www.igrid2005.org

iGrid 2005

GLOBAL LAMBDA INTEGRATED FACILITY

APPLICATIONS

Data Services

e-Science

Lambda Services

Scientific Instrument Services

Supercomputing Services

Video Streaming Services

Visualization Services

Participating countries/locations

Australia [AU]; Brazil [BR]; Canada [CA]; CERN [CE]; China [CH]; Czech Republic [CZ]; Germany [GE]; Hungary [HU]; Italy [IT]; Japan [JA]; Korea [KO]; Mexico [MX]; Netherlands [NL]; Poland [PL]; Russia [RU]; Spain [SP]; Sweden [SW]; Taiwan [TW]; United Kingdom [UK]; United States of America [USA]. Of course, during the week of iGrid, USA is an active participant in all these demonstrations!

SYMPOSIUM

Keynotes

Panels

Master Classes

GLIF-Specific Presentations

Welcome to iGrid 2005!

Maxine Brown and Tom DeFanti, iGrid 2005 co-chairs

iGrid 2005, the 4th community-driven biennial International Grid event, is a coordinated effort to accelerate the use of multi-10Gb international and national networks, to advance scientific research, and to educate decision makers, academicians and industry researchers on the benefits of these hybrid networks. This year, iGrid showcases more than four-dozen real-time application demonstrations from 20 countries, as well as a symposium with 25 lectures, panels and master classes on the applications, middleware, and underlying cyberinfrastructure.

At its core, this cyberinfrastructure has new architectural approaches to next-generation internet design and development using optical networking. A single optical fiber can carry multiple wavelengths of light, or lambdas, enabling multiple networks to run in parallel. New middleware technologies enable applications to dynamically manage these lambda resources just as they do any grid resource, creating "LambdaGrids" of interconnected, distributed, high-performance computers, data storage devices, and instrumentation.

On the last day of iGrid 2005, the Global Lambda Integrated Facility (GLIF) has its annual meeting. GLIF is the international virtual organization creating a world-scale LambdaGrid laboratory, driven by the demands of application scientists, engineered by leading network engineers, and enabled by grid middleware developers. iGrid showcases the latest advances in scientific collaboration and discovery enabled by GLIF partners, by providing a forum for these far-flung teams to test interoperability on a global scale.

www.igrid2005.org

iGrid 2005

GLOBAL LAMBDA INTEGRATED FACILITY

iGrid 2005 Workshop: 26-29 September 2005
GLIF Meeting: 29-30 September 2005
Calit2, University of California, San Diego, USA

Enabling e-Science with the LambdaGrid

Larry Smarr, iGrid 2005 host

The emergence of a global LambdaGrid cyberinfrastructure is leading e-science from a bandwidth-constrained to a bandwidth-rich world. In this new LambdaGrid architecture, it's possible to access scientific data anywhere in the world over optical networks with almost the same immediacy as if the data were stored on a local hard disk! We see at iGrid a few pioneering researchers who are showing us how this transformed cyberinfrastructure allows them to carry out a new level of science and discovery, using persistent high-performance collaboration on a planetary scale that allows global teams to interactively obtain, analyze, and share vast amounts of distributed data.

Previous iGrids in 1998, 2000 and 2002, and GLIF's organization that started in 2001, have rapidly led to a worldwide set of dozens of interconnected 10Gb lambdas. Since the last iGrid, we have seen a global movement toward supporting a wide range of e-science projects by adopting a Service-Oriented Architecture for the middleware that rides on top of the physical infrastructure. In this process, the traditional Grid middleware over the shared Internet is transformed into a LambdaGrid over the GLIF optical infrastructure, integrated with Web Services.

In the iGrid 2005 applications and symposium, one can see global "grass-roots" experiments combined with collegial "best-of breed" processes to develop a new generation of shared open-source LambdaGrid Services. We see demonstrations of LambdaGrid Services supporting scientific instruments, high-definition video and digital cinema streaming, visualization and virtual reality, high-performance computing, data analysis, and the control of the underlying lambdas themselves. The world is clearly in a rapid evolution to a new cyberinfrastructure, with global innovations making the various subsections of the infrastructure work efficiently and in harmony.

The process of building up the LambdaGrid infrastructure to support e-science is reminiscent of the effort to build up a networked supercomputer infrastructure 20 years ago. At first there was hardly any "real" science being done. Rather, the few pioneer scientists that showed up were allowing their codes to be used to understand how to restructure them to take advantage of the high-performance hardware (e.g., vector processors) or to set up visualization capabilities or remote interactive control of the supercomputer. Gradually, as those pioneers allowed the hardware and software of the infrastructure to mature, a second generation of "homesteaders" showed up and started using the infrastructure to do science. I think we are still in the pioneering phase of LambdaGrid, but by 2007, the research should advance sufficiently enough to be all about homesteading science that you can do with the global LambdaGrid Services developed by and demonstrated at iGrid 2005.

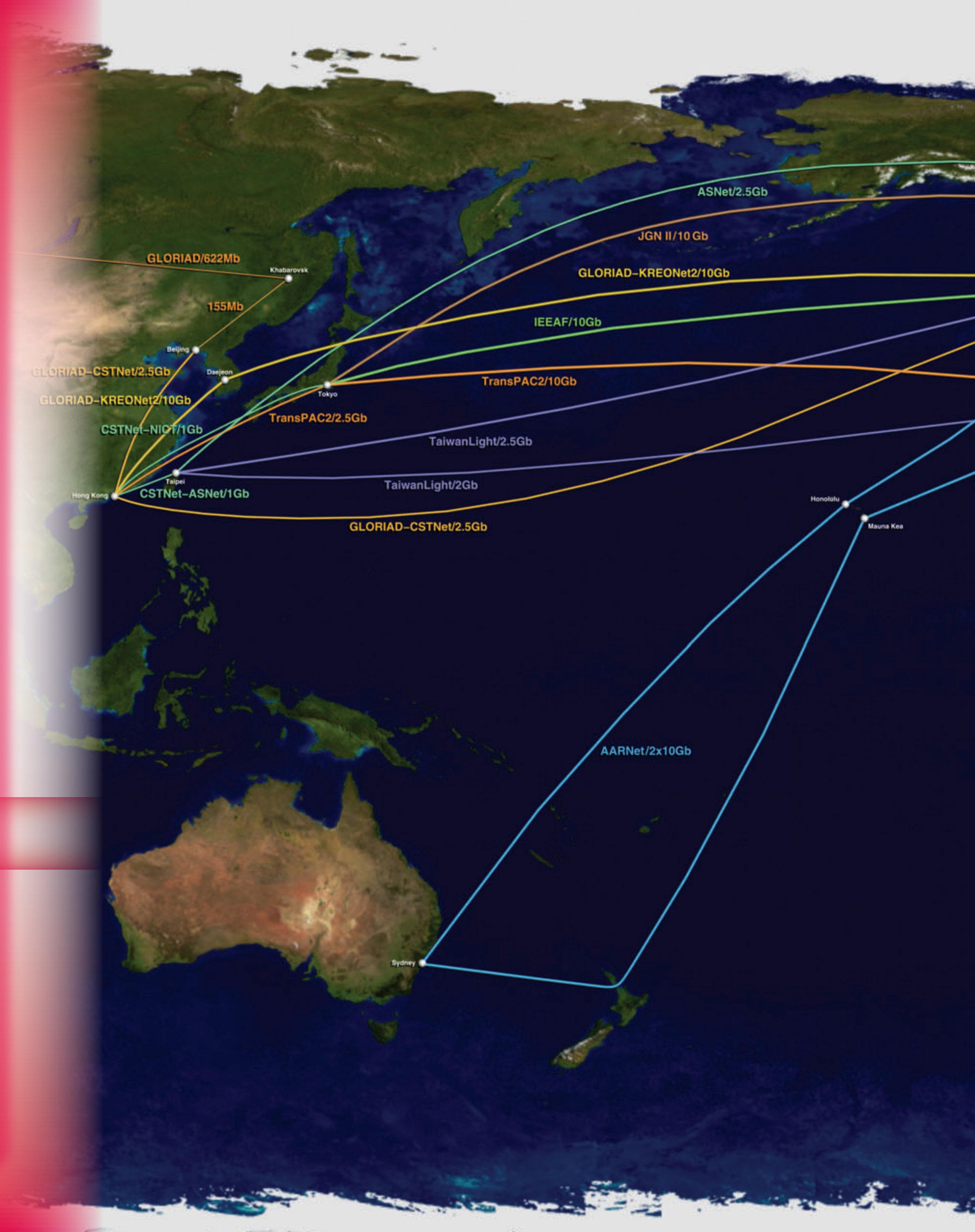
Global Lambda Integrated Facility

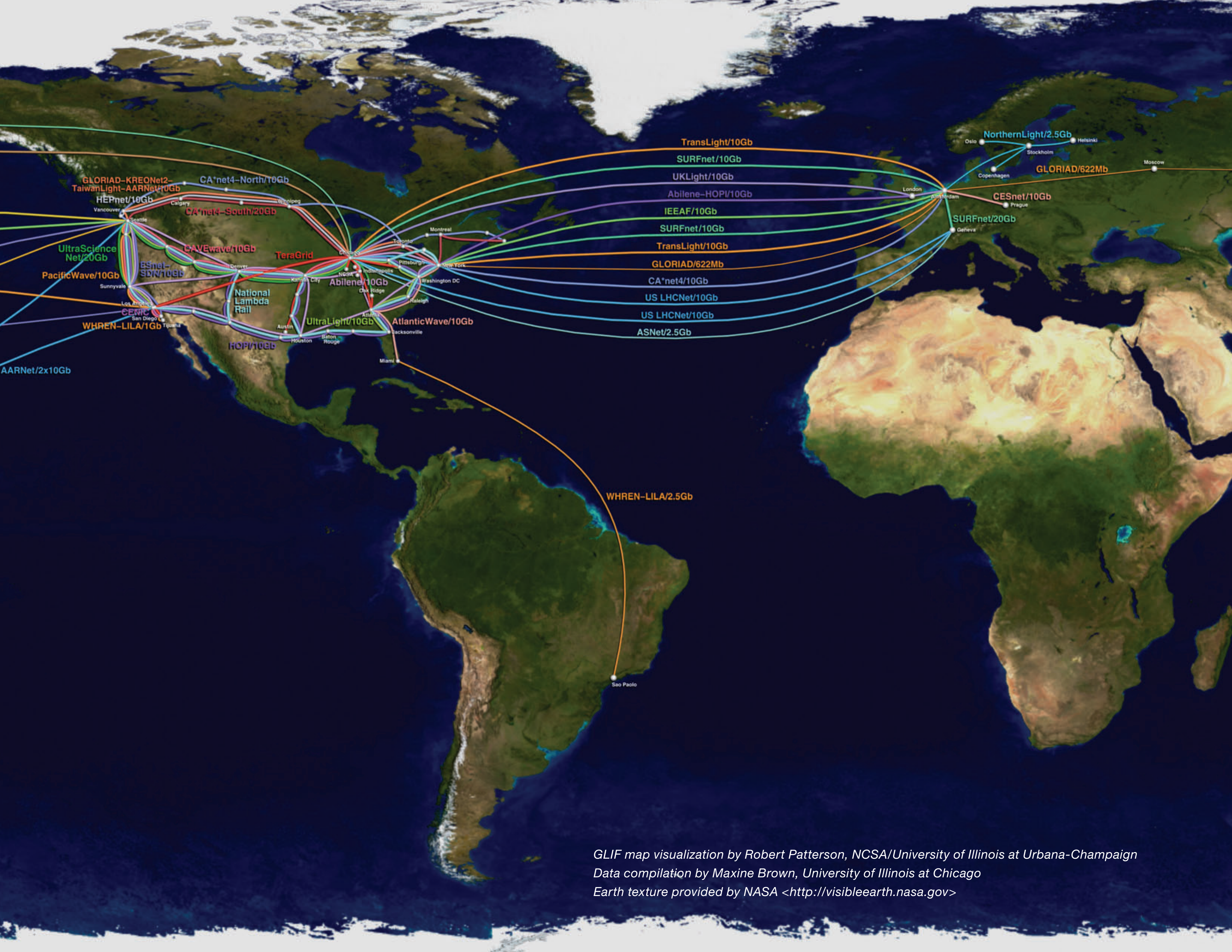
GLIF, the Global Lambda Integrated Facility, is an international virtual organization that supports persistent data-intensive scientific research and middleware development on LambdaGrids.

The GLIF community shares a common vision of building a new grid-computing paradigm to support this decade's most demanding e-science applications. In this paradigm, the central architectural element is optical networks, not computers, which use multiple wavelengths of light (lambdas) on single optical fibers to create "supernetworks." The GLIF infrastructure is evolving into a world-scale LambdaGrid laboratory for application and middleware development, where applications rely on dynamically configured networks based on optical wavelengths with known and knowable characteristics, including scheduling, bandwidth and latency guarantees.

