High Performance Collaboration

Invited Talk
National Astrobiology Institute Executive Council Meeting
Astrobiology Science Conference 2008
Santa Clara Convention Center
April 14, 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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The NASA Astrobiology Institute is a Virtual Research Institute

- **NAI Goals:**
  - Conducting, Supporting, and Catalyzing Collaborative Interdisciplinary Research
  - Exploring New Approaches, Using Modern Information Technology, to Conduct Interdisciplinary and Collaborative Research Among Widely Distributed Investigators
- **NRC Recommendations:**
  - Develop Strategic Alliances with Silicon Valley Companies
  - Partner with University Collaboration Systems Beyond Commercial
  - Take Advantage of Social Science Research
  - Have Reluctant Adopters Suggest Improvements
  - Explore Social Networks

Cisco Telepresence Provides Leading Edge Commercial VTC

- 191 Cisco TelePresence in Major Cities Globally
  - US/Canada: 83 CTS 3000, 46 CTS 1000
  - APAC: 17 CTS 3000, 4 CTS 1000
  - Japan: 4 CTS 3000, 2 CTS 1000
  - Europe: 22 CTS 3000, 10 CTS 1000
  - Emerging: 3 CTS 3000
- Overall Average Utilization is 45%

- 85,854 TelePresence Meetings Scheduled to Date
  - Weekly Average is 2,263 Meetings
- 108,736 Hours
  - Average is 1.25 Hours

- 13,450 Meetings Avoided Travel
  Average to Date
  (Based on 8 Participants)

  ~$107.60 M To Date
- Cubic Meters of Emissions Saved 16,039,052 (6,775 Cars off the Road)

Uses QoS Over Shared Internet ~ 15 mbps

Cisco Bought WebEx





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Source: Cisco 3/22/08

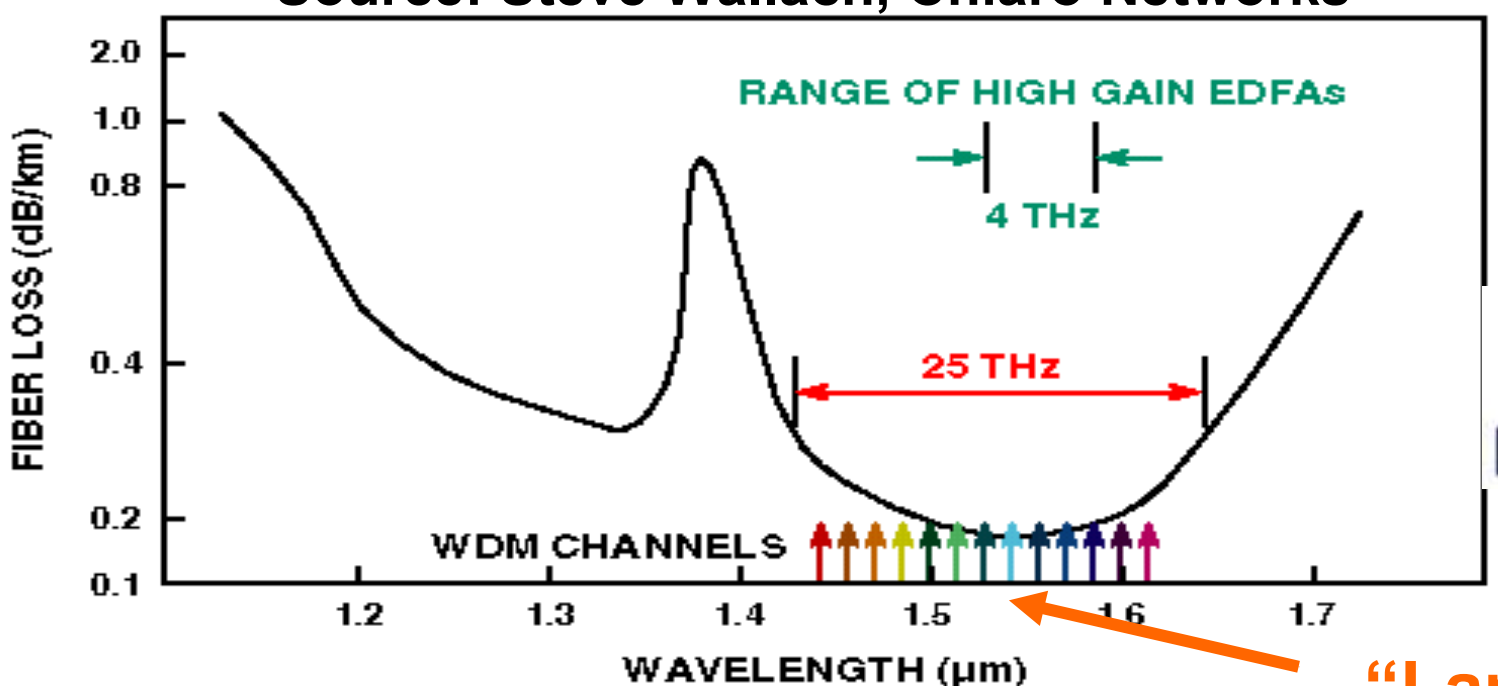
Dedicated Optical Channels Makes High Performance Cyberinfrastructure Possible

WAVELENGTH DIVISION MULTIPLEXING (WDM)

10 Gbps per User ~ 500x Shared Internet Throughput

- EXPLOITS
  - ENORMOUS BANDWIDTH OF SILICA FIBER
  - HIGH-GAIN WIDEBAND OPTICAL AMPLIFIERS

Source: Steve Wallach, Chiaro Networks



CHIARO

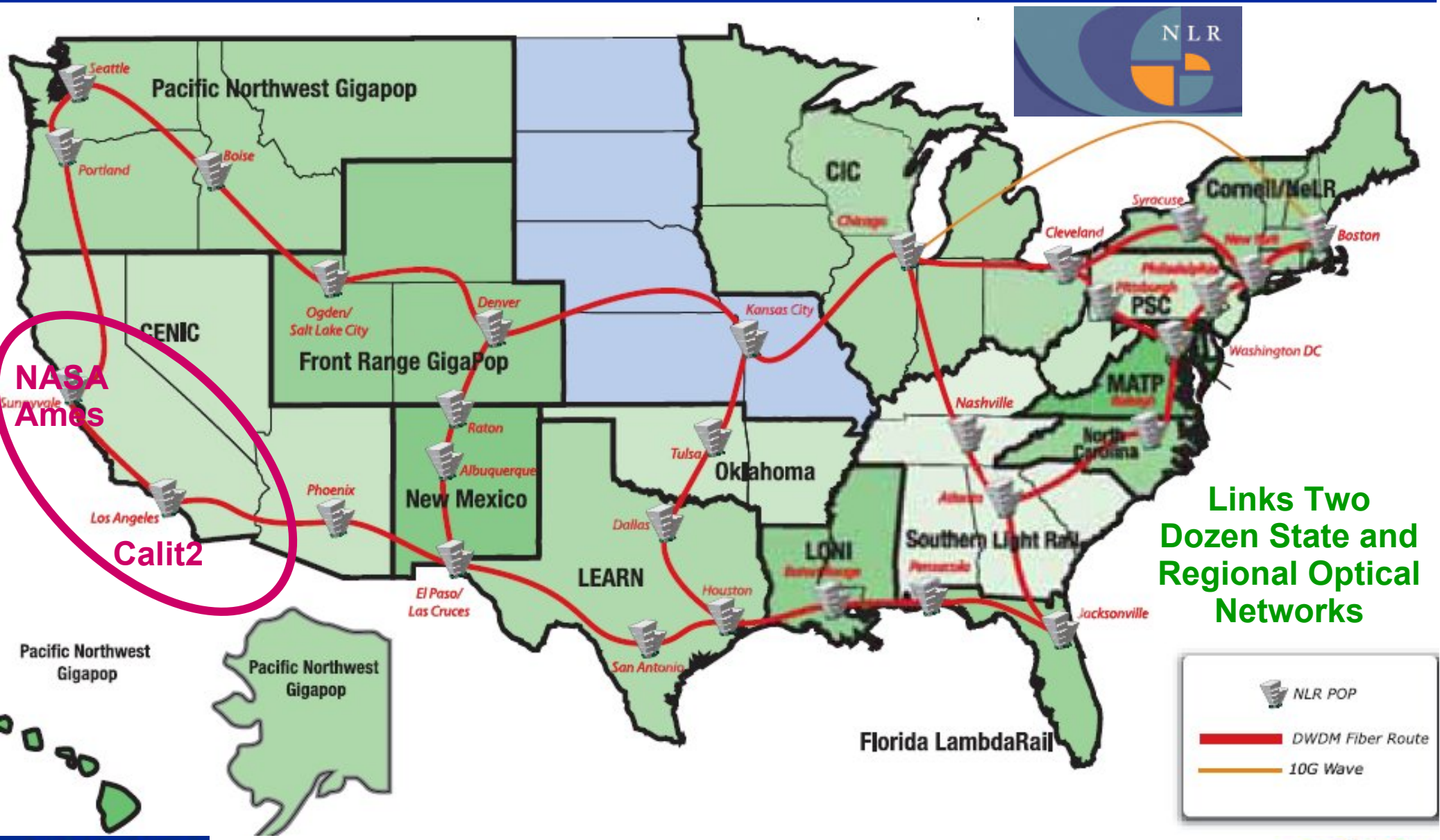
"Lambdas"

