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Special Emphasis Panel in Advanced Networking Infrastructure and Research

High Performance International Internet Services

Performance Review

Computational Science and Engineering Applications

www.startap.net/APPLICATIONS

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All applications documented herein appear on the STAR TAP web site; the vast majority relate to collaborative research among US scientists and colleagues at HPIIS-related National Research Network-connected institutions. Applications specific to each HPIIS project appear on the individual web sites.

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Table of Contents

A. Biology

A.1. Molecular and Cellular Biosciences

ProtoMap - A Map of Protein Space: An Interactive Web Site for Biological and Biomedical Investigations

This site classifies and groups all of the proteins in the Swiss-Prot and TrEMBL databases. Transitivity is used to identify homologous proteins, and within each group, every two members are either directly or transitively related. Transitivity is applied restrictively in order to prevent unrelated proteins from clustering together. The classification is done at different levels of confidence, and results in a hierarchical organization of all the proteins.

The resulting classification splits the protein space into well-defined groups of proteins, most of them closely correlated with natural biological families and superfamilies. The hierarchical organization may help to detect finer subfamilies that make up known families of proteins, as well as interesting relations between protein families.

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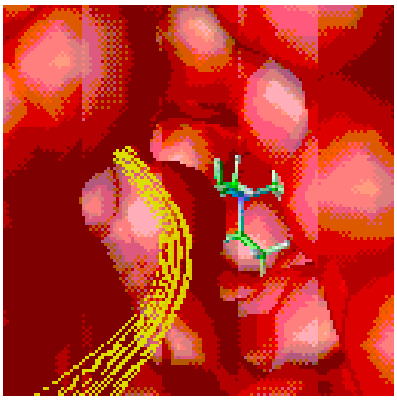

Visualization of Acetylcholinesterase: Nature's Vacuum Cleaner

Acetylcholinesterase (AcChoEase) is an enzyme that plays a key role in the human nervous system. In vertebrates, nerve impulses travel from cell to cell by means of chemical messenger. When an electrical impulse reaches the end of one cell, messenger molecules–acetylcholine (AcCho), in this case–are released to diffuse though the fluid-filled, intercellular, synaptic gap. Upon reaching the destination cell, the AcCho molecules dock into special receptors triggering a new electrical impulse. Much like a vacuum cleaner, the enzyme AcChoEase is constantly sweeping up and hydrolyzing AcCho during this process, so that the whole cycle can begin again.

Chemicals that inhibit the action of AcChoEase are being used in the treatment of glaucoma, myasthenia gravis and, experimentally, Alzheimer's disease. In spite of the ability to exploit the enzyme, its precise mechanism of operation is still a mystery.

The recent solution of the X-ray structure for AcChoEase, places the active catalytic site deep within a gorge-like fold of the protein. Electrostatic computations reveal the enzyme to be a single massive dipole. Such a configuration of charge suggests an electrostatic mechanism for directing the positively charged AcCho into the gorge and towards the active site.

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Interactive Simulation in the Field of Plant Nutrition

This US-Israel Bi-national Agricultural Research and Development (BARD) Foundation project involves hypotheses testing and result evaluation, using an interactive graphic model. *SimRoot*, a 3D model developed at Penn State, graphically describes the 3D deployment of plant root systems in soil. The model follows plant development and predicts the performance of plants under various environmental conditions, depending on their physiological characteristics.

Results are displayed graphically in 3D dynamic images that can be rotated by the viewer. This type of work was limited until now to users working at the console or on local area networks. This application requires high-speed computer communication to allow real-time responses between Israel and the US. If successful, a whole new area of applications in cooperative ecological and physiological research and teaching will evolve.

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Collaboration for Structural Biology: Remote Protein Crystallographic Structure Determination through Remote Real-Time Data Collection

Using high-performance networks, biologists in Singapore are able to collaborate with protein crystallographers at Stanford to solve complex biological molecules. Very large datasets typically have to be downloaded for subsequent analysis on-site, but through the networks, real-time collection of protein crystallographic data enables researchers in Singapore to solve structures without having to be physically present at Stanford.

To date, the toxic proteins bucandin, stonustoxin and phosphatases have been solved and/or studied in Singapore using this structural biology collaboration. Bucandin was subsequently solved in three weeks using direct methods by researchers at the Cornell High-Energy Synchrotron Source and the University of Goetting, Germany.

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DNA Structure and Dynamics

This project researches DNA structures and the dynamics induced by changing environmental conditions and local DNA sequences.

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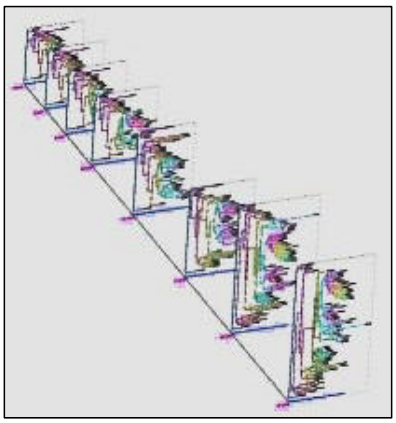

Maximum Likelihood Analysis of Phylogenetic Data

iGrid 1998

DNA data has accumulated more rapidly in recent years than compute power, so researchers must often exclude potentially informative data to make statistical analysis practical. For SC'98, the computationally intensive maximum-likelihood method of phylogenetic inference is used on three medium-to-large datasets: cytoplasmic coat proteins, mycrosporidia, and cyanobacteria.

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B. Computer, Information Systems

B.1. Advanced Computational Infrastructure and Research

Access Grid: Wide-Area Group Collaborative Visualization

iGrid 2000 and ongoing

The Access Grid is the ensemble of resources used to support group-to-group human interaction across the grid. It consists of large-format multimedia projective displays, presentation and interactive software environments, interfaces to grid middleware, and interfaces to remote visualization environments. The Access Grid is designed to support large-scale distributed meetings, collaborative teamwork sessions, seminars, lectures, tutorials and training.

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High Speed Networking with Subaru Telescope in Hawaii

iGrid 2000 and ongoing

The Subaru Telescope in Hawaii is connected via a high-speed link to the INET2000/iGrid 2000 conference site in Yokohama, and high-definition astronomical images are quickly retrieved and downloaded. Real-time interactive classes and discussions with researchers also take place between Hawaii and Yokohama using high-quality multimedia communication tools.

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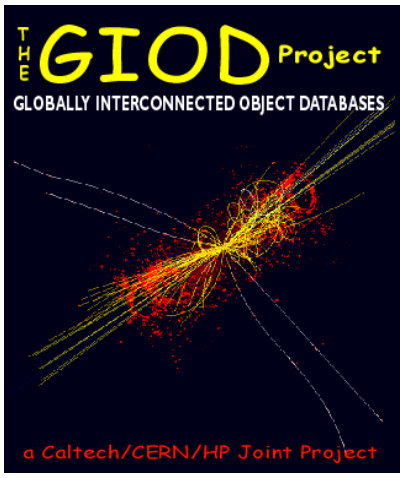

Globally Interconnected Object Databases (GIOD) Project

A data thunderstorm is gathering on the horizon with the next generation of particle physics experiments. The amount of data is overwhelming. Even though the prime data from the CERN Compact Muon Solenoid (CMS) detector will be reduced by a factor of more than 107, it will still amount to over a PetaByte (1015 bytes) of data per year accumulated for scientific analysis.

The task of finding rare events resulting from the decays of massive new particles in a dominating background is even more formidable. Particle physicists have been at the vanguard of data-handling technology, beginning in the 1940s with eye scanning of bubble-chamber photographs and emulsions, through decades of electronic data acquisition systems employing real-time pattern recognition, filtering and formatting, and continuing on to the PetaByte archives generated by modern experiments. In the future, CMS and other experiments now being built to run at CERN's Large Hadron Collider (LHC) expect to accumulate on the order of 100 PetaBytes within the next decade.

The scientific goals and discovery potential of the experiments will only be realized if efficient worldwide access to the data is made possible. Particle physicists are thus engaged in large national and international projects that address this massive data challenge, with special emphasis on distributed data access. There is an acute awareness that the ability to analyze data has not kept up with its increased flow. The traditional approach of extracting data subsets across the Internet, storing them locally, and processing them with home-brewed tools has reached its limits. Something drastically different is required. Indeed, without new modes of data access and remote collaboration we will not be able to effectively "mine" the intellectual resources represented in our distributed collaborations.

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JavaCMS - A Java 3D Particle Collision Event Viewer Using a Distributed Object Database Management System

iGrid 1998

This application is part of the Globally Interconnected Object Databases (GIOD) project, a joint effort among Caltech, CERN, and Hewlett-Packard Corporation. This JavaCMS application enables remote viewing of individual events in the large (~1TB) datastore of fully simulated particle collision events from CERN's Large Hadron Collider (LHC), due to begin operation in 2005.

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The MONARC Project for LHC Experiments (Models of Networked Analysis at Regional Centres)

The Large Hadron Collider (LHC) experiments have envisaged Computing Models (CM) involving hundreds of physicists doing analysis at institutions around the world. The Compact Muon Solenoid (CMS) and ATLAS projects also are considering the use of Regional Centers, each of which could complement the functionality of the CERN Center. They are intended to facilitate the access to the data, with more efficient and cost-effective data delivery to the groups in each world region, using national networks of greater capacity than may be available on intercontinental links.

The LHC models encompass a complex set of wide-area, regional and local-area networks, a heterogeneous set of compute- and data-servers, and a yet-to-be determined set of priorities for group-oriented and individuals' demands for remote data. Distributed systems of this scope and complexity do not exist yet, although systems of a similar size to those foreseen for the LHC experiments are predicted to come into operation by around 2005 at large corporations.

In order to proceed with the planning and design of the LHC Computing Models, and to correctly dimension the capacity of the networks and the size and characteristics of Regional Centers, it is essential to conduct a systematic study of these distributed systems. This project therefore intends to simulate and study network-distributed computing architectures, data access and data management systems that are major components of the CM, and the ways in which the components interact across networks. The project will bring together the efforts and relevant expertise from the LHC experiments and LHC R&D projects, as well as from the current or near-future experiments that are already engaged in building distributed systems for computing, data access, simulation and analysis.

As a result of this study, we expect to deliver a set of tools for simulating candidate CM of the experiments, and a set of common guidelines to allow the experiments to formulate their final Models. Distributed databases are an important part of the CM to be studied. The RD45 project has developed considerable expertise in the field of Object Oriented Database Management Systems (ODBMS), and this project intends to benefit from the RD45 experience and to cooperate with RD45 as appropriate, in the specific areas where the work of the two projects (necessarily) overlap. The proposed project intends to investigate questions that are largely complementary to RD45, such as network performance and prioritization of traffic for a variety of applications that must coexist and share the network resources.

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Virtual Room Videoconferencing System (VRVS)

The VRVS was introduced in early 1997, to provide a low cost, bandwidth-efficient, extensible tool for videoconferencing and collaborative work over networks within the High Energy and Nuclear Physics (HENP) communities, and to some extent, research and education at large. Since it went into production, deployment of the Web-based system has expanded to include hundreds of registered hosts running the VRVS software in more than 28 countries. There are currently 19 "reflectors" that create the interconnections and manage the traffic flow, at HENP labs and universities in the US and Europe. A reflector was installed at DOE Headquarters in Washington, DC in June 1998.

Virtual Room videoconferencing is now regularly employed as part of ATLAS and CMS, and increasingly for other DOE-supported programs. The system is managed by the Caltech L3/CMS group working in collaboration with the CERN IT Division, under a joint project approved by the LHC Computing Board (LCB) in July 1997. Future plans for the system include deployment of additional reflectors to Asia, among others, and the spawning of other sets of "Virtual Rooms" in Russia.

As an outgrowth of this work, CERN recently began collaborating with scientists and engineers in geology, biology, civil engineering, architecture and other fields who wish to use the VRVS technology. The clear benefit of this collaboration to HENP researchers is valuable experience in the use of network-shared applications, and shared VRML worlds and virtual spaces. This is an important part of our near-term plans for the development of more effective means of remote collaboration, through the use of collaborative environments.

Development and use of the VRVS system for international meetings has relied on the use of a minor part of the bandwidth on the transatlantic link, which is managed by the CERN group. For US-wide tests of new modes of collaboration and new applications requiring a higher range of bandwidth, CALREN-2 (2.5 Gbps regional network), will be used together with the vBNS and Internet2, before deploying the new systems on an upgraded transatlantic link.

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ReMaP—Regularity and Massive Parallelism

At its creation, the aim of the project was to develop new contributions and software tools for massively parallel computing applications. Data-parallel compilation is still an important part of the project but we are now investigating the application and impact of heterogeneous networks and libraries, virtual shared memory and communication protocols.

ReMaP researchers aim at designing methods and tools for parallelism at every level: from high-speed network protocols to parallel-compilation techniques, and from multithreaded run-time environments to computing and communication libraries for parallel applications. Within each of these topics, they produce both theoretical work and software prototypes.

The LHPC is a common research laboratory that utilizes massively parallel computers and high-performance computing. The main function of the LHPC is to serve as a center of expertise in the field of massively parallel computing by bringing together partners of academic and industrial projects with worldwide ambitions.

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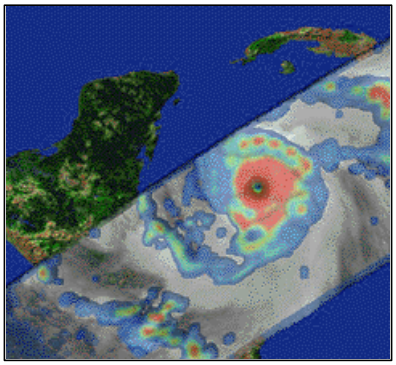

Data And Information Access Link (DIAL)

iGrid 2000 and ongoing

DIAL is a web-based distributed system to search, access and visualize satellite remote sensing data for Global Change research. It allows data providers to easily serve their Earth science data directly to their users. DIAL provides traditional catalog services like metadata search, while also providing extended interactive data services like browsing, subsetting, subsampling, reformatting, and direct downloading. The power of DIAL has recently been enhanced by the addition of the EOSDIS "Version 0" protocol, which enables a project to set up a distributed system of DIAL servers.

In collaboration with NASDA and other institutions, NASA has DIAL servers set up to distribute satellite remote sensing data. NASA and NASDA also collaborate on the Tropical Rainfall Measurement Mission (TRMM); 3D data is transferred from NASA to NASDA using TransPAC/APAN, processed and visualized for the web.

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Distributed Simulation Analysis Among Scientists in Germany, US and Japan

iGrid 2000 and ongoing

The High Performance Computing Center Stuttgart and Sandia National Laboratories have been researching, prototyping, and applying a distributed parallel supercomputing and collaborative virtual-reality computation steering environment since 1996.

The output of a metacomputing simulation is visualized by means of a distributed virtual collaborative environment. People and machines have the potential to interact via a virtual reality-based, online, on-demand service anywhere in the world. The project recognizes the unique combination of high-end resources and high-speed connectivity to networks spanning multiple continents, including Computer Services for Academic Research Centre (Manchester, UK), the Centre of Virtual Environments at University of Salford (UK), Tsukuba Advanced Computing Center (Japan) and Pittsburgh Supercomputing Center (USA).

The applications emphasize some of the largest supercomputers in the world being networked to support International Grand Challenge applications, and advanced visualization and collaboration tools being utilized to develop the workplace of the 21st Century.

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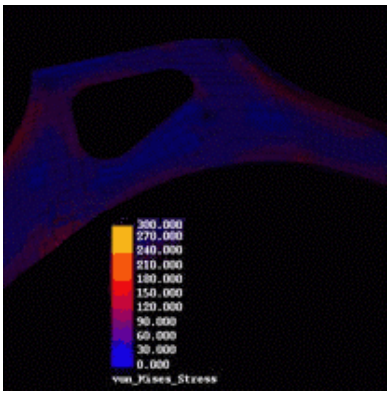
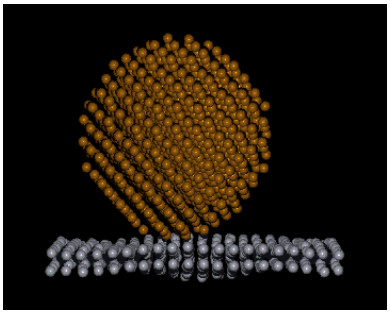
http://www.cs.sandia.gov/ilab/news/SuperComp98/iGrid/index.htm
http://www.hlrs.de
http://www.hlrs.de/news/events/2000/iGrid/





Metacomputing and Collaborative Visualization

iGrid 1998

This project demonstrates both research and industrial projects. Specifically, advanced visualization of 3D resistive magneto-hydro-dynamic (MHD) equations, using "Alegra" software, and molecular dynamics simulations of the mechanical stability of quasi-crystals using "IMD" software, are shown.

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Metacomputing Between the U.S. and Germany

Supercomputing '97 and ongoing

The Pittsburgh Supercomputing Center (PSC) and Sandia National Laboratories (SNL) are creating an international metacomputing environment with the Rechenzentrum Universitaet Stuttgart (RUS), which was demonstrated at the SC '97 conference in San Jose, CA, in November. The three sites utilized a connection spanning the vBNS, CA*net II, ESnet, and a transatlantic connection from Teleglobe.

Intended as a prototype for international high-performance networking, the project coupled Pittsburgh's 512-processor CRAY T3E with another 512-processor T3E at the High Performance Computing Center in Stuttgart and a Paragon at SNL. They visualized fluid dynamics simulations of the reentry of a space vehicle; the entry of meteorites into the Earth's atmosphere, as well as their impact on the Earth; and ab-initio calculations of magnetic properties of alloys.

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Nucleic Acid Database

The goal of the Nucleic Acid Database (NDB) project is to assemble and distribute structural information about nucleic acids. It provides a repository for the coordinates of oligonucleotide crystal structures. In addition, the NDB provides information of general interest to researchers in the field, and develops and distributes standard geometric information for use in molecular refinement and modeling programs.

The US National Science Foundation and the US Dept. of Energy support this project. In Asia, the NDB URL is mirrored at the Structural Biology Center at AIST, Japan.

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Ribosomal Database Project II (RDP); An Application of the APBioNet

This project provides ribosome related data services to the scientific community, including online data analysis, rRNA derived phylogenetic trees, and aligned and annotated rRNA sequences.

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World-Wide High Performance Network Mirroring of Public Genome Data

DNA and protein biosequence databanks are essential for advanced studies in genome research. Such sequence data has been collected by the United States, Japan and Europe since 1984. Software search engines such as FASTA/BLAST are used to find homology sequences, and SRS for content searching. These require huge local disks to store these databases. Mirror servers have been set up to provide frequent updates to the databases; however, they often fail due to the lack of existing network bandwidth. This project aims to develop a reliable mirror server with high-speed data transfer.

Due to increased human genome research, the data in DNA databases have been increasing tremendously. The existing servers, however, are mainly mirroring only US data to Japan. Establishing a bi-directional mirror server will help to distribute data collected in many countries and deliver them to researchers. This mirror server could not be established without a high-speed and reliable connection.

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Giga-Speed Bioinformatics Network to Power Canadian Genomic Research

Canada is implementing a national geonomics initiative aided by the parallel development of the fastest bioinformatics network in the world–CA*net 3. Genome Canada is expected to add over $1.5 billion to the Canadian economy within five years. Nearly one quarter of all disease-related genes have been discovered in Canada, or by Canadians.

Genomics researchers in Canada now have access to the Canadian Bioinformatics Resource (CBR Halifax, Nova Scotia), the world's first gigabyte network for genomics. It utilizes the national high-speed CA*net 2 and CA*net 3 networks, and comprises over 60 high-performance servers and workstations at six National Research Council of Canada centers nationwide, and the Rockefeller University in New York.

