iGrid 2002

THE INTERNATIONAL VIRTUAL LABORATORY

www.igrid2002.org

Amsterdam Science & Technology Centre (WTCW)
Amsterdam, The Netherlands

23-26 September 2002

Focusing on e-Science, LambdaGrid and Virtual Laboratory Applications

iGrid 2002, the 3rd biennial International Grid applications-driven testbed event, challenges scientists and technologists to utilize multi-gigabit experimental optical networks, with special emphasis on e-Science, LambdaGrid and Virtual Laboratory applications. The result is an impressive, coordinated effort by 28 teams representing 16 countries, showcasing how extreme networks, combined with application advancements and middleware innovations, can advance scientific research.

As computational scientists strive to better understand very complex systems – whether biological, environmental, atmospheric, geological or physics, from the micro to the macro level, in both time and space – they will require petascale computing, exabyte storage and terabit networks. A petaflop is one-hundred-times faster than today's largest parallel computers, which process ten-trillion floating-point operations per second (10 teraflops). An exabyte is a billion gigabytes of storage, and terabit networks will eventually transmit data at one trillion bits per second – some 20 million times faster than a dialup 56K Internet connection.

Recent, major technological and cost breakthroughs in networking technology have made it possible to send scores of *lambdas* on a pair of customer-owned or leased optical fiber, making the terabit network of the future conceivable. (Here, *lambda* refers to a fully dedicated wavelength of light, each capable of bandwidth speeds from 1-10 gigabits/second.) Research is moving from locally-connected, processor-centric environments to distributed-computing environments that rely on optical connections, where the networks are faster than the resources they connect. Researchers are moving from *grid-intensive computing* to *LambdaGrid-intensive computing,* in which computational resources are connected by multiple lambdas.

As a conference, iGrid 2002 demonstrates application demands for increased bandwidth. As a testbed, iGrid 2002 enables the world's research community to work together briefly and intensely to advance the state of the art – by developing new network-control and traffic-engineering techniques; new middleware to bandwidth-match distributed resources; and, new collaboration and visualization tools for real-time interaction with high-definition imagery. Much of the iGrid 2002 infrastructure will persist and be available for long-term experimentation.

LambdaGrid-intensive computing will become the main enabling technology for facilitating multi-institutional and multi-disciplinary advanced collaborations, enabling researchers to share unique resources and to have uniform and ubiquitous access to these facilities. In turn, this will enable the development of *Virtual Laboratories,* or science portals, for distributed analysis in applied scientific research. Groups worldwide are collaborating on major research projects, creating experimental platforms upon which future e-Science and large-scale distributed-computing experiments can take place. iGrid 2002 is a window into this world.

Application Demonstrations

APBioGrid (AU, JA, SI)
ATLAS LightPath Transfer (CA, CE, NL)
Bandwidth Challenge from Low-Lands (CA, CE, FR, IT, JA, NL, UK, US)
Bandwidth Gluttony: Physics (CE, US)
Beat Box (US)
Collaborative Access Grid (US)
D0 Data Analysis (NL, US)
Distributed Analysis (GE, JA, TA, UK, US)
Dynamic Load Balancing SAMR (UK, US)
Fine Grained Authorization for GARA (CE, US)
GENIUS (CE, IT)
Global Telescience with IPv6 (JA, TA, US)
Griz (NL, US)
High Performance Data Webs (CA, NL, SW, UK, US)
HDTV Over IP (SP, US)
Image Feature Extraction (GE, TA)
Kites Flying In and Out of Space (CA, FR, JA, NL, SI, US)
Network Intensive Computing (GE, US)
PAAPAB (SW, US)
Photonic TeraStream (NL, US)
TACC Quantum Chemistry Grid (JA)
TeraScope (US)
TeraVision (US)
The Universe (UK, US)
Video IBPster (FR, GE, IT, US)
Virtual Laboratory on National Scale (NL)
Visiting Ancient Olympia (GR, US)
vlbiGrid (FI, NL, UK, US)

Participating countries/locations: Australia (AU); Canada (CA); CERN/Switzerland (CE); France (FR); Finland (FI); Germany (GE); Greece (GR); Italy (IT); Japan (JA); Netherlands (NL); Singapore (SI); Spain (SP); Sweden (SW); Taiwan (TA); United Kingdom (UK); United States of America (US).

Of course, during the week of iGrid, NL is an active participant in all these demonstrations!

NetherLight

NetherLight, located at the Amsterdam Internet Exchange facility on the campus of the Amsterdam Science & Technology Centre, is an advanced optical infrastructure and proving ground for network services optimized for high-performance applications. Operational since summer 2001, NetherLight is a multiple Gigabit Ethernet (GigE) switching facility for high-performance access to participating networks and will ultimately become a pure lambda switching facility for wavelength circuits, as optical technologies and their control planes mature. NetherLight's international connectivity includes dedicated lambdas to the StarLight facility in Chicago and to CERN in Switzerland. On a national scale, SURFnet connects ASTRON/ JIVE in the region of Dwingeloo in northern Holland (ASTRON is the Netherlands' Foundation for research in astronomy and JIVE is the Joint Institute for VLBI [Very Long Baseline Interferometry] in Europe) to NetherLight by means of a 32-wavelength Dense Wave Division Multiplexing (DWDM) transport network.

Researchers use the NetherLight facility to investigate novel concepts of optical bandwidth provisioning and to gain experience with these techniques. In particular, researchers are investigating different scenarios on how lambdas can be used to provide tailored network performance for demanding grid applications. Important issues are: how to get traffic onto and out of lambdas; how to map load on the network to a map of lambdas; how to deal with lambdas at peering points; how to deal with provisioning when more administrative domains are involved; and, how to do fine-grain, near-real-time grid application-level lambda provisioning.

NetherLight has been realized by SURFnet, the Dutch Research Network organization, within the context of GigaPort, the Dutch Next Generation Internet project.

www.science.uva.nl/~delaat/optical
www.surfnet.nl

StarLight

StarLight, the optical STAR TAP initiative, is a persistent infrastructure that supports advanced applications and middleware research, and aggressive advanced networking services. StarLight is a multi-vendor 1Gbps, 2.5Gbps, and 10Gbps experimental switching facility, serving as a nodal point for the *other end,* or switching hub, for national and international experiments. StarLight will ultimately become an anchor for wavelength-rich LambdaGrids, with switching and routing at the highest experimental levels, laying the foundation for fully optical switching.

StarLight is a networking, database, visualization and computing research support facility planned by researchers for researchers. It is a middleware, protocol, and network measurement and monitoring research environment for applications, focusing on developing and testing methods for high-performance application provisioning on optical networks. It serves researchers using IP-over-lambda networks, addressing restoration issues, building LambdaGrids, optimizing DNS services, and testing novel protocols for long, very-high-bandwidth connections.

StarLight serves e-Science researchers who have spent the past 1.5 years helping design it. These include the technical leaders of USA research efforts, academic research and education networks, next-generation Federal networks, major state initiatives, Meta-PoPs, metro initiatives, and international research and education networks.

StarLight is being developed by the Electronic Visualization Laboratory at the University of Illinois at Chicago (UIC), the International Center for Advanced Internet Research at Northwestern University, and the Mathematics and Computer Science Division at Argonne National Laboratory (ANL), in partnership with Canada's CANARIE and Holland's SURFnet. STAR TAP and StarLight are made possible by major funding from the USA National Science Foundation to UIC (awards ANI-9980480 and ANI-9730202) and USA Dept. of Energy funding to ANL.

www.startap.net/starlight

iGrid 2002 Networking

iGrid 2002 Wide Area Network (WAN)

iGrid's enabling technology is a 2.5Gbps experimental network provided by SURFnet, the Dutch Research Network organization, which connects the NetherLight facility in Amsterdam to StarLight, a USA National Science Foundation-supported facility in Chicago. This very-high-speed transoceanic optical network between Europe and the USA is the first multi-gigabit link for use by the advanced scientific and engineering research community. Level 3 Communications, Inc., the wavelength service provider, graciously donated an additional, full 10Gbps transoceanic wavelength, from StarLight to NetherLight, for the benefit of iGrid 2002.

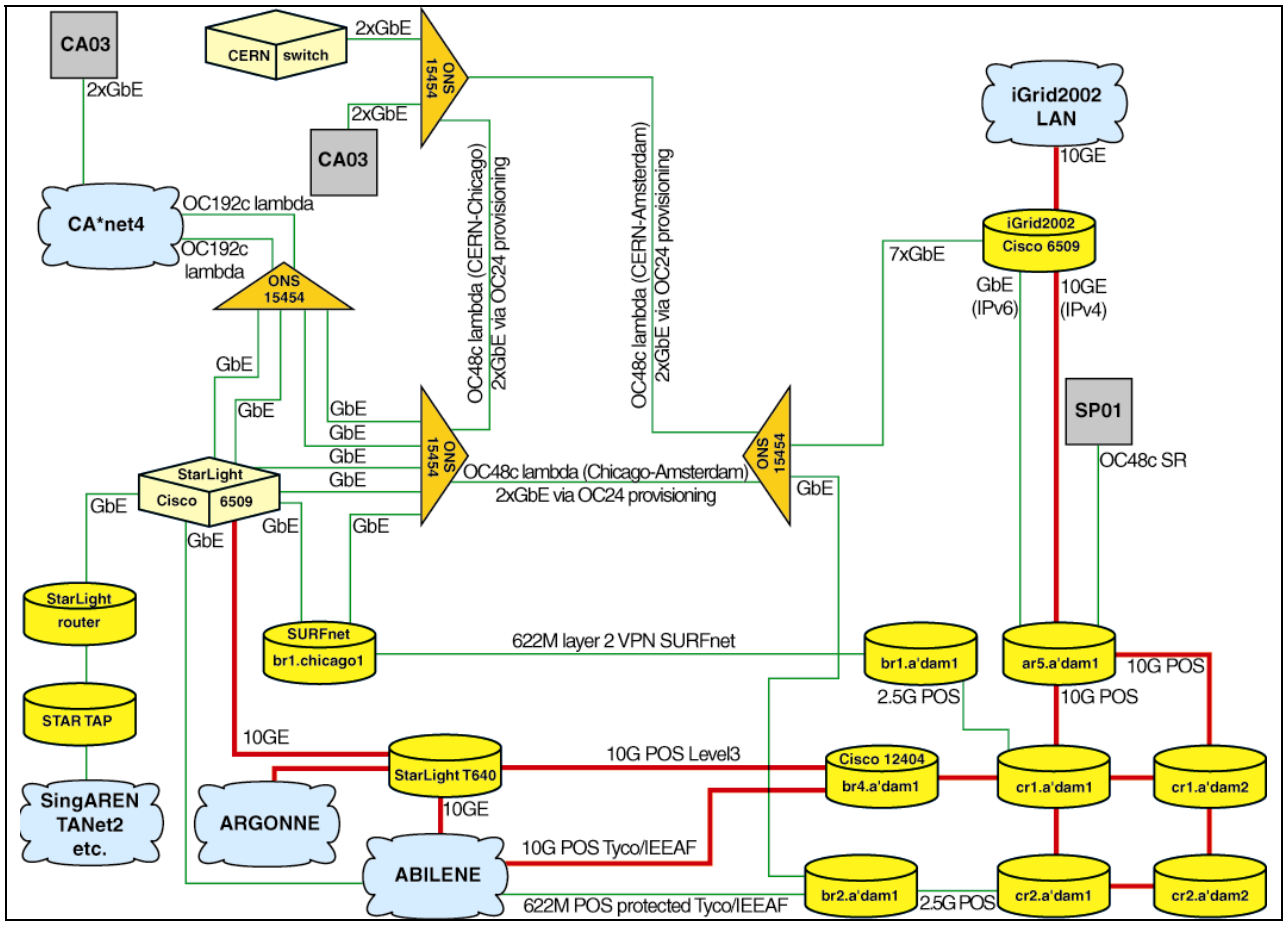
The USA's Internet2 Abilene 10Gbps network, the European Union's DataTAG 2.5Gbps network, and Canada's CA*net4 multi-gigabit network connect to StarLight, as do other networks from Europe, Asia and South America. In Europe, SURFnet provides a 2.5Gbps link from NetherLight to CERN. In the USA, Abilene's New York City Point of Presence (PoP) is connected to NetherLight via a 10Gbps wavelength provisioned by Tyco Telecom through the Internet Educational Equal Access Foundation (IEEAF).

