The Strongly Coupled LambdaCloud

Tour

TTI-Vanguard

Calit2@UCSD

February 20, 2009

Dr. Larry Smarr

Director, California Institute for Telecommunications and Information Technology

Harry E. Gruber Professor,

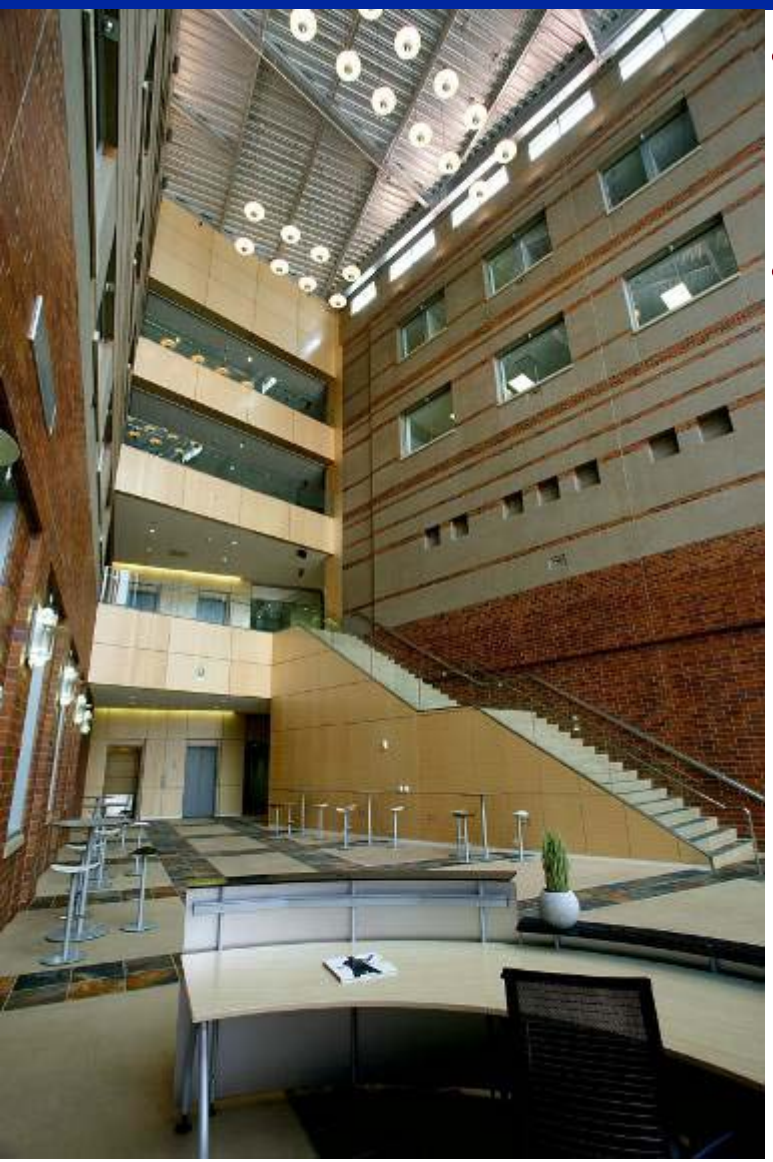
Dept. of Computer Science and Engineering

Jacobs School of Engineering, UCSD

OptIPuter

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Two New Calit2 Buildings Provide Laboratories for "Living in the Future"



- "Convergence" Laboratory Facilities
  - Nanotech, BioMEMS, Chips, Radio, Photonics
  - Virtual Reality, Digital Cinema, HDTV, Gaming
- Over 1000 Researchers in Two Buildings
  - Linked via Dedicated Optical Networks



www.calit2.net

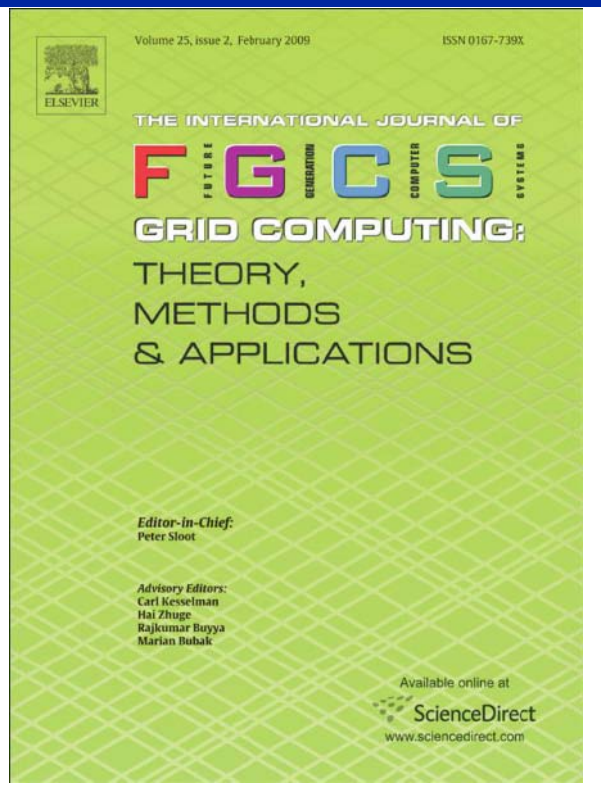
Preparing for a World in Which Distance is Eliminated…

OptIPuter

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The OptIPuter Creates a 10Gbps LambdaCloud: Enabling Collaborative Data-Intensive e-Research





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

ROCKS
www.rocksclusters.org

evl electronic visualization laboratory

50 OptIPortals Worldwide -- Campus CI Now the Bottleneck

OptIPuter

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

it²

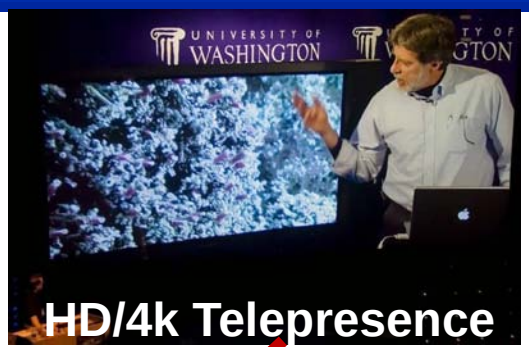
Academic Research "OptIPlatform" Cyberinfrastructure: A 10Gbps Lightpath Cloud



End User OptIPortal



Instruments



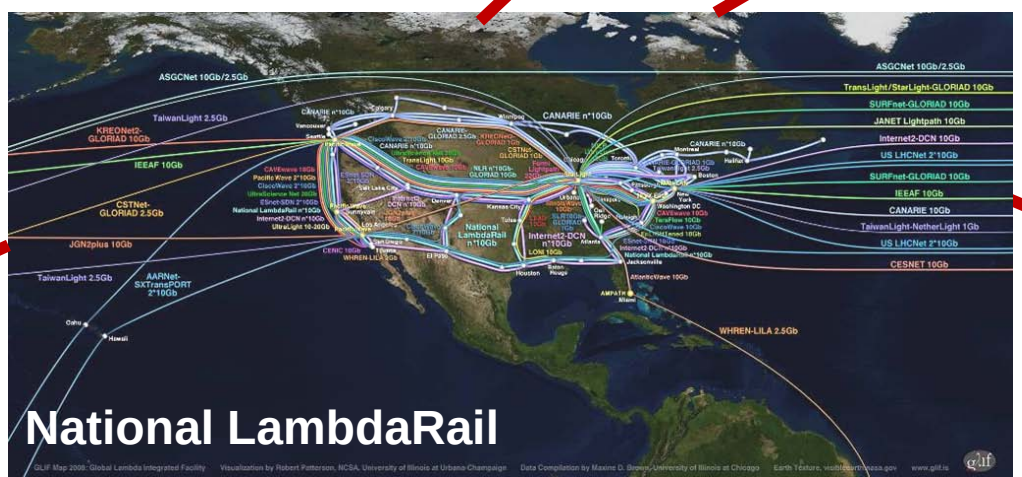
HD/4k Telepresence



HD/4k Video Cams



10G Lightpath

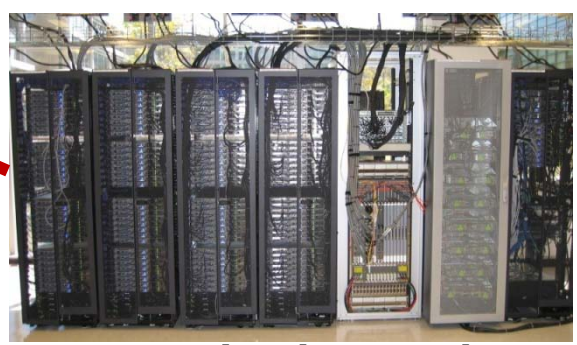


National LambdaRail

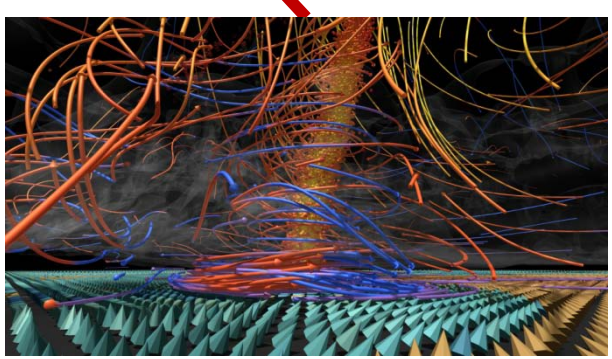
HPC

TeraGrid

Campus Optical Switch



Data Repositories & Clusters



HD/4k Video Images

OptIPuter

it2

1/3 Billion Pixel OptIPortal: Viewing Very Large Images or Many Simultaneous Images



