Calit2 - CSE's Living Laboratory for Applications

UCSD CSE 91 - Perspectives in Computer Science (Spring 2008)

Calit2@ UCSD

May 27, 2008

Dr. Larry Smarr

Director, California Institute for Telecommunications and Information Technology

Harry E. Gruber Professor,

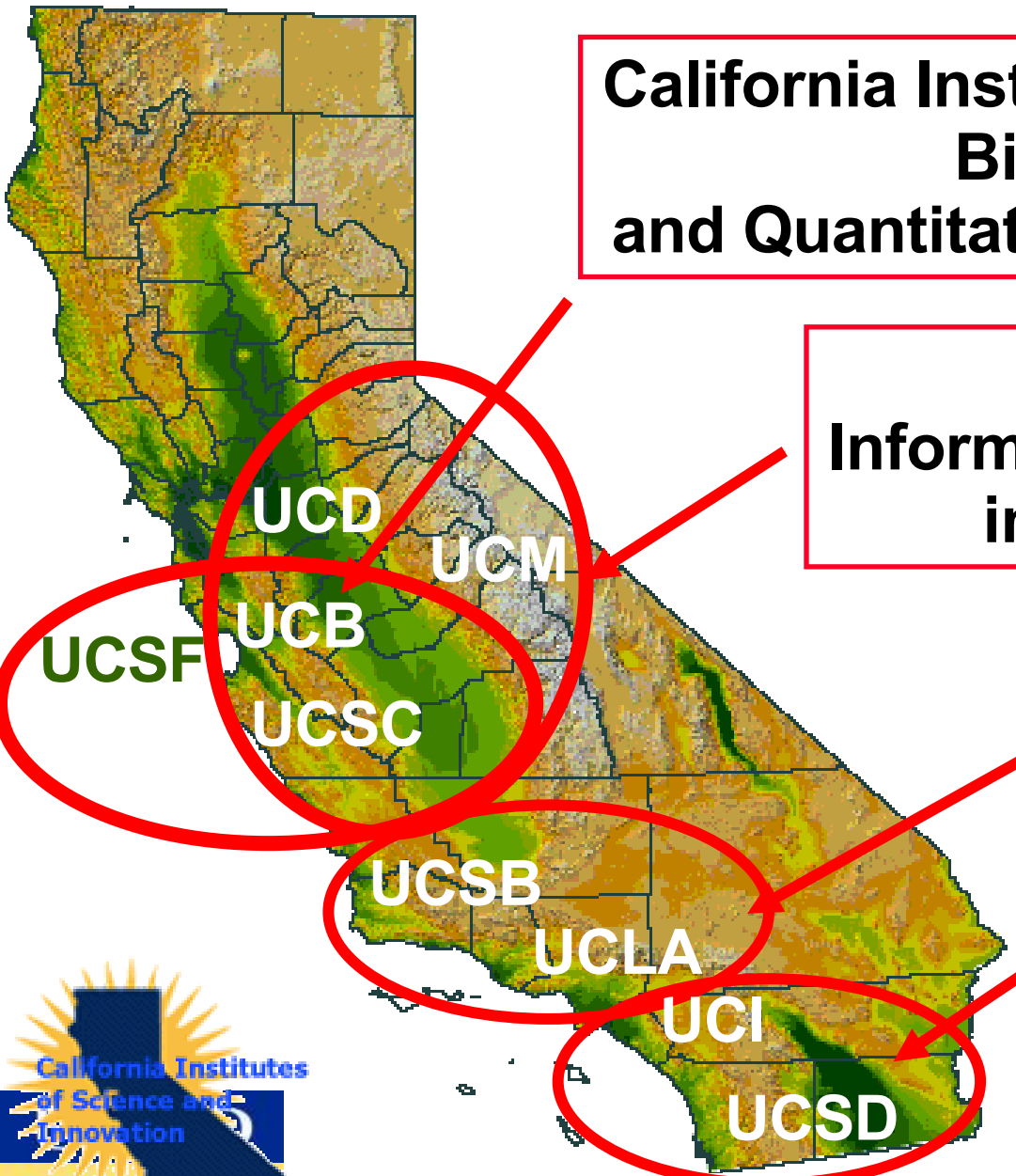
Dept. of Computer Science and Engineering

Jacobs School of Engineering, UCSD

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California's Institutes for Science and Innovation
A Bold Experiment in Collaborative Research



California Institute for Bioengineering, Biotechnology, and Quantitative Biomedical Research

Center for Information Technology Research in the Interest of Society

California NanoSystems Institute

California Institute for Telecommunications and Information Technology

California Institutes of Science and Innovation

UCHIVE

www.ucop.edu/california-institutes

it²

Scenarios in This New World

- Customized medical care based on genotype plus real-time vital signs
- Intelligent transportation systems to enable efficient traffic flow
- Real-time environmental data collection to inform decision making and policy setting
- Vast networked gaming environments in which to learn, communicate, work
- Digital entertainment networks, CineGrid



These scenarios are all based on…
- integrated systems of underlying technologies
- applied to real-world problems
- affecting California's economy and quality of life

"Someday, all this will be infrastructure."

Source: Warren Miller, New Yorker, April 11, 1988

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What Is Calit2?

