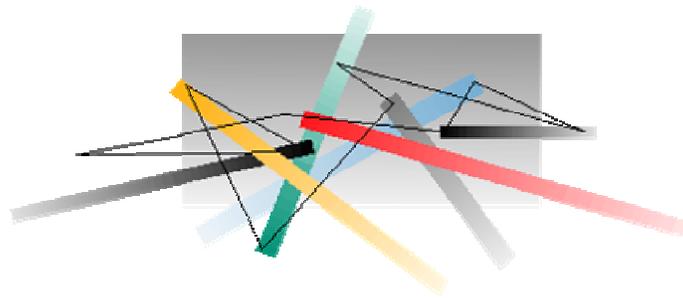


***Coalition for Academic
Scientific Computation***

C A S C



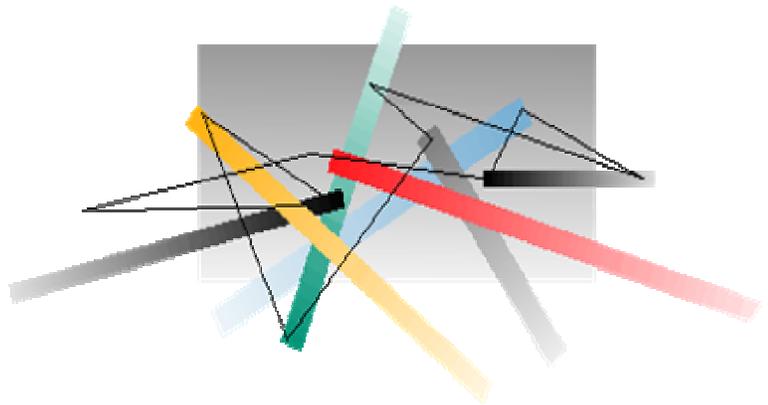
**Advancing High Performance
Computation and Communication
through Collaboration**

CASC is a nonprofit organization of supercomputing centers and research universities that offer leading edge hardware, software, and expertise in high performance computing resources and “advanced visualization environments.” Founded in 1989, CASC has grown into a national association representing 35 centers and programs in 22 states.

Working individually and together, coalition members complement traditional methods of laboratory and theoretical investigation by using high performance computers to simulate natural phenomena and environmental threats, handle and analyze data and create images – all at performance levels not available from smaller computers. By applying advanced technology, CASC members help extend the state of the art to achieve the scientific, technical, and information management breakthroughs that will keep the U.S. in the forefront of the 21st century information technology revolution.

Coalition members are involved in activities that foster major advances for virtually every element of society. The range of these efforts encompasses:

- ◆ Aiding in Homeland Security
- ◆ Accessing Information
- ◆ Improving Health Care
- ◆ Conducting Research
- ◆ Combating Cyber-Terrorism
- ◆ Enhancing Education
- ◆ Supporting the Arts
- ◆ Innovating in Design and Construction
- ◆ Understanding the Environment
- ◆ Preparing for Bio-Terrorism
- ◆ Advancing Bioinformatics

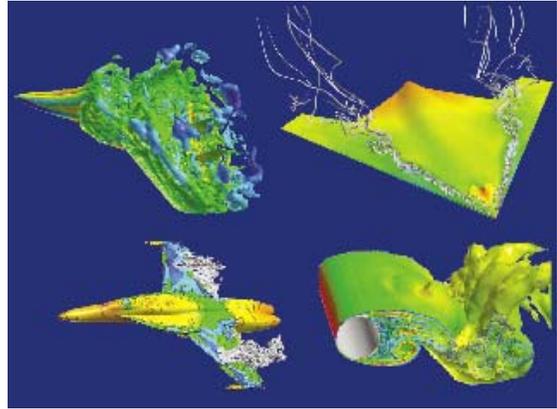


This brochure features the activities of a few of our members in each topic area. It is not intended to incorporate all of the research that all of our members are doing in these and many other fields. More information about CASC members may be found on our website at <http://www.casc.org>.

Aiding in Homeland Security

CASC members are involved in a wide range of activities supporting the Federal government in its efforts to develop and improve security measures to combat terrorism.

