

CENIC: Driving Innovation through Networking

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President and Chief Operating Officer

CENIC

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CENIC Mission and Goals

- **Mission:**

“...to develop, deploy and operate leading edge network-based services and to facilitate and coordinate their use for the research and education community to advance learning and innovation”

- **Goals:**

- Provide competitive advantage in global marketplace to education and research communities
- Provide opportunities for innovation in teaching, learning and research through use of the network.

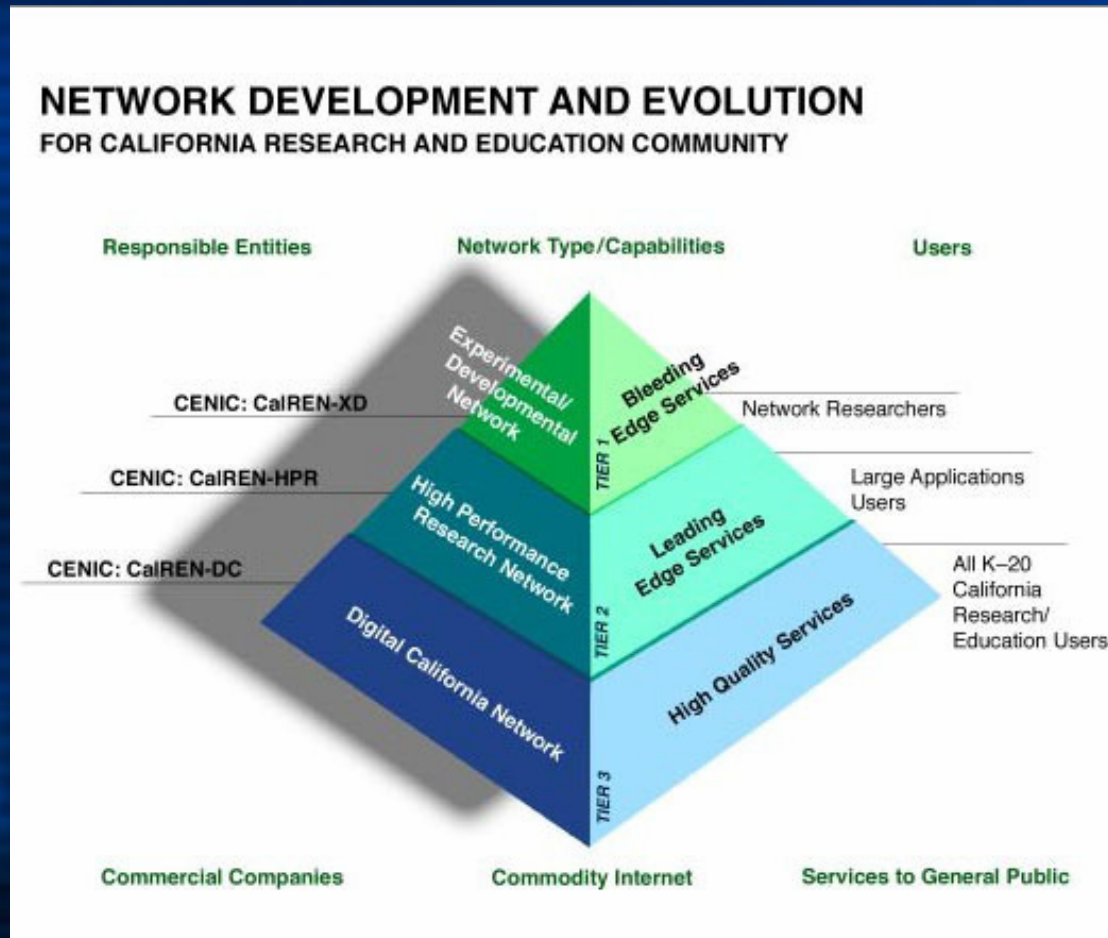
CENIC's Place in National R&E Networking

- 1969-90--**ARPANET** (Milnet split off in '83)
- 1981-96--**BITNET/CREN**
- 1981-91ish--**CSNET** (CSnet merged with BITNET into CREN)
- 1986-95ish—**NSFNet**
- Mid 90's-**Commercial Internet**
- 1995-2001ish--**vBNS**
- 1996-97---**Internet2/Abilene**
- 1997-**CENIC/CalREN 2 (California)-Phase I of CENIC evolution**
- 2000-2002-**CENIC/CalREN adds K-12-Phase II of evolution**
- 2003-04-**CENIC deploys statewide fiber backbone and begins to support CCC's and CSU's-Phase III of CENIC evolution**
- 2003-**NLR (www.nlr.net) created to deploy national fiber backbone for research**
- 2004-05-**CENIC expands-Phase IV of evolution**
- Current to future

CalREN

- Fiber network supports needs of high end research-it is a critical component of University research
- High speed network facilitates collaboration-faculty and researchers do not work alone. The network enables the barriers of geography to be removed
- Provides for long term cost effective network services

A Tiered Network . . . The Pyramid



National and Regional Participation

- Connect to commodity/commercial internet-multiple carriers/connections
- Connect to Internet 2/Abilene
- Connect to National LambdaRail (NLR)
- Connect to western U.S. state/regional networks - e.g., Nevada, Utah

Layer 3 Networks in the US

- There are several Layer 3 networks in the US including two national footprint Higher Education Networks:
 - Abilene (Internet2)
 - NLR layer 3 Packet Network
- Many Agency specific networks like ESNet
- Many project oriented networks like Teragrid
- And multiple regional networks like CalREN

CENIC-As Founding Member of NLR

- To address all 3 layers of pyramid
- To achieve advantages of fiber-based network instead of managed service

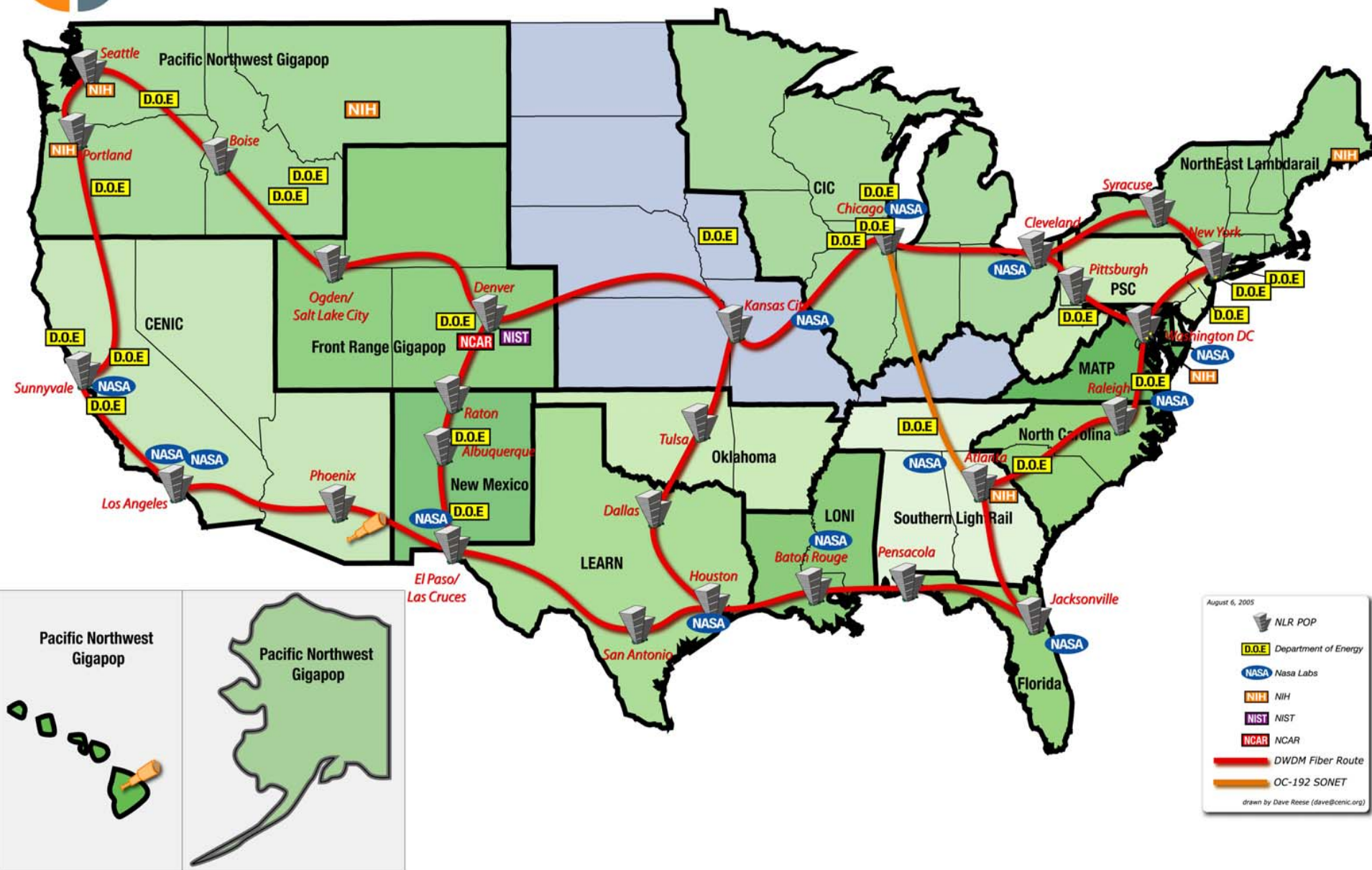
National LambdaRail Mission

- To advance the research, clinical and educational goals of members and other institutions by establishing and maintaining a nationwide advanced network infrastructure.



