The OptIPuter and Its Applications

Invited Talk

IEEE/LEOS Summer 2009 Topicals Meeting on Future Global Networks

July 27, 2009

Dr. Larry Smarr

Director, California Institute for Telecommunications and Information Technology

Harry E. Gruber Professor,

Dept. of Computer Science and Engineering

Jacobs School of Engineering, UCSD

OptIPuter

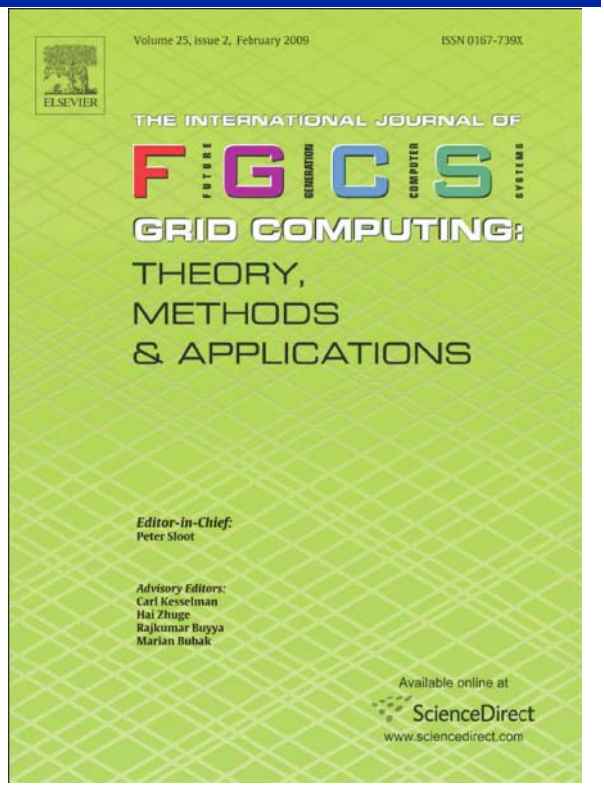
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Abstract

The NSF-funded OptIPuter project enables user-controlled 10Gbps dedicated lightpaths to provide direct access to global data repositories, scientific instruments, and computational resources from “OptIPortals,” PC clusters which provide scalable visualization in user's campus laboratories. I will describe applications from several disciplines of this global "OptIPlatform".

The OptIPuter Creates an OptIPlanet Collaboratory: Enabling Data-Intensive e-Research





"OptIPlanet: The OptIPuter Global Collaboratory" –
Special Section of Future Generations Computer Systems, Volume 25, Issue 2, February 2009

evl electronic visualization laboratory

NSF

ROCKS www.rocksclusters.org

SAGE

Calit2 (UCSD, UCI), SDSC, and UIC Leads—Larry Smarr PI
Univ. Partners: NCSA, USC, SDSU, NW, TA&M, UvA, SARA, KISTI, AIST
Industry: IBM, Sun, Telcordia, Chiaro, Calient, Glimmerglass, Lucent

OptIPuter

it²

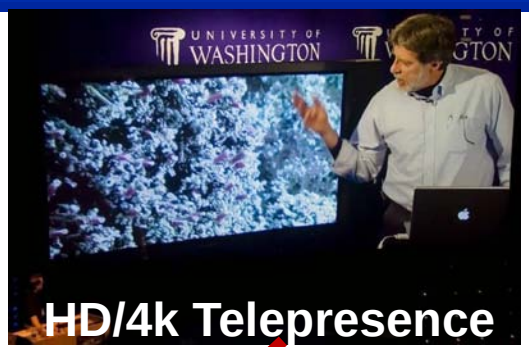
Academic Research "OptIPlatform" Cyberinfrastructure: A 10Gbps Lightpath Cloud



End User OptIPortal



Instruments



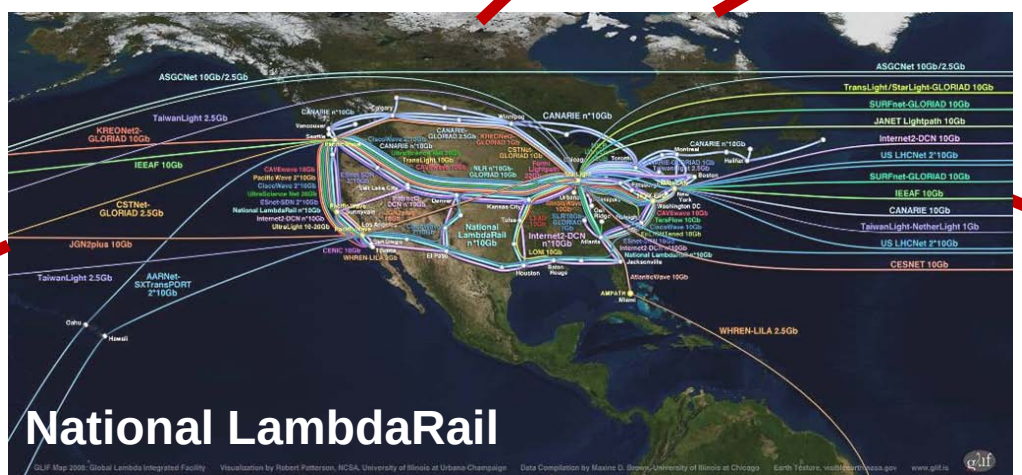
HD/4k Telepresence



HD/4k Video Cams



10G Lightpaths



National LambdaRail

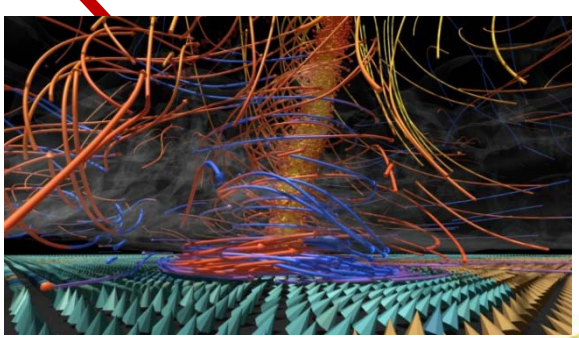
HPC

TeraGrid

Campus Optical Switch



Data Repositories & Clusters

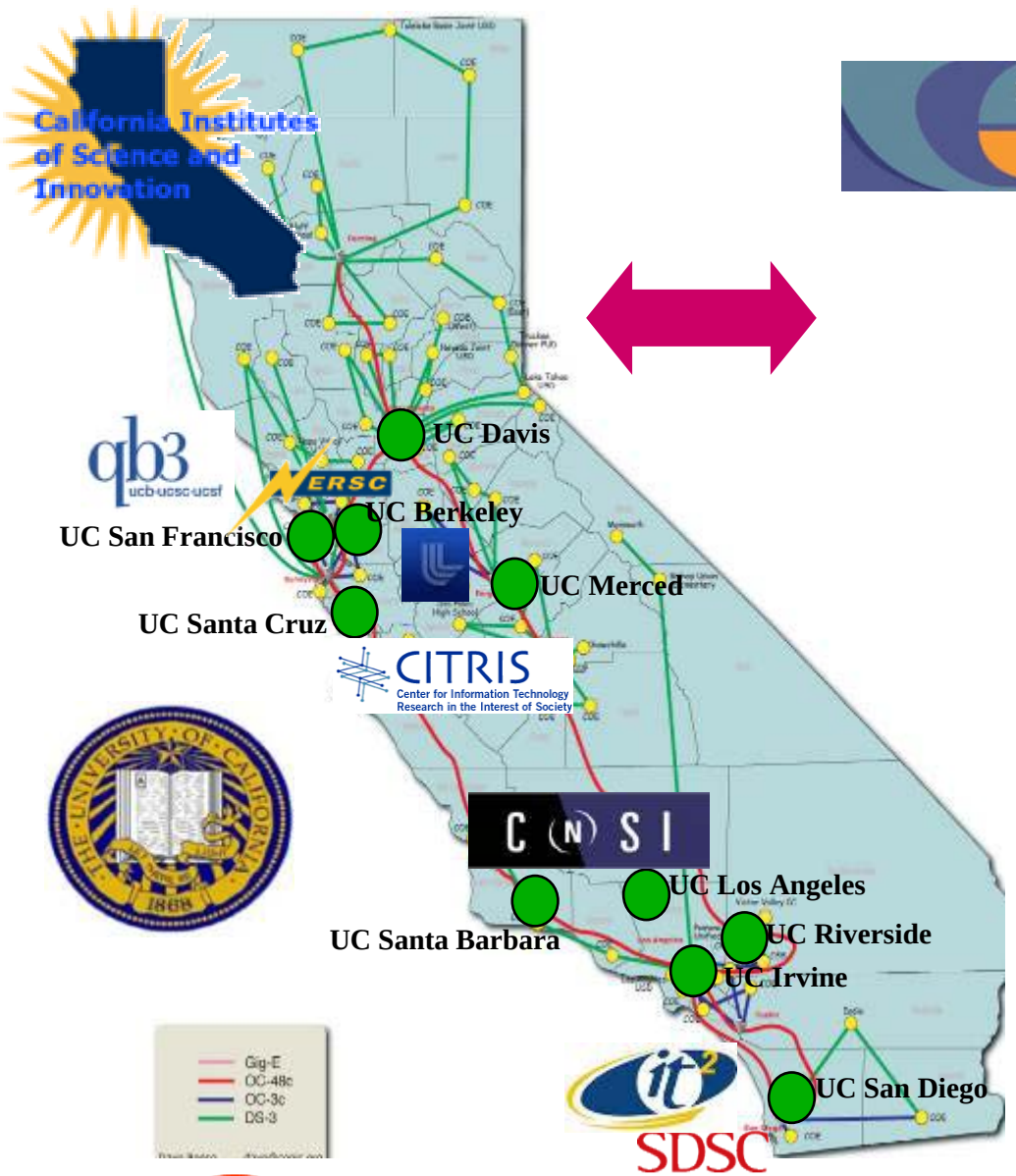


HD/4k Video Images

OptIPuter

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Creating a California Cyberinfrastructure of OptIPuter "On-Ramps" to NLR, I2DC, & TeraGrid



