The OptIPlanet Collaboratory Supporting Microbial Metagenomics Researchers Worldwide

Invited Talk-AIST Booth
Supercomputing '07
Convention Center, Reno, NV
November 13, 2007

Dr. Larry Smarr

Director, California Institute for Telecommunications and Information Technology

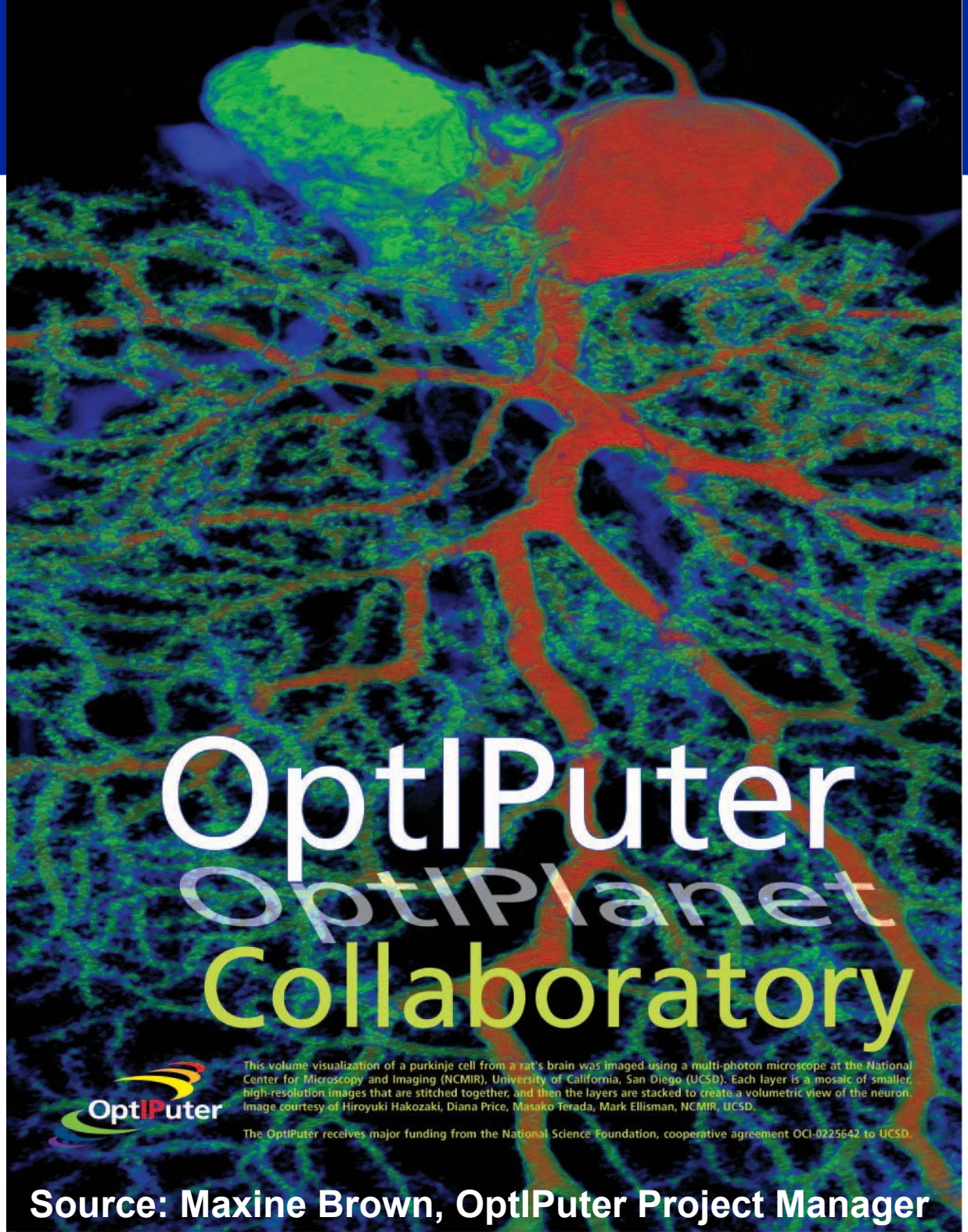
Harry E. Gruber Professor,

Dept. of Computer Science and Engineering

Jacobs School of Engineering, UCSD

UCSD
UCIrvine

it²



UCSD
UCIrvine

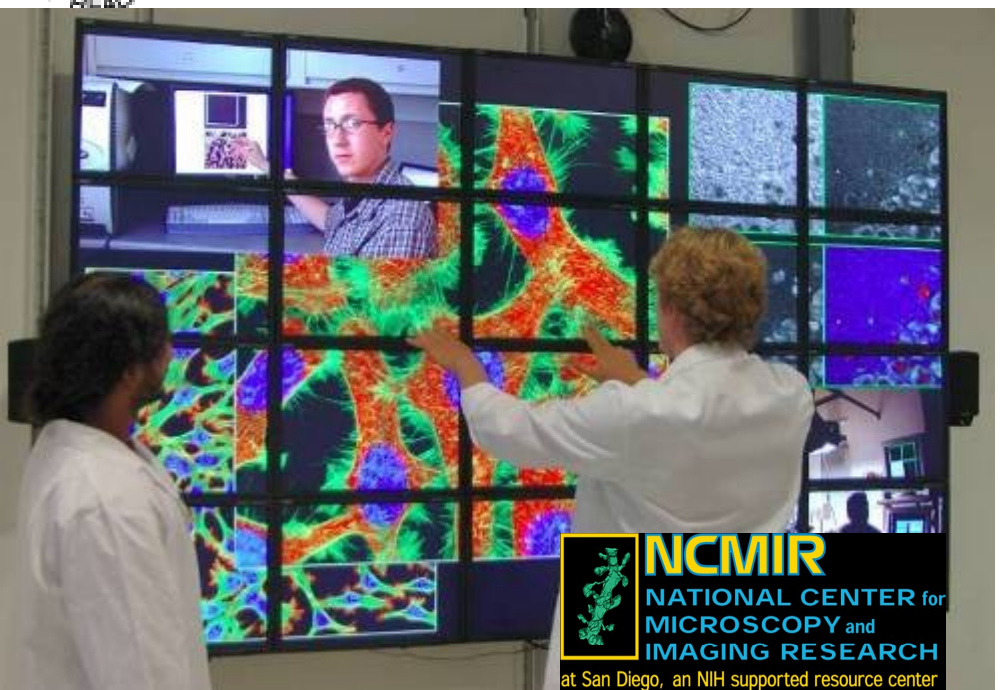
Source: Maxine Brown, OptIPuter Project Manager