National LambdaRail

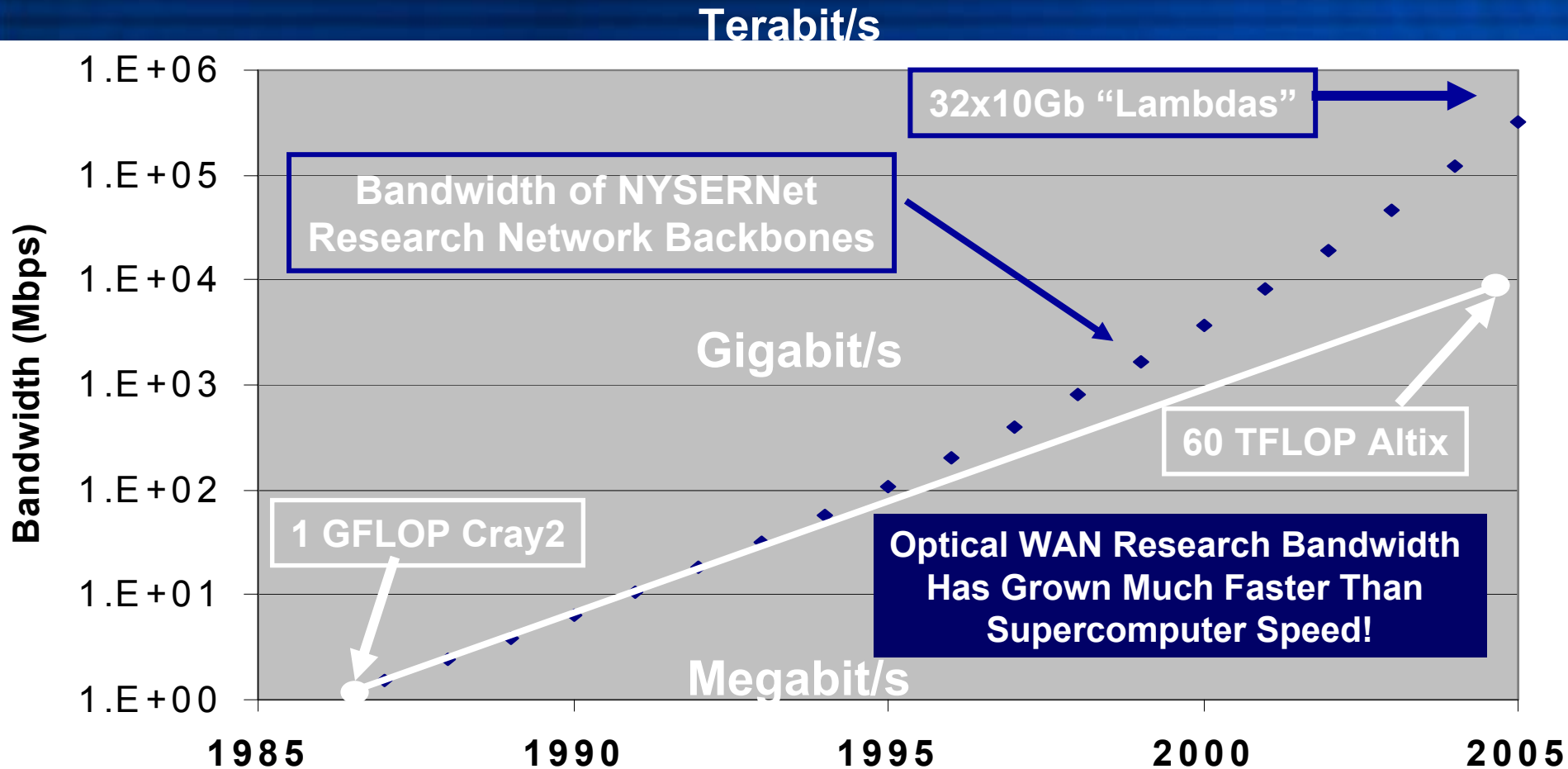
National LambdaRail Architecture



Changes in R&E Impacting Networking Needs

- **Growing urgency for new network technologies**
- **Increased collaboration worldwide on “Big” Science projects**
- **Exponential growth in size of data sets being accessed**
- **Need for multiple dedicated/private research networks**
- **iGRID demonstrated many examples of high-end and lightpath network applications**

From “Supercomputer-Centric” to “Supernetwork-Centric” Cyberinfrastructure



NASA Broadens Supercomputing



Computational Nanotechnology

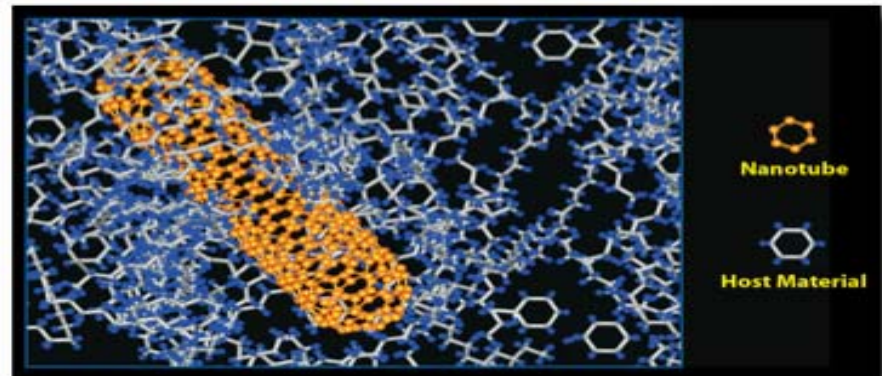


Objectives:

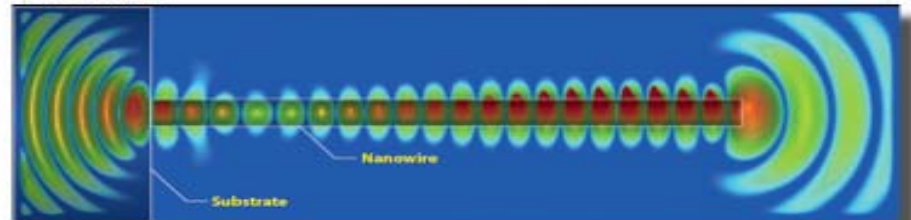
- Discover and explore phenomena in nanometer and molecular structures.
- Enable the design and fabrication of new materials and devices.
- Develop theory, models, and large scale simulations to establish the scientific basis and as cost-effective design tools.

Results:

- Running complex molecular dynamic simulations and models of various nano systems on Columbia has led to a variety of scientific discoveries and potential uses in:
 - Lightweight radiation shielding for astronauts and spacecraft
 - Communications and sensing
 - Astronaut health
 - Life detection
 - Decoding genomes



Like steel bars in concrete, carbon nanotubes embedded in a host material are expected to combine the best of both materials.



The complex interaction between light and nanometer structures, like wires, has possibilities as new technology for devices and sensors. NAS researchers are studying light emission from a semiconductor nanowire — typically 10-100 nanometers wide and a few micrometers long—that functions as a laser.