Single 10G Lightpath to Individual Users Enables Data-Intensive Science with High Performance Collaboration

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National Lambda Rail (NLR) Provides Cyberinfrastructure Backbone for U.S. Researchers



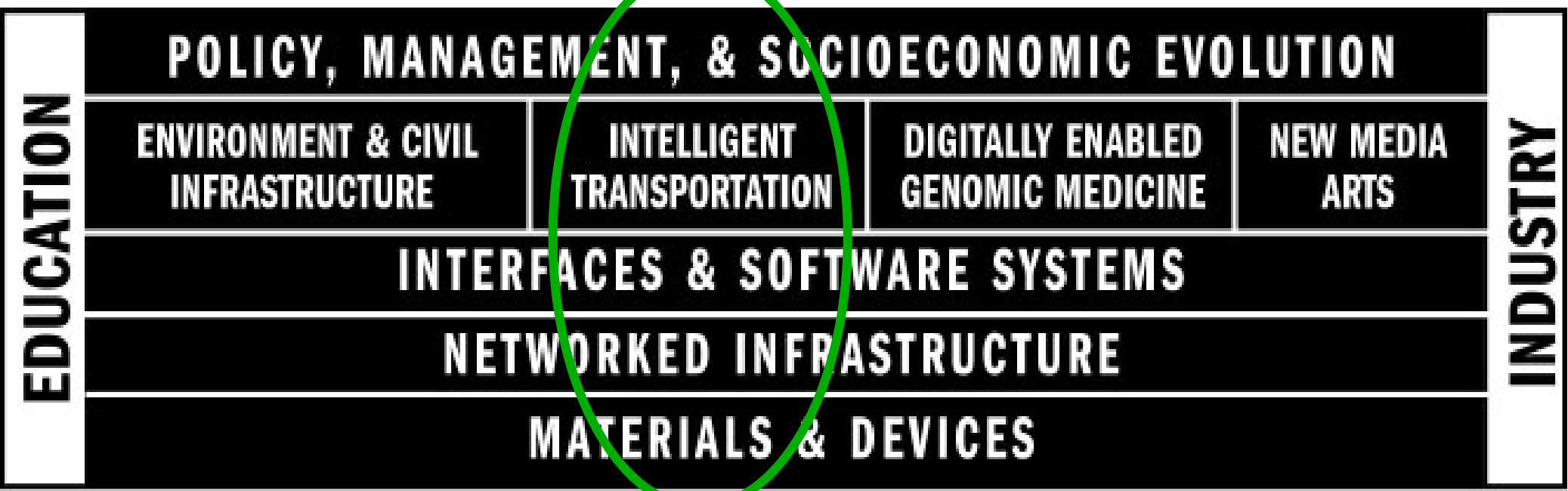
NLR 4 x 10Gb Lambdas Initially
Capable of 40 x 10Gb wavelengths at Buildout

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Calit2--A Systems Approach to the Future of the Internet and its Transformation of Our Society

Calit2 Has Assembled a Complex Social Network of Over 350 UC San Diego & UC Irvine Faculty From Two Dozen Departments Working in Multidisciplinary Teams With Staff, Students, Industry, and the Community



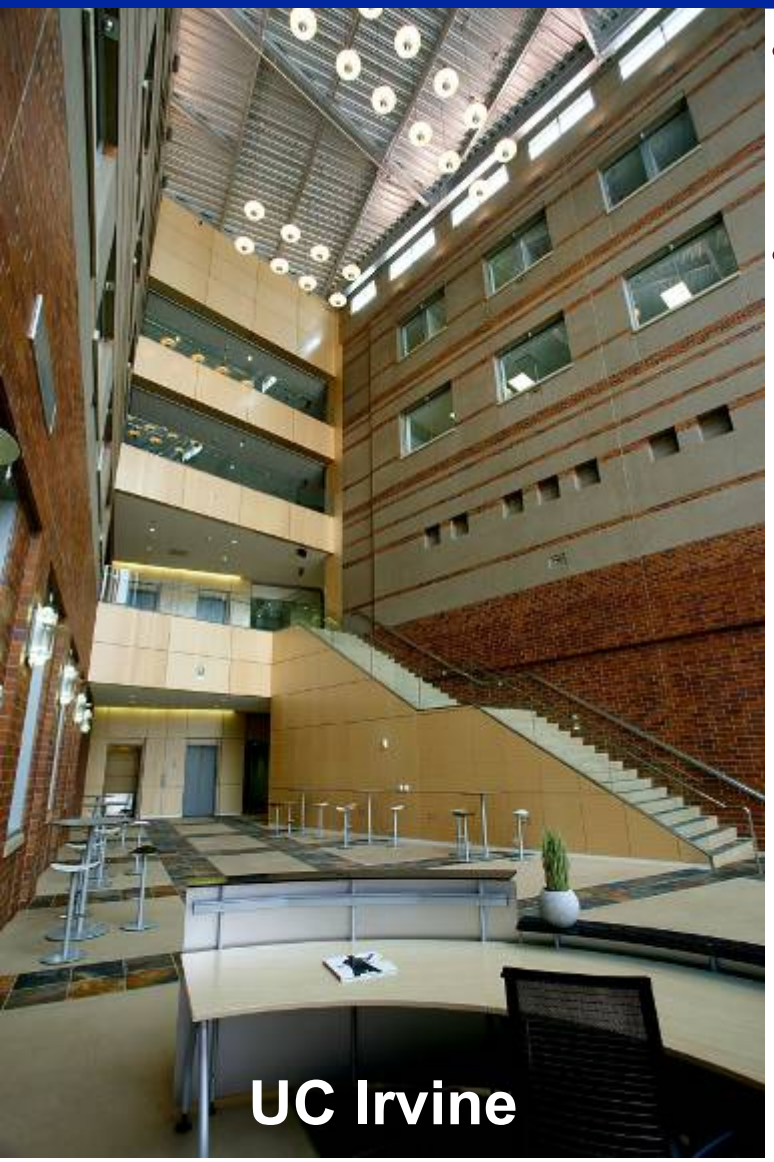
Integrating Technology Consumers and Producers Into "Living Laboratories"

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www.calit2.net

it²

Two New Calit2 Buildings Provide New 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

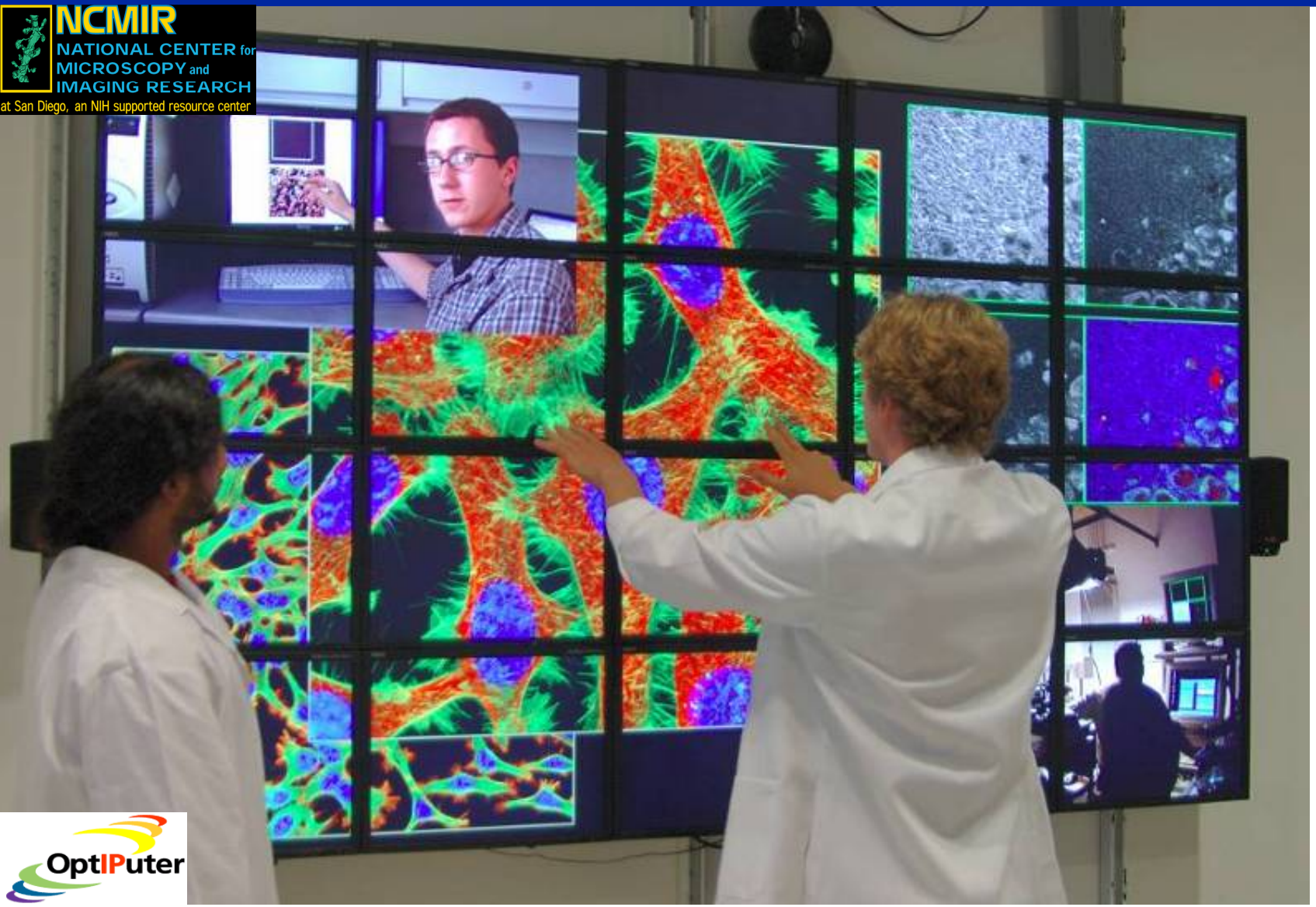
Preparing for a World in Which Distance is Eliminated…