it2

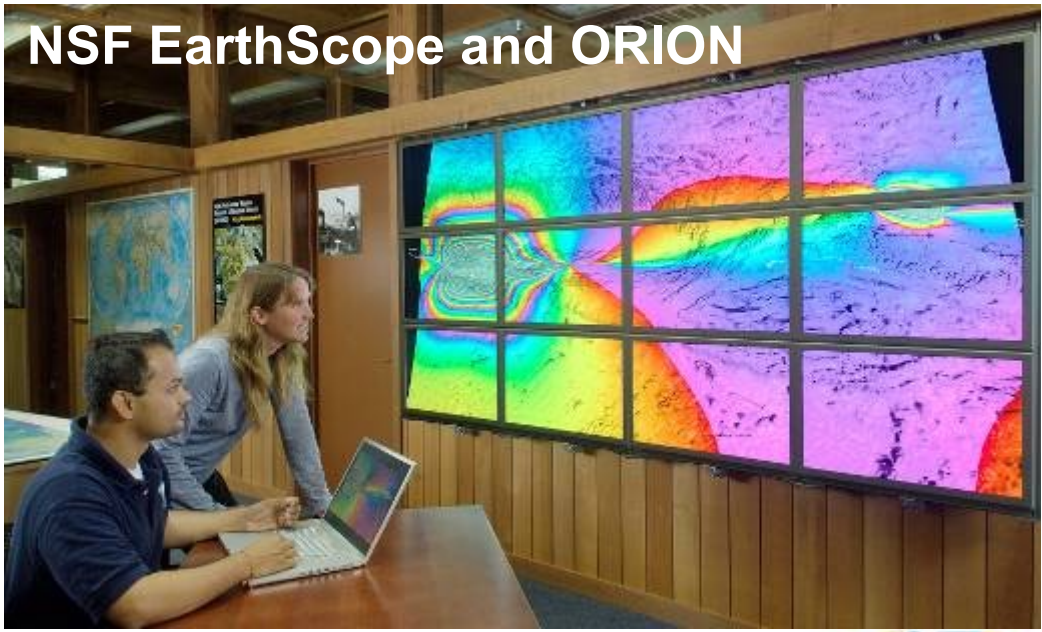
The OptIPuter Project – Creating High Resolution Portals Over Dedicated Optical Channels to Global Science Data

- **NSF Large Information Technology Research Proposal**
  - Calit2 (UCSD, UCI) and UIC Lead Campuses—Larry Smarr PI
  - Partnering Campuses: SDSC, USC, SDSU, NCSA, NW, TA&M, UvA, SARA, NASA Goddard, KISTI, AIST, CRC(Canada), CICESE (Mexico)
- **Engaged Industrial Partners:**
  - IBM, Sun, Telcordia, Chiaro, Calient, Glimmerglass, Lucent
- **$13.5 Million Over Five Years—Now In the Six and Final Year**

