of Energy Research determines that enhanced networking facilities are needed to improve access to supercomputing facilities and laboratories. It is recommended that MFEnet be combined with a similar network supporting high energy physics research.

Thinking Machines debuts its Connection Machine.

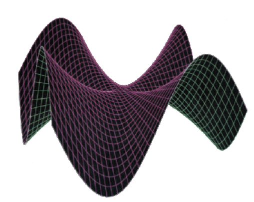
1986

A formal proposal for creating the Energy Sciences Network is approved and ESnet is born. Responsibility for operating the new network is assigned to NMFECC. Jim Leighton is named head of the new network.

The National Science Foundation launches five supercomputing centers: the National Center for Supercomputing Applications, the San Diego Supercomputer Center, the Cornell Theory Center, the Pittsburgh Supercomputer Center and the John von Neumann Center for Scientifc Computing. Sid Karin, an early NMFECC user, recalls, "I encapsulated what I had learned from [NMFECC] in the formulation of the original proposal to the NSF to establish SDSC."

An IBM 4381-M11 Data Cell library is installed to support the Central File System Testbed.

Kendall Square Research and Tera Computer enter the supercomputing business. Computing pioneers Sperry-Rand and Burroughs close up shop.



1987

Adequate storage is a key issue for the center. The Cray-2's I/O structure is modified to allow installation of another 20 gigabytes of storage. An IBM 4381-P141 tape library is installed to support the Central File System production system.

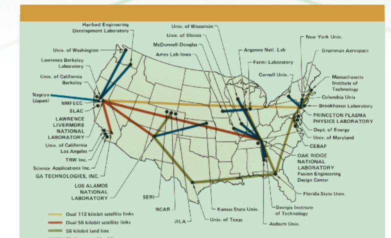
The broadening role of NMFECC in supporting DOE programs finds nearly a third of the computing resources going to projects other than fusion research. Basic energy sciences account for nearly 15 percent of the total allocations, health and environment 14 percent, high energy and nuclear physics 12 percent and applied math 2.5 percent.

The Energy Sciences Network

1988

ESnet begins providing networking services in January.

A second CRAY-2 goes on line in August.



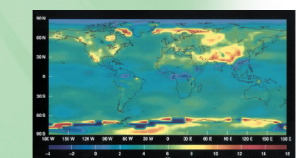
1989

Dieter Fuss, one of the four original staff members of the center, is named acting director after John Killeen suffers a debilitating stroke.

The CRAY-1 (serial number 6) is retired.

ESnet deploys commercially supplied multiprotocol routers via T1 lines.

Cray Computer Corp. is founded. Honeywell gets out of the business.



NERSC@25
NATIONAL ENERGY RESEARCH SCIENTIFIC COMPUTING CENTER

ESnet @25

NERSC & ESnet

U.S. DEPARTMENT OF ENERGY

25 YEARS OF HIGH-PERFORMANCE COMPUTING AND NETWORKING LEADERSHIP

THE 90s

1990

An eight-processor CRAY-2, the only one of its kind, is delivered and has a peak speed of 4 Gflops. Even with the additional hardware, demand for cycles is four times what the center can provide.

The center is renamed the National Energy Research Supercomputer Center to reflect its broadened mission.

NERSC signs a contract to buy a CRAY-3, the first computer to be built by Seymour Cray's latest enterprise, the Cray Computer Corp.

1991

C. William McCurdy, a co-founding director of the Ohio Supercomputer Center, is chosen as the next director of NERSC.

NERSC cancels its contract for the CRAY-3 and opts to acquire a Cray Research C-90 instead. The 16-processor C-90 has a theoretical peak speed of 16 Gflops.

Intel launches its Paragon machine built around off-the-shelf processors.

1992

An 8-processor Y-MP is installed as an interim machine until the 16-processor C-90 arrives. The new machine arrives on the last day of August and is named the A Machine.

1993

The Center for Computational Sciences and Engineering (CCSE) is established as a resource for developing new mathematical algorithms and applications software for modeling complex physical phenomena on high-performance computers.

IBM re-enters the supercomputer market with its RS/6000.

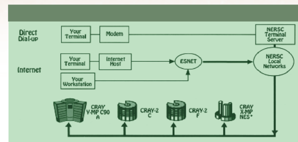
In June, the Top500 list of supercomputer sites around the world debuts. NERSC's Cray C-90 is tied for 14th place on list.