POC: Ioana Cozmuta, NASA Ames Research Ctr

NASA Simulations



Solar Storm Simulations with the Space Weather Modeling Framework

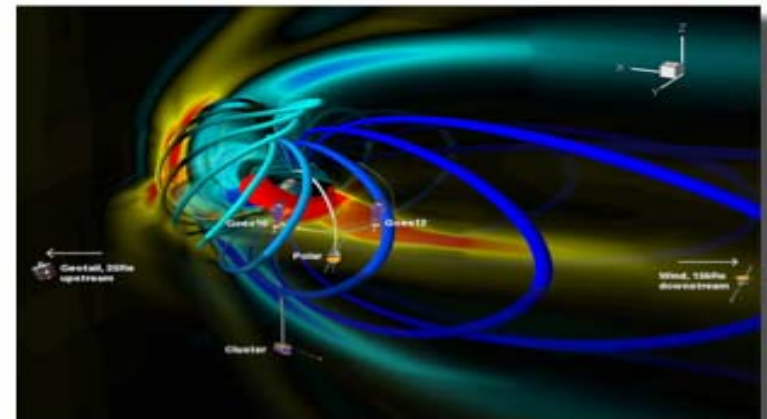


Project Goals:

- Faster than real-time simulation of the entire Sun-Earth system following large geo-effective solar storms
- Long term goal is to create a space weather forecast capability to support NASA's mission

Objectives:

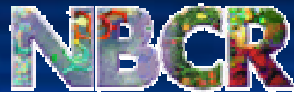
- To simulate the most geo-effective event of the Halloween solar storms of October-November 2003
- To simulate Saturn's space environment in support of the Cassini mission



For the first time, the simultaneous observations of six satellites located at very different regions of the magnetosphere was achieved. This is a big qualitative leap in magnetospheric physics, made possible by the *Columbia* system. Scientists were able to explore the parameter space in the simulations and obtained excellent agreement with all six magnetospheric satellites.

POC: Tamas I. Gombosi, CSEM, University of Michigan

CAMERA Builds on Cyberinfrastructure Grid, Workflow, and Portal Projects in a Service Oriented Architecture



**National Biomedical
Computation Resource**
an NIH supported resource center

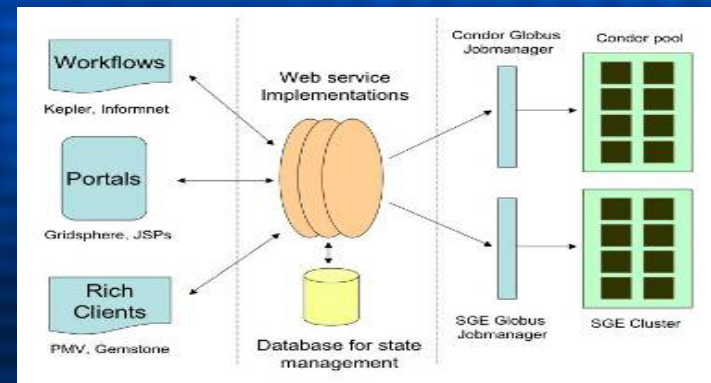
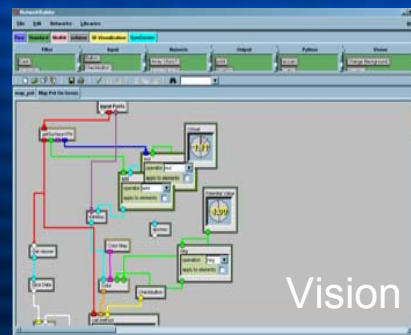
Cyberinfrastructure: Raw Resources, Middleware & Execution Environment

Virtual Organizations

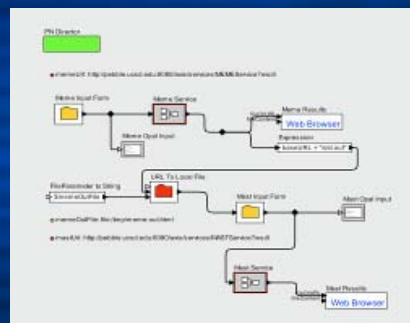
Workflow Management

Web Services

NBCR Rocks Clusters

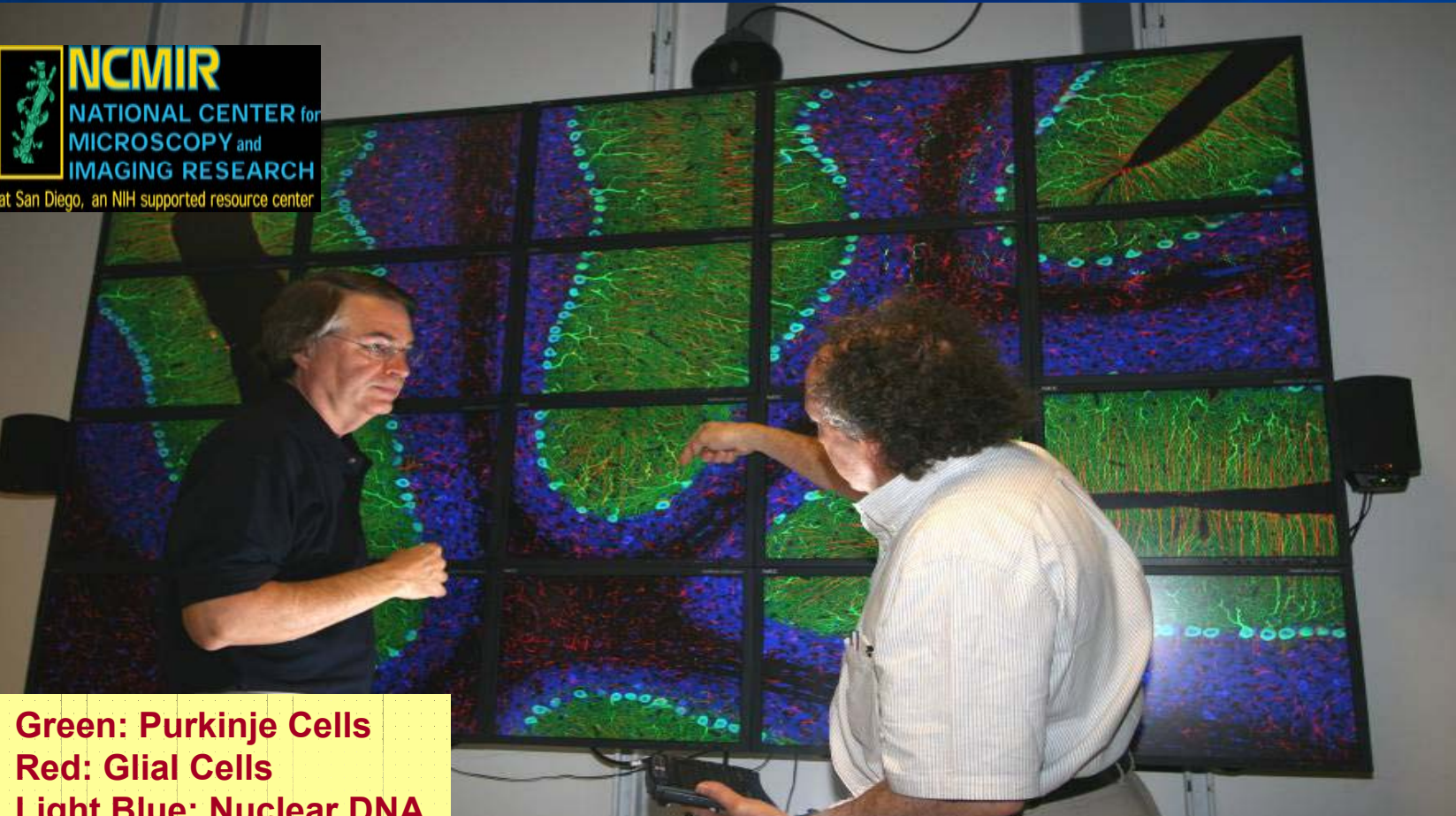


Telescience Portal



KEPLER

The OptlPuter – Creating High Resolution Portals Over Dedicated Optical Channels to Global Science Data



NCMIR
NATIONAL CENTER for
MICROSCOPY and
IMAGING RESEARCH
at San Diego, an NIH supported resource center