NIH Biomedical Informatics Research Network



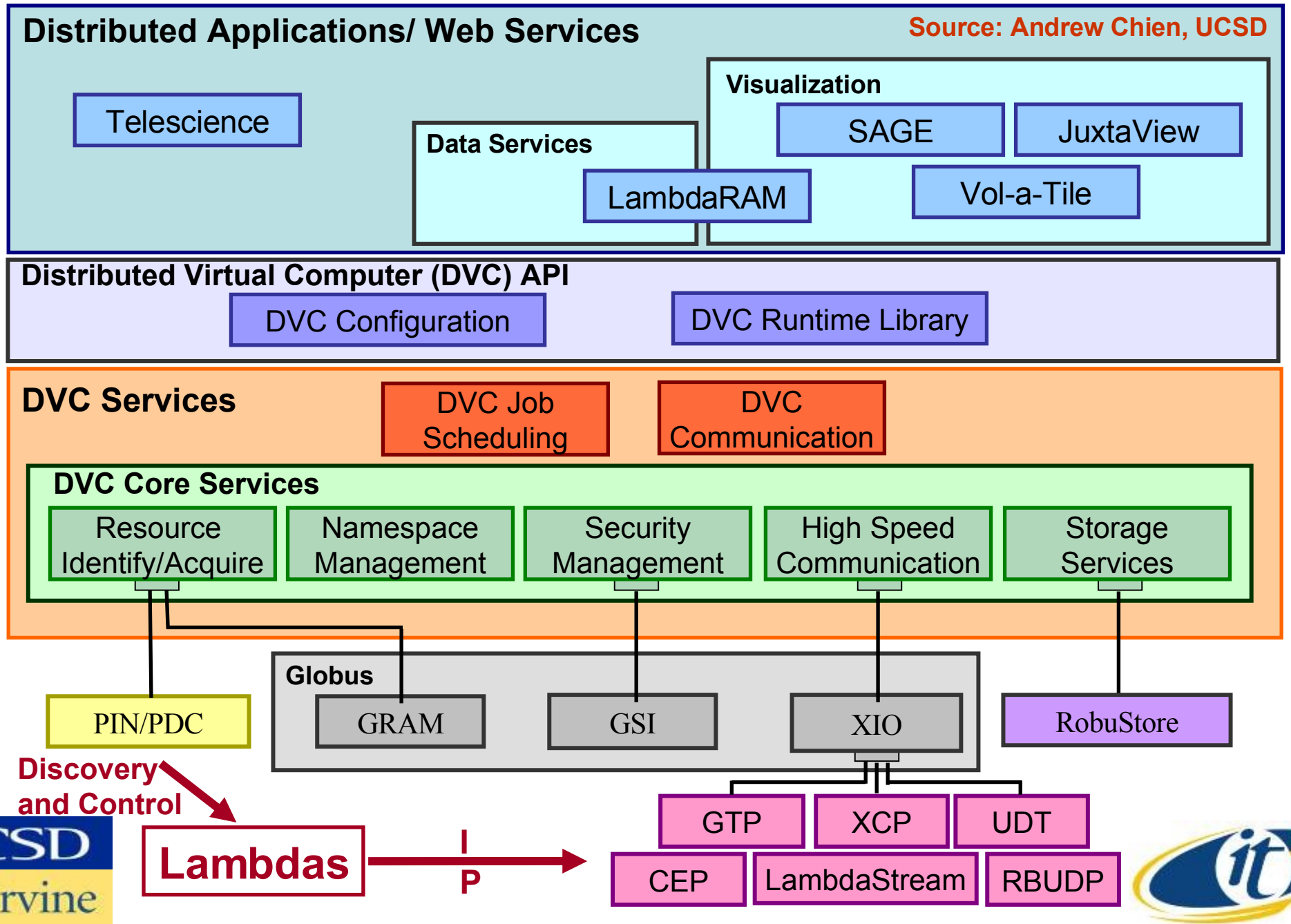
NSF EarthScope and ORION



SCRIPPS INSTITUTION OF OCEANOGRAPHY

it2

OptIPuter Software Architecture--a Service-Oriented Architecture Integrating Lambdas Into the Grid



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





UCSD UCIrvine

Powered by Rocks ROCKS

Source: Phil Papadopoulos SDSC, Calit2

it²

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:

camera
Marine Microbial Ecology

Announced January 17, 2006
$24.5M Over Seven Years

Building On Centers of Excellence and Achievement









Powered by Rocks









The Scripps Genome Center

Supported by:







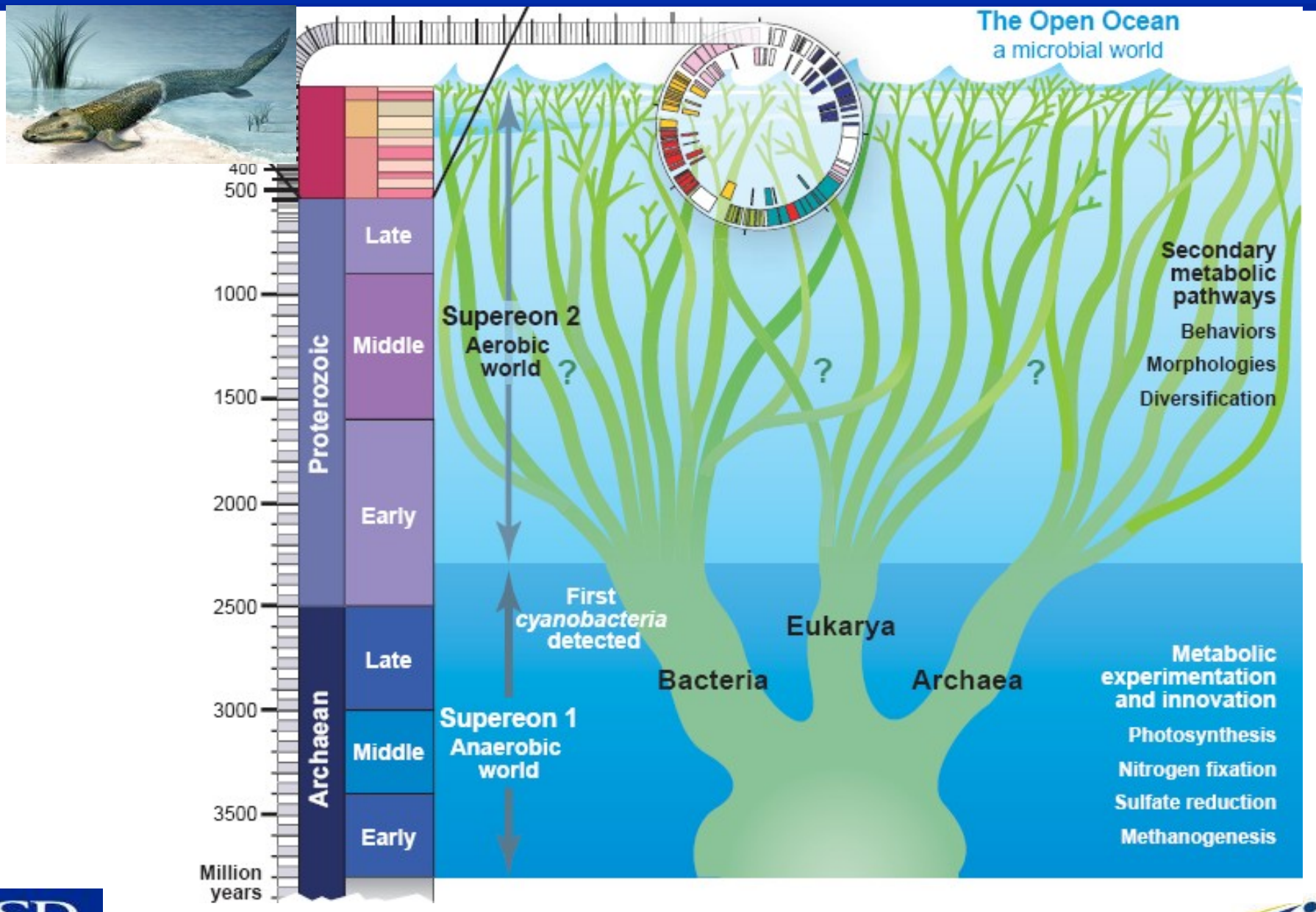








Microbial Genomics Allow Us to Look Back Nearly 4 Billion Years In the Evolution of Life