NERSC is one of five national laboratory organizations joining with IBM to develop the High Performance Storage System (HPSS) aimed at creating new tools for moving very large data objects between high performance computers.

1994

As part of the High Performance Parallel Processing project, a Cray T3D arrives at NERSC.

Thinking Machines rethinks its future and stops producing MPP computers.



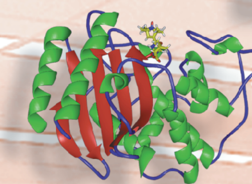
BERKELEY LAB

1995

In April, DOE asks Lawrence Livermore National Laboratory and Lawrence Berkeley National Laboratory to submit proposals on the future operation of NERSC. In November, DOE announces its decision to relocate NERSC to Berkeley Lab. Joining in the migration to Berkeley are ESnet and CCSE.

ESnet is the first major network to convert to the new Asynchronous Transfer Mode technology on a nationwide basis.

Cray Computer Corp. and Kendall Square Research close the books.



1996

Horst Simon becomes the new director of NERSC, the fourth person to lead the center since it was founded.

Staffing of the new NERSC, rechristened the National Energy Research Scientific Computing Center, begins. In April, the new Cray J90s are installed at Berkeley Lab and provide uninterrupted service when the C-90 is moved (ahead of schedule). Storage is moved in May.

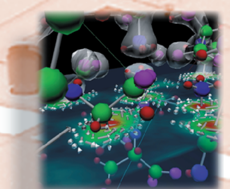
The 128-processor Cray T3E-600 is installed in September. The new center holds a gala grand opening in October.

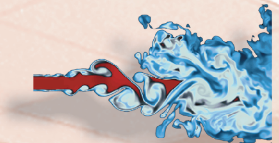
ESnet joins the Internet Protocol Version 6 (IPv6) backbone research effort.

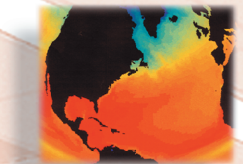
Seymour Cray dies on October 7.

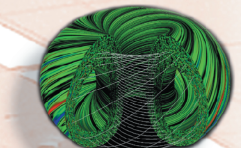
Cray Research Inc. is acquired by Silicon Graphics Inc.

Intel closes its Supercomputing Systems Division.









1997

NERSC's T3E-600 passes acceptance tests and a larger, faster 512-processor T3E-900 is ordered.

In August, NERSC becomes the first center to achieve a checkpoint/restart capability on a massively parallel processor machine. The T3E-900 passes acceptance tests in September.

ESnet begins planning its OC12 network.

The National Science Foundation refocuses its supercomputing program under two partnerships — the National Computational Science Alliance (NCSA), led by the University of Illinois at Urbana-Champaign, and the National Partnership for Advanced Computational Infrastructure (NPACI), led by the University of California, San Diego.

1998

The new NERSC is completely staffed and announces several scientific achievements:

- NERSC provides data analysis and simulations for the Supernova Cosmology project, which concludes that the universe is continuing to expand at an accelerating rate. This discovery is named the 1998 scientific breakthrough of the year by Science Magazine.
- NERSC, along with researchers at Oak Ridge National Laboratory, Ames Laboratory, Pittsburgh Supercomputing Center and the University of Bristol, shares the 1998 Gordon Bell Prize for the fastest application, the first science code to break the teraflops barrier.
- Phil Colella, leader of NERSC's Applied Numerical Algorithms Group, is named recipient of the IEEE's Sidney Fernbach Award at SC98.

On the systems side, NERSC begins converting its mass storage library to HPSS and decommissions the Cray C-90, the only machine moved from LLNL. NERSC's two Cray T3E machines are merged into a single 696-processor supercomputer, named MCurie.

In a networking demonstration of the feasibility of "differentiated services" between Berkeley Lab and Argonne National Laboratory, two video streams are sent over the Internet. The priority-marked stream moves at eight frames per second, while the standard version is transmitted at just one frame per second.

Compaq buys Digital Equipment Corp.

1999

NERSC's mass storage conversion to HPSS is completed.

Working with SGI/Cray, NERSC implements scheduling software on the T3E and achieves overall availability of more than 90 percent.