iGrid 2002 Local Area Network (LAN)

The iGrid 2002 LAN is a dedicated network built with Cisco equipment. The LAN's central router is a Cisco 6509 router/switch that is connected to the SURFnet backbone via 10GigE for IPv4 and 1GigE for IPv6. The SURFnet backbone router, a Cisco 12416, uses the new Ashara 10GigE linecard.

A second Cisco 6509 is installed in the conference's main demo room for switching purposes. It is connected to the central router at 10GigE as well. To provide connectivity to the smaller conference rooms, switching equipment (a Cisco 4006 and Cisco 3524) is used, interconnected at GigE. The conference also supports wireless local-area networking (WLAN).

iGrid 2002 Wide Area Network



The Netherlands' National Backbone

The SURFnet5 network, built in the context of the GigaPort Project, consists of a core at two distant locations in Amsterdam, each equipped with two fully resilient Cisco 12416 routers. The core routers are interconnected via multiple 10GigE Packet Over SONET (POS) links. The 15 SURFnet PoPs are resilient; they are connected to each of these two core locations at 2 x 10GigE POS. The iGrid 2002 LAN is connected to SURFnet's Amsterdam PoP at SARA, which delivers a total capacity of 20GigE to the SURFnet core.

The Netherlands' Global Connectivity

For iGrid 2002, SURFnet's connectivity to other National Research and Education Networks (NRENs) totals 30Gbps!

- 10Gbps lambda between Amsterdam and Chicago (Level 3), used to peer with StarLight and connected NRENs
- 10Gbps lambda between Amsterdam and New York (Tyco/IEEAF), used to peer with Abilene
- 2.5Gbps connectivity to Géant, used to peer with all European NRENs;
- 2.5Gbps lambda between Amsterdam and Chicago (SURFnet) connecting NetherLight with StarLight
- 2.5Gbps lambda between Amsterdam and CERN (SURFnet), connecting NetherLight with CERN
- 2.5Gbps lambda between CERN and Chicago (EU DataTAG), used to connect CERN and other European DataTAG members to StarLight.

StarLight Global Connectivity

The StarLight facility uses a Juniper M10 for National Research and Education Network (NREN) GigE connectivity, and uses a Juniper M5 for MREN (the Midwest MetaPoP) traffic. StarLight also has an OC-12 connection to the Ameritech Advanced Data Services (AADS) facility in Chicago, where a Cisco 7505 STAR TAP router is maintained for NREN ATM traffic. A Cisco 6509 serves as an additional MREN router as well as the StarLight GigE Exchange Point switch.

For iGrid 2002, Caltech and Juniper Networks loaned StarLight a Juniper T640 with 10GigE interfaces. The T640 router is being used to terminate Level 3's temporary OC-192 link, Abilene's 10GigE connection (upgraded from 2GigE for iGrid), and 10GigE links from the Midwest's two TeraGrid DTFnet sites, Argonne National Laboratory and the National Center for Supercomputing Applications at the University of Illinois at Urbana-Champaign.

Abilene

Abilene, developed by the University Corporation for Advanced Internet Development (UCAID), in partnership with Qwest Communications, Cisco Systems, Juniper Networks, Nortel Networks and Indiana University, is an Internet2 backbone network providing nationwide high-performance networking capabilities for over 215 USA universities and affiliated research laboratories in all 50 states, the District of Columbia and Puerto Rico. Abilene interconnects with more than 20 other high-performance research and education backbone networks in the USA and around the world.

Abilene's ongoing backbone upgrade to 10Gbps optical transport, its high-performance native IPv6 service, and a recently established 10Gbps connection between Abilene and StarLight in Chicago, are enabling those Abilene institutions participating in iGrid 2002 to leverage several newly established, high-performance transatlantic links. These links include a 10Gbps wavelength between Abilene's New York City PoP and NetherLight in Amsterdam provisioned by Tyco Telecom through the IEEAF, the permanent 2.5Gbps SURFnet connection between StarLight and NetherLight, and a temporary 10Gbps wavelength provisioned by Level 3 between StarLight and NetherLight.

Internet2 is an iGrid 2002 participating organization.

www.ucaid.org/abilene
www.internet2.edu

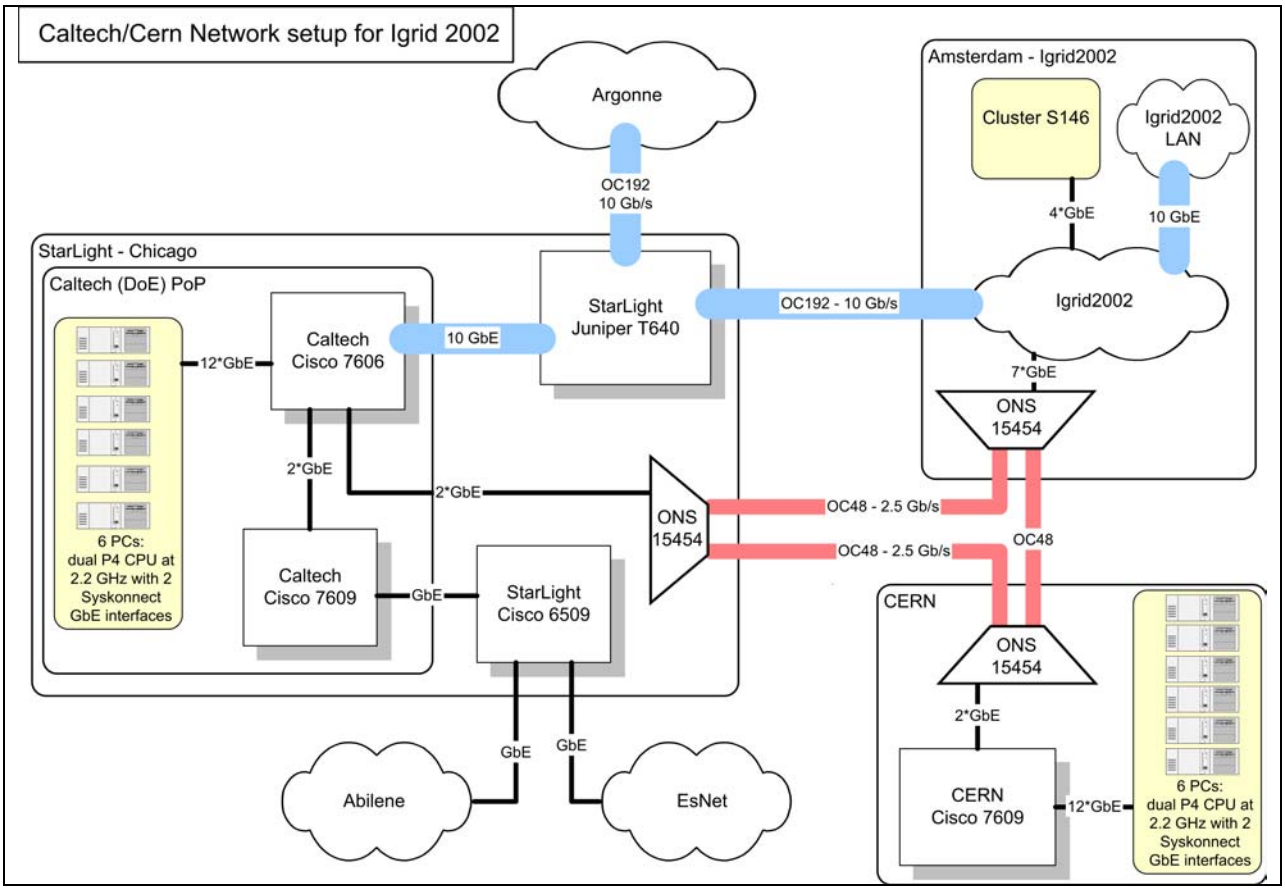
IEEAF

The Internet Educational Equal Access Foundation (IEEAF) is a non-profit organization whose mission is to obtain donations of telecommunications capacity and equipment and make them available for use by the global research and education community. IEEAF fosters global educational collaboration and equitable access to network resources – the *Global Quilt.*

IEEAF's member institutions: Corporation for Education Network Initiatives in California (CENIC, represented by California State Univ. at Hayward, California Polytechnic Univ. at San Luis Obispo, and Univ. of Southern California), Pacific Northwest GigaPoP (Univ. of Washington), Pacific Internet2 Coalition (Univ. of Hawaii), Univ. of Maryland, UCAID, Indiana Univ. and GEOgraphic Network Affiliates, Inc. (GEO)

www.ieeaf.org

Caltech/CERN iGrid Wide Area Network



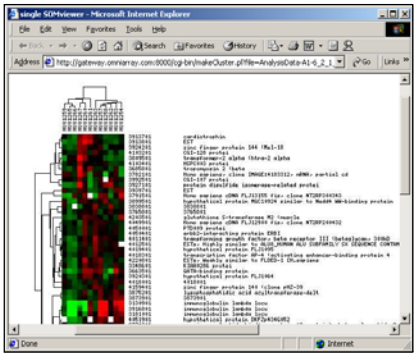
Equipment for the EU DataTAG 2.5Gbps circuit between StarLight (Chicago) and CERN (Geneva), including servers, switches and routers, is provided by Caltech (with USA Department of Energy funding) and StarLight/University of Illinois at Chicago (with USA National Science Foundation funding). Equipment in Europe is provided by the European Union in the framework of the EU DataTAG Project. To take advantage of the transatlantic OC-192 donation provided by Level 3, Cisco Systems loaned Caltech a 10GigE module and a 16-port GigE module.