UCSD
UCIrvine

Falkowski and Vargas *Science* 304 (5667) 2004

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



MARINE MICROBIOLOGY INITIATIVE

Gordon and Betty MOORE FOUNDATION

Sorcerer II Data Will Double Number of Proteins in GenBank!

UCSD
UCIrvine

J. Craig Venter INSTITUTE

it²

Enormous Increase in Scale of Known Genes Over Last Decade

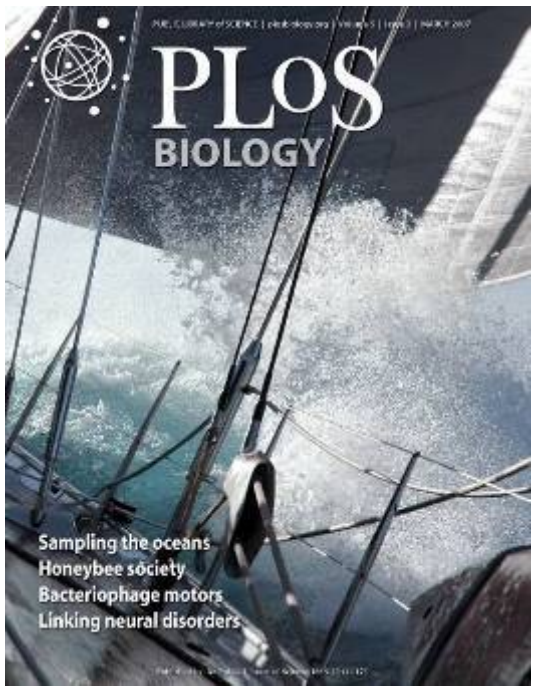
1995
First Microbe Genome



1.8 Million Bases
1749 Genes

J. Craig Venter
INSTITUTE

2007
Ocean Microbial Metagenomics



6.3 Billion Bases
5.6 Million Genes

~3300x

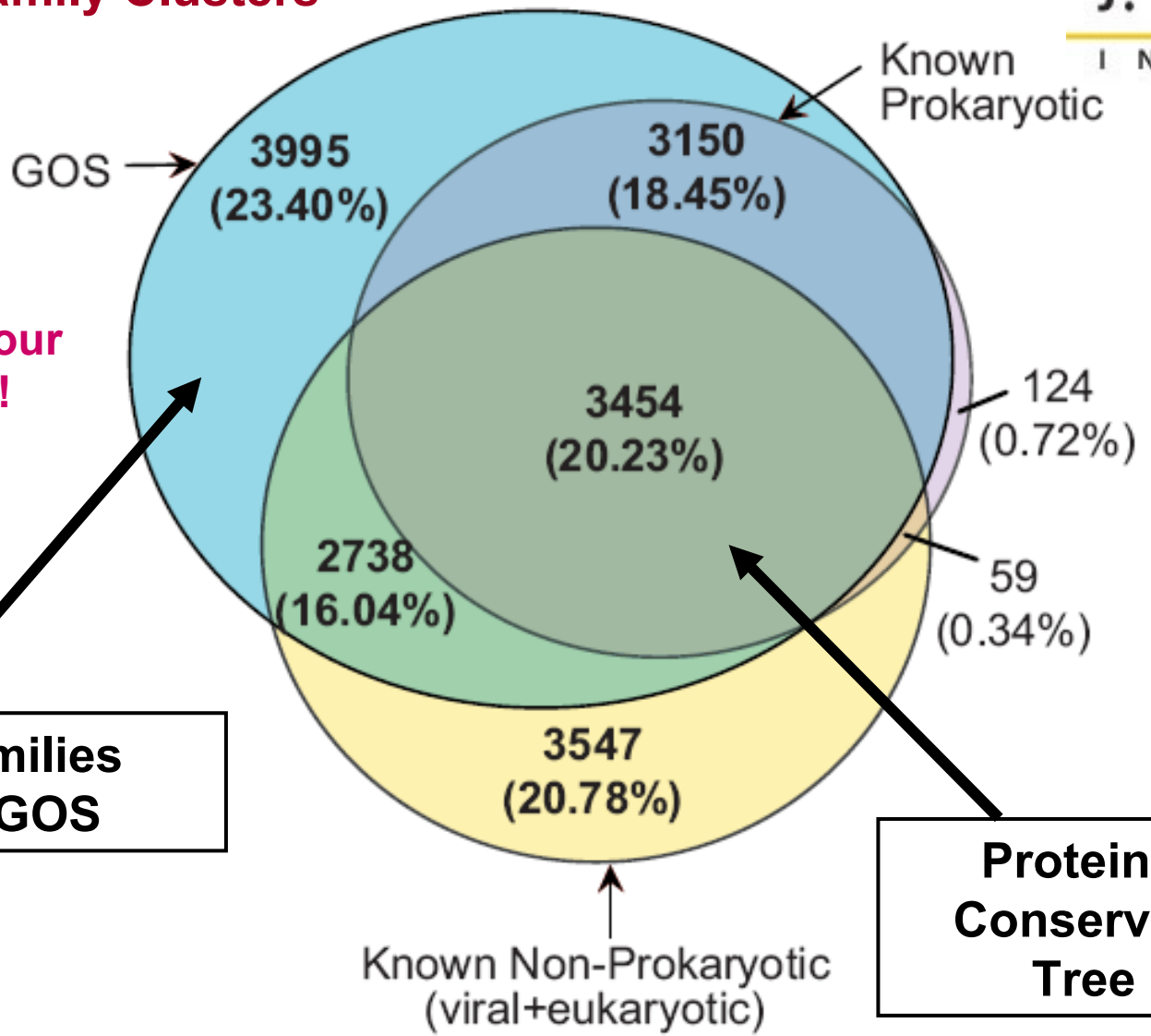
UCSD
UCIrvine

it²