Spitzer Space Telescope (Infrared)



NASA Earth Satellite Images Bushfires October 2007 San Diego

Source: Falko Kuester, Calit2@UCSD

Just in Time OptIPlanet Collaboratory: Live Session with NASA Ames from Calit2



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

Visit Yesterday by Acting NASA Administrator Chris Scolese

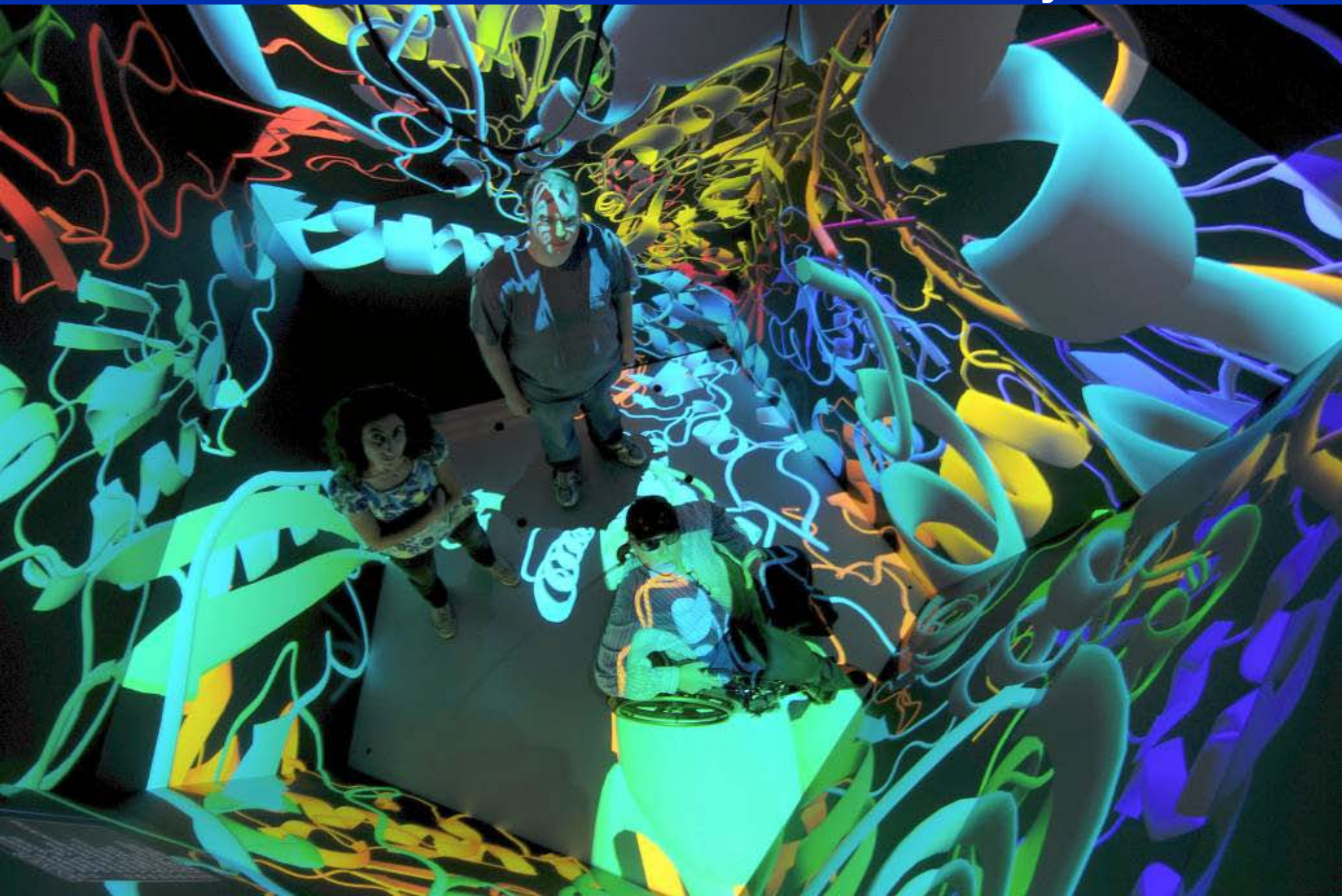
OptIPuter

CGLX

it²

Source: Falko Kuester, Calit2; Michael Sims, NASA

Ultra Resolution Virtual Reality: Toward a 3D Global Collaboratory



The GreenLight Project: Instrumenting the Energy Cost of Cloud Computing

- **Focus on 5 Communities with At-Scale Computing Needs:**
  - Metagenomics
  - Ocean Observing
  - Microscopy
  - Bioinformatics
  - Digital Media



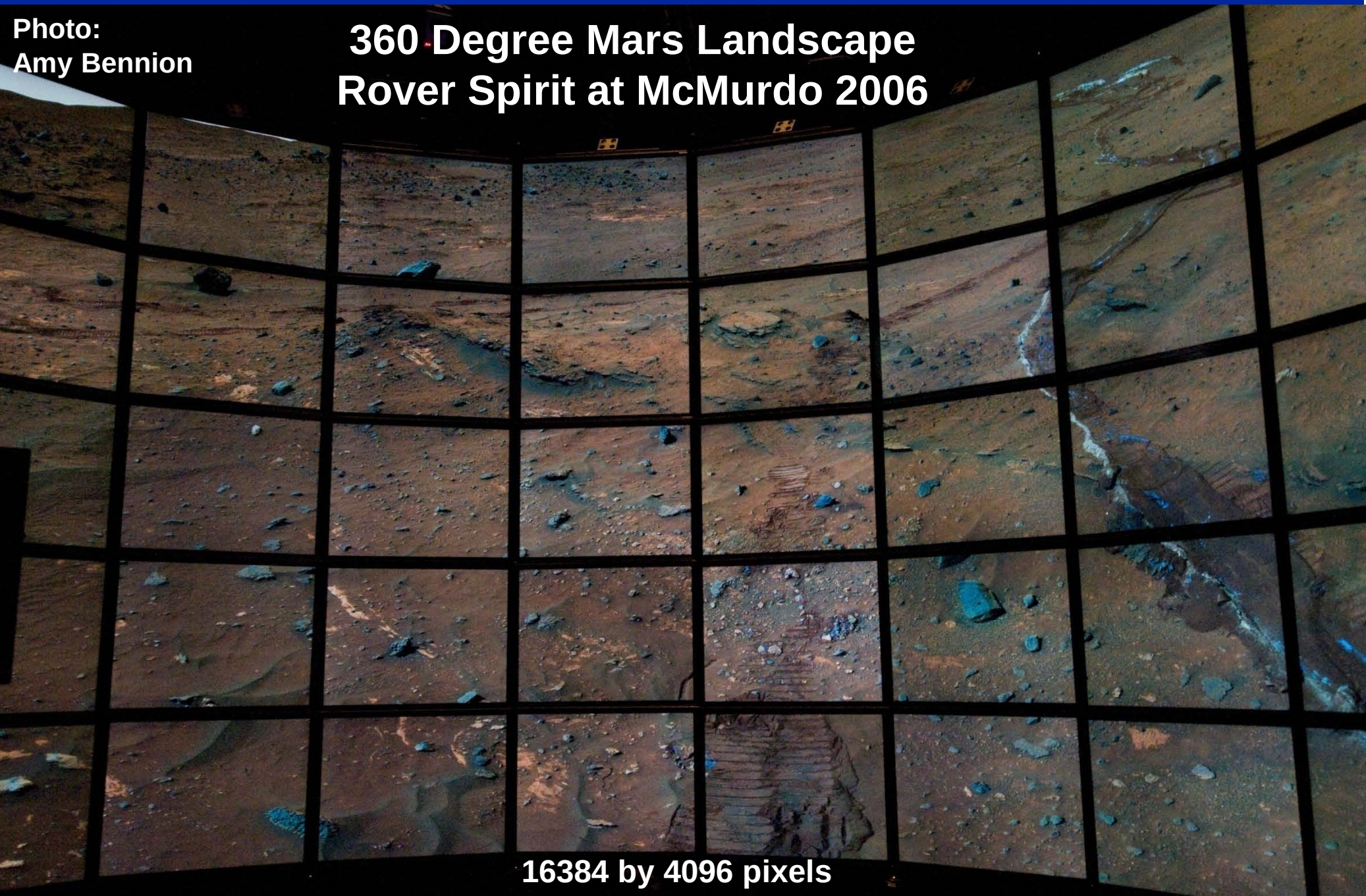


- **Measure, Monitor, & Web Publish Real-Time Sensor Outputs**
  - Via Service-oriented Architectures
  - Allow Researchers Anywhere To Study Computing Energy Cost
- **Develop Middleware that Automates Optimal Choice of Compute/RAM Power Strategies for Desired Greenness**
- **Partnering With Minority-Serving Institutions Cyberinfrastructure Empowerment Coalition**