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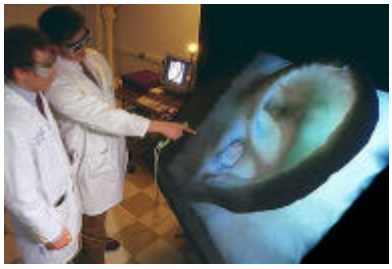

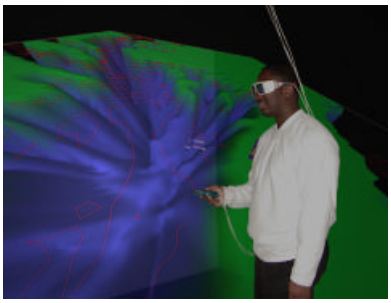

Visualization in Tele-Immersive Environments

In collaborative virtual reality (VR), the goal is to reproduce a face-to-face meeting in minute detail. Tele-immersion moves beyond this idea, integrating collaborative VR with audio- and videoconferencing that may involve data mining and heavy computation. When participants are tele-immersed, not only can they virtually see and interact with each other, but when they leave, their environment continues to evolve, autonomously controlling computation and data access.

Display technologies are ongoing. Since 1992, the Electronic Visualization Laboratory (EVL) at the University of Illinois at Chicago (UIC) has invented the CAVE and ImmersaDesk, both of which are commercially available, and the PARIS system, which is still in development.

Applications

Virtual Temporal Bone: Created by the UIC Virtual Reality Medicine Laboratory, and EVL. It is a tele-immersive education program that lets a remote physician teach medical students the 3D structure and function of the inner ear.

ALIVE: The Architectural Linked Immersive Virtual Environment was created by Stichting Academisch Redencentrum Amsterdam (SARA) and EVL. It is an application that lets viewers navigate through 3D CAD models to create and replay recorded animation paths. Amsterdam architect Rem Koolhaas used this teleimmersion technology to design and collaborate with his client, Illinois Institute of Technology, for the design of its campus center.

CAVE6D: Created by the Center for Coastal and Physical Oceanography and EVL. It is a powerful graphics system that provides visualization techniques to display multidimensional numerical data from atmospheric, oceanographic, and other similar models. Collaborators can collectively or independently manipulate the data.

Round Earth: Created by EVL with content advice from a UIC psychology professor. This educational project uses tele-immersion to teach young children the concept of the spherical Earth.

TIDE: The Tele-immersive Data Explorer (TIDE) was created by EVL and UIC's National Center for Data Mining. It is designed to let collaborators query and access terascale datasets.

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Creation of International Data Bank for Nuclear Physics and Nuclear Reactions

This project is in cooperation with scientists at the Brookhaven National Laboratory (BNL) National Nuclear Data Center and scientific centers in Austria, Hungary, China, Ukraine, France and Japan, on developing information systems supporting the study of nuclear physics and nuclear reactions.

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Collaborators

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Exploring CAVERNsoft Tele-Immersive Collaboratories Through the iGrid Portal

iGrid 1998 and ongoing

This demonstration starts with a virtual atrium that acts as a central tele-portation point to various "tele-immersive" collaboratories around the world: Cave6D (ODU/EVL); Motorola Impact Visualization (NUS/EVL); Virtual Temporal Bone (VRMedLab); The Silk Road Cave Shrines-Mogoa Grottoes of Dunhuang in China (NU/EVL); The CAVE Collaborative Console (Virginia Tech); and FutureCamp '98 (IUPUI).

Contact

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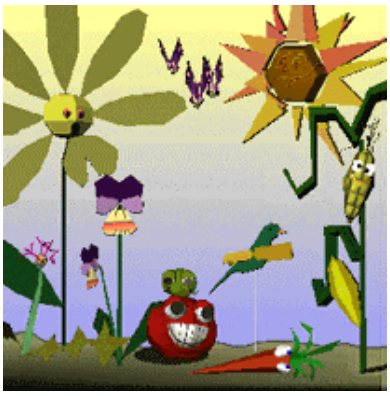
Collaborators

University of Illinois at Chicago, USA; Argonne National Laboratory, USA; Northwestern University, USA; Old Dominion University, USA; Indiana University-Purdue University Indianapolis, USA; Virginia Tech, USA; National University of Singapore (in cooperation with Motorola), Singapore; University of Tokyo, Japan; Australian National University, Australia

URL

http://www.evl.uic.edu/cavern/events/sc98/



Multiway Tele-Immersion at Supercomputing '97

Supercomputing '97

Using NICE, a collaborative learning environment for young children developed at UIC, UIC researchers worked with 17 members of the CAVE User's Society (CAVERNUS) to demonstrate collaborative VR worldwide. Collaborators included UIC Electronic Visualization Laboratory, Old Dominion University, Indiana University, SARA (The Netherlands), Cray Research, Boston University, Towa University (Japan), and various groups who brought their ImmersaDesk displays to SuperComputing '98 (Army Research Laboratory, UIC Laboratory for Advanced Computing, Argonne National Laboratory, NCSA, UIUC Department of Computer Science, and Indiana University).

Note: This application, demonstrated in 1997, relied on the Internet, rather than STAR TAP; however, it is mentioned here to promote a collaborative application that is STAR TAP "ready" when broadband, high-speed connections with foreign countries are in place.

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Collaborators

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URL

http://www.evl.uic.edu/cavern/events/sc98/

B.2. Advanced Networking Infrastructure and Research

World Health Organization (WHO) Collaborating Centers

The objective of WHO is the attainment by all peoples of the highest possible level of health. In support of this objective, the organization directs, coordinates, stimulates and advances work on issues related to health.

Since its inception, WHO has been heavily involved in research activities in the fields of cancer, cardiovascular diseases, diabetes, environmental health, HIV/AIDS, human reproduction, immunology, malaria control, mental health, tropical diseases, tuberculosis, etc., working with many top research institutions worldwide, officially designated as "Who Collaboration Centers."

Telecommunication with these collaborating centers is one of the essential requirements for the activities of the WHO. An increasing number of projects have high-bandwidth requirements. WHO will no doubt gain substantial benefit from being connected, via CERN, through the Internet2/vBNS via Chicago STAR TAP to its partners in the USA (who are or will be I2, NGI or vBNS members) with assurance of high-bandwidth, low latency and quality-of-service (QoS) guarantees on an end-to-end basis.

Finally, the WHO web site is an important information resource for US academic institutions. The *.edu* top-level domain name is its fourth largest user, with half a million accesses per month. Being connected on the high-speed backbone will bring the information on the WHO web site and on its Internet servers closer to all students and researchers in US academic institutions connected to Internet2.

Collaborators

World Health Organization. Worldwide collaborators: 200 centers exist in the US alone, many located in major medical and public health research centers and universities.

URL

www.who.int

TelePresence Microscopy (TPM)

TelePresence Microscopy (TPM) enables on-line cooperation between scientists, utilization of unique instrumentation by researchers who may not have access to such resources, and training of students of different levels. Video signals from the microscope (specimen view, detectors or peripheral instrumentation) are fed into a server, and can be directly accessed via a web browser capable of server "push" technology (such as Netscape).

Remote control is possible by sending instructions for magnification, movement of the specimen and focus using the web page interface. A control server sends this information into the microscope and the remote user can get instant feedback. Additionally, video conferencing allows for discussion between local and remote parties. The local user determines whether the microscope session is open or closed to the general public for viewing, and if the remote user may have remote control. Sharing of data is also possible on-line.

The Electron Microscopy Laboratory, located at the Department of Materials Engineering at the Technion, serves faculty and students within the Technion, as well as from other institutions and local industry. The facilities include computerized light microscopy (LM), scanning electron microscopy (SEM), and transmission electron microscopy (TEM). In addition, a complete specimen preparation laboratory is included within the framework of the Electron Microscopy Laboratory. Project consultation provided by Argonne National Laboratory, USA.

Contacts

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Argonne National Laboratory, USA; Technion – Israel Institute of Technology, Israel

URL

http://www.technion.ac.il/technion/materials/TPM/index.html

QBone

Launched in October 1998, the QBone is an Internet2 initiative to build a testbed for new IP quality of service (QoS) technologies. Advanced university applications like remote instrument control, scientific collaborations and virtual classrooms are placing increasingly higher demands on the research networks. The QBone testbed will initially implement the differentiated services (DiffServ) approach to QoS now taking shape within the IETF. DiffServ has great potential to overcome some of the complexities of earlier IP QoS architectures, but requires a great deal of implementation experience, engineering and study before it will mature to offer production-quality QoS.

This project uses two driver applications–digital video and tele-immersion–both of which are latency intolerant. Typical digital video streams currently used by some members of this consortium are MPEG1 1.5 Mbps. Tele-immersion can incorporate such a stream, and add a measure of control information and data (sometimes a separate audio channel for sound effects), but a basic 1.5 Mbps estimate is sufficient for now. It is expected that some experiments will be conducted using more than 1.5 Mbps, 3 Mbps and greater. This project will be linked to a parallel middleware project.

Contacts

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Collaborators

Northwestern University, USA; MREN, USA; Indiana University, USA; Centre for Telematics and Information Technology, The Netherlands; University of Twente, The Netherlands; Utrecht University, The Netherlands

URL

http://qbone.ctit.utwente.nl/
http://www.internet2.edu/qos/qbone/

The Megaconference

The Megaconference is a permanent, ongoing multipoint H.323 Internet videoconference. It is free and open to anyone with adequate equipment to provide good quality Internet video at the speed of 384 Kbps.

SURFnet has participated in H.323 videoconferences/demos between Ohio State University, University of South Carolina, NYSERnet, Buffalo University, Rochester University and Syracuse University

Associated Activities:

- IP-telephony tests together with Ohio State University (Selsius/Cisco IP-telephone hooked up to call manager at Ohio State University).
- Snelnet and SNOB demos by the iCAIR center at Northwestern University (Chicago) and at the Internet2 member conference in Washington DC during which MPEG-1 video transmission was provided between SURFnet and these locations.
- Streaming video demos from the iCAIR server to SURFnet and to the TERENA NORDUnet Networking Conference (TNNC) in June 1999, at Lund University, Sweden.
- Engineering efforts for native IPv6 connectivity between Amsterdam (SURFnet or AMS-IX and 6TAP).

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Collaborators

Hosted at Ohio State University, USA; *augmented by other organizations as needed:* other US sites, The Netherlands (SURFnet), Chile, China, Singapore, Russia, Taiwan, UK, Bulgaria, Antarctica, Germany, Canada, Italy, Mexico, Finland.

URL

http://www.mega-net.net/megaconference

APBioNet: Asia-Pacific Bioinformatics Network

The Asia-Pacific Bioinformatics Network, or APBionet, is dedicated to the advancement of the field of bioinformatics; specifically, the development of a network infrastructure, the exchange of data and information, the development of training programs, workshops and symposia, and the encouragement of collaborations.

More than 20 organizations and institutions from Australia, Canada, China, Hong Kong, India, Japan, Korea, Malaysia, Russia, Singapore, and the United States have become members. Broadband networks indispensable to APBioNet consist of:

- Fast and robust networks of databases and applications
- Facilities for visualization of large-scale data and interactive simulation of life phenomena for the advanced study on life sciences and biotechnology
- Distant learning systems based on multimedia servers to foster bioinformatics experts in the Asia-Pacific region

Contact

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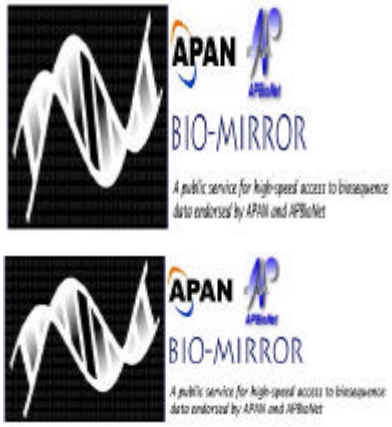
Collaborators

National University of Singapore. Over 20 organizations and institutions from Australia, Canada, China, Hong Kong, India, Japan, Korea, Malaysia, Russia, Singapore and the United States

URL

http://www.apbionet.org/



Bio-Mirror Public Service for High-Speed Access to Biosequence Data; A Project of APBioNet

This is a worldwide bioinformatic public service for high-speed access to up-to-date DNA and protein biological sequence databanks. The Internet, as the primary means for distributing the tens of Gigabytes of this public data, has been suffering delays due to the rapidly increasing demand for bandwidth.

The Bio-Mirror project is devoted to facilitate timely access to important large datasets for this research. High-speed access is provided by the advanced internet infrastructure of the Very High Speed Backbone Service (vBNS), Abilene, TransPAC, and the Asia-Pacific Advanced Network (APAN).

Currently available servers:

Japan: <http://bio-mirror.jp.apan.net/>
<ftp://bio-mirror.jp.apan.net/pub/biomirror/>

Australia: <http://bio-mirror.au.apan.net>
<ftp://bio-mirror.au.apan.net/biomirrors/>

Singapore: <http://bio-mirror.sg.apan.net>
<ftp://bio-mirror.sg.apan.net/biomirrors/>

USA: <http://bio-mirror.us.apan.net> <ftp://bio-mirror.us.apan.net>

China: <http://bio-mirror.cn.apan.net> <ftp://bio-mirror.cn.apan.net>

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Indiana University, USA; other sites in US; Japan; Australia; Singapore; China

URL

http://bio-mirror.sg.apan.net/bm/

Cultural Heritage in Virtual Reality

Using Cultural Heritage as an application driver, the goal of the Networked Virtual Environments Collaborative Trans-Oceanic Research (N*VECTOR) project is to link the University of Illinois' CAVE and University of Tokyo's CABIN, both room-sized virtual-reality devices (VR), to better understand the requirements of multiple media flows among sophisticated VR displays over great distances.

The two universities are studying collaborative problem solving over advanced networks using Nippon Telegraph and Telephone Corporation's (NTT) MediaCruising Standard Protocol (MCSP), a prototype Quality of Service protocol optimized for streaming media and bulk data transfer over next-generation networks.

Applications using MCSP are implemented over GEMnet, NTT's global research network. One such application is the Tele-Collaborative Virtual Harlem, which was developed to supplement African American Literature courses taught in US universities, and focuses on the Harlem Renaissance that began in the 1920s. A virtual environment allows networked students around the world to meet and become immersed in an interactive literature course. Students can navigate and investigate the environment, and hear a sampling of the music written and popularized during the period.

Earlier application studies using MCSP included high performance videoconferencing using MPEG-2, and remotely controlled Super High Definition image capture, transmission, and display.

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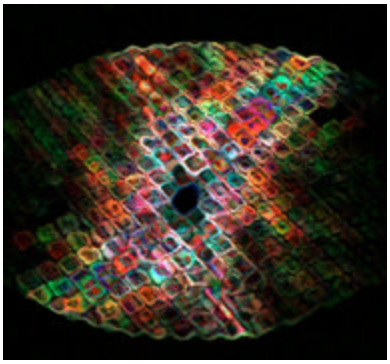
Collaborators

University of Illinois at Chicago, USA; University of Tokyo, Japan

URL

http://www.evl.uic.edu



GiDVN: Global Internet Digital Video Network

iGrid 2000 and ongoing

GiDVN projects are enhancing media capabilities for the next-generation Internet, enabling new applications to interoperate.

One general objective of the GiDVN project is to expand the capabilities of digital video from its current restricted usage on the Internet, to allow it to be utilized more as a common data type; especially with regard to core architecture, access, integration with other applications, infrastructure scalability, differentiated services, quality of services, and interfaces with other Internet technology components. Eventually, advanced capabilities will be an integral part of an architecture that will provide a general, persistent digital video "dial tone."

Contact

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Collaborators

Northwestern University, USA; Canada; CERN; Japan; Korea; Mexico; Netherlands; Singapore; Spain; Sweden

URL

http://www.icair.org/inet2000

RepliCache: A Web Cache Meta Network

Web caching has been successful in improving Internet performance by reducing wide-area network traffic and spreading server loads. Web caching is a technology for migrating copies of documents from a server toward a closer point to user location. It can reduce the retrieval latency and save the bandwidth by avoiding repetitive transmission of the same data over the Internet.

The introduction of high-speed access networks is providing the potential for increasing probability for the distribution of large data, thus expanding data diversity over the Internet. Many studies of the web workload have shown that object size follows heavy tailed distribution.

RepliCache is an enhanced web caching architecture to support application-level Quality of Service (QoS) in the presence of a high degree of variation in object size. It provides efficient methods for caching and delivering data by their characteristics while retaining user level transparency. It is also designed to ensure compatibility with existing networking standards, applications and system software.

RepliCache will be located at GigaPoPs, and will serve large-bandwidth data (e.g., multimedia data) to users or collaborating caches.

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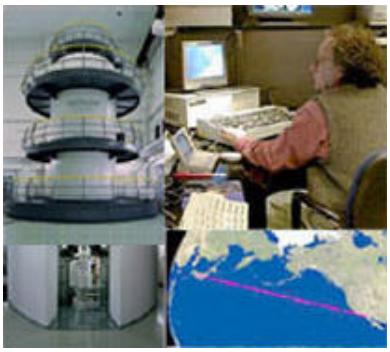
Collaborators

NLANR, USA; NTT, Japan; Keio University, Japan; Nihon University, Japan; KAIST, Korea

URL

http://cache.kaist.kr.apan.net/
http://cosmos.kaist.ac.kr/~jyjung/work/replicache.html
http://cache.jp.apan.net/



Trans-Pacific Telemicroscopy

iGrid 2000 and ongoing

Telemicroscopy software allows researchers to interactively operate a microscope located at a remote site for the purposes of investigating a specimen, capturing digital images to disk and deriving accurate 3D computer models of the specimen for analysis. Our telemicroscopy applications provide remote access to a specialized electron microscope at UCSD, and the world's most powerful electron microscope at Osaka University.

Using international research networks and advanced video streaming software, researchers in San Diego can readily investigate their specimens using the Osaka microscope, and vice versa. These telemicroscopy applications increase the utilization of unique resources and allow more research projects to be conducted faster and cheaper than ever before.

Trans-pacific telemicroscopy experiments have played a considerable role in analyzing and tuning network performance on an international scale. Project members are working closely with network engineers to develop and test next-generation Internet technologies, such as multicast, QoS and IPv6.

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Collaborators

SDSC/UCSD, USA; NLANR, USA; Lawrence Berkeley National Laboratory, USA; Research Center for Ultra-High Voltage Electron Microscopy, Osaka University, Japan

URL

http://www.npaci.edu/online/v3.10/telemicroscopy.html
http://www-ncmir.ucsd.edu/
http://www.uhvem.osaka-u.ac.jp/

Remote Visualization of Electron Microscopy Data

iGrid 1998 (a precursor to the UCSD/Osaka "Trans-Pacific Telemicroscopy" work shown at iGrid 2000; ongoing.

This application remotely processes and visualizes electron microscope data. Users access remote datasets and perform computationally intensive tomography, a 3D image reconstruction technique, for immediate viewing on an ImmersaDesk. The goal of this project is remote control of scientific instruments.

Contact

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Collaborators

Information Sciences Institute, University of Southern California, USA; SDSC, University of California, San Diego, USA; Argonne National Laboratory, USA; Osaka University, Japan; Tokyo Institute of Technology, Japan; Waseda University, Japan; National University of Singapore, Singapore

URL

http://www.mcs.anl.gov/xray-cmt
http://www-ncmir.ucsd.edu/

6TAP

The 6TAP project, co-sponsored by ESnet and CANARIE, provides native and tunneled IPv6 interconnections at STAR TAP, to provide early IPv6 production networks the ability to build and demonstrate IPv6-based applications. In addition, the 6TAP will develop: IPv6 route server technology, network tools for network measurement, analysis and display, and experience in supporting, provisioning and operating IPv6 Internet exchange points.

The 6TAP routers, route servers and net measurement/management systems are co-located with the STAR TAP switching systems to allow native router IPv6 interconnections to STAR TAP attached networks. The 6TAP became operational in July 1999, and is supported on a 24x7operational basis by ESnet network operations staff at Lawrence Berkeley National Laboratory, USA.

Contact

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Collaborators

USA: ESnet, vBNS, Abilene/Internet2, Argonne National Laboratory, Lawrence Berkeley National Laboratory, Oak Ridge National Laboratory, Stanford Linear Accelerator Center, University of Wisconsin, University of California, San Diego, Sun Microsystems. *Canada:* CANARIE. *Others:* APAN, CERN, SingAREN, SURFnet.