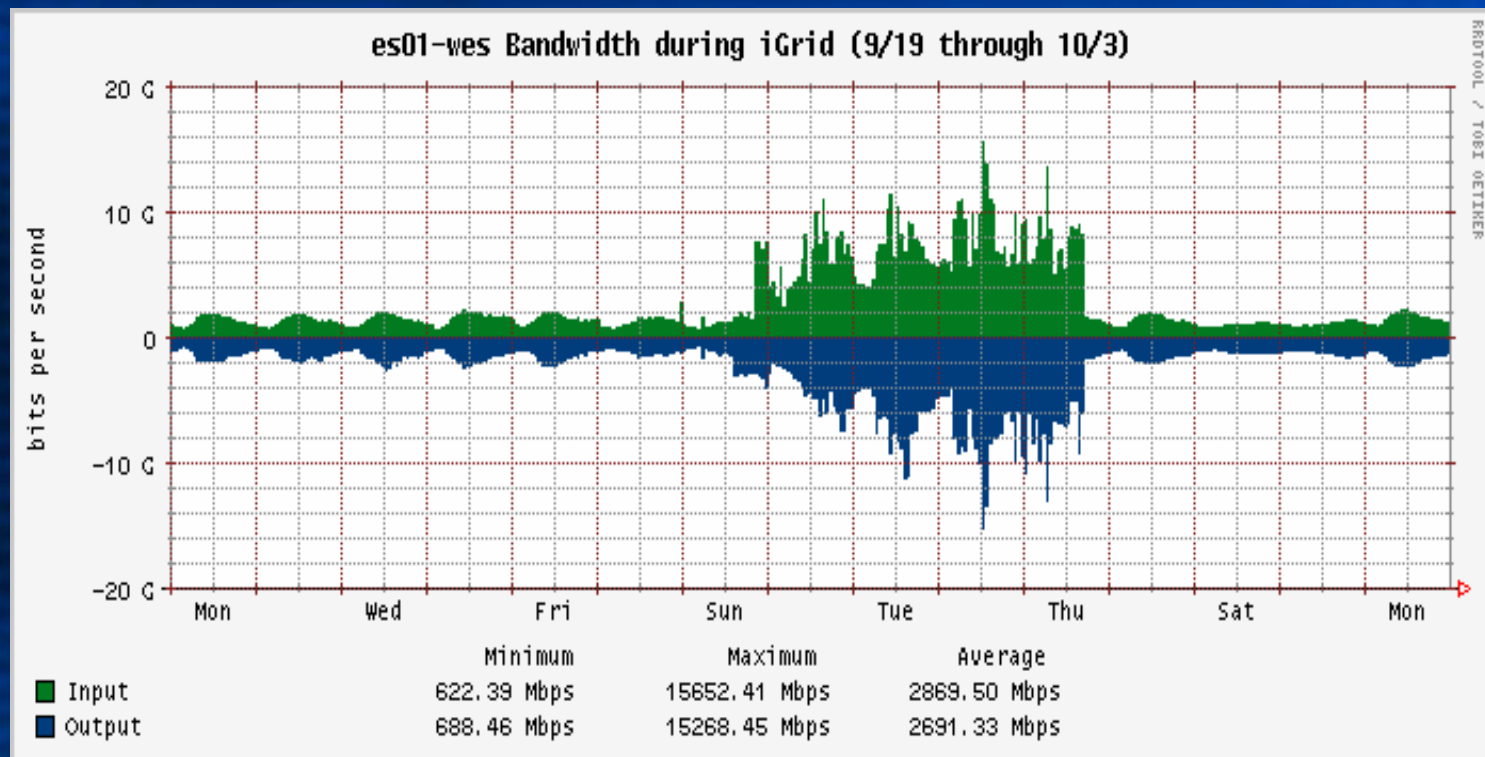
Source:
Mark
Ellisman,
David Lee,
Jason
Leigh

Green: Purkinje Cells
Red: Glial Cells
Light Blue: Nuclear DNA

Calit2 (UCSD, UCI) and UIC Lead Campuses—Larry Smarr PI
Partners: SDSC, USC, SDSU, NW, TA&M, UvA, SARA, KISTI, AIST

Larry Smarr, Calit2

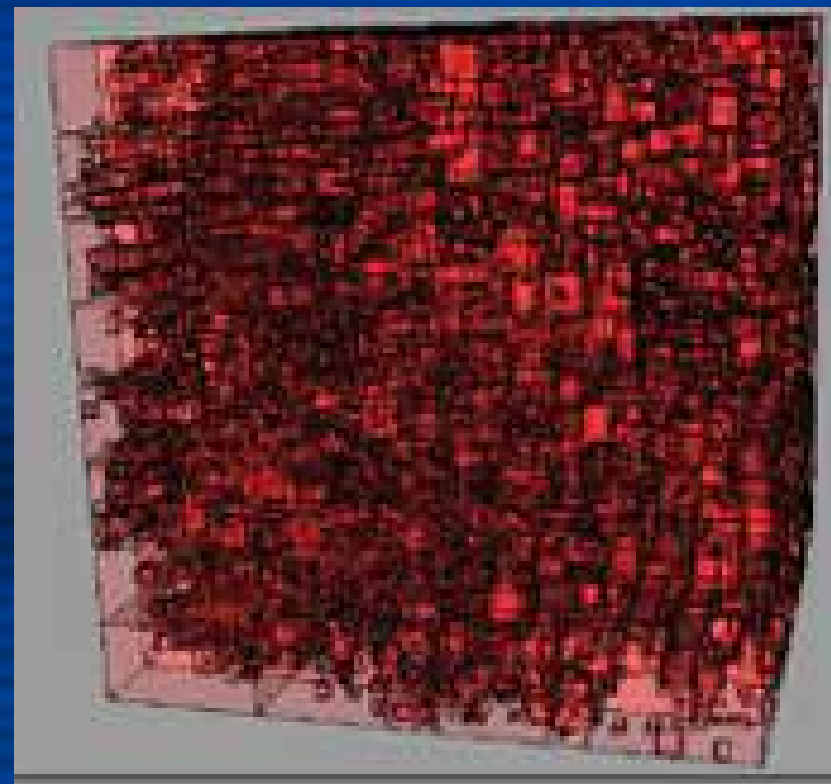
iGrid2005 Data Flows Multiplied Normal Flows by Five Fold!



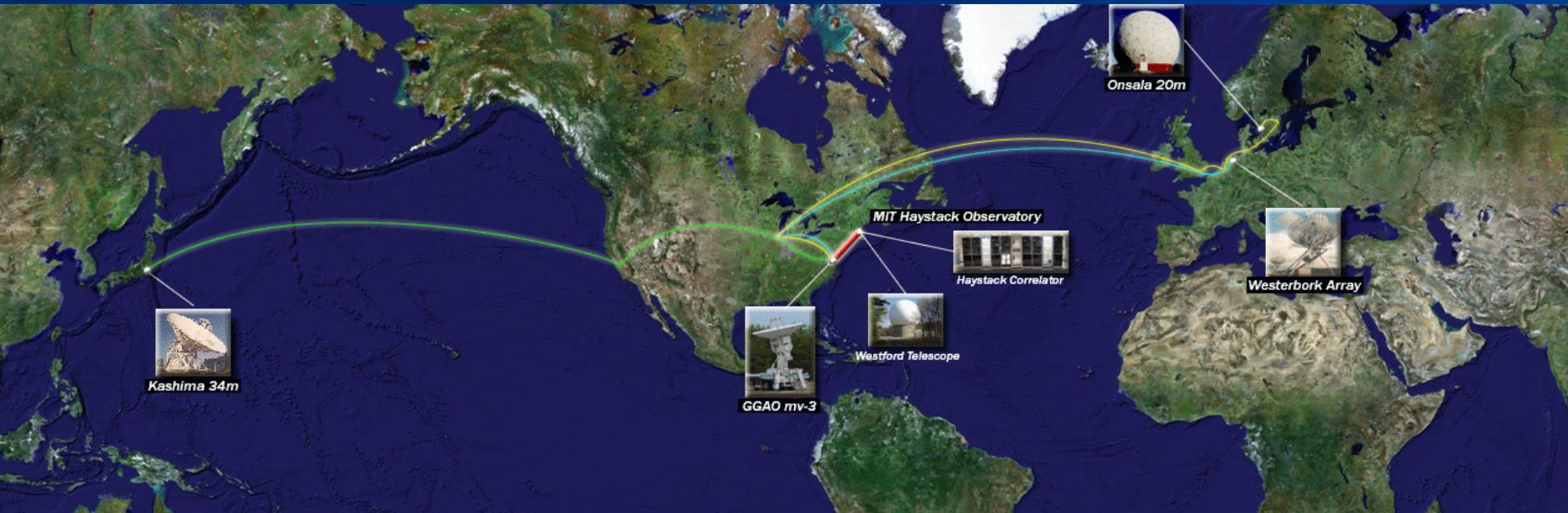
Data Flows Through the Seattle PacificWave International Switch

iGrid Lambda High Performance Computing Services: Distributing AMR Cosmology Simulations

- Uses ENZO Computational Cosmology Code
 - Grid-Based Adaptive Mesh Refinement Simulation Code
 - Developed by Mike Norman, UCSD
- Can One Distribute the Computing?
 - iGrid2005 to Chicago to Amsterdam
- Distributing Code Using Layer 3 Routers Fails
- Instead Using Layer 2, Essentially Same Performance as Running on Single Supercomputer
 - Using Dynamic Lightpath Provisioning



iGrid Lambda Control Services: Transform Batch to Real-Time Global e-Very Long Baseline Interferometry