Application Demonstrations

iGrid 2002 features applications from a number of disciplines: art, bioinformatics, chemistry, cosmology, cultural heritage, education, high-definition media streaming, medicine, neuroscience, physics and telescience. All these applications utilize underlying grid technologies, with major emphasis on grid middleware, data management grids, data replication grids, visualization grids, data/visualization grids, computational grids, access grids and grid portals. Additional technologies being demonstrated include distributed computing, visualization, tele-immersion, data mining, remote instrumentation control, collaboration, streaming media and human/computer interfaces. Participating researchers and resources are located worldwide: Australia, Canada, CERN/Switzerland, France, Finland, Germany, Greece, Italy, Japan, Netherlands, Singapore, Spain, Sweden, Taiwan, the United Kingdom and the USA.

SINGAPORE, AUSTRALIA, JAPAN

APBioGrid of APBioNet



URL

www.bic.nus.edu.sg
www.bic.nus.edu.sg/biogrid
www.apbionet.org
http://s-star.org/main.htm

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DESCRIPTION

Bioinformatics is the study of the information content and information flow in biological processes and systems. Understanding gene and protein sequence information helps find new medical drug leads. Using BIC's APBioGrid (the Asia Pacific Bioinformatics Grid, a collection of networked computational resources) and KOOP testbed technology, biologists can quickly build a complex series of computations and database management activities on top of computational grids to solve real-world problems.

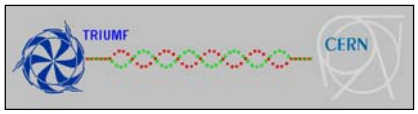
APBioGrid represents an integrated workflow that mimics tasks typical of a bioinformatician across various machines. APBioGrid does resource discovery over the network, remotely distributing tasks that perform data acquisition, data transfer, data processing, data upload to databases, data analysis, computational calculations and visualizations. It utilizes Cray SV1 supercomputers in Singapore, Japan and Australia. To demonstrate its ease of use, iGrid attendees can create their own workflows to retrieve, analyze and view bioinformatics data.

ACKNOWLEDGMENT

APAN; SingAREN.

CANADA, CERN AND THE NETHERLANDS

ATLAS Canada LightPath Data Transfer Trial



URL

www.triumf.ca

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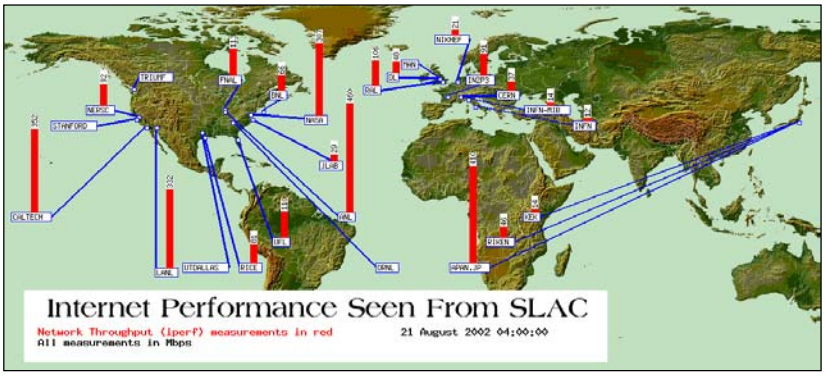
"We are entering into a brave new world of research opportunities in advanced computing and networking as bandwidth moves from a world of scarcity to a world of abundance. This bandwidth tsunami will let us think about networks from an entirely new perspective beyond the current 'telecommunication' paradigm. Those research programs that are focused on exploring these new concepts promise to make significant contributions to our body of knowledge in next-generation computing and collaboration."

– Bill St. Arnaud, Senior Director of Network Projects, CANARIE, October 2, 2001

THE NETHERLANDS, USA, CANADA, CERN, FRANCE, ITALY, JAPAN, UK

Bandwidth Challenge from the Low-Lands



DESCRIPTION

The Lightpath Trial is attempting to transmit 1 TeraByte (TB) of ATLAS data from TRIUMF, Canada's National Laboratory for Particle and Nuclear Physics, to CERN at high speed. ATLAS (A Toroidal LHC ApparatuS) is one of the experiments being constructed for the Large Hadron Collider (LHC) at CERN.

Using SURFnet's entire 2.5Gbps capacity between StarLight and NetherLight, as well as the planned 2.5Gbps links from Canada to StarLight, CERN to StarLight (EU DataTAG) and NetherLight to CERN, an end-to-end lightpath is being built between TRIUMF in Vancouver and CERN. The goal is to transfer a 1TB of Monte Carlo data between a cluster at TRIUMF and a cluster at CERN in under 2 hours.

ACKNOWLEDGMENT ■ □ ◆

CANARIE; BCnet; HEPnet Canada; Extreme Networks; Intel Corporation; EU DataGrid; EU DataTAG; The Globus Project.

URL

http://www-iepm.slac.stanford.edu/monitoring/bulk/igrid2002

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Olivier Martin, Sylvain Ravot, *CERN, Switzerland*
Robin Tasker, Paul Kummer, *Daresbury Laboratory, UK*
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Ruth Pordes, Frank Nagy, Phil DeMar, *Fermi National Accelerator Laboratory (Fermilab), USA*
Andy Germain, George Uhl, *NASA Goddard Space Flight Center, USA*
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DESCRIPTION

The avalanche of data already being generated by and for new and future High Energy and Nuclear Physics (HENP) experiments demands new strategies for how the data is collected, shared, analyzed and presented. For example, the SLAC BaBar experiment and JLab are each already collecting over a TB/day, and BaBar expects to increase by a factor of two in the coming year. SLAC and Fermilab's CDF (Collider Detector at Fermilab) and D0 experiments have already gathered well over a petabyte of data, and the CERN Large Hadron Collider (LHC) experiments expect to collect over 10-million terabytes. The strategies being adopted to analyze and store this unprecedented amount of data is the coordinated deployment of Grid technologies, such as those being developed for the Particle Physics Data Grid (PPDG) and the Grid Physics Network (GriPhyN). It is anticipated that these technologies will be deployed at hundreds of institutes that will be able to search out and analyze information from an interconnected worldwide grid of tens of thousands of computers and storage devices. This, in turn, will require the ability to sustain, over long periods, the transfer of large amounts of data among collaborating sites with relatively low latency.

This project demonstrates the current data-transfer capabilities to several sites worldwide that have high-performance links. The iGrid 2002 site acts as a HENP Tier 0 or Tier 1 site (an accelerator or major computation site) in distributing copies of raw data to multiple replica sites. The demonstration is over real live production networks with no efforts to manually limit other traffic. The results are displayed in real time. Researchers investigate/ demonstrate issues regarding TCP implementations for high-bandwidth long-latency links, and create a repository of trace files of a few interesting flows. These traces, valuable to projects like EU DataTAG, help explain the behavior of transport protocols over various production networks.

ACKNOWLEDGMENT

This demonstration uses SURFnet/ StarLight, Internet2, ESnet, JANET, GARR, Renater2, Japanese wide-area networks and the EU DataTAG link between CERN and StarLight. Work is sponsored by the USA Department of Energy (DoE) HENP program; USA DoE Mathematics and Information Computing Sciences (MICS) office; USA National Science Foundation; Particle Physics Data Grid; International Committee for Future Accelerators; and, the International Union of Pure and Applied Physics.

"The major High-Energy Physics (HEP) experiments of the next 20 years will break new ground in our understanding of the fundamental interactions, structures and symmetries that govern the nature of matter and space-time. Among the principal goals are to find the mechanism responsible for mass in the universe and the 'Higgs' particles associated with mass generation, as well as the fundamental mechanism that led to the predominance of matter over antimatter in the observable cosmos. The largest collaborations today, such as the Compact Muon Spectrometer (CMS) and A Toroidal LHC ApparatuS (ATLAS) experiments for CERN's Large Hadron Collider (LHC) program, each encompass 2000 physicists from 150 institutions in more than 30 countries. Each of these collaborations involves 300-400 physicists in the USA from more than 30 universities and major HEP laboratories. Realizing the scientific wealth of these experiments presents new problems in data access, processing and distribution, and collaboration across national and international networks, on a scale unprecedented in the history of science.

"Collaborations on this global scale would not have been attempted if the physicists could not plan on excellent networks – to interconnect the physics groups throughout the life cycle of the experiment, and to make possible the construction of Data Grids capable of accessing, processing and analyzing massive datasets. These datasets will increase in size from many petabytes by 2007 (1PB = 10^{15} Bytes) to exabytes (10^{18} Bytes) within the next decade. The current generation of operational experiments – BaBar at Stanford Linear Accelerator Center (SLAC), D0 and CDF at Fermi National Accelerator Laboratory, the Relativistic Heavy Ion Collider (RHIC) program at Brookhaven National Laboratory (BNL) – face similar challenges. BaBar in particular has already accumulated datasets approaching a petabyte.

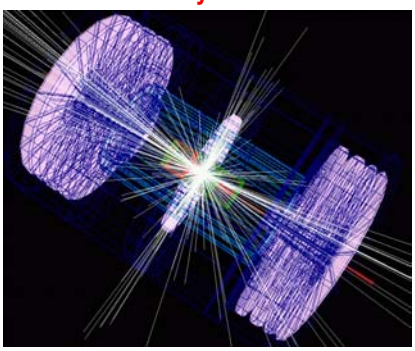
"Handling data on this scale requires the use of Gbps data flows on the major continental backbones and intercontinental links now, rising to multi-Gbps flows on OC-192 links within the next couple of years. By 2007, we expect to be putting multiple-10Gbps wavelengths to use on the major routes and in some regional networks, to support 'transactions' that take only minutes to extract and/or disseminate terabyte subsets drawn from multi-petabyte data stores.

"iGrid 2002, with its state-of-the-art links at OC-48 and OC-192 connecting the USA and European network infrastructures, provides a unique opportunity for many physics groups engaged in meeting these challenges to take major steps forward in their development of the necessary network and computing technologies."

– *Harvey Newman, California Institute of Technology (Caltech) researcher and CERN collaborator, September 2002, personal communication.*

USA AND CERN

Bandwidth Gluttony: Distributed Grid-Enabled Particle Physics Event Analysis



URL

http://pcbunn.cacr.caltech.edu/iGrid2002/demo.htm

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Jean-Philippe Martin-Flatin, *CERN, Switzerland*

DESCRIPTION

Requests for remote virtual data collections are issued by Grid-based software that is itself triggered from a customized version of the High-Energy Physics (HEP) analysis tool called ROOT. These requests cause the data to be moved across a wide-area network using both striped and standard GridFTP servers.

For iGrid, distributed databases located at ANL, StarLight, Caltech, CERN and other HEP institutions are used. As the collections are instantiated on the client machine in Amsterdam, ROOT analyzes the data, rendering the results in real time. The virtual data collections are catalogued using the Globus Replica Catalogue. This scheme is a preview of a general *Grid-Enabled Analysis Environment* that is being developed for CERN's Large Hadron Collider (LHC) experiments.