URL

http://www.6tap.net

First Real-Time Multi-Channel Audio Internet Demo for the 107th Audio Engineering Society (AES) Convention

Streaming real-time audio over wide-area networks has become a popular way to transmit audio content; however, network quality has tended to limit the range of formats and quality of the audio. Using advanced networks, it is possible to overcome some of these limitations, and implement applications that involve the transmission of higher bandwidth multi-channel audio content in real time.

The September 1999 AES demonstrations took place in a theater space at New York University (NYU), where dancers from that university performed to music provided remotely by a McGill jazz band playing live at McGill University in Montreal. The music was acquired as a multi-channel audio signal, and streamed to NYU across a high-performance network managed by CANARIE and Internet2.

Compressed and uncompressed multi-channel audio transmission of different sampling rates and word size were featured. The underlying software for the demonstration was developed at McGill University by a team involving several members of the Technical Committee on Network Audio Systems.

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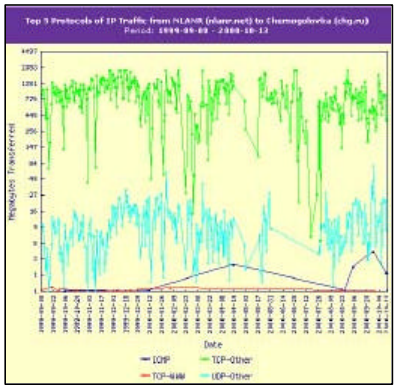
Collaborators

New York University, USA; McGill University, Canada

URL

http://athos.mcrcim.mcgill.edu/~jer/projects/aes/press.html
http://www.canet3.net/



Illustrated is total MIRnet traffic from the NLANR in the US, to Chernogolovka in Russia, since September 1999. The TCP-Other traffic (green line) primarily reflects web-cache transactions. (From the MIRnet MADAS system.)

US-Russian Networking Project: Web Cache for Science and Education

Averaging nearly 1.2 gigabytes of total traffic per day, the heaviest single producer of MIRnet traffic during its first year has been between the US National Laboratory for Applied Network Research (NLANR) web cache and the Russian academic web cache in Chernogolovka (scientific city located 50 km northeast of Moscow).

Managed by the Theoretical Physics Institute, the goal of the project is to study the properties of www traffic, and determine optimal path calculations for receiving and sending information via the distributed cache server network based at NLANR. The Cherogolovka web cache functions as the root web cache for the Russian Federation science and education community.

Contact

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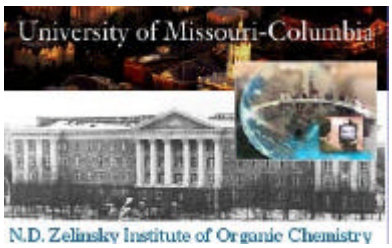
sakr@chg.ru

Collaborators

NLANR, USA; Theoretical Physics Institute, Russia



Telecommunications for Technology Transfer and Distributed Learning

The primary goal of the project is to develop an advanced infrastructure able to supply video conferencing (both point-to-point and multipoint) as a regular service for institutions involved in US-Russia research and academic collaboration and the commercialization of technologies. During the first year of MIRnet's operation, the two involved institutions (the Zelinsky Institute and the University of Missouri-Columbia) have engaged in regular video-conferences supporting a variety of programs – and have achieved good results using very low bandwidth (64 Kbps) H.323 and H.120 technologies.

Contact

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Collaborators

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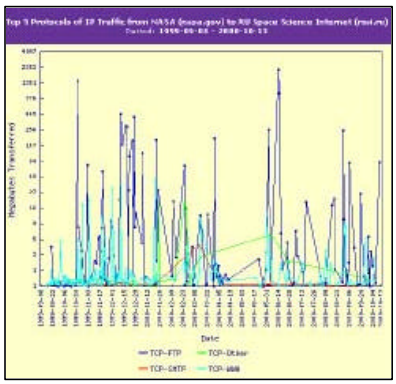

Traffic from NASA hosts to RSSI hosts is shown above. The primary application is ftp which often exceeds 256 MB transferred daily.

NASA-Russian Space Science Internet Cooperation

FTP dominates as the primary application between hosts on NASA's high performance NREN network and the Russian Space Science Internet. With daily flows occasionally reaching 1 Gigabyte or more, MIRnet supports a wide variety of NASA-RSSI programs and activities with network flows not previously possible.

Contact

Russian Space Science Internet
nic@rssi.ru

Collaborators

NASA, USA; Russian Space Science Internet, Russia

The Ural State University represents the furthest "reach" of MIRnet within Russia thus far. Located in Ekaterinburg, on the eastern edge of the Ural Mountains, USU has only recently acquired high speed access to Moscow (and thus MIRnet), but has quickly become a heavy network user, with daily flows occasionally exceeding 1 gigabyte. Principal partners are NLANR and the University of North Carolina.

Research of On-Line Collaboration Methods in Distance Learning Technology Development

The project addresses the methods of joint research and organization of distributed international workgroups based on contemporary on-line technologies. The model is the collaboration of Ural State University, Penn State University and North Carolina State University, in the framework of its 1997-2000 "Collaboration in the Field of Distance Learning in the Area of Business Management" project, supported by the US Dept. of State.

The project explores methods of remote collaboration via video- and audio-data exchange (including video-over-IP, on the basis of MBone and H.32x technologies). In 2001, Russia's Tyumen and Chelyabinsk state universities plan to join the project.

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Konstantin.Lovtsky@usu.ru

Collaborators

North Carolina State University, USA; Penn State University, USA; Ural State University, Russia

Digital Cinema 2000: Super High Definition Digital Movie Communication System

iGrid 2000 and ongoing

NTT's digital movie system using SHD images transmits extra-high-quality, digital, full-color movies of 2048x2048 pixel resolution at 24 or 60 Hz using 155/622 Mbps ATM transmission systems.

Contact

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Nippon Telegraph and Telephone Corporation (NTT), Japan; Makuhari Gigabit Research Center, Japanese Gigabit Network, Japan

URL

http://www.onlab.ntt.co.jp/en/mn/shd/

Digital Video (DV) Stream on IEEE 1394 Encapsulated into IP Over the Long-Distance, High-Speed Internet Link

iGrid 1998 and ongoing

This is the first video demonstration between the USA and Japan over an IP network with DV quality. This system encapsulates a digital video stream from a normal digital video camera using IEEE 1394 into IP packets without encoding delays. On the receiving end, the IEEE 1394 DV stream is directly input into a DV television or recorder.

Contact

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URL

http://www.sfc.wide.ad.jp/DVTS
http://www.jain.ad.jp/workshop/IWS99/
http://www.jp.apan.net/meetings/981022-SC98/SC98-Reports/DV/index.html

B.3. Computer-Communications Research

Tromsø And COrnell Moving Agents (TACOMA)

The TACOMA project focuses on operating system support for agents; and, how agents can be used to solve problems traditionally addressed by other distributed computing paradigms, e.g. the client/server model. We have completed a series of TACOMA distributed systems where agents can be moved about in the Internet.

An agent in TACOMA is a piece of code that can be installed and executed on a remote computer. Such an agent may explicitly migrate to other hosts in the network during execution. We are currently focusing on fault-tolerance, security, applicability and management issues. The TACOMA platform has also been ported to new operating system architectures, in particular Windows NT, Windows CE and the PalmOS.

Several TACOMA applications are under construction. One example is a wide-area network weather monitoring system accessible over the Internet. This distributed application is StormCast. We are also investigating whether agents can be useful in extensible file system architectures.

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Collaborators

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http://www.tacoma.cs.uit.no/

B.4. Experimental and Interactive Activities

Scalable High-performance Really Inexpensive Multi-Processor (SHRIMP)

The SHRIMP project investigates how to construct high-performance servers with a network of commodity PCs and commodity operating systems. The cost of such a multi-computer server is substantially less than a commercial, custom-designed multi-computer. The goal is to study how to build such a system to deliver performance competitive with or better than the commercial multi-computer servers.

The research project consists of several components: user-level, protected communication, efficient message-passing, shared virtual memory, distributed file system, performance measurement, scalable 3D graphics, and applications.

Princeton University's Computer Science Department is building a parallel computer using PCs running Linux as the processing elements. The first was a simple two-processor prototype that used a dual-ported RAM on a custom EISA card interface. A recent prototype will scale to larger configurations, using a custom interface card to connect to a "hub" that is essentially the same mesh routing network used in the Intel Paragon (see http://www.ssd.intel.com/paragon.html). Considerable effort has gone into developing low overhead "virtual memory mapped communication" hardware and support software.

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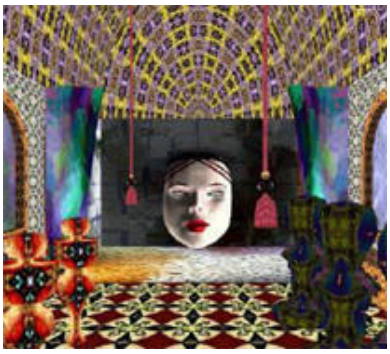

Blue Window Pane II

iGrid 2000 and ongoing

Blue Window Pane II is a networked environment that explores communication building through whimsical characters, conceptual landscapes and sound-activated graphics. Using art as a communication tool for shared connectivity, participants collaborate in a world of dreams, dilemmas and reflections.

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Haptic Collaboration in Networked Immersive Environments

iGrid 2000 and ongoing

This is a demonstration of wearable haptic gear (touch and force) communication, as well as visual communication, between the CAVE at iGrid 2000 and CABIN at The University of Tokyo.

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MediaZine – A Combination of Television, WWW, Telecommunications and 3D Computer Graphics

iGrid 2000 and ongoing

This interactive multimedia magazine includes text, images, live audio, live video, animations, 3D computer graphics and embedded electronic commerce and communication functions.

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Plate Window Manager (PWM)

iGrid 2000 and ongoing

PWM accesses traditional 2D window systems and applications, such as web browsers, in a 3D virtual world with a virtual mouse.

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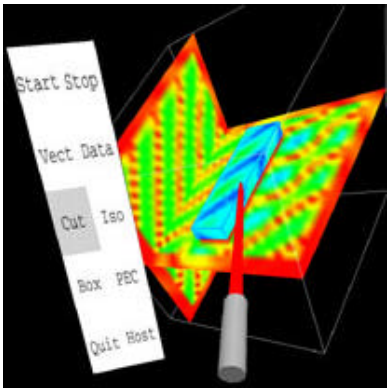

Steering and Visualization of a Finite-Difference Code on a Computational Grid

iGrid 2000 and ongoing

This application enables computational steering of electromagnetic simulations across distributed resources using interactive visualization in a virtual-reality environment.

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Video Avatar Communication in Networked Virtual Environment

iGrid 2000 and ongoing

Video avatars communicate among the CAVE at iGrid 2000, CABIN at The University of Tokyo and COSMOS at the Gifu Technoplaza.

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The Ganymede Telebot: An Enabling Technology for Teleconferencing

iGrid 1998

Accessibility for the handicapped goes far beyond providing ramps and elevators in buildings, cars, airplanes, and buses. Some, such as those afflicted by Multiple Sclerosis, do not have the health to travel even when physical access is available.

The Telebot prototype demonstrated at SC'98 integrates teleconferencing with life-sized display screens, robotics, and high-speed networking–to ensure that handicapped participants have both a virtual presence and an equal presence as regular participants.

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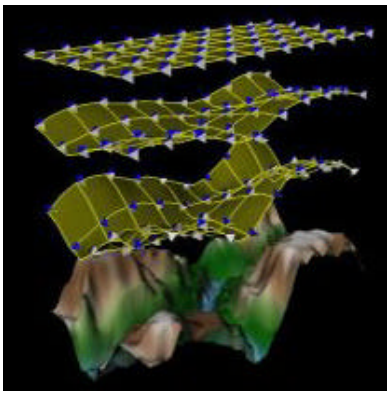

Constrained Navigation Techniques for Collaborative Virtual Environments

iGrid 1998

The goal of this research is to develop a set of software tools to "hide the details" of effective navigation within collaborative environments from application developers. The purpose of a collaborative virtual environment is two-fold: it facilitates information and viewpoint sharing (expert/student relationship) while it simultaneously promotes individual exploration and personal insight (peer/peer relationship).

Several navigation methods are explored. Applications demonstrated include a walking tour of a cityscape, a fly-over of a terrain, and an exploration of a molecular structure with no natural orientation.

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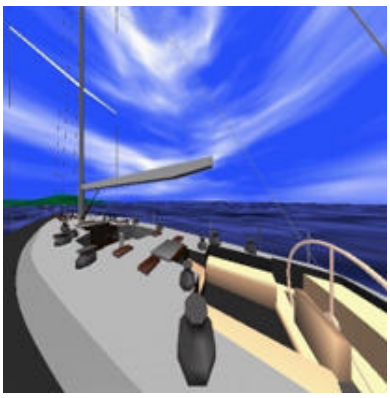

IMSRacer

iGrid 1998

The goal of this research is to enable users from a variety of disciplines to navigate and interact with 3D graphics models on any virtual reality display with little programming effort. New navigational tools are applied to "IMSRacer," a 25-meter long sailing yacht designed by the Department of Naval Architecture and Marine Engineering at the University of Michigan.

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B.5. Information and Intelligent Systems

Robotics Research

Moscow State University runs a multi-disciplinary project researching complex mobile roboto-technical systems, and elements of artificial intelligence. The project involves US, French and Japanese scientists.

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B.6. Large Datasets and Visualization

Distributed Virtual Reality Experiments

In art, science and industry communities alike, there is a rapidly growing need for 3D visualization. 3D simulations make it possible to test future products, or to investigate otherwise unreachable environments. At KTH, the Stockholm Exhibition of 1930 has been modeled as an educational exercise in the architecture department. At NCSA, a CAVE is used by George Francis to teach mathematics. Virtual reality (VR) can be also be used in city planning, giving the opportunity to walk around in a city that has not yet been built.

A number of projects that use the Center for Parallel Computers' (PDC) Cube–a fully immersive visualization environment that displays images on all surrounding surfaces, including the floor and the ceiling–have been initiated. These include science-oriented applications (e.g. analysis of glacier flows, volume rendering of biological data, flows in a jet engine, and visualization of computational fluid dynamics), and applications from other fields, such as architecture. Part of its design philosophy is to integrate new resources into an existing infrastructure. At PDC there are no stand-alone systems, but rather a collection of various integrated systems that improve over time. User accounts, file systems, storage facilities, and security systems have been distributed among the different computing resources for several years. The Cube is integrated in the same way and is therefore directly accessible to any PDC user with a suitable project.

The PDC bulk data transfer network is HiPPI-800 between most of the larger systems, including the SGI Onyx2 driving the Cube. Apart from HiPPI, internal networking topology consists of a mixture of 100Mb FDDI and FastEthernet. External connections are excellent, since PDC is directly connected by fiber to KTHNOC, where the main interconnect for both SUNET (Swedish University Network) and NORDUnet (Nordic University Network) is located. Even apart from academic networks, KTHNOC is one of the largest interconnects on the Internet today.

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iMAGIS – Models, Algorithms, Geometry for Graphics and Image Synthesis

The research at iMAGIS is driven by the simulation of complex phenomena. Users of virtual prototypes, such as scientists, engineers and architects, require interactive environments where they can create realistic models and run efficient simulations.

Using current graphics systems, these competing requirements cannot be mutually satisfied. Therefore, our research focuses on finding acceptable compromises using innovative approaches. To this end we are both investigating fundamental problems and applying this new technology to practical systems.

Fundamental issues include the development of efficient algorithms and the creation of geometric or physical models. Among our application domains are site evaluation, training simulators, medical images, and scientific visualization.

One project aims at the development of new visualization techniques enabling the interactive manipulation of urban data. This is important for applications such as project review, civil and military simulators, virtual tourism, education, climate and environmental studies. To achieve this goal, efficient image caching and interpolation techniques will be combined with traditional 3D techniques.

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http://www.inria.fr/Equipes/IMAGIS-fra.html
http://www-imagis.imag.fr/index.gb.html

Image/Video Transmission, Storage and Manipulation of 3D Images

In image/video transmission, storage, and manipulation, the key issue is representation. One strives to find representations of images and video that are efficient (requiring a small amount of bits to transmit or store) yet easy to manipulate (e.g., easy to find what one is looking for in a database). The group carries out research in image and video compression using a variety of approaches ranging from wavelets and fractals, to ideas from pattern recognition and computer vision. Also under study are methodologies and techniques for image/video indexing and editing.

Research in human visual perception is an essential part of this effort since, in many applications, the images after processing are viewed by humans, and the subjective quality of images is an important performance criterion. Applications of this research include video phone, teleconferencing, and multimedia databases.

3D interactive modeling, with real-time constraints, in a strongly reactive context constitutes the main collaboration axis between the two laboratories.

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http://www.LIMSI.fr
http://130.126.116.205/research/ifp.html

ALIVE: Architectural Linked Immersive Environment

iGrid 2000 and ongoing

ALIVE is used to evaluate the usability of collaborative virtual reality for architectural design. The ALIVE project started February 1999 at SARA, in cooperation with the Electronic Visualization Laboratory at the University of Illinois at Chicago and the Office for Metropolitan Architecture in The Netherlands.

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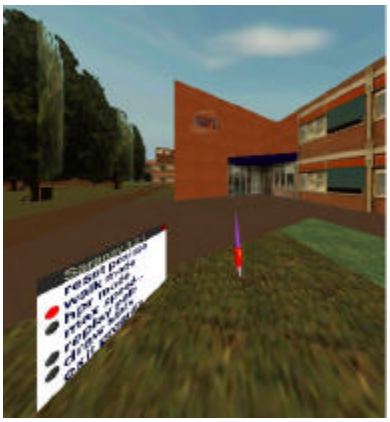

Architectural Walk-Through Coupled with a Parallel Lighting Simulation

1999; precursor of "ALIVE" system

CAVEs at SARA and EVL/UIC were initially interconnected to investigate visualization techniques at SC'98, where an architectural walk-through application was demonstrated. In architectural design, the lighting of a room can be simulated accurately by radiosity calculations, which are computationally intensive. If a design is reviewed in VR, the images must be generated in real time, and lighting conditions are simulated with an empirical shading model. Architects, however, find this simulation inadequate.

At SC'98, researchers showed an architectural walk-through in which lighting conditions were computed with a parallel radiosity simulation running on a remote computer. When lighting conditions were changed (e.g., switching lights on or off, changing colors) the simulation computed new room shading and sent the data to a VR-display over a high-speed network. Within seconds, a new lighting of the room could be evaluated.

In 1999, Amsterdam architect Rem Koolhaas used SARA's CAVE and the collaborative software Saranav to visualize and review his 1998 award-winning design of the new Campus Center at Illinois Institute of Technology's historic Mies van der Rohe campus. Collaborative Saranav was built in cooperation with the Electronic Visualization Laboratory at the University of Illinois at Chicago.

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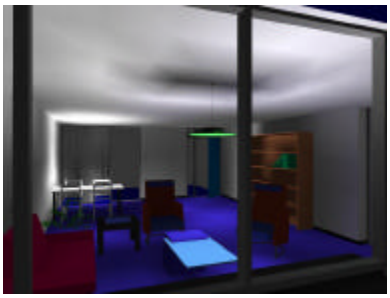

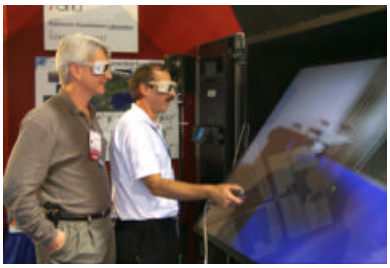

Architectural Walk-Through Coupled with a Parallel Lighting Simulation

iGrid 1998

This architectural walk-through accurately depicts room lighting conditions using a parallel radiosity simulation that runs on a supercomputer. Every time a user changes the lighting conditions (lights switch on or off, colors change) the simulation computes the new room shading and sends the resulting model over a high-speed network for display on the ImmersaDesk at SC'98. Within seconds, the new lighting of the room can be evaluated.