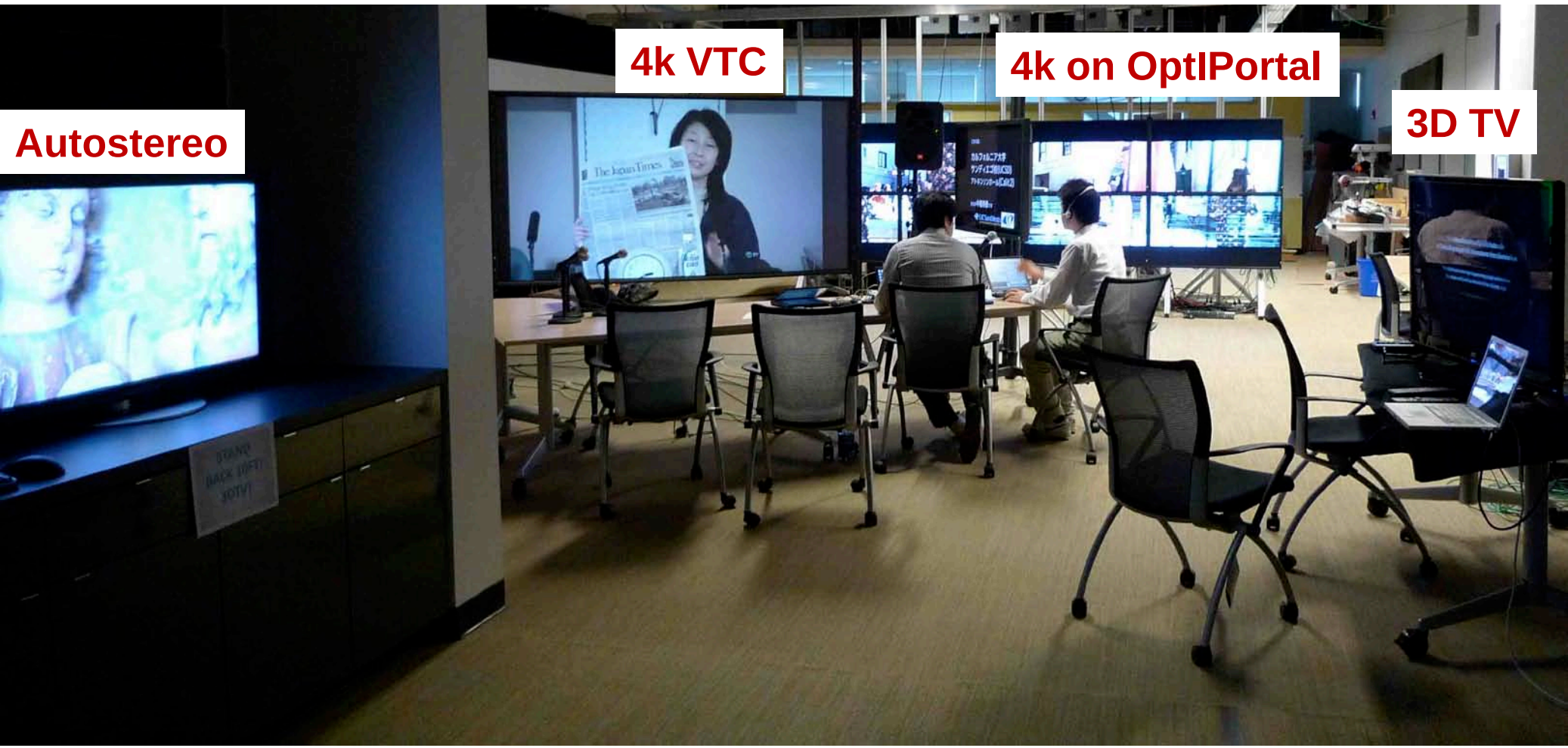
See the Virtual GreenLight Machine Room in the StarCAVE