In a closely related part of the demonstration, an attempt is made to saturate a 10Gbps (OC-192) link between Amsterdam, ANL and StarLight and a 2.5Gbps (OC-48) link between Amsterdam and CERN, by using striped GridFTP channels and specially tuned TCP/IP stacks. In this test, memory-cached data, in contrast to the file-based ROOT part of the demonstration, is used.

ACKNOWLEDGMENT ■ □ ◆

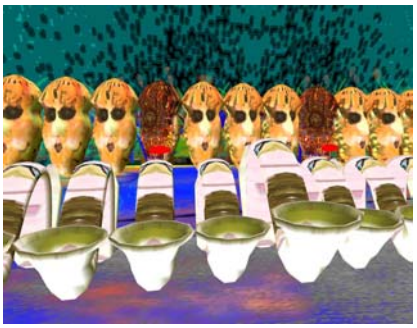
Caltech wishes to acknowledge the following awards: USA Department of Energy DE-FC03-99ER25410 (PPDG) and DE-FG03-92-ER40701 (Caltech/CMS), and USA National Science Foundation 8002-48195 (ALDAP) and PHY-0122557 (iVDGL).

ANL efforts are supported by the Mathematical, Information, and Computational Science Division subprogram of the Office of Advanced Scientific Computing Research, USA Department of Energy, under Contract W-31-109-Eng-38.

Also acknowledged are The Globus Project, GriPhyN, PPDG, iVDGL, EU DataGrid and EU DataTAG.

USA

Beat Box



URL

http://dolinsky.fa.indiana.edu/beatbox

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Dave Pape, *Res Umbrae, USA*

DESCRIPTION

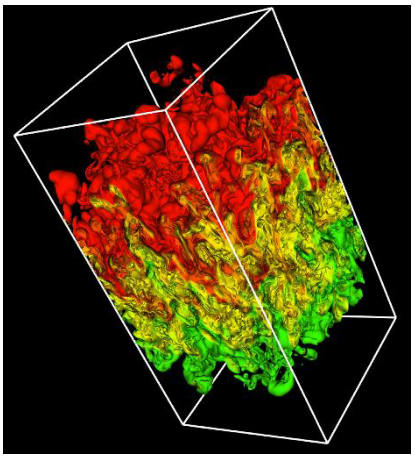
Beat Box presents networked CAVE participants with a playful environment of interactive virtual sound machines. Each machine acts as a sequencer and has a unique periodic duration. The machines control percussion sounds, ambient loops and bass sounds. Beat Box is virtual sonic chronometry as the environment develops visually and aurally by manipulating the sound machines. Participants cycle through sound selections and give voice to an interval by introducing it to a thoroughly odd indigenous head. Each head represents a distinct moment in a sequence that contributes to the resultant delivery of the collective instruments.

ACKNOWLEDGMENT ●

Indiana University/ Office of the Vice President for Information Technology, USA; University of Illinois at Chicago/ Electronic Visualization Laboratory, USA; University of Illinois at Champaign-Urbana/ National Center for Supercomputing Applications, USA; University of Buffalo/ New York State Center for Engineering Design and Industrial Innovation, New York, USA; USA National Science Foundation CDA-9601632; Ygdrasil (YG), a VR authoring system by Res Umbrae <http://resumbrae.com>; and, Quanta.

USA

Collaborative Visualization Over the Access Grid



URL

www.mcs.anl.gov/fl/events/igrid2002.html
www.accessgrid.org
www.globus.org/mpi
www.globus.org
www.teragrid.org

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DESCRIPTION

Using the Access Grid to collaborate with colleagues has gained widespread acceptance, with the collaborations commonly taking the form of shared audio, video and PowerPoint presentations. This demonstration shows next-generation Access Grid applications, where the Access Grid is coupled to high-speed networks and vast computational resources. Using the Globus Toolkit, MPICH-G2 and Access Grid technology, scientists can collaboratively and interactively analyze time-varying datasets that are multiple terabytes in size.

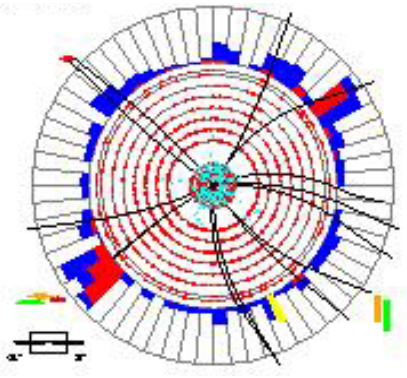
Users first collaborate over the Access Grid to explore low-resolution datasets in real time, in order to find areas of interest for detailed study. Then, using multiple distributed compute resources and a high-speed network, full-resolution high-quality images are produced and delivered to a tiled display. This demonstration shows how scientists can enhance their work environment by having easy access to worldwide resources.

ACKNOWLEDGMENT ◆

This work is supported in part by the Mathematical, Information, and Computational Sciences Division subprogram of the Office of Advanced Scientific Computing Research, USA Department of Energy, under Contract W-31-109-Eng-38, and in part by the USA National Science Foundation Middleware Initiative. Also acknowledged is the Globus Project.

THE NETHERLANDS AND USA

D0 Data Analysis



URL

www-d0.fnal.gov
www.nikhef.nl

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Raymond Brock, Reiner Hauser, *Michigan State University, USA*

DESCRIPTION

The D0 Experiment, which relies on the Tevatron Collider at Fermilab, is a worldwide collaboration of scientists conducting research on the fundamental nature of matter. The research focuses on precise studies of interactions of protons and antiprotons at the highest available energies as part of an intense search for subatomic clues that reveal the character of the building blocks of the universe.

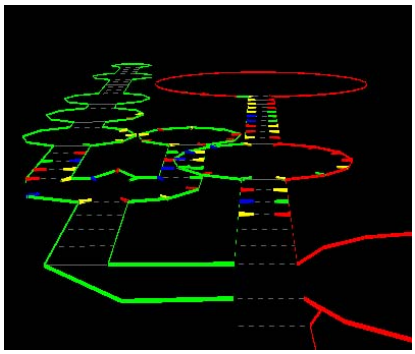
Currently, raw data from the D0 detector is processed at Fermilab's computer farm and results are written to tape. At iGrid, researchers show that by using the transoceanic StarLight/NetherLight network, it is possible for Fermilab to send raw data to NIKHEF for processing and then have NIKHEF send the results back to Fermilab.

ACKNOWLEDGMENT □

EU DataTAG; Amsterdam Virtual Laboratory.

USA, GERMANY, JAPAN, TAIWAN, UK

Distributed, On-Demand, Data-Intensive and Collaborative Simulation Analysis



URL

www.cs.sandia.gov/ilab
www.tbi.univie.ac.at/research/VirusPrj.html
www.hlrs.de

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John Brooke, *Manchester Computing Centre, UK*

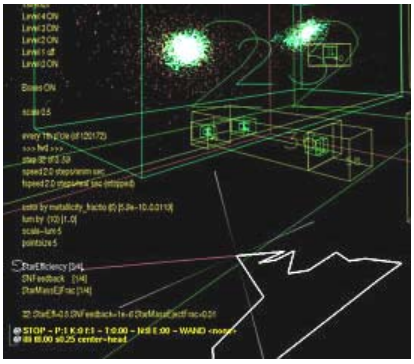
DESCRIPTION

This project focuses on grid-enabling tools for a variety of content areas. At iGrid, these tools are applied to bioinformatics, specifically predicting identifiable intron/exon splice sites in human genes based on RNA secondary structures.

The modeling and simulation program, RNAfold, previously limited to under 30K base pairs, now scales with the available computing resources. The thermodynamic calculations now use grid services, and run in parallel at geographically distributed supercomputer centers, allowing a tractable solution to very large DNA sequences, typically over 100K in the human genome. Results are visualized in a collaborative environment, displaying spatial relationships and insights into identifying exonic splicing enhancers.

USA AND UK

Dynamic Load Balancing of SAMR Applications on Distributed Systems



URL

www.ece.nwu.edu/~zlan/research.html

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DESCRIPTION

A typical Adaptive Mesh Refinement (AMR) application may require a large amount of computing power. For example, a simulation of the galaxy formation requires a few days to execute on a 128-node SGI Origin2000 machine and requires more than 100GB of memory. Distributed systems provide an economical alternative to traditional parallel systems; however, the adaptive structure of AMR applications results in load imbalance among processors on distributed systems. Dynamic load balancing is an essential technique to solve this problem.

ENZO is one of the successful parallel implementations of Structured Adaptive Mesh Refinement (SAMR) for use in astrophysics and cosmology. To sufficiently simulate the formation of galaxies, taking communication and latency issues into consideration, an estimated bandwidth of ~100Gbps would be required.

ACKNOWLEDGMENT ◆

The Globus Project; USA National Science Foundation; NASA; Alliance/National Center for Supercomputing Applications, University of Illinois at Urbana-Champaign, USA.

USA AND CERN

Fine Grained Authorization for GARA Automated Bandwidth Reservation

URL

www.citi.umich.edu/projects/qos

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DESCRIPTION

This demonstration shows modifications to the Globus Toolkit General-purpose Architecture for Reservation and Allocation (GARA). Specifically, it shows (1) a fine-grained cross-domain authorization for GARA that leverages existing security and group services and (2) the elimination of the need for long-term Public Key credentials, currently required by the system. Also shown is a secure and convenient Web interface for making reservation requests based on Kerberos credentials.

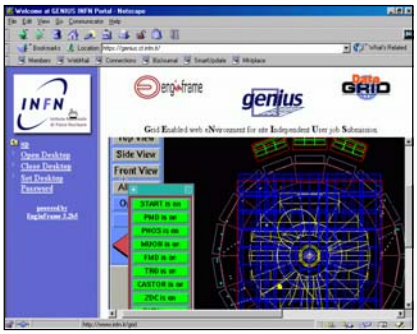
GARA modifications are demonstrated by reserving bandwidth for a videoconference application running between sites with distinct security domains. Traffic generators overload the router interface servicing the video receiver, degrading the video quality when bandwidth is not reserved. Successful reservation occurs only when the reservation parameters are within policy bounds, and when the requestor is a member of the required groups. At reservation start time, the end-domain Cisco ingress routers are configured with the appropriate Committed Access Rate (CAR) limit, which marks the packets and polices the flow. The participating routers are statically configured with Weighted Random Early Detection (WRED), Cisco's implementation of the Random Early Detection class of congestion avoidance algorithms. The router configurations are removed at reservation end.

ACKNOWLEDGMENT ■ □ ◆

University of Michigan Department of Physics; University of Michigan College of Literature, Science, and the Arts; University of Michigan Center for Information Technology Integration (CITI); University of Michigan Office of the Vice President for Research; Merit; University Corporation for Advanced Internet Development (UCAID); European Organization for Nuclear Research (CERN); Argonne National Laboratory; The Globus Project; EU DataGrid; EU DataTAG.