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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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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





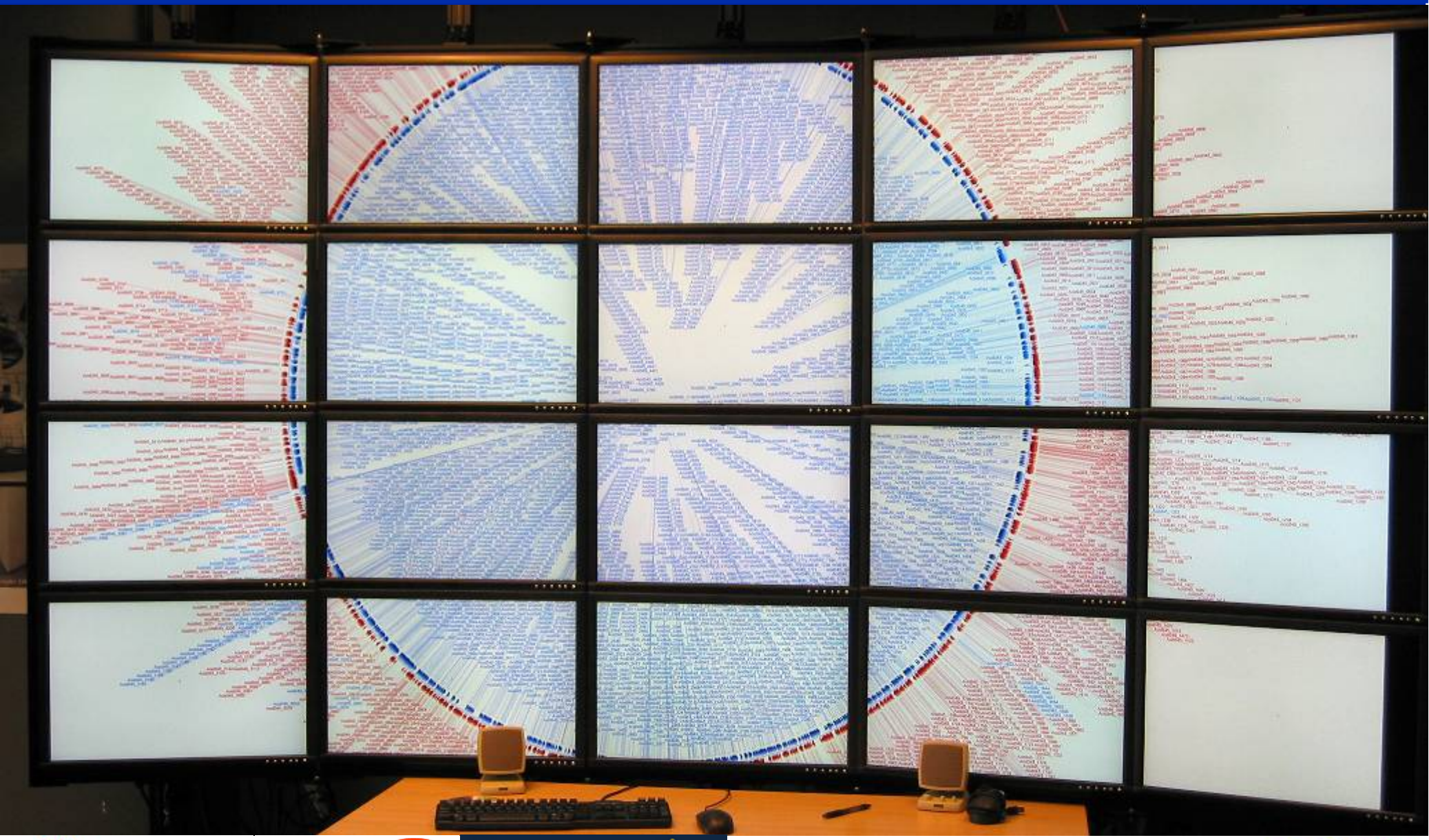
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Powered by Rocks ROCKS

Source: Phil Papadopoulos SDSC, Calit2

it²

Use of Tiled Display Wall OptIPortal to Interactively View Microbial Genome



camera Marine Microbial Ecology

OptIPuter

Powered by Rocks ROCKS

Acidobacteria bacterium Ellin345 Soil Bacterium 5.6 Mb; ~5000 Genes

Source: Raj Singh, UCSD

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Use of Tiled Display Wall OptIPortal to Interactively View Microbial Genome



camera Marine Microbial Ecology

OptIPuter

Powered by Rocks ROCKS

Source: Raj Singh, UCSD

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Use of Tiled Display Wall OptIPortal to Interactively View Microbial Genome



camera Marine Microbial Ecology

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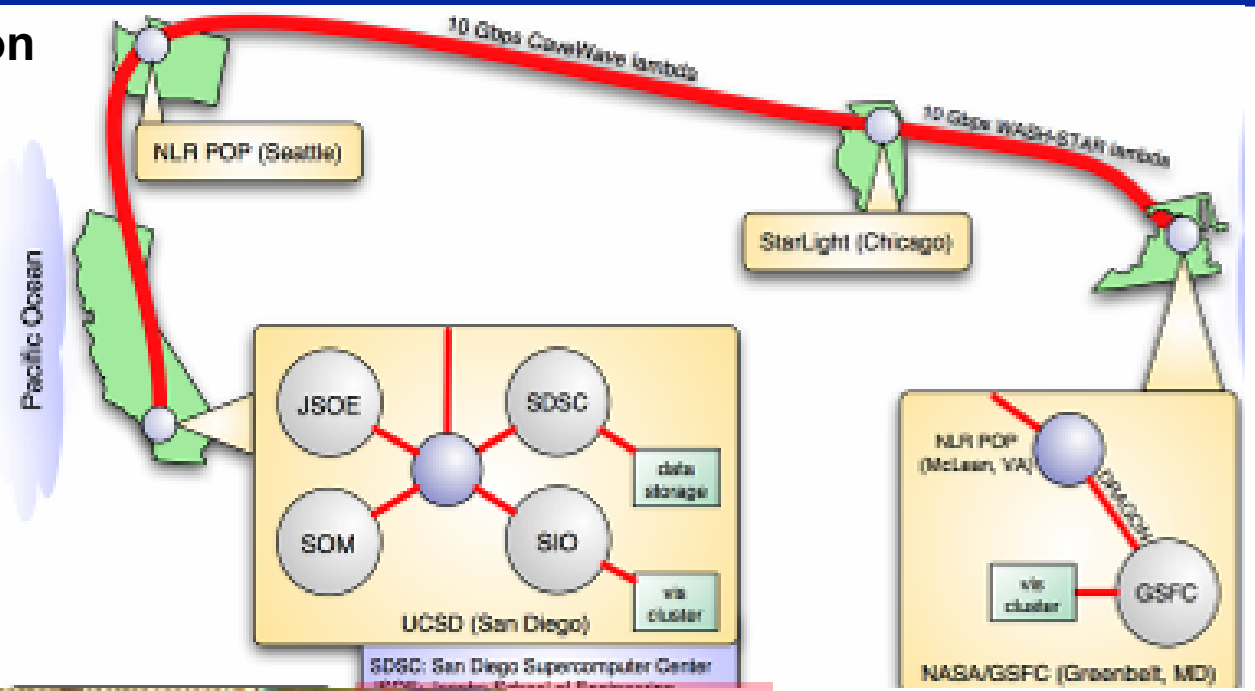
Source: Raj Singh, UCSD

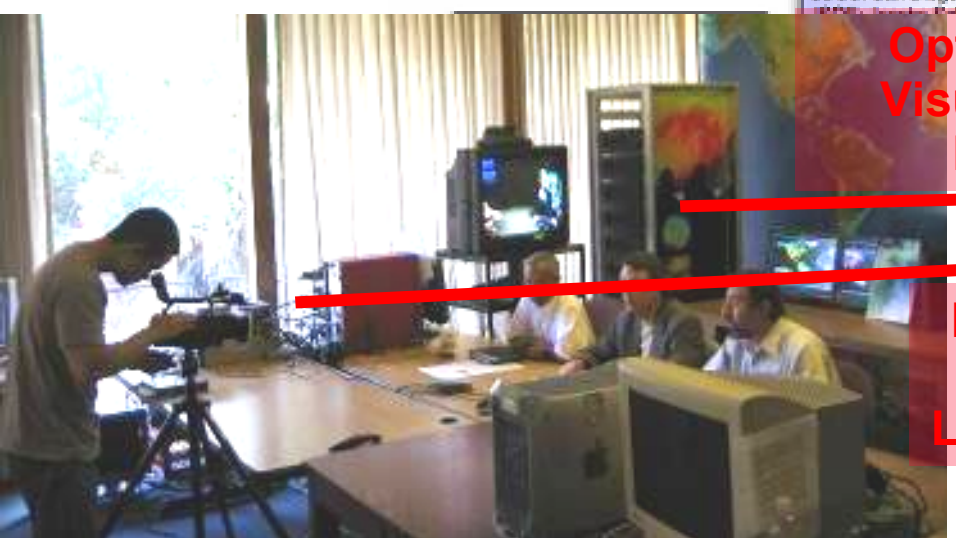
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OptIPuter Enables Telepresence Combined with Remote Interactive Analysis