NLR NATIONAL LAMBDARAIL

TeraGrid

Internet2 Network
Dynamic Circuit Network

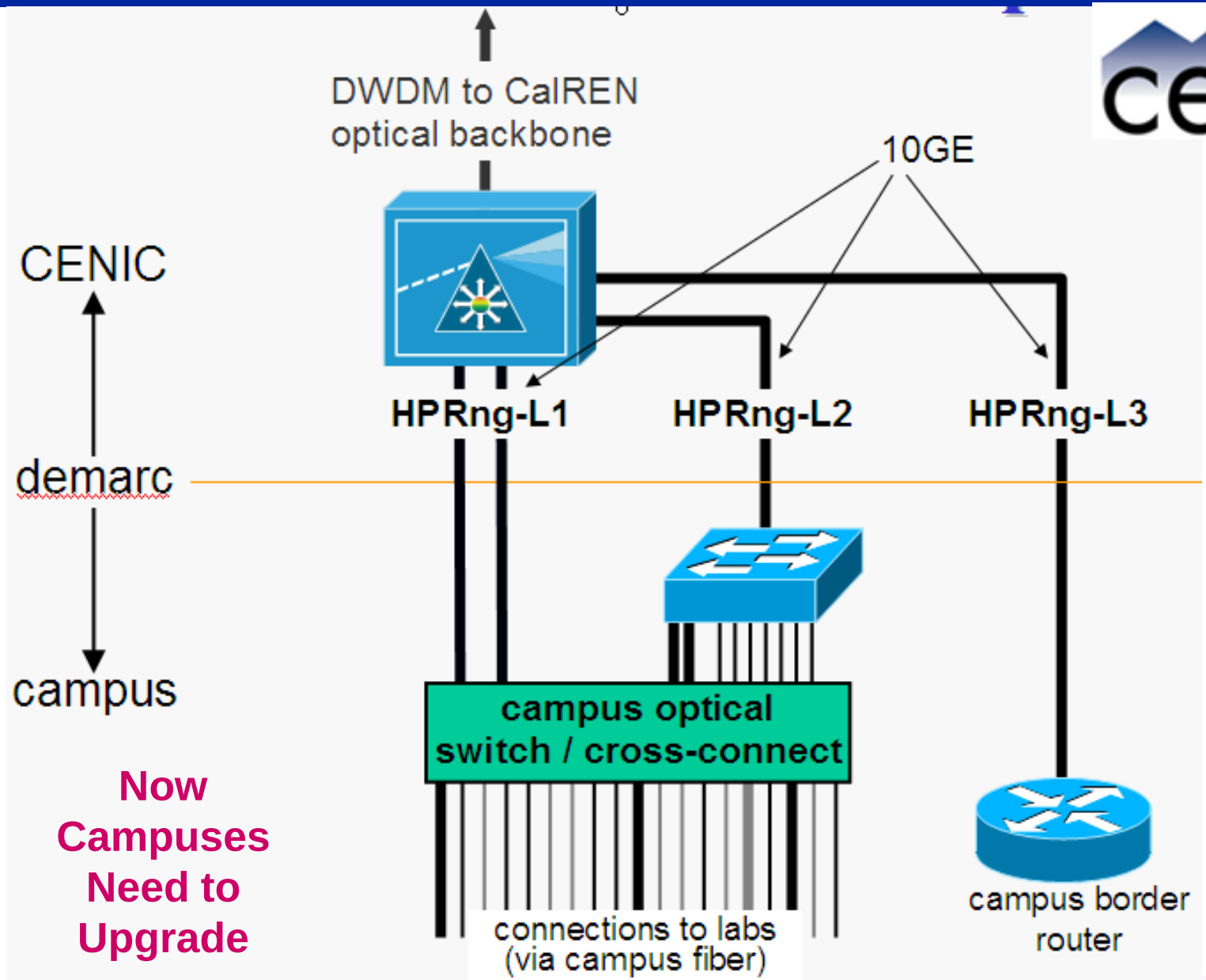
Creating a Critical Mass of OptIPuter End Users on a Secure LambdaGrid

CENIC Workshop at Calit2
Sept 15-16, 2008

OptIPuter

CENIC's New "Hybrid Network" - Traditional Routed IP and the New Switched Ethernet and Optical Services

CENIC Invested ~ $14M in Upgrade



Now Campuses Need to Upgrade

Source: Jim Dolgonas, CENIC

The "Golden Spike" UCSD Experimental Optical Core: Ready to Couple Users to CENIC L1, L2, L3 Services



Goals by 2008:

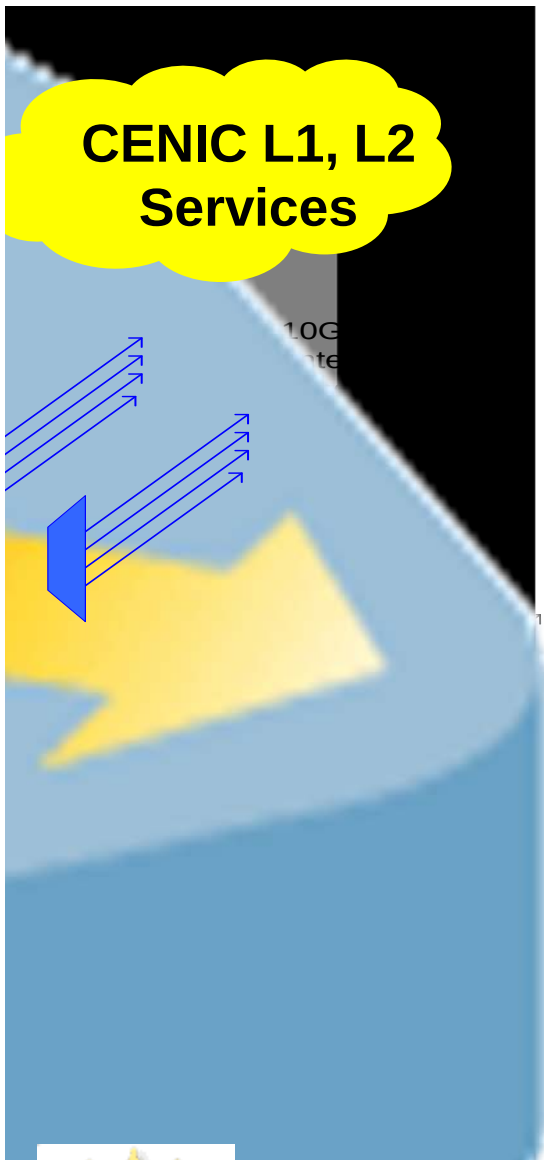
>= 60 endpoints at 10 GigE

>= 30 Packet switched

>= 30 Switched wavelengths

>= 400 Connected endpoints

Approximately 0.5 Tbps Arrive at the "Optical" Center of Hybrid Campus Switch



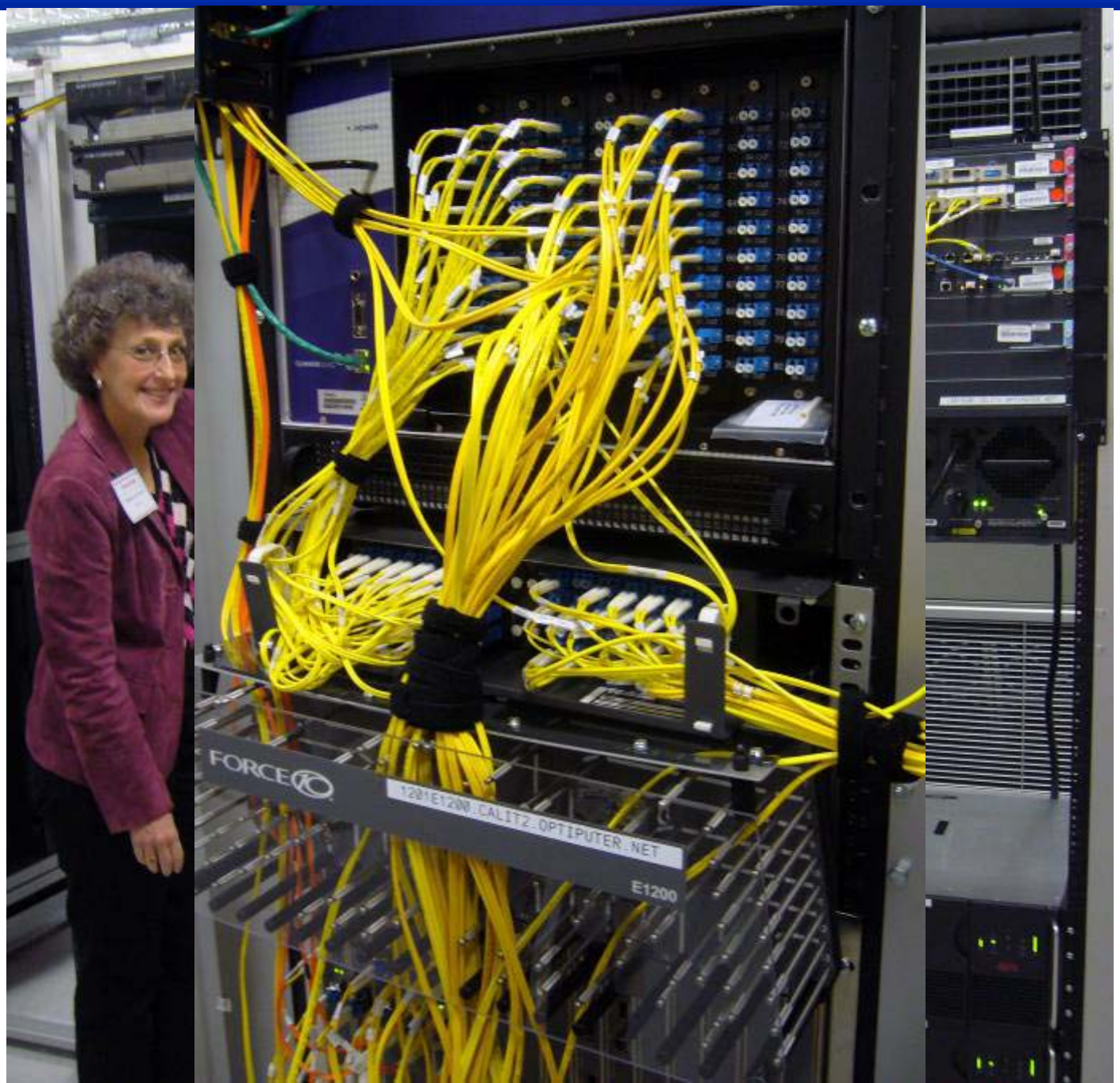
Funded by NSF MRI Grant

OptIPuter SDSC

Source: Phil Papadopoulos, SDSC/Calit2 (Quartzite MRI PI, OptIPuter co-PI)