Supercomputing resources provided by National Center for Supercomputing Applications, University of Illinois at Urbana-Champaign, and Argonne National Laboratory.

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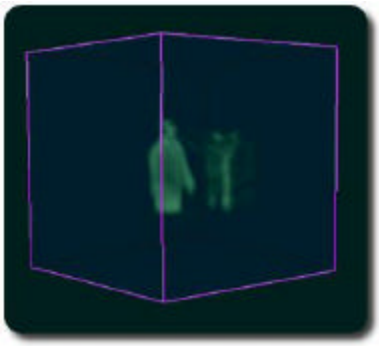

Argus: Controlling Real-Time Imaging Sensors from a Virtual Environment

iGrid 2000

This project streams 2D and 3D images from Argus, a room surrounded with cameras, into the CAVE using Crumbs volumetric rendering software. The project explores tradeoffs between sending 3D data volumes versus low-bandwidth, low-latency stereo pairs.

The demonstration at iGrid 2000 showcased how parallel video acquisition lends itself to viewing 3D scenes in different time zones.

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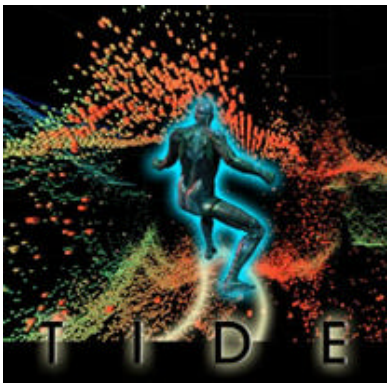
http://mayflower.isl.uiuc.edu/big.projects.crumbs.html



TIDE: The Tele-Immersive Data Explorer

iGrid 2000

The Tele-Immersive Data Explorer is a CAVERNsoft-based collaborative, immersive environment for querying and visualizing data from massive and distributed datastores. TIDE is designed to be a reusable framework to facilitate the construction of other domain-specific data exploration applications challenged with the problem of having to visualize massive datasets.

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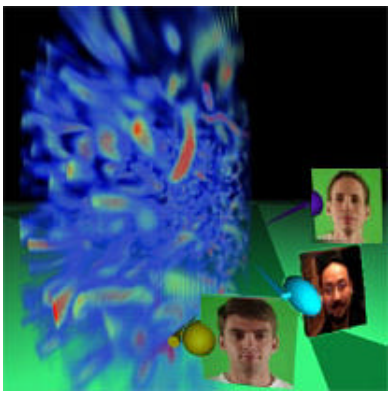

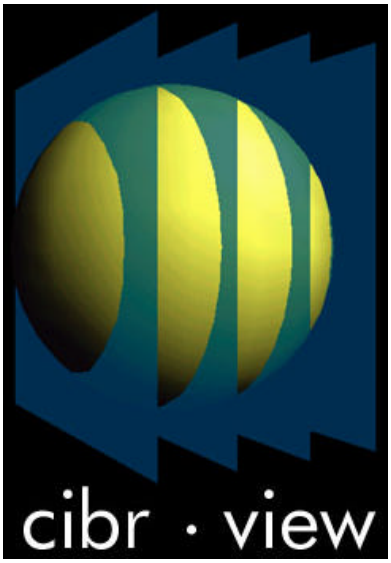

Tele-immersive Image Based Rendering

iGrid 2000

The Collaborative Image Based Rendering Viewer (CIBR View) is a CAVERNsoft-based tool for viewing animated sequences of image-based renderings from volume data. CIBR View was designed to allow Department of Energy scientists to view volume renderings composed of 2D image slices.

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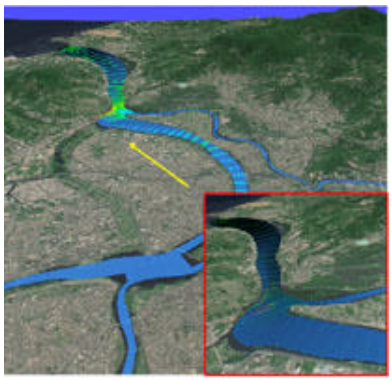

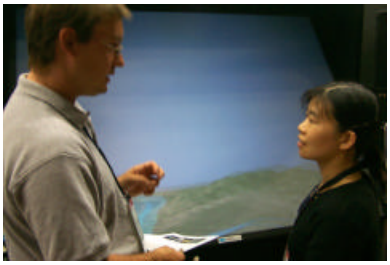

A Virtual GIS-Based 3D Hydrodynamic Model of Tamshui River

iGrid 2000 and ongoing

Due to the dense population and rapid economic development of the Tamshui River, the largest estuarine system of the island, Taiwan is studying the river's hydrodynamic and water quality. Dirty water, air, soil and mudslides pose a threat to public health, causing deaths and property losses during seasons of typhoon and heavy rain. Tele-immersion tools enable researchers to visualize and analyze the computed results.

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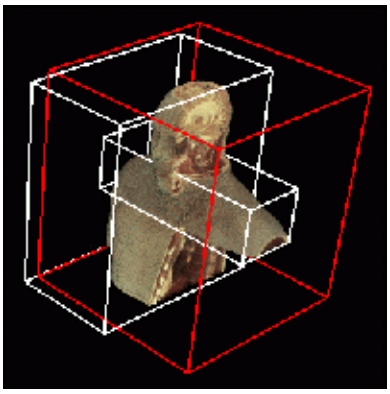
http://www.nchc.gov.tw/RESEARCH/taiger/taiger/Welcome.html
http://www.bauinf.tu-cottbus.de/taiger



3DIVE (3D Interactive Volume Explorer)

iGrid 1998

3DIVE is a visualization tool for interactively displaying and manipulating volumetric data. It has been developed by the Advanced Visualization Laboratory (AVL) in association with the IUPUI Computer Science Department and several groups within the IU School of Medicine.

3DIVE is the first immersive volume visualization environment to implement the concept of volumetric regions. Some of the region-based functionality 3DIVE incorporates includes interactive image processing, transfer function design and editing, and 2D slicing. A collaborative module is also being explored and should be available soon.

3DIVE currently accepts 8-bit intensity data or 32-bit RGBA data. These datasets can be collected or generated from a variety of sources. Some of the more common include MR and CT scans, confocal microscopy and "in-house" volume graphics techniques (such as volumetric CSG methods). This allows users to easily import their data. Several datasets are currently available. These include a chimp head, human spine, kidney, brain, microtubules, actin and portions of the visible human headset.

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TerraVision on the Grid: Interactive Immersive Fly-Throughs Using Distributed Image Servers

iGrid 1998

TerraVision, part of DARPA's MAGIC project, was developed to demonstrate a high-speed, wide-area IP/ATM network for real-time terrain visualization and high-speed distributed storage systems.

Running on an ImmersaDesk, users roam in real time about a 3D landscape, created from elevation data and registered aerial images and comprised of a TB of data. TerraVision is built using VRML 2.0, enabling users with VRML browsers to visualize large datasets from remote locations.

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C. Education

C.1. Elementary, Secondary and Informal Education

Collaborative Learning Over Broadband Internet: "Dialog Through Music"

Pinchas Zukerman and the National Arts Center have partnered with the National Research Council of Canada (NRC), Communications Research Centre Canada (CRC), CANARIE (Canada's Advanced Internet Development Organization) and the Canada-Israel Industrial Research and Development Foundation in an exploratory application of tomorrow's Internet for international learning.

On October 4, 2000, while the National Arts Centre Orchestra is in the Middle East, Maestro Zukerman will lead "Dialog Through Music," where Israeli, Palestinian, and Canadian youth will share their emotional and creative responses to Beethoven's famous melody "Ode to Joy" (from the Ninth Symphony). Three groups of ten high school students will be connected by live video, with Israeli students and Maestro Zukerman in Tel Aviv, Palestinian students in Jerusalem, and Canadian students in Ottawa.

Maestro Zukerman's extensive experience with live video violin teaching, and the potential for the National Arts Center to use broadband learning technologies to build passion for the arts among all Canadians, makes this partnership between the Arts and Sciences an exciting opportunity to explore our future.

High-speed connectivity for this project was provided by CA*net3, STAR TAP and the Internet 2 in Israel.

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Shared Miletus

This Cultural Heritage demonstration takes visitors on a shared virtual voyage through the ancient Greek city of Miletus as it existed 2000 years ago.

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http://www.fhw.gr
http://fhw.aec.at

Israel One – A Broadband High School Network

Israel One is a high school educational network. It uses distance learning technology and videoconferencing to reach remote schools, especially in the periphery where teachers are scarce, particularly those who teach English and math. Sixteen schools are expected to participate, representing the cultural diversity of Israel.

This project serves as a testbed for current broadband technology and ATM protocol, and utilizes voice, audio and data. The project provides teacher training to assist students in the use of the broadband technologies, and adopts a student empowerment program.

The multi-cultural model of the project encourages cooperation among schools of different geographical locations (Galilee, Negev), old Israelis and new immigrants, Arab, Druze and Jews; secular and religious; development towns, kibbutzim and moshavim.

The program builds upon the experience of the North Carolina Information Highway (NCIH) and the North Carolina School of Science and Mathematics (NCSSM). It is carried out in cooperation with the Israel Internet-2 program and industrial partners Bezeq (Telecom), Motorola Israel, Bynet, TNN and Accord. International corporate partners include VTEL, PictureTel and GTE.

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IUPUI Future Camp

iGrid 1998

The IUPUI Future Camp is a weeklong, multidisciplinary, virtual reality camp for eighteen students, grades 9 to 11. The three projects completed in Summer 1998 were demonstrated at SC'98: Virtual Art Gallery, Virtual Ocean Colonization, and Virtual Indianapolis Zoo.

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Collaborators

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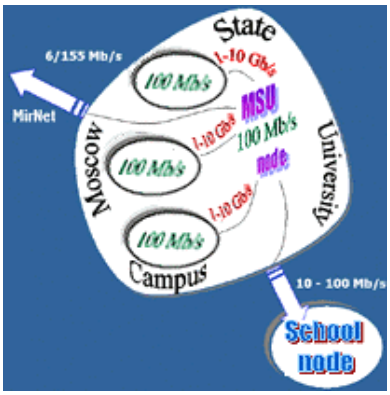
URL

http://www.science.iupui.edu/future_camp98
http://www.vrve.iupui.edu

C.2. Undergraduate Education



Education ICT Network Segment at Moscow State University

iGrid 1998

In 1998, Moscow State University began a distance-learning experiment between the physics and geology departments to remotely teach general physics, ecology, and foreign language courses. The goal is to continue course development and create an archive of teaching materials, potentially accessible worldwide via high-speed networks.

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C.3. Graduate Education

Lecture Exchange among University of Wisconsin-Madison, Keio University, and Nara Institute of Science and Technology (NAIST)

In Fall 1999, University of Wisconsin, Keio University, and NARA Institute of Science and Technology (NAIST), jointly offered an "Introduction to Computer Networks" graduate course, using next generation Internet technology and class archiving technology. Professors Lawrence H. Landweber, University of Wisconsin, and Jun Murai, Keio University, gave lectures in turn. The course consisted of both real-time interactive lectures and archived lectures. Students from all three universities were eligible for course credit.

The real-time lectures were carried out using next generation Internet technologies developed by the WIDE project, such as DVTS to transmit Digital Video stream over the Internet; and IPv6 and multicast over the high-speed Internet testbed. The testbed was being jointly developed and operated by Internet2, APAN, JGN (Japan Gigabit Network), JB (a Japanese research and development network association) and the WIDE project. Class archiving and on-demand lectures were carried out using the system developed by Japan's SOI (School of Internet).

Contacts

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http://www.sfc.wide.ad.jp/soi/wisc/public_e.html

Learn 2: A Network of Incubator Spaces for Developing and Designing Environments for Lifelong Learning

The purpose of the LEARN2 project is to develop resources, procedures, conventions and production methods for high-bandwidth multimedia learning, and its related knowledge distribution on the Web. An optimal format for lifelong learning of cross-disciplinary topics (based in the humanities) will be established and deployed in a series of actual courses.

The project takes into account that further progress in the field of multimedia learning environments must consider the formal shaping–the rhetoric and design–of the medium, and appropriate additional and closely-related pedagogical strategies to achieve optimal exploitation of the continued technological improvements.

The three goals of the project are: (1) establishing an optimal network of "incubator sites," or high-bandwidth multimedia learning environments, (2) focus on the development and design of high capacity multimedia courses, conventions and genres for learning within these spaces, and (3) conduct research and evaluation of the technological, rhetorical and pedagogical solutions employed.

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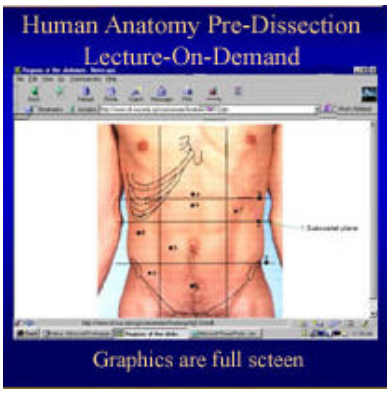
URL

http://www.media.uio.no/learn2



Human Anatomy Lecture-on-Demand at the National University of Singapore

iGrid 2000 and ongoing

The National University of Singapore (NUS) Integrated Virtual Learning Environment enables staff and students to communicate, exchange information, discuss and access custom learning materials and course-related web sites.

"Lecture-on-Demand" (LoD) delivery makes students assume more responsibility, and provides greater flexibility, in learning. "The Abdominal Wall and Inguinal Canal" is a prototype anatomy LoD.

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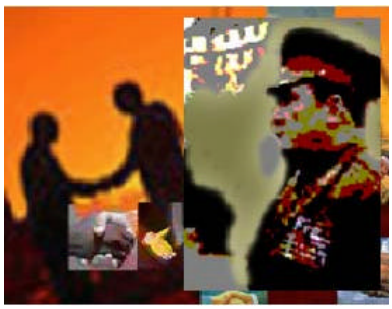
http://www.cit.nus.edu.sg/proj.htm
http://ivle.nus.edu.sg



US-Russian Military Officers Training: Humanitarian Law

This program is in support of a relatively new Russian Federation Defense order that requires humanitarian law training for all members of the Russian Armed Forces. Working with the University of Virginia Center for National Security Law, the Russian Ministry of Defense will begin using MIRnet to support curriculum development, transfer of training materials, and live classroom training between sites in Moscow and Charlottesville, Virginia. The initial demonstration event is scheduled for November 30, 2000.

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Collaborators

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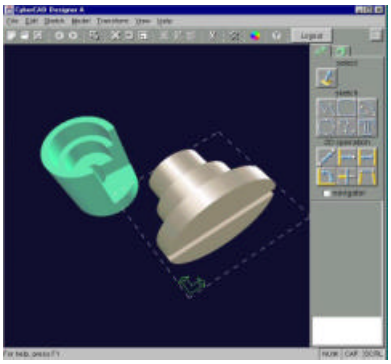
D. Engineering

D.1. Design, Manufacturing and Industrial Innovation



CyberCAD: Internet Distributed Interactive Collaborative Design

iGrid 2000 and ongoing

The goal of the Global Design Manufacturing Project (GDM) is to create a design and manufacturing hub in a global environment through the Internet, by sharing design and manufacturing tools among educational institutions and industry.

The CyberCAD software component of GDM has a controller-observer architecture to support reliable point-to-point synchronous portable Collaborative Computer Aided Design (COCAD). It allows geographically dispersed designers to work and communicate together synchronously on 3D design models, regardless of platform.

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http://eicu.tp.edu.sg/APAN-GDM/
http://ils.tp.edu.sg/apan/

Tele-Manufacturing via International High-Speed Network

iGrid 1998

The Global Design and Manufacturing (GDM) project uses advanced networks to control rapid prototyping devices for manufacturing medical prostheses at Temasek Polytechnic. The devices are controlled by a Java application developed by GDM researchers.

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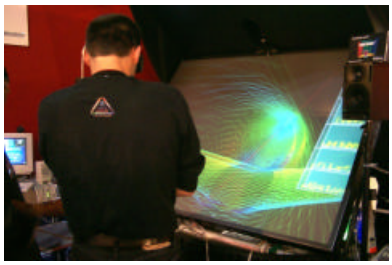
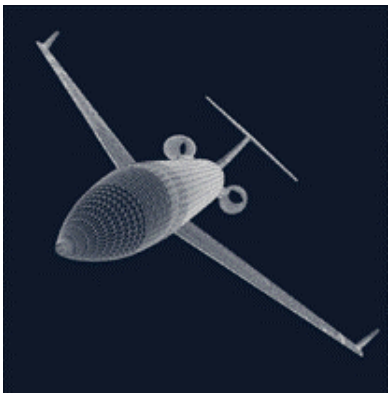
http://www.cir.nus.edu.sg/teleman





Construction of a Numerical Wind Tunnel Based on Design Procedure: From Aircraft Geometric Definition To Aircraft Flow Solutions

iGrid 1998

The Numerical Wind Tunnel (NWT) is a high-performance computational system dedicated to CFD solutions of an industrial scale. It enables users to easily and efficiently compute, manage growing data, visualize the results in real time, and devise engineering designs. For SC'98, NWT is applied to a conceptually designed inter-island small business aircraft.

Contact

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http://www.nchc.gov.tw/RESEARCH/NWT
http://www.nchc.gov.tw/RESEARCH/CFDEE/Publications/index.html

Distributed Virtual Reality for Industrial Applications

Supercomputing '98, Supercomputing '97

Between June 1997 and February 1998, a project between the National Center for Supercomputing Applications, University of Illinois at Urbana-Champaign, its industrial partner Caterpillar Inc., and the German National Research Center for Information Technology (GMD) establishing an interactive, real-time network connection between two virtual reality visualization systems across the North Atlantic, to evaluate the capabilities, practicality, performance, and cost of distributed virtual-reality technology for collaborative product or process design review on industrial showcase applications.

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NCSA, University of Illinois at Urbana-Champaign, USA; Caterpillar Inc., USA; German National Research Center for Information Technology, Germany

URL

http://www.ncsa.uiuc.edu/VEG/DVR/
http://engr.startap.net/apps/cat-gmd/nsf-form.txt

Caterpillar's Distributed Virtual Reality System: Remote Collaboration in Vehicle Design

Alliance '98

Caterpillar's Distributed Virtual Reality System was designed for engineers, located remotely, to work together on vehicle design. The system supports collaborative design review and will support interactive redesign. Integrated real-time video and audio enable engineers to see and talk to each other in a shared virtual environment.

The application is a vehicle simulation computation in which one participant controls and drives a virtual vehicle in a shared environment while participants at remote sites observe and evaluate it, using video and audio to communicate to each other.

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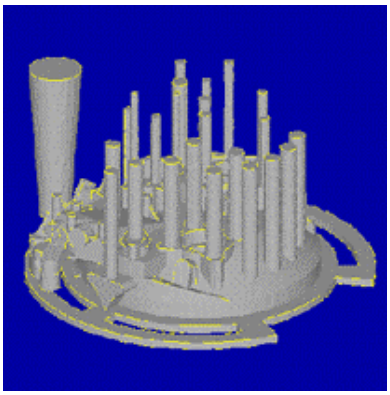
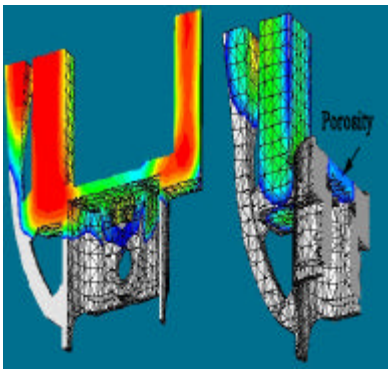
URL

http://www.ncsa.uiuc.edu/VEG/DVR/





Industrial Mold Filling Simulation Using an Internationally Distributed Software Component Architecture

iGrid 1998

This application connects high-performance software and hardware systems to provide an integrated solution environment for a 3D parallel finite element code that models industrial material processes, such as casting and injection molding.