Current Universe of Medium/ Large Protein Families

17,067 Protein Family Clusters

J. Craig Venter INSTITUTE



1 Million CPU-Hour Computation !

Protein Families Unique to GOS

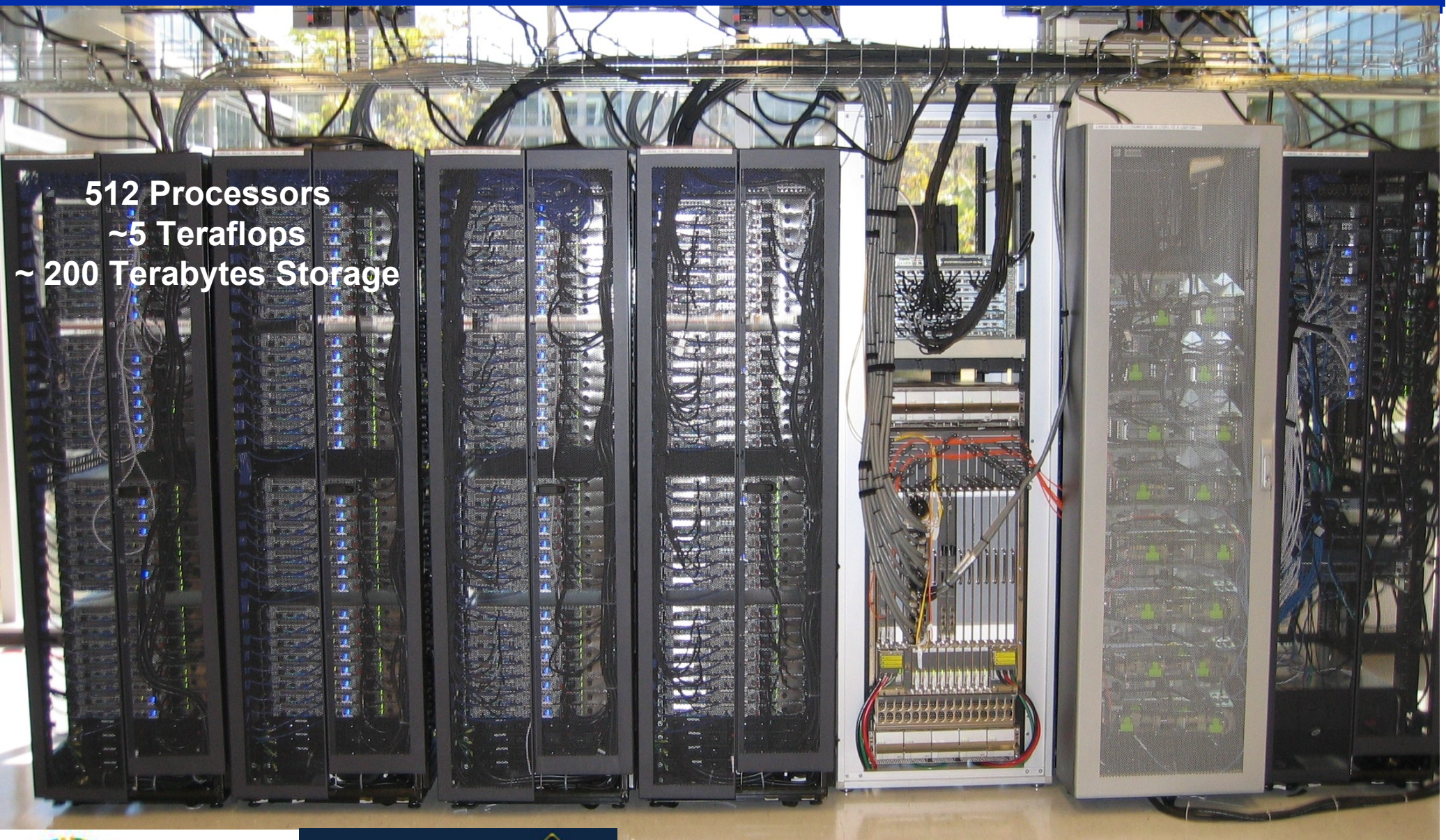
Protein Families Conserved Across Tree of Life

UCSD UCIrvine

Source: Shibu Yooseph, et al. (PLOS Biology March 2007)

it²

Calit2 CAMERA Production Compute and Storage Complex



camera
Marine Microbial Ecology

Powered by Rocks
ROCKS

it2

Calit2's Direct Access Core Architecture Will Create Next Generation Metagenomics Server

Gordon and Betty MOORE FOUNDATION

Sargasso Sea Data

Sorcerer II Expedition (GOS)