NSF it²

Calit2 Sunlight
Optical Exchange Contains Quartzite



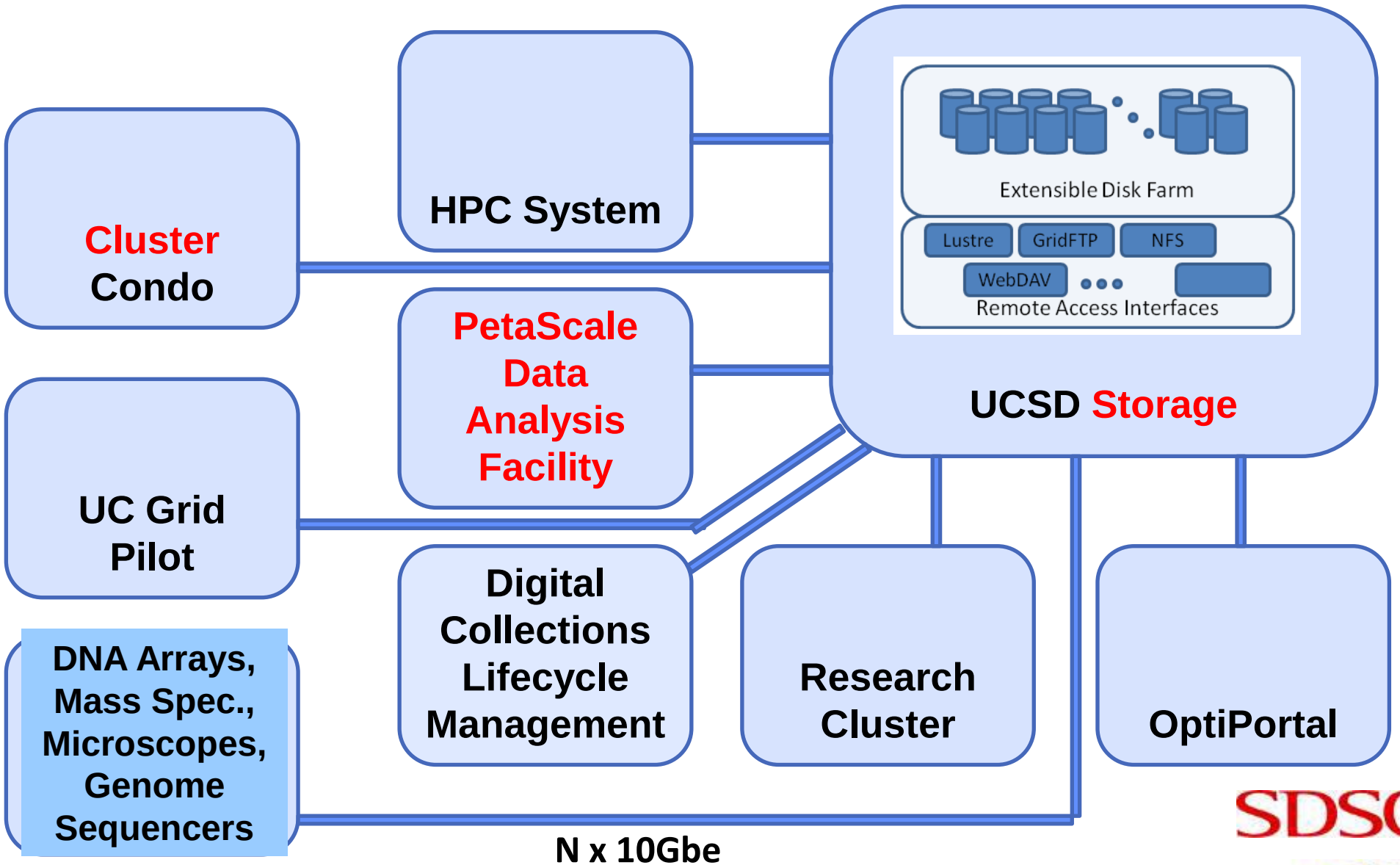
Maxine Brown, EVL, UIC OptIPuter Project Manager

OptIPuter

SDSC

it²

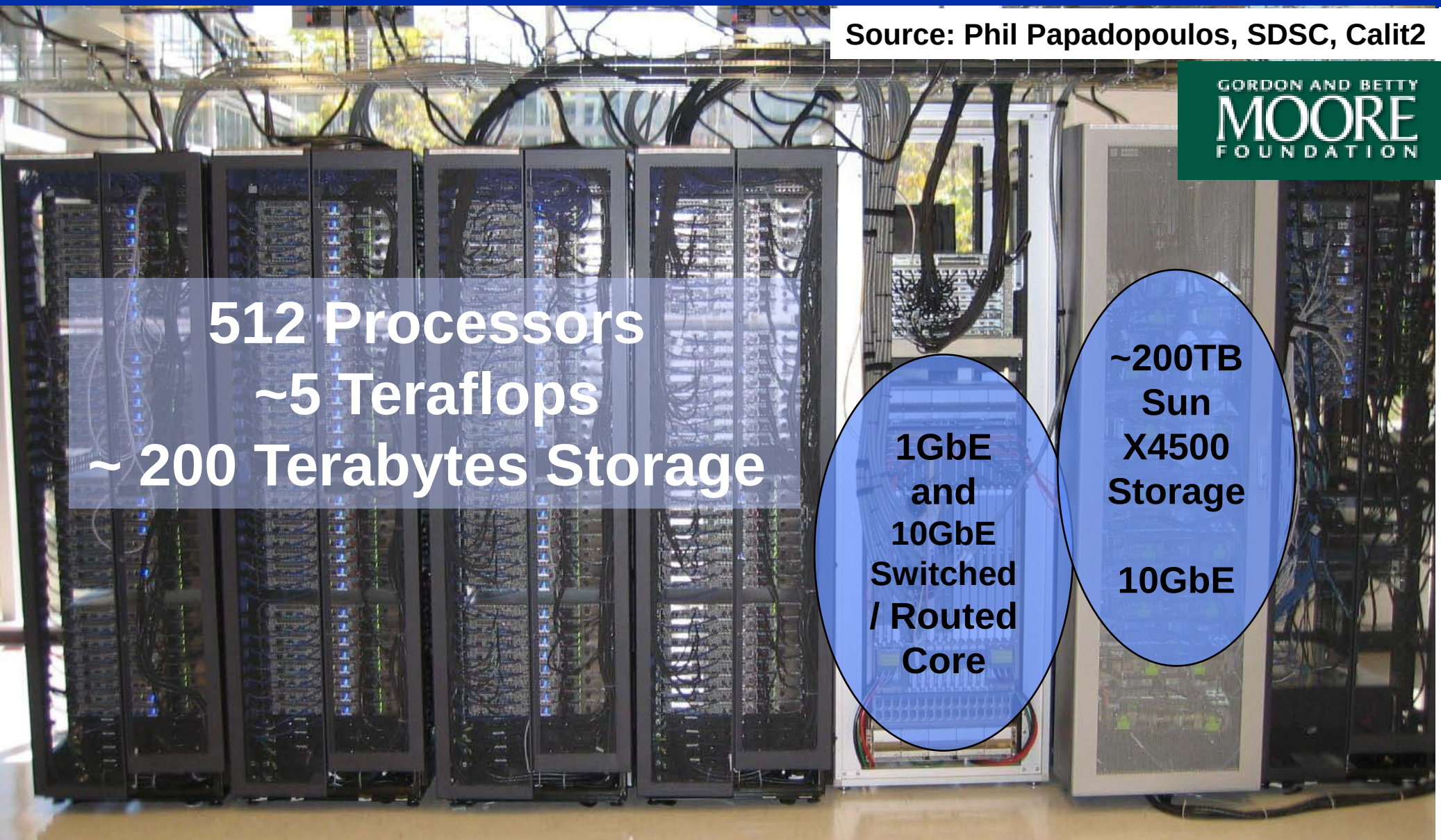
Campus Fiber Network Based on Quartzite Allowed UCSD CI Design Team to Architect Shared Resources



Source: Phil Papadopoulos, SDSC/Calit2

Calit2 Microbial Metagenomics Cluster- Next Generation Optically Linked Science Data Server