- **Research on the Future of the Internet and its Transformation of Our Society**
- **Core Partnership Between UCSD and UCI**
  - **Several Hundred Faculty**
  - **Alliances With Other Campuses**
- **Prototyping Of Infrastructure Through "Living Laboratories"**
  - **From Campus to Planetary Scale**
  - **Partnerships With Multiple Levels of Government and Industry**
  - **Secret Sauce: Technical Professionals to Move Projects Forward**
- **Multidisciplinary Research *Teams***
  - **Faculty, Postdocs, Staff, Students**
  - **Industry Partners –**
    - **From Giants to Start-up Companies**
  - **Community Partners**
    - **Emergency Responders**

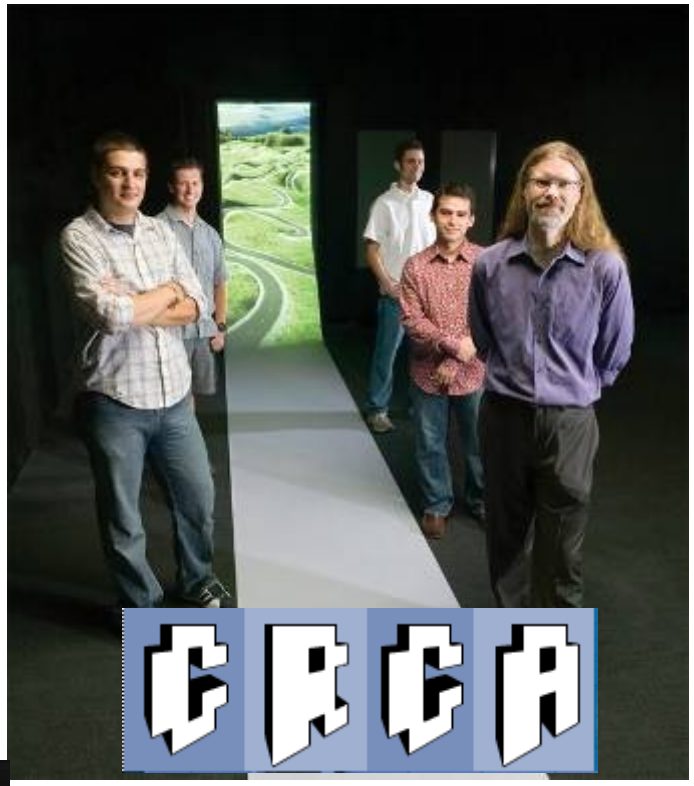


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Advanced Multimedia Facilities





- Audio Spatialization
- Motion Capture
- Gaming Lab



High Definition Studio

UCSD
UCIrvine



Laboratories

- ✓ Millimeter Wave
- ✓ Microwave/PA
- ✓ Circuits
- ✓ Photonics



Funded Projects

OptIPuter / NSF
WIISARD / NIH
RESCUE / NSF
CAMERA /
Moore Foundation



The Center for Networked Systems

Technologies and Frameworks for Robust, Secure, and Open Networked Systems

Incoming CNS Director Amin Vahdat (left) with predecessor Andrew Chien



Member Companies

Research Interests

Center Faculty



Project Proposals

Diverse Research Projects

-Multiple faculty
-Multiple students
-Multidisciplinary
-CNS Research Theme

UCSD Jacobs School of Engineering

UCSD Jacobs Computer Science and Engineering

UCSD Jacobs Electrical and Computer Engineering

Calit2 Brings Computer Scientists and Engineers Together with Biomedical Researchers

- **Some Areas of Concentration:**
  - Algorithmic and System Biology
  - Bioinformatics
  - Metagenomics
  - Cancer Genomics
  - Human Genomic Variation and Disease
  - Proteomics
  - Mitochondrial Evolution
  - Biomedical Instruments
  - Multi-Scale Cellular Imaging
  - Information Theory and Biological Systems
  - Telemedicine

CAGB

INSTITUTE FOR GENOMICS AND BIOINFORMATICS
University of California, Irvine

NanoTumor Center

camera
Marine Microbial Ecology

ICSI

JCSG
Joint Center for Structural Genomics

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

NBCR
National Biomedical Computation Resource
an NIH supported resource center

BIOMEDICAL INFORMATICS RESEARCH NETWORK

WISARD

lifechips
university of california, irvine
www.lifechips.org

Information Theory and Applications

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Southern California Telemedicine Learning Center (TLC)

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Broadband Depends on Where You Are









- **Mobile Broadband**
  - **0.1-0.5 Mbps**

100,000 Fold Range
All Here Today!

- **Home Broadband**
  - **1-5 Mbps**

"The future is already here,
it's just not evenly distributed"
William Gibson, Author of Neuromancer