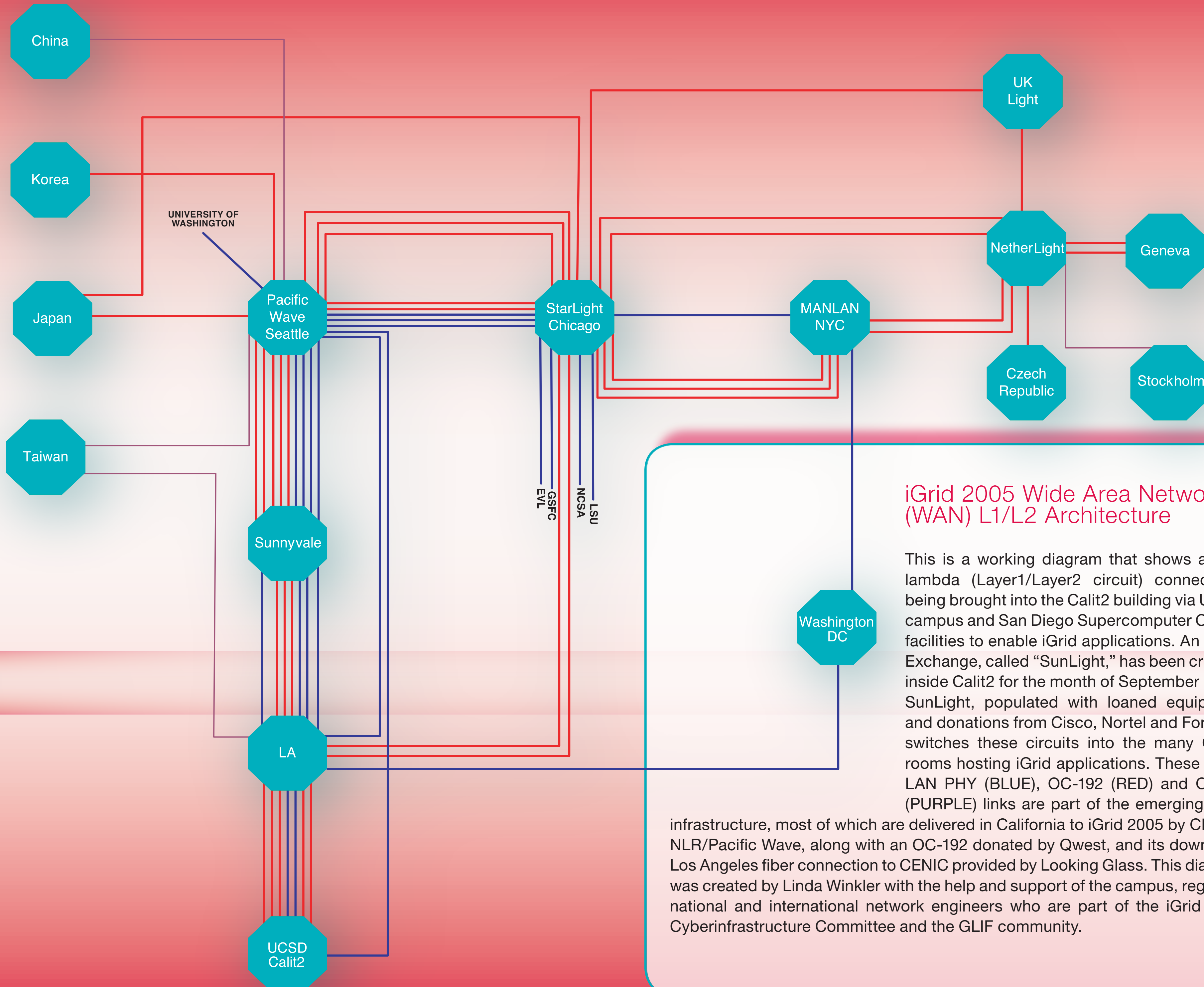
To create this infrastructure, National Research Networks, countries, consortia, institutions and individual research initiatives are providing the physical layer. The world's premier research and education networking engineers are defining Open Exchanges to assure the interconnectivity and interoperability of links by specifying equipment, connection requirements and necessary engineering functions and services. Computer scientists are exploring the development of intelligent optical control planes and new transport protocols, building on the wealth of middleware that currently exists. And, e-science teams are the primary drivers for these new "application-empowered" networks, where e-science represents very-large-scale applications – such as astronomy, bioinformatics, environmental, geoscience, high-energy physics – that study very complex micro- to macro-scale problems over time and space. GLIF is building more than a network – it is building an "integrated facility" in which broad multidisciplinary teams can work together.

This map illustrates the GLIF infrastructure in use for the iGrid 2005 Workshop. iGrid showcases advances in scientific collaboration and discovery enabled by GLIF, by providing a forum for the world's premier discipline scientists, computer scientists and network engineers to meet and work together in multidisciplinary teams to understand, develop and demonstrate innovative solutions in a LambdaGrid world.



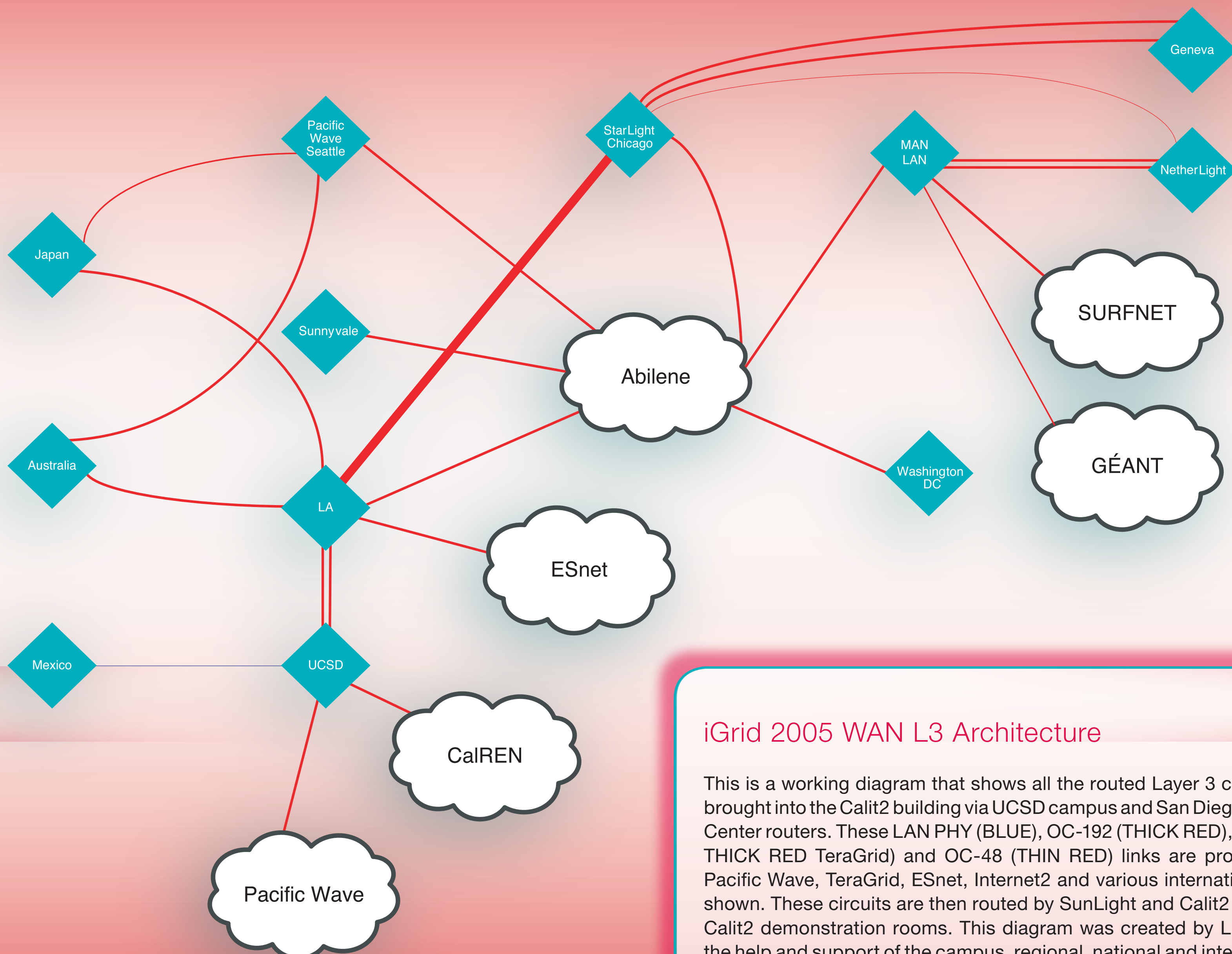


GLIF map visualization by Robert Patterson, NCSA/University of Illinois at Urbana-Champaign
Data compilation by Maxine Brown, University of Illinois at Chicago
Earth texture provided by NASA <http://visibleearth.nasa.gov>



iGrid 2005 Wide Area Network (WAN) L1/L2 Architecture

This is a working diagram that shows all the lambda (Layer1/Layer2 circuit) connections being brought into the Calit2 building via UCSD campus and San Diego Supercomputer Center facilities to enable iGrid applications. An Open Exchange, called "SunLight," has been created inside Calit2 for the month of September 2005. SunLight, populated with loaned equipment and donations from Cisco, Nortel and Force10, switches these circuits into the many Calit2 rooms hosting iGrid applications. These 10Gb LAN PHY (BLUE), OC-192 (RED) and OC-48 (PURPLE) links are part of the emerging GLIF infrastructure, most of which are delivered in California to iGrid 2005 by CENIC/NLR/Pacific Wave, along with an OC-192 donated by Qwest, and its downtown Los Angeles fiber connection to CENIC provided by Looking Glass. This diagram was created by Linda Winkler with the help and support of the campus, regional, national and international network engineers who are part of the iGrid 2005 Cyberinfrastructure Committee and the GLIF community.

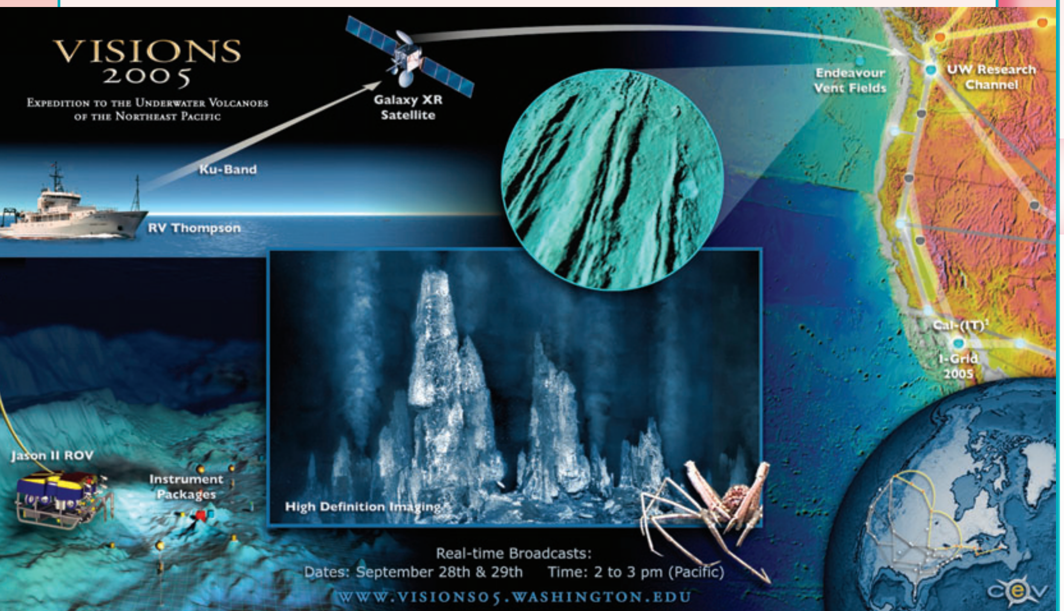


iGrid 2005 WAN L3 Architecture

This is a working diagram that shows all the routed Layer 3 connections being brought into the Calit2 building via UCSD campus and San Diego Supercomputer Center routers. These LAN PHY (BLUE), OC-192 (THICK RED), 3xOC-192 (VERY THICK RED TeraGrid) and OC-48 (THIN RED) links are provided by CENIC, Pacific Wave, TeraGrid, ESnet, Internet2 and various international partners, as shown. These circuits are then routed by SunLight and Calit2 equipment to the Calit2 demonstration rooms. This diagram was created by Linda Winkler with the help and support of the campus, regional, national and international network engineers who are part of the iGrid 2005 Cyberinfrastructure Committee and the global R&E networking community.

20,000 Terabits Beneath the Sea: Global Access to Real-Time Deep-Sea Vent Oceanography

www.researchchannel.org/projects
www.neptune.washington.edu/index.html
www.orionprogram.org
www.lookingtosea.org



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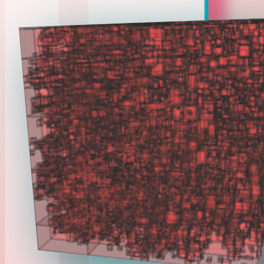
Real-time, uncompressed, high-definition video from deep-sea, high-temperature venting systems (2.2km, ~ 360 °C) associated with active underwater volcanoes off the Washington-British Columbia coastlines, is transmitted from the seafloor robot JASON to the Research Vessel Thompson through an electro-optical tether. An on-board engineering-production crew delivers a live HD program using both ship-board and live sub-sea HD imagery. This program is encoded in real-time in MPEG-2 HD format, and is delivered to shore via the Galaxy 10R communication satellite using a specialized shipboard HD-SeaVision system developed by the UW and ResearchChannel with early support from HiSeasNet.

The MPEG-2 HD satellite signal is downlinked and decoded at the UW in Seattle. The resulting uncompressed HD stream is mixed in real-time with live two-way discussion and HD imagery from participating, land-based researchers working in a studio with undergraduates, K-12 students and teachers. This integrated stream is then transmitted at 1.5Gb to iGrid in San Diego. The transmission utilizes the ResearchChannel's iHD1500 uncompressed HD/IP software on a Pacific Wave lambda over National LambdaRail. Multicast HD streams of the same production are simultaneously transmitted as 20Mb (MPEG-2) and 6Mb (Windows Media 9) streams.

Challenges of this effort include: operating high-definition video in extreme ocean depths amid corrosive, dynamic vent plumes, capturing and processing the video aboard ship, potentially coping with adverse weather, configuring and using satellite links for transmission, and transferring signals from the associated downlink site to a land-based IP network. Exceptional engineering is required to maximize the bandwidth available and to appropriately transmit the video via satellite paths from a moving ship at sea. This appears to be the first live HDTV transmission by cable, from the deep seafloor-to-ship, coupled in real-time with a ship-satellite-shore HD link that is distributed to a broad community of land-based viewers via IP networks.