Live Demonstration

of 21st Century National-Scale Team Science





OptIPuter Visualized Data

HDTV Over Lambda



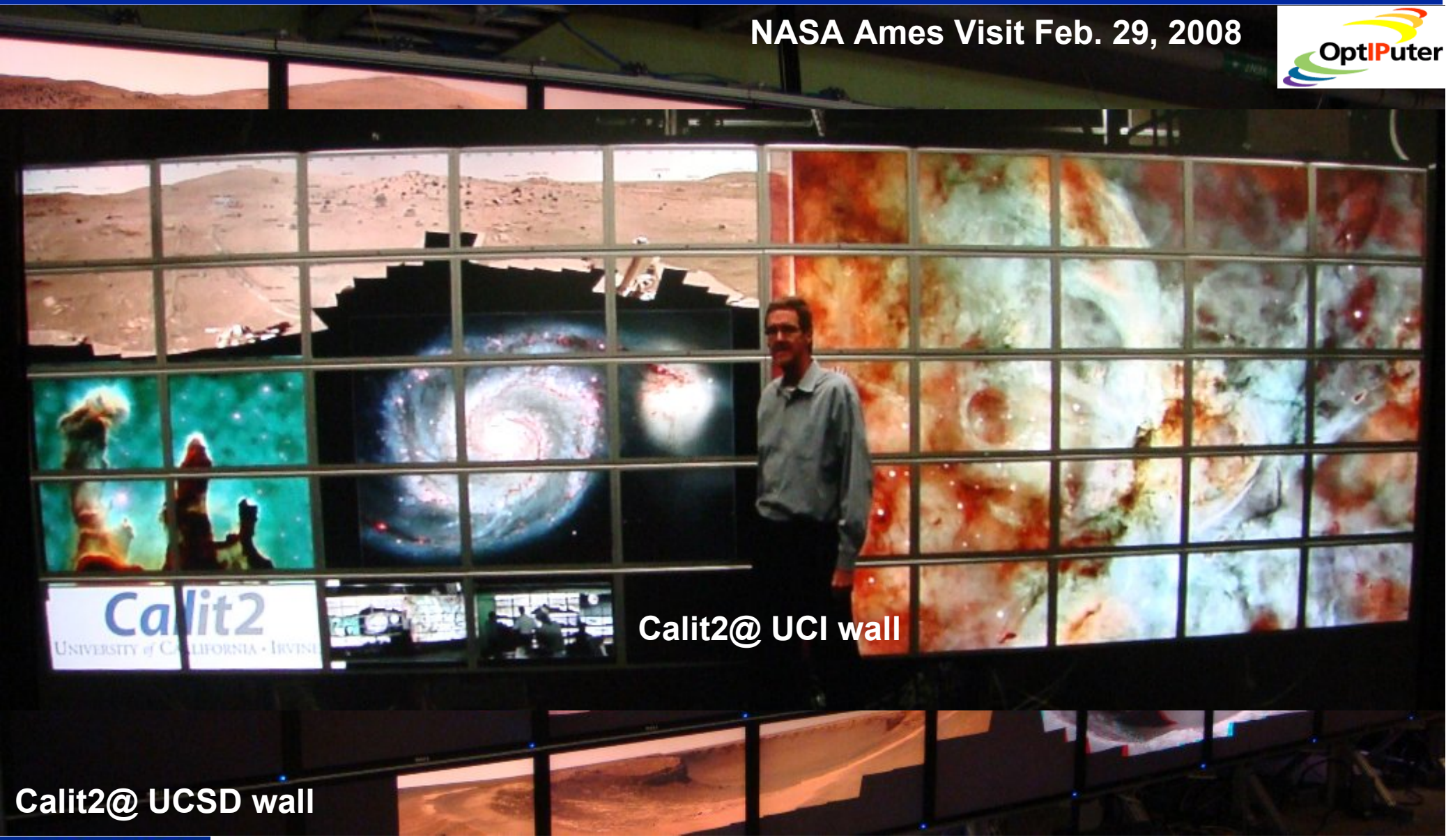
SIO/UCSD

NASA Goddard

August 12, 2005

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



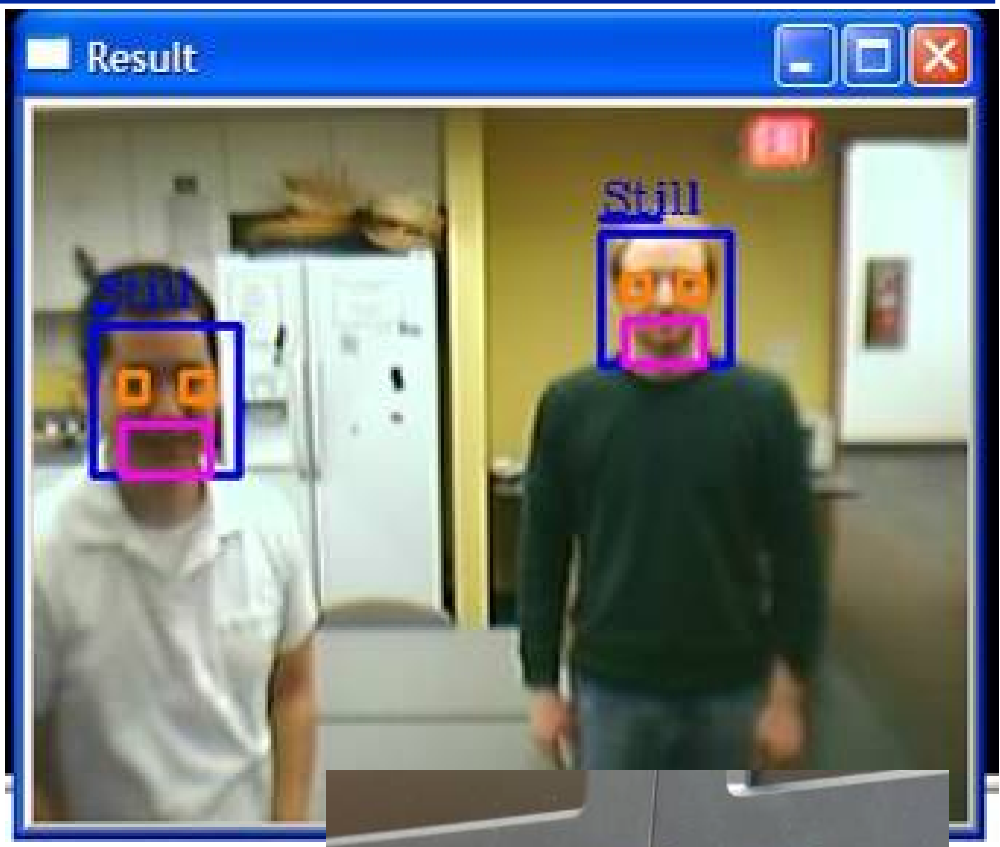
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NASA Ames is Completing a 245 Mpixel Hyperwall as Project Columbia Interface

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U Michigan Virtual Space Interaction Testbed (VISIT) Instrumenting OptIPortals for Social Science Research

- Using Cameras Embedded in the Seams of Tiled Displays and Computer Vision Techniques, we can Understand how People Interact with OptIPortals
  - Classify Attention, Expression, Gaze
  - Initial Implementation Based on Attention Interaction Design Toolkit (J. Lee, MIT)
- Close to Producing Usable Eye/Nose Tracking Data using OpenCV