Source: Tom DeFanti, Calit2; GreenLight PI

Calit2/EVL Varrier -- 60 Screen Panorama OptIPortal

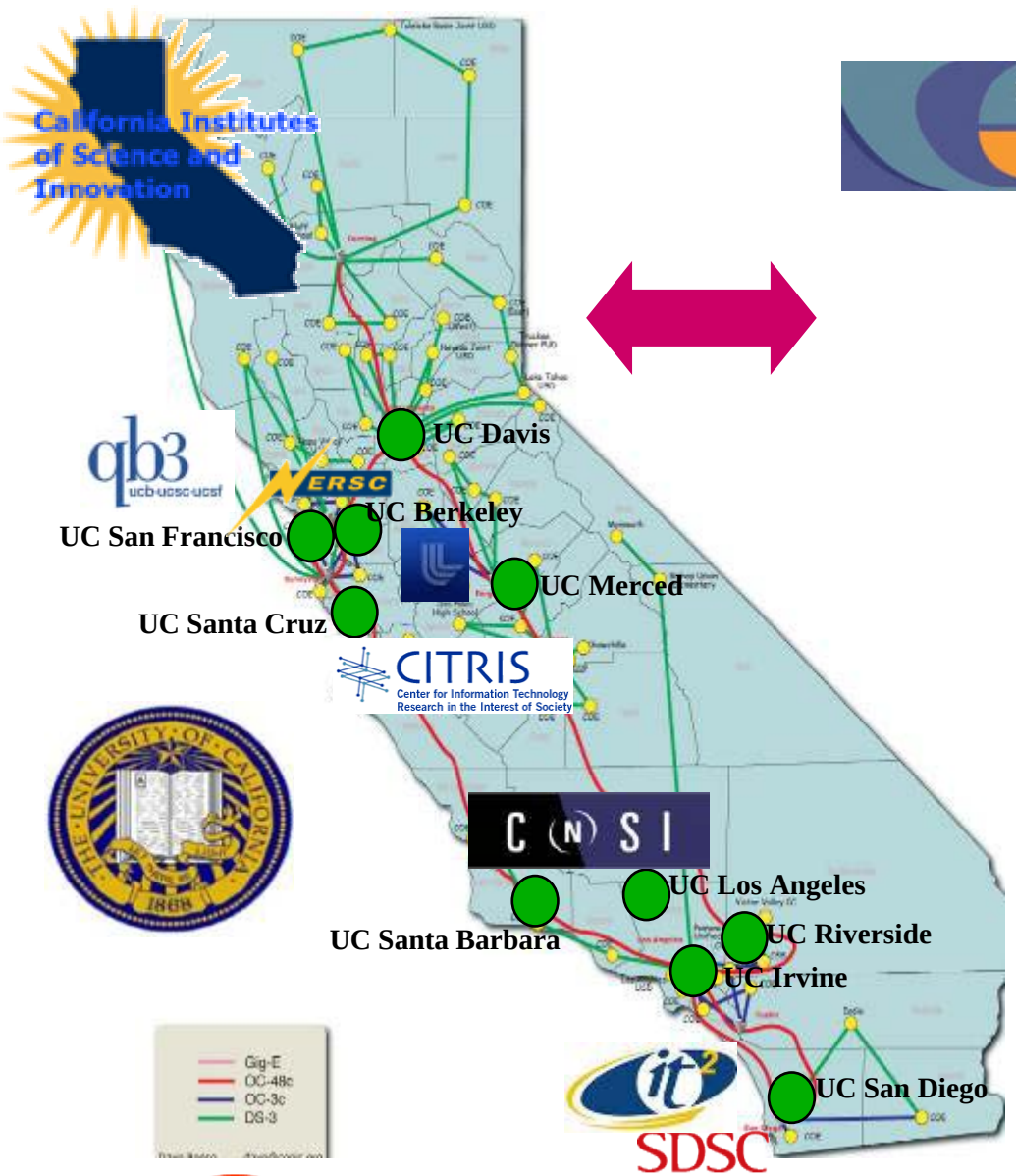


Calit2 VirtuLab-
Our Visual Skunkworks



Source: Tom DeFanti, Calit2

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



NLR NATIONAL LAMBDARAIL

TeraGrid

Internet2 Network
Dynamic Circuit Network

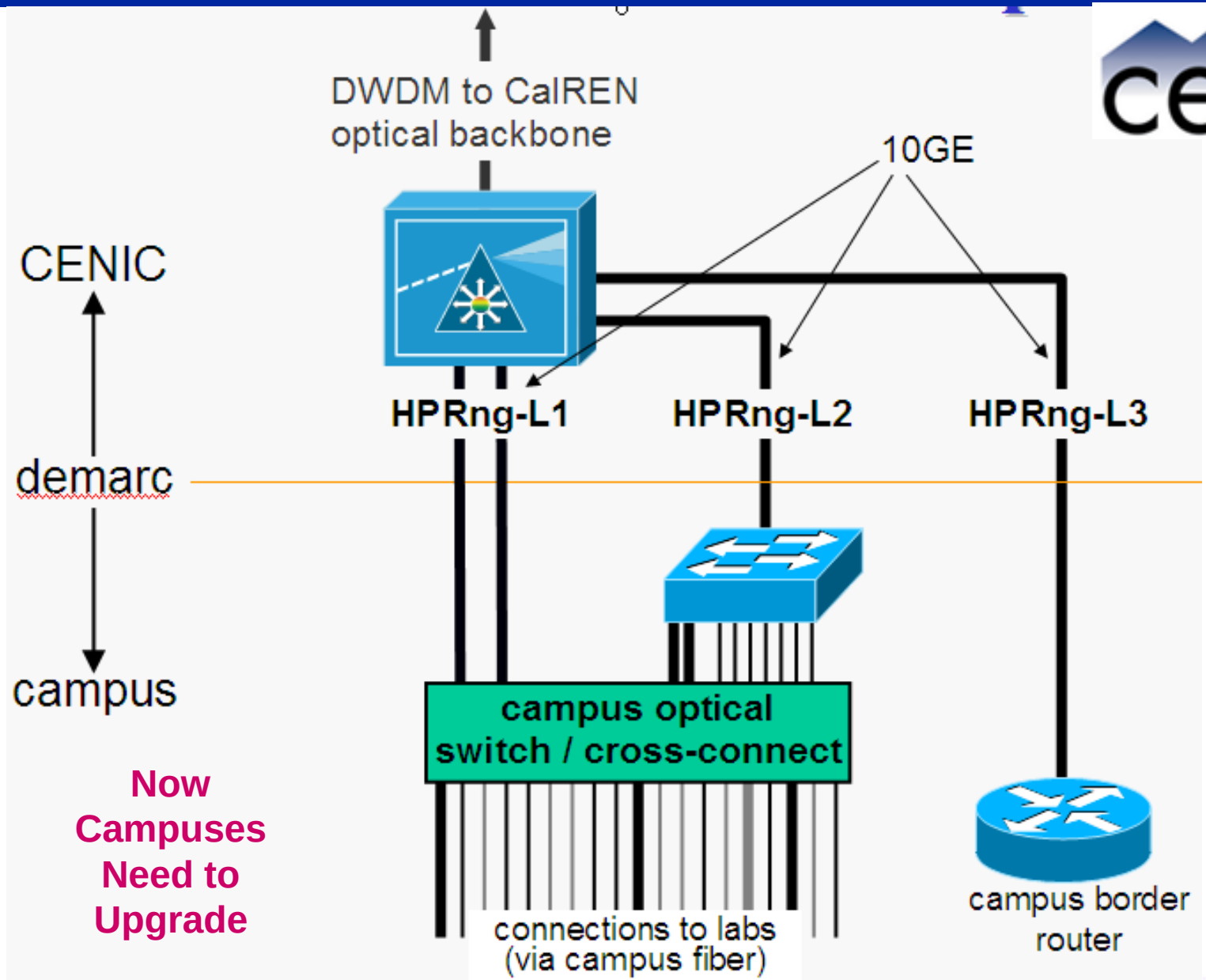
Creating a Critical Mass of OptIPuter End Users on a Secure LambdaGrid

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

~ $14M Invested 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:

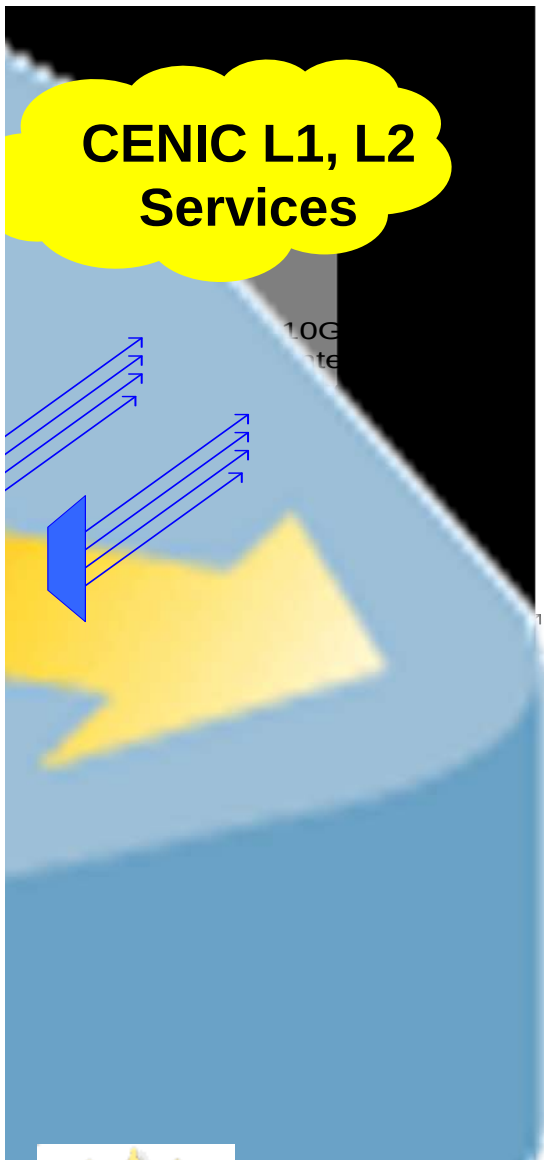
>= 60 endpoints at 10 GigE

>= 30 Packet switched

>= 30 Switched wavelengths

>= 400 Connected endpoints

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



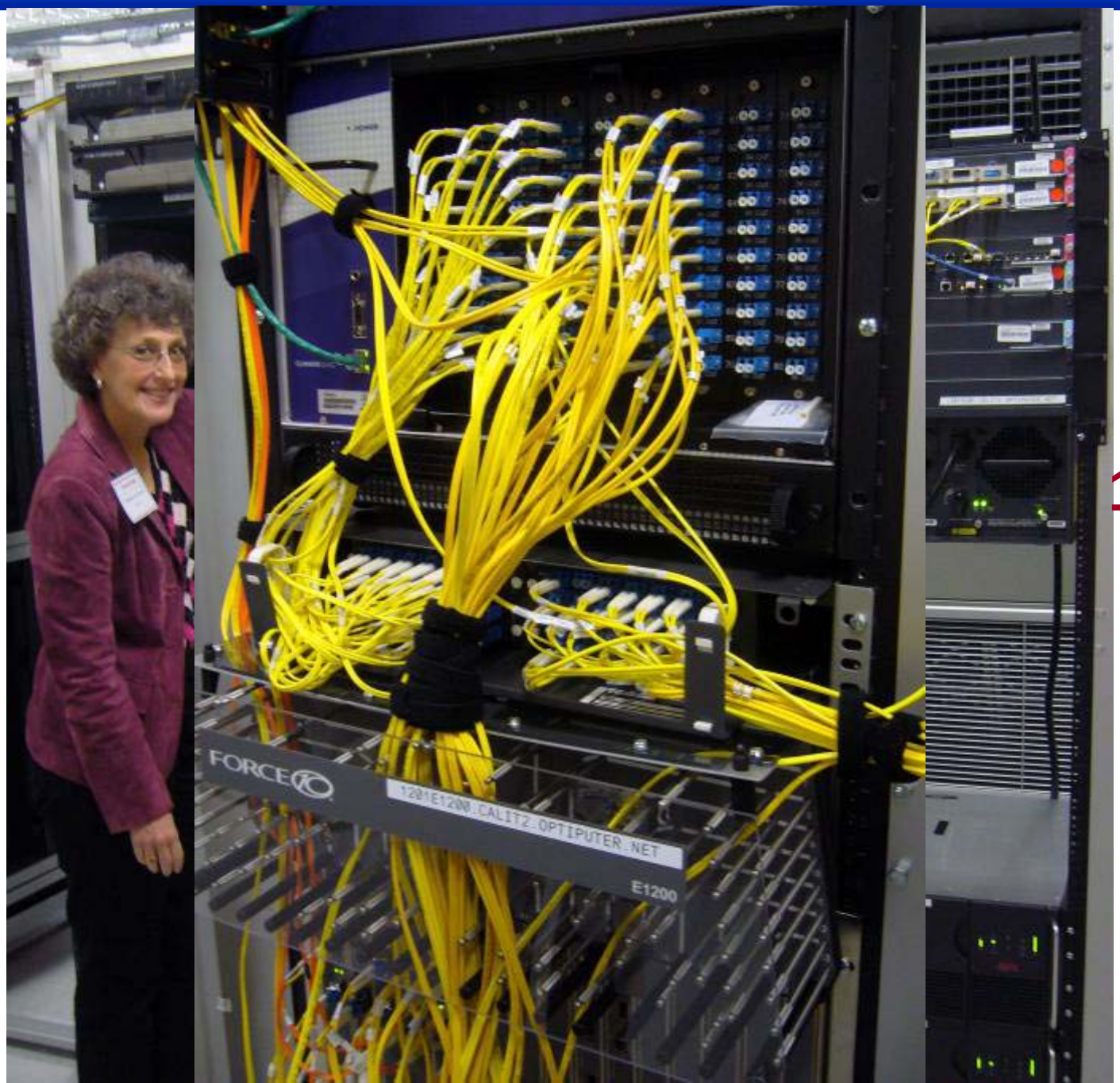
Funded by NSF MRI Grant

OptIPuter SDSC

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

NSF it²

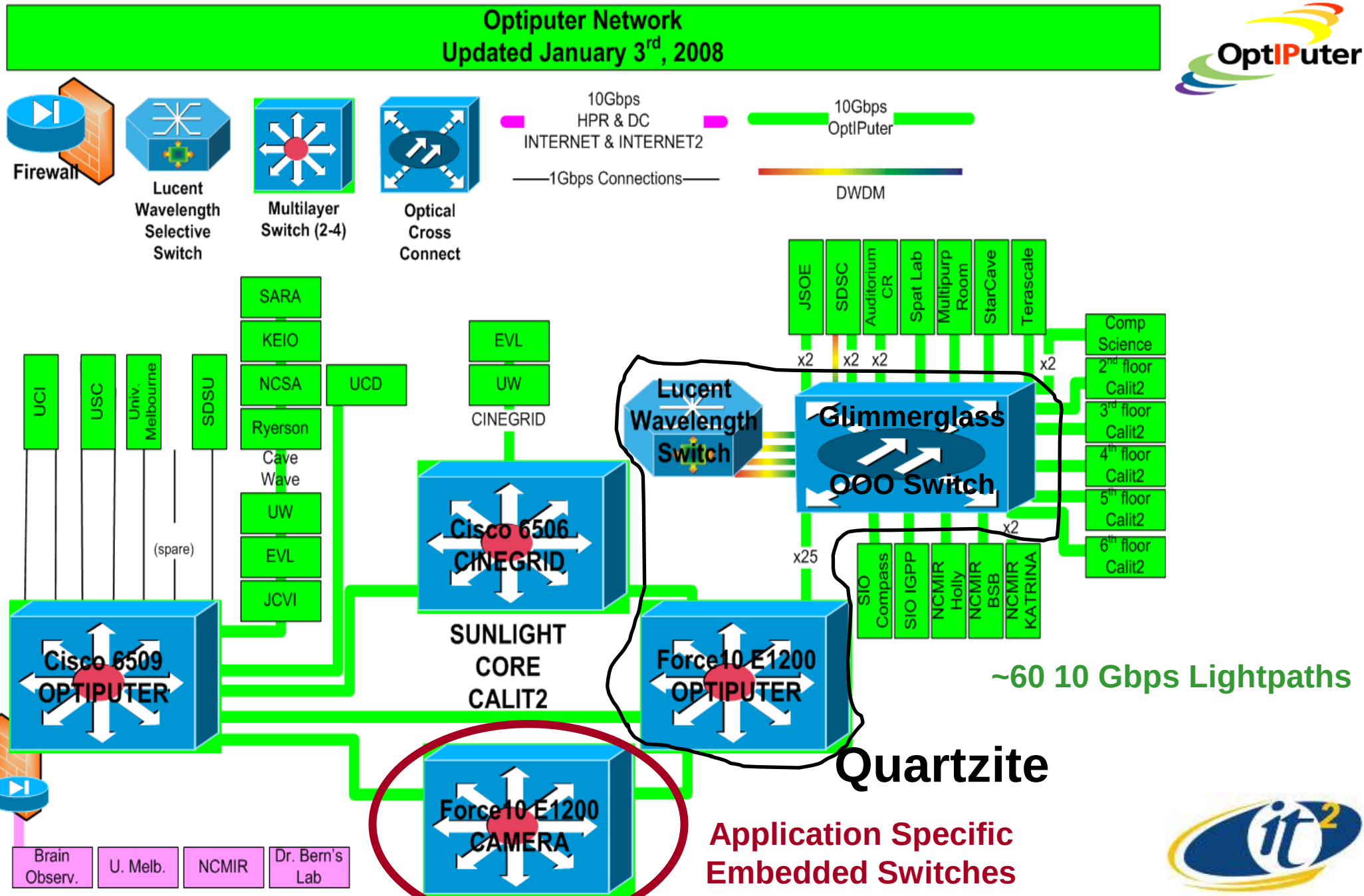
Calit2 Sunlight
Optical Exchange Contains Quartzite



Maxine Brown, EVL, UIC OptIPuter Project Manager

10:45 am Feb. 21, 2008

Block Layout of UCSD Quartzite/OptIPuter Network



CAMERA: Community Cyberinfrastructure for Advanced Marine Microbial Ecology Research and Analysis

National LambdaRail
Direct Connect
Computation and Storage Complex

Funded by: Gordon and Betty Moore Foundation

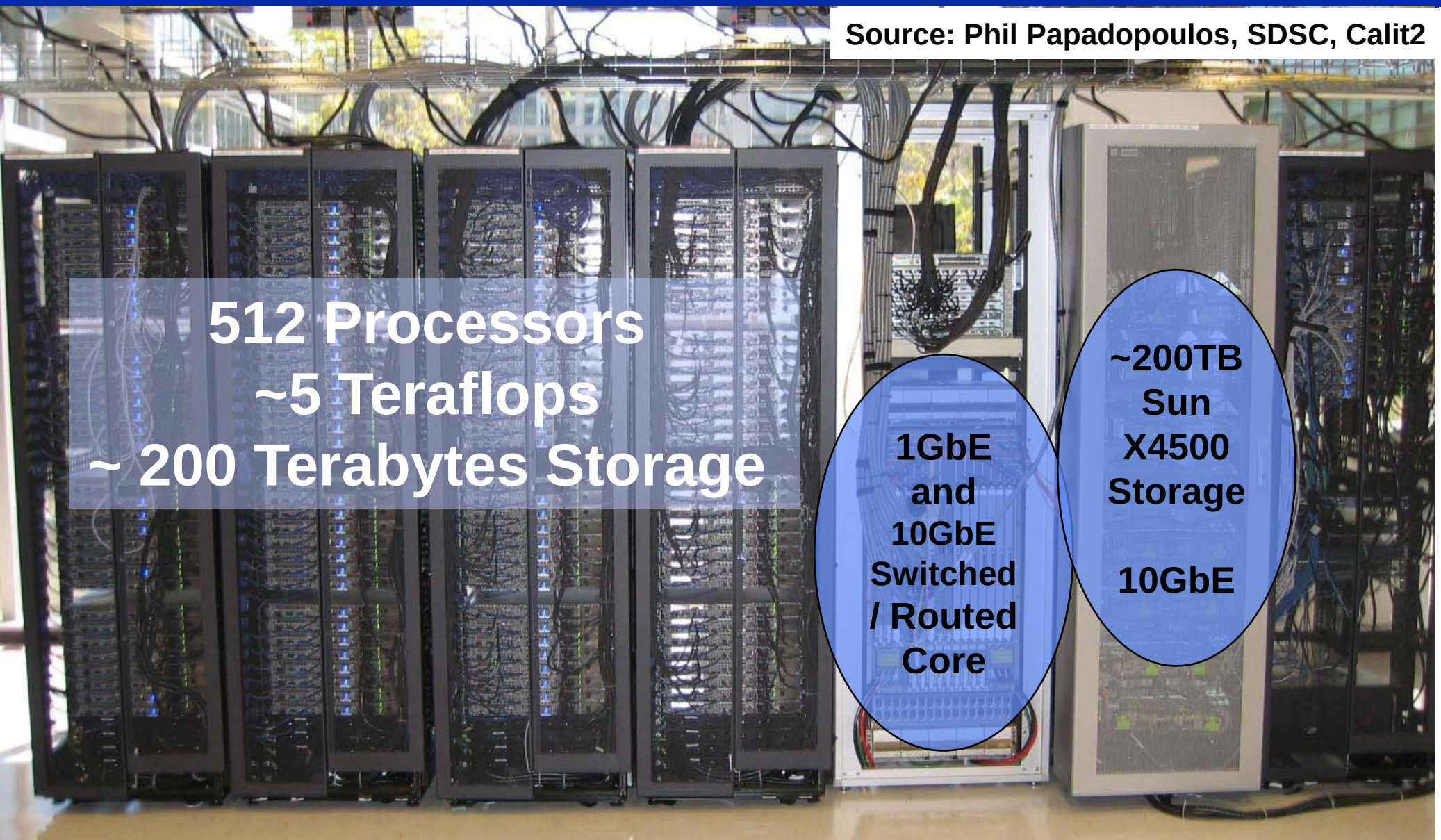
Joint Partnership of:

OptIPuter

PI Larry Smarr

Calit2 Microbial Metagenomics Science Cloud Server
Moving Compute to the Data--Web and Optical Available

Source: Phil Papadopoulos, SDSC, Calit2

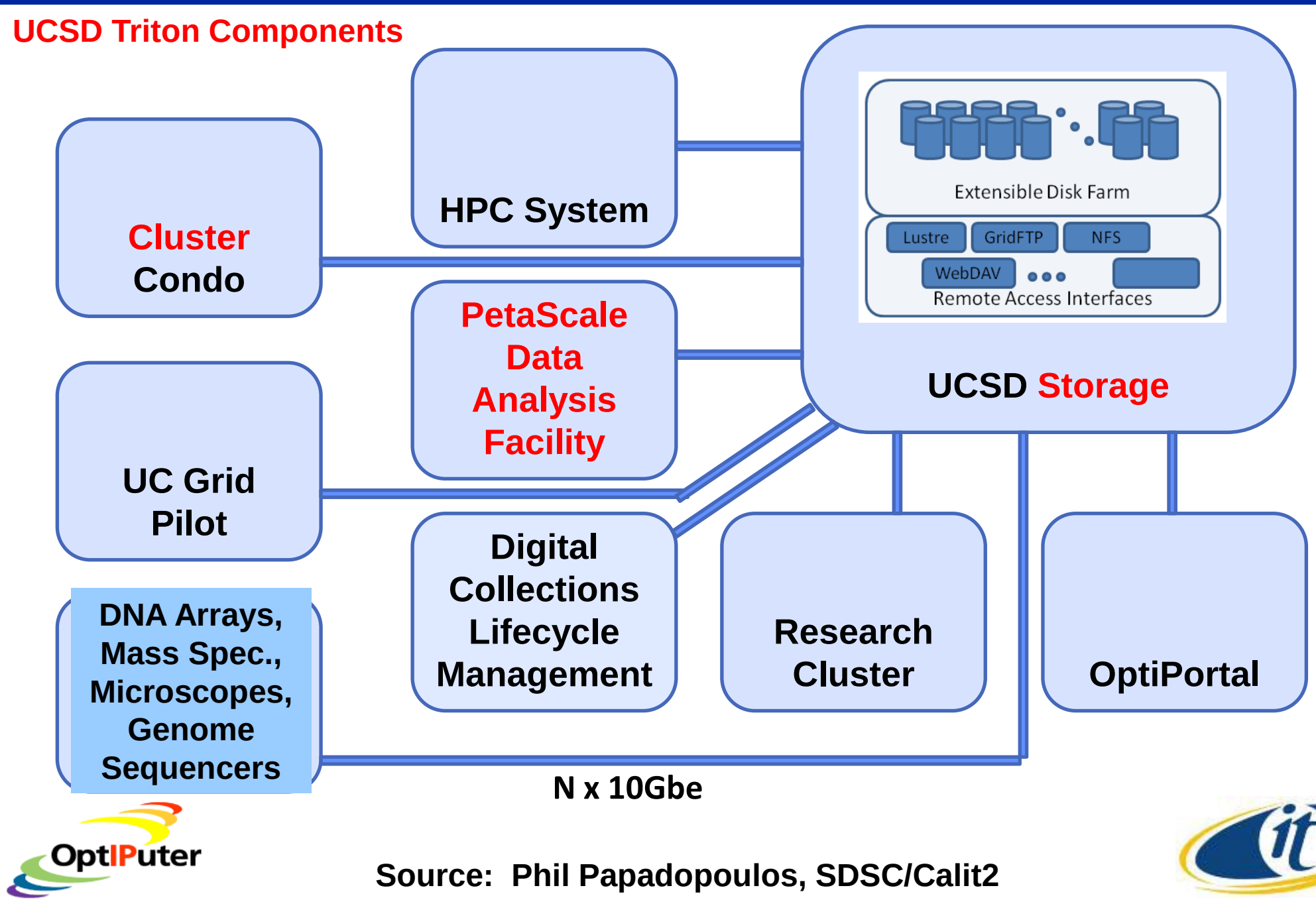


OptIPuter SDSC ROCKS camera Marine Microbial Ecology

2500 Users From 70 Countries!

it²

UCSD Campus Research CI: Design Team Architecture for Fiber Shared Resources



Source: Phil Papadopoulos, SDSC/Calit2

Current Planning for UCSD Triton
"OptIPuter on Steroids" *

Large Memory
PSDAF
- 256 GB/Node
- 8TB Total
- 128 GB/sec
- ~ 10 TF





Shared Resource
Cluster
- 16 – 32 GB/Node
- 4 - 8TB Total
- 256 GB/sec
- ~ 25 TF

SDSC



Large Scale Storage
- 2 – 4 PB
- 75 – 150 GB/sec
- 3000 – 6000 disks



UCSD Research Labs





Campus Research Network

TRITON RESOURCE

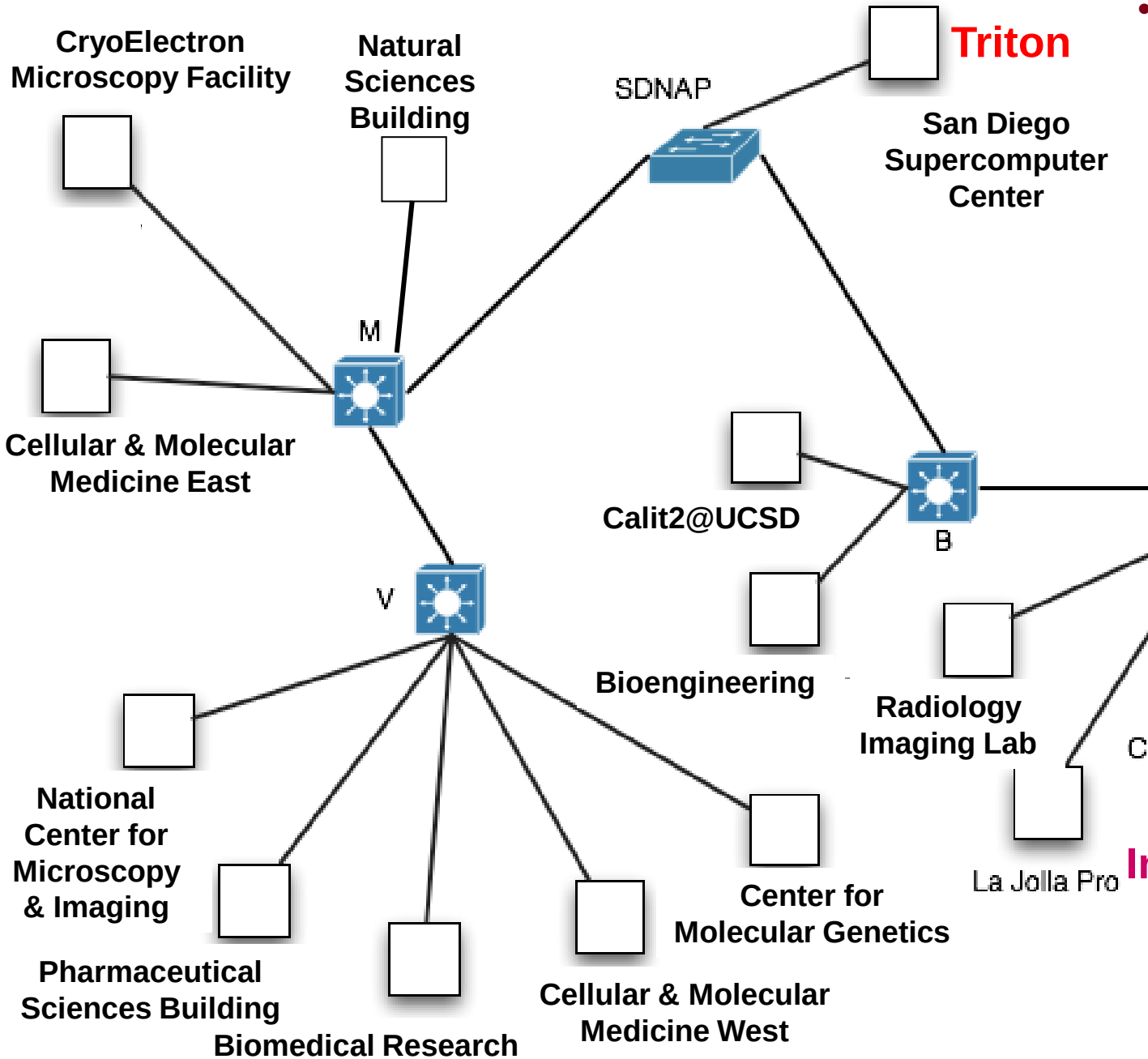