- ◆ The Maui High Performance Computing Center (MHPCC), managed by the University of Hawaii, is an allocated distributed center of the Department of Defense (DoD) High Performance Computing Modernization Program (HPCMP). The HPCMP provides the research community with HPC hardware and software to support combat troops. These DoD Research Projects involve simulating turbulent flows around aircraft, modeling laser beam qualities, modeling the designs of RF weapons, simulating pump-jet propulsion for submarines, and high resolution global ocean/ice modeling.



Turbulent flows around aircraft

- ◆ The Pacific Northwest National Laboratory (PNL) has developed a Holographic Imaging System, which, with a few modifications, could be used in airports to stop the smuggling of box-cutters or explosive sneakers onto airplanes. This imaging system, originally designed for the Federal Aviation Administration to detect metal objects hidden in clothing, uses millimeter waves that can penetrate fabric, but are completely harmless to people
- ◆ The Center for High Performance Computing at the University of New Mexico (UNM) is leading the New Mexico Partnership, one of two national alliances of universities supporting the Defense Threat Reduction Agency (DTRA). UNM's DTRA effort includes activities from social and political modeling to the modeling and analysis of nuclear weapons effects.
- ◆ Oak Ridge National Laboratory (Tennessee) and strategic partners are working to immediately build a comprehensive national incident-management system for the real-time detection, identification, and assessment of chemical, biological, radiological and nuclear threats. SensorNet will aggregate and coordinate all necessary knowledge and response assets quickly and effectively. The network will function through the use of sensors, real-time threat assessment, and nationwide real-time remote communications.
- ◆ The University of Southern California's Information Sciences Institute has identified two areas in which research and modeling capabilities can be improved substantially to provide a new level of support for homeland security decisions. The first is detailed modeling of the consequences of terrorist attacks. The second is modeling economic impacts of terrorist attacks at several levels of the economy. They are building upon recent advances in scaling up detailed entity-level military simulations to create regional simulations that will have sufficient fidelity to model entities such as people, vehicles, structures, infrastructure and human activities. Potential attacks can then be examined for their immediate physical, psychological and economic consequences on the region; and proposed remediation, response and recovery strategies and policies can be tested along with their physical, psychological and economic consequences.

Accessing Information

CASC members are working to improve access to data so it can be retrieved and manipulated, regardless of the user's location. This type of information architecture and access becomes increasingly important as new research creates ever-larger data sets distributed nationwide.

- ◆ The Pittsburgh Supercomputing Center's main computing resource is the National Science Foundation's Terascale Computing System. The system features six teraflops of processing power, and remarkable capabilities for large-scale data handling. In a collaborative project supported by NSF, Distributed Terascale Facilities (DTF) are being built at two other CASC member institutions: the National Center for Supercomputing Applications (Illinois) and the San Diego Supercomputer Center. This project, known as the Teragrid, adds as partners the California Institute of Technology and Argonne National Laboratory (Illinois). NSF's next step in terascale computing, the Extensible Terascale Facility (ETF), will be a scalable distributed computational grid based on the DTF and TCS. The ETF will enable researchers to conduct analyses at unprecedented scale, to merge multiple data resources seamlessly, and to advance discovery at the frontiers of science and engineering. Other CASC participants in the ETF Grid include Purdue University, Indiana University, Oak Ridge National Laboratory (Tennessee), the National Center for Supercomputing Applications, California Institute of Technology, and the San Diego Supercomputer Center.



Map of NSF ETF Facilities, including 7 CASC Centers

- ◆ Data collections are growing to phenomenal sizes due to experimental data generated by major instruments and datasets generated by large-scale simulations. The Center for Advanced Computing Research at the California Institute of Technology (CACR) is focused on building virtual organizations that exploit and federate heterogeneous information resources and creating unified, interoperable services and registries that exploit the richness and diversity of these resources. Collaborations address the frontiers of astronomy (NVO, QUEST, GRIST) and high energy physics (GriPhyN, PPDG, iVDGL), for example. In 1996, CACR was the first university to install the IBM High Performance Storage System (HPSS) with a 15 terabyte tape library. Due to collaborator's interest in data intensive applications, CACR's tape library has grown to a capacity exceeding a petabyte.

Improving Health Care

CASC members have been in the forefront of medical research, using supercomputers to expand knowledge, increase collaboration, and improve health care delivery. Today's medical providers already use videoconferencing (to interview or examine patients from hundreds of miles away), and computer-aided surgery with Internet-based video. Researchers use powerful computers for sophisticated analyses of huge amounts of information generated by advanced non-invasive imaging technology, such as CAT scans.