Leading U.S. Researchers on the Social Aspects of Collaboration

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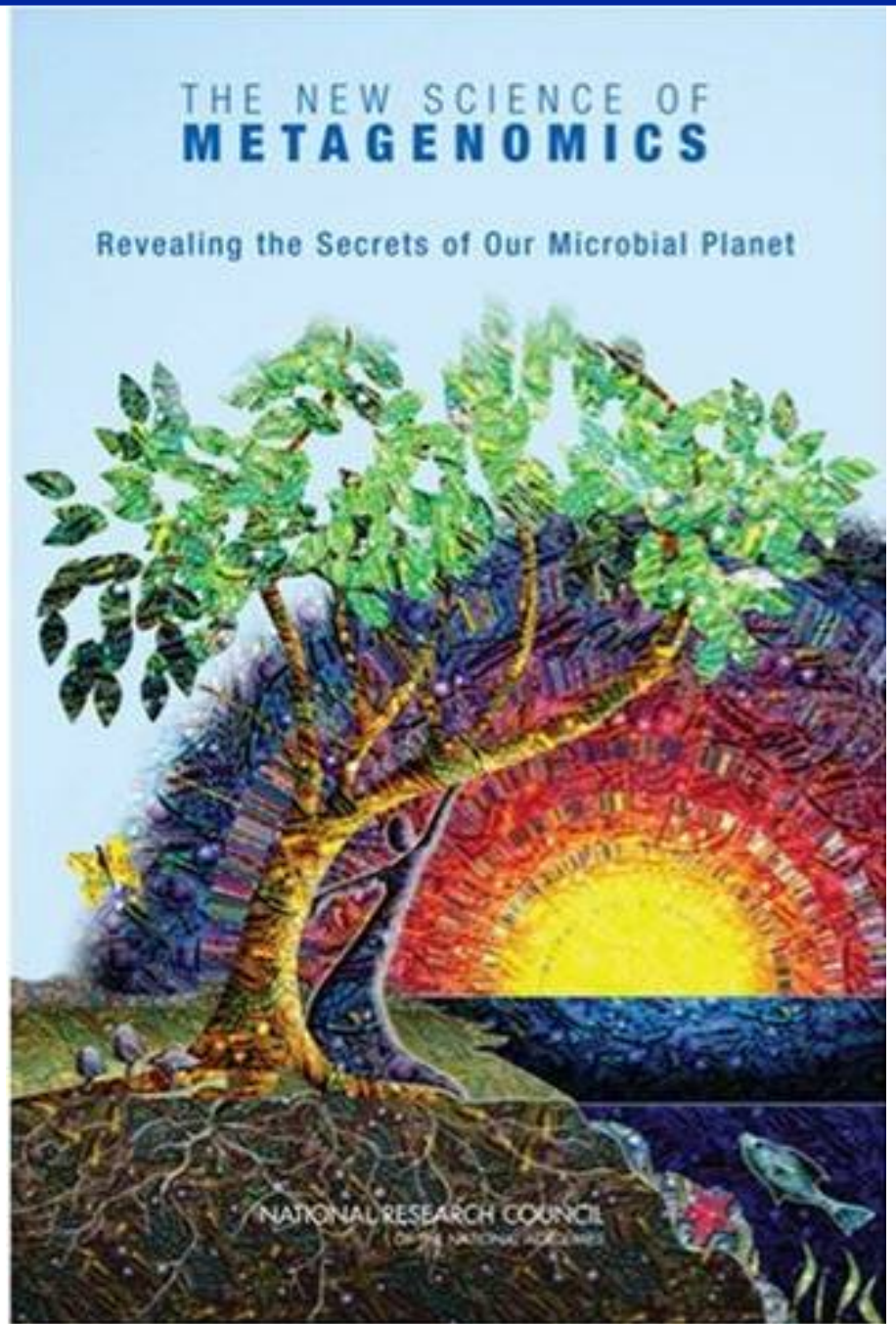
Source: Erik Hofer, UMich, School of Information

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The New Science of Metagenomics: Application Driver for OptIPuter Collaboration

NRC Report:

Metagenomic data should be made publicly available in international archives as rapidly as possible.



"The emerging field of metagenomics, where the DNA of entire communities of microbes is studied simultaneously, presents the greatest opportunity -- perhaps since the invention of the microscope – to revolutionize understanding of the microbial world." –

National Research Council
March 27, 2007

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



Paul Gilna Ex. Dir.

National LambdaRail
Direct Connect
Computation and Storage Complex

PI Larry Smarr

Funded by: Gordon and Betty Moore Foundation

Joint Partnership of:

UCSD
UCIrvine

Announced January 17, 2006—
$24.5M Over Seven Years

Community Cyberinfrastructure for Advanced Marine Microbial Ecology Research and Analysis



http://camera.calit2.net/

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

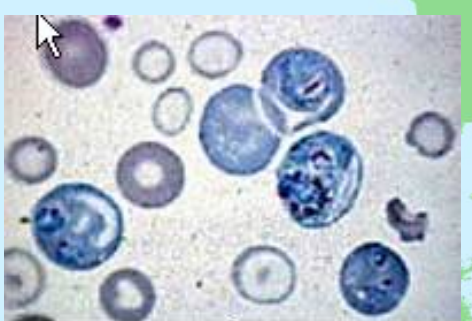
Plus 155 Marine Microbial Genomes



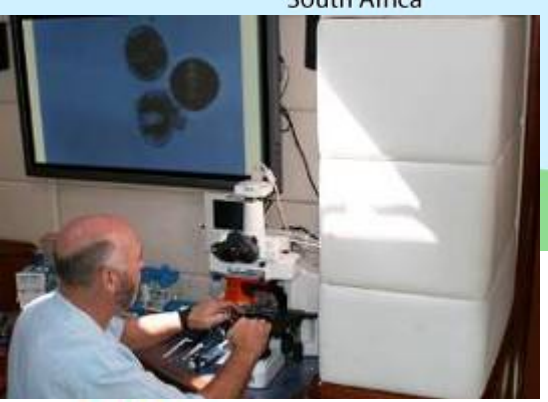
Each Sample ~2000 Microbial Species

Specify Ocean Data

Canada
United States
Mexico
Puerto Rico
Honduras
Costa Rica
Panama
Galapagos Islands
x 10 samples
Tanzania/ Zanzibar
x 7 samples
Seychelles
Madagascar
South Africa
Cocos-Keeling Is.
Vanuatu
x 17 samples
Fiji
Tonga
French Polynesia
Cook Islands
Australia
New Caledonia
x 8 samples



Analyzed Sampled, but not Analyzed



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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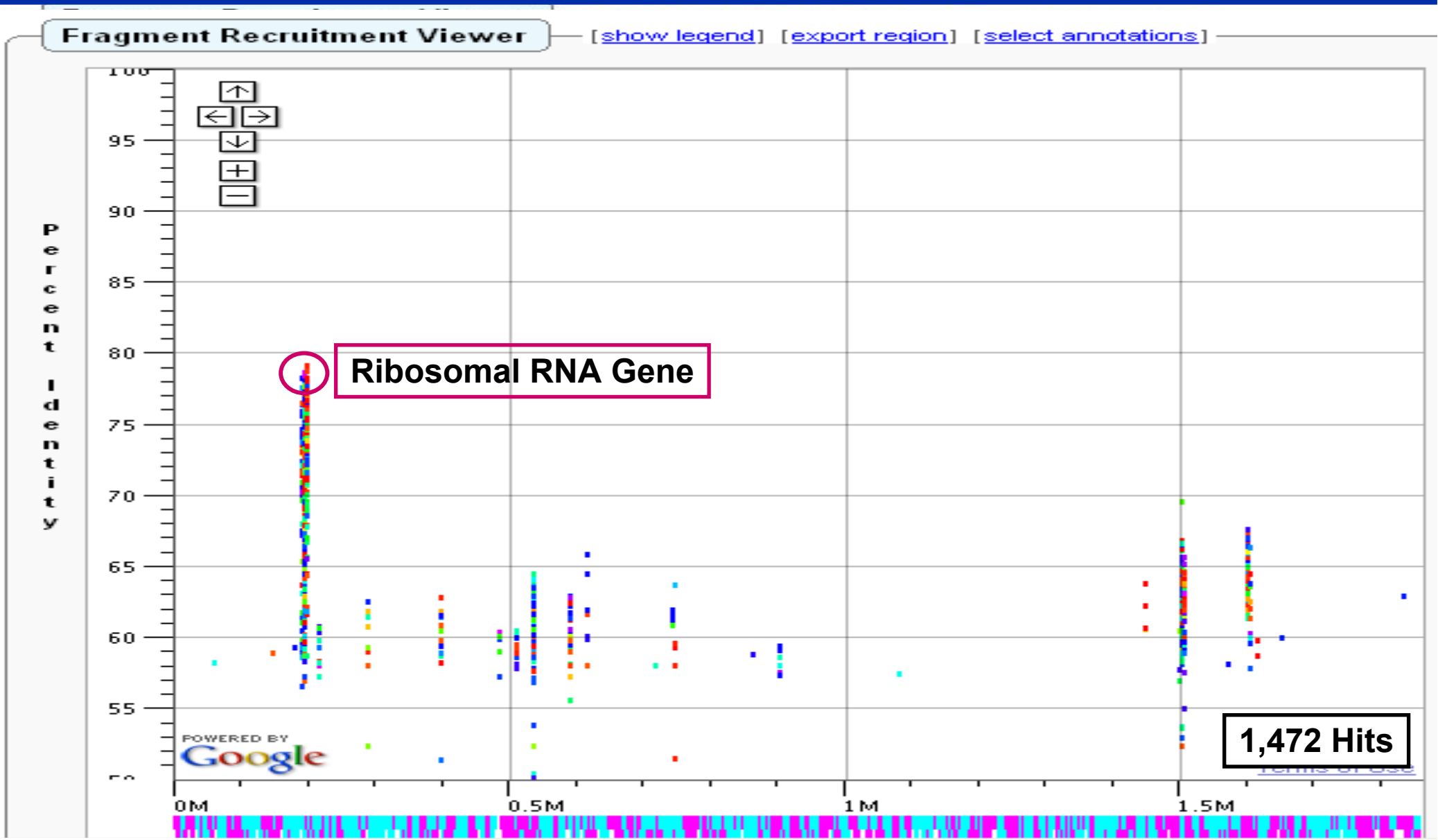
CAMERA Fragment Recruitment Viewer Compares Candidate Genome Against GOS Sites



