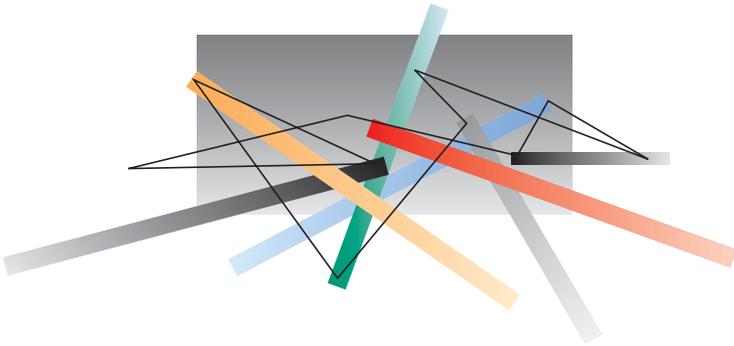


# **Coalition for Academic Scientific Computation**

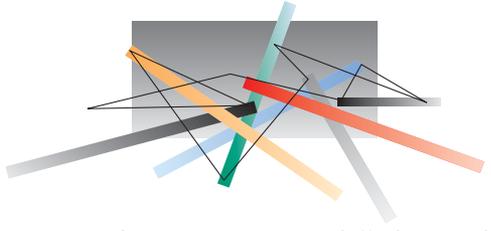
**C A S C**



**Advancing Security, Education and  
Healthcare Through  
High Performance Computation**



**CASC** is a nonprofit organization of supercomputing centers, research universities and federal laboratories 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 41 centers and programs in 28 states.



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.

Public-private partnerships with major corporations have been created to guarantee that cutting-edge technologies will be applied to real world challenges faced by industry and education. CASC members participate in research and development in all of the Grand Challenge areas posed by the Networking and Information Technology Research and Development (NIRTD) Program. Grand Challenge projects include education, healthcare, cybersecurity, bioinformatics, national security, and the environment.

This brochure features the activities of a number of CASC members in a few of these areas. 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>**.

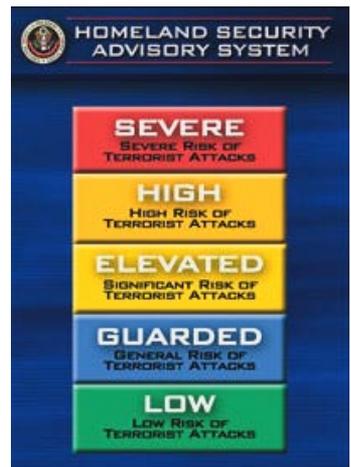
## Homeland Security and Cybersecurity Research

**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, both physical and electronic. Program partners include:

- Department of Defense (DoD)
- Department of Homeland Security
- National Security Agency
- Office of Naval Research

CASC Members participate in the DoD's High Performance Computing Modernization Program (HPCMP), the Defense Threat Reduction Agency (DTRA), and host a variety of other government-sponsored programs. Researchers at CASC centers are working on ways to increase the effectiveness of the response to terrorist acts and reduce response time; improve incident management and detection; assess chemical, biological, radiological and nuclear threats; improve nationwide crisis communications systems; and simulate attacks to facilitate development of appropriate recovery strategies and policies.

CASC members also utilize 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. In this realm, CASC members participate in national cyber-defense efforts, such as the Research and Education Networking Information Sharing and Analysis Center (REN-ISAC), hosted at the University of Indiana.



## Grid Computing

**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.

Eight CASC Members are active participants in the National Science Foundation's Terascale Computing System, or "Teragrid". The system features six teraflops ( $10^{12}$  – one trillion point operations per second) of processing power, and remarkable capabilities for large-scale data handling, over a network that operates at 40 gigabits per second.