- ◆ The Ohio Supercomputer Center's Biomedical Applications Research Group has developed a working prototype system for the virtual simulation of temporal bone dissection. The system integrates technological advances to provide a safer and more cost effective way to learn fundamental techniques, and obviates the need for physical material in initial training. By increasing the realism and complexity of the representation, this project will advance training in surgical intervention, which remains a key element in improving the control of hearing and balance disorders and enhancing the health of many.



- ◆ East Carolina University's Telemedicine Program provides training in Technology for Homeland Security, in topics such as the Role of Health in Security; Situational Awareness; Distributed Medical Intelligence Concepts and Practices; Data Collection Technologies; Flexible Telecommunications; and Toolkits and Systems. The track is designed to provide an overview of the use of technology to increase homeland vigilance and to improve health care quality through the use of innovative, appropriate applications of health telematic practices and technologies.

- ◆ The National Supercomputing Center for Energy and the Environment (NSCEE) at the University of Nevada Las

Vegas is working on an on-going telemedicine and distance education program, which represents a model program for the electronic delivery of health care and education. The purpose of the Telehealth Technology Initiative is to evaluate the technical requirements for public health applications and to establish the infrastructure to effectively deliver health and medical care through a technology based infrastructure. This telemedicine program will meet the needs of rural health care providers by providing access to knowledge databases and library services as well as providing interactive video conferencing. The proposed system is designed to meet the following objectives: high-quality video, user-friendly interface, reliable connections, portability, low costs and low maintenance.

Conducting Research

CASC members routinely use high performance computing in virtual laboratories to conduct research without regard to the researchers' physical location. Within these virtual settings, scientists and engineers can interact with colleagues, access instrumentation, share data and computational resources, and find information in digital libraries.

- ◆ The Access Grid continues to be developed by an alliance composed of broad sectors of society, including traditionally underrepresented groups. The goal is to make the tools and resources of emerging technologies accessible to all levels of learners and educators, and to forge a national computing infrastructure that will support the next wave of scientific discovery. Nineteen (19) CASC members participate in this program nationwide, ranging from Massachusetts to Hawaii and Alaska to Florida.



- ◆ The University of Florida is one of eight universities funded by the National Science Foundation to participate in the Middleware Initiative Testbed. 'Middleware' denotes software components aimed at increasing collaborative capabilities amongst peer groups. It is intended to provide a platform for academics and other groups to create effective virtual collaboration environments, as well as administrative applications. It is also meant to enable the seamless use of computer and storage resources across distributed domains, empowering individual scientists to analyze large volumes of data, perform high throughput simulations, and compute intensive scientific calculations without requiring that all the data reside on a server at their home facility.
- ◆ Researchers at the University of Texas at Austin are delving into the area of Hardware Accelerated Visualization and Computation on graphics processing units (GPUs). In the early years of the development of computers, scientific and industrial applications played a major role in promoting computer technology. In more recent years, the advent of the desktop computer has promoted further advances in computer processor technology in a much broader context. In the development of graphics processor capability, the entertainment industry, computer games and related applications have been the main driving force(s) and a significant component of the economic base of the computer industry at large. The project therefore focuses on the development of GPUs, which are leading this trend in high-volume markets.
- ◆ The Nearby Supernova Factory (SNfactory), based at the Lawrence Berkeley National Lab, has discovered 34 supernovae during its first year of operation — the best performance ever for a "rookie" supernova search. The SNfactory processed a quarter-million images in its first year and archived 6 terabytes (trillion bytes) of compressed data at the National Energy Research Scientific Computing Center (NERSC) at Berkeley Lab — one of the few centers with an archive large enough to store this much data. The SNfactory's goal is to find and examine in detail up to 300 nearby Type Ia supernovae, many more than have been studied so far. Knowing more about nearby supernovae will help scientists put observations of very distant supernovae to better use in understanding the history of the universe — particularly the mysterious dark energy that is causing the universe to expand at an accelerating rate.

Combating Cyber-Terrorism

CASC members use computer simulations to conduct research on basic and advanced computer security issues. The goal is not only the protection of vital national security data, but also the protection of our college and university networks, continuing the free flow of information and ideas without the fear of interference or infiltration.