Source: Phil Papadopoulos, SDSC, Calit2

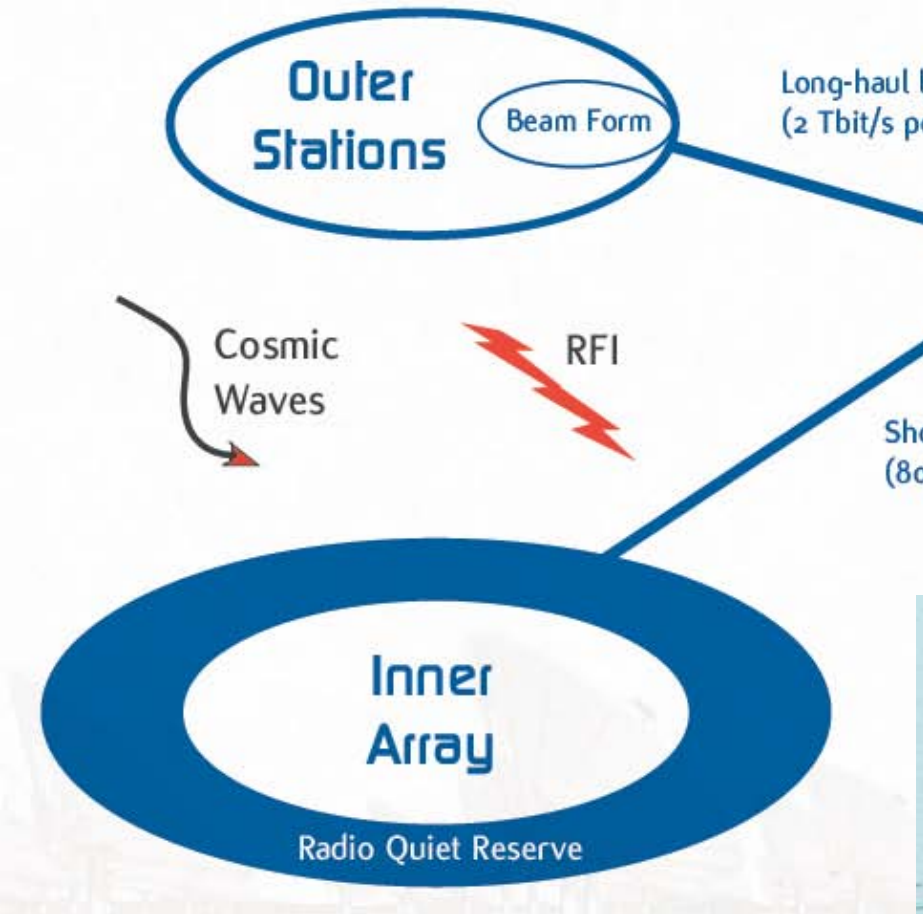


GORDON AND BETTY MOORE FOUNDATION

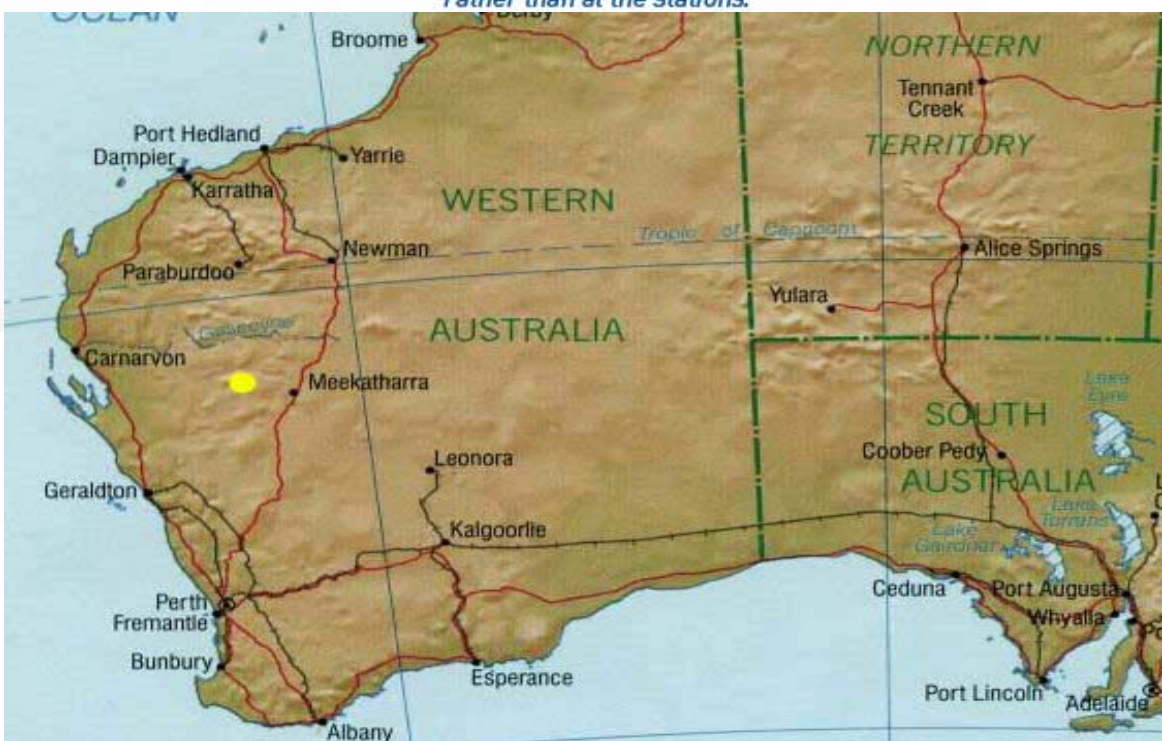
OptIPuter SDSC ROCKS camera Marine Microbial Ecology J. Craig Venter INSTITUTE it²

Next Great Planetary Instrument: The Square Kilometer Array Requires Dedicated Fiber

www.skatelescope.org



Schematic of SKA signal flow. Advances in signal transport technology may later allow more signals to be processed at the core, rather than at the stations.



Transfers Of 1 TByte Images World-wide Will Be Needed Every Minute!

OptIPuter

My OptIPortal™ – Affordable Termination Device for the OptIPuter Global Backplane

- 20 Dual CPU Nodes, 20 24” Monitors, ~$50,000
- 1/4 Teraflop, 5 Terabyte Storage, 45 Mega Pixels--Nice PC!
- Scalable Adaptive Graphics Environment (SAGE) Jason Leigh, EVL-UIC

evl electronic visualization laboratory





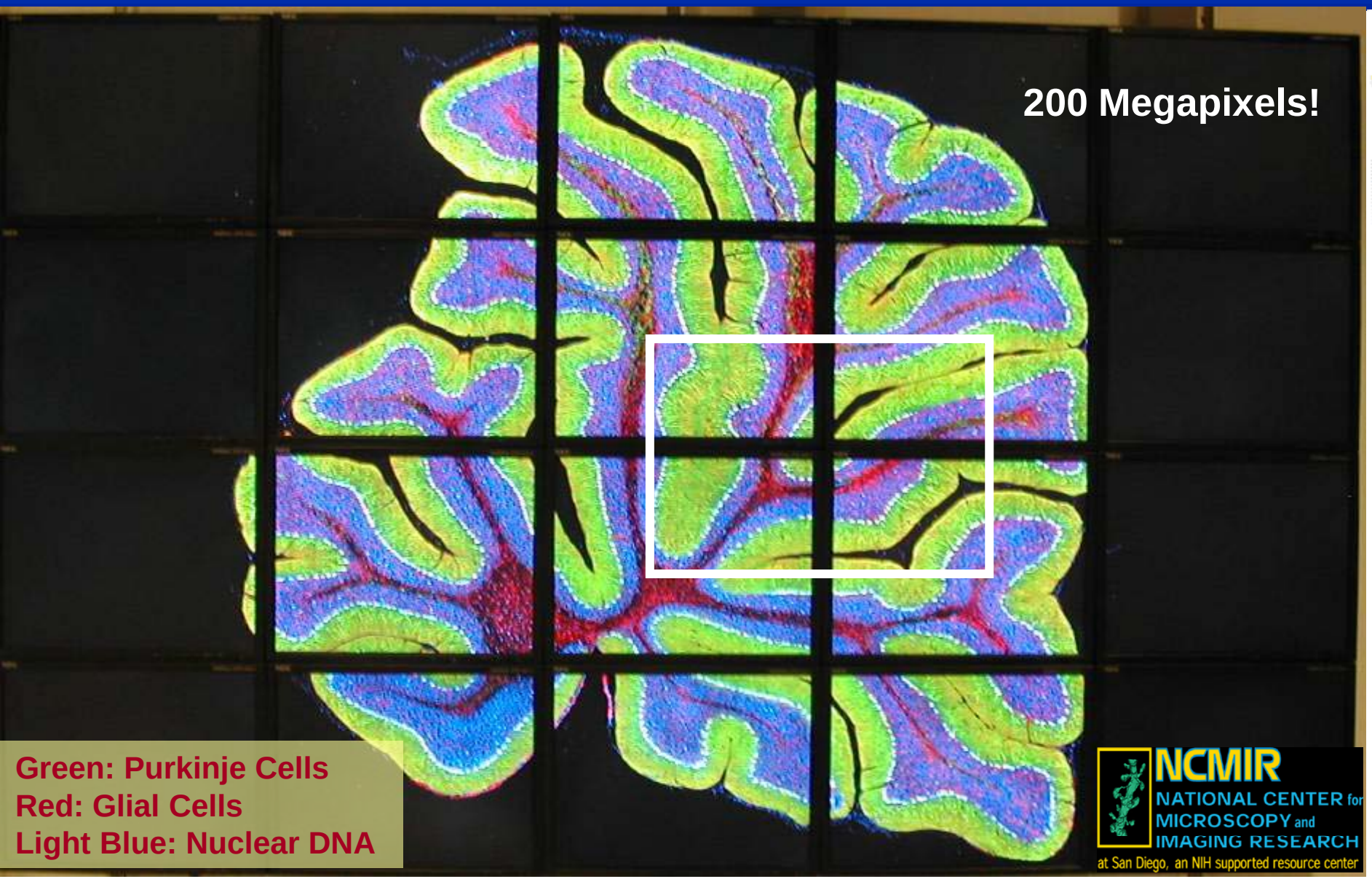
OptIPuter

Powered by Rocks ROCKS

Source: Phil Papadopoulos SDSC, Calit2

it²

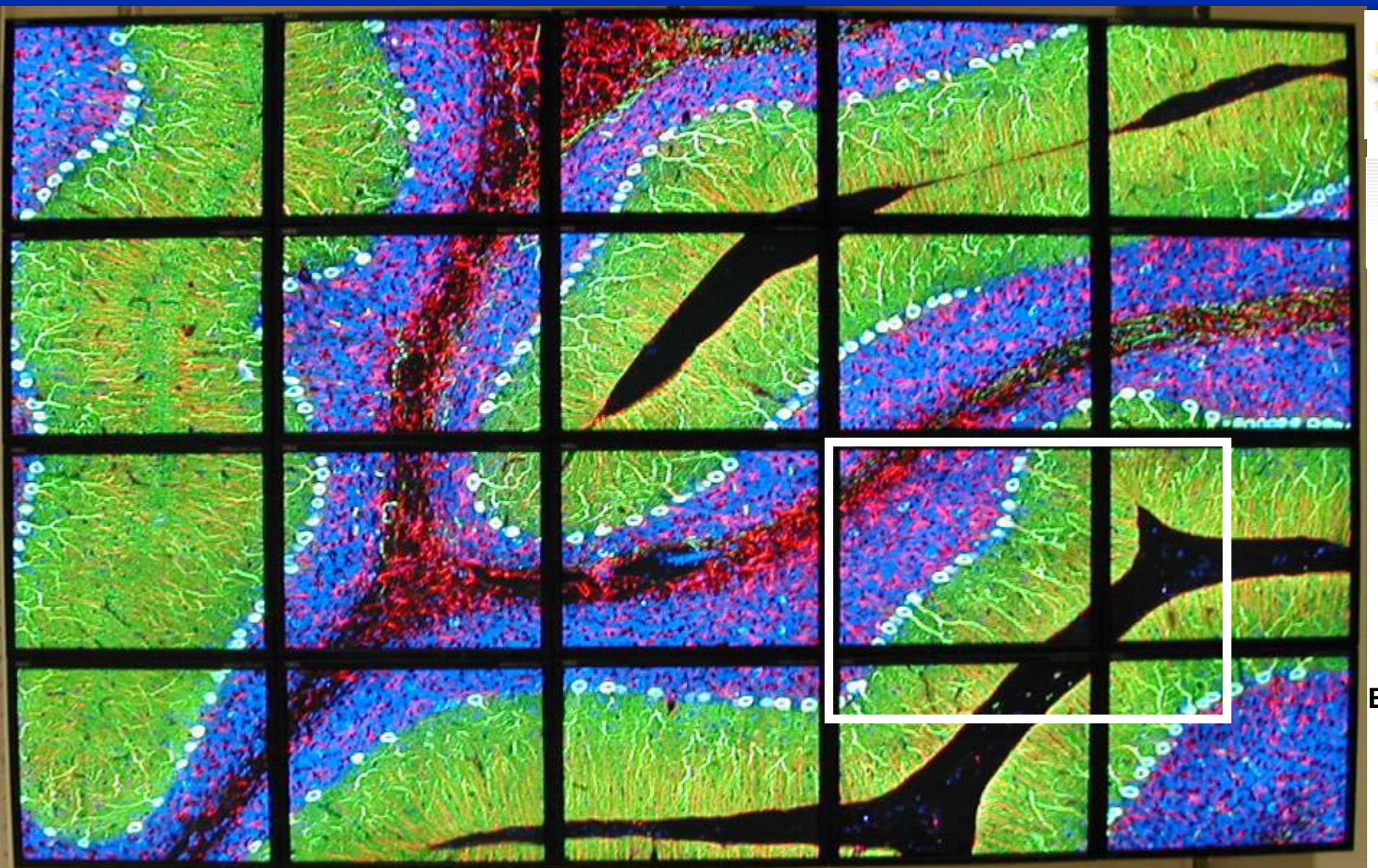
Use of OptIPortal to Interactively View Multi-Scale Biomedical Imaging



Source: Mark Ellisman, David Lee, Jason Leigh

Two-Photon Laser Confocal Microscope Montage of 40x36=1440 Images in 3 Channels of a Mid-Sagittal Section of Rat Cerebellum Acquired Over an 8-hour Period