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Indiana University, USA; Argonne National Laboratory, USA; Los Alamos National Laboratory, USA; Industrial Materials Institute, NRC Quebec, Canada; Centre de Recherche en Calcul Appliqué (CERCA), Montréal, Canada

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http://www.extreme.indiana.edu/sc98/sc98.html

Parallel Computation of High-Speed Train Aerodynamics

High-speed trains will have a possible maximum speed of 500Km/h, ~Mach 0.4. Side branches in a tunnel are commonly used to reduce the pressure gradient of a compression wave generated at the inlet as a train rushes into the tunnel. This project demonstrates a parallelized 3D compressible Euler solver for high-speed train aerodynamic simulations.

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Collaborators

University of Minnesota, USA; National Center for High-Performance Computing, Taiwan

E. Geosciences

E.1. Atmospheric Sciences

Collection of SeaWiFS data for the Eastern Mediterranean and the Middle East Image (Israel)

The Sea-viewing Wide Field-of-View Sensor (SeaWiFS) is a newly developed satellite, integrating advanced technology that acquires multi-channel data over land and sea. Daily SeaWiFS images over the Eastern Mediterranean and the Middle East are received at the J. Blaustein Institute in HRPT format (1.1 Km resolution) using a PC-based receiving station. The volume of daily images will range from 30-130 Mb, depending on the area of acquisition. These PCs receive raw HRPT-type data and convert it to level-0 to match the specifications of NASA documentation. Subsequently, each image is transferred from the receiving station to NASA/GSFC, to create a global image based on several HRPT stations across the globe.

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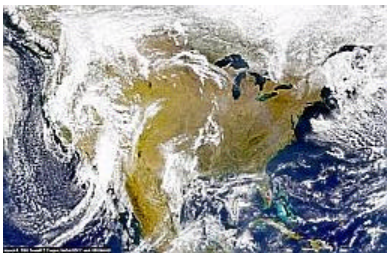
Goddard Space Flight Center, NASA, USA; Ben Gurion University, Israel

URL

http://seawifs.gsfc.nasa.gov/SEAWIFS.html



The SEAWIFS Project (France)

The purpose of the Sea-viewing Wide Field-of-view Sensor (SeaWiFS) Project is to provide quantitative data on global ocean bio-optical properties to the Earth science community. Subtle changes in ocean color signify various types and quantities of marine phytoplankton (microscopic marine plants), the knowledge of which has both scientific and practical applications.

The SeaWiFS Project will develop and operate a research data system that will process, calibrate, validate, archive and distribute data received from an Earth-orbiting ocean color sensor.

The SeaWiFS Mission is a part of NASA's Mission to Planet Earth (MTPE), which is designed to look at our planet from space to better understand it as a system in both behavior and evolution. Since an orbiting sensor can view every square kilometer of cloud-free ocean every 48 hours, satellite-acquired ocean color data constitute a valuable tool for determining the abundance of ocean biota on a global scale, and can assess the ocean's role in the global carbon cycle and the exchange of other critical elements and gases between the atmosphere and the ocean.

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Collaborators

Worldwide collaborators; based at NASA's Goddard Space Flight Center, USA. *US/France collaborators:* LSCE (Laboratoire des Sciences du Climat et de l'Environnement, CEA Saclay), France; Rosenstiel School of Marine and Atmospheric Science (RSMAS), University of Miami, USA

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http://seawifs.gsfc.nasa.gov/SEAWIFS.html

NORDUnet Supports Global Observation Information Network (GOIN) Demonstration in Stockholm

GOIN 99

NORDUnet cooperated with the NASA Research and Education Network (NREN) and the Asia-Pacific Advanced Network (APAN), to support live demonstrations of the Global Observation Information Network (GOIN) in Stockholm, during the Committee on Earth Observation Satellites (CEOS) 1999 Plenary. The event was hosted by the European Meteorological Satellite (EUMETSAT) organization, with the support of the Swedish Space Corporation (SSC). CEOS (www.ceos.org) is the worldwide technical coordinator for all agencies that develop and operate satellites that observe the earth from space.

GOIN was initiated in 1993 by the President of the United States and the Prime Minister of Japan, under the United States-Japan Framework for a New Economic Partnership. It is a cooperative effort between agencies of both governments to strengthen Earth observation information networks, involving both satellite and in-situ data.

Over the past two years, GOIN has expanded to include Asia-Pacific regional partners. Of particular interest would be the addition of European earth observation research organizations, such as the EC Joint Research Centre (JRC) in Ispra, Italy.

Collaborators

NASA Research and Education Network (NREN), USA and Asia-Pacific Advanced Network (APAN), Japan

URL

http://www.nordu.net/news/index.html
http://www.nnic.noaa.gov/GOIN/GOIN.html
(overview and links to various projects)

Global Observation Information Network (GOIN) Project (Japan)

GOIN was initiated in 1993 by the President of the United States and the Prime Minister of Japan, under the United States-Japan Framework for a New Economic Partnership. It is a cooperative effort between agencies of both governments to strengthen Earth observation information networks, involving both satellite and in-situ data.

Over the past two years, GOIN has expanded to include Asia-Pacific regional partners. Of particular interest would be the addition of European earth observation research organizations, such as the EC Joint Research Centre (JRC) in Ispra, Italy.

Collaborators

United States and Japan

URL

http://www.nnic.noaa.gov/GOIN/GOIN.html (overview and links to various projects)

Japan-US Joint Research Program on Optical and Radio Technology for Atmospheric Science; An Application of the GOIN Project

The Communications Research Laboratory (CRL) of Japan's Ministry of Posts and Telecommunications (MPT) is developing and implementing a suite of electromagnetic wave-based technologies to observe the middle atmosphere, as a collaborative project with the Geophysical Institute of the University of Alaska Fairbanks (GI/UAF).

The project aims to develop and demonstrate the observational technologies and science for investigating global environmental changes and abnormalities. Nine kinds of scientific instruments have been developed that, in combination, give a detailed picture of the Arctic atmospheric environment. The major target of the atmospheric observations associated with this pan, is the middle atmosphere from the stratosphere to the lower thermosphere (10-100 km), above Alaska.

The Poker Flat Research Range of GI/UAF was chosen as the primary field site, where aurora borealis and other effects of solar activity are especially pronounced. Also, the interior of Alaska is often located near the edge of the Arctic polar vortex that forms a suitable condition for the ozone hole, and is a region where other unique polar atmospheric phenomena are displayed.

A data transfer experiment of the computer network began with a new connection of the University of Alaska Arctic Region Supercomputing Center, to the Seattle GigaPoP in October 1999. This enabled the middle and upper atmosphere observation instruments in Alaska to connect to other states, and thus Japan, with a high-speed link, through the APAN project.

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Collaborators

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http://www.crl.go.jp/t/team5/ScienceplanE/

ELDORA (ELectra DOppler RAdar)

ELDORA is an airborne, dual beam, meteorological research radar developed jointly at the National Center for Atmospheric Research (NCAR), USA, and the Centre de Recherches en Physique de L'Environnement Terrestre et Planetaire (CETP), France.

ELDORA mounts on NCAR's Lockheed Electra aircraft. Its two antennas extend back from the tail of the aircraft and spin about the longitudinal axis of the aircraft. One antennae points slightly ahead of the aircraft, and one slightly aft. As the aircraft translates the antennas through space, ELDORA traces two conical helixes through the atmosphere, essentially observing the atmosphere with two separate looks within 50-100 kilometers of the aircraft. The fore and aft looks from ELDORA yield two wind components for each location in the atmosphere. Applying the conservation of momentum and mass, a 3D structure of the atmosphere is produced which can then be sliced through any axis to produce 2D plots.

The ELDORA radar system consists of five major functional blocks: the RF signal generator/receiver unit, the TWT high power amplifiers, the signal processor, the antenna/rotodome system, and the radar control equipment. Since the radar system consists of two separate fore- and aft-pointing radars, much of the hardware contains two identical modules. Only the basic signal generation equipment and the radar control equipment do not contain duplicate modules.

The ELDORA output variables include radar reflectivity, mean radial velocity, spectral width, and normalized coherent power. These data are passed to the data recording and display system, thus enabling the data system to receive all data from both the fore and the aft radars, to tag it with aircraft position information and to record and display the data.

ELDORA's first deployment was to TOGA COARE in the Solomon Islands in January and February 1993.

Collaborators

National Center for Atmospheric Research, USA; Centre de Recherches en Physique de L'Environnement Terrestre et Planetaire, France

URL

http://www.atd.ucar.edu/rsf/eldora/eldora.html
http://www.ncar.ucar.edu/
http://www.CETP.IPSL.fr

Indian Ocean Experiment (INDOEX)

Regional consequences of global warming depend critically on the potentially large cooling effect of another pollutant, known as aerosols. These tiny particles, of about a millionth of a centimeter or smaller in diameter, scatter sunlight back to space and cause a regional cooling effect. These aerosols, consisting of sulfates, soot, organic carbon and mineral dust, are produced both naturally and by human activities.

Results of numerous global warming models suggest that aerosol cooling is one of the largest, if not the largest, source of uncertainty in predicting future climate. Still, the complex influence of aerosol cooling on global warming is not clearly understood. This issue will remain a mystery unless field experiments, such as the Indian Ocean Experiment (INDOEX), are undertaken to collect in-situ data on the regional cooling effect of sulfate and other aerosols.

INDOEX addresses questions of climate change that are of high priority and great value to the US and the international community. The project's goal is to study natural and anthropogenic climate forcing by aerosols and feedbacks on regional and global climate. This issue is at the core of the International Global Change Research Program and has been identified by the Intergovernmental Panel on Climate Change (IPCC) as a major gap in the science of climate change prediction.

Premier environmental scientists, universities and national laboratories from the US, Europe and Indian Ocean region are committed to INDOEX through the support of their national global change research programs. In the US, the National Science Foundation is the primary sponsor.

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Collaborators

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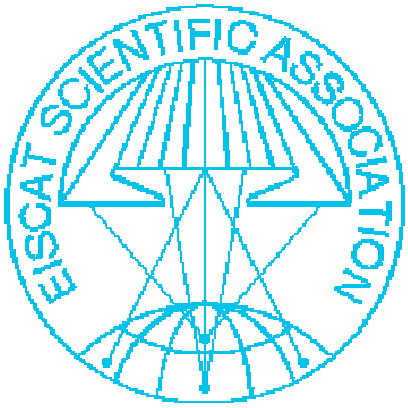
URL

http://www-indoex.ucsd.edu/
http://www.lmd.ens.fr/INDOEX/

F. Math, Physical Sciences

F.1. Astronomical



European Incoherent SCATter (EISCAT)

The EISCAT Scientific Association (Nordic members from Finland, Norway and Sweden) operates radars and receivers to study the interaction between the Sun and the Earth, as revealed by disturbances in the magnetosphere and the ionized parts of the atmosphere (these interactions also give rise to the spectacular aurora, or Northern Lights).

There are major continuing collaborations with the USA, notably with the other incoherent scatter radars (funded by the Upper Atmosphere Facilities part of the NSF) as well as projects in the NSF KDI initiative. The radars are operated in both Common and Special Program modes, depending on the particular research objective, and Special Program time is accounted and distributed between the Associates according to rules that are published from time to time.

The EISCAT transmitter site is located close to the city of Tromsø in Norway, and additional receiver stations are located in Sodankylä, Finland, and Kiruna, Sweden. Several Incoherent Scatter facilities are distributed about the world, such as Millstone Hill Observatory (MHO), in Westford, Massachusetts. MHO is a broad-based atmospheric sciences research facility owned and operated by the Massachusetts Institute of Technology. The Atmospheric Sciences Group, which staffs and manages the observatory, is a part of MIT's Haystack Observatory, a basic research organization whose focuses on radio wave and radar science, instrumentation and techniques.

The Incoherent Scatter Radar technique requires sophisticated technology and EISCAT engineers are constantly involved in upgrading the systems. The EISCAT Scientific Association is currently constructing a new incoherent scatter radar facility, the EISCAT Svalbard Radar. The first ionospheric returns were received on 16 March 1996. General and detailed hardware and software documentation of the new facility is under construction, and an evolving description of related ground-based instrumentation is also available.

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Accélération de Particules par Ondes de Choc

Development of hydrodynamic models for the acceleration of particles in Supernovae remains

Collaborators

Institut Astrophysique de Paris (IAP), France; North Carolina State University, USA

CASSINI-HUYGENS Cluster II WBD (The Wide-Band Plasma Wave Investigation)

As part of the Cluster Wave Experiment Consortium (WEC), the Wide-band (WBD) Plasma Wave investigation is designed to provide high-resolution measurements of both electric and magnetic fields in selected frequency bands from 25 Hz to 577 kHz. Continuous waveforms are digitized and transmitted in either a 220 Kbps real-time mode or a 73 Kbps burst mode. The real-time data are received directly by a NASA Deep-Space Network (DSN) receiving station, and the burst-mode data are transferred to the spacecraft solid-state recorder for later playback. On the ground, the waveforms are Fourier-transformed to provide high-resolution frequency-time spectrograms. The WBD measurements complement those of the other WEC instruments and also provide a unique new capability to perform very-long baseline interferometry (VLBI) measurements.

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Collaborators

University of Iowa, USA; University of Minnesota, USA; NASA Goddard Space Flight Center, USA; Observatoire de Paris, France; Centre de Recherches en Physique de L'Environnement Terrestre et Planetaire, France; University of Sheffield, UK; Austrian Academy of Science Space Research Institute, Austria; Swedish Institute of Space Physics, Sweden; European Space Research and Technology Centre, Netherlands

URL

http://despa.obspm.fr/plasma/cassini/cassini.html
http://www-pw.physics.uiowa.edu/plasma-wave/cassini/home.html

CASSINI-HUYGENS Cluster 2 Wave Experiment Consortium (WEC)

The European Space Agency's Huygens probe is heading for Titan, Saturn's largest moon, aboard NASA's Cassini spacecraft. Titan's orange, chemical-heavy atmosphere is thought to resemble that of a young Earth, meaning it could hold the secret to the origins of life. Huygens will penetrate the moon's atmosphere and, during a brief descent, analyze the physical and chemical environment. The probe is named after Dutch astronomer Christiaan Huygens (1629-95) who first detected Saturn's rings and its giant moon.

Huygens remote-sensing instruments use visible ultraviolet and infrared light and radar. These will record details of Titan's chemical make-up, its weather and clouds, and surface. A shield will protect the probe from 12,000-degree heat as it enters the atmosphere. Parachutes will slow its descent and stabilize it, allowing the instruments to do their work. If the probe survives the impact, it will continue to send back data as long as its batteries last or until the Cassini orbiter is out of range.

In order to get the maximum scientific return from available resources, the wave experimenters on Cluster established the Wave Experiment Consortium (WEC). The WEC's scientific objectives are described, together with its capability to achieve them in the course of the mission. WEC has organized technical coordination for experiment pre-delivery tests and spacecraft integration and tests, and has also established associated working groups for data analysis and operations in orbit. All scientific operation aspects of WEC have been worked out in meetings with wide participation of scientists from five WEC instrument teams.

The five WEC experiments are designed to measure quasi-static electric fields, electric and magnetic fluctuations and small-scale plasma density structures in the Earth's magnetosphere and in the solar wind. These experiments are: EFW, STAFF, WHISPER, WBD and DWP.

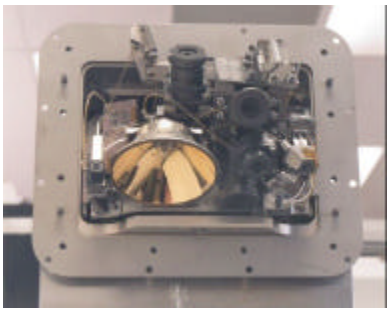
The Cluster community includes 11 Principal Investigators and more than 200 Co-Investigators from Europe, the United States, Canada, China, the Czech Republic, Hungary, India, Israel, Japan and Russia.

Collaborators

Consortium of institutions worldwide, including: University of Berkeley Space Science Laboratory, USA; University of Iowa, USA; Centre de Recherches en Physique de L'Environnement Terrestre et Planetaire, France

URL

http://www.estec.esa.nl/spdwww/cluster/html2/wec.html
http://www.estec.esa.nl/spdwww/cluster/html2/exp.html



CASSINI-HUYGENS Descent Imager/Spectral Radiometer (DISR)

The Descent Imager/Spectral Radiometer (DISR) is a scientific instrument designed to explore Saturn's largest moon Titan. It was launched in October 1997, on board the European Space Agency's Huygens Probe, as part of the Cassini Mission to Saturn. The DISR will make a pioneering effort to obtain close-up pictures of Titan's surface and determine the nature of Titan's atmosphere.

The Cassini Spacecraft will enter orbit around Saturn in 2004. The Huygens Probe will detach from the spacecraft in late 2004 to enter the atmosphere of Titan. For about 2 hours and 15 minutes the probe will fall from 160 km altitude to Titan's surface. During the descent the DISR and 5 other science instruments will send data about the moon's atmosphere and surface back to the spacecraft for relay to Earth.

DISR measures solar radiation using silicon photo-diodes, a 2D silicon Charge Coupled Device (CCD) detector and two InGaAs near-infrared linear array detectors. The light is brought to the detectors using fiber optics from many separate sets of foreoptics that collect light from different directions and in different spectral regions. In this way, the instrument can make a suite of measurements that is carefully selected to answer key questions concerning the nature of the surface and the composition, meteorology, thermal balance, and clouds and aerosols in the atmosphere of Titan.

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Collaborators

University of Arizona, USA; US Geological Survey, USA; NASA Jet Propulsion Laboratory, USA; Observatoire de Paris Meudon, France; Laboratory of Glaciology and Geophysics of Grenoble, France; Technical University of Bruanschweig, Germany; Max-Planck-Institute for Astronomy, Germany

URL

http://www.estec.esa.nl/spdwww/huygens/html/topdisr.htm
http://www.lpl.arizona.edu/

CASSINI-VIMS (Visual and Infrared Mapping Spectrometer)

The Visible and Infrared Mapping Spectrometer (VIMS) is essentially a color camera mounted on the Cassini spacecraft bound for Saturn. It has a pair of imaging grating spectrometers designed to measure reflected and emitted radiation from atmospheres, rings, and surfaces over wavelengths from 0.35 to 5.1 micrometers to determine their compositions, temperatures and structures.

When the human eye looks at an object, the cones in the retina are able to discern the amount of light hitting them at 3 different wavelengths, which are interpreted as colors. Light with a wavelength of around 420 nm (nanometers, or billionths of a meter) looks blue, light at 534 nm looks yellow and 564 nm looks red. Colors other than red, yellow, and blue are the result of the eye receiving different amounts of light at each wavelength at the same time.

Cassini VIMS takes pictures in 352 different colors at the same time, with wavelengths between 300 and 5100 nm. Thus the color range of VIMS's vision is greater than that of the human eye (300-5100 nm, as opposed to 380-620 nm), and far more accurate in determining the wavelength of the light that strikes it.

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University of Arizona, NASA Ames Research Center, NASA Jet Propulsion Laboratory, Caltech, Cornell University, US Geological Survey, Denver, University of Arizona, University of Hawaii, USA; Institut d'Astrophysique Spatiale, CNRS, DESPA/Observatoire de Meudon, Observatoire de Paris, France; Instituto di Astrophysica Spaziale, CNR/IRSI, Instituto di Fisica, Agenzia Spatiale Italiana, Italy; Institut fur Planetenerkundung, DLR, Germany

URL

http://vimsops.lpl.arizona.edu/

Catalogue des Etoiles au Beryllium (Catalog of Beryllium Stars)

Collaborators
Institut Astrophysique de Paris (IAP), France; Limber Observatory (Pipe Creek, Texas), USA

CLIMSERV-CDC (Une Activité de Service Effectuée par l'IPSL)
Data transfers from the NOAA Climate Diagnostic Center database to the French database CLIMSERV

Collaborators
LMD (IPSL, Ecole Polytechnqiue-Palaiseau), France; Climate Diagnostic Center-CIRES, France; University of Colorado (Boulder), USA

CLIMSERV-EOSDIS / LARC (Une Activité de Service Effectuée par l'IPSL)
Data transfers from the EOSDIS database to the French database CLIMSERV.