This mission is an early demonstration of next-generation capabilities being explored for NSF's Ocean Research Interactive Observatory Networks (ORION) program, one potential example being the US-Canadian NEPTUNE project. The demonstration features ongoing research and education supported by the W.M. Keck Foundation, the NSF Ocean Sciences Division and the NSF Office of CyberInfrastructure. Additional support is provided by NOAA's Coastal Science Center, UCSD's Calit2, Scripps Institution of Oceanography, and the Woods Hole Oceanographic Institution. The HD activity is partially sponsored by the NSF-funded LOOKING (Laboratory for the Ocean Observatory Knowledge INtegration Grid) project, which is investigating the requisite cyberinfrastructure necessary to support routine, remote Ocean and Earth science/education of the future.

AMROEBA-EA: Computational Astrophysics Modeling Enabled by Dynamic Lightpath Switching



www.icair.org/igrid2005
http://cosmos.ucsd.edu/enzo
www.cass.ucsd.edu
www.dotresearch.org
www.science.uva.nl/research/air

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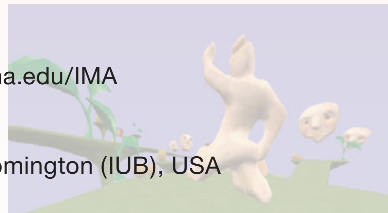
Enzo is a grid-based adaptive mesh refinement (AMR) simulation code for cosmological structure formations, provided by the UCSD Laboratory for Computational Astrophysics at the Center for Astrophysics and Space Sciences. The AMROEBA-EA (Adaptive Mesh Refinement Optical Enzo Backplane Architecture Enabled Application) project investigates the potential for conducting data-intensive Enzo simulations on a distributed infrastructure based on dynamic lightpath provisioning. This project is investigating new mechanisms that allow Enzo processes to understand changing requirements for resources under dynamic conditions, to discover those resources, even if remote, and to optimize their use.

Cabinet of Dreams



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

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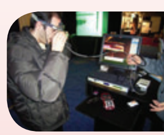
Cabinet of Dreams highlights the Indianapolis Museum of Art's Chinese art collection in 3D virtual reality. Visitors confront surreal worlds: for example, a small mountain landscape with a dragon reveals a philosopher's inkstone; scenes of country pursuits show layers of lacquers upon a brushpot; and, a ritual cooking vessel carries a precious inscription of a man on a chariot. The actual wood, bronze and clay ceremonial pieces range in date from 1000 BC to the mid-1800s. They are mediated on 21st-century collaborative networks in an effort to integrate earlier treasures into an extended version of modern reality.

Collaborative Analysis



www.sandia.gov/isrc/UMBRA.html
www.hlrs.de

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Sandia and HLRS are developing a high-resolution architectural virtual environment in which physically based characters, such as vehicles and dynamic cognitive human avatars, interact in real time with human participants. Collaborative environments, combined with applications for scientific visualization modeling, multiple-player role-play gaming and mixed reality sessions, enable researchers to view updates to high-resolution datasets as if those datasets were local. The datasets are displayed at multiple locations using both unicast and multicast.

Coordination of Grid Scheduler and Lambda Path Service Over GMPLS: Toward Commercial Lambda Path Service

www.gtrc.aist.go.jp/g-lambda

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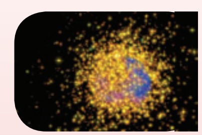
In the future, grid application developers will be able to schedule lightpaths provided by commercial network providers. In this demonstration, a large-scale nano-quantum application utilizes both computational resources and an optical path. The application uses Ninf-G middleware, which calls on a Scheduler that calls on a Lambda Path Resource Manager to request an optical path in a GMPLS control environment, specifying the end nodes' locations and other requirements, such as bandwidth. GMPLS, in turn, programs physical OXCs (optical cross connects) to set up end-to-end lightpaths over multiple domains. The goal is to define a standard interface between the grid and the optical network, which can be used as a tool for realizing emerging new commercial services that both application service providers and commercial network companies will accept.

Data Reservoir on IPv6: 10Gb Disk Service in a Box



http://data-reservoir.adm.s.u-tokyo.ac.jp
http://grape-dr.adm.s.u-tokyo.ac.jp

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The Data Reservoir project's goal is to create a global grid infrastructure for scientific disciplines, to enable distributed data sharing and high-speed computing for data analysis and numerical simulations. At the center of this infrastructure is the 2-PFLOPS system being developed as part of the GRAPE-DR project, to be operational in 2008. At iGrid, storage services that use the GRAPE-DR's single-box high-density 10Gb storage server and an IPv6 fast TCP data transfer protocol demonstrate, for the first time, 10Gb TCP utilization in a production environment. By using "inter-layer coordination optimization" for TCP on both IPv4 and IPv6, 10Gb storage services can be realized using only a few TCP streams, providing new opportunities for large-scale data sharing. This project receives funding from the Special Coordination Fund for Promoting Science and Technology, MEXT, Japan.

DataWave: Ultra-High-Performance File Transfer Enabled By Dynamic Lightpaths

www.icair.org/igrid2005
www.teraflowtestbed.net
www.icair.org/PhotonicDataServices
www.science.uva.nl/research/air

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Science applications generate extremely large files that must be globally distributed. Most network performance methods focus on memory-to-memory data transfers as opposed to data-file-to-data-file. The DataWave project demonstrates the potential for transferring extremely large files internationally using dynamic Layer 1 services.

Dead Cat

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Using a small handheld display device, viewers in San Diego "see" inside the body of a small panther in a bottle of formaldehyde (or a similar substitute). The handheld device's location, relative to the animal, is tracked, and its coordinates are transferred to Amsterdam, where a volumetric dataset of a small panther, created with a CT scan, is stored. Information is extracted from the database, rendered, and volumetric pictures/frames are sent back to the display, creating a stunning real-time experience.

Additional support provided by SARA Computing and Networking Services (SARA), Virtual Laboratory for eScience (VL-e), Academic Medical Center (AMC), Silicon Graphics Inc. (SGI), Advanced Realtime Tracking (ART, GmbH) and GigaPort.

Dynamic Provisioning Across Administrative Domains

http://hopi.internet2.edu
http://evlbi.haystack.mit.edu
http://dragon.east.isi.edu

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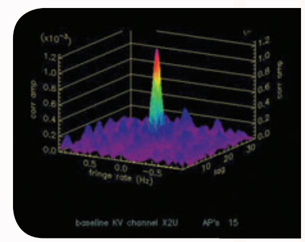

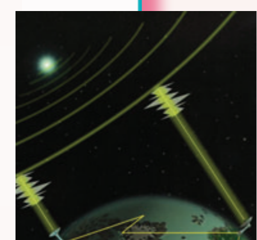

collaborators ESLEA

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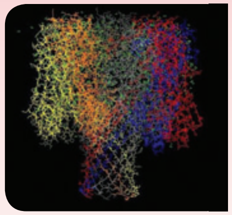
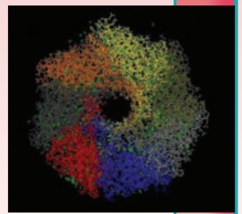
Dynamic Resource Allocation via GMPLS Optical Networks (DRAGON) demonstrates dynamic provisioning across multiple administrative domains to enable Very Long Baseline Interferometry (VLBI). Using simultaneous observations using radio telescopes in the USA (MIT Haystack), Japan (Kashima) and Europe (Onsala in Sweden, Jodrell in the UK, Westerbork in The Netherlands), scientists collect data to create ultra-high-resolution images of distant objects and make precise measurements of the Earth's motion in space. The HOPI testbed facilitates connectivity between various domains across the globe to simultaneously transfer VLBI data from these stations to the MIT Haystack Observatory at 512Mb/station, where the data is cross-correlated in real time, and then sent to iGrid where the results are visualized in real time.

ESLEA

www.eslea.uklight.ac.uk





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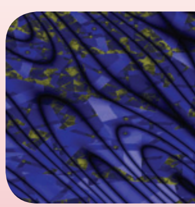
The UK e-Science ESLEA (Exploitation of Switched Lightpaths for eScience Applications) project demonstrates the benefits of switched lightpaths for scientific applications using UKLight. At iGrid, UKLight is used to move data for three e-science disciplines: high-energy physics, computational science, and radio astronomy. In the high-energy physics application demonstration, data is moved at gigabit speeds between disk servers in the UK and on the iGrid floor. Visualizations of the transfers show real-time analysis of the transport protocols and also insight into the operation of the computer buses themselves as the data is moved. In the computational science demonstration, the RealityGrid steering framework is used with SPICE (Simulated Pore Interactive Computing Experiment), to show how a researcher can perform simulation and visualization of complex condensed matter, running at meso- and nano-scales, on high-performance machines at the University of Manchester and the TeraGrid at the Pittsburgh Supercomputer Center. This work is helping scientists understand DNA translocation across protein nano-pores in lipid membranes. In addition to this presentation, ESLEA researchers are participating in the demonstration “Dynamic Provisioning Across Administrative Domains,” in which real-time radio astronomy data is transported from Jodrell Bank (UK), Onsala (Sweden) and Westerbork (Netherlands) to the correlator at MIT Haystack.

Exploring Remote and Distributed Data Using Teraflows

www.teraflowtestbed.net
www.icair.org/PhotonicDataServices



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High-performance data services for data exploration, data integration and data analysis are demonstrated; these services are designed to scale to 1Gb and 10Gb networks. These services are layered over the High-Performance Protocols (HPP) toolkit. In turn, these network protocols are layered over services for setting up, monitoring, and tearing down optical paths. Applications built with these data services demonstrate what are sometimes called “photonic data services,” i.e., advanced Layer-3 protocols and services that are closely integrated with Layer-2 and Layer-1 services. The latter is based on dynamic lightpath switching and supported by advanced optical control planes and leading-edge photonic technologies.

First Functional Demonstration of OVC/Terabit LAN with SAGE

www.evl.uic.edu/cavern/terabitlan/index.html

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The Terabit LAN/WAN project focuses on parallelism in switching and transporting multiple lambdas. Switching is done by the applications; applications create a Lambda Group Path (LGP) and specify the number of lambdas, or channels, in each LGP. Each LGP is logically treated as one end-to-end optical path, so during parallel transport, the LGP channels have identical optical paths and no relative latency deviation occurs. However, optical path diversity (due to restoration) or group velocity dispersion in optical fibers can cause LGP relative latency deviations and negatively affect quality of service, particularly in applications involving streaming media. NTT’s OVC (Optical Virtual Concatenation) hardware compensates for relative latency deviations to achieve a virtual terabit bulk transport. Using the EVL-developed SAGE application, 2x1GE video streams are sent from Chicago to San Diego for display on a 2x1 tiled display. An LGP with two channels is established. Tests are performed in which the channels have identical paths and then different paths, and with OVC turned “on” and OVC turned “off.” OVC eliminates relative latency deviation, or jitter, which is visually apparent as poor synchronization between the two images on the tiles of the display. OVC is realized by the OTN (Optical Transport Network) function defined in ITU-T recommendation G.709.

From Federal Express to Lambdas: Transporting SDSS Data Using UDT

www.teraflowtestbed.net
www.sdss.org

contact

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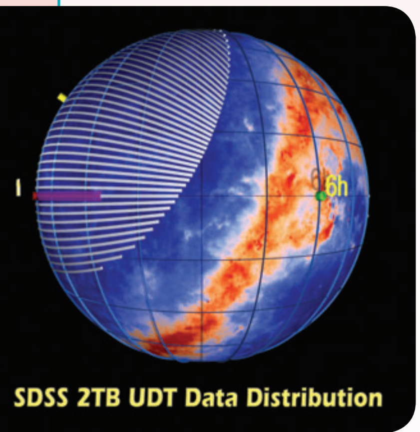

collaborators

NCDM, UIC, USA: Robert Grossman, Yunhong Gu, David Hanley, Mike Sabala, David Turkington, Shirley Connelly • Johns Hopkins University, USA: Alex Szalay • Korea Astronomy and Space Science Institute, Korea: Changbom Park, Jongsoo Kim, Bongkyu Kim • Korea Institute of Science and Technology Information, Korea: Minsun Lee • Department of Astronomy, School of Science, University of Tokyo, Japan: Sadanori Okamura • National Astronomical Observatory, China: Chenzhou Cui, Yongheng Zhao • Chinese Academy of Sciences, China: Kai Nan • School of Physics, University of Melbourne, Australia: David Barnes • Max-Planck-Institut für Plasmaphysik, Germany: Hermann Lederer

Until now, Sloan Digital Sky Survey (SDSS) datasets have been shared with collaborators using Federal Express. Optical paths and new transport protocols are enabling these datasets to be transported using networks over long distances. The SDSS DR3 multi-terabyte dataset is transported between Chicago and various sites in Europe and Asia using NCDM's data transport protocol UDT (UDP-based Data Transport Protocol) over the Teraflow Testbed. The Teraflow Testbed is an infrastructure designed to test new 10Gb network protocols and data services with high-volume data flows, or teraflows, over both traditional routed networks as well as optical networks.