- ◆ SUNY-Buffalo's Center of Excellence in Information Systems Assurance Research and Education (CEISARE) is working on Intrusion Detection systems, in cooperation with the US National Security Agency. They are also developing e-commerce and Web assurance applications, as well as new approaches to trusted mobile computing and security in enterprise systems. Basic security measures used here include encryption, firewalls, intrusion detection and vulnerability testing.
- ◆ Purdue University's Center for Education and Research in Information Assurance and Security (CERIAS) is the world's foremost university center for multidisciplinary research and education in areas of information security. Key projects include Detecting Denial of Service Attacks and Online Security Communication about Credit Card Usage. The Purdue Incidence Response team has also developed a tool called "Cassandra" (named for the Greek woman who told the Trojans not to admit the wooden horse), which allows the user to create saved profiles of the services and applications running on his or her network, typical (standard configuration) hosts or important hosts. Cassandra can then notify the user by email of new vulnerabilities relevant to his/her user profile. The database is based on NIST's ICAT server, a searchable index of information on computer vulnerabilities that is updated bi-weekly.
- ◆ The Pacific Institute for Computer Security (PICS) is a cooperatively funded research program at the San Diego Supercomputer Center (SDSC). PICS is a research-oriented operation that conducts and publishes leading-edge research into real-world computer and network security issues, with an emphasis on solutions grounded in practical reality. In addition to its technical work, PICS is at the forefront in recognizing the legal and policy implications of computer security and computer crime.



Global Impact of the 'Code Red' Worm

- ◆ The National Center for Supercomputing Applications (NCSA) will lead the National Center for Advanced Secure Systems Research (NCASSR). The new center will be launched with an initial outlay of \$5.7 million, to address the nation's critical need for a dynamic, adaptive cybersecurity infrastructure. The center will enhance and safeguard the computing and networking tools available to the nation's military forces through a variety of projects. These will include the development of better ways of monitoring network security to prevent hostile cyber-attacks, such as computer worms and viruses, and the creation of adaptable radios that will allow emergency personnel from crisis response agencies to communicate more effectively.

Enhancing Education

CASC members are involved in a range of activities aimed at creating and improving educational programs that foster computer skills so that students can engage in the high-tech work force when they leave school. They also encourage superior students to consider future engineering and scientific careers, and teach computational skills to researchers whose backgrounds do not include computational methodology.

- ◆ The Arctic Region Supercomputing Center (ARSC) and the University of Alaska Fairbanks joined forces with the High Performance Computing Center at the University of New Mexico to initiate the first for-credit course in High Performance Computing, offered simultaneously in multiple locations via the Internet, during the fall semester of 2001. The course was designed to introduce students with research interests in the physical sciences to the concepts of parallel scientific computation, by focusing on the development of an intellectual and physical computing infrastructure.
- ◆ The University Corporation for Atmospheric Research (UCAR) runs an award winning, user-friendly Web site for general public use, known as *Windows to the Universe*. The site contains a rich array of documents – images, movies, animations, and data sets – that explore the Earth and space sciences, and the historical and cultural ties between science, exploration, and the human experience. Some four million users explored the site during the past year.



Students tour the Oak Ridge Graphite Reactor

workforce, especially at national Department of Energy (DOE) laboratories. The RAM program is designed to provide collaborative research experiences among faculty and students at colleges or universities and DOE national laboratory researchers. These experiences will improve the U.S. competitive research edge while encouraging and promoting science and technology research throughout the academic year.

- ◆ The Oak Ridge National Laboratory supports the Research Alliance for Minorities (RAM) program. This program is based on the belief that national laboratories and universities, working hand in hand, offer the best opportunity to make a positive impact on the quality of a diverse workforce. The overall short-term goal is to increase the number of underrepresented minorities who pursue degrees in science, mathematics, engineering, and technology. This supports the long-term goal of increasing the number of underrepresented individuals with advanced degrees in these fields in the

Supporting the Arts

CASC members participate in a variety of projects to ‘push the envelope’ in the Arts – dance, visual arts, graphic design and theater are all impacted through the use of supercomputers. The introduction of advanced technologies into these areas has led to remarkable advances in interdisciplinary cooperation among artists and computer scientists.