ITALY AND CERN

GENIUS



URL
https://genius.ct.infn.it

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DESCRIPTION

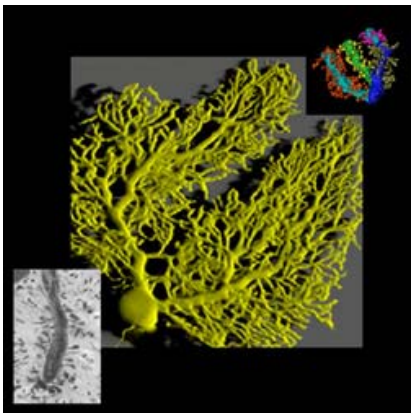
The grid portal GENIUS (Grid Enabled web eNvironment for site Independent User job Submission) is an interactive data management tool being developed on the EU DataGrid testbed. At iGrid 2002, researchers are demonstrating GENIUS's data movement and discovery, security mechanisms and system monitoring techniques, as well as optimization and fail-safe mechanisms — for example, how to find network optimized files and how to detect system failure.

ACKNOWLEDGMENT ■ ◆

GENIUS is a joint development project of INFN and NICE srl in the context of the EU DataGrid Project. Also acknowledged is the Globus Project.

USA, JAPAN AND TAIWAN

Global Telescience Featuring IPv6



URL

https://gridport.npaci.edu/Telescience

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Tom Hutton, *San Diego Supercomputer Center, UCSD, USA*

Fang-Pang Lin, *National Center for High-Performance Computing (NCHC), Taiwan*

Shimojo Shinji, Toyokazu Akiyama, *Cybermedia Center, Osaka University, Japan*

Hirotaro Mori, *Research Center for Ultra-High Voltage Electron Microscopy, Osaka University, Japan*

DESCRIPTION

NCMIR, in collaboration with Osaka University and NCHC, is demonstrating a *real* scientific application utilizing native IPv6 and a mixture of high bandwidth and low latency. This demonstration features a network-enabled end-to-end system for 3D electron tomography that utilizes richly connected resources to remotely control the intermediate-high-voltage electron microscope in San Diego and the ultra-high-voltage electron microscope in Osaka. To provide the highest possible video quality, the Telescience system features digital video over native IPv6 networks.

At iGrid, researchers use high-quality low-latency digital video to navigate around a specimen in a microscope. In addition, data is transferred to and from distributed storage resources, intensive distributed computational jobs are completed, and data-intensive visualizations are performed – all utilizing a Global Grid composed of heterogeneous resources located at: NCMIR, San Diego Supercomputer Center, NASA Ames' Information Power Grid (USA); NCHC (Taiwan); and, Osaka University (Japan).

ACKNOWLEDGMENT ◆

This work is supported in part by grants from the USA National Science Foundation (#DBI-9318180 and ASC-975249) and the USA National Institutes of Health (RR 04050 and DC 03192). Also acknowledged is the Globus Project.

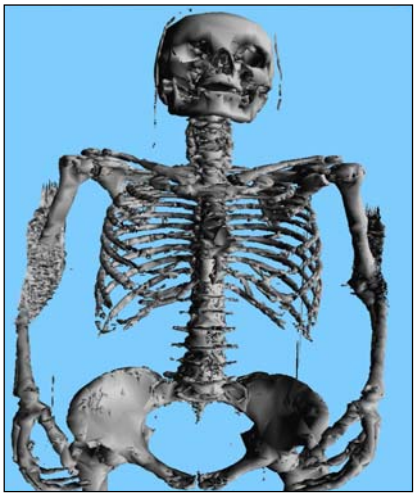
"The Biomedical Informatics Research Network (BIRN), funded in Fall 2001, is a pioneering large USA National Institutes of Health (NIH) project establishing a networked federated repository of multi-scale and multi-dimensional images, with the first two years of challenges related to neuro-imaging. These images, currently totaling more than 200TB, are generated by a wide variety of neuroscience imaging instruments into local data collections maintained by research teams participating in BIRN. By the end of 2004, the BIRN network is expected to grow to 500TB of sanitized data located at more than 20 sites. The cumulative data-generation rate can be as high as 100GB/day at a steady rate, with burst loads exceeding 500GB/day. NIH expects to add additional neuro-imaging partnering groups over the next 18 months and then expand to other organ systems and disease loci (heart, liver, diabetes, cancer, etc.), creating a projected 100x data rate growth over the next five years."

"A major issue within medical imaging is the simultaneous need to increase 3D resolution while maximizing field-of-view. The biologist's dream is to study structures at the highest magnifications, across large fields, and from extremely thick samples. Currently, single volumetric datasets acquired using electron tomography are common at 2048 x 2048 x 512. New energy-filtered microscopes will allow for correction of chromatic aberration and consequently the use of much thicker specimens. With these technologies, single datasets will commonly exceed 4K x 4K x 2K within 2 years and 12K x 12K x 2K in the 5-7 year timeframe. While the process of reconstructing the volumes from raw projection data can be addressed with current parallel supercomputers, it is not yet possible to interactively explore, segment and analyze the resultant volumes."

– *Mark Ellisman, University of California, San Diego (UCSD), co-principal investigator of "The OptIPuter," an NSF Information Technology Research (ITR) proposal, with Larry Smarr/UCSD (principal investigator) and Tom DeFanti, Jason Leigh and Philip Papadopoulos (co-principal investigators).*

THE NETHERLANDS AND USA

Griz: Grid Visualization Over Optical Networks



URL

www.cs.vu.nl/~renambot/vr/html/intro.htm

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Jason Leigh, *Electronic Visualization Laboratory, University of Illinois at Chicago*

DESCRIPTION

Aura, a distributed parallel rendering toolkit, is used to remotely render data on available graphics resources (in Chicago and in Amsterdam) for local display at the iGrid conference. Aura is applied to real-world scientific problems; notably, the visualization of high-resolution isosurfaces of the Visible Human dataset and an interactive molecular dynamics simulation.

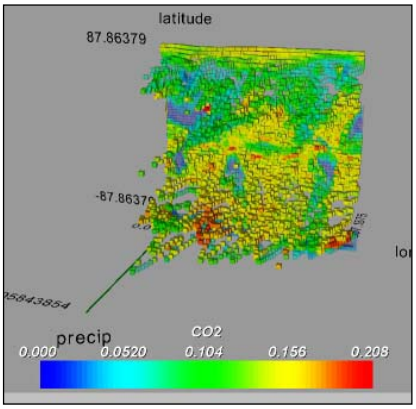
Interactive and collaborative applications have a near-real-time requirement. For interaction over long distances, network delay is a key factor. Optical networks seem to have a predictable latency, making near-real-time interactive behavior easier, and the higher bandwidth allows faster access to large datasets and remote visualization machines.

ACKNOWLEDGMENT ●

Data courtesy of the Visible Human Project, National Library of Medicine, USA; Quanta.

USA, CANADA, THE NETHERLANDS, SWEDEN AND UK

High Performance Data Webs



URL

www.ncdm.uic.edu
www.dataspaceweb.net

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Jacob Slonim, Michael A. Shepherd, David Zitner, Nick Cercone, Syed Sibte, Raza Abidi, *Dalhousie University, Halifax, Canada*
Yike Guo, *Imperial College of Science, Technology & Medicine, University of London, UK*

"In the early '90s, Moore's Law growth curves for CPU processing dominated the growth of storage and bandwidth. Instruction rates were the important metric, while storage and bandwidth were the tail of the computing dog. Computing carefully conserved scarce bandwidth and storage, since they were slow 'peripherals' to the computer. Now, in contrast, the growth rate of optical bandwidth and storage capacity is much higher than Moore's Law. The fact that the bandwidth and storage exponentials are crossing Moore's Law turns the old computing paradigm on its head: that which was scarce is now abundant and vice versa, as futurist George Gilder has repeatedly emphasized. Simply stated, the world is going from a processor-centric network to a lambda-centric processor. For this NSF ITR award, we focus on Grids that operate on single or multiple lambdas in a fiber-based network, or LambdaGrids. The OptIPuter will be built from PC clusters that are *bandwidth-matched* to rapidly increasing numbers of lambdas on the Grid. We will carry out the research to enable end-to-end lambda connectivity of data-intensive e-Science projects, building the on ramps and off ramps for the applications along the way."

– *Larry Smarr, University of California, San Diego, principal investigator of the NSF ITR proposal "The OptIPuter," with Tom DeFanti, Mark Ellisman, Jason Leigh and Philip Papadopoulos (co-principal investigators).*

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Paul Wielinga, *SARA Computing and Networking Services, The Netherlands*
Lennart Johnsson, *Center for Parallel Computers, Royal Institute of Technology, Sweden*

DESCRIPTION

DataSpace is a high-performance data web for the remote analysis, mining, and real-time interaction of scientific, engineering, business, and other complex data. DataSpace applications are designed to exploit the capabilities provided by emerging domestic and international high-performance networks so that gigabyte and terabyte datasets can be remotely explored in real time. This demonstration uses the Terra Wide Data Mining (TWDM) testbed, which consists of high-performance clusters worldwide linked by wide-area advanced networks, providing the data and compute services required.

DataSpace is an open, standards-based infrastructure that combines data web services, data grid services and semantic web services for remote data analysis and distributed data mining.

ACKNOWLEDGMENT

USA National Science Foundation awards ANI-9977868 and ANI-0129609.

SPAIN AND USA

HDTV Transmission Over IP of a Cultural TV Production

URL

www.i2cat.net
www.researchchannel.com
www.washington.edu
www.icair.org

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Joe Mambretti, *International Center for Advanced Internet Research (iCAIR), Northwestern University, USA*
Leo Grebot, *Starmaze, Spain*

DESCRIPTION

To demonstrate the first intercontinental transmission of studio quality HDTV productions via Internet technology, researchers are bi-directionally broadcasting footage of the *Year Gaudí 2002* events, celebrating the famous architect's 150th birthday. The UPC produced live HDTV cultural content at 1.5Gbps (HDSDI), and is compressing and transmitting it at 270Mbps (SDTI) over IP between Seattle, Chicago and Amsterdam using HD/IP transmission technologies.

The ResearchChannel Consortium and the University of Washington, who pioneered the real-time transport of HDTV over the Internet, are demonstrating uncompressed bi-directional HDTV/IP using prototype Tektronix hardware at 1.5Gbps (each direction), Sony HDCAM/IP software technology developed at the University of Washington at 270Mbps, MPEG-2 multicast up to 10 Mbps, VideoOnDemand at 5.6Mbps, and AudioOnDemand at 1.4Mbps.

ICAIR is streaming Barcelona content at 270Mbps over IP using technology specifically designed for high-performance digital video over IP and GigE.

The dual network paths supporting these demonstrations transit the Pacific NorthWest's GigaPoP, StarLight in Chicago and SURFnet in The Netherlands via Internet2's Abilene backbone and transatlantic links provided by SURFnet, Level 3 and Tyco Telecommunications. Tyco donated long term use of a 10Gbps optical circuit to the IEEAF for use by the international research and education community.