A new allocations policy is adopted, increasing the role of scientific peer review in determining NERSC allocations and opening NERSC to the general scientific community.

NERSC announces the procurement of a new IBM SP-3 as its next-generation supercomputer. When fully installed, no later than December 2000, the system will have 2,048 processors dedicated to large-scale scientific computing and a peak performance capability of more than 3 teraflops.

ESnet is assigned the first production IPv6 address.

NERSC@25
NATIONAL ENERGY RESEARCH SCIENTIFIC COMPUTING CENTER

ESnet @25

70s

80s

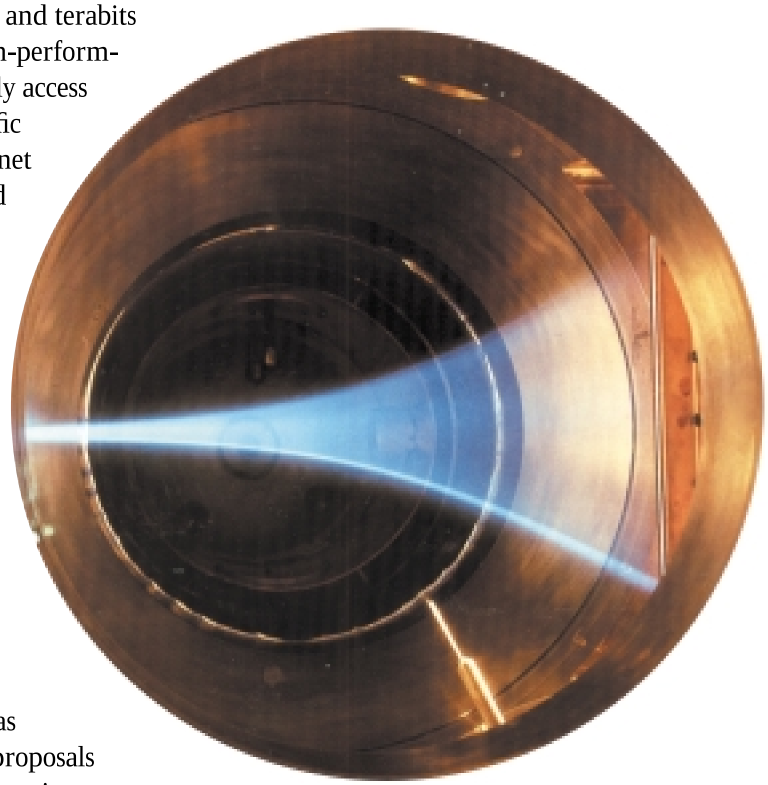
90s

BLAZING THE TRAIL

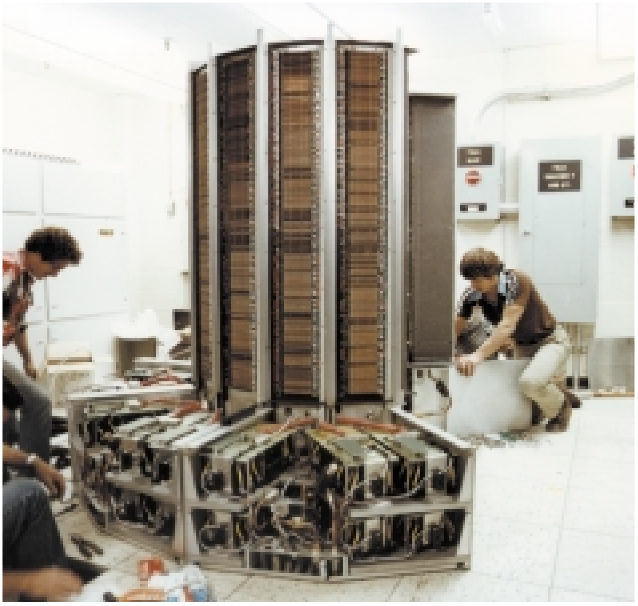
Teraflops of computing power, terabytes of data storage and terabits of network capability are givens in today's world of high-performance computing and networking. The ability to routinely access data, computers and expertise is now essential to scientific research, but when the forerunners of NERSC and ESnet were first proposed, skeptics said it couldn't be done and even if it could, there'd be no value in doing it.