- ◆ The Department of Modern Dance and the Center for High Performance Computing at the University of Utah are currently involved in an exciting new project that builds on the rich history of collaboration between dance and technology. ADAPT (Association for Dance and Performance Telematics) was founded in December 2000 as an interdisciplinary collaboration between artists, technologists, and scholars from five educational institutions in the United States. ADAPT is dedicated to research and critical dialogue on performance and media in telematic space using advanced network technologies, such as those developed under the Internet2 initiative. Since March of 2001 members of ADAPT have been meeting on-line monthly to experiment with a variety of methods and processes for distance collaboration.



Innovating in Design and Construction

CASC members use computer simulations to create accurate representations of a structure’s physical properties before it is built. These models allow designers, manufacturers, builders and end-users to participate in the process, offer feedback, and reduce the time and cost of engineering designs and analyses. The ability to predict long-term fatigue and failure in vital system parts may be of even greater benefit in decreasing design costs and possible accidents in the future.

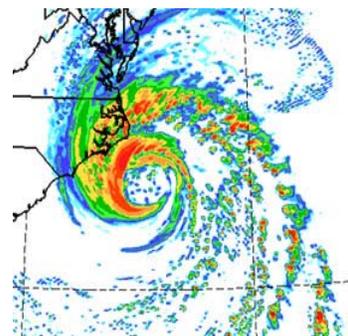
- ◆ The Engineering Research Center at Mississippi State University is studying aerodynamic optimization and improvement capabilities for turbine airfoil configurations. This will help turbine engine manufacturers achieve the goals of increased thrust-to-weight ratio for future weapons systems and commercial applications. An aerodynamic shape design code has been developed which seeks to optimize a prescribed objective function, subject to various flow and geometric constraints, to evaluate candidate designs.



Understanding the Environment

CASC members are generating knowledge and understanding about such environmental concerns as water and air quality, and controlling the effects of toxic materials. Supercomputers are used to create accurate models of regional climate systems, ecosystems, and population trends. These models provide valuable data to scientists and policy makers so that they can make decisions about reducing environmental impact, adapting to changes in climate, or dealing with public safety.

- ◆ The Encyclopedia of Life (EOL) is an ambitious project to catalog the complete proteome of every living species in a flexible, powerful reference system. An open collaboration led by the San Diego Supercomputer Center, the EOL will generate biological insight using the world's foremost academic computational resources. This includes calculating three-dimensional models and assigning biological function for all recognizable proteins in all currently known genomes. Scientists will be able to uncover the prevalence of a given protein across all kingdoms of life, molecular interactions with that protein, and whether the function of the protein varies across species. The EOL caters to a diverse range of users, from researchers interested in proteomic associations, to undergraduates wishing to know the name and function of proteins associated with a particular organism, and even to elementary school students learning about proteins for the first time.
- ◆ The National Center for Atmospheric Research (NCAR) Weather Research and Forecast (WRF) is becoming the nation's flagship computer model for weather prediction. The model, in development since the mid-1990s, is now undergoing rigorous testing. With a horizontal resolution of 1 to 10 km (0.6 – 6.2 miles), the model will generate mesoscale forecasts so detailed that they will resemble radar images. WRF is also designed to mesh easily with models of air chemistry and other specialized areas. With the recent occurrence of Hurricane Isabel, researchers dispatched three "Doppler on Wheels" (DOW) mobile radars developed partly at NCAR toward the mid-Atlantic coast to intercept the eye of Isabel as the storm made landfall. These radars provided real-time, three-dimensional observations of the hurricane – boundary layer rolls, wind gusts, embedded tornadoes, and other phenomena as they evolve. These observations are compared to the WRF model running at NCAR on the IBM p690 supercomputer cluster, named Bluesky, to test the model's skill at predicting Isabel's intensity, structures, and track. The result is a highly precise two-day forecast.

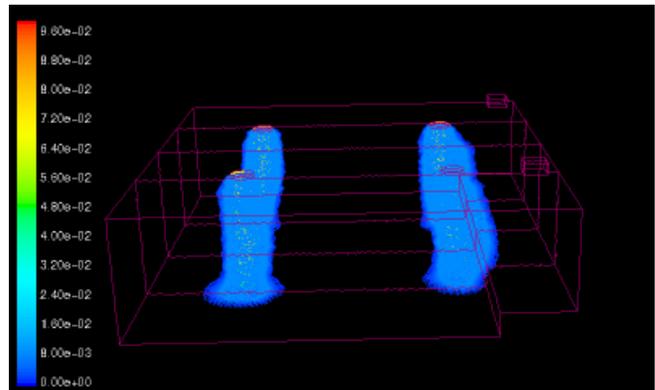


Hurricane Isabel

Preparing for Bio-Terrorism

CASC members conduct research into the prevention of, preparation for, and response to bio-terrorism. Biological Terrorism is defined as the use or threatened use of biological or biologically related toxins against civilians, with the objective of causing illness, death or fear. With the help of supercomputers, researchers are able to simulate biological attacks, in order to determine spread capability of an agent, possible outcomes, and response rates.