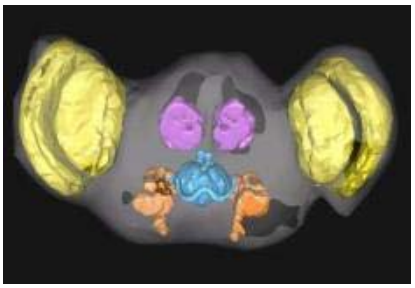
ACKNOWLEDGMENT

UPC receives funding from the Departament de Universitats Recerca i Societat de l'Informació (DURSI) de la Generalitat of Catalunya and members of Internet2 a CATalunya (i2CAT) Consortium.

Special thanks to the Pacific Northwest GigaPoP; NSF StarLight; Level 3; SURFnet/NetherLight; IEEAF; Tyco Telecommunications and Internet2 Abilene.

TAIWAN AND GERMANY

Image Feature Extraction on a Grid Testbed



URL

http://motif.nchc.gov.tw/DataGrid

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Chun-Ho Chen, *Institute of Statistical Science Academia Sinica, Taiwan*
Matthias Mueller, *High Performance Computing Center, Rechenzentrum Universität Stuttgart, Germany*

DESCRIPTION

For medical imagery (confocal laser-scanning microscopes, CT, MRI and PET), NCHC does image processing, analysis and 3D reconstruction. For biotechnology imagery (such as microarray biochips), NCHC uses a data clustering procedure for feature extraction that provides insight into an image, such as identifying diseases caused by some protein. Grid techniques enable the use of distributed computing resources and shared data. High-speed networks enable fast processing. For these technologies to be useful in daily medical activities, doctors need responses to procedures in typically five seconds.

USA, CANADA, FRANCE, JAPAN, THE NETHERLANDS AND SINGAPORE

Kites Flying In and Out of Space

URL

http://calder.ncsa.uiuc.edu/ART/MATISSE

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Paul Weilinga, *SARA Computing and Networking Services, The Netherlands*
Ulrike Kasper, *Sorbonne and La Cité Museum de Musique Paris, France*
Kukimoto Nobuyuki, *Virtual Reality Development and Research Laboratory, Tohwa University, Japan*
Kurichi Kumar, Jie Wei, *Institute of High Performance Computing, Singapore*
Brian Corrie, *New Media Innovation Center, Vancouver, British Columbia, Canada*

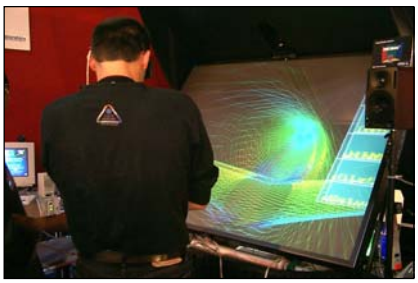
DESCRIPTION

This virtual-reality art piece is a replication and study of the physical properties of the flying kinetic artwork of Jacqueline Matisse-Monnier. The complexity involved with calculating and rendering data is facilitated by distributed computing over high-speed networks.

Because the calculations for these kinetic art pieces (kites) are so computationally intensive, a single PC can only support the simulation of one kite. To support the many kites flown at iGrid, collaborators with computing resources around the world are performing the physically-based kite simulations at their home institutions and then streaming the results of the calculations, in real time, to Amsterdam. In essence, this is grid computing for arts.

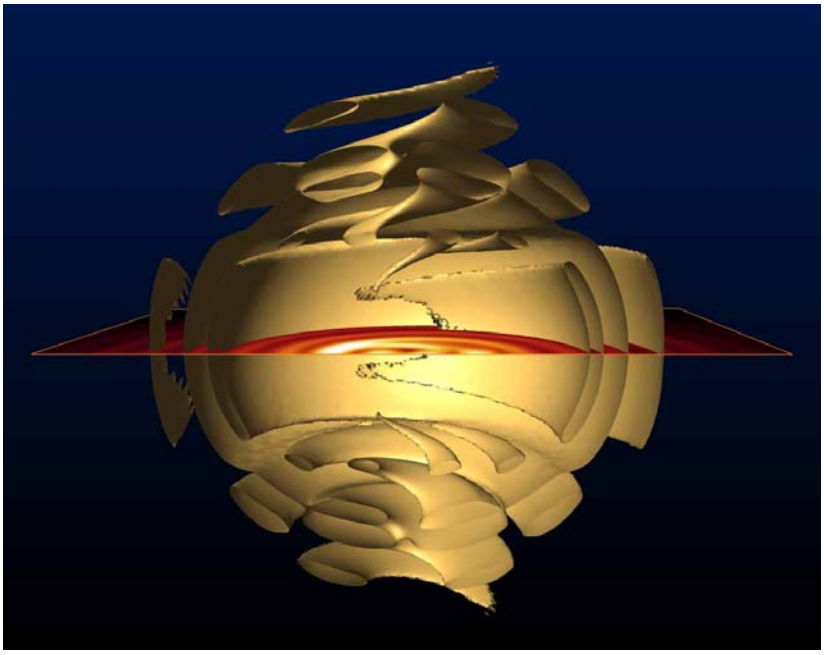
ACKNOWLEDGMENT ●

Quanta



GERMANY AND USA

Network Intensive Grid Computing and Visualization



URL

www.cactuscode.org
www.griksl.org

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DESCRIPTION

Based on their SC'2001 work that won the Gordon Bell Prize and the Bandwidth Challenge, these scientists are running an astrophysics simulation at a USA supercomputing center and then computing detailed remote visualizations of the results. One part of the demo shows remote online visualization – as the simulation continues, each time step's raw data is streamed in parallel from the USA over the transatlantic network connection to a Linux cluster in Amsterdam for parallel volume rendering. The other part demonstrates remote off-line visualization using advanced grid technologies to efficiently access data on remote data servers, as well as new rendering techniques for network-adaptive visualizations.

This application currently saturates any network given to it, so the scientists work around the limitations. 10Gbps networking can be utilized immediately.

ACKNOWLEDGMENT ◆

The following people and projects are acknowledged: Frank Herrmann, Peter Diener, Denis Pollney, MPG, AEI/Golm, Germany; Helmut Heller, Isabel Campos, Leibniz Rechenzentrum, Munich, Germany; Werner Nagel, MPG Rechenzentrum Garching, Germany; GridLab Project, Work Package 5– Testbed Management <www.GridLab.org>; GriKSL Project, funded by Deutsche Forschungsgemeinschaft (DFG) <www.griksl.org>; the Globus Project.

"We read about Compute Grids, Data Grids, Science Grids, Access Grids, Knowledge Grids, Bio Grids, Sensor Grids, Cluster Grids, Campus Grids, Tera Grids, and Commodity Grids. The skeptic can be forgiven for wondering if there is more to the Grid than, as one wag put it, a 'funding concept' and, as industry becomes involved, a marketing slogan. If by deploying a scheduler on my local area network I create a 'Cluster Grid,' then doesn't my Network File System deployment over that same network provide me with a 'Storage Grid?' Indeed, isn't my workstation, coupling as it does processor, memory, disk, and network card, a 'PC Grid?' Is there any computer system that isn't a Grid? Ultimately the Grid must be evaluated in terms of the applications, business value, and scientific results that it delivers, not its architecture… I suggest that the essence of the definitions above can be captured in a simple checklist, according to which a Grid is a system that: coordinates resources that are not subject to centralized control; uses standard, open, general-purpose protocols and interfaces; and, delivers nontrivial qualities of service.

"The three criteria apply most clearly to the various large-scale Grid deployments being undertaken within the scientific community, such as the distributed data processing system being deployed internationally by 'Data Grid' projects (GriPhyN, PPDG, EU DataGrid, iVDGL, EU DataTAG), NASA's Information Power Grid, the Distributed ASCI Supercomputer (DAS-2) system that links clusters at five Dutch universities, the DOE Science Grid and DISCOM Grid that link systems at DOE laboratories, and the TeraGrid being constructed to link major USA academic sites. Each of these systems integrates resources from multiple institutions, each with their own policies and mechanisms; uses open, general-purpose (Globus Toolkit) protocols to negotiate and manage sharing; and, addresses multiple quality of service dimensions, including security, reliability and performance."

– Ian Foster, "What is the Grid? A Three-Point Checklist," Grid Today, July 22, 2002, <www.gridtoday.com>

USA AND SWEDEN

PAAPAB

URL

http://resumbrae.com/projects/paapab
www.ccr.buffalo.edu/anstey/VR/PAAPAB
www.nyscedii.buffalo.edu

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DESCRIPTION

PAAPAB (Pick An Avatar, Pick A Beat) is a shared virtual-reality disco environment inhabited by life-size puppets, animated by users in CAVEs and ImmersaDesks around the globe. Users can tour the dance floor to see the puppets they animate, dance with the puppets, and dance with avatars of other users. This research focuses on creating interactive drama in virtual reality; that is, immersive stories. PAAPAB serves as a testbed for technology development as well as character and world design.

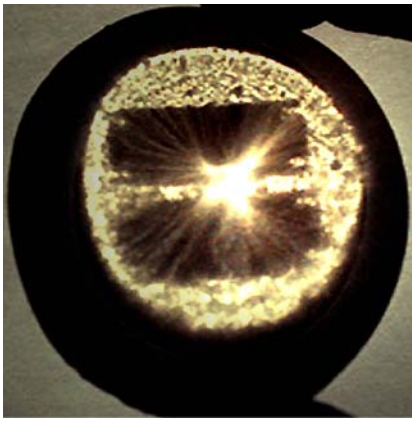
In addition to interacting with the PAAPAB demonstration, iGrid attendees are treated to performances with the Interactive Institute's *Incarnation of a Divine Being,* an environment built using the same software infrastructure. *Incarnation* is a virtual-reality space based on ancient Greek theater, where people meet and together perform an improvised drama in cyberspace.

ACKNOWLEDGMENT ●

Ygdrasil (YG), a VR authoring system by Res Umbrae <http://resumbrae.com>; Quanta

USA AND THE NETHERLANDS

Photonic TeraStream



URL

www.icair.org/igrid2002
www.uva.nl
www.icair.org/omninet

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DESCRIPTION

ICAIR, in partnership with the Materials Sciences Research Center at Northwestern University, is developing an International Virtual Institute (IVI) for Materials Science. The IVI wants to be able to instantaneously discover, gather, integrate, and present information – whether large-scale datasets, scientific visualizations, streaming digital media, results of computational processes – from resources worldwide. To accomplish this, iCAIR is developing "Global Services-on-Demand" technologies for optical networks.

The Photonic TeraStream is supported by OMNInet, the Chicago-area Optical Metro Network Initiative. OMNInet is designed and developed by SBC/Ameritech, Nortel Networks and iCAiR, in collaboration with EVL, CANARIE and ANL. It is an experimental networking testbed, enabling researchers to assess and validate next-generation optical technologies, architectures and applications in metropolitan networks. For iGrid 2002, however, the OMNInet testbed has been extended to Amsterdam through StarLight and NetherLight in order to demonstrate that photonic-enabled applications are possible, not only at the metro level, but also on a global scale (the global LambdaGrid).