GLVF: An Unreliable Stream of Images

http://home.sara.nl/~bram/usoi
www.evl.uic.edu/cavern/glvf

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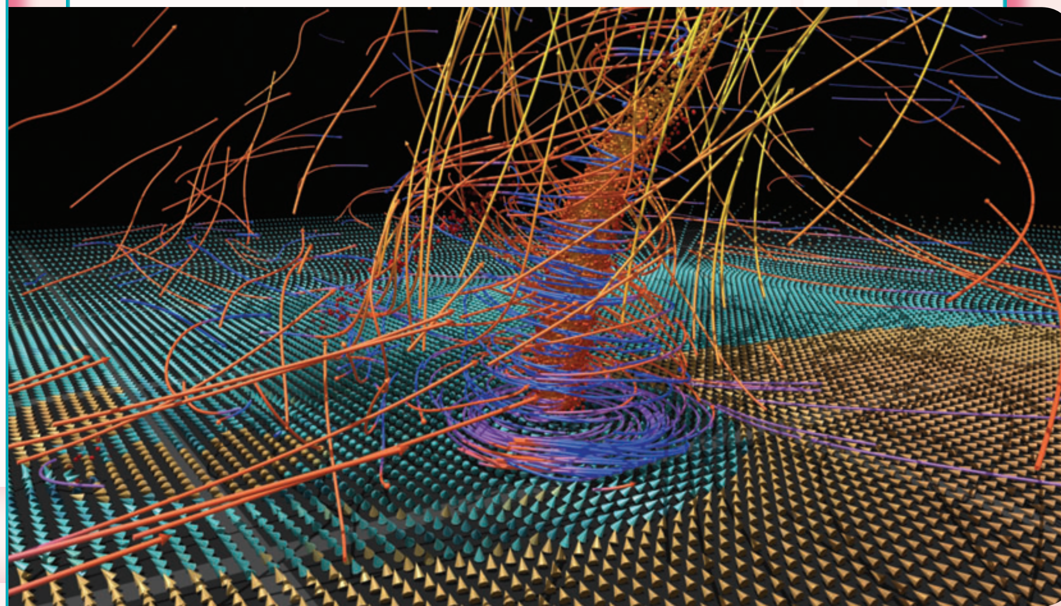
SARA has developed a light-weight system for visualizing ultra-high-resolution 2D and 3D images. A key design element is the use of UDP, a lossy network protocol, which enables higher transfer rates but with possible resulting visual artifacts. The viewer may tolerate these artifacts moreso than lower throughput, as the artifacts have a short lifespan. At iGrid, this lossy approach is compared to the more robust SAGE system. (See iGrid demo "GLVF: Scalable Adaptive Graphics Environment.") Visualization scientists from the USA, Canada, Europe and Asia are creating the Global Lambda Visualization Facility (GLVF), an environment to compare network-intensive visualization techniques on a variety of different display systems.

GLVF: NCSA Streaming High-Definition Stereo of Computational Scientific Visualizations

www.ncsa.uiuc.edu/AboutUs/People/Divisions/divisions4.html
www.evl.uic.edu/cavern/glvf



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A bulk movie playback package (bplay) integrated into the OptIPuter's Scalable Adaptive Graphics Environment (SAGE) coordinates and displays multiple incoming streams of high-definition digital images over optical networks. NCSA participates in the Global Lambda Visualization Facility (GLVF). This research is funded by the USA National Science Foundation OptIPuter and LOOKING projects, the Office of Naval Research and the State of Illinois. Future plans include connecting NCSA to ACCESS DC and TRECC DuPage with optical networks for collaboration among sites.

The following high-definition, uncompressed, stereo visualizations are being streamed from NCSA to iGrid:

- Development of an F3 Tornado within a Simulated Supercell Thunderstorm (Simulation by: Wilhelmson, Gilmore, et. al., UIUC, USA; Wicker, NSSL/NOAA, USA)
- Jet Instabilities in a Stratified Fluid Flow (Simulation by: Kraig Winters, Scripps Institute of Oceanography, UCSD, USA)
- Flight to the Galactic Center Black Hole (a visual excerpt from “Blackhole: The Other Side of Infinity,” a planetarium dome production by the Denver Museum of Nature and Science, NCSA, and Thomas Lucas Productions, USA)
- Interacting Galaxies in the Early Universe (Simulation by: Michael Norman, Brian O’Shea, UCSD, USA)

GLVF: Personal Varrier Auto-Stereoscopic Display

www.evl.uic.edu/core.php?mod=4&type=1&indi=275
www.evl.uic.edu/cavern/glvf

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This demonstration of the new NSF-funded Personal Varrier display shows how auto-stereo enables 3D images to be easily integrated into the work environment. Personal Varrier demonstrations include a networked teleconference between Chicago and San Diego using EVL-developed TeraVision to stream video, and local demonstrations of the European Space Station’s Hipparcos star data, NASA’s Mars Rover imagery, and various test patterns. UIC participates in the Global Lambda Visualization Facility (GLVF).

GLVF: Scalable Adaptive Graphics Environment

www.evl.uic.edu/cavern/glvf
www.evl.uic.edu/cavern/sage
www.evl.uic.edu/luc/cytoviz

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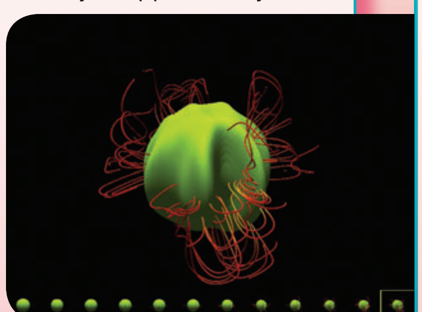
The OptIPuter project's Scalable Adaptive Graphics Environment (SAGE) system coordinates and displays multiple incoming streams of ultra-high-resolution computer graphics and live high-definition video on the 100Megapixel LambdaVision tiled display system. Network statistics of SAGE streams are portrayed using CytoViz, an artistic network visualization system. UIC participates in the Global Lambda Visualization Facility (GLVF). SAGE is a research project of the UIC Electronic Visualization Laboratory, supported by the OptIPuter project.

GLVF: The Solutions Server over Media Lightpaths

www.westgrid.ca/support/collab/collabviz.php
www.irmacs.ca
www.evl.uic.edu/cavern/glvf



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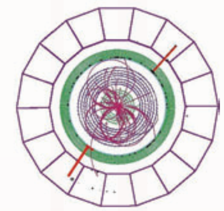
The University of Alberta's Solutions Server is a suite of tools that couples live computational simulation with visualizations. The Solutions Server, combined with SGI's VizServer software, streams visualizations to computer consoles of distantly located scientists and engineers over the WestGrid dedicated Gigabit network. The Media Lightpaths project seeks to move toward configurable lightpaths to support on-demand visualizations among non-WestGrid collaborators. Ultimately, the goal is to integrate the User Controlled LightPath (UCLP) technology with the Access Grid. WestGrid peers with Canada's CA*net 4 infrastructure at a number of locations. Simon Fraser University and the University of Alberta are participants in the Global Lambda Visualization Facility (GLVF).

WestGrid core network is provided by BCNet (British Columbia advanced Network), Netera (Alberta advanced network) and CANARIE. Media LightPaths project is funded by CANARIE.

Global Lambdas for Particle Physics Analysis



http://ultralight.caltech.edu/web-site/igrid

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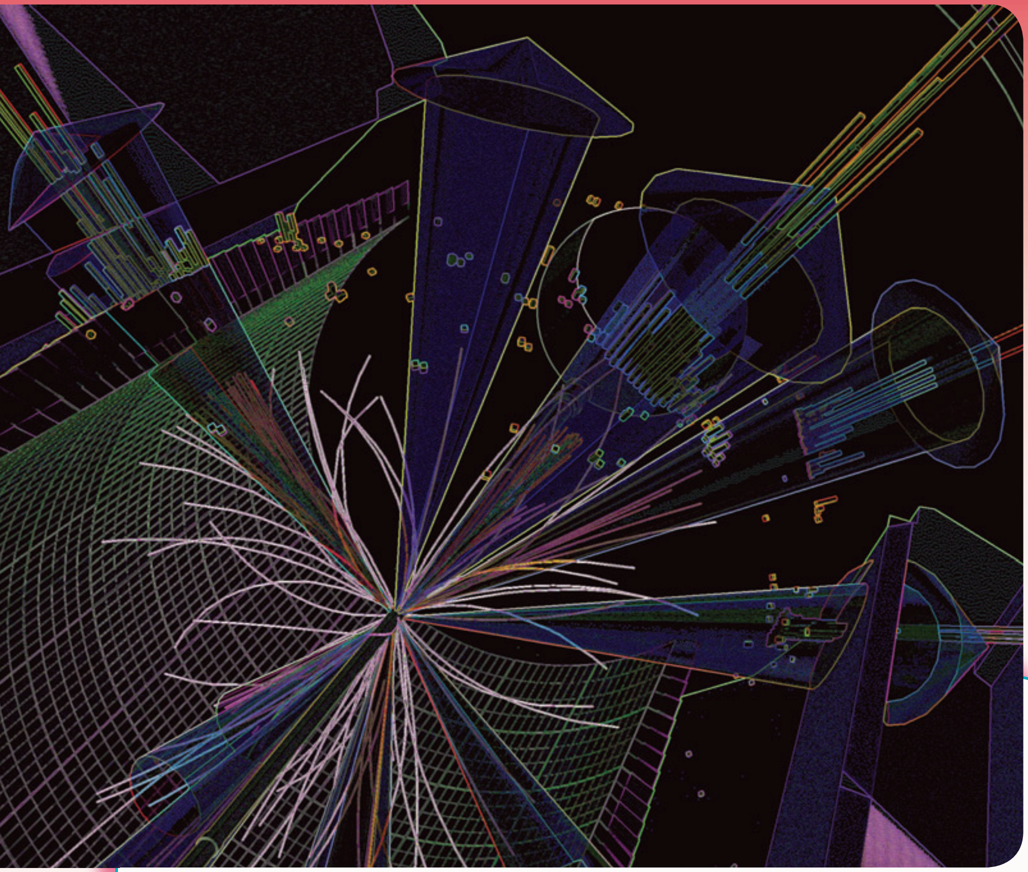
Caltech, USA: Julian Bunn, Harvey Newman, Conrad Steenberg, Rick Wilkinson, Suresh Singh, Xun Su, Michael Thomas, Yang Xia, Iosif LeGrand, Saima Iqbal, Frank Van Lingen, Dan Nae • Stanford Linear Accelerator Center (SLAC), USA: Les Cottrell, Richard Mount • Fermi National Accelerator Laboratory (FNAL), USA: Don Petravick • University of Florida, USA: Richard Cavanaugh • University of Michigan, USA: Shawn McKee • CERN: David Foster • Korea Advanced Institute of Science and Technology, Korea: Yusung Kim • Kyungpook National University, Korea: Kwon Kihwon • Universidade do Estado do Rio de Janeiro, Brazil: Alberto Santoro, Moacyr Souza, Andre Sznajder, Jose Afonso, Eduardo Revoredo • University of Manchester, UK: Richard Hughes-Jones • GLORIAD, USA: Greg Cole, Natasha Bulashova • Cisco Systems, Inc., USA: Doug Walsten

Caltech, SLAC and FNAL use advanced networks to demonstrate analysis tools that will enable physicists to control worldwide grid resources when analyzing major high-energy physics events. Components of this "Grid Analysis Environment" are being developed by such projects as UltraLight, FAST, PPDG, GriPhyN and iVDGL. The iGrid demonstration shows how a physicist can issue on-demand network and resource provisioning in response to event analysis requests from his desktop computer. A request's complex workflows are translated using provisioning algorithms into network flow allocations and scheduled resource bookings on remote computers/clusters. Caltech's MonALISA monitoring framework illustrates the progress of the analysis tasks, data flows in the network, and the effects on the global system.



Global N-Way Interactive High-Definition Video Conferencing over Long-Pathway, High-Bandwidth Networks

www.pnw-gigapop.net
www.researchchannel.org/projects
www.aarnet.edu.au
www.wide.ad.jp
www.surfnet.nl

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This is a demonstration of real-time, high-resolution, high-definition communication with very low latency among multiple sites across the world. People at each site use very-high-quality video conferencing to communicate with the other sites and, in some cases, two-way, completely "uncompressed" (i.e., not compressed) raw HDTV is sent. The University of Washington developed this system in conjunction with the Pacific Northwest GigaPoP, ResearchChannel and AARNet. Other partners include SURFnet, University of Wisconsin-Madison, WIDE and APAC.

Each remote site transmits uncompressed HD video and audio via IP to receivers at the iGrid venue. Each received stream is "tiled" into a single HD stream that is multicast to all the remote sites. In addition, the current speaker is multicast to all the other sites as a single uncompressed HD stream. Participants see both a full-resolution picture of the speaker as well as a tiled display of all the remote video-conference participants. This is the first demonstration of 1.5Gb HD video multicast and the first multi-point video conference using uncompressed HD.

A special session is planned with Larry Smarr, Calit2 director, UCSD computer science professor and iGrid host, extending a welcome from iGrid to the APAC'05 conference in Queensland, Australia. The APAC keynote by Ian Foster, senior scientist and head of the Distributed Systems Laboratory at Argonne National Laboratory and professor of computer science at University of Chicago, is delivered in high definition from Queensland to iGrid in San Diego.

Great Wall Cultural Heritage

www.internationalmediacentre.com/imc/index.html

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An interactive visual presentation using graphical tools and high-resolution videoconferencing enabled by high-speed networks makes it possible for iGrid attendees in San Diego to visit China's Great Wall. Visualizations of CAD environments are combined with high-resolution 3D scans of physical images and satellite imagery stored on servers in China and San Diego. Visualizations focus on the Jinshanlin Section of the Great Wall, located in the Hebei Province of China, which was constructed during the Ming Dynasty. Data acquisition from laser scanning combined with photogrammetry enables the construction of unique cultural heritage images from China and forms the medium by which content can be organized and interactively delivered from China to locations worldwide.