Scalable Displays Allow Both Global Content and Fine Detail



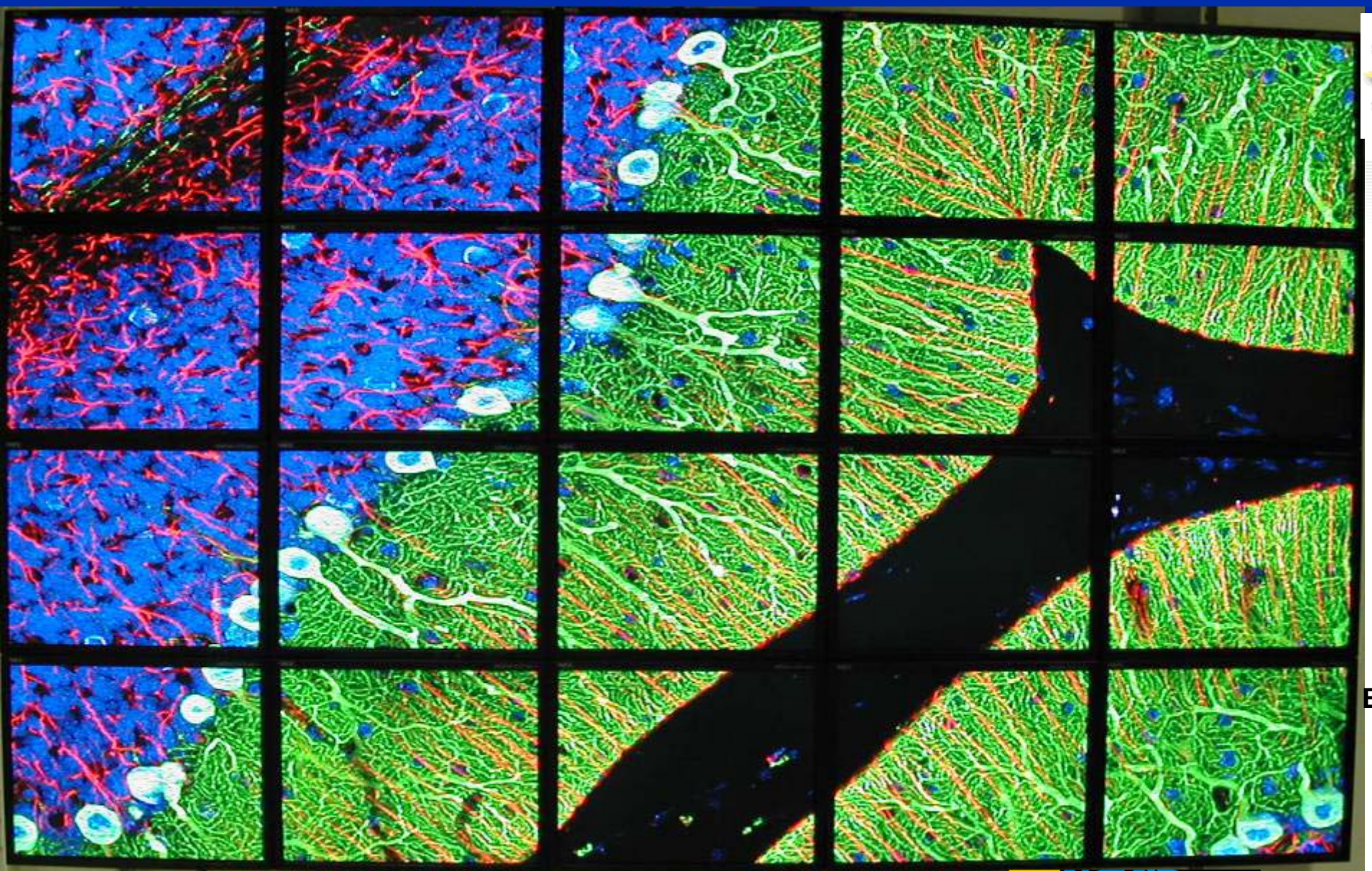
Source: Mark Ellisman, David Lee, Jason Leigh

OptIPuter

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

it²

Allows for Interactive Zooming from Cerebellum to Individual Neurons



Source: Mark Ellisman, David Lee, Jason Leigh

OptIPuter

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

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On-Line Resources
Help You Build Your Own OptIPortal

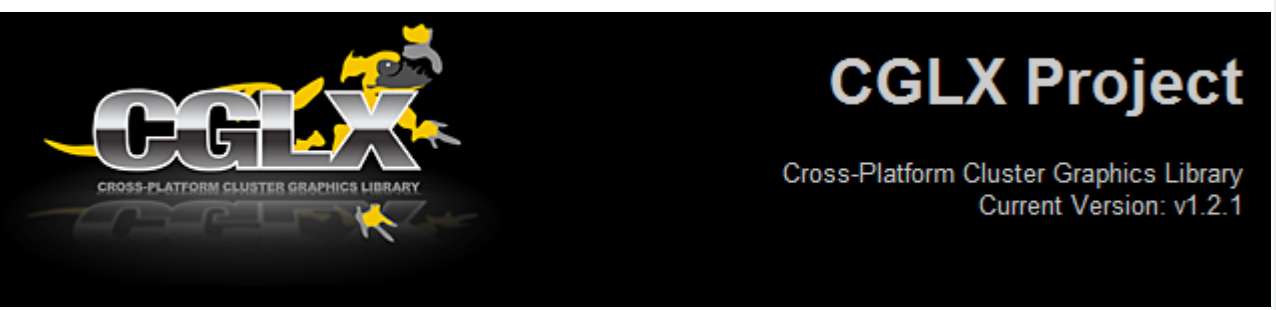
www.optiputer.net

http://wiki.optiputer.net/optiportal



www.evl.uic.edu/cavern/sage





http://vis.ucsd.edu/~cglx/



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Launch of the 100 Megapixel OzIPortal Kicked Off a Rapid Build Out of Australian OptIPortals



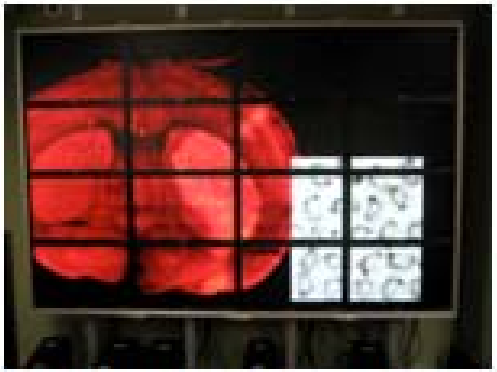
ANU



U Queensland



AARNet



Monash U-Caufield



CSIRO



Monash U-Clayton



U Wellington, NZ

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Building a Data and Visualization Intensive Working Environment Across Remote Sites



UCSD cluster: 15 x Quad core Dell XPS with Dual nVIDIA 5600s
UCI cluster: 25 x Dual Core Apple G5

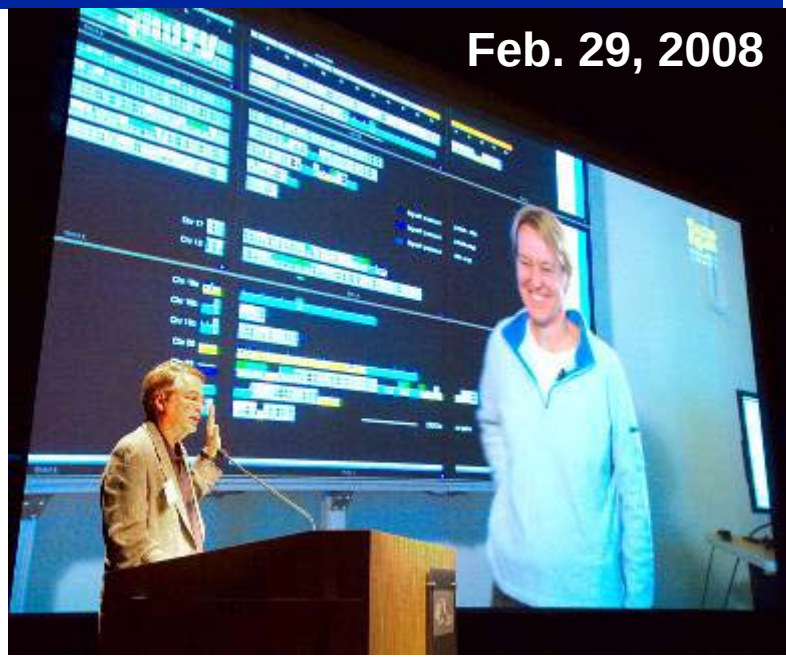
OptIPuter Persistent Infrastructure Enables Calit2 and U Washington CAMERA Collaboratory