The Teragrid project was launched by the National Science Foundation (NSF) in August 2001 with \$53 million in funding to four sites: the National Center for Supercomputing Applications (NCSA) at the University of Illinois, Urbana-Champaign; the San Diego Supercomputer Center (SDSC) at the University of California, San Diego; the Center for Advanced Computing Research (CACR) at the California Institute of Technology in Pasadena; and the Argonne National Laboratory in Argonne, IL. (<http://www.teragrid.org> )

In October 2002, the Pittsburgh Supercomputing Center (PSC) at Carnegie Mellon University and the University of Pittsburgh joined the TeraGrid as a major new joint partner when NSF announced \$35 million in supplementary funding. Another \$10 million in NSF awards in September 2003 added four additional sites to the partnership: Oak Ridge National Laboratory (ORNL), Oak Ridge, TN; Purdue University, West Lafayette, IN; Indiana University, Bloomington; and the Texas Advanced Computing Center (TACC) at The University of Texas at Austin.

## ***Challenges in Education and Awareness***

**CASC** members are involved in a wide 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.

As the need for high performance computing research increases, CASC centers have begun offering for-credit courses and workshops in High Performance Computing, both in the university setting and online. These learning modules are designed to introduce students to the concepts of parallel scientific computation, visualization, and a wide range of software programs, focusing on the development of an intellectual and physical computing infrastructure. The courses are taken by graduate students and postdoctoral researchers in the physical sciences.

In order to help extend high performance computing to the next generation of scientists, CASC centers also work to train high school teachers to be leaders in computational science. With a grant from the NSF and assistance from the Institute of Electrical and Electronics Engineers (IEEE), six CASC member institutions worked under the auspices of the National Computational Science Education Consortium (NCSEC) to lead a 42-month professional development program for 200 high school teachers across the United States.

CASC centers also host a wide range of research projects aimed at improving human interaction with technology, from hand-held personal digital assistants to video game graphics processing units (GPUs). Building on the widespread success of wireless technologies, CASC member universities are using Blackberry and Handspring devices to support students in a wide range of non-technological fields, including art history, English, nursing and education. Students are able to download their lesson plans, course content and syllabi, and can reference these documents from anywhere.

## Challenges in 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.

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 Arctic Region Supercomputing Center provides the computational tools that allow researchers to study the minute changes in proteins and DNA that may one day provide drug companies with the keys to create medications to cure diseases like Alzheimer's. Research of hibernating animals in Alaska has provided scientists with integral information about the proteins that are present in animals during hibernation, which are similar to the proteins that are present in the brains of Alzheimer's patients. By using computational resources at ARSC, scientists are able to compare these proteins in extreme detail, facilitating discovery of their importance to human health and their role in particular diseases.

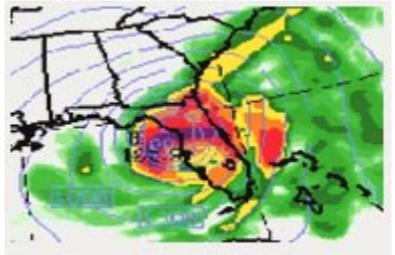


The Cornell Theory Center facilitates the study of food-borne pathogens and virulent bacteria through the development of a bioinformatics tool known as the PathogenTracker. This web-based database contains the genetic fingerprints of food-borne pathogens, enabling researchers to more quickly analyze outbreaks and epidemics of infectious diseases.

## Challenges in 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 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 being used to forecast large storms, including Frances, Ivan and Jeanne, which bombarded the state of Florida in September 2004. With a horizontal resolution of 1 to 10 km (0.6 – 6.2 miles), the model generates mesoscale forecasts so detailed that they resemble radar images. WRF is also designed to mesh easily with models of air chemistry and other specialized areas. WRF provided real-time, three-dimensional observations of each of the three storms, at a resolution of 4 km. The information was used by various government forecasting agencies, along with forecasts from other centers, to predict the paths of the storms as they approached the continental U.S. The models were run on NCAR's Bluesky system, the world's largest IBM p690 cluster, with nearly 1600 processors and a peak capability of 8.5 Teraflops. Bluesky is used for atmospheric science-related investigations, including climate change, research weather forecasting, ocean modeling, and solar research.