Grid-Based Visualization Pipeline for Auto-Stereo and Tiled Displays

www.isi.edu/~thiebaux/gvu

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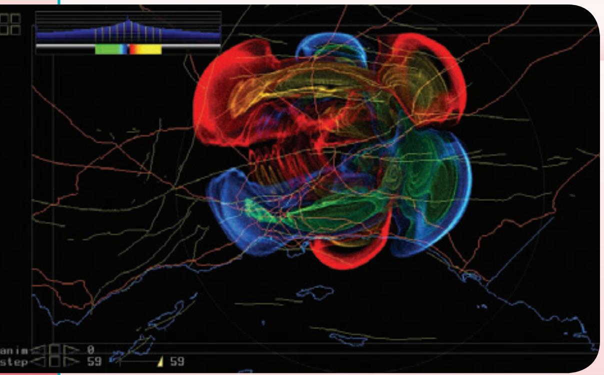

The OptIPuter-supported Grid Visualization Utility (GVU) facilitates the construction of scalable visualization pipelines based on the Globus Toolkit. Scalable pipeline architectures are necessary to sustain interactive browsing of large datasets, such as time-series volumes, by coordinating parallel and remote resources for large-scale data storage, filtering and rendering. ISI demonstrates interactive point splatting of geophysical and biomedical volume data for the Varrier auto-stereo display.

GridON: Grid Video Transcoding using User-Controlled Lightpaths

www.i2cat.net/i2cat/servlet/I2CAT.MainServlet?seccio=2
www.canarie.ca/canet4/uclp/igrid2005/demo.html

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GridON is an application that converts raw SDI video to MPEG-2, using UCLP to create on-demand lightpaths to access appropriate remote computers during the process. GridON first uses UCLP to create an end-to-end connection between San Diego and Barcelona, where SDI film is sent to a "distribution grid center" and segmented into N fragments. Then UCLP is used to create an end-to-end connection between Barcelona and Ottawa; some of the N fragments are then shipped to the Communications Research Centre for conversion to MPEG-2, and then shipped back to Barcelona for reassembly. After the entire film is reassembled, it is sent to San Diego over the first connection provisioned by UCLP for display at iGrid. Last, GridON tells UCLP to tear down the end-to-end connections.

This application is part of the iGrid demo "World's First Demonstration of X GRID Application Switching using User Controlled LightPaths."

HD Multipoint Conference

http://sitola.fi.muni.cz/sitola/igrid

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High-definition (HD) interactive video requires minimal transmission latency to be truly effective, which is afforded by today's optical networks. While point-to-point "raw" HD video streams (i.e., streams with no latency due to encoding) have been successfully demonstrated, multicast HD is more demanding. One raw stream takes 1.5Gb, so multi-site meetings can easily saturate 10Gb links. In addition, it is advantageous to do real-time translation of raw HD video into less demanding formats in order to allow sites without adequate bandwidth to participate. A shared "virtual" lecture hall is created among the iGrid site in San Diego, Masaryk University and Louisiana State University. Each site has at least one HD camera; HD streams are multicast to the other sites at the highest bandwidth. Additional USA and European collaborators can receive/send digital video (DV) streams that are translated in real-time from/to raw HD. Synchronously, the lecture is also sent to a distributed storage system for archiving purposes.

Special thanks to Eric Taborek and Chelsio Communications for providing equipment in support of this demonstration.

Human Arterial Tree Simulation

www.teragrid.org

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Brown University researchers are developing the first-ever simulation of the human arterial tree in collaboration with researchers from ANL, Northern Illinois University and the University of Chicago. The human arterial tree model contains the largest 55 arteries in the human body with 27 artery bifurcations at a fine-enough resolution to capture the flow dynamics as well. This requires a total memory of about 3-7 terabytes, which is beyond the current capacity of any single supercomputing site, and therefore harnesses the true power of the TeraGrid by using multiple sites simultaneously to complete a single simulation – Pittsburgh Supercomputing Center, National Center for Supercomputing Applications and San Diego Supercomputer Center for the computation, and University of Chicago for the visualization.

Interactive 3D HD Video Transport and Collaborative Data Analysis for e-Science over UCLP

www.gloriad-kr.org/iGrid2005
www.canarie.ca/canet4/uclp/igrid2005/demo.html

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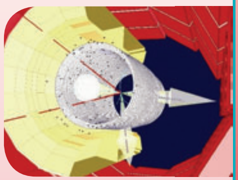

collaborators

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Two projects are demonstrated: high-definition stereo video transmission and distributed data grid developments over UCLP (User Controlled LightPath). In the former, high-quality monoscopic and stereoscopic HD1080i video, both uncompressed and compressed, are transmitted between Daejeon, Korea and San Diego, enabling scientists in Korea and the USA to have interactive discussions about the iGrid demonstrations in an HD environment. The distributed data grid project demonstrates tools being designed as a part of the worldwide Compact Muon Solenoid (CMS) collaboration for CERN's Large Hadron Collider program, to come online in 2007. In the CMS demonstration, simulated CMS data is sent to several sites in Korea for analysis and the results are transferred to iGrid for display in real time.

This application is a part of the iGrid demo "World's First Demonstration of X GRID Application Switching using User Controlled LightPaths." Lightpath resources are provided by CANARIE and CRC, Canada, and those resources are coordinated with other partners, i2CAT/UPC, Spain and NCHC, Taiwan.

Interactive Control of Remote Supercomputer Simulations

www.lcse.umn.edu/PPMdemo

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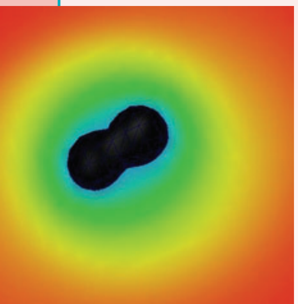
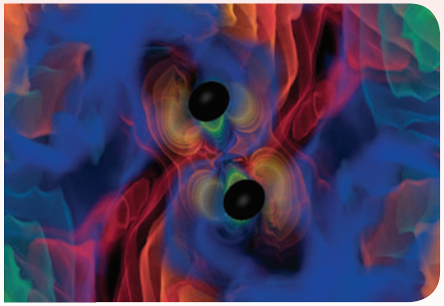
The ability to quickly do short, exploratory runs of PPM simulations of turbulence will have a significant impact on scientific productivity. The Cray Red Storm machine at the Pittsburgh Supercomputer Center has the potential to compute a relatively small problem, on a grid of just 512^3 cells, fast. Previous systems are only able to achieve their best performance on extremely large problems. LCSE demonstrates a prototype computational steering, visualization and data analysis system that will be able to produce volume rendered images from this data at a rate of a few per frames second on its 10-panel PowerWall. Ultimately, data from the complete run, stored on the data archive system at the San Diego Supercomputer Center, will be accessed, compressed and streamed over National LambdaRail for interactive viewing on the PowerWall.

Interactive Remote Visualization across the LONI and the National LambdaRail

www.cct.lsu.edu/Visualization/iGrid2005
www.cactuscode.org
www.gridsphere.org
www.gridlab.org/GAT
www.amiravis.com
http://sitola.fi.muni.cz/sitola/igrid/





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Interactive visualization coupled with computing resources and data storage archives over optical networks enhance the study of complex problems, such as the modeling of black holes and other sources of gravitational waves. At iGrid, scientists visualize distributed, complex datasets in real time. The data to be visualized is transported across the Louisiana Optical Network Initiative (LONI) to a visualization server at LSU in Baton Rouge using state-of-the-art transport protocols interfaced by the Grid Application Toolkit (GAT) and dynamic optical networking configurations. The data, visualization and network resources are reserved in advance using a co-scheduling service interfaced through the GAT. The data is visualized in Baton Rouge using Amira, and HD video teleconferencing is used to stream the generated images in real time from Baton Rouge to Brno and to San Diego. Tangible interfaces, facilitating both ease-of-use and multi-user collaboration, are used to interact with the remote visualization.

International Real-Time Streaming of 4K Digital Cinema

www.calit2.net

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Live and pre-recorded 4K content, with four times the resolution of HDTV, is compressed using JPEG 2000 at 200-400Mb and streamed in real-time via 1Gb IP networks, from Keio University in Tokyo to iGrid 2005 in San Diego. 4K content includes materials shot with digital motion picture cameras and digital still cameras, pre-rendered computer animations, real-time computer-generated visualizations, and digitally scanned 35mm and 65mm motion-picture film.

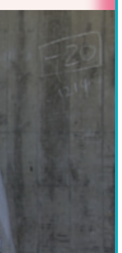
Using the JGN-II/NiCT and GEMnet2 links across the Pacific Ocean, a combination of Layer-2 and Layer-3 networks is configured using NTT Labs' FLEXCAST technology, which enables multicast over IP unicast networks to deliver the 4K content simultaneously to two playback systems at the iGrid 2005 venue. An HD-over-IP side-channel for interactive video conferencing between Keio and iGrid is also implemented using HDTV cameras and MPEG-2 MP@HL codecs operating at 30-50Mb.

Content contributors:

- Guttenberg Bible – Keio University Library
- Indonesian Arts – NiCT
- Japanese Arts – Olympus
- Nijo Castle – Toppan
- Noh Performance – DMC and Naohiko Umewaka
- Anime – Mits Kaneko, CTC/Tokyo University of Technology
- Study of 4D Julia Sets – Dan Sandin, EVL/UIC
- Milky Way Fly-Through – Donna Cox, Bob Patterson, NCSA/UIUC

- Tornado Simulation – Donna Cox, Bob Patterson, NCSA/UIUC
- Digital Plants – Richard Weinberg, USC/School of Cinema-TV
- Blue Cavier – Michael Forsberg, USC/School of Cinema-TV
- Circle of Love – ARRI
- Mystic India Trailer – BAPS Swaminarayan Sanstha, Keith Melton
- GeoFusion – Eric Frost, SDSU
- Digital Dailies – PixelFarm, DALSA

Special thanks to the generous cooperation of Sony Electronics USA, SGI and SGI Japan, Olympus Corporation and ASTRODESIGN Inc.



International 10Gb Line-Speed Security

www.evl.uic.edu

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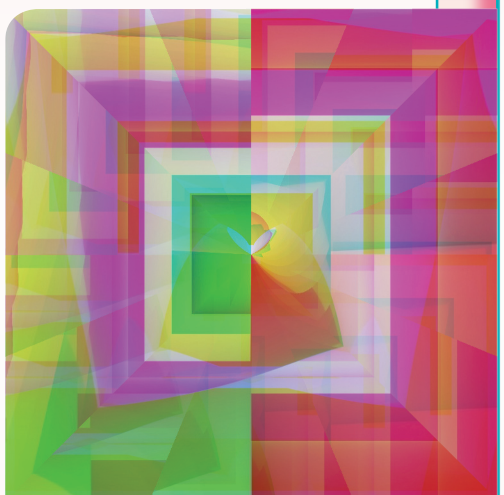

This security demonstration uses AES-256 encryption and OME switching hardware to send encrypted streaming media at 10Gb speeds with minimal latency from Nortel's Ottawa facility, and from Amsterdam, through StarLight in Chicago, to iGrid in San Diego. Such capability is desirable for many applications of lightpaths to reduce vulnerability to theft or modification of commercially valuable information. Applications can enable and disable the encryption on demand during the iGrid demonstration.

IPv4 Link-Local IP Addressing for Optical Networks

www.science.uva.nl/research/air

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When setting up lightpaths, the end nodes use IP addresses to communicate. Address assignment is now done manually. An automatic solution is demonstrated that uses IPv4 link-local addresses while retaining the authenticity of the hosts.

Large-Scale Multimedia Content Delivery over Optical Networks for Interactive TV Services

http://itvp.psnc.pl/en

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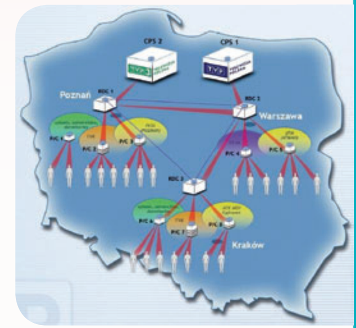

A high-quality multimedia content delivery system is being developed for National Public Television of Poland, for delivery of live TV, Video-on-Demand and Audio-on-Demand with interactive access over broadband IP networks. While terrestrial, satellite and cable platforms are used for digital TV distribution, only a completely IP-based solution offers true interactivity, enabling the creation of new content access services. PSNC has developed a scalable architecture Content Delivery System (CDS), in which Regional Data Centers (RDCs) can obtain content from content providers and then distribute it among themselves and to lower-level proxy/cache servers. A prototype installation has RDCs in Warsaw, Cracow and Poznan, and is able to provide service for up to 15,000 users. The content is digitally encoded with an MPEG-4 compatible codec at 1.5Mb. During iGrid, one CDS node is set up in San Diego. Multimedia content is sent over a Gigabit link from RDC Poznan to San Diego, triggered by many simultaneous user requests. iGrid attendees see firsthand the quality of the response time and media delivery. The prototype CDS system is deployed by PIONIER, the Polish National Research and Education Optical Network.

Large-Scale Simulation and Visualization on the Grid with the GridLab Toolkit and Applications

www.gridlab.org/Software/index.html

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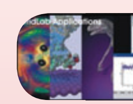

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GridLab is one of the biggest European research projects for the development of application tools and middleware for Grid environments, and will include capabilities such as dynamic resource brokering, monitoring, data management, security, information, and adaptive services. GridLab technologies are being tested with Cactus (a framework for scientific numerical simulations) and Triana (a visual workflow-oriented data analysis environment). At iGrid, a Cactus application runs a large-scale black-hole simulation at one site and writes the data to local discs, and then transfers all the data to be post processed and visualized to another site. In the meantime, the application checkpoints and migrates the computation to another machine, possibly several times due to external events such as system performance is decreasing or a machine is going to be shutdown. Every application migration requires a transfer of several gigabytes of checkpoint data, together with the output data for visualization. The European Commission under the 5th Framework Programme funds GridLab.