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Source: *Phil Papadopoulos, SDSC/Calit2

it²

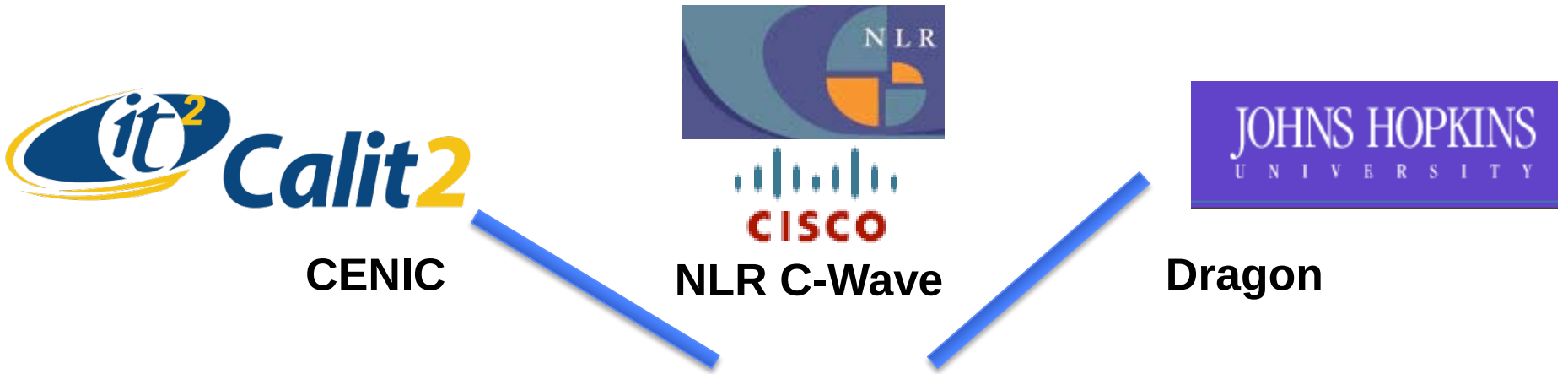
UCSD Planned Optical Networked Biomedical Researchers and Instruments



- **Connects at 10 Gbps :**
  - **Microarrays**
  - **Genome Sequencers**
  - **Mass Spectrometry**
  - **Light and Electron Microscopes**
  - **Whole Body Imagers**
  - **Computing**
  - **Storage**

Creates Campus–Wide Instrument "Data Utility" - Lab Portals to Triton

Open Cloud OptIPuter Testbed
Manage and Compute Large Datasets



HW Phase 1 (2008)

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

STARLIGHT℠ The Optical STAR TAP™

MREN

UIC

Open Source SW

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

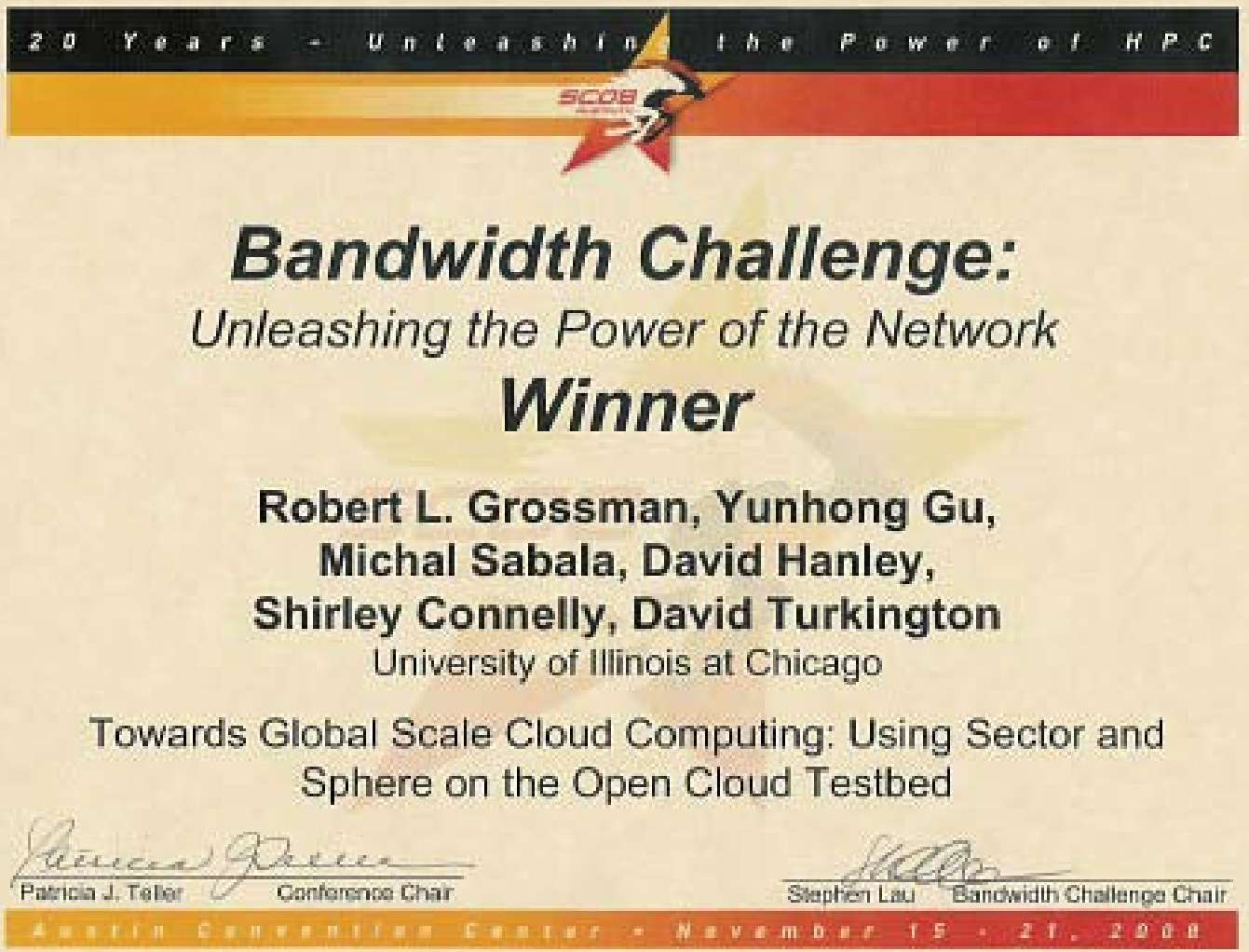
Phase 2 (2009) will add additional racks to current sites and increase number of sites