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CAMERA Fragment Recruitment Viewer Visualizes Overlap of GOS with Reference Microbial Genome

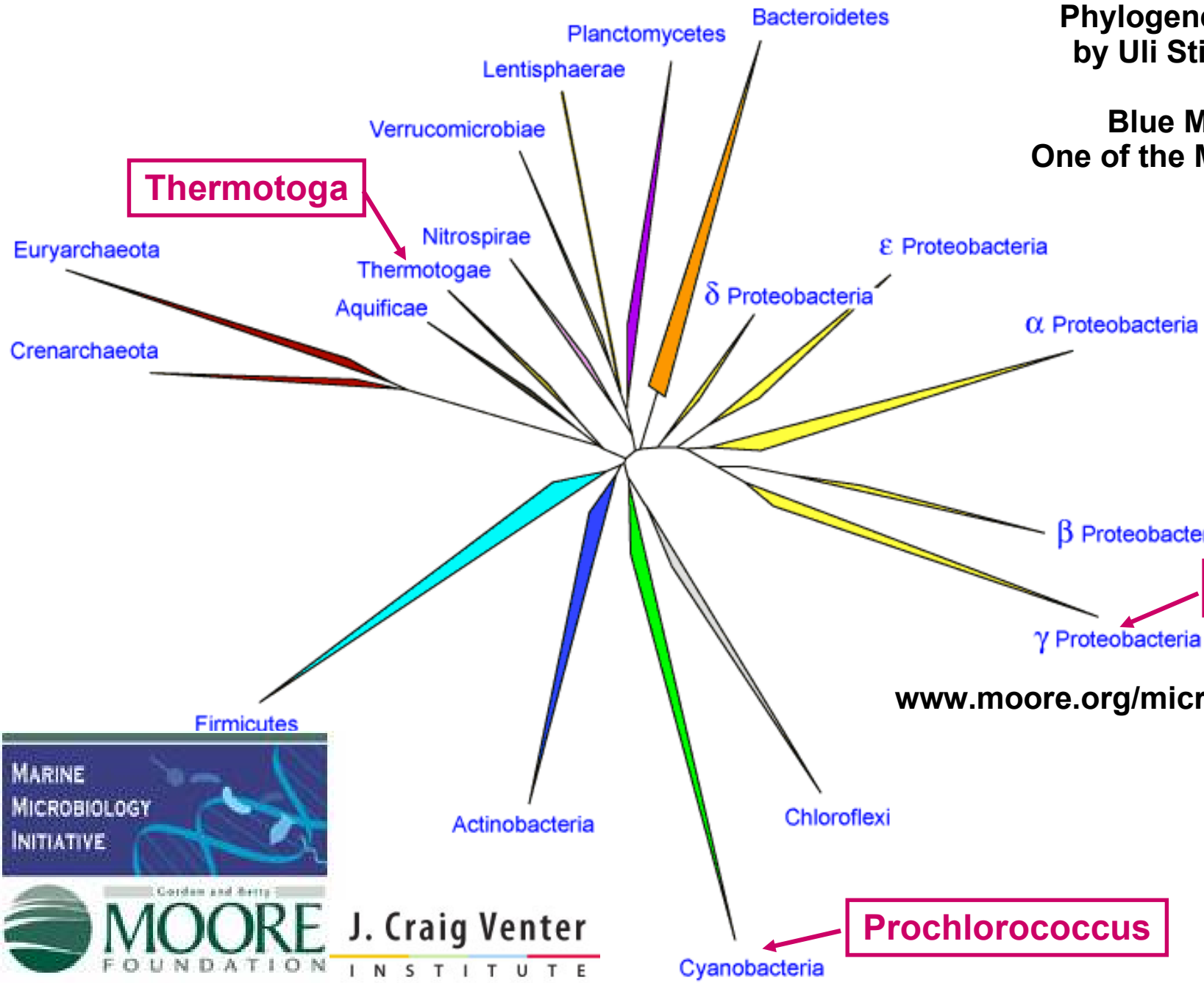


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***Thermotoga maritima MSB8*, complete genome**
Thrives at 80°C—1/4 of Genome is Archaeal

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Moore Foundation Funded the Venter Institute to Provide the Full Genome Sequence of 155+ Marine Microbes



Phylogenetic Trees Created by Uli Stingl, Oregon State

Blue Means Contains One of the Moore 155 Genomes

www.moore.org/microgenome/trees.aspx

MARINE MICROBIOLOGY INITIATIVE

Gordon and Betty MOORE FOUNDATION

J. Craig Venter INSTITUTE

CAMERA's Global Microbial Metagenomics CyberCommunity—Can We Employ Social Network Software?

Over 1850 Registered Users From Over 50 Countries



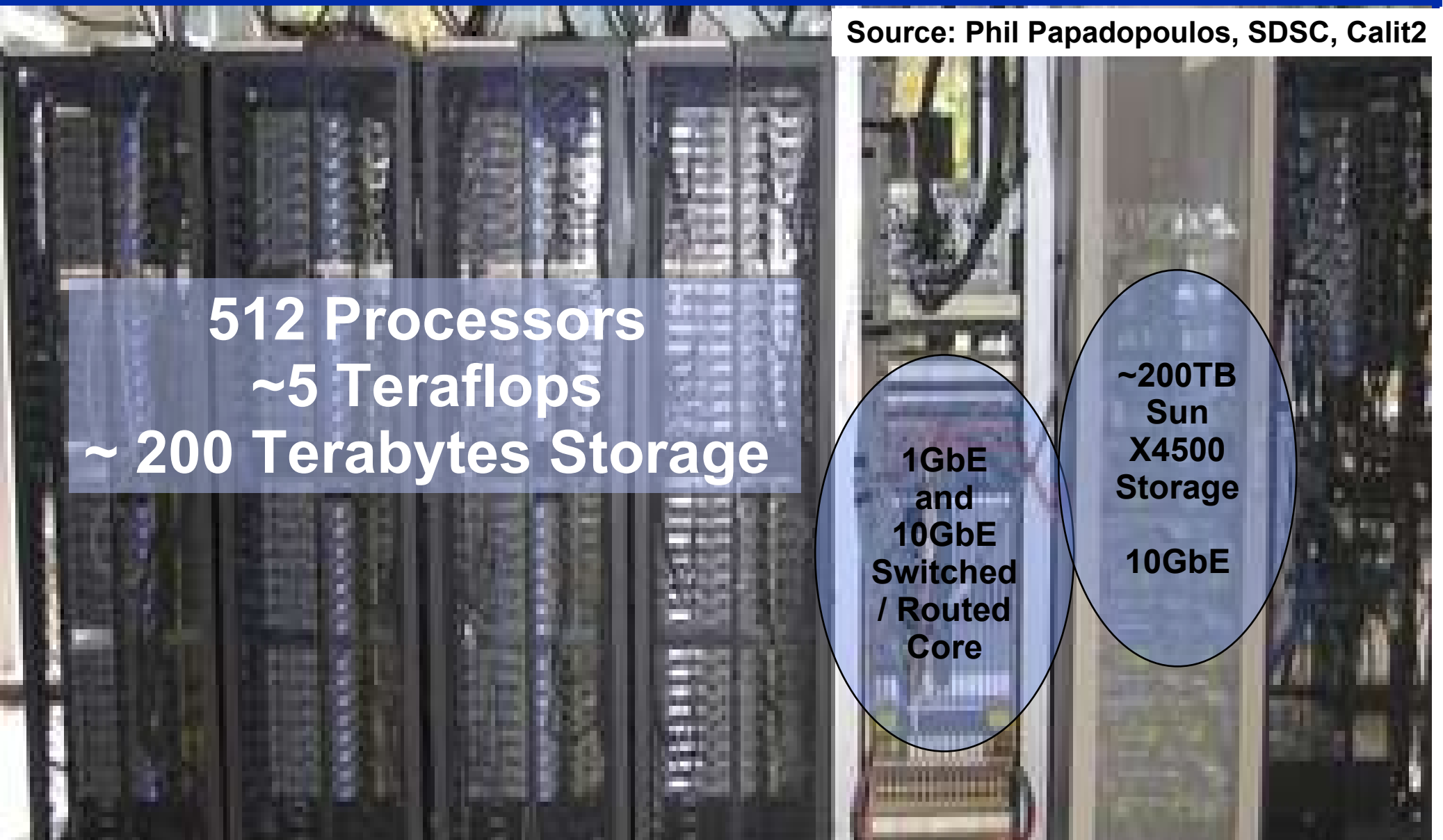
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Marine Microbial Ecology