Through the years, however, NERSC and ESnet pioneered many of the computing and networking practices taken for granted today, and served as models for other agencies. These practices include remote access by thousands of users, high-performance data storage and retrieval, and providing on-line documentation and around-the-clock support for the user community.

The idea for creating such a center came in 1973 from Alvin Trivelpiece, then head of the Atomic Energy Commission's Division of Controlled Thermonuclear Research. Lawrence Livermore National Laboratory was chosen as the site for the new center, winning out over proposals from Los Alamos Scientific Laboratory, New York University, Princeton Plasma Physics Laboratory and Oak Ridge National Laboratory. The idea, said John Fitzgerald, who was named program manager in 1974, was that if magnetic fusion were to advance, researchers needed the same kind of computing horsepower then available only to the national defense programs. Along with John Fitzgerald, the management included Dieter Fuss as the programming supervisor, Hans Bruijnes, the deputy director, and John Killeen, the director.



NERSC's original mission was to enable computational science as a complement to magnetically controlled plasma experiments such as this one.



The first Cray-1 to arrive at Livermore is installed.

Delivery of the Cray-2 caught the center's interest.

The center, originally called the Controlled Thermonuclear Research Computer Center, began providing cycles in July 1974, using a cast-off Control Data Corp. 6600 computer. Access was provided at 110 baud via four dial-up modems. "The reason they let CTRCC use it was because nobody else wanted it — it was the last 6600 and it was in an unclassified area," recalls Keith Fitzgerald, who helped maintain the first machine and today heads NERSC's Mass Storage Group. But the 6600 worked and got the center up and running. Within a year, the center was home to a Control Data Corp. 7600, which Fitzgerald also helped install and maintain.

Along with this upgrade in computing power, the new center was also providing users with remote access. Following the pattern of Remote Job Entry Terminals, or RJETS, already in place at LLNL, the center provided a similar terminal for researchers at the Princeton Plasma Physics Lab. The RJET consisted of a PDP-11 computer, four terminals, a printer and a data card reader and went on line in March 1975. The center provided similar local computing equipment to Oak Ridge, Los Alamos and Livermore labs, as well as to the General Atomics research center in San Diego. Called User Service Centers, these centers provided fully integrated, powerful computing resources for local computing, as well as immediate access to the main computer.

"These sites were not accustomed to inter-lab communications," John Fitzgerald said. "There wasn't a system or tradition in place — we had to invent it. The delivery of high-performance computing resources to a distributed community was a brand new idea."

The center changed its name to the National Magnetic Fusion Energy Computer Center in 1976-77 and took steps to acquire a Cray-1 supercomputer, the first one delivered to LLNL. In those days, Bruijnes notes, the computers weren't delivered with software — each center had to develop their own.

To take advantage of the Cray-1's capabilities, the center undertook a major software project to convert the 7600 operating system (LTSS or Livermore Time Sharing System), utilities and libraries to the new CRAY-1. The resulting system was called the Cray Time Sharing System (CTSS) and allowed interactive use of the CRAY-1. CTSS was later adopted by six other computer centers. Over the years, additional supercomputers such as the Cray-2 and Cray X-MP were installed at the center. Each time, the staff worked diligently behind the scenes so that researchers could seamlessly move their jobs from one computer to the next. In fact, Keith Fitzgerald recalls, the center created a Cray-2 simulator for debugging the operating system before the system was installed —

and actually had CTSS up and running for the Cray-2 before the computer was completed. Having the operating systems up and running before the vendor did was a hallmark of the center, Bruijnes said.

In the early years, accessing archived data also required staffers to move around behind the scenes. When a user filed a request, an operator would retrieve the nine-track tape from a rack and load it, then notify the user that the data were available. Delivery of the Automated Tape Library in 1979 changed that, allowing hands-off access.

Another innovation aimed at helping users was the center's extensive on-line documentation, then a rarity, but today the norm.

During the 1980s, the center broadened its research mission to support other programs within DOE's Office of Energy Research. In 1990, the name was changed to the National Energy Research Supercomputer Center to reflect the larger mission.