- ◆ The Pittsburgh Supercomputing Center supports the BioMedical Security Institute (BMSI), which is charged with advancing our capability to detect, analyze, prevent and respond to acts of terrorism and natural events involving biological agents. The BMSI is a collaboration between Carnegie Mellon University and the University of Pittsburgh.
- ◆ Researchers at Cornell University are using their background experience in large-scale epidemiological studies to study questions associated with the deliberate release of biological agents such as small pox or influenza into the populace using transportation systems. They are using high-performance computing to simulate outbreaks of epidemics in large networks to identify worst-case scenarios, to aide in policy and planning.
- ◆ At Texas Tech University, researchers are performing modeling and simulation experiments of chemical and biological operations in urban terrains. This project will include the toxicity impact on soldiers and civilians, as well as behavioral and physiological responses to such an attack, in order to improve the operational effectiveness of soldiers and Marines through the integration of advanced technologies and associated tactics, techniques and procedures. Researchers are using similar modeling experiments to evaluate the fluid flow of airborne chemical and biological agents within buildings and enclosed spaces. These three-dimensional, real-time visualization techniques will allow researchers to analyze the interaction between fluid, toxic and human behavior, to further the development of training modules for soldiers as well as civilian first-response units.

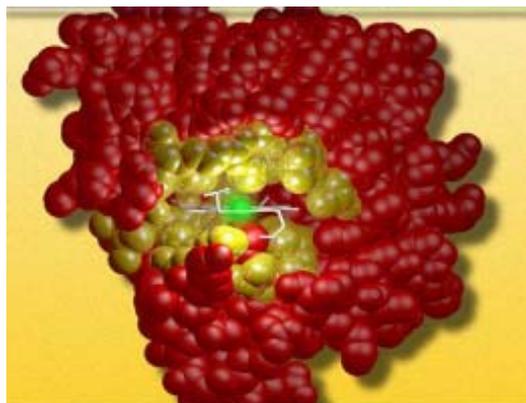


Fluid flow model of airborne chemical agents

Advancing Bioinformatics

CASC members are instrumental in advancing the field of bio-informatics, including applications in Computational Chemistry, Functional Genomics, Neural Imaging (brain mapping), Pharmacogenetics, Proteomics and Structural Biology.

- ◆ The Buffalo Center of Excellence in Bioinformatics, in partnership with biotechnology, computing and engineering industry partners, seeks to combine computational science and high-throughput experimental biology to enable the development of new medical treatments. The Center is developing and exploiting state-of-the-art algorithms for data acquisition, storage, management, and transmission, as well as utilizing innovative parallel and grid computing techniques.
- ◆ The North Carolina Bioinformatics Grid, established in December 2000, seeks to facilitate collaboration among the state's researchers and educators in genomics, proteomics, and bioinformatics education, research, and development. The North Carolina Supercomputer Center and the North Carolina Research and Education Network provide the base infrastructure for the Bio-Grid.
- ◆ Computational Chemistry research will soon be carried out on a Terascale level, due to the ever-increasing quantities of data required for research in this field. At the University of Kentucky, Bioinformatics studies are carried out using software programs that utilize data parallelization techniques to automate the splitting of query databases into smaller chunks, which are then spread out over the cluster nodes' local disks for querying.
- ◆ Rice University's Computer & Information Technology Institute (CITI) is the host campus of the Gulf Coast Consortia for Bioinformatics (GCCBN). The purpose of the GCCBN is to foster excellent cross-disciplinary research and education in the field of bioinformatics, particularly in the Houston/Galveston geographical area. The GCCBN will serve as a means of building and maintaining a community of interest among researchers at member institutions in the biological, information, and computer sciences, as well as affiliated industrial partners. The GCCBN seeks to fulfill this mission through activities in three areas: education, communication, and research funding. The consortium coordinates a cross institutional curriculum in bioinformatics, and will certify the completion of this curriculum by students at both the bachelor and graduate levels. By combining the strongest instructional offerings by each of the member educational institutions, we are able to provide a program that is competitive with any at a national level.