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INSTITUTE

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

Source: Phil Papadopoulos, SDSC, Calit2



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

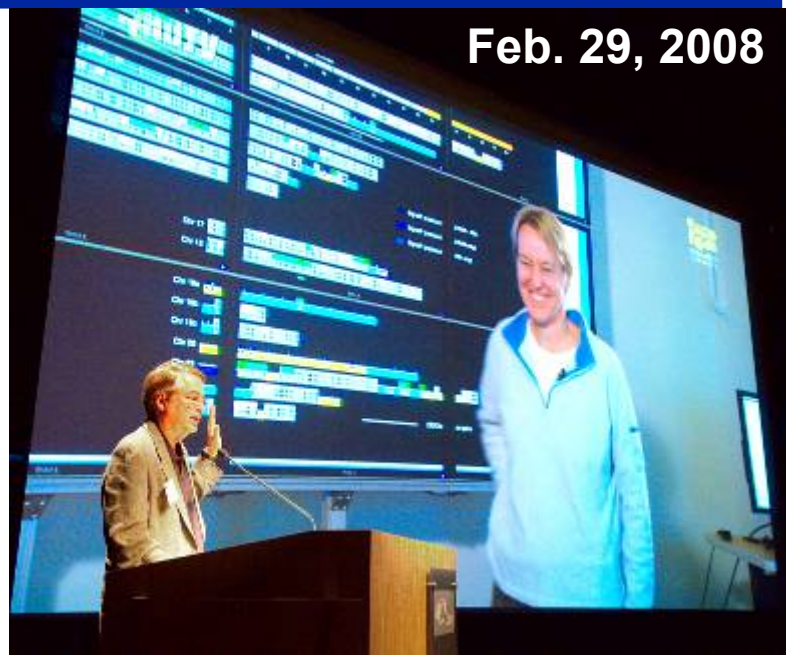
OptIPlanet Collaboratory Persistent Infrastructure Supporting Microbial Research



OptIPuter

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

ROCKS



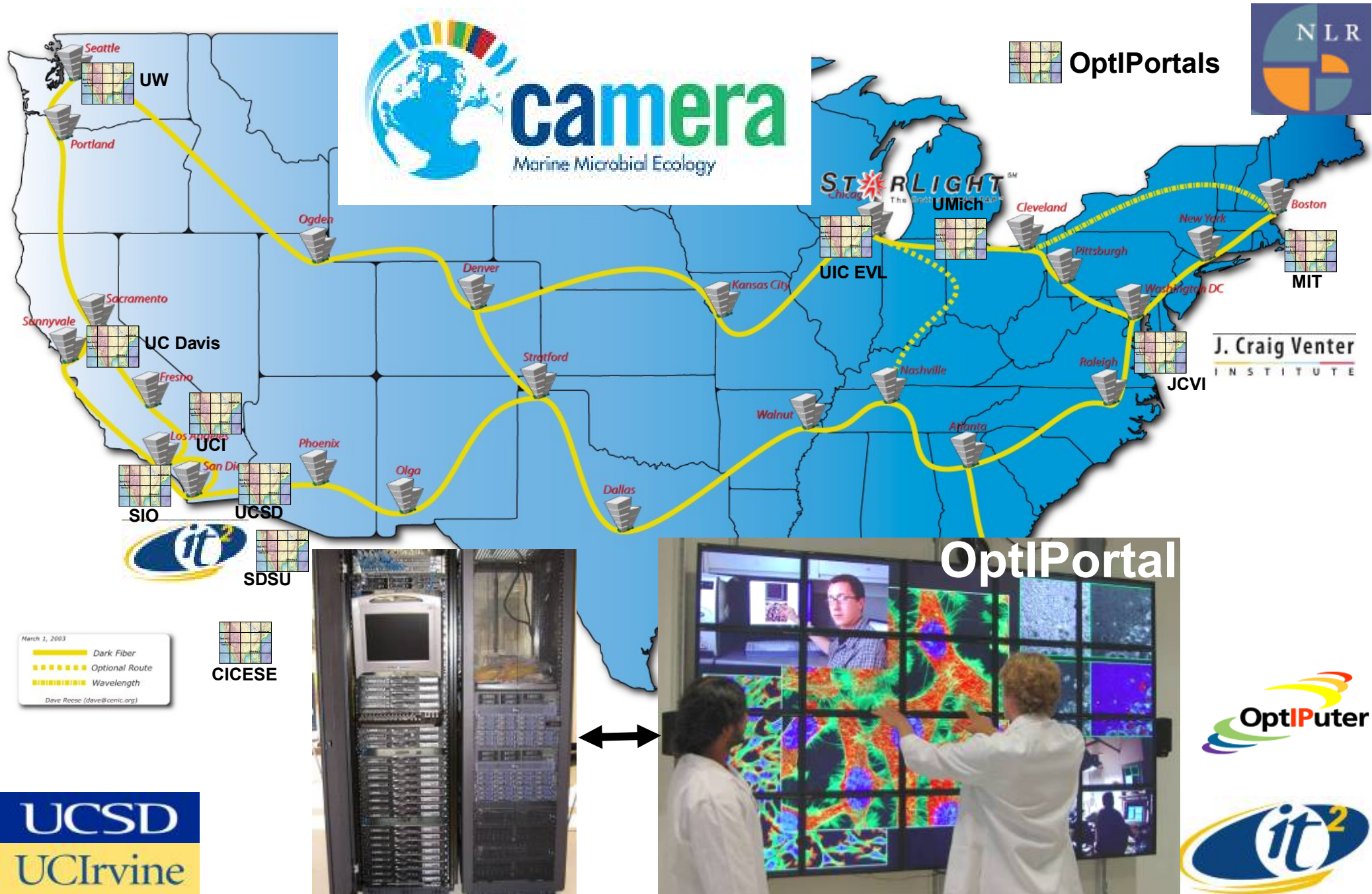




UW's Research Channel Michael Wellings

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An Emerging High Performance Collaboratory for Microbial Metagenomics

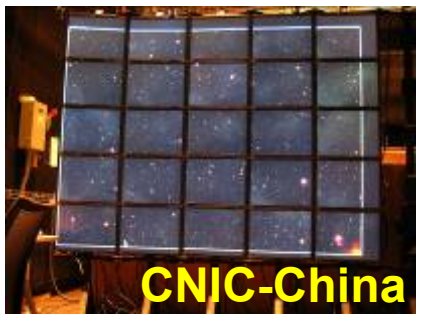


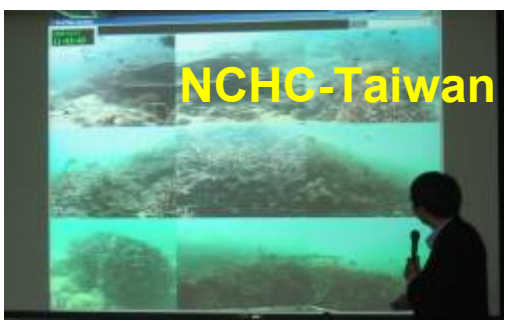
OptIPortals
Are Being Adopted Globally


AIST-Japan


Osaka U-Japan


KISTI-Korea


CNIC-China


NCHC-Taiwan


UZurich


SARA- Netherlands


Brno-Czech Republic


EVL@UIC


Calit2@UCSD


Calit2@UCI

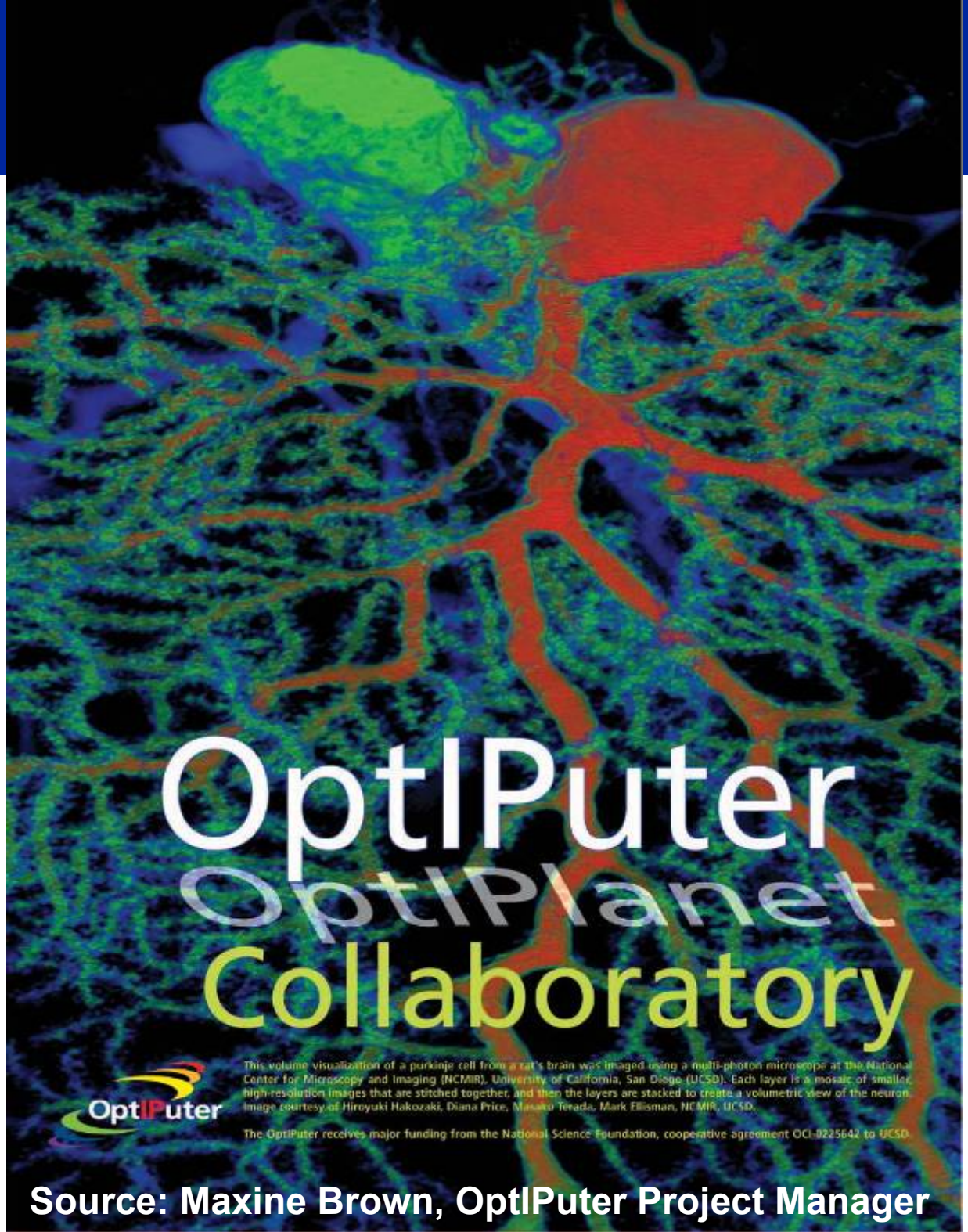

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evl electronic visualization laboratory