In the mid-1980s, the National Science Foundation decided to establish a group of supercomputer centers to support its research community. One of the successful proposals was submitted by Sid Karin, who had been a fusion researcher at General Atomics and a user of the Livermore center. Karin, who today heads the NSF's National Partnership for Advanced Computational Infrastructure and the San Diego Supercomputer Center, drew heavily on the Livermore center's experience in hardware, facilities and network protocols.

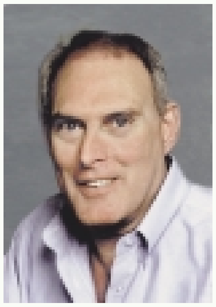
Also in the 1980s, the remote access capabilities pioneered by the center and MFEnet (Magnetic Fusion Energy Network) and the growth of other research networks pointed to the need for a more comprehensive approach for networking among DOE facilities. In 1985, Alvin Trivelpiece, then director of DOE's Office Energy Research (or ER, now the Office of Science), recommended that MFEnet and a similar network serving high energy physics research be joined. The result was the Energy Sciences Network, or ESnet, which was established in 1986 and began providing ER-wide networking services in January 1988.

ESnet The Energy Sciences Network

SHARED MEMORIES

SID KARIN

Director, San Diego Supercomputer Center
National Partnership for Advanced Computational Infrastructure

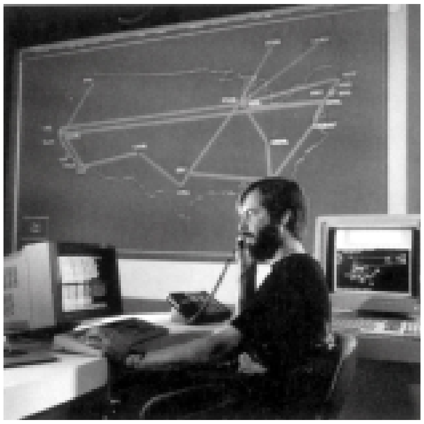


I was responsible for the General Atomics User Service Center in the very early days and was a small user of the CDC 6600, CDC 7600 and Cray-1 at CTRCC (later MFECC, now NERSC). While I had previously acquired some experience with what might well be termed high performance scientific computing, my early NERSC interactions constituted my real introduction into supercomputing. My own career was strongly influenced by those experiences, as were many other careers. That is only one of the ways in which NERSC had enormous impact upon the field.

I have a clear recollection of sitting in front of a PDP-11 switch panel here in San Diego, with a voice telephone cradled on my shoulder, acting as a remote servomechanism for Barry Howard to help in debugging MFEnet (now ESnet). NERSC pioneered remote access to supercomputers and took the concept of time-shared supercomputers out of the classified environment and brought it to the rest of the scientific community. We take these things for granted these days, but they were quite controversial at the time and I am proud to have played a small part in helping make them happen.

I encapsulated what I had learned from NERSC in the formulation of the original proposal to the NSF to establish SDSC. Remote interactive access to a supercomputer was a key point and NERSC was the proof of its efficacy. Moreover, it was the very existence of both NERSC and also NCAR that paved the way for the NSF Supercomputer Centers program.

NERSC has remained at the forefront of supercomputing, computational science and engineering, high performance computing — whatever name is in fashion — for all of its history. In the early days there was little competition for the leadership role. Today there are many more respectable participants, yet NERSC remains among the leaders. This is a remarkable sustained accomplishment. Congratulations to everyone at NERSC on your 25th anniversary.



Initially, ESnet operated at speeds of 56 and 256 kilobytes per second. By 1989, ESnet had begun deployment of commercially supplied multiprotocol routers and T1 backbone lines, which provided speeds of 1.5 megabits per second. This configuration became fully operational in early 1990, with 19 major ER-supported sites connected to the backbone. Although the performance level supported by the T1 backbone seemed quite respectable at first, by early 1991 it was becoming clear that a bandwidth upgrade would be required within a very few years, and planning for T3 (45 megabits per second) capability began almost immediately.

ESnet also began providing international connectivity in support of ER program activities. International connectivity was shared and coordinated with NASA, NSF, and DARPA (the Defense Advanced Research Projects Agency), an approach that established a framework for future interagency cooperation. In the same time period, ESnet began connecting to regional NSF networks, thereby providing more ubiquitous network communications through which university researchers could utilize DOE/ER laboratories and facilities.