Researchers are using OMNInet to prototype tools for intelligent application signaling, dynamic lambda provisioning, and extensions to lightpaths through dynamically provisioned Layer2 and Layer3 configurations, in part, to allow for access to multiple types of edge resources. In turn, these network-control capabilities are being incorporated into next-generation large-scale global applications, which include high-performance data transfer (based on GridFTP), digital media streaming (270Mbps encoding), and high-performance remote data-access methods (based on iSCSI).

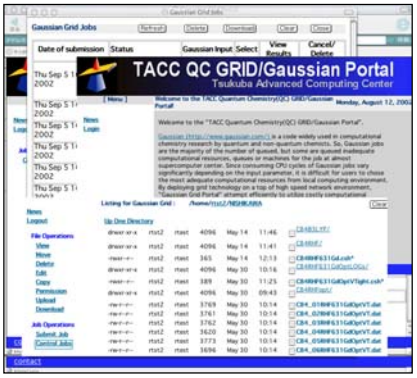
At iGrid 2002, iCAIR is presenting its innovative dynamic lambda provisioning capability – the Optical Dynamic Intelligent Network (ODIN) service layer. Applications use intelligent signaling to provision their own lightpaths with ODIN in order to optimize network-based resource discovery and performance; for example, to access and to dynamically interact with very large amounts of distributed data. Applications supported by dynamic lambda switching provide for significantly more powerful capabilities than those based on today's communication infrastructure.

ACKNOWLEDGMENT

Hal Edwards and Paul Daspit, Nortel Networks; Teresa Elliott, Carol Huss and Rachel Alarcon, SBC/Ameritech; USA National Science Foundation awards, including ANI-0123399 on intelligent signaling.

JAPAN

TACC Quantum Chemistry Grid/



Gaussian Portal

URL

http://unit.aist.go.jp/grid/GSA/gaussian

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DESCRIPTION

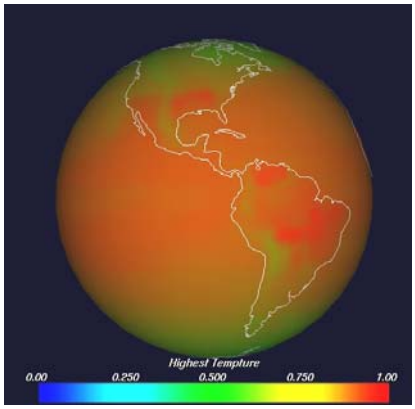
Gaussian code, used in computational chemistry, sometimes receives inadequate computational resources when run on large computers. The Tsukuba Advanced Computing Center (TACC) Gaussian Grid Portal efficiently utilizes costly computational resources without knowing the specifications of each system environment. It consists of a Web interface, meta-scheduler, computational resources, archival resources and Grid software. Grids allow one to compute from anywhere. Ultimate access to 10Gbps networking shall eliminate much of the latency incurred using the portal to obtain adequate resources.

ACKNOWLEDGMENT

This research was carried out at the Information Technology Research & Development Office, TACC, AIST. Special thanks to Dr. Terakura, a TACC director, for his help, for funding, and for access to computer resources. Researchers Nishikawa, Nagashima and Sekiguchi, are currently at GTRC but were previously at TACC.

USA

TeraScope: Visual Tera Mining



URL

www.evl.uic.edu/cavern/teranode/terascope
www.dataspaceweb.net

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DESCRIPTION

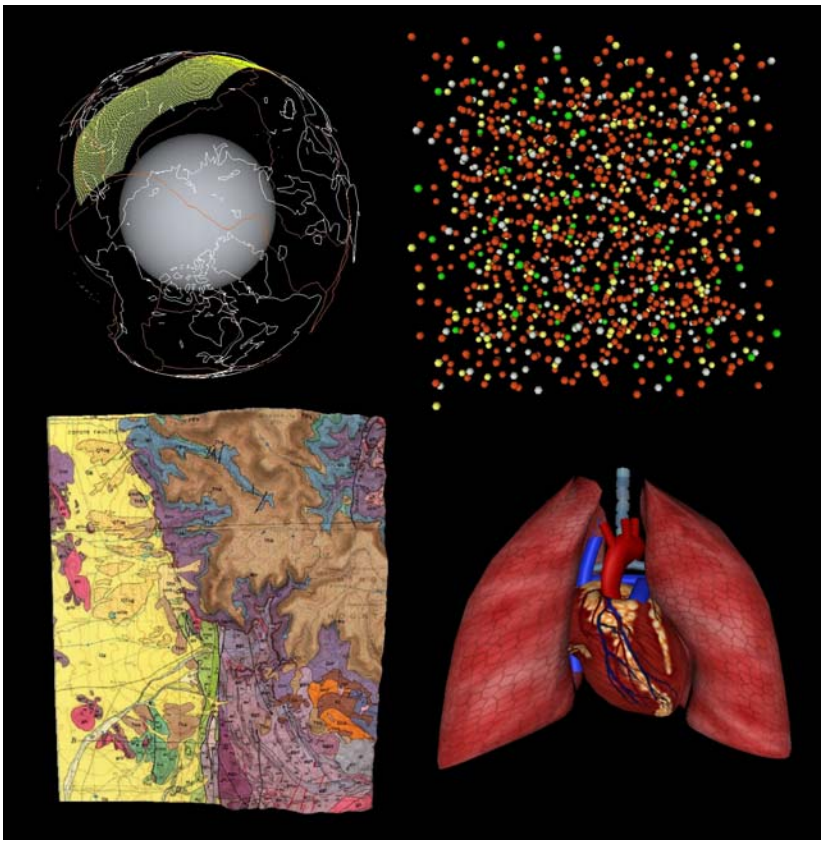
TeraScope is a massively parallelized set of information visualization tools for Visual Data Mining that interactively queries and mines terabyte datasets, correlates the data, and then visualizes the data using parallelized rendering software on tiled displays. TeraScope's main foci are to develop techniques to create TeraMaps (visualizations that summarize rather than plot enormous datasets) and to develop a distributed memory cache to collect pools of memory from optically connected clusters. These caches are used by TeraScope to bridge the impedance mismatch between large and slow distributed data stores and fast local memory. TeraScope currently works with Project DataSpace's distributed data servers; however, it can be adapted to work with other database systems.

ACKNOWLEDGMENT ●

DataSpace, developed by UIC's NCDM; USA National Science Foundation awards EIA-9802090, ANI-9730202, ANI-0129527 and ACI-9619019 (to the National Computational Science Alliance); and, Quanta.

USA

TeraVision: Visualization Streaming Over Optical Networks



URL

www.evl.uic.edu/cavern/teranode/teravision

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DESCRIPTION

TeraVision is a hardware-assisted, high-resolution graphics streaming system for the Access Grid, enabling anyone to deliver a presentation without having to install or configure any software or distribute any data files in advance. A user giving a presentation on a laptop or showing output from a node of a graphics cluster simply plugs the VGA or DVI output of the computer into the TeraVision Box. The box captures the signal at its native resolution, and digitizes and broadcasts it to another networked TeraVision Box, which is connected to a PC and DLP projector.

Two Boxes can be used to stream stereoscopic computer graphics. Multiple Boxes can be used for an entire tiled display. TeraVision synchronizes both image capture at the source and image display at the destination. By decoupling image generation from image capture and transmission, the host graphics system operates at optimal frame rates.

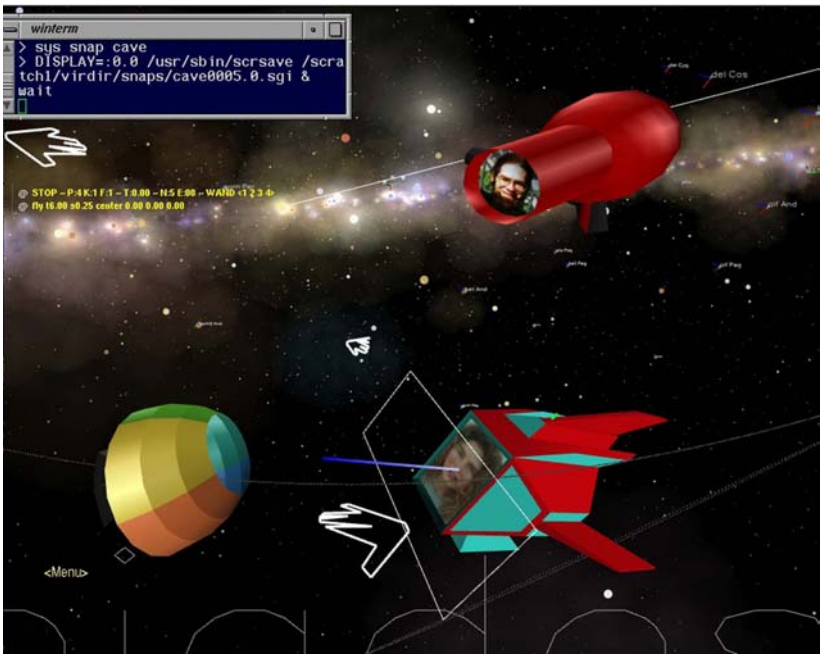
In five years, TeraVision will be like Television, enabling scientists to simply dial into their streamed visualizations. For a 20-node tiled display, they will need ~10Gbps without image compression. This provides a resolution of 5120 x 3072 in 24-bit color at 30 frames per second.

ACKNOWLEDGMENT ●

USA National Science Foundation EIA-9802090, ANI-9730202, ANI-0129527 and ACI-9619019 (to the National Computational Science Alliance); Microsoft Research; and, Quanta.

USA AND UK

The Universe: Distributed Virtual Collaboration and Visualization



URL

http://virdir.ncsa.uiuc.edu/virdir/virdir.html

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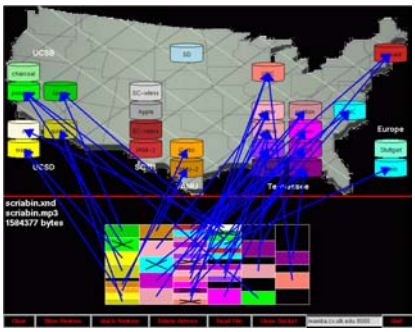
DESCRIPTION

Virtual Director and related technologies enable multiple users to remotely collaborate in a shared, astrophysical virtual world. Users can collaborate via video, audio and 3D avatar representations, and through discrete interactions with the data. Multiple channels of dynamically scalable video allow the clients to trade off between video processing and scene rendering as appropriate. At iGrid, astrophysical scenes are rendered using several techniques, including an experimental renderer that creates time-series volume animations using pre-sorted points and billboard splats, allowing visualizations of very large datasets in real-time.