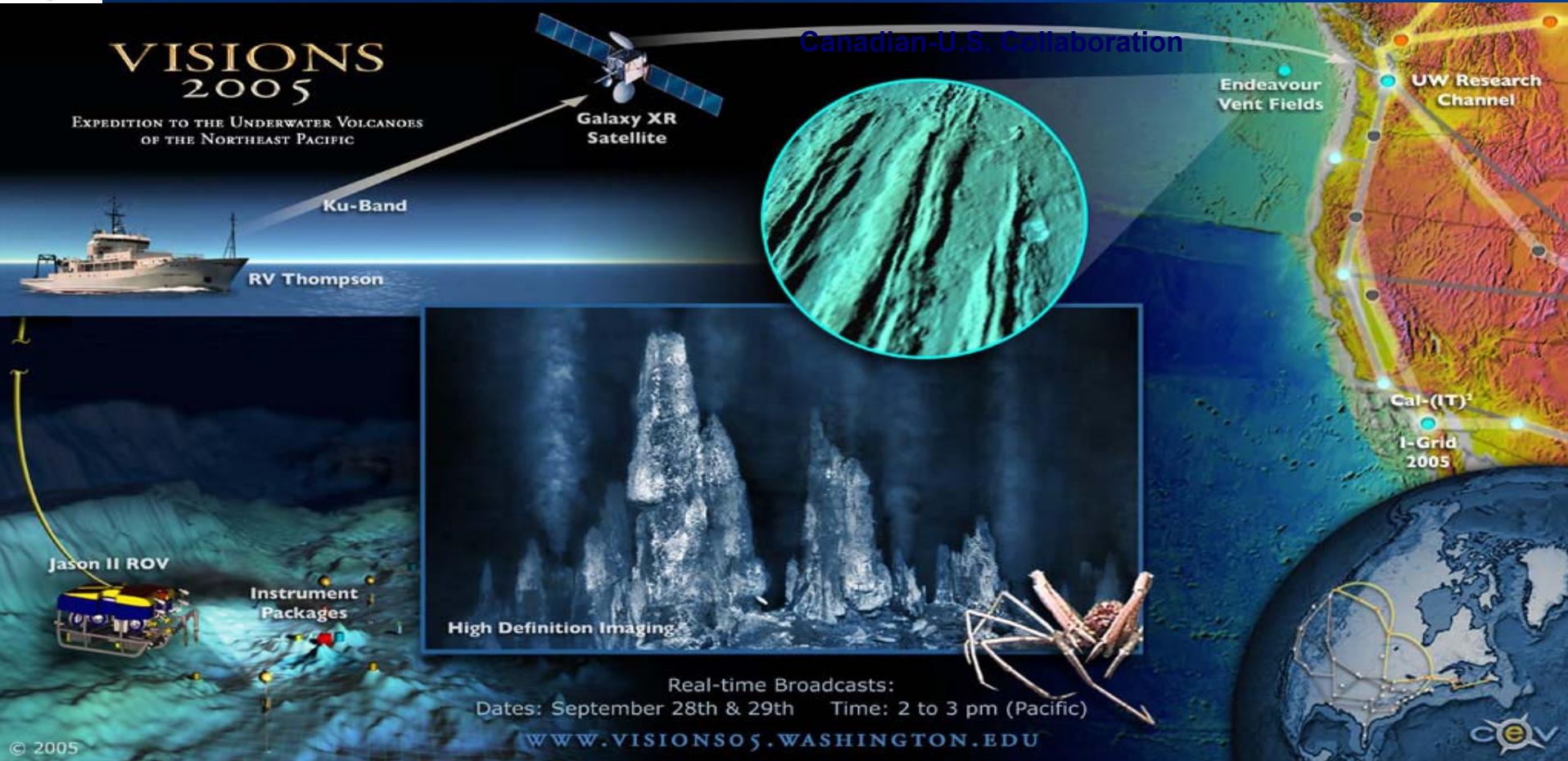


- Goal: Real-Time VLBI Radio Telescope Data Correlation
- Achieved 512Mb Transfers from USA and Sweden to MIT
- Results Streamed to iGrid2005 in San Diego

Optical Connections Dynamically Managed Using the DRAGON Control Plane and Internet2/HOPI Network

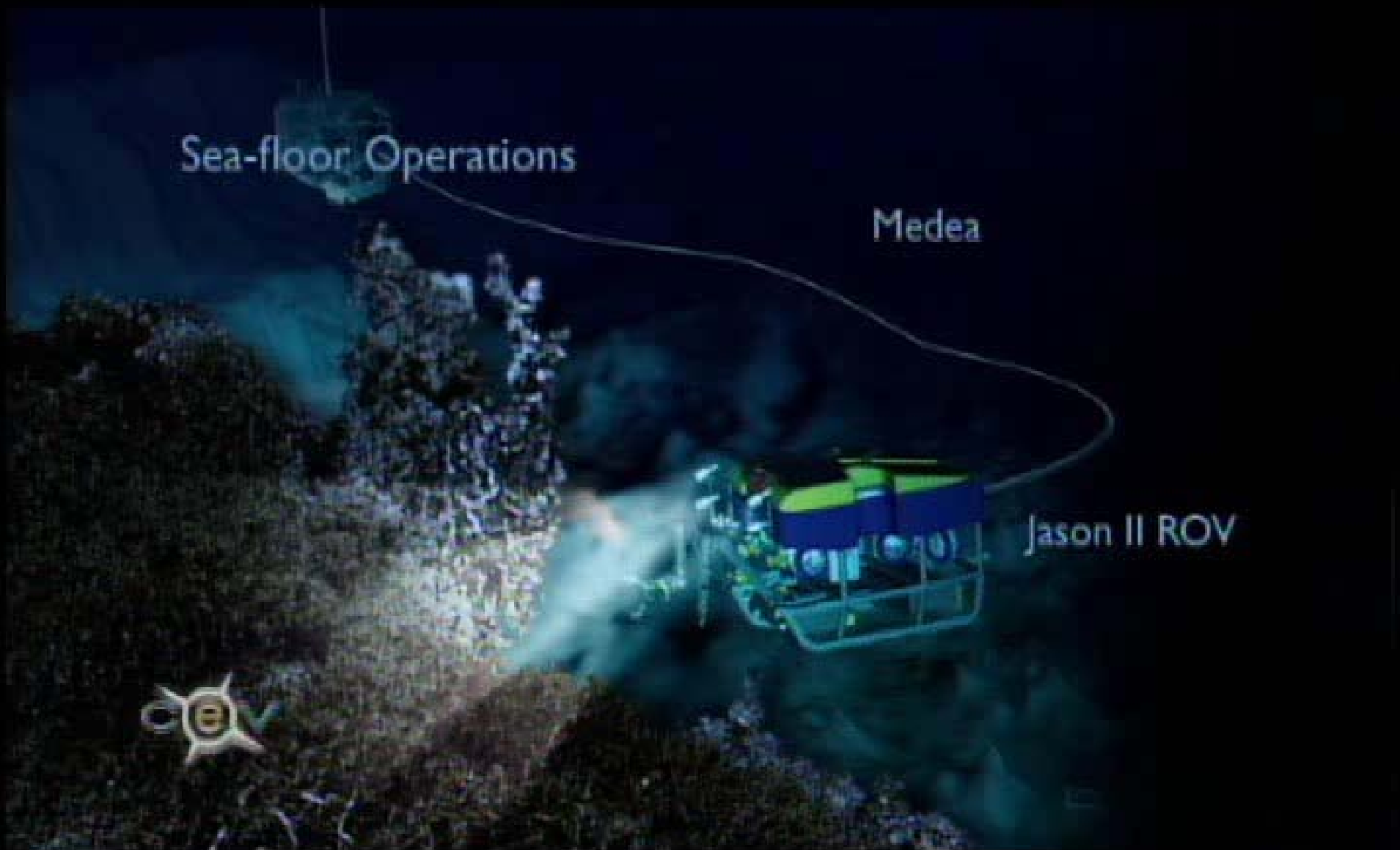
Source: Jerry Sobieski, DRAGON

iGrid Scientific Instrument Services: Enable Remote Interactive HD Imaging of Deep Sea Vent



Source John Delaney & Deborah Kelley, UWash

High Definition Video - 2.5 km Below the Ocean Surface



Teamwork and Science

Technology-enabled Neurosurgery



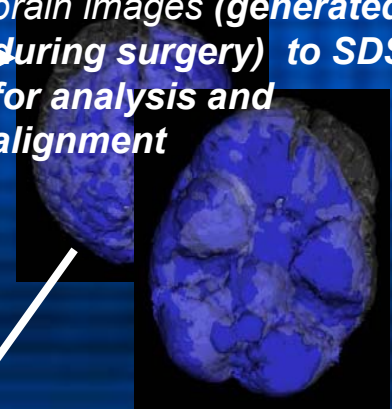
- **PROBLEM: Neuro-surgeons seek to remove as much tumor tissue as possible while minimizing removal of healthy brain tissue**
- *Brain deforms during surgery*
- **Surgeons must align preoperative brain image with intra-operative images to provide surgeons the best opportunity for intra-surgical navigation**

Transmission repeated every hour during 6-8 hour surgery.