- **University Dorm Room Broadband**
  - **10-100 Mbps**

- **Calit2 Global Broadband**
  - **1,000-10,000 Mbps**

Borderless Collaboration Between Global University Research Centers at 10Gbps

Maxine Brown, Tom DeFanti, Co-Chairs

iGrid 2005

THE GLOBAL LAMBDA INTEGRATED FACILITY

www.igrid2005.org

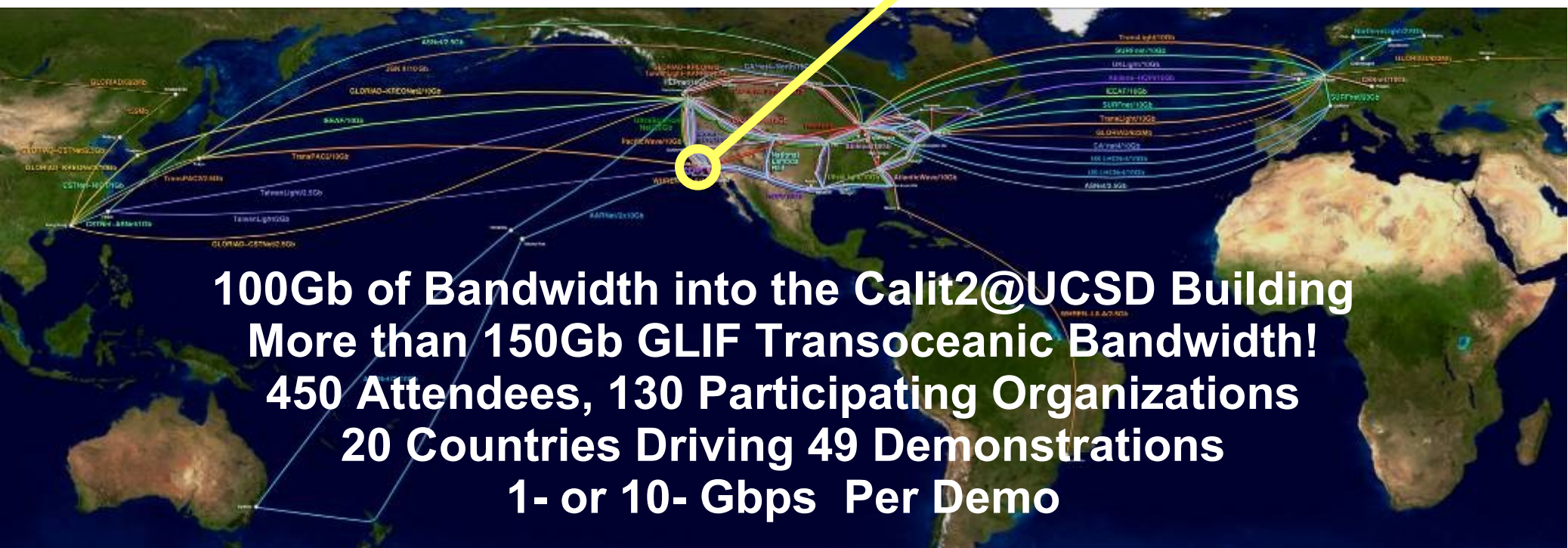


the UC Discovery Grant

September 26-30, 2005

Calit2 @ University of California, San Diego

California Institute for Telecommunications and Information Technology



100Gb of Bandwidth into the Calit2@UCSD Building

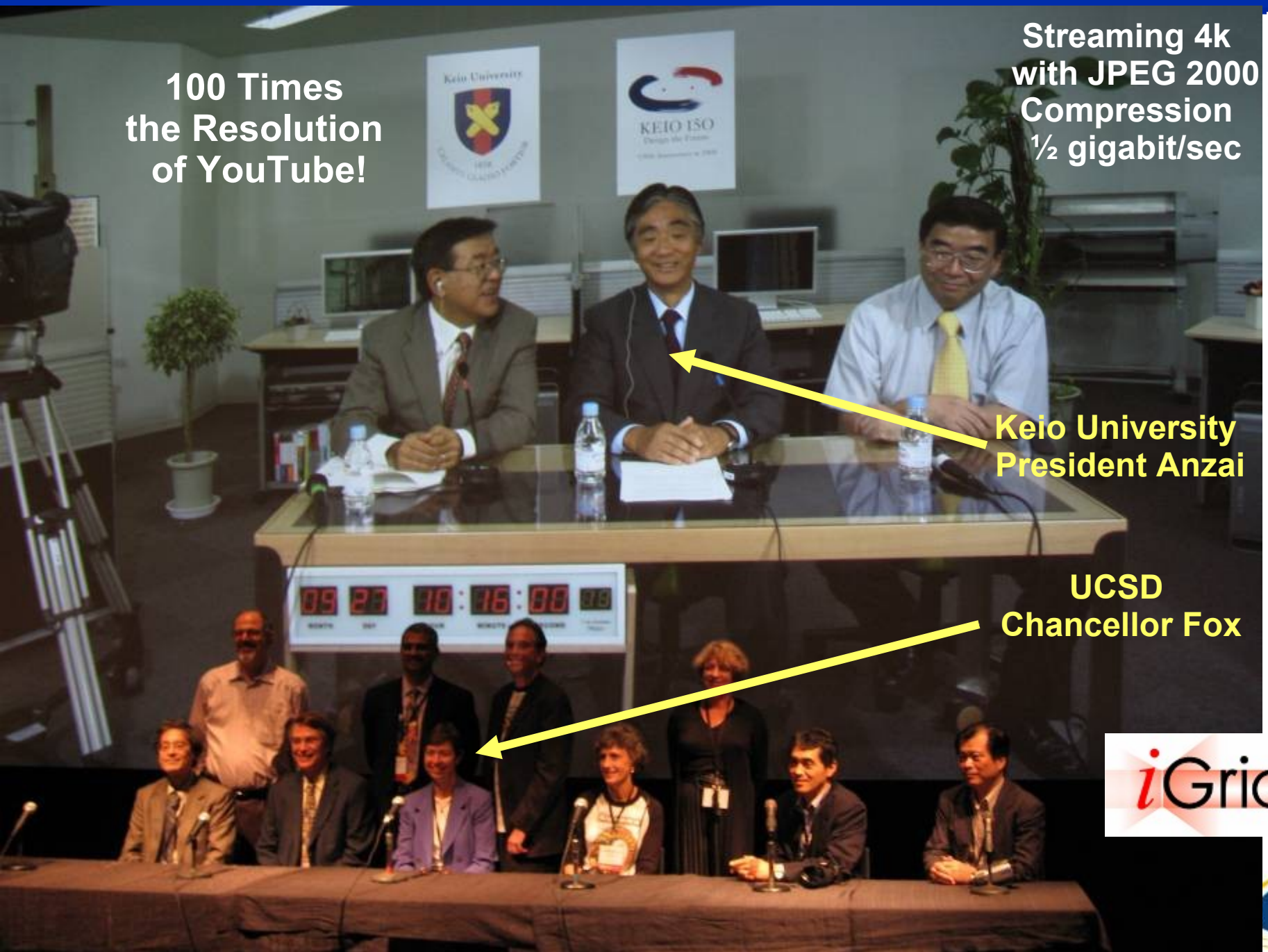
More than 150Gb GLIF Transoceanic Bandwidth!