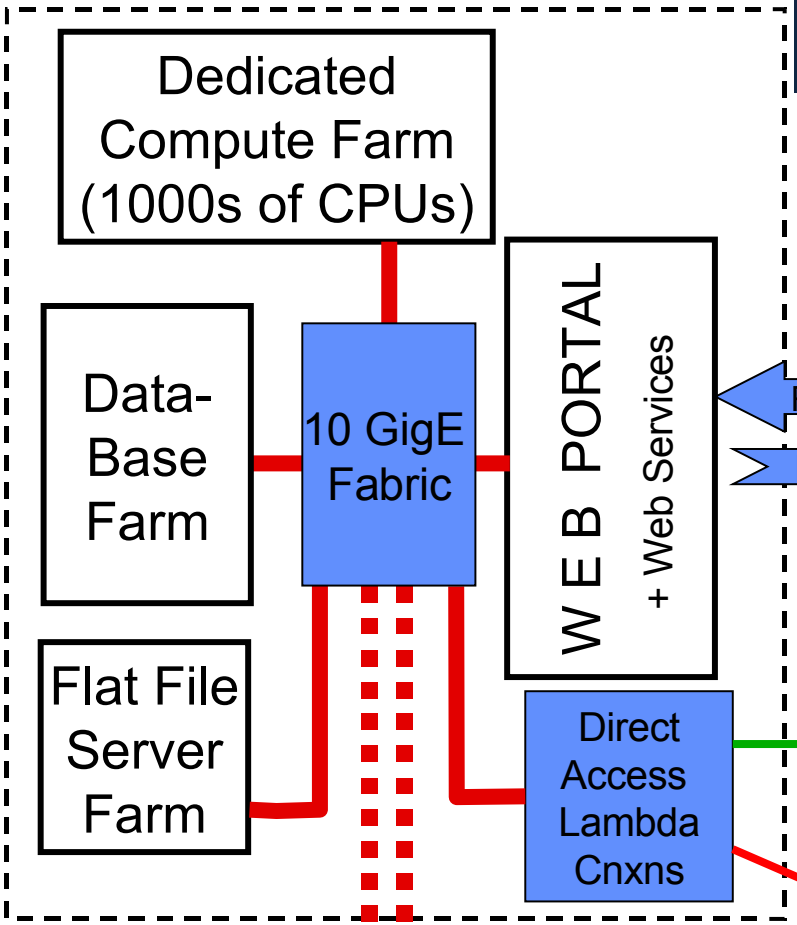
JGI Community Sequencing Project

Moore Marine Microbial Project

NASA and NOAA Satellite Data

Community Microbial Metagenomics Data

Powered by Rocks



Source: Phil Papadopoulos, SDSC, Calit2

CENTER FOR EARTH OBSERVATIONS & APPLICATIONS

SCRIPPS INSTITUTION OF OCEANOGRAPHY

SDSC SAN DIEGO SUPERCOMPUTER CENTER

UCSD UCIrvine

J. Craig Venter INSTITUTE

it2

“Instant” Global Microbial Metagenomics CyberCommunity

Over 1500 Registered Users From 50 Countries



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

camera
Marine Microbial Ecology

J. Craig Venter
INSTITUTE

it2

Interactive Exploration of Marine Genomes Using 100 Million Pixels

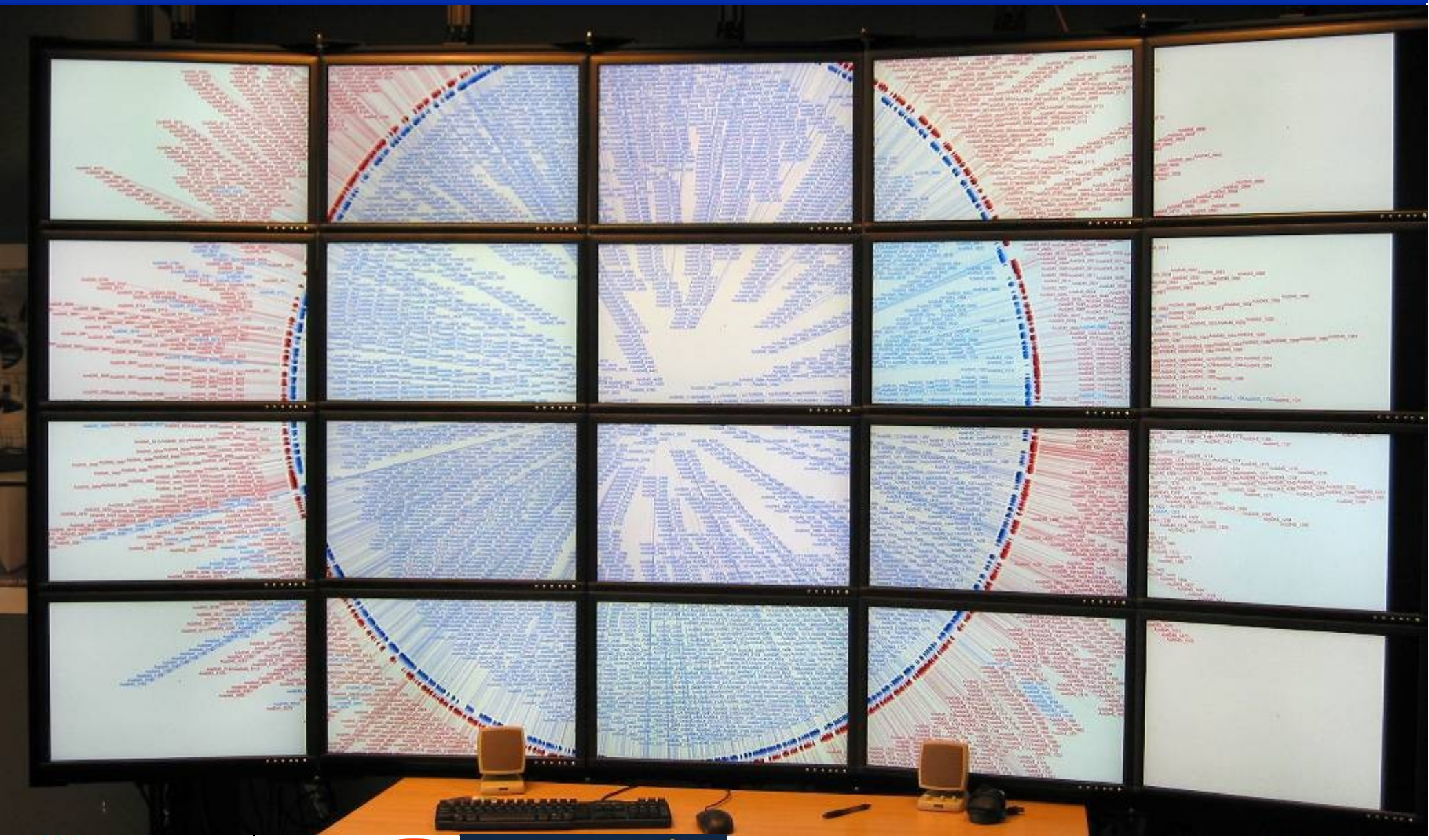


camera
Marine Microbial Ecology

Ginger Armburst (UW), Terry Gaasterland (UCSD SIO)