USA, FRANCE, GERMANY AND ITALY

Video IBPster



URL

http://loci.cs.utk.edu
http://nws.cs.ucsb.edu

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DESCRIPTION

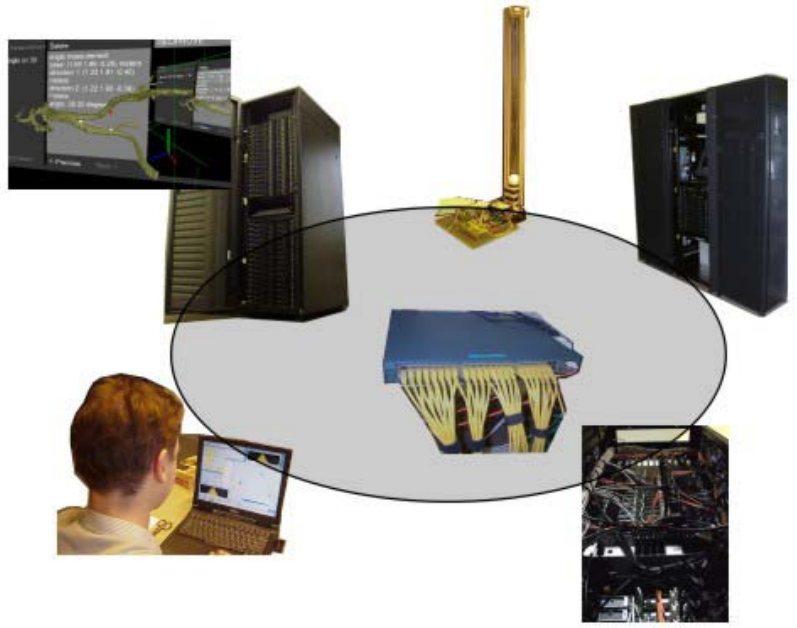
Logistical Networking is the global scheduling and optimization of data movement, storage and computation. At LoCI, scientists develop tools for fast data transfer, such as the Data Mover, using as much bandwidth as is available. At iGrid, a geographically distributed abstraction of a file is replicated, transported to depots that are closer according to network proximity values calculated in real time using the Network Weather Service (NWS), and downloaded from the nearest site in a completely transparent way for a high-level application.

ACKNOWLEDGMENT

USA DoE DE-FC02-01ER25465; USA NSF ANI-9980203, EIA-9975015 and EIA-9972889; UTenn Center for Information Technology Research; Internet2.

THE NETHERLANDS

Virtual Laboratory on a National Scale



URL

www.vl-e.nl/VLAM-G

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DESCRIPTION

This demonstration of upper middleware complements Grid services, enabling scientists to easily extract information from raw datasets utilizing multiple computing resources. The Virtual Laboratory develops a formal series of steps, or *process flow,* to solve a particular problem in a particular application domain. The process steps may generate raw data from instruments, may contain data processing, may retrieve and store either raw or processed data and may contain visualization steps. A Process Flow Template (PFT) represents a typical analysis and visualization cycle of some raw experiment data.

iGrid demonstrations include data cubes from the UvA Material Analysis of Complex Surfaces Lab and data cubes from an MRI brain scan. The Virtual Lab software assigns various clusters (using DAS-2, a wide-area distributed computer of 200 Dual Pentium-III nodes in The Netherlands) parts of a problem (retrieval, analysis, visualization, and so on). High bandwidth is a necessary prerequisite in order to do data analysis and visualization on a distributed system.

ACKNOWLEDGMENT ◆

Globus Project

GREECE AND THE USA

Virtual Visit to the Site of Ancient Olympia

URL

www.fhw.gr/fhw/en/projects
www.fhw.gr/fhw/en/projects/3dvr/templezeus.html
www.grnet.gr/grnet2/index_en.htm

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DESCRIPTION

In preparation for the 2004 Olympic Games to be hosted by Greece, the FHW, a cultural heritage institution based in Athens, is developing an accurate 3D reconstruction of the site of Olympia as it used to be in antiquity. Through access to a high-performance network, the FHW's museum can serve as a center of excellence, delivering educational and heritage content to a number of sites worldwide.

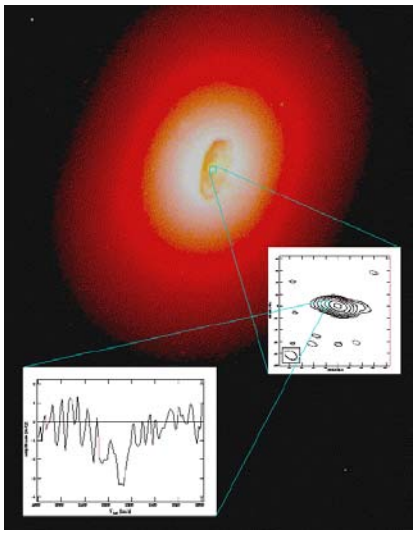
GRNET, the Greek Research and Technology Network, with its next-

generation network, GRNET2, provides 1Gbps access to major universities and research institutions and a core network currently at 2.5Gbps delivering advanced services. The network is based on Gigabit routers interconnected through DWDM leased lambdas.

ACKNOWLEDGMENT

General Secretariat for Research and Technology, Ministry of Development, Greece; Project GRNET2, Operational Programme for the Information Society, 3rd Community Support Framework; and, IST Project Géant, the pan-European Gigabit research network, co-funded by the European Commission as part of Framework V Programme. Special thanks to EVL/UIC for providing the FHW with a TeraVision streaming video system for iGrid.

vlbiGrid



URL

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www.jb.man.ac.uk
www.haystack.edu

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Cees de Laat, *University of Amsterdam, The Netherlands*

DESCRIPTION

Very Long Baseline Interferometry (VLBI) is a technique in which an array of physically independent radio telescopes observes simultaneously to yield high-resolution images of cosmic radio sources. Today, magnetic tape transports data from telescopes to data processors. The European VLBI Network (EVN) has access to multiple data sources that can deliver 1Gbps each and a dedicated supercomputer that can process 16 data streams simultaneously. High-speed networks are enabling the EVN to achieve many-fold improvements in bandwidth.

ACKNOWLEDGMENT

SURFnet.

EU DataGrid Project

The EU-funded DataGrid Project aims to develop, implement and exploit a computational and data-intensive grid of resources for the analysis of scientific data. Next-generation scientific exploration will require coordinated resource sharing, collaborative processing and analysis of huge amounts of data produced and stored by many scientific laboratories.

The main goal of DataGrid is to develop a new hardware/software infrastructure to allow geographically distributed processing of such data. This will enable the implementation of scientific *collaboratories,* where researchers can perform their activities regardless of geographical location, interacting with colleagues from sites all over the world and sharing data and instruments. DataGrid members are developing the scalable software solutions and testbeds to handle petabytes of distributed data, tens of thousands of computing resources and thousands of simultaneous users from multiple research institutions. DataGrid is using real-world applications drawn from three scientific areas: High Energy Physics, Biology and Earth Observation.

DataGrid, led by CERN, brings together the following leading European research agencies: European Space Agency (ESA), France's Centre National de la Recherche Scientifique (CNRS), Italy's Istituto Nazionale di Fisica Nucleare (INFN), Dutch National Institute for Nuclear Physics and High Energy Physics (NIKHEF) and the UK's Particle Physics and Astronomy Research Council (PPARC). The 15 associated partners are from the Czech Republic, Finland, France, Germany, Hungary, Italy, Netherlands, Spain, Sweden and the UK.

www.eu-datagrid.org

■ = EU DataGrid application

SURFnet Video and Documentary

For iGrid 2002, SURFnet is streaming live conference plenary sessions and demonstration material over the Internet using Real Surestream, IP multicast H.261, MPEG-1 and MPEG-2. SURFnet is also producing a documentary of the iGrid 2002 demonstrations. After the conference, all video, both plenary sessions and documentary, will be available for on-demand viewing through the iGrid 2002 website and the SURFnet A/V streaming service.

www.igrid2002.org/webcast.html

EU DataTAG Project

The EU-funded DataTAG Project is creating an intercontinental testbed *(Trans-Atlantic Grid)* for data-intensive grids, with a focus on networking techniques and interoperability issues among different grid domains.

Networking efforts are performed over a dedicated 2.5Gbps circuit between CERN (Geneva) and StarLight (Chicago). The project addresses all issues specific to high-performance inter-grid networking, including sustained and reliable high-performance data replication, end-to-end advanced network services, and novel monitoring techniques. It also addresses issues of interoperability between the grid middleware layers, such as information and security services.

Two European grid projects (DataGrid and CrossGrid) and three USA grid projects (International Virtual Data Grid Laboratory [iVDGL], Grid Physics Network [GriPhyN] and Particle Physics Data Grid [PPDG]) are involved in the EU DataTAG effort.

www.datatag.org

☐ = EU DataTAG application

NLANR DAST

The Distributed Applications Support Team (DAST) of the National Laboratory for Applied Network Research (NLANR) is assisting iGrid 2002 with general infrastructure and application support. It is providing multi-site support and coordination of Grid services infrastructure based on the USA NSF Middleware Initiative (NMI) Release 1 software suite, which includes Globus Toolkit, Condor-G and the Network Weather Service. DAST is establishing a special instantiation of its Multicast Beacon software to monitor the multicast infrastructure, and is assisting to install and use Web100 to monitor and enhance TCP performance for Linux-based hosts. DAST is also helping optimize application network performance, file transfer and data movement.

NLANR/DAST is located at the National Center for Supercomputing Applications at the University of Illinois at Urbana-Champaign. It is funded by the USA National Science Foundation, award ANI-0129681.

http://dast.nlanr.net

Globus Project

The Globus Project conducts research and development on the application of Grid concepts to scientific and engineering computing. The Globus Project provides software tools that make it easier to build computational grids and grid-based applications. These tools are collectively known as the Globus Toolkit. The Toolkit is open architecture, open source software used by hundreds of scientific and engineering projects around the world. A growing number of companies have committed to support this open source activity, porting the software to their platforms or by other means.

The Globus Project is led by the Distributed Systems Laboratory at Argonne National Laboratory, the Information Sciences Institute at University of Southern California and the University of Chicago. Sponsors include USA Federal agencies such as DoE, DARPA, NASA and the NSF, along with commercial partners such as IBM and Microsoft.

www.globus.org

◆ = The Globus Project application

Quanta

Quanta, the Quality of Service (QoS) Adaptive Networking Toolkit, is backward compatible with CAVERNsoft, and provides application developers with an easy-to-use system to efficiently utilize the extremely high bandwidth afforded by optical networks. Programmers specify their application's data transfer characteristics, and then Quanta transparently translates these requirements into transmission protocols and network QoS services.

Quanta consists of a set of networking protocols designed for a variety of high-bandwidth application traffic flows, and a QoS architecture to flexibly control these protocols and support emerging techniques for lightpath reservations, such as GMPLS and OBGP.

Quanta is being developed by the Electronic Visualization Laboratory at the University of Illinois at Chicago. It is funded by the USA National Science Foundation, ANI-0129527.

www.evl.uic.edu/cavern/teranode/ quanta

● = Quanta application

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Northwestern University/ International Center for Advanced Internet Research
University of Illinois at Chicago/ Electronic Visualization Laboratory (UIC/EVL)

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Global Grid Forum
Globus Project
GRIDS Center
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Pacific Rim Applications and Grid Middleware Assembly (PRAGMA)
TERENA
UCAID/Internet2
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