450 Attendees, 130 Participating Organizations

20 Countries Driving 49 Demonstrations

1- or 10- Gbps Per Demo

First Trans-Pacific Super High Definition Telepresence Meeting Using Digital Cinema 4k Streams



CineGrid™

Lays Technical Basis for Global Digital Cinema

Sony
NTT
SGI

iGrid 2005

it²

CineGrid @ iGrid2005:
Six Hours of 4K Projected in Calit2 Auditorium

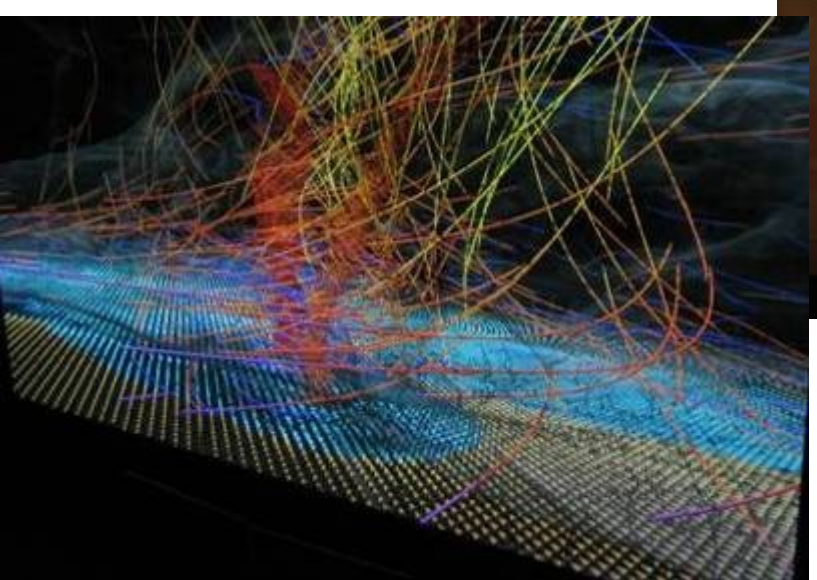
4K Distance Learning





4K Virtual Reality

4K Scientific Visualization





4K Digital Cinema

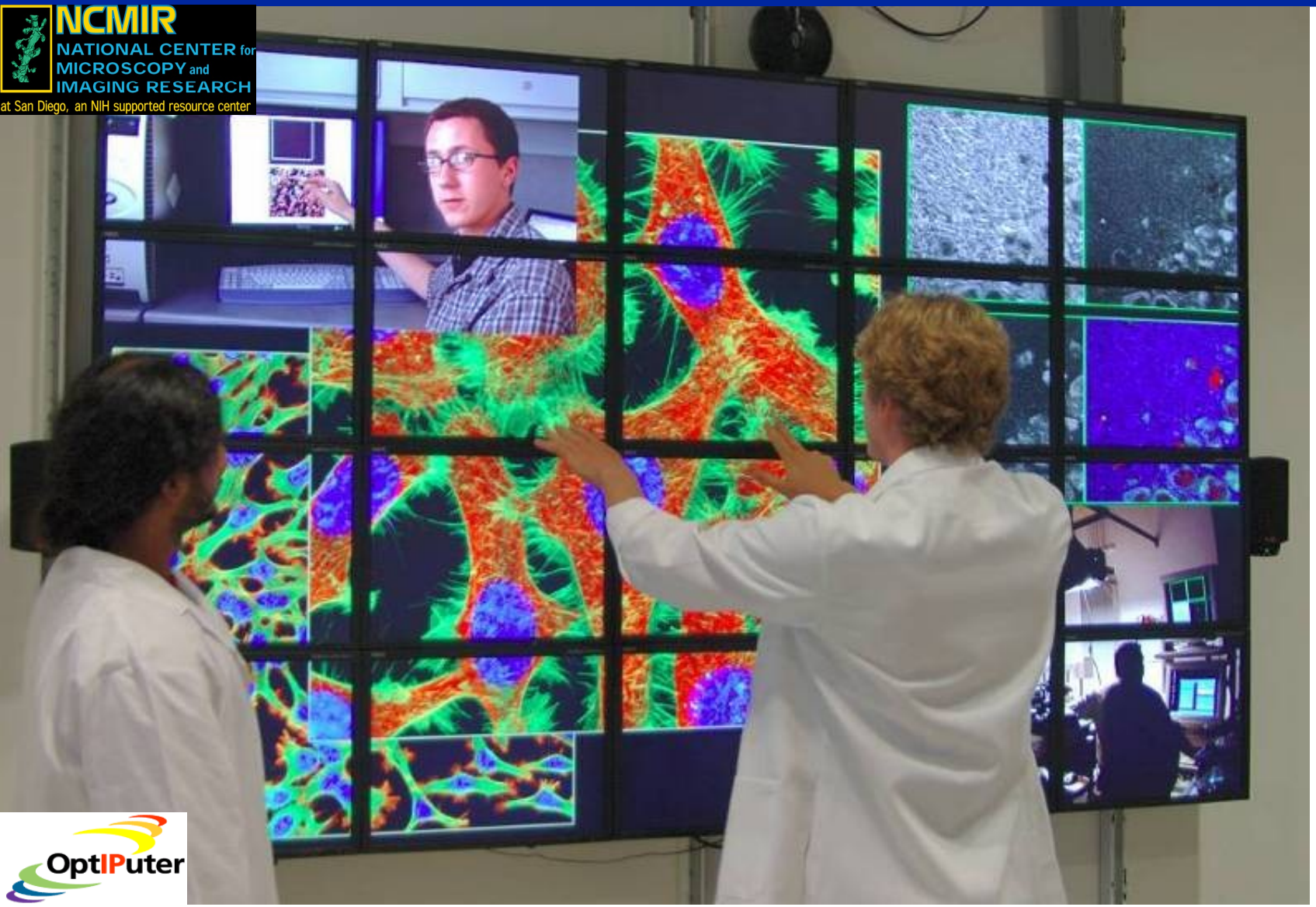
4K *Anime*



Source: Laurin Herr

The OptIPuter Project: 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



Scalable Adaptive Graphics Environment (SAGE)

evl electronic visualization laboratory

NSF

$13.5M Over Five Years

Picture Source: Mark Ellisman, David Lee, Jason Leigh

OptIPuter

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

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The Calit2 200 Megapixel OptIPortals at UCSD and UCI Are Now a Gbit/s HD Collaboratory