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
Source: Raj Singh, UCSD

it2

Use of Tiled Display Wall OptIPortal to Interactively View Microbial Genome



camera Marine Microbial Ecology

OptIPuter

Powered by Rocks ROCKS

Source: Raj Singh, UCSD

it2

Use of Tiled Display Wall OptIPortal to Interactively View Microbial Genome



camera Marine Microbial Ecology

OptIPuter

Powered by Rocks ROCKS

Source: Raj Singh, UCSD

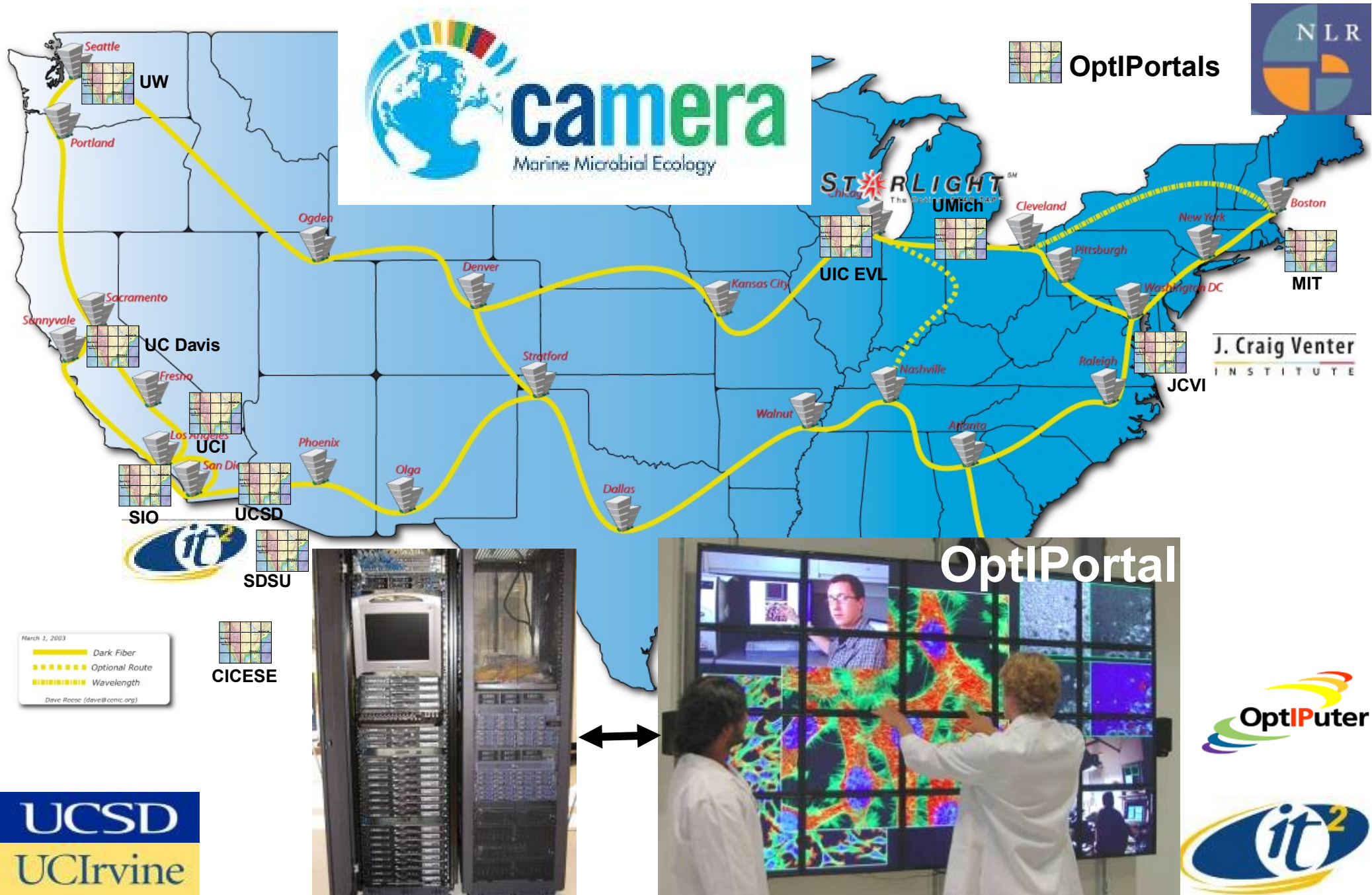
it2

CAMERA is Partnering to Port Metagenomic Community Software to the OptIPortal