Collaborators
LMD (IPSL, Ecole Polytechnqiue-Palaiseau), France; EOSDIS/LARC, NASA Langley Atmospheric Sciences Data Center (Virginia), USA

Détection des Etoiles Doubles par Haute Résolution Angulaire
Detection of binary stars.

Collaborators
Institut Astrophysique de Paris (IAP), France; Center for High Angular Resolution Astronomy, Georgia State University, USA

Etude d'Amas de Galaxies en Ultraviolet
Analysis of observations of galaxy clusters with the EUVE satellite.

Collaborators
Institut Astrophysique de Paris (IAP), France; University of Alabama (Huntsville), USA

Etude de l'Amas ZWICKY 3146
Studies of properties of clusters observed with X telescopes.

Collaborators
Institut Astrophysique de Paris (IAP), France; Harvard-Smithsonian Center for Astrophysics (CfA), USA

Etude des Disques de Gaz

Study of gaz disks around young planetary systems, such as Beta Pictoris.

Collaborators

Institut Astrophysique de Paris (IAP), France; Yerkes Observatory, University of Chicago, USA

Etude des Effets de la Poussière dans les Galaxies

Theoretical prediction of observations with new telescopes in the infrared.

Collaborators

Institut Astrophysique de Paris (IAP), France; Space Telescope Science Institute (STSCI), Johns Hopkins University, Baltimore, USA

Etude Théorique et Expérimentale des Profils de Raies

Theoretical computation of ray profiles and comparison with experimental spectra.

Collaborators

Institut Astrophysique de Paris (IAP), France; University of Louisville, USA

Fluctuations de Brillance de Surface

Theoretical predictions and observations of signal fluctuations in infrared imaging of galaxies

Collaborators

Institut Astrophysique de Paris (IAP), France; University of California at Berkeley, USA

FUSE (Far Ultraviolet Spectroscopic Explorer)

FUSE is a NASA-supported astronomy mission that was launched on June 24, 1999, to explore the Universe using the technique of high-resolution spectroscopy in the far-ultraviolet spectral region.

The Johns Hopkins University has the lead role in developing and now operating the mission, in collaboration with The University of Colorado at Boulder, the University of California at Berkeley, international partners – the Canadian Space Agency (CSA) and the French Space Agency (CNES) and corporate partners. FUSE is part of NASA's Origins Program under the auspices of NASA's Office of Space Science.

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Collaborators

The Johns Hopkins University, USA; The University of Colorado at Boulder, USA; The University of California at Berkeley, USA; Goddard Space Flight Center (NASA), USA; Canadian Space Agency (CSA), Canada; French Space Agency (Centre National d'Etudes Spatiales), France; Institut Astrophysique de Paris (IAP), France

URL

http://fuse.pha.jhu.edu/
http://www.iap.fr/Fuse/

GALILEO

Galileo is a NASA spacecraft mission to Jupiter, launched October 18, 1989, and designed to study the planet's atmosphere, satellites and surrounding magnetosphere for two years, starting December 1995.

This mission will be the first to make direct measurements from an instrumented probe within Jupiter's atmosphere, and the first to conduct long-term observations of the planet and its magnetosphere and satellites from orbit around Jupiter. It is already the first to encounter an asteroid, and to photograph an asteroid's moon.

The Jet Propulsion Laboratory designed and developed the Galileo Jupiter orbiter spacecraft and is operating the mission; NASA's Ames Research Center developed the atmospheric probe with Hughes Aircraft Company as prime contractor. The German government is a partner in the mission through its provision of the spacecraft propulsion subsystem and two science experiments. Scientists from six nations are participating in the mission. Galileo communicates with its controllers and scientists through the Deep Space Network, using tracking stations in California, Spain and Australia.

The Galileo Europa Mission (GEM) is a highly focused follow-on to Galileo's Jupiter system exploration, and a precursor for future missions to two of Jupiter's moons, Europa and Io. GEM will conduct a detailed study of Europa over 14 months, then plunge repeatedly through the Io Plasma Torus to reach volcanic Io.

Collaborators

NASA Jet Propulsion Laboratory; worldwide collaborators. *US/France collaborators:* CETP/IPSL, France; University of Iowa, USA

URL

http://www.jpl.nasa.gov/galileo/

GALILEO/NIMS

Infrared spectro-imagery of Jupiter with the Galileo spacecraft.

Collaborators

NASA Jet Propulsion Laboratory, USA; Department of Space Research (DESPA)/Observatoire de Paris Meudon, France

HESSI (High Energy Solar Spectroscopic Imager)

A solar flare is the rapid release of a large amount of energy stored in the solar atmosphere. During a flare, gas is heated to 10 to 20 million degrees Kelvin (K) and radiates soft X-rays and longer-wavelength emission. Unable to penetrate the Earth's atmosphere, the X-rays can only be detected from space.

Instruments on Skylab, SMM, the Japanese/US Yohkoh mission and other spacecraft have recorded many flares in X-rays over the last 20 years or so. Ground-based observatories have recorded the visible and radio outputs. This data forms the basis of our current understanding of a solar flare. But there are many possible mechanisms for heating the gas, and observations to date have not been able to differentiate among them.

Researchers believe that much of the energy released during a flare is used to accelerate, to very high energies, electrons (emitting primarily X-rays) and protons and other ions (emitting primarily gamma rays). The new approach of the HESSI mission is to combine, for the first time, high-resolution imaging in hard X-rays and gamma rays with high-resolution spectroscopy, so that a detailed energy spectrum can be obtained at each point of the image. This new approach will enable researchers to find out where these particles are accelerated and to what energies. Such information will advance understanding of the fundamental high-energy processes at the core of the solar flare problem.

Contact

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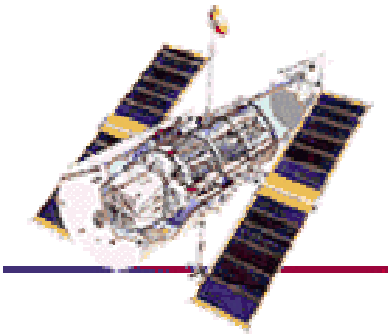
Collaborators

NASA Goddard Space Flight Center, USA; University of Berkeley Space Science Laboratory, USA; Montana State University, USA; University of Alabama at Huntsville, USA; Lawrence Berkeley National Laboratory, USA; National Oceanic and Atmospheric Administration, USA; Observatoire de Paris Meudon, France; ETHZ, Switzerland; Paul Scherrer Institute, Switzerland; University of Glasgow, Scotland; University of Tokyo, Japan; University of Delft, The Netherlands

URL

http://hessi.ssl.berkeley.edu/
http://www.obspm.fr



Hubble Space Telescope

The Hubble Space Telescope (HST) is a cooperative program of the European Space Agency (ESA) and the National Aeronautics and Space Administration (NASA) to operate a long-lived space-based observatory for the benefit of the international astronomical community. HST is an observatory first dreamt of in the 1940s, designed and built in the 1970s and 80s, and operational only in the 1990s.

Since its preliminary inception, HST was designed to be a different type of mission for NASA–a long-term space-based observatory. To accomplish this goal and protect the spacecraft against instrument and equipment failures, NASA had always planned on regular servicing missions. Hubble has special grapple fixtures, 76 handholds, and is stabilized in all three axes. HST is a 2.4-meter reflecting telescope that was deployed in low-Earth orbit (600 kilometers) by the crew of the space shuttle Discovery (STS-31) on April 25, 1990.

HST's current complement of science instruments include three cameras, two spectrographs, and fine guidance sensors (primarily used for astrometric observations). Because of HST's location above the Earth's atmosphere, these science instruments can produce high-resolution images of astronomical objects. Ground-based telescopes can seldom provide resolution better than 1.0 arc-seconds, except momentarily under the very best observing conditions. HST's resolution is about 10 times better, or 0.1 arc-seconds. Responsibility for conducting and coordinating the science operations of the HST rests with the Space Telescope Science Institute (STScI) on the Johns Hopkins University Homewood Campus in Baltimore, Maryland.

Collaborators (partial list)

Space Telescope Science Institute, Johns Hopkins University, USA; University of Washington, USA; University of California at Berkeley, USA; University of Hawaii, USA; Vassar College, USA; Ohio State University, USA; University of Arizona, USA; University of Texas at Austin, USA; Sterrewacht, Leiden University, The Netherlands; CEA-CEN Saclay, France; Osservatorio Astronomico di Padova, Italy

Context of US/France collaboration: Search for absorption rays in spectra from the Hubble Space Telescope, in the framework of the "Absorption Line Systems in Quasars" program.

URL

http://www.stsci.edu/

Large Scale Structure and Cluster Formation

Long-term NASA project: Combined analysis in optical, X-ray and radio.

Collaborators

Institut Astrophysique de Paris (IAP), France; Harvard-Smithsonian Center for Astrophysics (CfA), USA

LIC

Study of the local interstellar cloud.

Collaborators

Institut Astrophysique de Paris (IAP), France; LPL-WEST (Tucson, Arizona), USA

Modèles de Formation d'Etoiles avec Vent Galactique

Models for formation and evolution of galaxies with loss of mass. Consequences for the chemical evolution of elements D, He, O, Fe and others.

Collaborators

Institut Astrophysique de Paris (IAP), France; University of Illinois at Urbana-Champaign, USA

Nucléosynthèse du Big Bang dans le Modèle Cosmologique Standard

Development of a model for the primordial nucleosynthesis. Study of cosmologic parameters and comparison with observational constraints.

Collaborators

Institut Astrophysique de Paris (IAP), France; Theoretical Physics Institute School of Physics and Astronomy, University of Minnesota, USA

Observation of Lithium, Beryllium and Bore Elements in Halo Stars, and Development of Astrophysical Models Detailing Their Chemical Evolution in the Galaxy

Collaborators

Institut Astrophysique de Paris (IAP), France; University of Chicago, USA

Theoretical Computation Dealing with Distribution of Gaseous Components of Circumstellar Shells

Collaborators

Institut Astrophysique de Paris (IAP), France; New York University, USA

Minor Planet Ephemeris Service

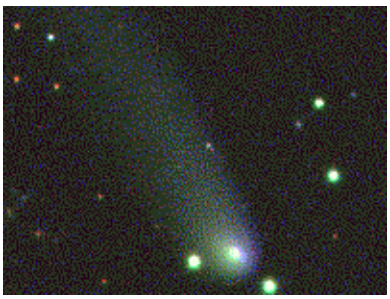
A Smithsonian Astrophysical Observatory–based server for computation of asteroid and comet ephemeredes

Collaborators

Harvard-Smithsonian Center for Astrophysics (CfA), USA; Institut Astrophysique de Paris (IAP), France

URL

http://cfa-www.harvard.edu/newtop/saohome.html
http://cfa-www.harvard.edu/iau/mpc.html



SLOAN Digital Sky Survey

The Sloan Digital Sky Survey is the most ambitious astronomical survey project ever undertaken. The survey will map in detail one-quarter of the entire sky, determining the positions and absolute brightness of more than 100 million celestial objects. It will also measure the distances to more than a million galaxies and quasars.

The SDSS addresses fascinating, fundamental questions about the universe. With the survey, astronomers will be able to see the large-scale patterns of galactic sheets and voids in the universe. Scientists have varying ideas about the evolution of the universe, and different patterns of large-scale structure point to different theories of how the universe evolved. The Sloan Digital Sky Survey will tell us which theories are right, or whether we have to come up with entirely new ideas.

Collaborators

University of Chicago, USA; Institute for Advanced Study, USA; Johns Hopkins University, USA; Princeton University, USA; University of Washington, USA; Fermi National Accelerator Laboratory; USA; Japan Participation Group, Japan; Max-Planck-Institute for Astronomy, Germany; US Naval Observatory, USA

URL

http://www.sdss.org/sdss.html

Surveys Radio

Properties of deep radio surveys.

Collaborators

Institut Astrophysique de Paris (IAP); National Radio Astronomy Organization, USA

TERAPIX (Traitement Elementaire Reduction et Analyse des PIXels) de MEGACAM

TERAPIX is an astronomical data processing center at the Institut d' Astrophysique de Paris (IAP) dedicated to very large CCD images and massive data flow provided by the MEGACAM camera.

The objectives of TERAPIX are organizing the MEGACAM image processing, and providing images and catalogues to the Canada-France-Hawaii-Telescope (CFHT) users community.

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Centre National de la Recherche Scientifique (CNRS), France; University of Hawaii, USA; National Research Council Canada, Canada

URL

http://terapix.iap.fr
http://www.cfht.hawaii.edu/

Japan-US Collaboration in Sloan Digital Sky Survey over the Network

Sloan Digital Sky Survey (SDSS) is a project to carry out imaging and spectroscopic surveys of half the northern sky, using a dedicated wide-field 2.5-m telescope. The imaging survey with a large mosaic CCD camera will produce digital photometric maps of the sky in five color bands. These maps will be used to extract the position and various photometric parameters of about 100 million galaxies and nearly the same number of stars. Among the extracted objects, about 1 million galaxies and 100,000 quasars are selected, for which medium resolution spectra will be obtained.

The observation, i.e., data taking, will be carried out at the Apache Point Observatory, New Mexico, where some on-line data processing is performed. The bulk of the data reduction will be done at Fermi National Accelerator Laboratory, where the master database will also be maintained. The Japan Participation Group (JPG) will maintain a set of the same data in Japan, except for the raw data. The JPG is planning to produce the merged pixel map noted above from the flat-fielded data. The data processing to construct the merged pixel map involves reference to the raw data as well as the flat-fielded data.

Significant scientific analyses of these data will often produce a result as large as the input catalog itself. Accordingly, a network capable of transferring some 10Gb in one day is of critical importance to promoting active timely discussion between the JPG and US astronomers spread over several institutions. Similar imaging data taken with the Subaru Telescope will sometimes be useful to interpret the result of the SDSS data analysis.

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Collaborators

Johns Hopkins University, USA; Fermilab, USA; Apache Point Observatory, New Mexico, USA; Japan Participation Group (JPG), Japan

URL

http://www.sdss.org

Investigation of Magnetospheric Perturbances

Moscow State University and the University of Michigan Space Physics Research Laboratory are using MIRnet in support of a joint project involving a heavy computational component and the creation/maintenance of a shared cosmophysical information database addressing experimental and theoretical research in magnetospheric and space physics.

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Collaborators

University of Michigan, USA; Moscow State University, Russia

F.2. Chemistry

Large-Scale Atomistic Modeling of Semiconductors and Ceramics; A United States-Israel Binational Science Foundation (BSF) Project

The field of computational atomistic modeling is a research area of considerable importance and interest. In particular, the quantitatively accurate atomistic modeling of solids is no longer a dream, but a rapidly developing discipline with many practical applications. In this project we plan to use various kinds of molecular dynamics and Monte Carlo simulation techniques to explore a range of phenomena associated with semiconductors and ceramics.

The kinds of behavior that will be studied include the interfaces in mixtures of silicon, germanium and carbon, and the processes responsible for generating defects and the subsequent graphitization of diamond; the complexity of these phenomena is such that a detailed atomistic modeling approach is essential. The simulations will be closely coordinated with ongoing experimental studies. Because of the heavy computational requirements and the detailed data analysis involved, the work entails the development of algorithms to support parallel processing together with specialized visualization techniques.

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URL

http://www.bsf.org.il/

Site Selective Chemistry: Surroundings Effects on Protonic Systems; A United States-Israel Binational Science Foundation (BSF) Project

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University of Wisconsin, Madison, USA; Technion–Israel Institute of Technology, Israel

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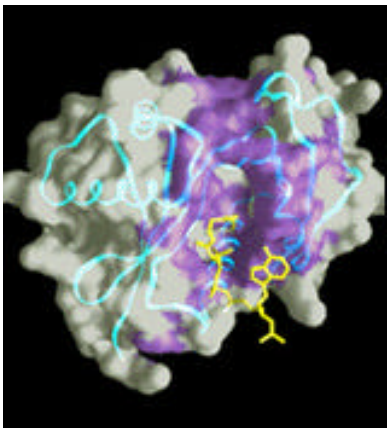
http://www.bsf.org.il/



Visualization of Virus Particles

The Wistar Institute has a major interest in studying the 3D structure of viruses to understand their properties and evolutionary relationships. Wistar is collaborating with the University of Helsinki to use electron microscopy and crystallography to image viruses and their component molecules. Collaboration between the institutions is done over the Internet. The most demanding task is exchanging images of complete virus particles—both the raw 2D EM data and the 3D reconstructions made from them.

Although adenoviruses cause human ailments, such as respiratory infections, conjunctivitis and enteric dysentery, they can also be used as vectors in human gene therapy to combat sickness. The organization of the virion is being studied using electron microscopy and image analysis. A 3D image reconstruction at high resolution from cryo-electron micrographs has revealed how hexon proteins form the viral facets and showed the interaction of penton base and fiber at the vertex. Wistar is also attempting to crystallize the entire adenovirus.

Although Bacteriophage PRD1 is structurally unusual, recent work has shown its remarkable similarities to adenovirus. Both are icosahedral with vertex fibers, have trimeric major coat proteins, and contain double-stranded linear DNA with terminal proteins. PRD1 is the only known spherical prokaryotic virus to have this form of genome, and is also unique in possessing a lipid membrane within its outer capsid. The viral capsid, or outer shell, is formed from two proteins; P31 lies at the vertices, while the major coat protein, P3, forms the facets. Wistar is investigating the PRD1 structure in collaboration with the University of Helsinki, Finland.

The strong similarities between P3 and hexon suggest strongly that PRD1 and adenovirus are related, and establish the first direct structural link between viruses from the animal and bacterial kingdoms. The analogy is suggesting interesting directions for future research, such as the role that the PRD1 fiber proteins may play in entry. A more detailed portrait of the PRD1 virion will be obtained by combining the EM and X-ray images. This will lead to an increased understanding of PRD1 organization and stability, and allow further exploration of its intriguing similarity to adenovirus.

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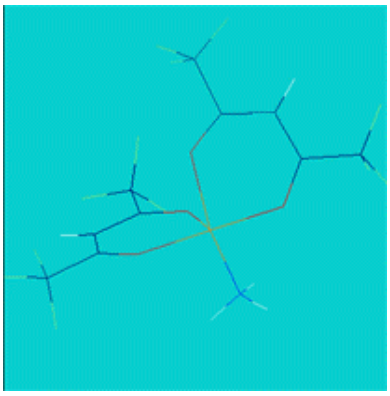

Reciprocal Net – A Global Shared Database for Crystallography

iGrid 1998

The Reciprocal Net project, a collaboration of initially 14 crystallography laboratories, is an attempt to create a new type of database structure for crystallographic data. The current interface allows users to graphically examine and manipulate the data in a variety of ways, using simple Web browsers, advanced workstations, stereographic equipped workstations, and immersive technologies. There is currently one publicly accessible server at the Indiana University Molecular Structure Center.

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Collaborators

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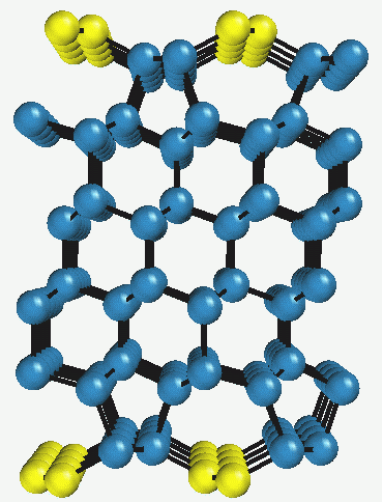
URL

http://www.iumsc.indiana.edu/

F.3. Materials Science



Computer Alchemy Using Virtual Reality

Computational Condensed Matter Physics and Material Science is a rapidly growing field, fueled in part by the advent of computer alchemy. As computers have become more powerful and algorithms more robust, this practical research tool models molecularly dynamic systems in virtual reality—notably, atomistic material simulations up to several million particles.

Especially suitable for discussing simulation results with experimental collaborators, visualization is also essential for teaching quantum mechanics and condensed matter physics, since most effects on the atomic scale cannot be demonstrated in the usual way.