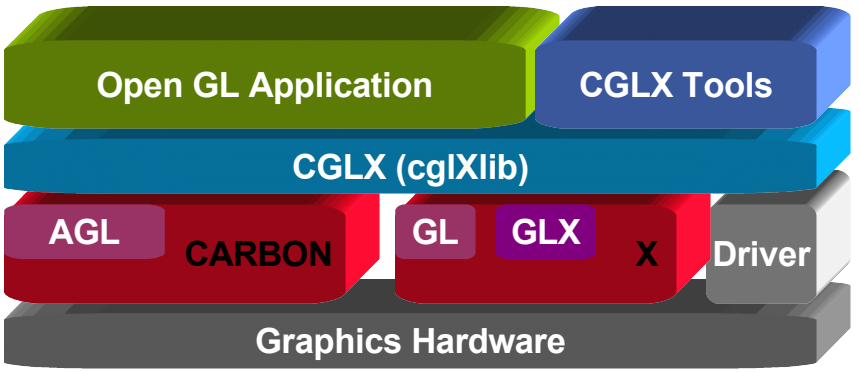
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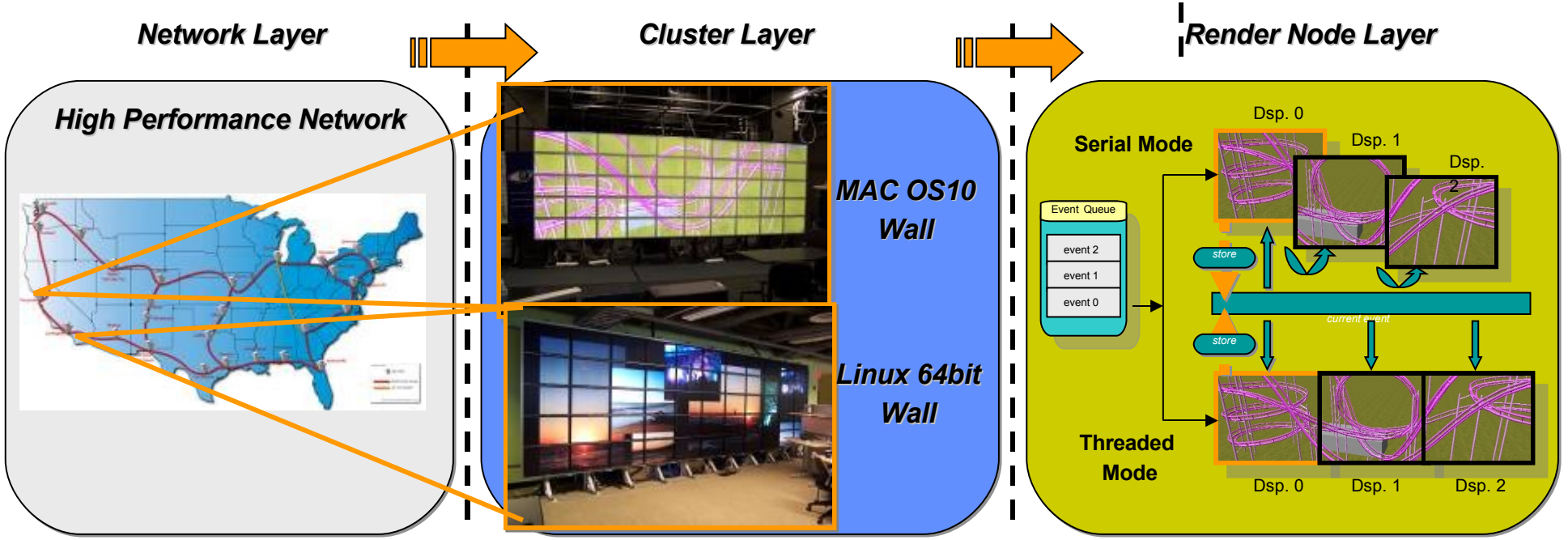
NASA Ames is Completing a 245 Mpixel Hyperwall as Project Columbia Interface

it2

Rocks/CGLX OptIPortal Uses OpenGL Hardware Accelerated

- **CGLX features:**
  - Cross-Platform Hardware Accelerated Rendering
  - Synchronized Multi-Layer OpenGL Context Support
  - Distributed Event Management
  - Scalable Multi Display Support





Source: Kai-Uwe Doerr, Falko Kuester, Calit2

Marine Genome Sequencing Project – Measuring the Genetic Diversity of Ocean Microbes

Plus 155 Marine Microbial Genomes



Each Sample ~2000 Microbial Species

Specify Ocean Data

Sorcerer II Data Will Double Number of Proteins in GenBank!