LightForce: High-Performance Data Multicast Enabled By Dynamic Lightpaths

www.icair.org/igrid2005

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Advanced applications require reliable point-to-point transport of extremely large data files among multiple nodes. Currently no communication service meets these data transport needs cost effectively. LightForce demonstrates the potential for transporting multiple gigibits of data with virtually no jitter by exploiting the capabilities of dymanic lightpath switching. It uses dynamic Layer-1 services and rapidly changing topologies that integrate multiple source and destination nodes, including remote nodes. Key technologies demonstrated include transparent mapping, lightpath control algorithms, resource allocation, arbitration among contending demands, extended FEC, error control, traffic stream quality, performance monitoring, and new protocols that exploit enhanced methods for low levels of BER.

Opening a University Fiber Highway between Mexico and the USA

http://iGridMX.cicese.mx

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Optical fiber newly installed between San Diego and Tijuana, and ultimately extending down to CICESE in Ensenada in the Baja California Peninsula, is enabling collaborative USA/Mexican research in Earth, oceanographic and atmospheric sciences. At iGrid, 3D visualizations of shared terrain enable scientists to better understand the consequences of fires, floods, and earthquakes, which have no geographical boundaries. Environmental modeling and simulation visualizations fed by real-time sensor information combined with legacy visualizations provide hybrid visualizations for situational awareness for public safety, economic effect assessment, and shared Homeland Security.

PRIME: Pacific Rim Research Experiences for Undergraduates

http://prime.ucsd.edu
www.pragma-grid.net

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UCSD undergraduate students discuss their experiences working at selected destinations in Australia, China, Japan, and Taiwan this summer with groups of researchers who are members of PRAGMA, the Pacific Rim Assembly for Grid Middleware and Applications. The USA National Science Foundation, which supports PRAGMA, also funded these research experiences for undergraduates, to better prepare students for the global workplace of the 21st century. Calit2 also supported this program.

Real-Time Multi-Scale Brain Data Acquisition, Assembly, and Analysis using an End-to-End OptIPuter

http://ncmir.ucsd.edu/iGrid2005

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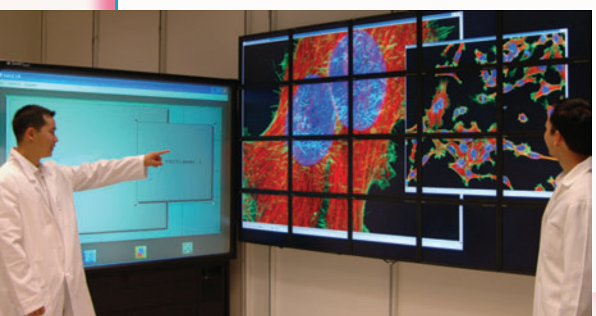

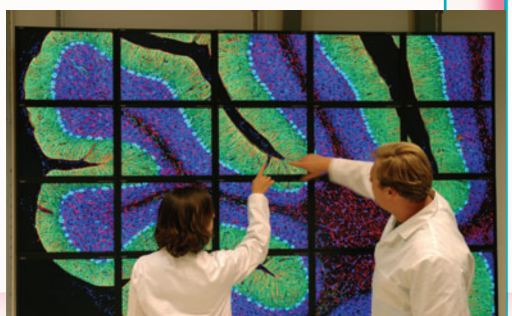

The operation of a scientific experiment on a global testbed consisting of visualization, storage, computational, and network resources is demonstrated. These resources are bundled into a unified platform using OptIPuter-developed technologies, including dynamic lambda allocation, advanced transport protocols, the Distributed Virtual Computer (DVC) middleware, and a multi-resolution visualization system running over the Scalable Adaptive Graphics Environment (SAGE). With these layered technologies, runs a multi-scale correlated microscopy experiment where a biologist images a sample and progressively magnifies it, zooming from an entire system, such as a rat cerebellum, to an individual spiny dendrite. Using both the 100Megapixel LambdaVision display and the autostereo Personal Varrier, scientists can effectively and simultaneously view every step of a multi-scale microscopy correlation process, viewing large 2D scenes and 3D subsections of the scene while comparing them to dozens of possible contexts and matching these to live video output of an electron microscope.

Real-Time Observational Multiple Data Streaming and Machine Learning for Environmental Research using Lightpaths

www.canarie.ca/canet4/uclp/igrid2005/demo.html
http://ecogrid.nchc.org.tw/igrid2005/demo.html

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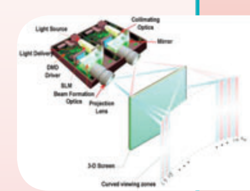
The Ecogrid is a grid-based ecological and biological surveillance system that uses sensors and video cameras to monitor Taiwan's coral reef ecosystem and wildlife behavior. Based on grid technologies, the Ecogrid can be regarded as an open-layered pipeline: the sensors collect raw images and transmit information over IP; grid middleware is used for distributed computing and data storage; and, then the data is analyzed, synthesized and archived for scientific discovery. At iGrid, images from high-definition underwater monitoring cameras in the coral reef reserve of Kenting, Taiwan, and from an innovative omni-directional camera for telepresence from Osaka, are streamed to San Diego, demonstrating the technologies that have been developed for real-time data streaming. Also shown is stereo image streaming, which is currently being studied as a way to do machine learning. Using UCLP, a single end user controls the setup of lightpaths between Taiwan and North America.

TWAREN (Taiwan Advanced Research and Educational Network), provided by NCHC, provides 2.5Gb between Taiwan and the USA. This application is part of the iGrid demo "World's First Demonstration of X GRID Application Switching using User Controlled LightPaths."

Real-Time True-3D/HDTV (No Goggles) Visualization Over the National LambdaRail



www.poc.com/emerging_products/3d_display/default.asp

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NASA and Physical Optics Corporation demonstrate a holographic 3D HDTV video display system that does not require goggles or other special head gear, using a live cross-country video feed from NASA GSFC to the iGrid 2005 site in San Diego. Physical Optics Corporation is a NASA SBIR Phase 1 awardee, and worked with NASA GSFC on this project.

Rutopia2

www.evl.uic.edu/animagina/rutopia/rutopia2

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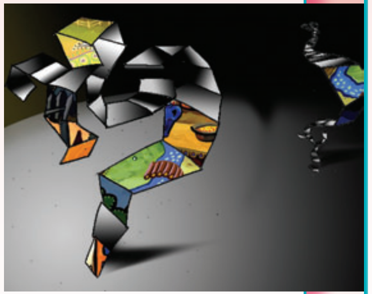

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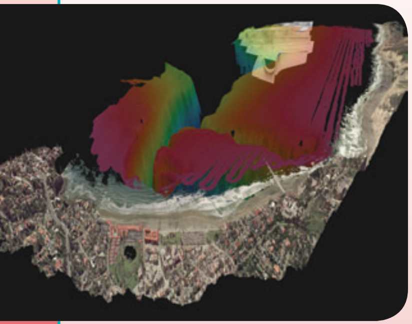
Rutopia2 continues the tradition of Russian folktales by combining traditional folkloric utopian environments with futuristic technological concepts. This virtual-reality art project describes a futuristic sculpture garden with geometric-formed trees that change their shapes in real time under user control. Each tree module is a “monitor,” or mirror, into other worlds that are reflected onto the geometric planes of the trees in high resolution.

Scientific Collaboration with Parallel Interactive 3D Visualizations of Earth Science Datasets

www.siovizcenter.ucsd.edu/optiputer/igrid2005.html



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The ability to transfer multi-gigabyte objects among remote collaborating sites is an enabling technology for the Earth sciences. For this demonstration, the OptIPuter’s Distributed Virtual Computer (DVC) middleware is used to establish a collaborative environment with visualization endpoints at UCSD and UC-Irvine. OptIPuter’s Composite Endpoint Protocol (CEP) and Group Transport Protocol (GTP), two cluster-to-cluster transport protocols, are used to efficiently send multi-gigabyte 3D scene files from the various storage sites for interactive visualization on tiled displays at the visualization sites.

SPIN and ISON to Support Emerging Collaborative Applications

www.evl.uic.edu/cavern/anr/optical.html

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As deployment of local LambdaGrid domains based on wavelength-routing optical networks gains momentum, there is increasing demand to interoperate them for the deployment of global collaborative grid applications. The SPIN (Secure Photonic Interdomain Negotiator) network control plane enables seamless deployment of global collaborative grid applications over a multi-domain wide-area LambdaGrid with secure interdomain access to shared optical resources. In addition, an increasing number of collaborative grid applications require multimedia traffic support as they generate variable-rate streaming and bursty traffic. The Integrated Services Optical Network (ISON) enables a multi-purpose LambdaGrid capable of efficiently supporting multimedia collaborative grid applications with diverse networking bandwidth and communication requirements. At iGrid, scientists use a SPIN-based optical networking monitor and an ISON-based dataset portal application to post, mine and visualize scientific datasets in a multi-domain LambdaGrid.

Token-Based Network Element Access Control and Path Selection

www.science.uva.nl/research/air

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For grid computing to successfully interface with control planes and firewalls, new security techniques must be developed. Traditional network access security models either use an "outsourcing" model or an (OGSA-based) "configuration" model. The "push," or token, model, demonstrated here, works at lower network levels. In this model, an application's or user's access rights are determined by a token issued by an authority. The token is used to signal the opening of the data path. The advantage of using tokens is that a path can be pre-provisioned and an application or user holding tokens can access the network resource potentially faster then in the other models.

Transfer, Process and Distribution of Mass Cosmic Ray Data from Tibet
http://argo.ihep.ac.cn

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The Yangbajing (YBJ) International Cosmic Ray Observatory is located in the YBJ valley of the Tibetan highland. The ARGO-YBJ Project is a Sino-Italian Cooperation, which was started in 2000 and will be fully operational in 2007, to research the origin of high-energy cosmic rays. It will generate more than 200 terabytes of raw data each year, which will then be transferred from Tibet to the Beijing Institute of High Energy Physics, processed and made available to physicists worldwide via a web portal. Chinese and Italian scientists are building a grid-based infrastructure to handle this data, which will have about 400 CPUs, mass storage and broadband networking, and which is demonstrated at iGrid.

UCLP-Enabled Virtual Design Studio
www.cims.carleton.ca
http://phi.badlab.crc.ca/uclp
www.canarie.ca/canet4/uclp/igrid2005/demo.html

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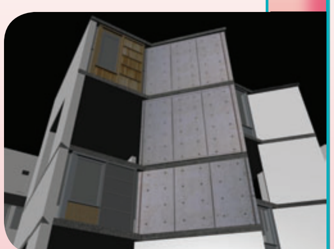

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In this collaborative architectural design process, the Virtual Design Studio (VDS) application uses UCLP to access remote visualization and data cluster arrays to create a sophisticated production environment for the 3D digitization of existing conditions and urban and architectural design workflows. The demonstration involves the digital reconstruction of the Salk Institute in La Jolla, CA. VDS assembles a collaborative work environment by incorporating variable and heterogeneous digital landscapes of maps and survey data, orthographic CAD drawings, photographs, 3D non-contact imaging data (such as laser scanning and photogrammetry), 3D models, and other digital imaging and visualization techniques. Advanced networks, UCLP and high-definition video teleconferencing enable effective computer-supported collaborative work.

This application is part of the iGrid demo "World's First Demonstration of X GRID Application Switching using User Controlled LightPaths." Additional resources are provided by Canada's Society of Arts and Technology, Canada.

Virtual Laboratory on Demand
http://vlab.psnc.pl

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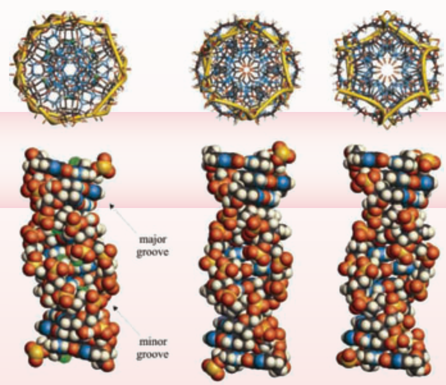

While grid computing lets researchers access equipment remotely, there is no way to monitor what's happening locally. The Virtual Laboratory (VLAB) project is a framework to enable end users to directly access and monitor usage of grid resources (workflow, accounting, job prioritization), particularly remote, expensive instrumentation, such as in chemistry (spectrometer), radio astronomy (radio telescope) and medicine (CAT scanner). In Europe, the architecture utilizes the GÉANT pan-European network and national optical networks like PIONIER in Poland. At iGrid, VLAB is used to run remote instruments in Poland – spectrometers and a radio telescope – and real-time visualization and video stream feedback is sent to San Diego to provide feedback to local users.

Virtual Unism

www.evl.uic.edu/virtualunism
www.gosiakoscielak.com

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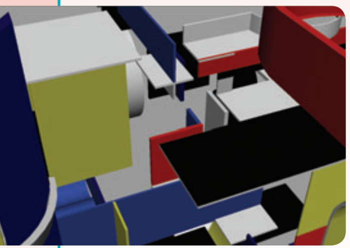

Sculptress Katarzyna Kobro and painter Wladyslaw Strzeminski are two early 20th century art pioneers who created the Unism art movement. In their 1931 book “Space Compositions: Space-Time Rhythm and Its Calculations,” they describe the mathematics of open spatial compositions in terms of a ratio 8:5. They developed the theory of the organic character of sculpture, a fusion of Strzeminski’s Unistic theory of painting and Kobro’s ideas about sculpture’s basis in human rhythms of movement, time-space rhythm, and mathematical symbolism. Virtual Unism is a networked art piece that explores how Unistic theories can be translated, interpreted and extended to virtual reality to create harmonic experiences that address the human senses, such as sight with visuals, hearing with sound, and balance with movement.