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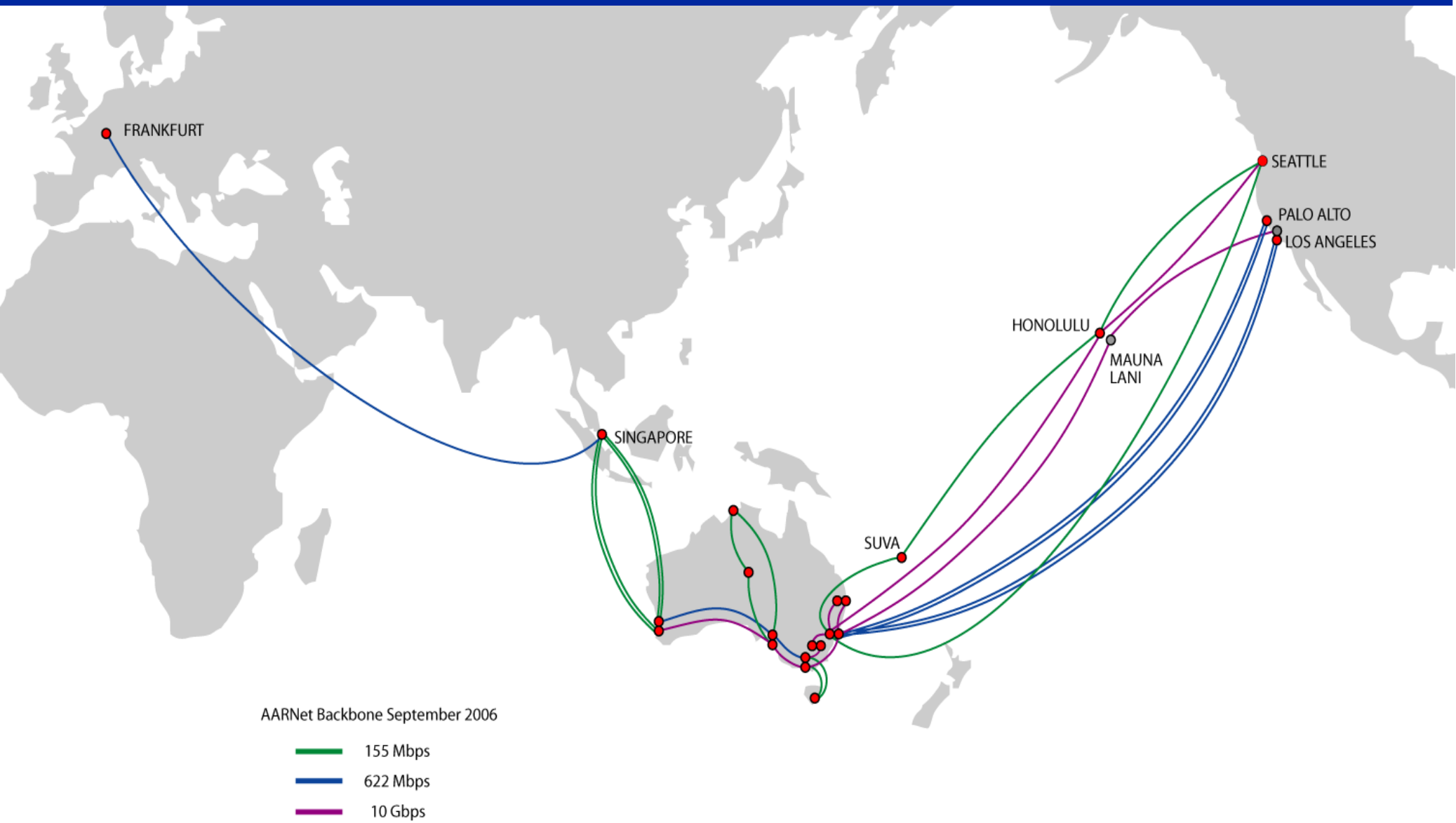
Source: Maxine Brown, OptIPuter Project Manager

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



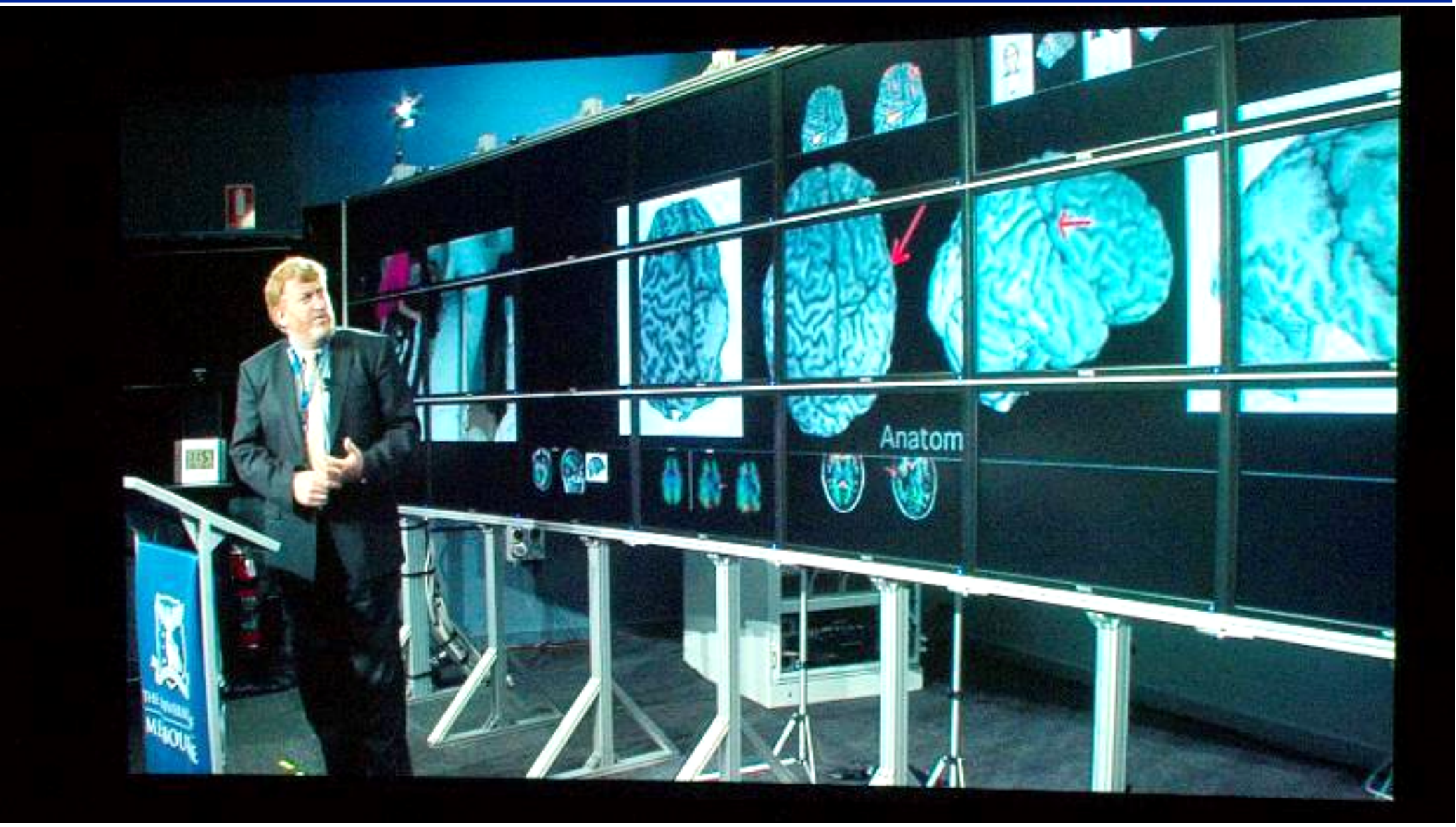
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January 15, 2008

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

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UM Professor Graeme Jackson Planning Brain Surgery for Severe Epilepsy as Seen from Calit2



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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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“Using the Link to Build the Link”
Calit2 and Univ. Melbourne Technology Teams



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No Calit2 Person Physically Flew to Australia to Bring This Up!

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