Transmission and output must take on the order of minutes



Radiologists and neurosurgeons at Brigham and Women's Hospital, Harvard Medical School exploring transmission of 30/40 MB brain images (generated during surgery) to SDSC for analysis and alignment

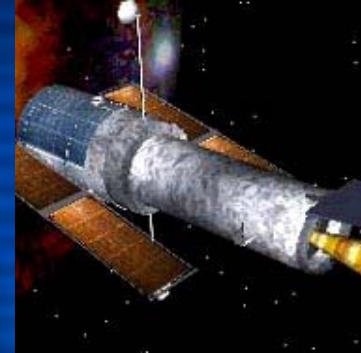


Finite element simulation on biomechanical model for volumetric deformation performed at SDSC; output results are sent to BWH where updated images are shown to surgeons

Tracking the Universe

“The Universe is now being explored systematically, in a panchromatic way, over a range of spatial and temporal scales that lead to a more complete, and less biased understanding of its constituents, their evolution, their origins, and the physical processes governing them.”

Towards a National Virtual Observatory



*Hubble
Telescope*



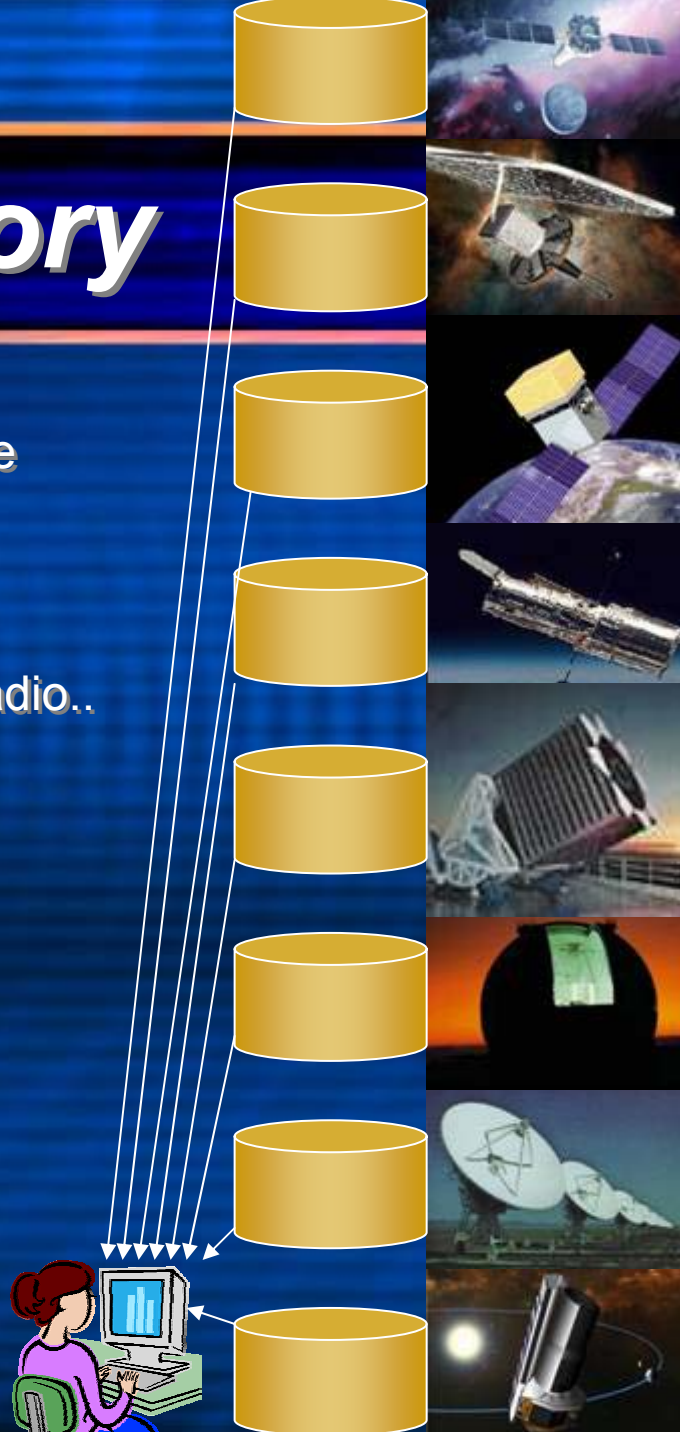
*Palomar
Telescope*



*Sloan
Telescope*

The Virtual Observatory

- Premise: most observatory data is (or could be) online
- So, **the Internet is the world's best telescope:**
 - It has data on every part of the sky
 - In every measured spectral band: optical, x-ray, radio..
 - It's as deep as the best instruments
 - It is up when you are up
 - The "seeing" is always great
 - It's a smart telescope:
links objects and data to literature on them
- **Software has become a major expense**
 - Share, standardize, reuse..



Downloading the Night Sky

The National Virtual Observatory (NVO)

- Astronomy community came together to set standards for services and data
 - Interoperable, multi-terabyte online databases
 - Technology-enabled, science-driven.
- NVO combines over 100 TB of data from 50 ground and space-based telescopes and instruments to create a comprehensive picture of the heavens
 - Sloan Digital Sky Survey, Hubble Space Telescope, Two Micron All Sky Survey, National Radio Astronomy Observatory, etc.



*Hubble
Telescope*



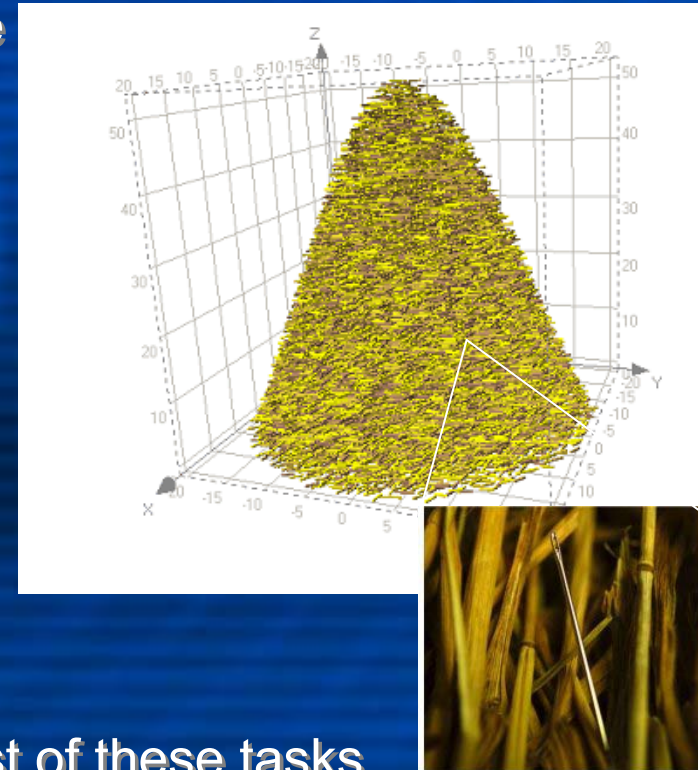
*Palomar
Telescope*



*Sloan
Telescope*

Using Technology to Evolve Astronomy

- Looking for
 - **Needles in haystacks** – the Higgs particle
 - **Haystacks** -- Dark matter, Dark energy
- Statistical analysis often deals with
 - Creating uniform samples
 - Data filtering
 - Assembling relevant subsets
 - Censoring bad data
 - “Likelihood” calculations
 - Hypothesis testing, etc.
- Traditionally these are performed on files, most of these tasks are much better done inside a database



NVO at SDSC



**SDSS –
New Mexico**

The Sloan Digital Sky Survey provides a 3D map of a million galaxies and quasars covering more than a quarter of the sky.



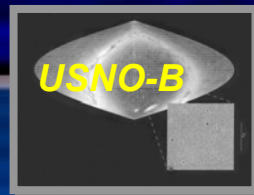
**2MASS --
Arizona**

The 2 Micron All Sky Survey (2MASS) provides direct answers to questions on the large-scale structure of the Milky Way and the Local Universe



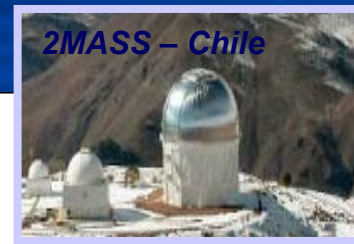
POSS – CA

The Palomar Oschin telescope provides a catalogue of the entire northern sky in blue, red and near-infrared colors.