VM Turntable: Making Large-Scale Remote Execution more Efficient and Secure with Virtual Machines Riding on Dynamic Lightpaths

www.science.uva.nl/research/air

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Traditional grid computing focuses on remote computing and data analysis, while the underlying network resources are treated as separate and inflexible. Recent advances in controllable and dynamic lightpaths extend the meaning of “remote execution” to include the networks themselves, creating an environment that permits orchestration of computation+data+network resources. With this capability three problems associated with remote execution are addressed: (a) the elusive locality of data references (with computation and working datasets that often end up being separated by a whole ocean), (b) confidentiality and integrity (with sensitive programs and/or data at the mercy of subtly compromised, bugged hosting environments), and (c) portability, versioning woes in the presence of end systems’ complex software stacks. The VM Turntable is structured around Xen-based Linux Virtual Machines that can be migrated in real time while still supporting live applications – transporting the whole set of memory pages and hard disk contents to various destinations. The

“Service-Oriented Architecture (SOA) allows everything from the individual components of the physical optical network infrastructure up to the highest abstraction of an application to be represented as a web service. With SOA, we can represent the optical network, or its constituent components, as web services that can be linked or integrated directly with application web services. In this way, the network becomes an integral part of the application, and not an infrastructure layer akin to the telephone or electricity. The network can now have a peer-to-peer relationship with the application, as opposed to being an underlying transport service, and can even be extended deeply into the application or server.

CANARIE and its partners have used SOA tools and techniques through the UCLP (User Controlled Lightpath) program to provide users with complete control of the network, including the ability to self provision, integrate heterogeneous network resources, deploy their own control plane, attach their own virtual routers, and, in turn, offer these same capabilities to their users.

The ability of users to own, control and manage their own networks with SOA will have a profound impact on network economics. Already we are seeing many large organizations, such as Google, acquire their own fiber and wavelengths in order to reduce network costs, but also to increase the network’s flexibility and security. UCLP with SOA will enable organizations large and small to do the same thing.”

Bill St. Arnaud, CANARIE

live migration of Virtual Machines exploits a high degree of pipelining between the staggered operations of assembling the data to be transferred, verifying its integrity, and finally halting and transferring execution. To maintain lightpath security, the VM Turntable utilizes a token-based approach to efficiently enforce policies at both the bearer and control path levels (see the iGrid application "Token-Based Network Element Access Control and Path Selection"). At iGrid 2005, the VM Turntable live-migrates the execution of a search-refine iterative workflow against unique datasets located in Amsterdam, Chicago and San Diego.

World's First Demonstration of X GRID Application Switching using User Controlled LightPaths

www.canarie.ca/canet4/uclp/igrid2005/demo.html

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collaborators

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Researchers from CANARIE and CRC in Canada, NCHC in Taiwan, KISTI in Korea and i2CAT in Spain are collaborating on the world's first demonstration of multiple end users dynamically controlling the setup and switching of lightpaths to various grid application resources worldwide using CANARIE's UCLP (User Controlled LightPath) management software. In the future, grid users will be able to quickly configure (and reconfigure) global optical lightpaths among collaborating research institutions so their applications can exchange data in real time. While other iGrid 2005 demos may also use UCLP, these groups are accessing resources at each other's institutions in order to demonstrate how one controls 40,000 kilometer of lightpaths; the applications driving these demonstrations are described elsewhere in this brochure:

- UCLP-Enabled Virtual Design Studio (CRC, Canada)
- Interactive 3D HD Video Transport and Collaborative Data Analysis for e-Science over UCLP (Korea)
- GridON: Interactive Simulation with Grid Productor/Consumer (Spain)
- Real-Time Observational Multiple Data Streaming and Machine Learning for Environmental Research using Lightpaths (Taiwan)

Special thanks to Japan's National Institute of Information and Communications Technology (NiCT) and Tokyo Electronics Limited (TEL) for use of Ruff Systems, a High Definition Video (HDV) teleconferencing system.

CREDITS

Cactus is an open-source problem-solving environment designed for scientists and engineers. Its modular structure easily enables parallel computation across different architectures and collaborative code development among different groups. Cactus originated in the academic research community, where it was developed and used over many years by a large international collaboration of physicists and computational scientists. See <www.cactuscode.org>.

LambdaVision is an ultra-high-resolution visualization and networking instrument designed to support collaboration among co-located and remote experts requiring interactive ultra-high-resolution imagery. LambdaVision investigates means to advance both science and public safety as validated by users in various disciplines of Earth science research, and training exercises in disaster response and crisis management. LambdaVision is funded by the USA National Science Foundation award CNS-0420477 to the Electronic Visualization Laboratory at the University of Illinois at Chicago. See <www.evl.uic.edu/cavern/lambdavision>.

OptIPuter, so named for its use of **Opt**ical networking, **I**nternet **P**rotocol, comp**uter** storage, processing and visualization technologies, is a 21st-century cyberinfrastructure that will tightly couple computational resources over parallel optical networks using the IP communication mechanism. The goal of this new architecture is to enable scientists who are generating terabytes and petabytes of data to interactively visualize, analyze, and correlate their data from multiple storage sites connected to optical networks. The OptIPuter is funded by the USA National Science Foundation, cooperative agreement SCI-0225642, to Calit2 at UCSD. See <www.optiputer.net>.

User Controlled LightPaths (UCLP) software allows end-users – either people or sophisticated applications – to treat network resources as software objects and provision and reconfigure lightpaths within a single domain or across multiple, independently managed, domains. Users can also join or divide lightpaths and hand off control and management of these larger or smaller private sub-networks to other users. The first phase of software development was co-funded by Cisco Canada and CANARIE under CANARIE's Directed Research program. See <www.canarie.ca/canet4/uclp>.

Scalable Adaptive Graphics Environment (SAGE) is a graphics streaming architecture for supporting collaborative scientific visualization environments with potentially hundreds of megapixels of contiguous display resolution. The network-centered architecture of SAGE allows collaborators to simultaneously run various applications (such as 3D rendering, remote desktop, video streams and 2D maps) on local or remote clusters, and share them by streaming the pixels of each application over ultra-high-speed networks to large tiled displays. SAGE is a research project of the Electronic Visualization Laboratory at the University of Illinois at Chicago, supported by the OptIPuter project, NSF award SCI-0225642 to UCSD. See <www.evl.uic.edu/cavern/sage>.

Varrier is a panel-based, head-tracked, barrier-strip auto-stereographic display, where the viewer does not wear stereo glasses. The hardware and software are designed to augment the work environment, enabling collaborators to share 3D immersive content alongside 2D content, such as PowerPoint and/or video conferencing. Personal Varrier is a high-resolution one-screen desktop model. Varrier is funded by the USA National Science Foundation award CNS-0115809 to the Electronic Visualization Laboratory at the University of Illinois at Chicago. See <www.evl.uic.edu/core.php?mod=4&type=1&indi=275>.

SYMPOSIUM

Keynotes

CyberInfrastructure at the National Science Foundation

Jose L. Munoz, National Science Foundation, USA
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There is a growing awareness of cyberinfrastructure at the NSF and other USA agencies. Its increasing importance and visibility demands that cyberinfrastructure's very complex inter-relationships be better understood, as well as its activities coordinated. What does the NSF mean by the term "cyberinfrastructure"? What's "in" and what's "out"? Which of its components is currently demanding our most attention and why? Where does the NSF foresee the future of cyberinfrastructure moving?

Greetings from iGrid 2005 to APAC'05

Larry Smarr, Calit2, USA
lsmarr@ucsd.edu

iGrid 2005 host Larry Smarr broadcasts a warm welcome to the APAC'05 audience from San Diego, California, and then introduces the next iGrid speaker, Ian Foster, who broadcasts his keynote presentation on "Service-Oriented Science" from Queensland, Australia.

The ResearchChannel and University of Washington are using a specially designed HDTV broadcast system to transmit real-time presentations between the iGrid 2005 Workshop in San Diego and the APAC'05 (Australian Partnership for Advanced Computing) conference in Queensland, Australia. This is part of their iGrid demonstration "Global N-Way Interactive High-Definition Video Conferencing over Long-Pathway, High-Bandwidth Networks," where a persistent setup between the two sites is in place.

How LambdaGrids are Transforming Science

Larry Smarr, Calit2, USA
lsmarr@ucsd.edu

The emergence of a global LambdaGrid cyberinfrastructure is transforming e-science from a bandwidth-constrained world to a bandwidth-rich world. Currently, most science is done locally in the end-user's lab, with the only tightly coupled compute and storage systems being the lab's cluster. Collaboration is largely sustained by physical visits and email or telephone calls. In this new LambdaGrid architecture, scientific data can be accessed anywhere in the world via LambdaRAM with less latency than if it were stored on a local hard disk! Furthermore, remote scientific instruments and collaborators appear to be in the next room. We see at iGrid a few pioneering researchers who are showing us how this transformed cyberinfrastructure allows them to carry out a new level of science, with persistent high-performance collaboration on a planetary scale, allowing global teams to interactively obtain, process and share vast amounts of distributed data. This presentation provides an early glimpse of a broad range of scientific research applications that a Service-Oriented LambdaGrid Cyberinfrastructure will enable.

Network Security and Optical Networks

Carter Bullard, QoSient LLC, USA
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This presentation describes current trends in data network security, and discusses how optical networking both supports and threatens these security strategies, suggesting that a more classic approach is needed. Practical issues in high-performance networking are motivating people to revisit the NSA's "Red Book" approach to network security, and how this approach can affect the design and operation of optical networks, especially with regard to the optical control plane. The ultimate goal is to support a cycle that provides effective security threat identification, assessment, prevention and incident response.

Service-Oriented Architectures for Research and Education Networks

Bill St. Arnaud, CANARIE, Canada
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We may soon deploy Research and Education Services Networks (RESNs) that enable Web Services, based on Service-Oriented Architecture (SOA) standards, to be securely published, reused and invoked. CA*net 4 is a prototypical RESN, allowing end users to provision, manage and control the routing of their own lightpaths and/or Articulated Private Networks without having to signal or request services from a central network management authority or server. The next phase of this User Controlled LightPath (UCLP) software will seamlessly integrate large scientific instruments and sensors into the network using Web Services workflow and orchestration techniques. CANARIE has over a dozen SOA instrument/sensor/network projects under development; RESNs will seamlessly provide network "services," from the optical network layer to the application layer, where every element is, in effect, a "LEGO"-like building block that end users can assemble in any configuration they choose. SOAs for networks complement many of the developments being undertaken in the USA cyberinfrastructure program.

Service-Oriented Science

Ian Foster, Argonne National Laboratory and University of Chicago, USA
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New information architectures enable new approaches to publishing and accessing valuable data and programs. So-called service-oriented architectures define standard interfaces and protocols that allow developers to encapsulate information tools as services which clients can access without knowledge of, or control over, their internal workings. Thus, tools formerly accessible only to the specialist can be made available to all; previously manual data processing and analysis tasks can be automated by having services access services. Such service-oriented approaches to science are already being applied successfully, in some cases at substantial scales, but much more effort is required before these approaches are applied routinely across many disciplines. Grid technologies can accelerate the development and adoption of service-oriented science by enabling a separation of concerns between discipline-specific content and domain-independent software and hardware infrastructure.

The ResearchChannel and University of Washington are using a specially designed HDTV broadcast system to transmit real-time presentations between the iGrid 2005 Workshop in San Diego and the APAC'05 (Australian Partnership for Advanced Computing) conference in Queensland, Australia. This is part of their iGrid demonstration "Global N-Way Interactive High-Definition Video Conferencing over Long-Pathway, High-Bandwidth Networks," where a persistent setup between the two sites is in place.

Panels

Advances Toward Economic and Efficient Terabit LANs and WANs

Moderator

Lawrence G. Roberts, Anagran, USA, lroberts@anagran.com

Panelists

Lawrence G. Roberts, Anagran, USA
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Cees de Laat, University of Amsterdam, The Netherlands, delaat@science.uva.nl
Hank Dardy, Naval Research Laboratory, USA, dardy@cmf.nrl.navy.mil

Major advances in routing and switching are making possible the economic interconnection of many thousands of servers to form multi-terabit LANs with much higher utilization and QoS. Panelists brainstorm potential application and system requirements as well as alternative architectural design approaches and WAN interfaces.

Bridging the Challenges: Medicine Meets the LambdaGrid

Organizer

Mary Kratz, University of Michigan and TATRC (Telemedicine Advanced Technology Research Center), USA, mkratz@umich.edu

Moderator

Jean-Louis Belard, TATRC International Relations, USA, belard@tatrc.org

Panelists

Greg Mogel, University of Southern California and Director TATRC Operations, USA, mogel@usc.edu
Kevin Montgomery, National Biocomputation Center, Stanford University, USA, kevin@biocomp.stanford.edu
Parvati Dev, Stanford University Medical Media & Information Technologies (SUMMIT) Laboratory, Stanford University, USA, parvati@stanford.edu
Jonathan Silverstein, University of Chicago and lead of the Global Grid Forum Healthcare, USA, jcs@uchicago.edu

The medical industry represents a challenge to the grid community. Tools such as Globus remain tangentially relevant to the medical research community, and nearly irrelevant to the practice of clinical care. Fundamental transformations are currently underway to produce value to both the grid and medical cultures. The TATRC, as a subordinate element of the United States Army Research and Material Command (USARMC), is charged with managing core Research Development Test and Evaluation (RDT&E) and congressionally mandated projects in telemedicine and advanced medical technologies. This panel presents exemplary telemedicine research projects that provide a framework of technological challenges to the grid community from the perspective of medical researchers.

Data Plane and Content Security on Optical Networks

Moderator

Leon Gommans, University of Amsterdam, The Netherlands, lgommans@science.uva.nl

Panelists

Leon Gommans, University of Amsterdam, The Netherlands
Kim Roberts, Nortel Networks, Canada, krob@nortel.com
Laurin Herr, Pacific Interface Inc., USA, laurin@pacific-interface.com

In some grid environments, optical networks may not connect publicly accessible resources. When optical networks in different domains are stitched together into an end-to-end path, each domain may have its own policies regarding access. How do we ensure that every stakeholder is able to express and enforce its admission policies so only authorized people or applications can access resources in that domain? Firewalls may support requirements that are unacceptable to network security managers. "Punch 1002 holes in my firewall for GridFTP? You must be joking!" is a commonly heard complaint. How can we keep both worlds from fighting each other and create sensible solutions instead? Digital content transmitted across an optical network may have monetary value, and therefore needs protection against piracy. How do we protect this data while maintaining good network performance? This panel addresses some of the security issues that must be considered when designing optical networks for production environments.