Current work at the Technion involves atomic-level modeling of diamond and aluminium/alumina interfaces. Computational physics and experimental research faculty are collaborating to produce 3D computer visualization models. High-bandwidth networks are used to transfer the visualizations, as well as develop protocols for interactive conferencing and discussion.

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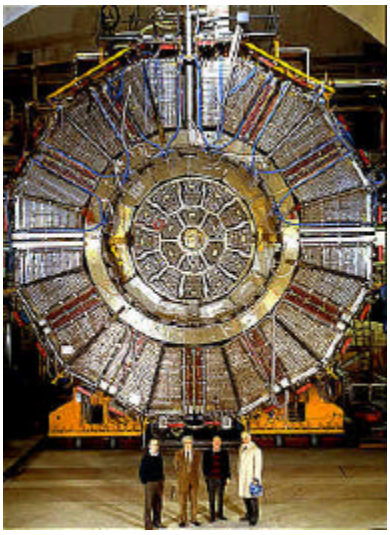
Collaborators

Technion – Israel Institute of Technology

URL

http://phycomp.technion.ac.il/

F.4. Physics



Networked Experiments of the European Laboratory for Particle Physics (CERN)

CERN provides experimental facilities for particle physics experiments, mainly in the domain of high-energy physics (HEP). CERN's current major facility is the Large Electron Positron (LEP) collider in a 27-km tunnel, the largest machine of this type in the world. Four very large experiments in man-made caverns intersect the LEP tunnel, constituting about half of CERN's total experimental program for the 1990s. Each of the experiments is carried out by teams of several hundred of physicists from more than 50 institutes in five continents.

All existing and future CERN experiments produce large amounts of data. For example, the LEP experiments generate 25 terabytes of data each year, which are stored on magnetic tape cartridges, whereas the Large Hadron Collider (LHC) experiments, expected to commence in 2005, are expected to produce several order of magnitudes more data.

The sheer volume of the data combined with the complexity of the analysis to be performed, and the requirement that the processing of the data may also be done remotely, places heavy demands on the High Energy & Nuclear Physics (HENP) computing and networking infrastructure, which can only be met by using leading edge technology and services.

Collaborators

Worldwide collaborations based at CERN. *CERN/US collaborators:* Argonne National Laboratory (ANL), California Institute of Technology (Caltech), Cornell University, Fermilab, Harvard University, Lawrence Berkeley National Laboratory, MIT, Princeton University and ESnet

URL

http://www.cern.ch

Large Hadron Collider (LHC) Project

The Large Hadron Collider (LHC) is an accelerator that brings protons and ions into head-on collisions at higher energies than ever before. This will allow scientists to penetrate still further into the structure of matter, and recreate the prevailing conditions of the early post-"Big Bang" universe.

The LHC is a remarkably versatile accelerator. It can collide proton beams with energies around 7-on-7 TeV and beam crossing points of unsurpassed brightness, providing the experiments with high interaction rates. It can also collide beams of heavy ions, such as lead, with total collision energy in excess of 1,250 TeV–about 30 times higher than at the Relativistic Heavy Ion Collider (RHIC) under construction at the Brookhaven Laboratory in the US.

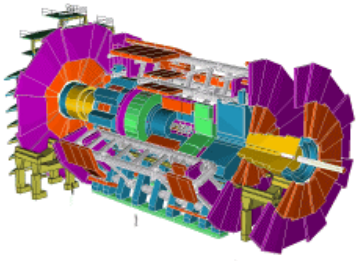
Joint LHC/LEP operation can supply proton-electron collisions with 1.5 TeV energy, some five times higher than presently available at HERA, in Germany's DESY laboratory. The research, technical and educational potential of the LHC and its experiments is enormous.

Collaborators

Worldwide collaborations based at CERN

URL

http://www.cern.ch/LHC/



ATLAS

The ATLAS experiment will study proton-proton interactions at the Large Hadron Collider (LHC), at the European Laboratory for Particle Physics CERN. The detector is due to begin operation in the year 2005.

ATLAS is designed to improve our fundamental understanding of matter and forces. A prime physics goal of ATLAS is to understand the nature of mass.

Contact

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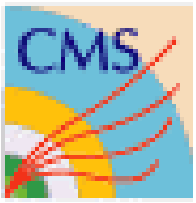
Collaborators

CERN; 1,850 collaborators in 150 institutes worldwide

URL

www-atlas.lbl.gov
atlasinfo.cern.ch/Atlas/public/Welcome.html



Compact Muon Solenoid (CMS)

The Compact Muon Solenoid (CMS) will be a general-purpose detector designed to run at the highest luminosity at CERN's Large Hadron Collider (LHC). The CMS detector has been optimized for the search of the SM Higgs boson over a mass range from 90 GeV to 1 TeV, but it also allows detection of a wide range of possible signatures from alternative electro-weak symmetry breaking mechanisms.

CMS is also well adapted for the study of top, beauty and tau physics at lower luminosities, and will cover several important aspects of the heavy ion physics program. We have chosen to identify and measure muons, photons and electrons with high precision. The energy resolution for the above particles will be better than 1% at 100 GeV.

At the core of the CMS detector sits a large superconducting solenoid generating a uniform magnetic field of 4 T. The choice of a strong magnetic field leads to a compact design for the muon spectrometer without compromising the momentum resolution up to rapidities of 2.5. The inner tracking system will measure all high pt charged tracks with a momentum precision of Delta(p)/p ~ 0.1 pt (pt in TeV) in the range |eta| < 2.5.

A high-resolution crystal electromagnetic calorimeter, designed to detect the two photon decay of an intermediate mass Higgs, is located inside the coil. Hermetic hadronic calorimeters surround the intersection region up to |eta| = 4.7 allowing tagging of forward jets and measurement of missing transverse energy.

Contact

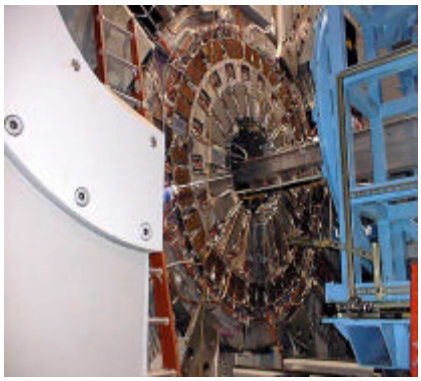
cms.outreach@cern.ch

Collaborators

CERN; 148 institutions in 31 countries worldwide

URL

http://cmsinfo.cern.ch/Welcome.html



BaBar (CERN)

The BaBar detector was built at Stanford Linear Accelerator Center to study the millions of B mesons produced by the PEP-II storage ring. The BaBar collaboration consists of around 600 physicists and engineers from 85 institutions in 9 countries.

Collaborators

Worldwide collaboration of 600 physicists and engineers from 85 institutions in nine countries, based at Stanford Linear Accelerator Center, Stanford University, USA. *US institutions include:* Lawrence Berkeley National Laboratory, University of California at Berkeley; Rutgers University; University of California at Santa Barbara; University of Cincinnati. *French institutions include:* French National Institute of Nuclear and Particle Physics (IN2P3); Commissariat a l'Energie Atomic (CEA); DAPNIA-Saclay; Laboratoire de L'Accelerateur Lineaire (LAL), Orsay; LPNHE Paris VI et Paris VII; LPNHE de l'Ecole Polytechnique.

URL

http://www.slac.stanford.edu/BF/

The DØ Experiment

The DØ Experiment

The DØ Experiment consists of a worldwide collaboration of scientists conducting research on the fundamental nature of matter. The experiment is located at the world's premier high-energy accelerator, the Tevatron Collider, at the Fermi National Accelerator Laboratory (Fermilab).

The research is focused on precise studies of interactions of protons and antiprotons at the highest available energies. It involves an intense search for subatomic clues that reveal the character of the building blocks of the universe.

Contacts

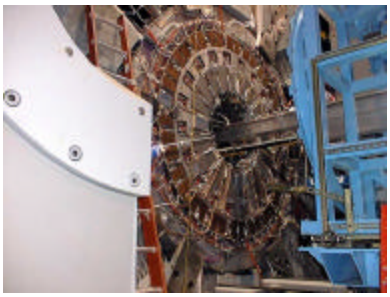
Contacts for each participating institution
http://www-d0.fnal.gov/newd0/d0people.html

Collaborators

Worldwide collaborations based at Fermilab, USA. *US institutions include:* Brookhaven National Laboratory; USA; Cornell University, USA; Lawrence Berkeley Laboratory, USA; Stanford Linear Accelerator Center, USA. *Others:* CERN, Switzerland; DESY, Germany; KEK, Japan. *French institutions include:* French National Institute of Nuclear and Particle Physics (IN2P3); DAPNIA/SPP, Saclay; Centre de Physique des Particules, Marseille; Institut des Sciences Nucleaires, Grenoble; LPNHE, Universites Paris VI and VII; Laboratoire de L'Accelerateur Lineaire (LAL), Orsay.

URL

http://www-d0.fnal.gov



Detection of Internally Reflected Cherenkov Light (DIRC), Particle Identification for BaBar (France)

The BaBar detector was built at Stanford Linear Accelerator Center to study the millions of B mesons produced by the PEP-II storage ring. The BaBar detector comprises the usual nested set of detector sub-systems to precisely measure the collision point and decay points that the B-meson pairs produced, the momentum and energy of the decay particles, and the nature of the kind of particles in these decays (i.e. electrons, muons, pions, kaons).

An important issue in studying CP violation is the ability to tag decays of b-quark versus b-antiquark mesons for particle momenta up to 2.5 GeV/c, and to separate charged pions from charged kaons for momenta up to 4 GeV/c in B decays. The driftchamber provides particle identification (PID) by *dE/dx* measurements for tracks up to 0.7 GeV/c momentum. Dedicated PID system (DIRC) for higher momenta.

The BaBar collaboration consists of 600 physicists and engineers from 85 institutions in nine countries.

Contact

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Collaborators

Based at Stanford Linear Accelerator Center, Stanford University, USA. *Participating US institutions:* Lawrence Berkeley National Laboratory, University of California at Berkeley; Rutgers University; University of California at Santa Barbara; University of Cincinnati. *Participating French institutions:* French National Institute of Nuclear and Particle Physics (IN2P3); Commissariat a l'Energie Atomic (CEA); DAPNIA-Saclay; Laboratoire de L'Accelerateur Lineaire (LAL), Orsay; LPNHE Paris VI et Paris VII; LPNHE de l'Ecole Polytechnique.

URL

http://www.slac.Stanford.edu/BFROOT
http://www-dapnia.cea.fr/Phys/Spp/
http://www.SLAC.Stanford.edu
http://institut.in2p3.fr

The IRON Project

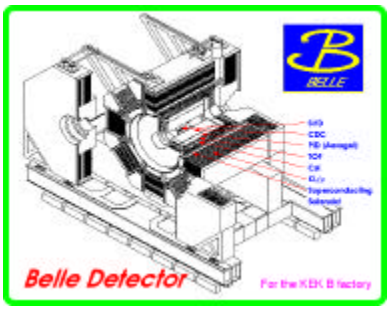
The primary aim of the Iron Project is to compute collision data for the iron-peak elements in various ionization stages. The first two phases of the project deal with fine structure transitions along several isoelectronic sequences and for all iron ions. Radiative data for low ionization stages of iron ions, Fe I-V, is also being computed to higher accuracy than in the earlier work from the Opacity Project.

Collaborators

Observatoire de Paris Meudon, France; Ohio State University, USA

URL

http://www.am.qub.ac.uk/projects/iron/
http://www.obspm.fr
http://www.astronomy.ohio-state.edu/~pradhan/ip.html



Asia-US-Australia Collaboration in the Silicon Vertex Detector Project for the BELLE High Energy Physics Experiment at KEK

The BELLE detector is the state-of-the-art detector built to investigate CP violating phenomena. The goal is to identify the origin of Charge conjugation Parity Violation (CPV) in B-meson decays–a key to explaining why matter, not anti-matter, dominates the universe. The BELLE detector contains a high-precision particle trajectory detection system, consisting of silicon microstrip sensors. This silicon system contains about 100K channels, which will be read by a high-speed, on-line data system. All electronic channels must be constantly monitored and calibrated.

The BELLE collaboration consists of 49 institutions from 11 countries (Australia, China, India, Korea, Japan, Philippines, Poland, Russia, Taiwan, Ukraine and USA). The participating institutions will jointly analyze the data generated. The Asia-US-Australia collaboration was formed to design and build the silicon vertex detector. KEK (High Energy Accelerator Research Organization) is located in Japan.

Contact

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Collaborators

KEK, Osaka University, Tokyo Metropolitan University, University of Tokyo, University of Tsukuba, Japan; University of Melbourne, University of Sydney, Australia; University of Hawaii, Princeton University, USA.

URL

http://bsunsrv1.kek.jp/

Japan-US Collaboration on ICRF Heating and Current Drive Experiments and Modeling

The ICRF heating experiments on the Alcator C-Mod Tokamak at MIT have been highly successful. With the additional power and current drive capabilities currently being added in collaboration with PPPL (Princeton Plasma Physics Laboratory), the emphasis of research will shift toward steady-state advanced Tokamak experiments using current drive and profile control. MIT is already preparing the infrastructure necessary to support remote collaborators.

Participation in these experiments by the University of Tokyo group, including planning of experiments, real-time participation, and data analysis, became possible with the increased bandwidth provided by APAN. The University of Tokyo group, collaborating with MIT physicists, performed theoretical modeling of various heating and current drive scenarios in 1998. The results indicate potential usefulness of the harmonic fast wave for current drive in both conventional and spherical Tokamaks.

Contact

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Collaborators

MIT, USA; University of Tokyo, Japan

URL

http://www.psfc.mit.edu/cmod/

The Pioneering High-Energy Nuclear Interaction Experiment (PHENIX)

Nearly 1,000 physicists from around the world are cooperating to build several experiments at Brookhaven National Laboratory's Relativistic Heavy Ion Collider (RHIC), to capture and analyze the results of RHIC collisions. PHENIX and STAR are the large experiments, or detectors.

The PHENIX detector will look for many different particles emerging from RHIC collisions, including photons, electrons, muons and quark-containing particles called hadrons. To do so, it will use large steel magnets that surround the area where RHIC collisions will take place. Photons (particles of light) and leptons (electrons and muons) are not affected by the strong force, which binds quarks and gluons together into hadrons. Because they can emerge from the interior of a RHIC collision unchanged, photons and leptons can carry information about processes or actions within the collision. By focusing on them, PHENIX will be able to "gaze" inside the collision and gain insight into its internal structure.

PHENIX has over 450 members from 45 institutions in 10 countries. The Center for Nuclear Study (CNS), University of Tokyo maintains the International Collaboration in Experimental Research in High Energy Heavy Ion Collisions web server, and has collaborated with various US and Japanese institutions to construct PHENIX's RICH (Ring Image Cherenkov Counter) subsystem and RICH FEE (Front End Electronics).

The PHENIX Computing Center in Japan (CC-J) at RIKEN Wako, will serve as the principal site of computing for PHENIX simulations, a regional PHENIX Asian computing center, and a center for the analysis of RHIC spin physics. The planned computing capacity will be sufficient to meet the bulk of the simulation needs of PHENIX. The planned robotic storage capability will permit efficient micro-DST production as a regional computing center. By providing a vital source of regional computing, the CC-J will also encourage collaborators from China, Korea, India and Japan to be actively involved in analysis of PHENIX physics data.

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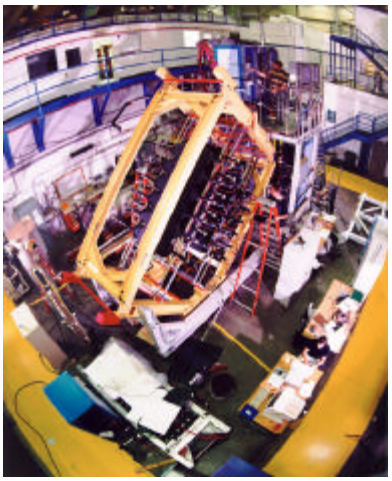
Collaborators

Brookhaven National Laboratory, USA; Center for Nuclear Study, University of Tokyo, Japan; RIKEN, Japan

URL

http://www.rhic.bnl.gov/
http://phenix.cns.s.u-tokyo.ac.jp



Large-Scale Remote Data Collection

A series of experiments are being carried out the Jefferson Lab using a high-intensity, high-duty-factor electron beam, to better understand the structure of the atomic nucleus. The idea is to bombard a target with the electron beam, and then detect the subatomic particles, called events, produced in the collision. For each event, the signals in the particle detectors are digitized and recorded. On average, the information from a single event totals about 2 KB, stored as a stream of binary data.

The current capabilities of Jefferson Lab allow University of Regina physicists to produce several hundred events each second, corresponding to a data rate of up to 1 Mbps. Experiments run 24 hours a day, and can last as long as two months. This results in a total dataset of several TeraBytes for an entire experiment. This data is initially stored on a massive robotic arm magnetic tape silo at Jefferson Lab before being transferred to the University of Regina for analysis. Several methods for data transfer are used, including: 4mm Exabyte, 8mm DLT tapes and FTP file transfer. The latter method has proven very successful recently, given the increased bandwidth at the university.

Contacts

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Collaborators

Thomas Jefferson National Accelerator Facility, USA; University of Regina, Canada

US participants interact with Dr. Evgenii Velikhov, President of the Moscow Kurchatov Institute, and other Russian academicians during the February 22 video conference between Moscow, Washington, Knoxville and Oak Ridge. In addition to the video conferencing, a demonstration was conducted of application sharing for joint control of a radio propagation analysis.

US-Russia Material, Protection, Control & Accountability Program

The objective of the lab-to-lab MPC&A Program is to enhance, through US-Russian technical cooperation, the effectiveness of nuclear materials protection, control, and accounting in Russian nuclear facilities. Russian institutes, through laboratory-to-laboratory contracts, implement the enhancements.

The two partnering institutions, the Oak Ridge National Laboratory and the Kurchatov Institute in Moscow, have used MIRnet since February, 2000 to support a variety of applications—including video-conferencing (demonstrations, seminars, contract negotiation), large database (200+ Mbytes) transfer, radio propagation analysis and application sharing.

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Collaborators

Oak Ridge National Laboratory, USA; Kurchatov Institute, Russia

Academician Ponimarev-Stepnoi (seated, on screen from Moscow) of the Kurchatov Institute addresses the June 13, 2000 video conference involving participants from Moscow, Washington, Argonne National Lab in Chicago and Oak Ridge. Included was Howard Baker, former US Senate Majority leader, heading up a Blue Ribbon Panel observing US-Russian programs.

Weapons Disposal: Reactor Physics/Thermal Hydraulics Analyses for Plutonium Disposition

The US and the Russian Federation are engaged in a cooperative program to dispose of weapons usable plutonium in pressurized water reactors in both countries. While plutonium fuels have been routinely used in pressurized water reactors (PWRs) in France and Germany, such fuels have not been used in Russian reactors (VVERs). For the past four years, Oak Ridge National Laboratory (ORNL) has been responsible for transferring technology for mixed oxide (MOX) fuel to Russia, and the Kurchatov Institute has been responsible for educating ORNL staff as to the design and operation of VVERs.

MIRnet has supported this cooperative program through video conferencing, ftp, use of the Centra Symposium web-based teaching package, whiteboard, and applications sharing.

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Collaborators

Oak Ridge National Laboratory, USA; Kurchatov Institute, Russia

Nonproliferation and Arms Control Projects in the Former Soviet Union

Since February 2000, MIRnet has been used by the Oak Ridge National Laboratory (ORNL) to support its various collaborations with the Kurchatov Institute and other Russian research laboratories. In June 2000, peering arrangements were put in place enabling all DOE laboratories in the US to use MIRnet.

The primary applications discussed and observed related to US-RF programs are in nonproliferation and arms control. Several video conferencing demonstrations have been held, some attended by senior US government leaders, to showcase the utility of high performance networks in supporting existing US-RF collaborative efforts. All of these demonstrations have been coordinated with Oak Ridge National Laboratory and the Kurchatov Institute.