OptIPuter

Source: Robert Grossman, UIC

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

Supercomputing 2009



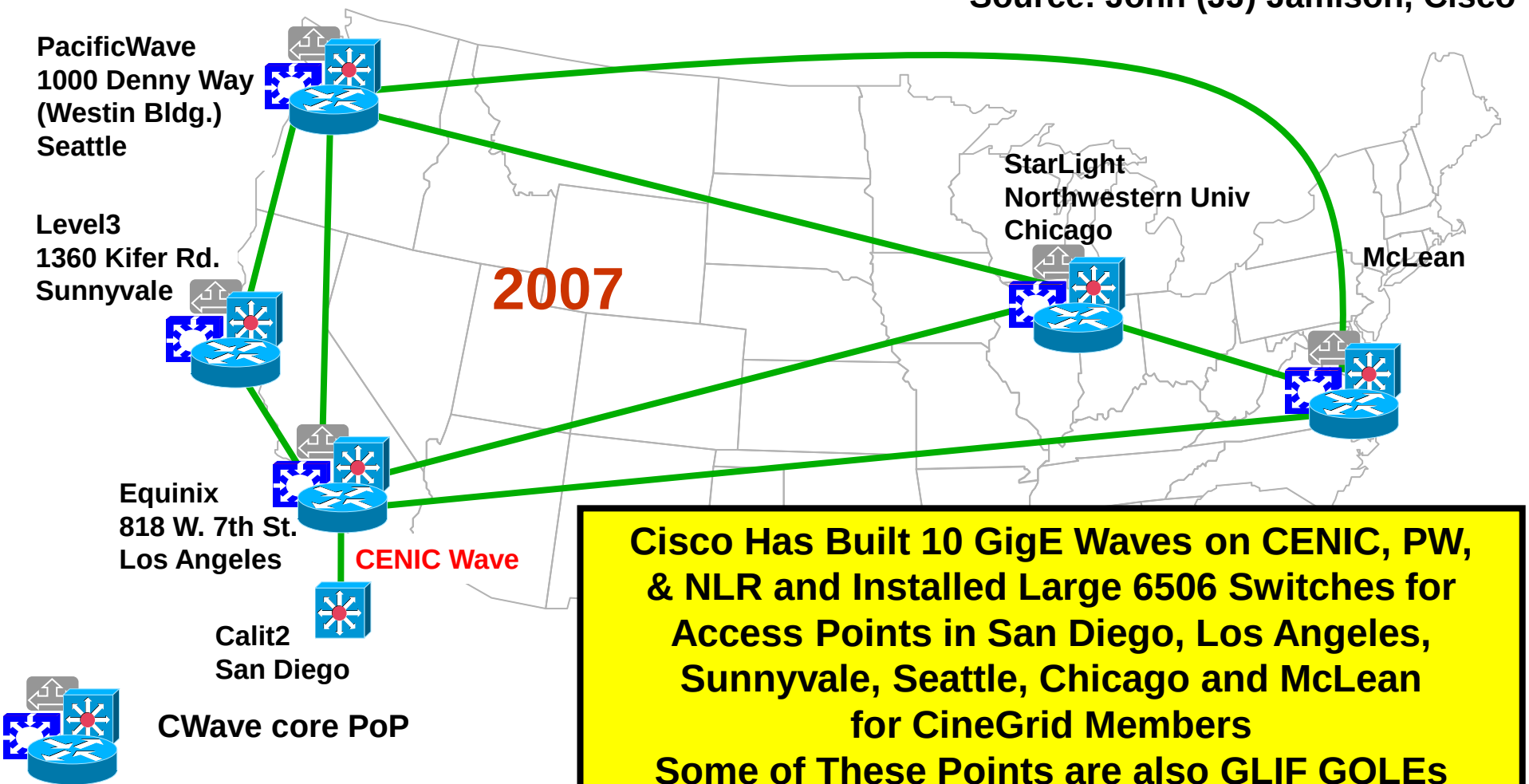
OptIPuter

http://angle.ncdm.uic.edu/simnetup/

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

The Commercial Market for High Resolution Teleconference Systems in Rapidly Expanding

Changing the Way We Work, Live, Play and Learn

- **320** Cisco TelePresence major cities globally
- **US/Canada: 101** CTS 3000, **79** CTS 1000, **3** CTS 3200, 13 CTS 500
- **APAC: 24** CTS 3000, **20** CTS 1000, 3 CTS 500
- **Japan: 5** CTS 3000, **2** CTS 1000, 1 CTS 500,1 CTS3200
- **Europe: 30**CTS 3000, **19** CTS 1000, 1 CTS3200, 5 CTS500
- **Emerging: 13** CTS 3000, 1CTS1000

- **216K** TelePresence meetings scheduled to date.
- **48%** Average Utilization
- **279K** hours (average meeting is 1.25 hrs)
- **22K+** meetings with customers to discuss Cisco Technology over TelePresence

- **31K+** meetings avoided travel
- Conservative estimate of cost savings:
  - **~$278M** to date
- Cubic meters of emissions saved: **90 million**
- Equal to **>15,500+ cars** off the road



Experience Live Telepresence on Calit2 5th Floor

Source: Cisco-Updated January 5, 2009

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The GreenLight Project Focuses on Minimizing Energy for Key User Communities

- Microbial Metagenomics
- Ocean Observing
- Microscopy
- Bioinformatics
- Digital Media—CineGrid Project

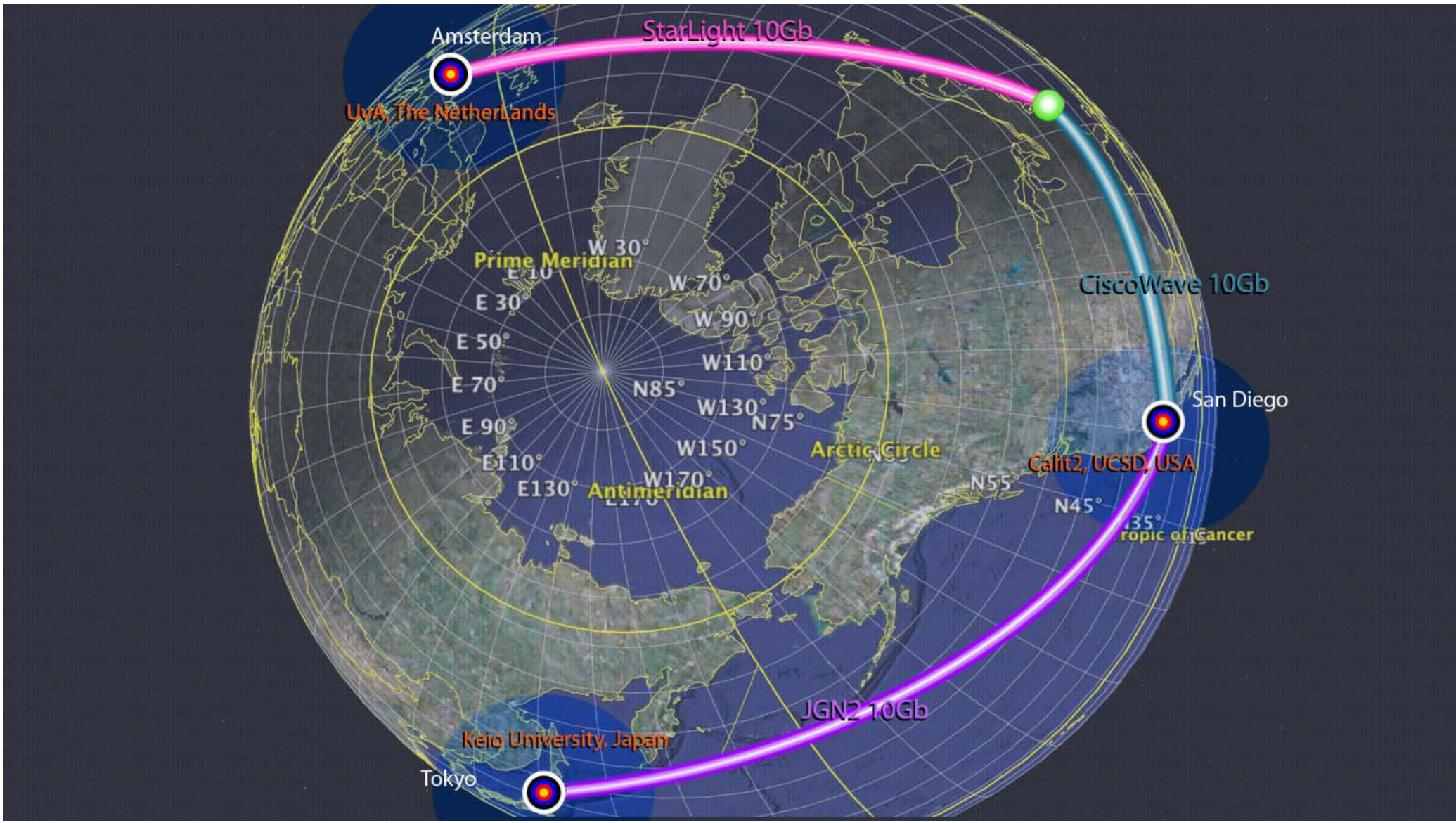


  - Calit2 will Host TB of Media Assets in GreenLight CineGrid Cloud Exchange to Measure and Propose Reductions in the “Carbon Footprint” Generated by:
    - File Transfers and
    - Computational Tasks
  - Required for Digital Cinema and Other High Quality Digital Media Applications

OptIPuter

it²

CineGrid Exchange:
Using Optical Fibers to Create Remote Storage



Global Warming will Drive Cloud Computing!