OptIPuter

Ginger Armbrust's Diatoms: Micrographs, Chromosomes, Genetic Assembly

ROCKS





Gordon and Betty MOORE FOUNDATION

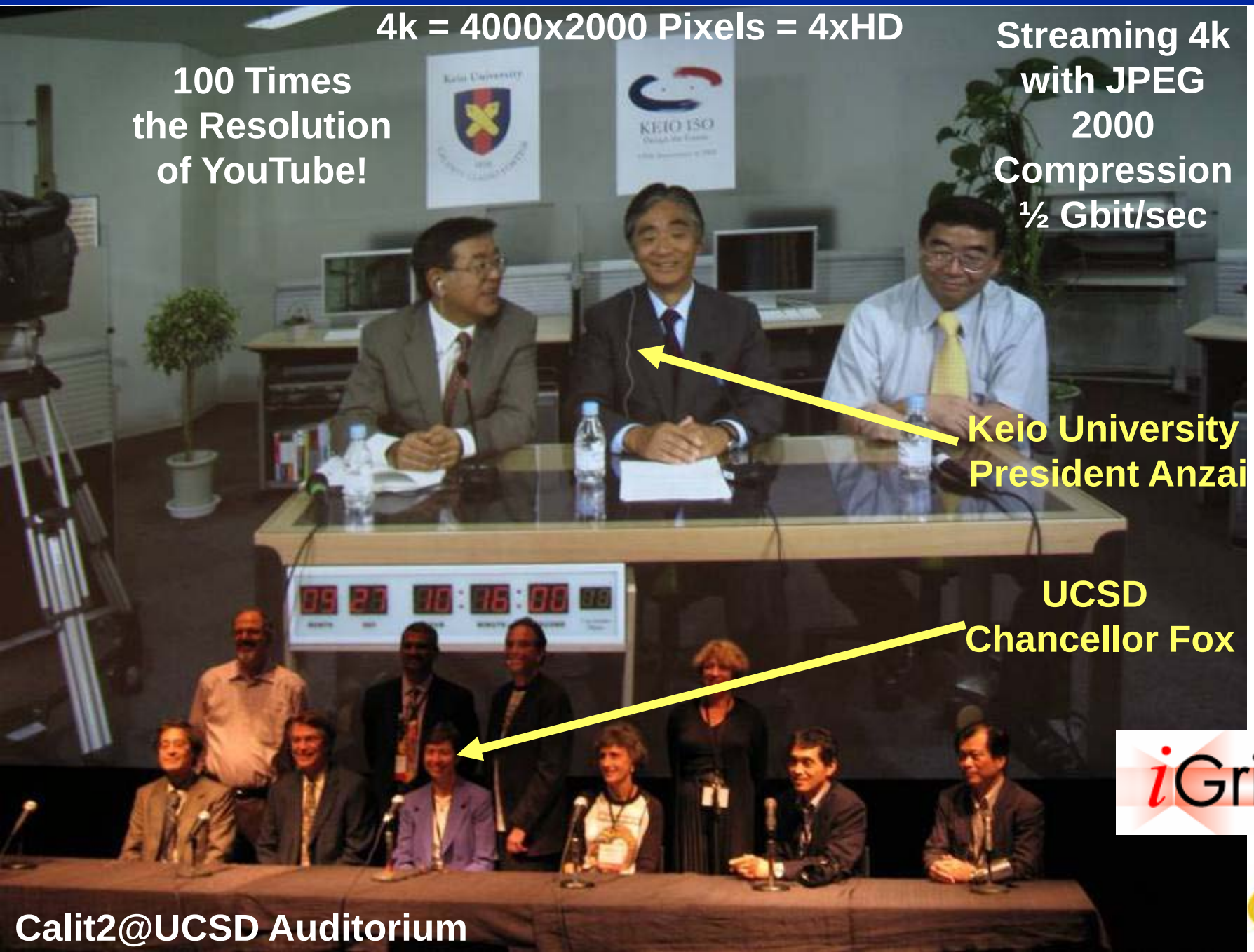
camera
Marine Microbial Ecology

OptIPuter

NSF

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Telepresence Meeting
Using Digital Cinema 4k Streams



CineGrid

Lays Technical Basis for Global Digital Cinema

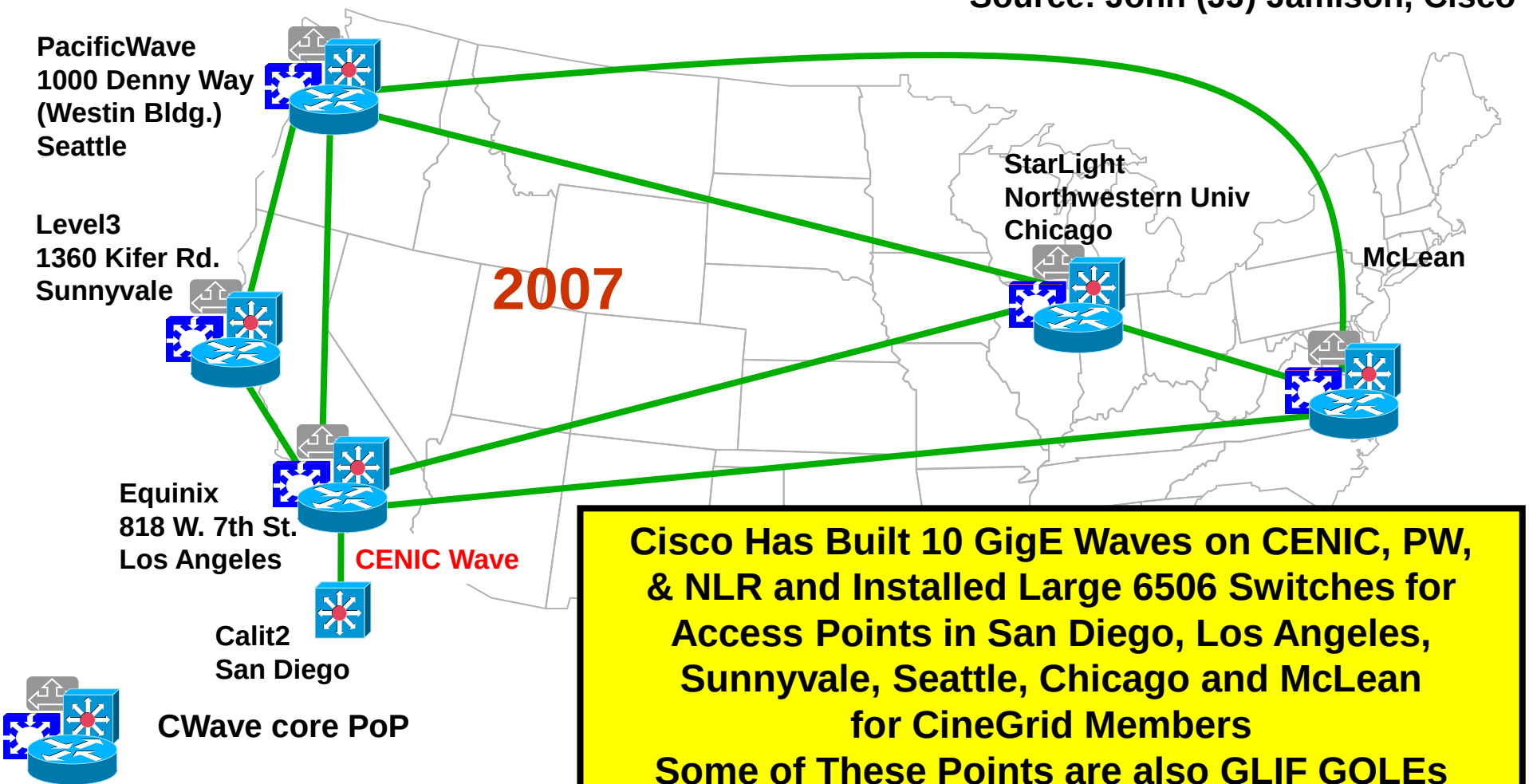
Sony
NTT
SGI

iGrid 2005

it²

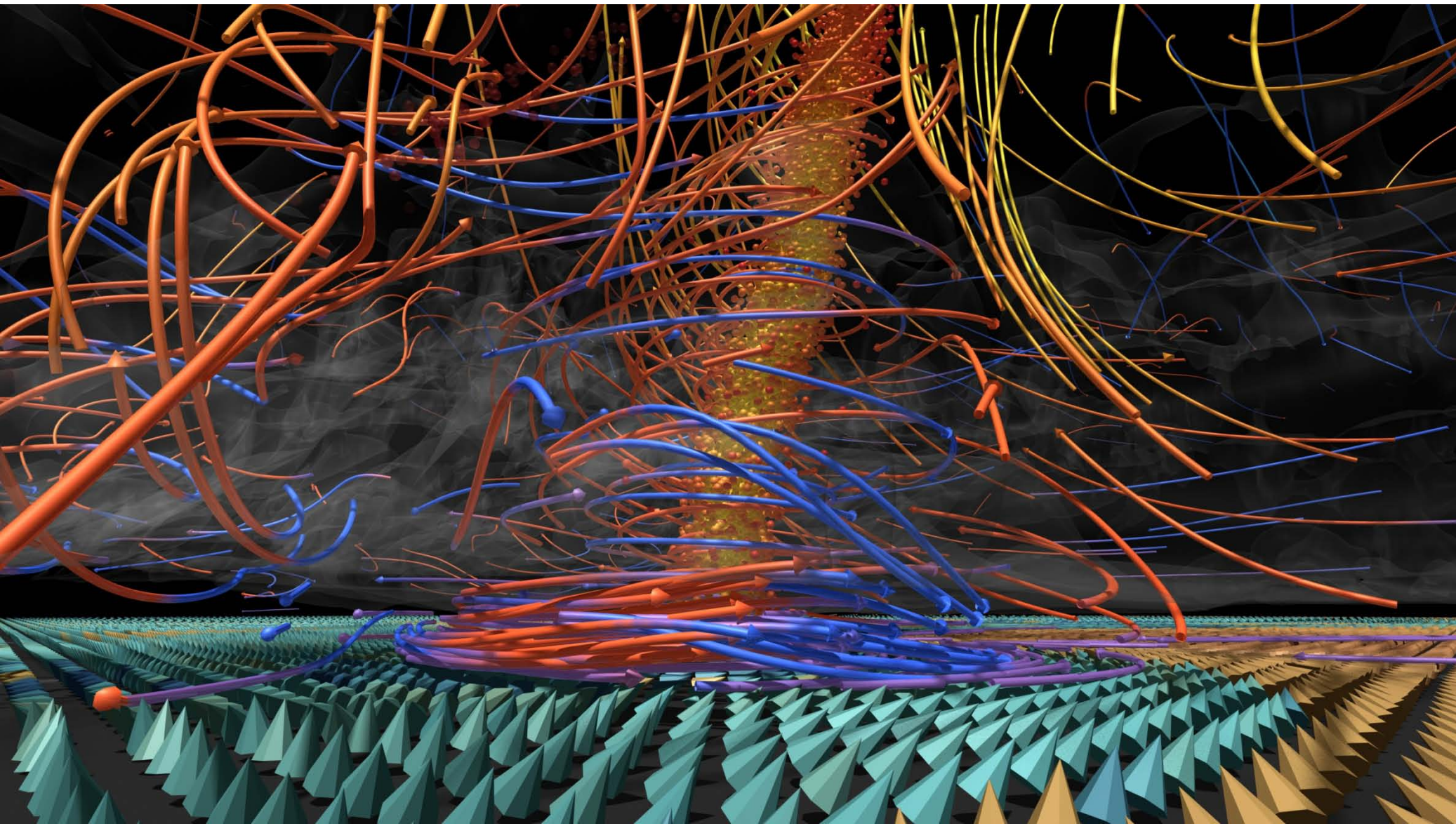
Cisco CWave for CineGrid: A New Cyberinfrastructure for High Resolution Media Streaming*

Source: John (JJ) Jamison, Cisco



Cisco Has Built 10 GigE Waves on CENIC, PW, & NLR and Installed Large 6506 Switches for Access Points in San Diego, Los Angeles, Sunnyvale, Seattle, Chicago and McLean for CineGrid Members
Some of These Points are also GLIF GOLEs