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Evgenii P. Velikhov
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Collaborators

Oak Ridge National Laboratory, USA; Argonne National Laboratory, USA; Kurchatov Institute, Russia

Experimental High Energy Physics

High-energy physicists in the Skobeltsyn Institute of Nuclear Physics at Moscow State University use MIRnet to collaborate with US partners at the Fermi National Accelerator Laboratory (FNAL) and the Stanford Linear Accelerator Center (SLAC). Data is shared and analyzed from experiments performed in the particle accelerators for the purpose of obtaining insight into macroworld structures.

Contact

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P.F. Ermolov
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Nikolai Sinev
SLAC
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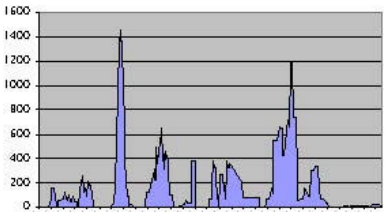
Vicky White
FNAL
white@fnal.gov

Collaborators

Fermilab, USA; Stanford Linear Accelerator Center, USA; Moscow State University, Russia



MIRnet traffic between Iowa State University and Moscow State University often exceeds 500 megabytes daily. The graph above shows total traffic transitting MIRnet between the two institutions since September, 1999.

Moscow State/Iowa State University Cooperation in Nuclear and High-Energy Physics

The project is in support of cooperation between three units of Moscow State University—the Institute of Nuclear Physics, the Department of Theoretical High Energy Physics, and the Department of Physics of Atomic Nucleus—and the International Institute of Theoretical and Applied Physics at Iowa State University.

Contact

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Institute of Nuclear Physics
Moscow State University
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Collaborators

Iowa State University, USA; Moscow State University, Russia

US-Russia Collaboration in Plasma Astrophysics

The US-Russia collaborative group is multi-disciplinary, involving specialists in numerical magnetohydrodynamics, plasma physics and astrophysics. Russian scientists work at Cornell University for one-month intervals, and the US scientists visit Russia on a regular basis.

The Principal Investigators plan to treat a number of astrophysical problems based partly on advanced 2D computer codes created at the M.V. Keldysh Institute of Applied Mathematics at Moscow State University, and on codes developed at Cornell University.

Contact

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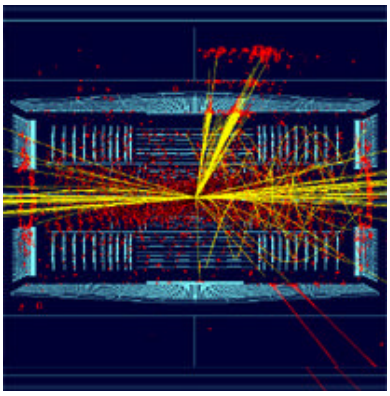
Collaborators

Cornell University, USA; Moscow State University, Russia



Distributed Particle Physics Research

iGrid 2000 and ongoing

This application demonstrates remote viewing and analysis of particle physics events. The application is the front end to an engineered object-oriented global system that incorporates Grid middleware for authentication and resource discovery, a distributed object database containing several terabytes of simulated events, and a component that enables queries issued by the front-end application to be matched to available computing resources in the system (the matchmaking service).

Contact

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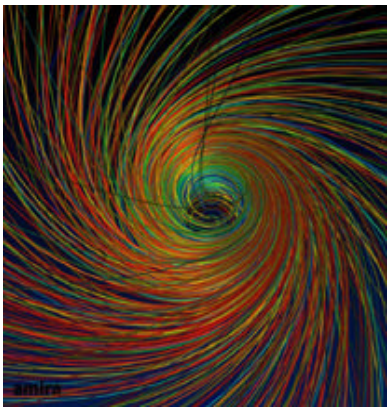
Collaborators

California Institute of Technology, USA; CERN, Switzerland

URL

http://pcbunn.cacr.caltech.edu
http://cmsdoc.cern.ch/orca/
http://iguana.web.cern.ch/iguana/
http://vrvs.cern.ch



Online Monitoring and Steering of Remote Black Hole Simulations

iGrid 2000 and ongoing

This project demonstrates several remote monitoring, steering, and visualization tools for Remote Black Hole Simulations and Remote Visualization of Large-Scale Datasets.

Contact

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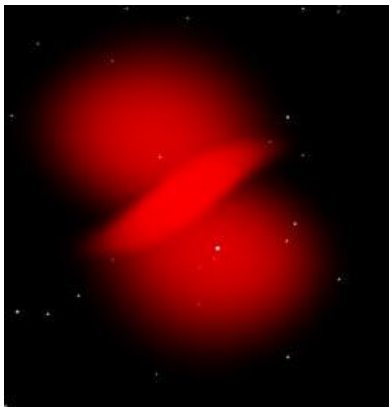
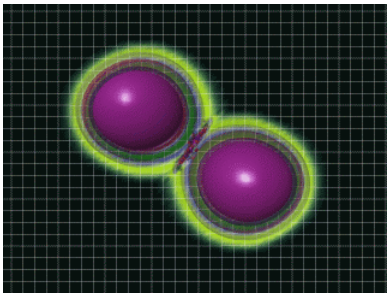
Collaborators

Max-Planck-Institut-für-Gravitationsphysik, Albert-Einstein-Institut, Germany; Konrad-Zuse- Zentrum für Informationstechnik, Germany

URL

http://www.zib.de/visual/igrid/
http://www.cactuscode.org
http://amira.zib.de





Metacomputing the Einstein Theory of Space Time: Colliding Black Holes and Neutron Stars Across the Atlantic Ocean

iGrid 1998

This simulation of the complete set of 3D Einstein equations of general relativity, performed using a new parallel computer code called "Cactus," enables astrophysicists to study colliding black holes, neutron stars, the formation of singularities, and other aspects of Einstein's theory that cannot be handled by analytic means.

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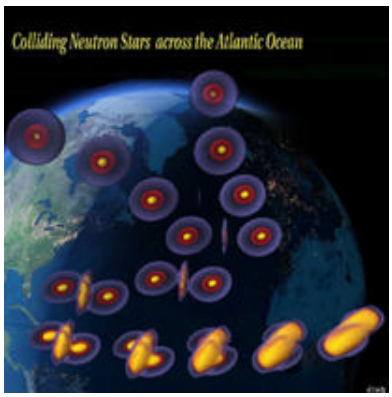
eseidel@aei-potsdam.mpg.de

Collaborators

NCSA, University of Illinois at Urbana-Champaign, USA; Argonne National Laboratory, USA; Washington University, USA; Max-Planck-Institut-für-Gravitationsphysik, Albert-Einstein-Institut, Germany

URL

http://jean-luc.ncsa.uiuc.edu/SC98



Black-Hole Interactions and Gravitational Waves

Alliance '98

Researchers at the Max-Planck-Institut für Gravitationsphysik and Rechenzentrum Garching der Max-Planck-Gesellschaft are collaborating with scientists at the National Center for Supercomputing Applications and Argonne National Laboratory to solve the 3D Einstein equations to simulate interactions between black holes and gravitational waves in support of design and interpretation of detection experiments. Gravitational wave iso-surfaces can be selected and displayed near to real-time with the ImmersaDesk equipment.

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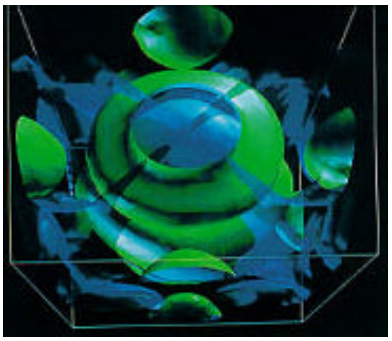
Collaborators

NCSA, University of Illinois at Urbana-Champaign, USA; Argonne National Laboratory, USA; Max-Planck-Institut-für-Gravitationsphysik, Albert-Einstein-Institut, Germany



Inter-Continental Online Visualization and Control of T3E Simulations of Black-Hole-Interactions and Gravitational Waves

Supercomputing 97

Researchers at the Max-Planck-Institut für Gravitationsphysik and Rechenzentrum Garching der Max-Planck-Gesellschaft are collaborating with scientists at the National Center for Supercomputing Applications and Argonne National Laboratory to solve the 3D Einstein equations to simulate interactions between black holes and gravitational waves in support of design and interpretation of detection experiments. Gravitational wave iso-surfaces can be selected and displayed near-to-real-time with the ImmersaDesk equipment.

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URL

http://www.rzg.mpg.de/rzg/batch/Crays/t3e/projects.old/sc97/sc97.html

G. Appendix: International Events

Enclosed are reprints of brochures from several international events hosted by the University of Illinois at Chicago and Indiana University in support of global research community networking.

G.1. iGrid 2000

G.2. iGrid 1998

H. Appendix: USA Institution International Network Usage

USA Research Institution International Network Usage													
Page No.	USA Institution	N/S Amer		Europe and Russia						Asia			
		CA*net3	REUNA	CERN	IUCC	NORDUnet	RENATER2	SURFnet	MIRnet	APAN	CERNET	SingAREN	TANet2
108	Apache Point Observatory									•			
7	Argonne National Laboratory [1]									•			
24	Argonne National Laboratory									•			
25	Argonne National Laboratory							•		•			
27	Argonne National Laboratory				•								
36	Argonne National Laboratory									•		•	
37	Argonne National Laboratory	•		•				•		•		•	
62	Argonne National Laboratory							•					
83	Argonne National Laboratory	•											
115	Argonne National Laboratory			•									
129	Argonne National Laboratory								•				
135	Argonne National Laboratory [2]												
136	Argonne National Laboratory [2]												
137	Argonne National Laboratory [2]												
5	Arizona State University								•				
25	Army Research Laboratory							•		•			
25	Boston University							•		•			
11	Brookhaven National Laboratory			•									
23	Brookhaven National Laboratory								•				
120	Brookhaven National Laboratory			•			•			•			
125	Brookhaven National Laboratory									•			
9	Caltech			•									
10	Caltech			•									
12	Caltech			•									
97	Caltech						•						
115	Caltech			•									
133	Caltech			•									
1	Cornell University				•								
2	Cornell University				•								
45	Cornell University					•							
58	Cornell University	•					•						
97	Cornell University						•						
115	Cornell University			•									
120	Cornell University			•			•			•			
132	Cornell University								•				
11	Fermi National Accelerator Laboratory			•									

1 Japan-based conference demonstrations using APAN

2 US-based conference demonstrations using temporary connections

		CA*net3	REUNA	CERN	IUCC	NORDUnet	RENATER2	SURFnet	MIRnet	APAN	CERNET	SingAREN	TANet2
106	Fermi National Accelerator Laboratory									●			
108	Fermi National Accelerator Laboratory									●			
115	Fermi National Accelerator Laboratory			●									
120	Fermi National Accelerator Laboratory			●			●			●			
130	Fermi National Accelerator Laboratory								●				
98	Georgia State University						●						
115	Harvard University			●									
98	Harvard-Smithsonian Center for Astrophysics						●						
104	Harvard-Smithsonian Center for Astrophysics						●						
105	Harvard-Smithsonian Center for Astrophysics						●						
6	Indiana University									●		●	
20	Indiana University									●			
25	Indiana University							●		●			
28	Indiana University							●					
31	Indiana University									●			
47	Indiana University	●		●									
54	Indiana University [2]												
78	Indiana University											●	
79	Indiana University											●	
83	Indiana University	●											
113	Indiana University [2]												
24	Indiana U-Purdue U Indianapolis									●		●	
67	Indiana U-Purdue U Indianapolis [2]												
72	Indiana U-Purdue U Indianapolis [2]												
106	Institute for Advanced Study									●			
131	Iowa State University								●				
99	Johns Hopkins University						●						
100	Johns Hopkins University	●					●						
103	Johns Hopkins University						●	●					
106	Johns Hopkins University									●			
108	Johns Hopkins University									●			
35	Lawrence Berkeley National Laboratory									●			
37	Lawrence Berkeley National Laboratory	●		●				●		●		●	
65	Lawrence Berkeley National Laboratory [1]									●			
68	Lawrence Berkeley National Laboratory [2]												
102	Lawrence Berkeley National Laboratory			●			●	●		●			
115	Lawrence Berkeley National Laboratory			●									
119	Lawrence Berkeley National Laboratory						●						
120	Lawrence Berkeley National Laboratory			●			●			●			
121	Lawrence Berkeley National Laboratory						●						
55	Lawrence Technological University [2]												
98	Limber Observatory						●						
83	Los Alamos National Laboratory	●											

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2 US-based conference demonstrations using temporary connections

		CA*net3	REUNA	CERN	IUCC	NORDUnet	RENATER2	SURFnet	MIRnet	APAN	CERNET	SingAREN	TANet2
104	LPL-WEST						•						
58	Massachusetts Institute of Technology	•					•						
92	Massachusetts Institute of Technology					•							
115	Massachusetts Institute of Technology			•									
124	Massachusetts Institute of Technology									•			
19	Michigan State University									•			
102	Montana State University			•			•	•		•			
14	NASA									•			
41	NASA								•				
85	NASA				•								
86	NASA						•						
94	NASA					•	•	•					
96	NASA						•						
97	NASA						•						
98	NASA						•						
100	NASA	•					•						
101	NASA (Galileo)						•						
101	NASA (Galileo NIMS)						•						
102	NASA			•			•	•		•			
90	National Center for Atmospheric Research (NCAR)						•						
102	National Oceanic and Atmospheric Administration			•			•	•		•			
106	National Radio Astronomy Organization						•						
38	New York University	•											
104	New York University						•						
34	National Laboratory for Applied Network Research (NLANR)									•			
35	National Laboratory for Applied Network Research (NLANR)									•			
39	National Laboratory for Applied Network Research (NLANR)								•				
71	North Carolina School of Science and Mathematics				•								
42	North Carolina State University								•				
93	North Carolina State University						•						
24	Northwestern University									•			
28	Northwestern University							•					
33	Northwestern University	•		•		•		•		•		•	
37	Oak Ridge National Laboratory	•		•				•		•		•	
127	Oak Ridge National Laboratory								•				
128	Oak Ridge National Laboratory								•				
129	Oak Ridge National Laboratory								•				

1 Japan-based conference demonstrations using APAN

2 US-based conference demonstrations using temporary connections

		CA*net3	REUNA	CERN	IUCC	NORDUnet	RENATER2	SURFnet	MIRnet	APAN	CERNET	SingAREN	TANet2
29	Ohio State University					•		•					
103	Ohio State University						•	•					
122	Ohio State University						•						
24	Old Dominion University									•			
25	Old Dominion University							•		•			
3	Penn State University				•								
42	Penn State University								•				
16	Pittsburgh Supercomputing Center [2]												
17	Pittsburgh Supercomputing Center [2]												
46	Princeton University					•							
106	Princeton University									•			
115	Princeton University			•									
123	Princeton University									•			
21	Rockefeller University	•											
18	Rutgers University									•			
119	Rutgers University						•						
121	Rutgers University						•						
15	Sandia National Laboratories									•			
16	Sandia National Laboratories [2]												
17	Sandia National Laboratories [2]												
37	Stanford Linear Accelerator Center	•		•				•		•		•	
119	Stanford Linear Accelerator Center			•			•						
120	Stanford Linear Accelerator Center						•			•			
121	Stanford Linear Accelerator Center						•						
130	Stanford Linear Accelerator Center								•				
1	Stanford University				•								
4	Stanford University											•	
58	Stanford University	•					•						
75	Stanford University					•							
126	Thomas Jefferson National Accelerator Facility	•											
11	Tufts University			•									
98	University of Alabama						•						
102	University of Alabama			•			•	•		•			
89	University of Alaska Fairbanks									•			
96	University of Arizona						•						
97	University of Arizona						•						
103	University of Arizona						•	•					
95	University of Berkeley Space Science Laboratory						•						
102	University of Berkeley Space Science Laboratory			•			•	•		•			
99	University of California at Berkeley						•						

1 Japan-based conference demonstrations using APAN

2 US-based conference demonstrations using temporary connections

		CA*net3	REUNA	CERN	IUCC	NORDUnet	RENATER2	SURFnet	MIRnet	APAN	CERNET	SingAREN	TANet2
100	University of California at Berkeley	•					•						
103	University of California at Berkeley						•	•					
119	University of California at Berkeley			•			•						
121	University of California at Berkeley						•						
35	University of California, San Diego/ San Diego Supercomputer Center (SDSC)									•			
36	University of California, San Diego/ San Diego Supercomputer Center (SDSC)									•		•	
37	University of California, San Diego/ San Diego Supercomputer Center (SDSC)	•		•				•		•		•	
45	University of California, San Diego/ San Diego Supercomputer Center (SDSC)					•							
91	University of California, San Diego/ San Diego Supercomputer Center (SDSC)						•						
119	University of California, Santa Barbara						•						
121	University of California, Santa Barbara						•						
99	University of Chicago						•						
104	University of Chicago						•						
106	University of Chicago									•			
119	University of Cincinnati						•						
121	University of Cincinnati						•						
98	University of Colorado						•						
100	University of Colorado	•					•						
110	University of Georgia, Athens				•								
8	University of Hawaii									•			
97	University of Hawaii						•						
103	University of Hawaii						•	•					
107	University of Hawaii	•					•						
123	University of Hawaii									•			
51	University of Houston					•							
57	University of Houston					•							
82	University of Houston					•							
22	University of Illinois at Chicago							•		•			
24	University of Illinois at Chicago									•		•	
25	University of Illinois at Chicago							•		•			
32	University of Illinois at Chicago									•			
53	University of Illinois at Chicago [2]												
60	University of Illinois at Chicago							•					
61	University of Illinois at Chicago							•					
64	University of Illinois at Chicago [1]									•			
65	University of Illinois at Chicago [1]									•			
70	University of Illinois at Chicago [1]									•			
82	University of Illinois at Chicago					•							

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2 US-based conference demonstrations using temporary connections

		CA*net3	REUNA	CERN	IUCC	NORDUnet	RENATER2	SURFnet	MIRnet	APAN	CERNET	SingAREN	TANet2
25	University of Illinois, Urbana-Champaign/ NCSA							•		•			
57	University of Illinois, Urbana-Champaign/ NCSA					•							
59	University of Illinois, Urbana-Champaign/ NCSA						•						
62	University of Illinois, Urbana-Champaign/ NCSA							•					
63	University of Illinois, Urbana-Champaign/ NCSA [1]									•			
81	University of Illinois, Urbana-Champaign/ NCSA [2]												
82	University of Illinois, Urbana-Champaign/ NCSA					•							
104	University of Illinois, Urbana-Champaign/ NCSA						•						
135	University of Illinois, Urbana-Champaign/ NCSA [2]												
136	University of Illinois, Urbana-Champaign/ NCSA [2]												
137	University of Illinois, Urbana-Champaign/ NCSA [2]												
94	University of Iowa					•	•	•					
95	University of Iowa						•						
101	University of Iowa						•						
99	University of Louisville						•						
86	University of Miami						•						
55	University of Michigan [2]												
109	University of Michigan								•				
84	University of Minnesota												•
94	University of Minnesota					•	•	•					
104	University of Minnesota						•						
40	University of Missouri-Columbia								•				
112	University of Pennsylvania					•							
36	University of Southern California									•		•	
13	University of Tennessee						•						
103	University of Texas at Austin						•	•					
57	University of Utah					•							
82	University of Utah					•							
77	University of Virginia								•				
106	University of Washington									•			
37	University of Wisconsin-Madison	•		•				•		•		•	
74	University of Wisconsin-Madison									•			
111	University of Wisconsin-Madison				•								

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2 US-based conference demonstrations using temporary connections

		CA*net3	REUNA	CERN	IUCC	NORDUnet	RENATER2	SURFnet	MIRnet	APAN	CERNET	SingAREN	TANet2
96	US Geological Survey						•						
97	US Geological Survey						•						
106	US Naval Observatory									•			
103	Vassar College						•	•					
24	Virginia Tech									•		•	
135	Washington University [2]												
26	World Health Organization			•									

1 Japan-based conference demonstrations using APAN
2 US-based conference demonstrations using temporary connections