Earth Science Applications

Moderator

John Orcutt, Scripps Institution of Oceanography, UCSD, USA, jorcutt@igpp.ucsd.edu

Panelists

John Orcutt, Scripps Institution of Oceanography, UCSD, USA
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New computing models based on high-performance networks are enabling Earth science researchers to develop next-generation, fully interactive Earth system prediction models and data assimilation systems capable of resolving many questions about geological, atmospheric and oceanographic variability and change. These models will be at least an order of magnitude more compute and data intensive than today's most advanced operational models, enabling scientists to interactively and visually examine shared large and detailed data objects. Panelists discuss various advancements taking place today.

Enabling Data Intensive iGrid Applications with Advanced Optical Technologies

Moderator

Joe Mambretti, Northwestern University, USA, j-mambretti@northwestern.edu

Panelists

Joe Mambretti, Northwestern University, USA
Kim Roberts, Nortel Networks, Canada, krob@nortel.com
Lawrence G. Roberts, Anagran, USA, lroberts@anagran.com
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Joseph Berthold, Ciena, USA, berthold@ciena.com
Cees DeLaat, University of Amsterdam, The Netherlands, delaat@science.uva.nl

This panel presents an overview of some of the leading-edge technologies that are enabling iGrid applications, particularly those related to dynamic optical networking, including grid optical networking research trends; iGrid demonstrations and emerging optical technologies; grid applications, flow control and optical transport; GMPLS and flexible optical switching; grids and optical access; designing and implementing optical Open Exchanges; and, grid networking and trends in advanced optical component research and development.

From ARPANET to LambdaGrid: 10-Year Eruptions in Networking

Moderator

Larry Smarr, Calit2, USA, lsmarr@ucsd.edu

Panelists

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Dennis Jennings, University College Dublin, Ireland, Dennis.Jennings@ucd.ie
Tom DeFanti, University of Illinois at Chicago (UIC) and UCSD/Calit2, USA, tom@uic.edu
Maxine Brown, UIC, USA, maxine@uic.edu

This panel looks at eruptive (though some might say disruptive) decadal networking advancements that have changed the way we work and communicate. We start with 1969, when the first economic crossover of routing and transmission occurred, just as Larry Roberts joined ARPANET, making packet routing economical and allowing the Internet to be built. In 1985, Dennis Jennings was the NSF program manager who funded NSFNet. By 1995, the SC conference featured a major event called I-WAY, organized by Tom DeFanti, Larry Smarr and Rick Stevens, which featured scientific applications using the most advanced R&E networks in the USA and Canada, with major outgrowths being Globus and the grid, national partnerships, interconnectivity and interoperability of USA Federal agency networks and a focus on international collaboration. By 2005, optical technologies are enabling more advancements in global e-science, as showcased at iGrid.

Global Data Repositories: Storage, Access, Mining and Analysis

Moderator

Radha Nandkumar, National Center for Supercomputing Applications, University of Illinois at Urbana-Champaign, USA, radha@ncsa.uiuc.edu

Panelists

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Mark Ellisman, Biomedical Imaging Research Network/University of California, San Diego, USA, mark@ncmir.ucsd.edu
Kei Hiraki, University of Tokyo, Japan, hiraki@gem.hi-ho.ne.jp

Data is growing at an exponential rate, and the number of distributed data repositories is also increasing. Global collaborations, advanced networks and new transport protocols are now changing the way scientists use and analyze large distributed datasets. Panelists discuss their respective research involving distributed data storage, data movement, data mining and data analysis.

High-Resolution Streaming Media

Moderator

Laurin Herr, Pacific Interface Inc., USA, laurin@pacific-interface.com

Panelists

Laurin Herr, Pacific Interface Inc., USA
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Michael Wellings, ResearchChannel, USA, wellings@washington.edu
Ludek Matyska, CESNET and Masaryk University Brno, Czech Republic, ludek@ics.muni.cz
Naohisa Ohta, Keio University, Japan, naohisa@dmc.keio.ac.jp

It has been long recognized that streaming media is required for a class of networked applications such as: interactive conferencing, remote scientific observation, long-distance educational mentoring and distributed media production. But increasing the resolution of streaming media from standard definition to high-definition and then to super-high-definition only tends to increase the technical challenges associated with high data rates, latency, codecs, switching, multicasting, and input/output devices like cameras and displays. This panel examines the state of the art of the technology and the potential applications for high-resolution streaming media.

International e-Science Infrastructure

Moderator

Bernhard Fabianek, Information Society and Media Directorate, European Commission (EC), Belgium, Bernhard.Fabianek@cec.eu.int

Panelists

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Modern information and communication technology-based infrastructures – so-called International e-Science Infrastructures, (or e-Infrastructures, or cyberinfrastructures or i-infrastructures) – are critical for all fields in science and technology. This infrastructure plays a pivotal role in the creation and exploration of knowledge and thus in promoting innovation. The momentum created by the pioneering developments of International e-Science Infrastructures is huge; advanced communication technologies and services transform the way science is carried out and benefit research, education and innovation. Each panelist gives a short introduction to key elements of his/her country's international e-science infrastructure initiatives, followed by a discussion of common elements and where further collaboration (or joint projects) can be envisioned to advance global e-Science collaborations and discoveries.

L1/L2 Services of National Networks in Support of the GLIF Community

Moderator

Gigi Karmous-Edwards, NLR and MCNC Grid Computing and Network Services, USA, gigi@mcnc.org

Panelists

Ron Johnson, University of Washington, NLR and Pacific Northwest GigaPoP, USA, ronj@cac.washington.edu
Kees Neggers, SURFnet, The Netherlands, kees.neggers@surfnet.nl
Bill St. Arnaud, CANARIE, Canada, bill.st.arnaud@canarie.ca

This panel explores how national optical backbones can support the GLIF community. The panelists first describe their existing Layer-1/Layer-2 (L1/L2) service offerings, and then discuss their experiences, challenges and successes from a national and international perspective. Several key topics are covered:

- Comparing the role of USA Regional Optical Networks (RONs) to European National Research & Education Networks (NRENs), and the role of CANARIE and GÉANT2 to NLR
- Production and experimental capabilities and services
- Network research experimental capabilities and services
- Existing information exchange between networks (what exists and what is required?)
- Thoughts on experimentation with control planes
- Thoughts on the economic equation for end-to-end services traversing multiple national networks

North American Networking Requirements for the Large Hadron Collider

Moderator

William E. Johnston, Lawrence Berkeley Laboratory and ESnet, USA, wej@es.net

Panelists

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Erik-Jan Bos, SURFnet, The Netherlands, erik-jan.bos@surfnet.nl
David Foster, CERN, David.Foster@cern.ch

The CERN Large Hadron Collider (LHC) experiments (ATLAS, CMS, ALICE, etc.) will generate huge amounts of data starting in 2007. There are seven data centers in Europe, three in North America, and two in Southeast Asia, which will be the source of data for the physics groups analyzing it. The network requirements for the North American data centers are 20Gb in 2007, ramping up to 40+Gb by 2010. (The physics community has been running a series of increasingly realistic service challenges to ensure that the data centers, analysis centers, and networks will be able to meet their needs.) In addition to the primary data paths (which are being provided as part of the LHC experiment infrastructure) there must be secondary and tertiary backup paths to the data centers. This panel describes the LHC networking architecture and the needed backup architecture, and then solicits input from the GLIF community as to how the GLIF circuits might participate in this largest of all science projects.

OptIPuter Application-Centered Tools and Techniques

Moderator

Jason Leigh, Electronic Visualization Laboratory (EVL), University of Illinois at Chicago (UIC), USA, spiff@evl.uic.edu

Panelists

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The OptIPuter is a project to examine a new model of computing whereby ultra-high-speed networks form the backplane of a distributed virtual computer whose peripherals consist of dedicated storage, computation and visualization clusters. Panelists describe the impact that such a model has or will have on their areas of research and discuss the challenges ahead to bring these advanced capabilities to scientists, engineers and the general public.

Master Classes

Optical Control Plane Master Class

Speakers

Gigi Karmous-Edwards, MCNC Grid Computing and Network Services, USA
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Admela Jukan, University of Illinois at Urbana-Champaign, USA
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This Master Class explains what a “control plane” is and why it is important to the GLIF community. Specifically, the GLIF community is trying to address various application grid challenges such as: dynamic use of end-to-end optical networking resources; global transfers of large datasets (terabytes and petabytes) across long distances; coordination of network and grid resources, such as CPU and storage; the ability to make reservations for networking resources; deterministic end-to-end connections (low jitter, low latency); time scales of a few micro-seconds to longer-term wavelengths; and, near-real-time feedback of network performance measurements to the applications and grid middleware.

To meet these challenges, the optical networking community, in conjunction with the grid community, has to rethink intelligent optical control planes for future grid computing. The goal is to raise attendee awareness of new developments in the area of optical control planes and grid infrastructure that address current research activities, and to provide visionary scenarios for future grid computing combined with optical networking technologies.

Service-Oriented Infrastructure Master Class

Speaker

Carl Kesselman
Information Sciences Institute, University of Southern California, USA
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This Master Class gives an overview of Globus Toolkit 4 (GT4) and its use for developing service-oriented technologies.

UCLP Master Class

Speakers

Hervé Guy, CANARIE, Canada
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Jun Jian, CANARIE, Canada
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The User Controlled LightPaths or UCLP was originally developed as a critical component of Canada’s CA*net 4 advanced network program with the software being developed by teams at CRC/Ottawa University, Waterloo University and University Quebec à Montreal. UCLP allows end users to setup end-to-end lightpaths and change the configuration and topology of lightpaths or optical VPNs without the involvement of a central network management facility. UCLP development is becoming an international initiative with software developers and researchers in Taiwan, Korea, Spain, Netherlands and the USA participating.

In this Master Class, attendees are briefly introduced to the Version-1 release of UCLP, along with examples of how UCLP is currently deployed and used on advanced networks around the world, particularly CA*net 4. UCLP (version 2) is then discussed, and how it extends the concept of lightpaths defined by UCLPv1 to Articulated Private Networks (APNs), enabling users to take control of their own APNs. Attendees are encouraged to visit the iGrid demonstration area to see UCLP firsthand, as users from Canada, Korea, Taiwan and Spain dynamically configure lightpaths for end-to-end connections from grid application resources located worldwide to the iGrid demonstration floor.

“Web services, as part of a larger Service-Oriented Architecture (SOA), can now be thought of as “LEGO” blocks that can be assembled virtually any way the user desires. There is no more artificial hierarchy of layers in which the LEGO blocks can be assembled. Essentially every service, every application, and every network component has a peer-to-peer relationship with everything else. The assembly of web services into a solution set is done through web-service workflow tools. SOAs promise to liberate us from the straight-jacket thinking of the past 30 years where the network and application are made up of “layers,” or “planes,” with each layer only communicating with its neighboring layer immediately above or below.”

Bill St. Arnaud, CANARIE

GLIF-Specific Presentations

GLIF Update

Keynote

Kees Neggers, SURFnet, The Netherlands
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"Lambda networking for research" is only four years young with the first real demo of its potential presented at iGrid 2002 in Amsterdam. Since 2001, international lambda pioneers have been meeting annually. In 2003, at the third LambdaGrid Workshop in Reykjavik, Iceland, it was agreed to continue this cooperation under the name GLIF, the Global Lambda Integrated Facility. Today, hybrid networking is rapidly moving from pioneering to mainstream. This session provides an update of the international cooperation and collaboration that has occurred to date, including a status report from the GLIF Governance and Growth (GOV) Working Group, which is responsible for identifying future goals in terms of lambdas, connections and applications support, and for deciding which cross-domain policies need to be put in place.

Building GLIF with Open Exchanges

Keynote

Cees de Laat, University of Amsterdam, The Netherlands
delaat@science.uva.nl

A growing number of optical and lambda exchanges are being built; however, no systematic description exists of which technologies must be in place to assure the interconnectivity and interoperability of network links among sites. This presentation summarizes recent developments in control models and architectures for multi-layer, or hybrid, networks, and then attempts to classify interconnection points, primarily by enumerating the properties of various control planes. Three control models are defined: autonomous, federated, and distributed. Also discussed is when it is appropriate to apply the adjectives "open" and "automated" to the control models.

GLIF Control Plane and Grid Integration Middleware Working Group

Update

Gigi Karmous-Edwards, MCNC Grid Computing and Network Services, USA
gigi@mcnc.org

The overall mission and future challenges of the GLIF Control Plane and Grid Integration Middleware Working Group are presented. This update includes a short survey of existing global activities in this area, followed by why these activities are important to the GLIF community.

GLIF Technical Issues Working Group

Update

Erik-Jan Bos, SURFnet, The Netherlands
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The GLIF Technical Issues Working Group is responsible for the design and implementation of an international LambdaGrid infrastructure, identifying what equipment colleagues are using, what connection requirements are needed, and what engineering functions and services should be provided. One major outcome is the design of Open Exchanges to ensure interconnectivity and interoperability. This session provides an update of these efforts to date.

"Scientific research has no geographical boundaries; it is a global activity. To have an impact, today's innovations, collaborations and advanced technologies must be accessible from beyond the physical borders of a specific country or network. Hence, international cooperation is essential. GLIF is the virtual organization that allows new hybrid networking and grid-computing paradigms to be translated into a world-scale LambdaGrid in support of this decade's most demanding e-science applications."

Kees Neggers, SURFnet

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