Rendering Supercomputer Data at 4k Digital Cinema Resolution



OptIPuter

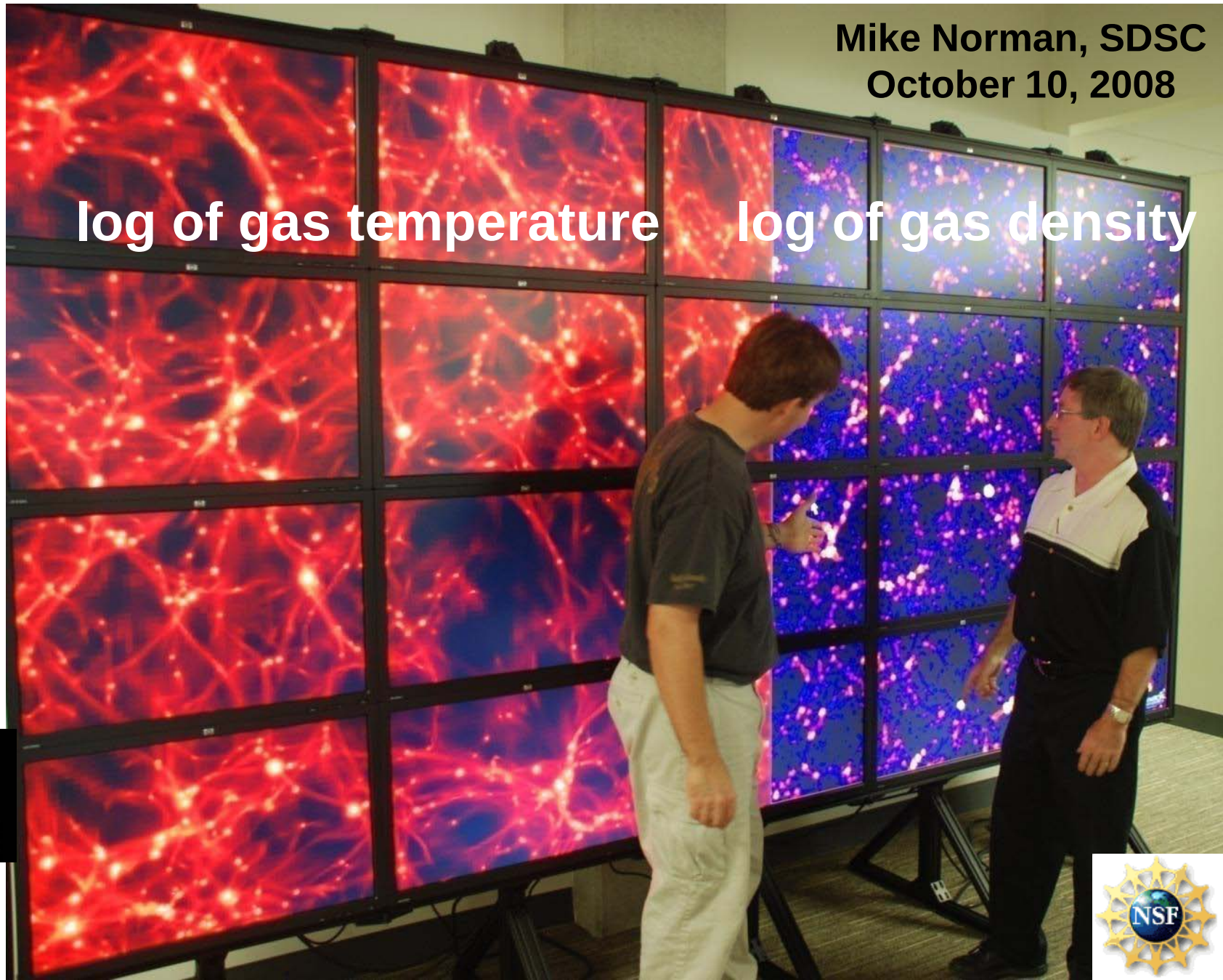
Source: Donna Cox, Robert Patterson, Bob Wilhelmson, NCSA

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Providing End-to-End CI for Petascale End Users

SDSC
SAN DIEGO SUPERCOMPUTER CENTER

Two 64K Images From a Cosmological Simulation of Galaxy Cluster Formation



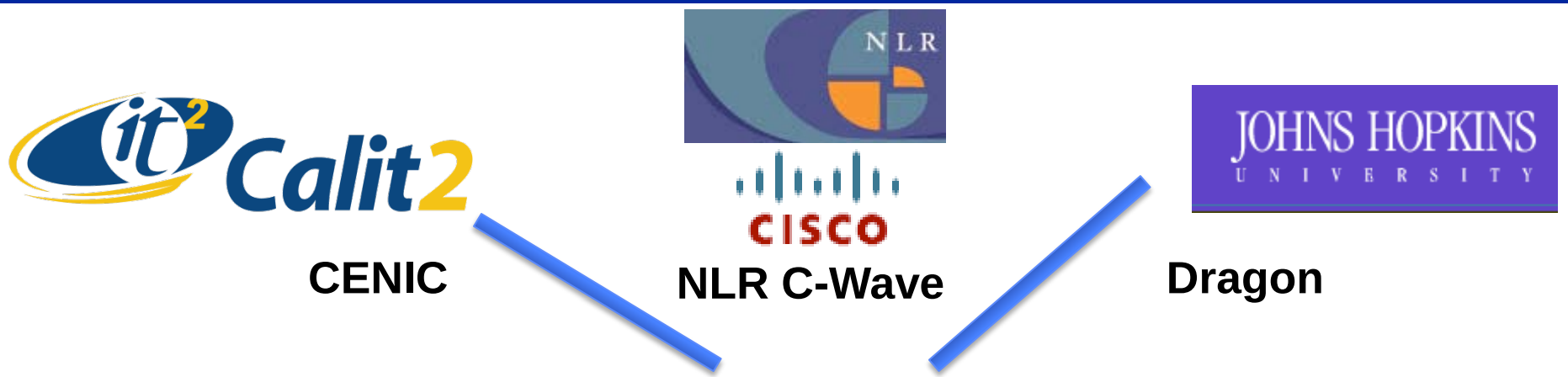
ROCKS
www.rocksclusters.org

CGLX

OptIPuter

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Open Cloud OptIPuter Testbed--Manage and Compute Large Datasets Over 10Gbps Lambdas



HW Phase 1 (2008)

- 4 racks
  - 120 Nodes
  - 480 Cores
- 10+ Gb/s WAN



MREN

UIC

Open Source SW

- Hadoop
- Sector/Sphere
- Thrift, GPB
- Eucalyptus
- Benchmarks

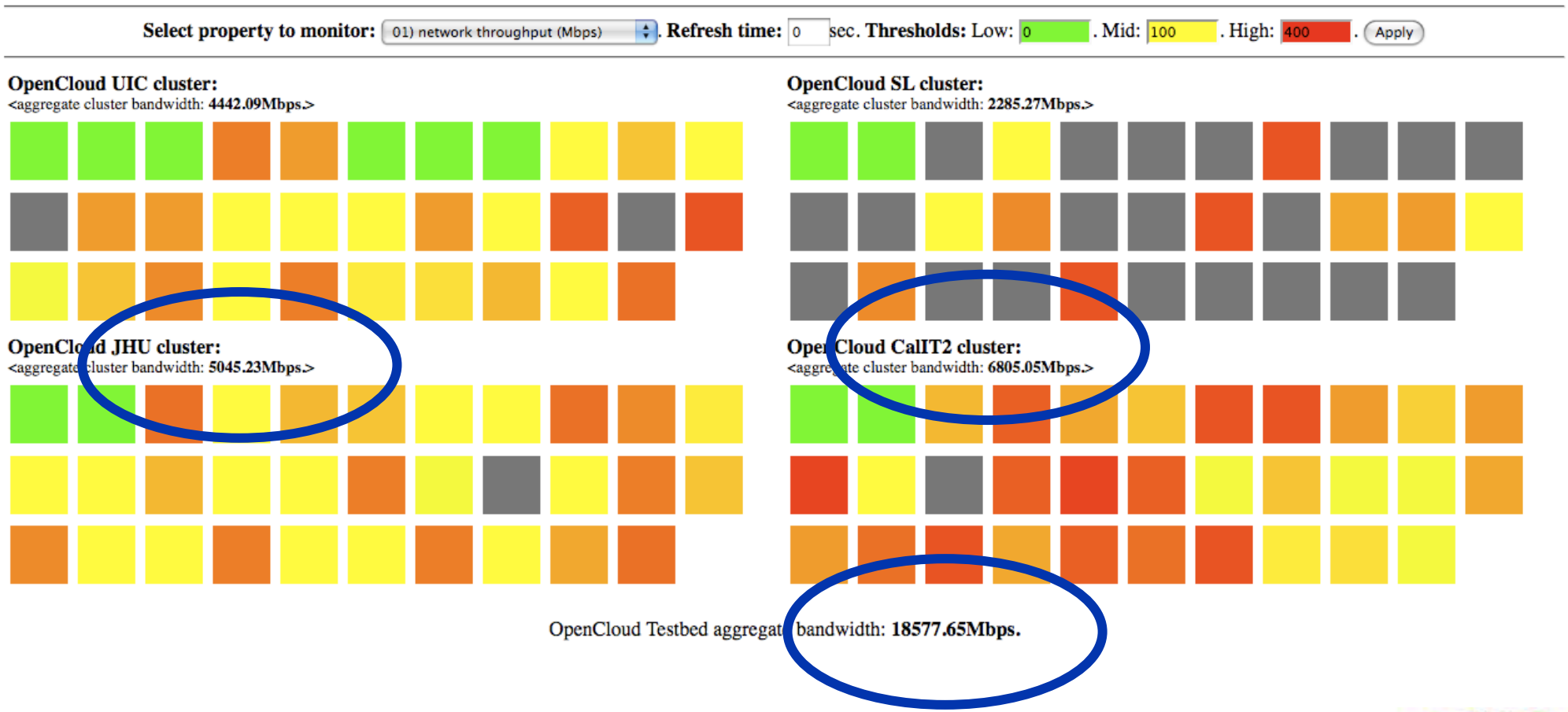
Phase 2 (2009) will add additional racks to current sites and increase number of sites

OptIPuter

Source: Robert Grossman, UIC

Terasort on Open Cloud Testbed

Sorting 10 Billion Records (1.2 TB) at 4 Sites (120 Nodes) Sustaining >5 Gbps--Only 5% Distance Penalty