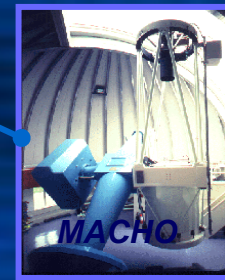
USNO-B

The USNO-B all-sky catalogue was obtained from various sky surveys during the last 50 years. USNO provides all-sky coverage and 85% accuracy for distinguishing stars from non-stellar objects



2MASS – Chile

2MASS gathers data from a northern facility in Arizona and a southern facility in Chile



MACHO

Photometric data from Mt. Stromlo observatory in Australia on several million stars gathered since 1992 to explore constitution of dark matter in the halo of the Milky Way



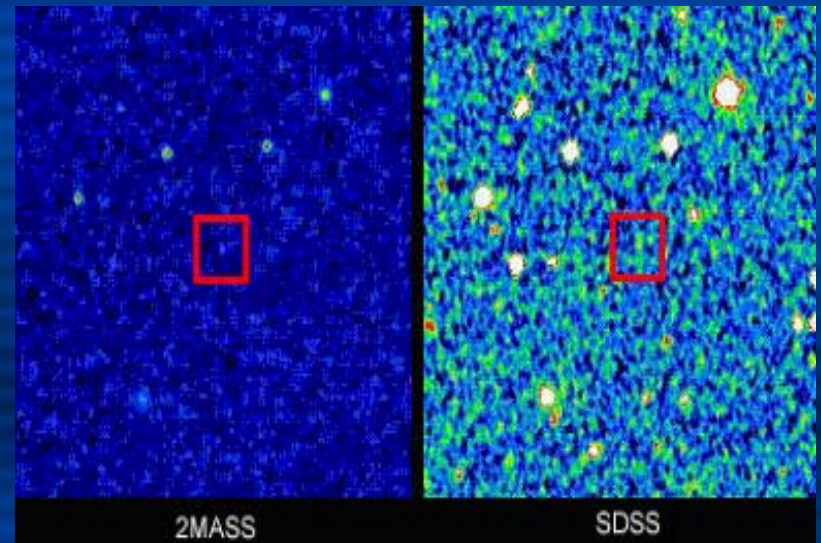
SDSC

SDSC's NVO collection is nearly 100 TB and has grown over 5-fold since 2002

Making Discoveries Using the NVO

Scientists at Johns Hopkins, Caltech and other institutions confirmed the discovery of a **new brown dwarf**. Search time on 5,000,000 files went **from months to minutes** using NVO database tools and technologies.

Brown dwarfs are often called the “**missing link**” in the study of star formations. They are considered small, cool “failed stars”.



Currently Developing OptIPuter Software to Coherently Drive 100 MegaPixel Displays

- **55-Panel Display**
***100 Megapixel**
- **Driven by 30**
Dual-Opterons
(64-bit)
- **60 TB Disk**
- **30 10GE**
interfaces
***1/3 Tera bit/sec**
- **Linked to**
OptIPuter



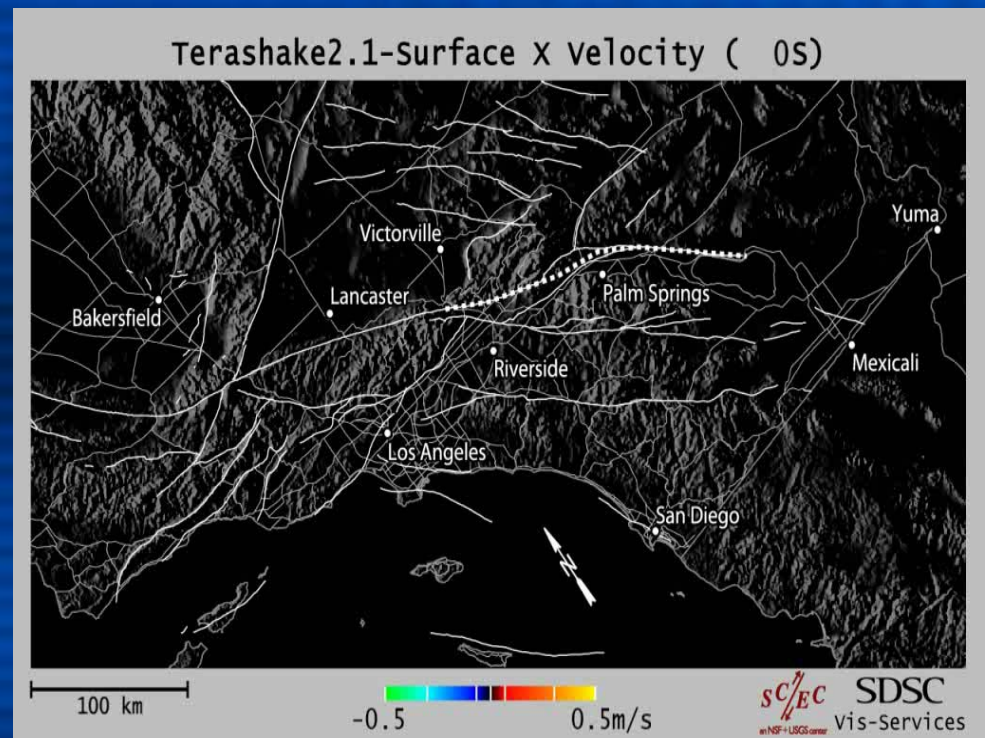
Source: Jason Leigh, Tom DeFanti, EVL@UIC, OptIPuter Co-PIs

TeraShake Simulations

Simulation of Southern of 7.7 earthquake on lower San Andreas Fault

- Physics-based dynamic source model – simulation of mesh of 1.8 billion cubes with spatial resolution of 200 m
- Builds on 10 years of data and models from the Southern California Earthquake Center
- Simulated first 3 minutes of a magnitude 7.7 earthquake, 22,728 time steps of 0.011 second each
- Simulation generates 45+ TB data

TeraShake

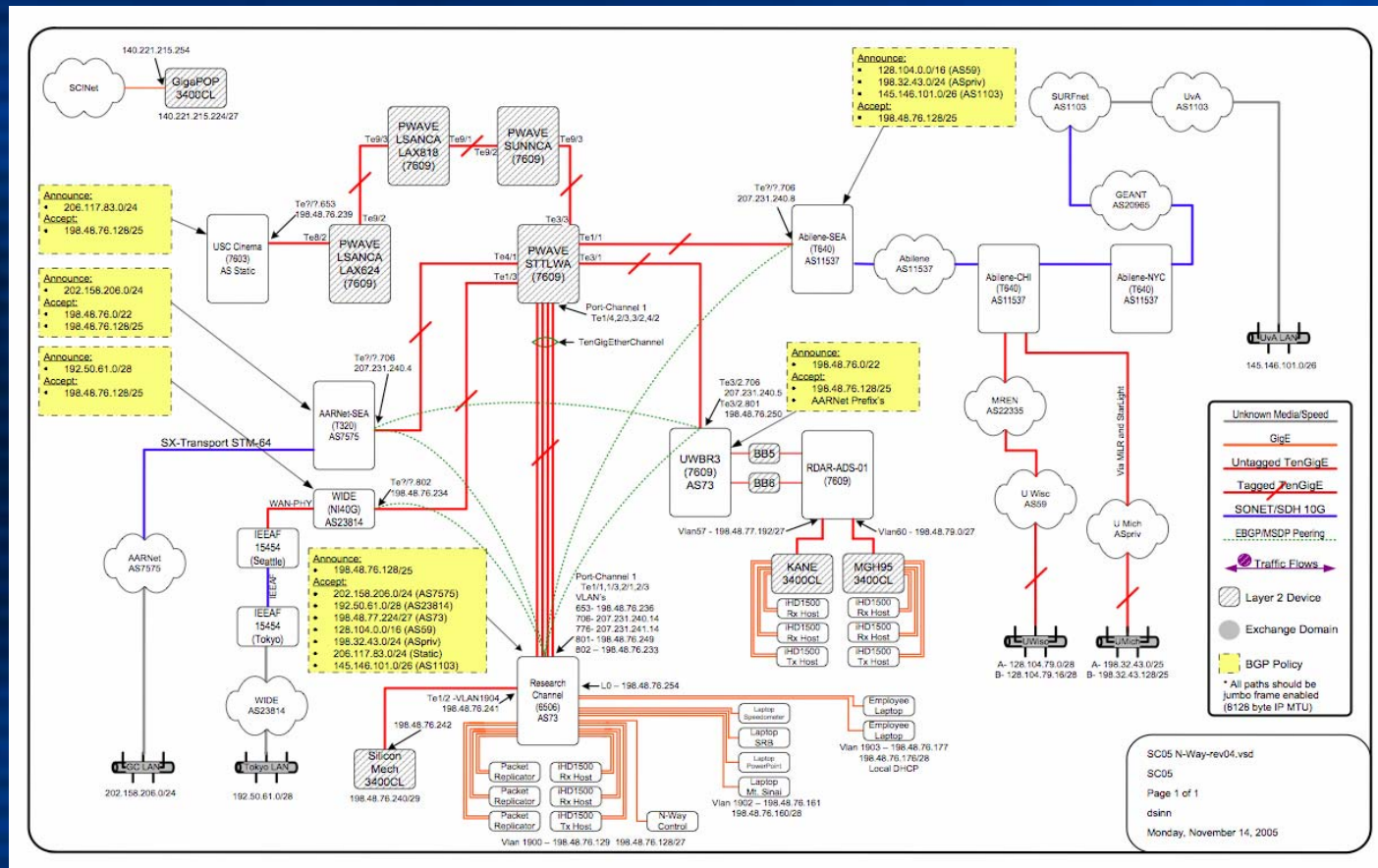


Shaking up quake research. NEESgrid



One of the beauties of the NEESgrid will be its power as a teleobservation and teleoperation tool. In other words, researchers will be able to control experimental tools – such as a seismograph, a camera, or even a robot – at remote sites from their desktop workstation.