camera
Marine Microbial Ecology

MARINE MICROBIOLOGY INITIATIVE

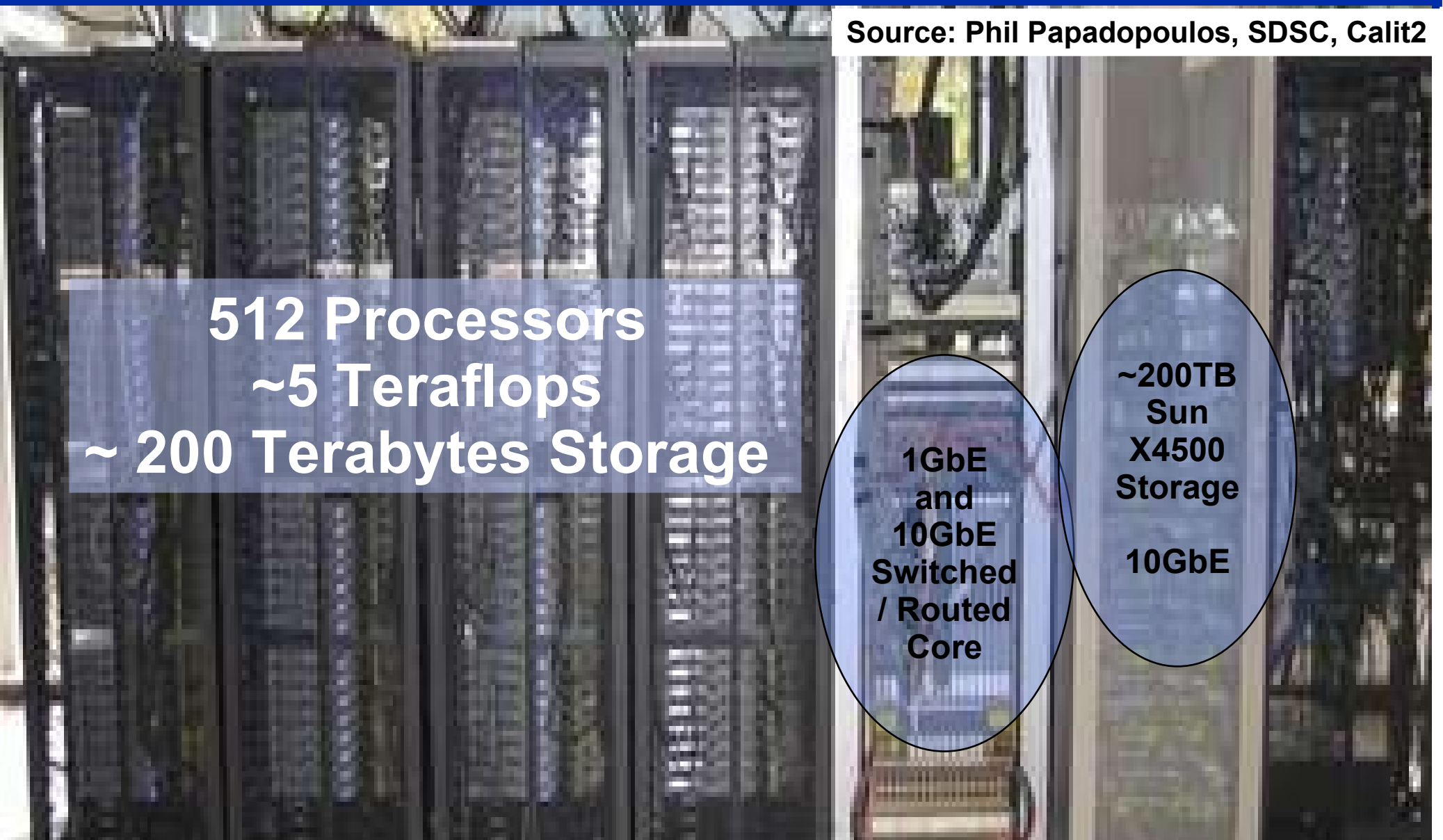
Gordon and Betty MOORE FOUNDATION

J. Craig Venter INSTITUTE

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Calit2 Microbial Metagenomics Cluster- Used by Over 2000 Scientists in 50 Countries

Source: Phil Papadopoulos, SDSC, Calit2



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

“Instant” Global Microbial Metagenomics CyberCommunity

Over 1300 Registered Users From 48 Countries



USA	761
United Kingdom	64
Germany	54
Canada	46
France	44
Brazil	33

camera
Marine Microbial Ecology

J. Craig Venter
INSTITUTE

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OptIPlanet Collaboratory Persistent Infrastructure Between Calit2 and U Washington



OptIPuter

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

ROCKS







UW's Research Channel
Michael Wellings

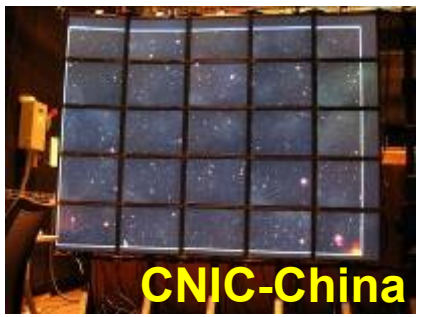
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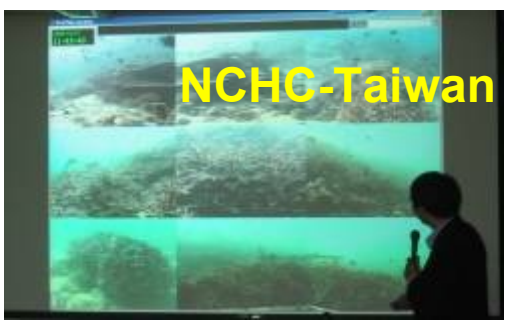
OptIPortals
Are Being Adopted Globally