WRF image of Hurricane Jeanne

## Challenges in Safety and Security

**CASC** members are working on improving the real-time detection of natural and man-made threats, as well as the response time to these threats for both government and civilian organizations. In addition, the supercomputer centers are involved in the development of high confidence infrastructure control systems, to mitigate any threats to the nation's vital communications networks.

The National Center for Supercomputing Applications (NCSA) is developing techniques for ensuring the integrity of as many as hundreds of thousands of mobile sensors deployed in the battlefield or other hostile environments. NCSA leads the National Center for Advanced Secure Systems Research (NCASSR), a new center that addresses 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, improving methods of network security monitoring to prevent hostile cyber-attacks, and the creation of adaptable radios that will allow emergency personnel from crisis response agencies to communicate



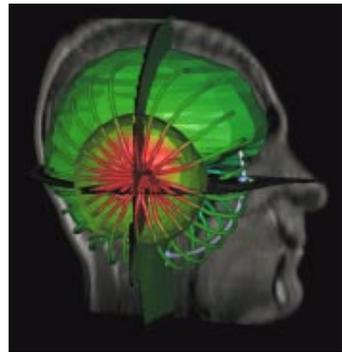
more effectively. NCASSR is also sponsoring NCSA researchers in developing innovative software tools that are designed to give security engineers a visual overview of an entire cyberinfrastructure network, in order to help them more readily determine when a network is under attack, what parts of the network are being attacked, and the form that the attack is taking.

## Scientific Visualization

Scientific visualization is a major component of the **CASC** member centers' activities. "Visualization" refers to rendering techniques that create images out of non-geometric data sets. Because of the highly specialized graphics and large datasets used in these programs, supercomputers are ideally suited for this work.

The Scientific Visualization Group at the Texas Advanced Computing Center (TACC) received a grant from Microsoft Research to study the graphics and architecture of video games, to improve the graphic systems of the future in terms of performance, techniques, and graphic simulations. The program also seeks to train students to enter the computer graphics industry.

Three CASC members participate in the NSF Graphics and Visualization Center, which was created to build a stronger scientific foundation for computer graphics and scientific visualization, and to help create the basic framework for future interactive graphical environments. The Center pursues research in four main areas of computer graphics: modeling, rendering,



Rendering of a simulated seizure

user interfaces and high-performance architectures. Medical research projects are key users of visualization, in brain variability mapping (for diseases such as Alzheimer's or schizophrenia), 3-dimensional MRI heart segmentation, electron microscopy visualization, and intravascular ultrasound imaging.

At the San Diego Supercomputer Center, the visualization staff has championed several forms of stereographic (3-D) image presentations for scientific visualizations, from clinical cancer data to cosmological models of the early universe. The center's video and 3-D visualization tools are regularly used by researchers, educators, clinicians, science centers and museums.

## ***Industry Partnerships***

CASC members have formed partnerships with major industry leaders, in the areas of parallel computing, wireless technology, interactivity among operating systems, financial data analysis, and infrastructure development. Corporations such as IBM, Motorola, Sun, and Microsoft have donated equipment and funding to these and other research areas, to advance state of the art technologies and systems and educate the next generation of scientists.

The Ohio Supercomputer Center (OSC) and the federal government (DOE, DoD) are making substantial investments in the new Springfield Advanced Technology Research Park (ARTP). This park has already attracted companies such as Lexis-Nexis and is expected to attract more from across the US. Blue Collar Computing, a new OSC initiative, enables advanced manufacturing and other industries to tap into OSC's high performance computing resources and expertise. High performance computing and networking are critical elements of this strategy to turn the "rust belt" into a hub for US-based manufacturing of high-end goods and services again.