In 1991, several key decisons were made which changed the direction of NERSC. First, Bill McCurdy was chosen as the second permanent director of the center. His selection was noteworthy in that he came from outside the Lawrence Livermore community and he was a research scientist — a chemical physicist — as opposed to a computer scientist or engineer. Within six months of McCurdy's arrival, NERSC canceled its contract with Cray Computer Corp. for the Cray-3 machine, and also halted development of operating system software. Together, these changes set the stage for NERSC to devote even more resources to advancing the state of computational science.

The new look of computing at NERSC in Berkeley

REINVENTING SCIENTIFIC COMPUTING

In the mid-1990s, NERSC and DOE began two transitions which would dramatically change the nature of computational science in the DOE community.

The first was the procurement of a Cray T3E-600, the first massively parallel processor-architecture machine to be installed at the center. The MPP architecture allows scientists to scale up their models to achieve larger, more accurate simulations. The MPP architecture, which marked a fundamental change in the computing environment, also led to the consideration of operational changes for the center.

In 1995, the Department of Energy also made a decision to seek proposals for the future operation of NERSC. Lawrence Livermore, where the center was then housed, and Lawrence Berkeley national laboratories both submitted proposals. Ultimately, Berkeley Lab's proposal was selected and the decision to move the center was announced on November 3, 1995. Among the reasons cited for the change were the integration of the center with ER-sponsored research at Berkeley Lab, the proximity to UC Berkeley and the opportunity to combine intellectual resources. The Berkeley proposal also called for revamping the organizational structure of NERSC to allow the center to operate with fewer staff members.

The decision by DOE also resulted in the transfer of ESnet administration, which had been under NERSC, from Livermore to Berkeley. The Center for Computational Sciences and Engineering, which had been established several years earlier, also made the move to Berkeley Lab.

Horst Simon, who was hired as the new director of NERSC in early 1996, remembers touring the future center with Bill Kramer, who had also just signed on as head of the High Performance Computing Department. "We had no machines and no people working for NERSC at Berkeley." Outside the facility, things were not much more encouraging. "The crews had dug trenches for the power cables and when we saw the ditches, they were filled with muddy water," Simon recalls. "We were worried that the job wouldn't be finished in time. However, under the muddy water, the cables were already installed and connected."

The physical move of NERSC and ESnet was achieved just two months later with no downtime to clients. New Cray J90 supercomputers were installed and brought on line in Berkeley before machines in Livermore were shut down for the move. The result was a nearly transparent transition. Kramer recalls, "It's always a challenge getting up to speed with a new system, but this was the

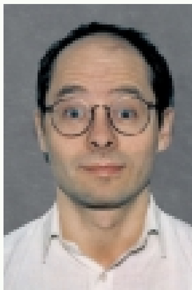
The machine room in Berkeley takes shape.

An Enviable Resource for Advancing Scientific Understanding

BASTIANN BRAAMS

Chair, NERSC Users Group Executive Committee

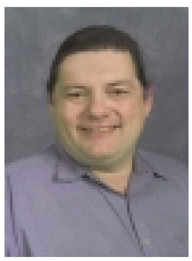
Courant Institute of Mathematical Sciences, New York University



From its inception in 1974 as the computer center for the Fusion program, NERSC has been tremendously valuable to computational research in the energy sciences. As the National Magnetic Fusion Energy Computer Center, it provided the U.S. Fusion community with supercomputer access of a kind that was envied everywhere and that created a national collaboratory for fusion theory before the name "collaboratory" had been invented.

Now, as the National Energy Research Scientific Computing Center, it is the unique high-end resource for open computational research in all the Office of Science. Supporting research across physics, chemistry, geoscience and biology, from massively parallel computations in climate research, calculations of large-scale electronic structure in chemistry and materials science, particle and fluid modelling of plasma turbulence, to calculations of protein dynamics and genome analysis, NERSC is enabling researchers in the Office of Science to advance science and technology for energy production and management, for understanding environmental effects and global change, and for fundamental understanding of matter.