Myoglobin molecule

Federal Partnerships

CASC members develop partnerships with federal government entities to meet important national goals. A representative list appears below.

Federal Departments and Agencies

U.S. Department of Agriculture
U.S. Department of Defense
U.S. Department of Education
U.S. Department of Energy
U.S. Department of Transportation
Environmental Protection Agency
National Aeronautics and Space Administration
National Institutes of Health
National Library of Medicine
National Nuclear Security Administration
National Oceanic and Atmospheric Administration
National Science Foundation

Federal Programs

Air Force Laser Challenge Project
Advanced Simulation and Computing Program (ASCI)
Adventures in Supercomputing
Defense Modernization Program
Digital Library Initiative
Distributed Terascale Facility & Extensible Terascale Facility (at NSF)
Genomes to Life (GTL)
Human Genome Project
Information Technology Research Program (at NSF)
Minority Science Scholars Program
NASA Information Power Grid
National Middleware Initiative (at NSF)
Partnerships for Advanced Computational Infrastructure (PACI)
Scientific Discovery through Advanced Computing (SciDAC)

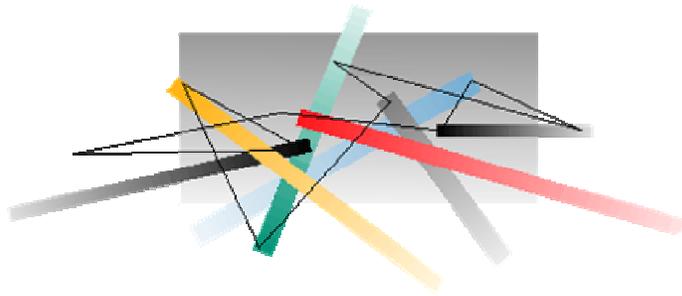
Federal Task Forces and Committees

Internet Engineering Task Force (IETF)
NSF Computer Information Sciences and Engineering (CISE) Advisory Committee
Presidential Information Technology Advisory Committee (PITAC)

CASC Members

Arctic Region Supercomputing Center, Fairbanks AK
Arizona State University, Tempe AZ
Boston University Center for Computational Science, Boston MA
Center for Advanced Computing Research, California Institute of Technology, Pasadena CA
Center for Computational Research, University at Buffalo, Buffalo NY
Center for Computational Sciences, University of Kentucky, Lexington KY
Center for High Performance Computing, University of Utah, Salt Lake City UT
Center for Parallel Computing, University of Michigan, Ann Arbor MI
Computational Science and Information Technology, Florida State University, Tallahassee FL
Computer and Information Technology Institute, Rice University, Houston TX
Cornell Theory Center, Ithaca NY
East Carolina University, Greenville NC
High Performance Computing Education and Research, University of New Mexico,
Albuquerque NM
Indiana University, Bloomington IN
Louisiana State University, Baton Rouge LA
Maui High Performance Computing Center, University of Hawaii, Manoa HI
Mississippi State University, Mississippi State MS
National Center for Atmospheric Research, Boulder CO
National Center for Supercomputing Applications, University of Illinois Urbana- Champaign,
Champaign IL
National Energy Research Scientific Computing Center, Berkeley CA
National Supercomputing Center for Energy and the Environment, University of Nevada
Las Vegas, Las Vegas NV
North Carolina State University, Raleigh NC
Northeastern University, Boston MA
Oak Ridge National Laboratory Center for Computational Sciences, Oak Ridge TN
Ohio Supercomputer Center, Columbus OH
Pacific Northwest National Laboratory, Richland, WA
The Pennsylvania State University, University Park PA
Pittsburgh Supercomputing Center, Pittsburgh PA
Purdue University, West Lafayette IN
San Diego Supercomputer Center, San Diego CA
Texas A&M University Supercomputer Center, College Station TX
Texas Advanced Computing Center , University of Texas, Austin TX
Texas Learning and Computation Center, The University of Houston, Houston TX
Texas Tech University, Lubbock TX
University of Florida, Gainesville FL
University of Oklahoma, Norman OK
University of Southern California Information Sciences Institute, Marina del Rey CA

C A S C



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