AIST-Japan


Osaka U-Japan


KISTI-Korea


CNIC-China


NCHC-Taiwan


UZurich


SARA- Netherlands



Brno-Czech Republic


EVL@UIC


Calit2@UCSD


Calit2@UCI



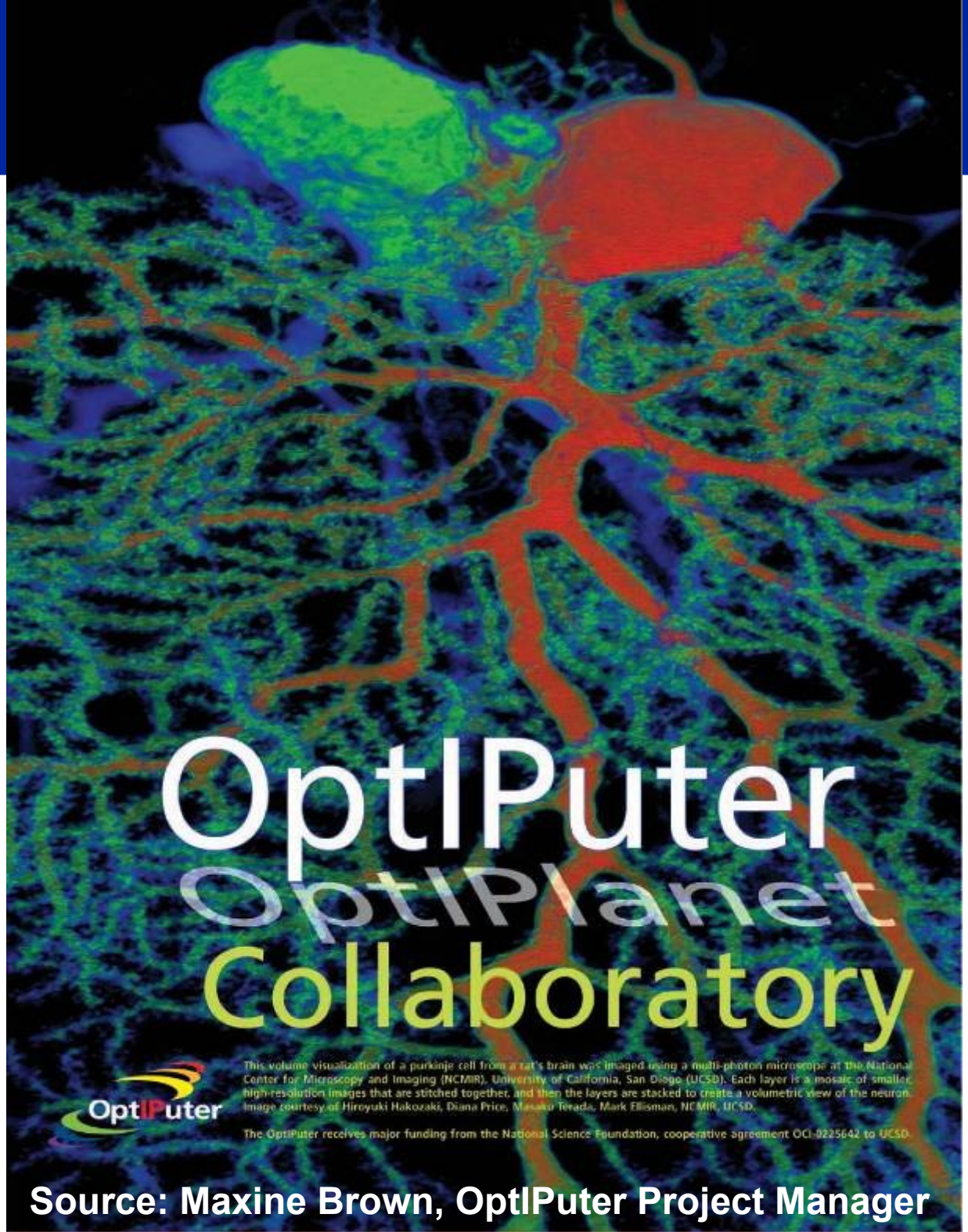
U. Melbourne, Australia

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Powered by Rocks ROCKS

evl electronic visualization laboratory

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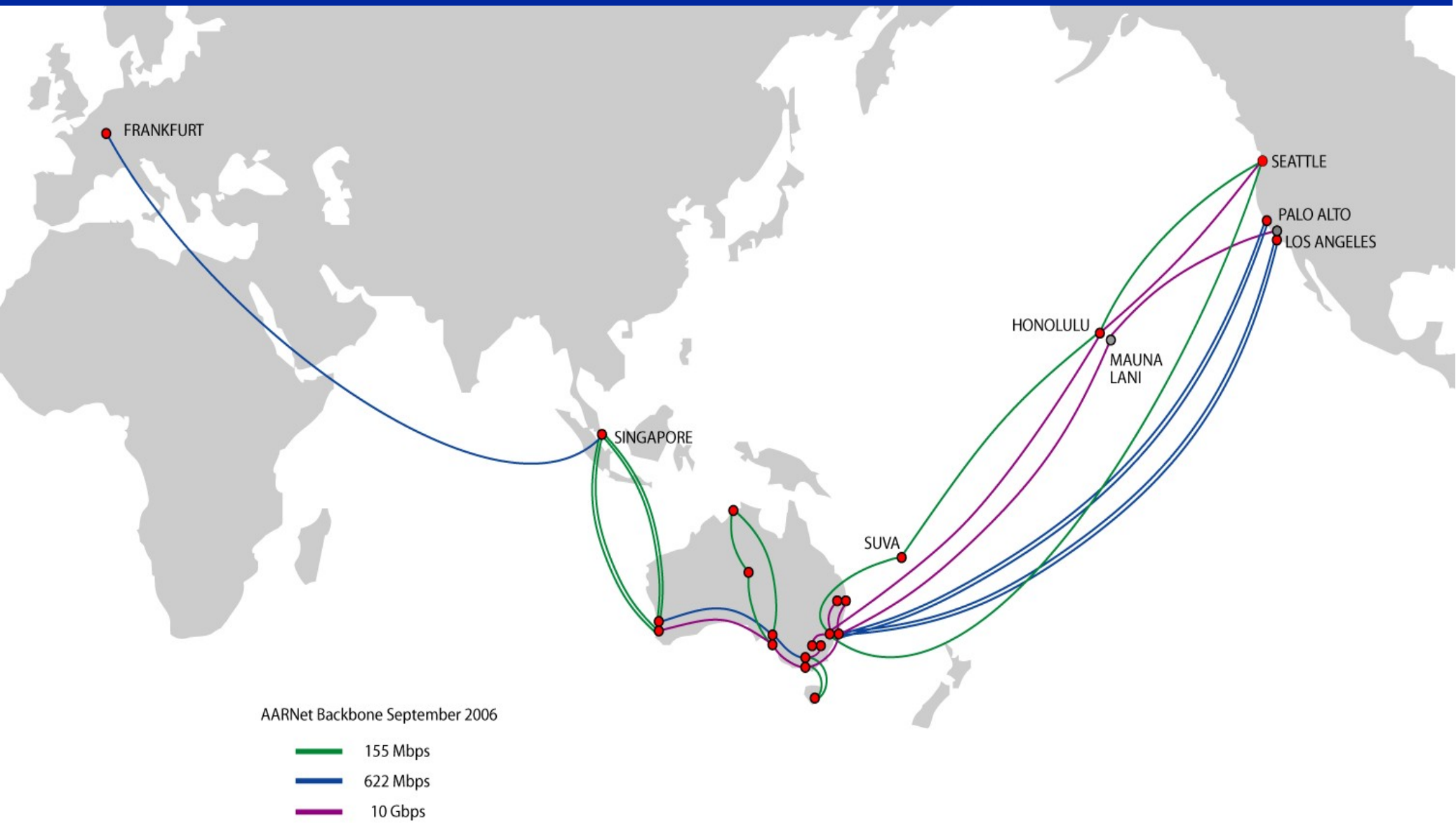
Source: Maxine Brown, OptIPuter Project Manager