Andrew Canning
Co-recipient of the 1998
Gordon Bell Prize



Phillip Colella
Recipient of the 1998
Sidney Fernbach Award

NERSC pioneers (from left)
John Fitzgerald, Hans Bruijnes
and Dieter Fuss in front of the
center's first home in Livermore

first occasion I can rememeber where our system analysts had to wear hardhats — we were working on the J90 at the same time construction crews were finishing the new machine room." Simon credits the NERSC staff at LLNL for making the move go so smoothly. "They carried out their responsibilities to the very end and the transition was handled extremely professionally. Without their support, the transition would not have worked nearly as well," Simon said. "Their efforts really reinforced the NERSC tradition of going the extra mile to anticipate and exceed the needs of our users. We believe we're continuing that tradition and building on it as we enter our next 25 years."

Since the move, NERSC installed the 128-processor Cray T3E and upgraded it to 696 processors. New storage systems were installed and the Cray J90s were upgraded to provide more powerful vector computing resources.

NERSC also developed new research programs and became integrated with existing computer science research efforts at Berkeley Lab and on the UC Berkeley campus. Among the areas of research are distributed computing, data storage, data management, computer architectures and data intensive computing. As in the past, NERSC's ability to bring varied intellectual resources to bear on difficult problems resulted in new approaches and innovative solutions.

NERSC's leadership in the field was recognized at SC98, the annual conference on high-performance computing and networking. Andrew Canning, a member of NERSC's Scientific Computing Group, joined researchers from Oak Ridge National Laboratory, Pittsburgh Supercomputer Center and the University of Bristol in winning the 1998 Gordon Bell Prize for the fastest application. The team won for their 1,024-atom first-principles simulation of metallic magnetism in iron which ran at 657 gigaflops (billions of calculations per second) on a 1024-processor Cray/SGI T3E supercomputer. The group later ran their simulation at 1.02 teraflops on an even larger Cray T3E, making the code the first teraflops application with true scientific results.

Also at SC98, Phil Colella, leader of NERSC's Applied Numerical Algorithms Group, was presented with the Institute of Electrical and Electronics Engineers Computer Society's 1998 Sidney Fernbach Award, given each year to one person who has made "an outstanding contribution in the application of high performance computers using innovative approaches." Colella was honored "for fundamental contributions in the development of software methodologies used to solve numerical partial differential equations, and their application to substantially expand our understanding of shock physics and other fluid dynamics problems."

For 25 years, the staff of NERSC and ESnet have continually defined and advanced the state of high-performance computing and networking for researchers across the nation. Perhaps the largest overall contribution of the center has been to help prove the validity of computer simulations as "real" science, noted Dieter Fuss. Initially, there was skepticism that computer-based research would ever rival theoretical or experimental science. Today, he said, it's standard procedure to generate simulations before conducting an experiment.

"One thing the center can be truly proud of is that we were recognized as being the first to do something that has become really important to this country, both in computing and networking," John Fitzgerald said. "It's nice to have been involved with an organization that pulled off this achievement."

END WORD

"NERSC has long been a model for other institutions wishing to establish supercomputing centers," said C. William McCurdy, who co-founded the Ohio Supercomputer Center in 1988 and became director of NERSC in 1991. McCurdy, who today heads the Computing Sciences Directorate at Berkeley Lab, adds, "The story of NERSC is really that of modern computational science in the U.S. From pioneering large-scale simulations to developing the early time sharing systems for supercomputers, much of the action has always been in this center."