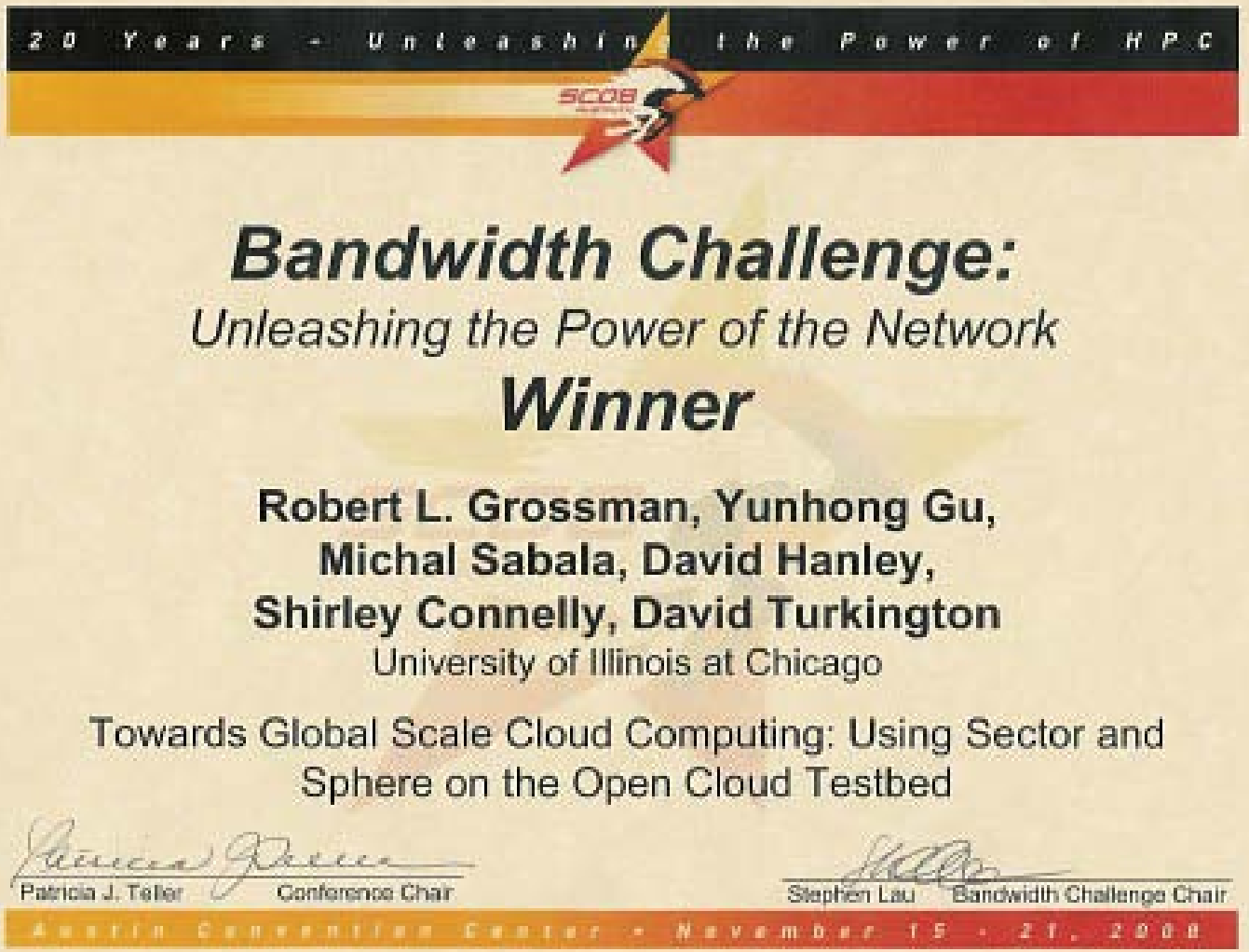


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OpenCloud Testbed Wins Against All Comers!

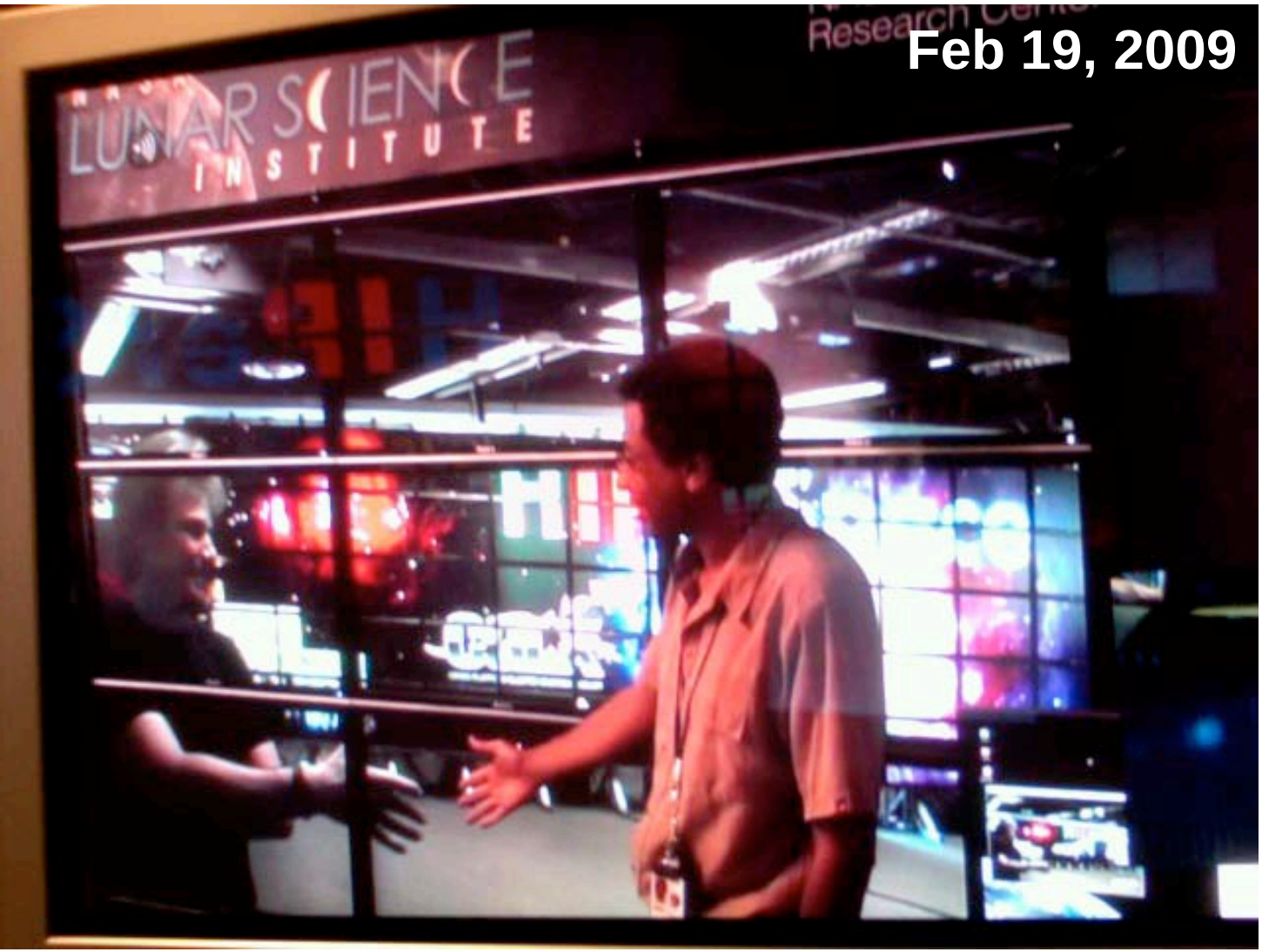
Supercomputing 2008



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Just in Time OptIPlanet Collaboratory: Live Session Between NASA Ames and Calit2@UCSD



From Start to This Image in Less Than 2 Weeks!

View from NASA Ames Lunar Science Institute Mountain View, CA

Virtual Handshake

HD compressed 6:1

NASA Interest in Supporting Virtual Institutes

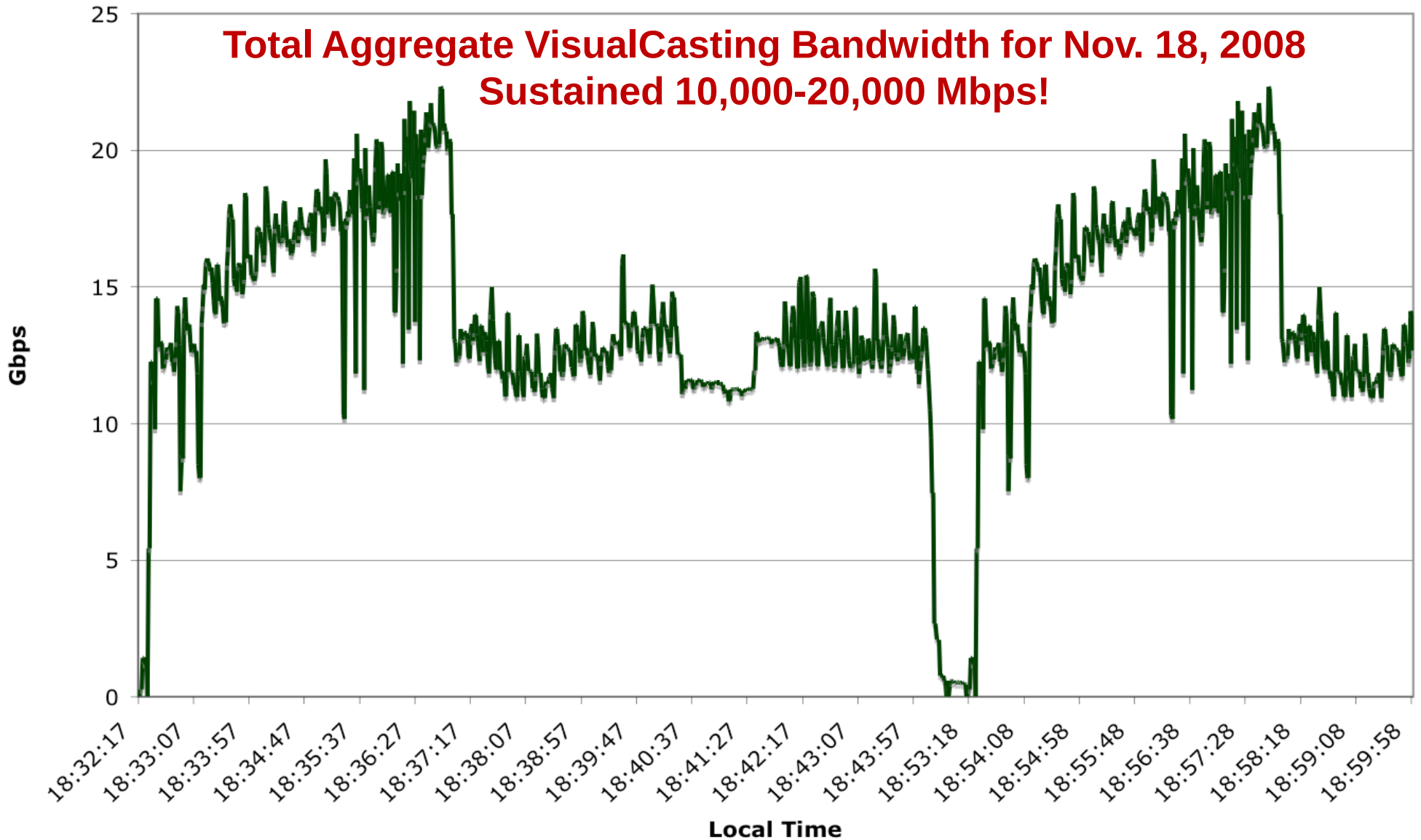
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Source: Falko Kuester, Calit2; Michael Sims, NASA

EVL's SAGE OptIPortal VisualCasting Multi-Site OptIPuter Collaboratory



Source: Jason Leigh, Luc Renambot, EVL, UI Chicago