The goal of the NCSA Private Sector Program (PSP) is to partner with leading-edge companies to guarantee that NCSA's cutting-edge technology development will be applied to real-world challenges faced by industry. Working with NCSA, companies have reaped the benefits of access to technological breakthroughs before their competition. The PSP is a doorway for business—leading to the emerging technologies and computing innovations developed at NCSA. Current PSP partners are Allstate, Caterpillar, Inc., Motorola, Boeing, IBM and SAIC.

MBA Students at East Carolina University now have access to MineSet software, which analyzes high volumes of financial data, thanks to a grant from Silicon Graphics Inc. (SGI). The program is housed on a server at the supercomputer center, which easily handles the large data sets, allowing the students to analyze trends and examine economic structures, as well as supporting the study of artificial intelligence in finance and economics.

## **Government & Industry Partnerships**

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

### **Federal Departments and Agencies**

U.S. Department of Defense  
U.S. Department of Education  
U.S. Department of Energy  
U.S. Department of Homeland Security  
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

### **Industry Partnerships**

- Allstate
- Boeing
- Caterpillar
- Ericsson
- Handspring
- IBM
- Intel
- Microsoft
- Motorola
- SAIC
- Sun Microsystems
- Unisys

### **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, University of Michigan, Ann Arbor MI

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

Computer and Information Technology Institute, Rice University,  
Houston TX

Cornell Theory Center, Ithaca NY

Duke University, Durham NC

East Carolina University, Greenville NC

Florida State University School of Computational Science and Information  
Technology, Tallahassee, FL

Georgia Institute of Technology, Atlanta GA

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

## **CASC Members**

NDSU Center for High Performance Computing, North Dakota State  
University, Fargo ND  
Northeastern University, Boston MA  
Oak Ridge National Laboratory Center for Computational Sciences,  
Oak Ridge TN  
Ohio Supercomputer Center, Columbus OH  
OU Supercomputing Center for Education and Research, University of  
Oklahoma, Norman OK  
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 Iowa, Iowa City IA  
University of Southern California Information Sciences Institute,  
Marina del Rey CA  
Virginia Tech Terascale Computing Facility, Blacksburg, VA

## **CASC Officers:**

**Chair:** Dr. Frank Williams, Arctic Region Supercomputer Center

**Vice Chair:** Dr. Craig Stewart, Indiana University

**Secretary/Treasurer:** Dr. Richard Pritchard, Ohio Supercomputer Center

## 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  
University of Michigan  
Ann Arbor MI
- 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
- Computer and Information  
Technology Institute,  
Rice University  
Houston TX
- Cornell Theory Center  
Ithaca NY
- Duke University  
Durham NC
- East Carolina University  
Greeneville NC
- Florida State University School of  
Computational Science and  
Information Technology  
Tallahassee, FL
- Georgia Institute of Technology  
Atlanta GA
- 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

## CASC Members

National Supercomputing Center for  
Energy and the Environment  
University of Nevada Las Vegas  
Las Vegas NV

NDSU Center for High  
Performance Computing  
North Dakota State University  
Fargo ND

Northeastern University  
Boston MA

Oak Ridge National Laboratory  
Center for Computational Sciences  
Oak Ridge TN

Ohio Supercomputer Center  
Columbus OH

OU Supercomputing Center for  
Education and Research  
University of Oklahoma  
Norman OK

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 Iowa  
Iowa City IA

University of Southern California  
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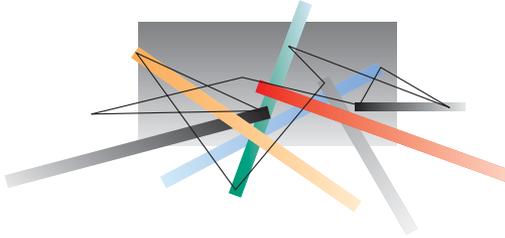
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# CASC



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