PUB-831 99A02391

BERKELEY LAB

NERSC@25 ESnet@25

25 Years of High Performance Computing and Networking Leadership

ANN ALMGREN, CARL ANDERSON, MARY ANDERSON, CAROL AVELLINO, MAJDI BADDOURAH, CLAYTON BAGWELL, DAVID BAILEY, JON BASHOR, ELIZABETH BAUTISTA, RICHARD BEARD, VINCENT BECKNER, JOHN BELL, LUIS BERNARDO, EDWARD WES BETHEL, JULIAN BORRILL, ROBERTA BOUCHER, PATRICK BOZEMAN, CHRISTY BROWER, JOSEPH BURRESCIA, GREGORY BUTLER, TINA BUTLER, PAOLO CALAFIURA, ANDREW CANNING, NICHOLAS CARDO, JONATHAN CARTER, CHRIS CAVALLO, ROXANNE CLARK, PHILLIP COLELLA, MICHAEL COLLINS, JAMES CRAW, BRIAN CROWLEY, WILLIAM CRUTCHFIELD, DAVID CULLER, JIM DAVELER, THOMAS DAVIS, DONN DAVY, MARCUS DAY, THOMAS DEBONI, MICHAEL DECLERCK, TINA DECLERCK, MARCELLA DEL ROSARIO, DAVID DEMIRJIAN, JAMES DEMMEL, CHRISTINE DIESCH, CHRIS DING, JAMES DONNELLEY, MARTIN DOOLY, BRENT DRANEY, INNA DUBCHAK, NORMA EARLY, EWA ELKINS, ERIK ELMROTH, LISA ERSPAMER, ERIC ESSMAN, ROBERT FINK, KEITH FITZGERALD, JAMES GAGLIARDI, TONY GENOVESE, RICHARD GERBER, SUSAN GRAHAM, SUSAN GREEN, STACY GREENE, JUNMIN GU, DANIEL GUNTER, CHIN GUOK, WILLIAM HARRIS, DEBORAH HAYNES, YUN HE, MARK HEER, MICHAEL HELM, ANTAL HERZ, YVONNE HINES, MASON HOLDING, HARVARD HOLMES, CRAIG HOPKINS, RUSSELL HUIE, JOHN HULES, WAYNE HURLBERT, PARRY HUSBANDS, WILLIAM ILES, PEGGY JELLINGHAUSEN, NIELS JENSEN, GUOJUN JIN, SANKU JO, NANCY JOHNSTON, JOHN JONES, JULIE RODRIGUEZ JONES, TERESA KALTZ, MARCY KAMPS, GIZELLA KAPUS, ANTON KAST, JINBAEK KIM, STANLEY KLUZ, WILLIAM KRAMER, JODI LAMOUREUX, STEPHEN LAU JR., CHERI LAWRENCE, VUI LE, JAMES LEE, JASON LEE, CHARLES LEGGETT, JAMES LEIGHTON, XIAOYE SHERRY LI, TERRY LIGOCKI, MICHAEL LIJEWSKI, STEVEN LOWE, ROBERT LUCAS, ANDREW LUMSDAINE, MARVELLA LUTER, LINDA MAIO, OSNI MARQUES, DANIEL MARTIN, SCOTT MASON, JOHN MCCARTHY, PETER MCCORQUODALE, HEATHER MCCULLOUGH, ZAIDA MCCUNNEY, C. WILLIAM MCCURDY, ALEXANDER MEROLA, JOSEPH METZGER, NANCY MEYER, JOHN MILFORD, GREG MILLER, BRENT MILNE, DAVID MODIANO, ROBERTO MORELLI, ANDREAS MUELLER, VIJAYA NATARAJAN, ROBERT NEYLAN, ESMOND NG, REBECCA NITZAN, HENRIK NORDBERG, KEVIN OBERMAN, KENNETH OKIKAWA, LEONID OLIKER, EKOW OTOO, R.K. OWEN, HARSH ANAND PASSI, DAVID PAUL, DANIEL PETERSON, MIKE PIHLMAN, MELISSA PRINCE, RICK PROPP, JOSEPH RAMUS, MARK REDMAN, CHARLES RENDLEMAN, LYNN RIPPE, ROBERT RITCHEY, DAVID ROBERTSON, CYNTHIA ROGERS, ERIC ROMAN, BURTON SAMPLEY, WILLIAM SAPHIR, KATHERINE SAUCEDA, JACQUELINE SCOGGINS, ARIE SEGEV, DAVID SERAFINI, GEORGE SHANTHIKUMAR, ARIE SHOSHANI, ALEXANDER SIM, HORST SIMON, SUZANNE SMITH, ROBERTA SPALDING, SCOTT STANLEY, MARTIN STOUFER, NANCY TALLARICO, BRIAN TIERNEY, MARGARET TRELEAVEN, CRAIG TULL, DAVID TURNER, ALEX UBUNGEN, BRIAN VAN STRAALEN, FRANCESCA VERDIER, CLINT WADSWORTH, HOWARD WALTER, LIN-WANG WANG, MICHAEL WELCOME, TAMMY WELCOME, CARY WHITNEY, DENISE WOLF, ADRIAN WONG, KESHENG JOHN WU, ERIC XING, KATHERINE YELICK, MANFRED ZORN, KAREN ZUKOR

BERKELEY LAB