HDTV Conferencing Spanning Two Oceans Enabled by Pacific Wave



CalREN's Use for Innovations in Teaching and Learning

CENIC helps UC prepare high school students for college.

U.C. College Prep Online

UNIVERSITY OF CALIFORNIA
UCCP
COLLEGE PREP ONLINE

Preview Our Multimedia Content

Contact Us F.A.Q.

STUDENTS

PREPARING STUDENTS FOR COLLEGE SINCE 1999

EVENTS:

- UCCP Online Teaching & Learning Institute 2005

STUDENTS:

- Enroll in Spring courses now!
- Online tutoring and AP Exam prep available

SCHOOLS:

- Offer online courses to your students with UCCP
- UCCP multimedia content available through Classroom Learning Kits

NO CHILD LEFT BEHIND:

- UCCP is an official services provider
- Online tutoring available

EDUCATORS

SERVICES

RESEARCH

Login

AP Biology

AP Calculus

AP Environmental Science

It is not possible to provide a teacher of advanced mathematics within every high school in California. There are not enough teachers in enough places to meet the need. UCCP delivers Advanced Placement (AP), honors, and pre-AP courses throughout the state.

CENIC takes the distance out of learning.

Virtual Education in Orange County



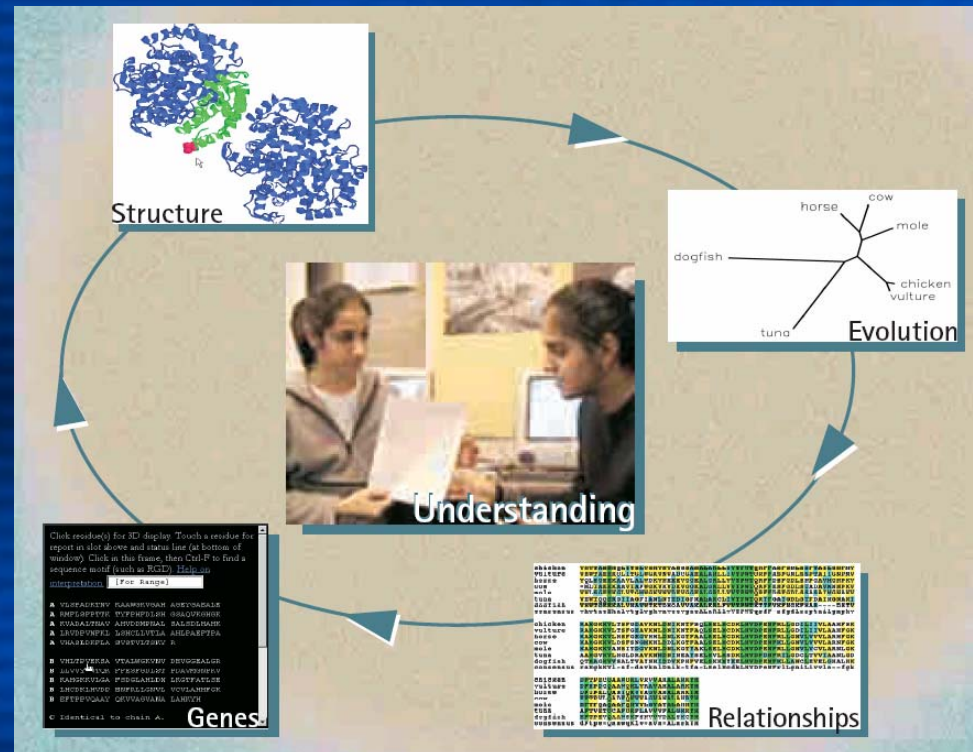
Instead of reading about space history in textbooks, students from Brea Junior High School toured the Smithsonian National Air and Space Museum guided by LeRoy London, director of educational outreach.

Educators in Orange County enjoy direct access to nationally renowned researchers and practitioners and to their colleagues both in the county and beyond.

CENIC enables interactive learning.

The Biology Workbench

The Biology Workbench supports remote identification and manipulation of protein sequences. It has been used by university faculty nationwide in biology courses.



CENIC does digital media.

ACME Animation

Twice weekly ACME links classrooms high schools, occupational centers, community colleges and California State Universities to studio professionals at Disney, DreamWorks, and Warner Brothers. The college matriculation rate of ACME high school participants has reached 91%



CENIC enables interactive learning.

CCC Confer

CCC Confer leverages CalREN's high speed to offer students and faculty the opportunity to combine phone calls with online chat and simultaneous application sharing.

The screenshot shows the CCC Confer website. At the top, there's a green banner with the text "Connect To Your Community" and the "CCC Confer" logo. Below this is a navigation bar with links: HOME, ABOUT US, MEETING CENTER, TRAINING CENTER, SERVICES/PRODUCTS, HELP, and CONTACT US. The main content area features three logos: "Meet & Confer", "Call Confer", and "Office Hours". Below these logos, it states "Used in 109 California Community Colleges System Wide." and includes a button that says "Click Here To Test Drive The New CCC Confer 2005 Model". On the left side, there's a sidebar with sections: LOG IN (with links to Meet & Confer, Office Hours, and Live Online Training), SCHEDULE (with links to Meet & Confer Request, Office Hours Request, and Call Confer Request), TRAINING, RESOURCES, and ARCHIVES (with a link to Meet & Confer). The main content area also has three columns: "Anytime, Anywhere" (describing internet-based meetings), "Just the Phone" (describing phone-based meetings), and "Virtual Office Space" (describing online interactions). Each column has a "Learn More" link and a "Demo Room" link. At the bottom, there's a section titled "Experience the Power of CCC Confer" with a paragraph describing the service.

Connect To Your Community

CCC Confer

HOME ABOUT US MEETING CENTER TRAINING CENTER SERVICES/PRODUCTS HELP CONTACT US

Meet & Confer Call Confer Office Hours

Used in 109 California Community Colleges System Wide.

Click Here To Test Drive The New CCC Confer 2005 Model

LOG IN

- >> Meet & Confer
- >> Office Hours
- >> Live Online Training

SCHEDULE

- >> Meet & Confer Request
- >> Office Hours Request
- >> Call Confer Request

TRAINING

RESOURCES

ARCHIVES

- >> Meet & Confer

Anytime, Anywhere

Use the phone and the Internet to meet, collaborate or train in real-time.

Learn More View Slideshow Demo Room

Just the Phone

Here's a conference call service for those who just want to use the phone.

Learn More

Virtual Office Space

Faculty and students can interact using the phone and the Internet for meetings, tutoring, counseling and more.

Learn More Demo Room

Experience the Power of CCC Confer

Whether you need to get together with one colleague or many, one student or a whole group, CCC Confer is YOUR system-wide e-conferencing solution. All you need is your computer and a phone – the service is provided to you at no cost. Collaborate, meet, train, educate in real time... regularly scheduled or on-the-fly. Get ready to Confer.

Future Directions

- Networks (DC and HPR nets need refreshing/upgrading)
- Communities/educational institutions acquiring fiber
- Need for multiple dedicated/private research networks (iGRID conference demonstrated yesterday includes many examples)
- Uses of network for teaching and learning
- NLR/Internet 2 Merger

Potential List of Future CENIC Net Services

- End to end optical lambda/wave services
 - ✓ Ends are labs/desktops at campuses
 - ✓ Cross national and international network boundaries
 - ✓ Ability to obtain these for short periods of times on short notice (user switched??)
- End-to-end switched ethernet services (same as above)
- New-experimental routed services (layer 3, to complement experimental routed services of NLR)

Questions?

<http://www.cenic.org>

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