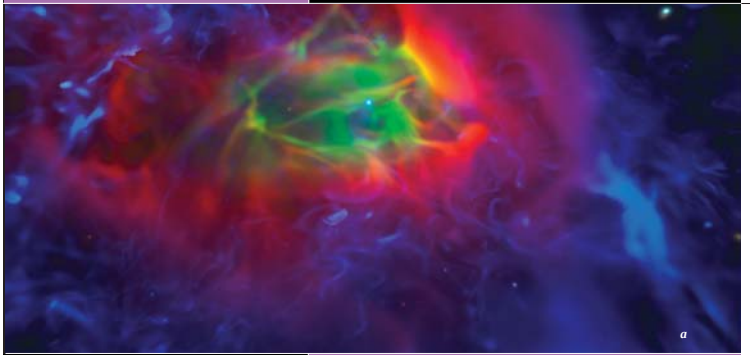
Foundations for SCIENTIFIC LEADERSHIP

WORKING ON THE GRID



a

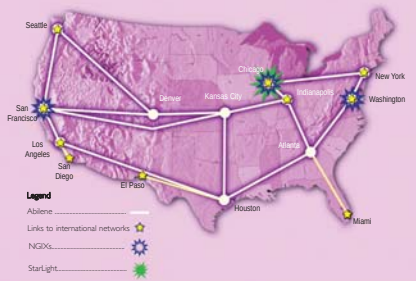
A Working Partnership

From the foundation of Federal R&D investments in networking technologies, a working partnership among the NITRD agencies, universities, and industry has developed a broadband infrastructure for research, providing connectivity not only to research facilities throughout the U.S. but to research networks around the globe. The optical backbone links (shown in white) are the Abilene network, supported by the Internet2 consortium of universities and partners Cisco, Nortel, and Qwest. The OC-192 backbone, able to transmit data at nearly 10 gigabits per second, connects to Federal research networks at Next Generation Internet Exchange Points (NGIXs, shown as blue stars). These Federal "peering" points transparently route traffic from one network to another. International exchange points to networks in Asia, Europe, and South America are shown as yellow stars. NSF's new StarLight facility (shown as green star) at the University of Illinois-Chicago adds to to these capabilities an advanced optical infrastructure and proving ground for network services optimized for high-performance applications.

The Federal research networks are:

DREN – Defense Research and Engineering Network, DoD
vBNS – very high-performance Backbone Network Services, NSF
NREN – NASA Research and Education Network
ESnet – Energy Sciences Network, DOE
BOSSnet – Boston-South Network, DARPA

U.S. HIGH-PERFORMANCE RESEARCH NETWORKS



a) *Image of interstellar gas and dust opens 8-minute simulation of the solar system's birth developed for the Hayden Planetarium by a distributed multidisciplinary research team. The team used advanced computational techniques and grid technologies to share and work with nearly 7 terabytes of data, which ultimately were rendered into 70,000 high-resolution frames on the Blue Horizon platform at the San Diego Supercomputer Center. The processing took a day at a rate of 1.7 trillion operations per second.*

The Globus software suite for grid computing – first developed by researchers in a joint effort by DARPA and DOE/SC and still being elaborated in the DOE/SC Science Grid, NSF's TeraGrid, and NASA's Information Power Grid – makes possible large-scale collaborative research frameworks in key domains of 21st century science. The NSF-funded National Virtual Observatory, for example, is developing grid-based tools to enable scientists for the first time to access and work with experimental data from more than 50 astronomical research facilities. The initiative aims to close the gap between the output of the international array of land- and space-based telescopes and sensors – now generating more empirical data annually than existed in the field of astronomy before 1980 – and the ability of researchers to make use of it.

Major IT vendors worldwide also are adopting the Globus Toolkit™, named "most promising new technology" of 2002 by *R&D Magazine*. The NITRD agencies are founding participants in the Global Grid Forum, the leading organization working to expand grid technologies for international scientific collaboration. A major related initiative in middleware research at NSF supports grid development by strengthening the underlying software technologies that make distributed computing possible.

IT frameworks for large-scale scientific collaboration being developed with NITRD support include:

DOE/SC

Collaboratory for Multi-Scale Chemical Sciences – Developing a Web portal and informatics infrastructure to enable sharing of validated data and collaborative investigation by researchers working in combustion science at scales from the atomic level to the macro level of turbulent combustion phenomena.

Earth System Grid II – Integrating storage, management, access, and collaboration technologies for massive data generated in DOE/SC climate research.

National Fusion Collaboratory – As the Administration moves to renew U.S. participation in development of the International Thermonuclear Experimental Reactor (ITER), this project is establishing secure frameworks for fusion scientists to work collaboratively with the massive data sets generated by the Nation's three large fusion facilities. The ensemble will include data repositories and advanced applications and collaboration software.

Particle Physics Data Grid (PPDG) – Creating high-bandwidth connectivity, storage and data access, and software tools for researchers in the most data-intensive of all the physical sciences. In a collaboration with NSF's Grid Physics Network, PPDG scientists have successfully simulated more than 1.5 million particle-collision events over a nationwide five-node grid.

NASA

Earth System Modeling Framework and Earth Observing System (EOS) testbed – In collaboration with DOE, NOAA, and NSF, this NASA effort has the ambitious goals of making the world's richest and most dynamic stores of scientific data about Earth both more accessible and more useful to a broad range of researchers. A central goal is to develop a single software framework that will enable researchers for the first time to integrate data from many different climate, weather, and environmental models. The testbed will create a data-storage and networking infrastructure to accommodate the growing volume of empirical data being generated by DOE/SC, EOS, NOAA, and the NSF-supported National Center for Atmospheric Research as well as tools to make the data accessible to the wider U.S. research community.

NSF

Geosciences Network (GEON) – In collaboration with the U.S. Geological Survey and the Geological Survey of Canada, this effort involving researchers from 13 universities is building digital libraries of high-quality geological information and integrated software tools for data access, analysis, modeling, and visualization. GEON will be a national resource for researchers, students, teachers, and the public.

Grid Physics Network (GriPhyN) – Using grid technologies to make the results of experiments at the world's largest experimental physics facilities accessible to the broader academic community.

Network for Earthquake Engineering Simulation (NEESgrid) – Creating a high-performance infrastructure for real-time collaboration among the scientists and engineers who study earthquake dynamics in order to design materials and structures that reduce their threat to life and property. More details on page 27.

PROJECT URLs

Collaboratory for Multi-Scale Chemical Sciences (http://cmcs.ca.sandia.gov)
Earth System Grid II (http://www.earthsystemgrid.org)
Earth System Modeling Framework (http://www.esmf.ucar.edu)
Geosciences Network (GEON) (http://www.geongrid.org)
Grid Physics Network (GriPhyN) (http://www.griphyn.org/index.php)
National Fusion Collaboratory (http://www.fusiongrid.org)
Network for Earthquake Engineering Simulation (NEESgrid) (http://www.neesgrid.org)
Particle Physics Data Grid (http://www.ppdg.net)