Green Initiative:

Can Optical Fiber Replace Airline Travel for Continuing Collaborations ?

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AARNet International Network



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Launch of the 100 Megapixel OzIPortal Over Qvidium Compressed HD on 1 Gbps CENIC/PW/AARNet Fiber



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www.calit2.net/newsroom/release.php?id=1219

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Victoria Premier and Australian Deputy Prime Minister Asking Questions



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www.calit2.net/newsroom/release.php?id=1219

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University of Melbourne Vice Chancellor Glyn Davis in Calit2 Replies to Question from Australia



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Green Cyberinfrastructure
Exponential Time Bomb for Global Warming

- **Gartner Estimates the Manufacture of IT Equipment, its Use and Disposal Accounts for 2% of Global CO_2 Emissions**
  - **Equivalent To The Aviation Industry!**
  - **www.globalactionplan.org.uk/upload/resource/Full-report.pdfEnergy**
- **Usage Per Compute Server Rack Is Growning Rapidly**
  - **From ~ 2 KW/Rack In 2000 To ~30 KW/Rack (= 6 Houses) In 2010**
  - **Cooling and Power Issues are a Major Factor in System Design**
- **Calit2 is Developing a Full-scale Virtualized Device, the Greenlight Instrument, to Measure, Monitor, and Make Publicly Available, Real-Time Energy Sensors on Distributed IT Systems**
  - **Allowing Researchers Anywhere to Study the Energy Cost of At-Scale Computing, Storage, and Transmission of Information**

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Optically Connected "Green" Modular Datacenters
UCSD Installing Two Sun Microsystems Boxes



Sun Black Box Container



7 Racks plus Network



Takes up 2 Parking Spaces



Data Power Cooling

- **Sun Has Shown up to 40% Reduction in Energy Using Active Management of Disks, CPUs, etc.**
- **Measures Temperature at 40 Points in the Air Stream (5 Spots on 8 Racks), Internal Humidity and Temperature at the Sensor Module, External Temperature and Humidity, Incoming and Exiting Water Temperature and Power Utilization in Each of the 8 Racks**

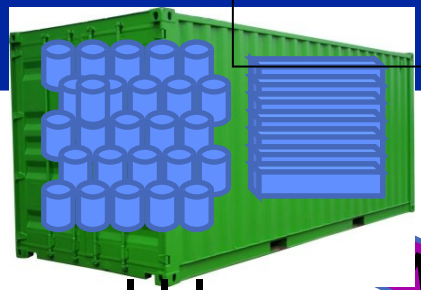
UCSD Structural Engineering Dept. Conducted Tests May 2007

UCSD Jacobs School of Engineering

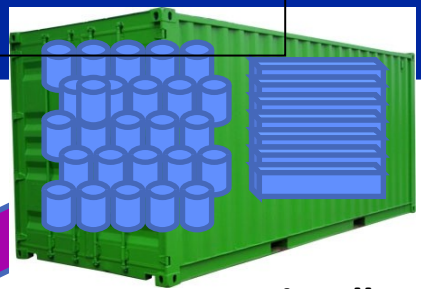
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Planned UCSD Energy Instrumented Cyberinfrastructure



Active Data Replication



Eco-Friendly
Storage and Compute

N x 10 Gbit

N x 10 Gbit

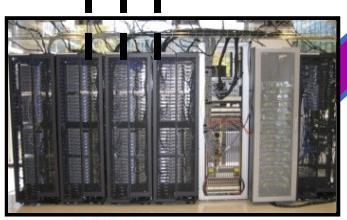


10 Gigabit
L2/L3 Switch

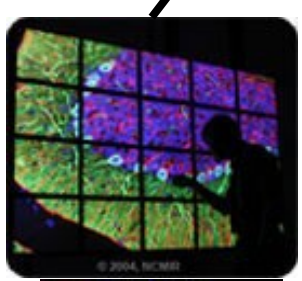
"Network in a box"
- > 200 Connections
- DWDM or Gray Optics

Wide-Area 10G
- Cenic/HPR
- NLR Cavewave
- Cinegrid
- …

On-Demand Physical Connections



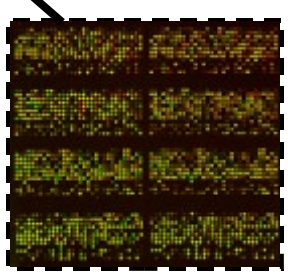
camera
Marine Microbial Ecology



NCMIR
NATIONAL CENTER for MICROSCOPY and IMAGING RESEARCH



NBCR



Microarray

Your Lab Here

OptIPuter

UCSD
UCIrvine

ROCKS

Source:Phil Papadopoulos, SDSC/Calit2

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