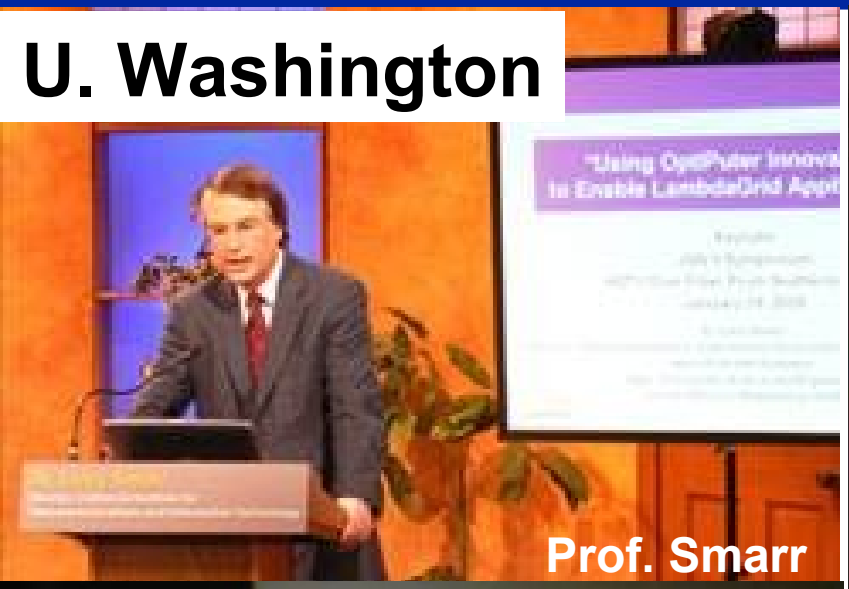
Collaboration Between Microbial Genomics Group, Max Planck Institute for Marine Microbiology in Bremen, Germany and CAMERA / Rocks Group

An Emerging High Performance Collaboratory for Microbial Metagenomics



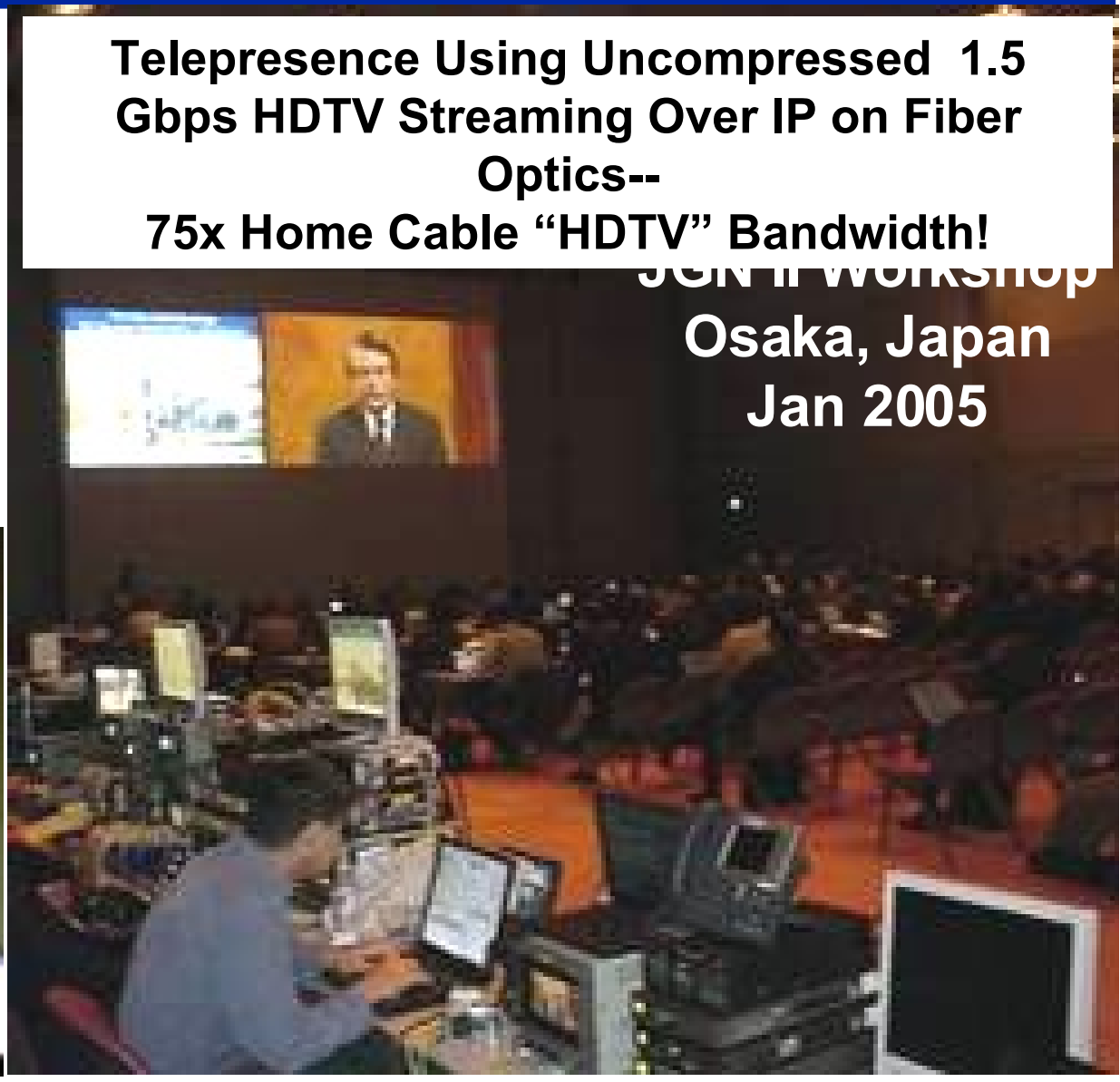
Multiple Gigabit HD Streams Over Lambdas Will Radically Transform Global Collaboration

U. Washington





Telepresence Using Uncompressed 1.5 Gbps HDTV Streaming Over IP on Fiber Optics--
75x Home Cable "HDTV" Bandwidth!



UCSD
UCIrvine

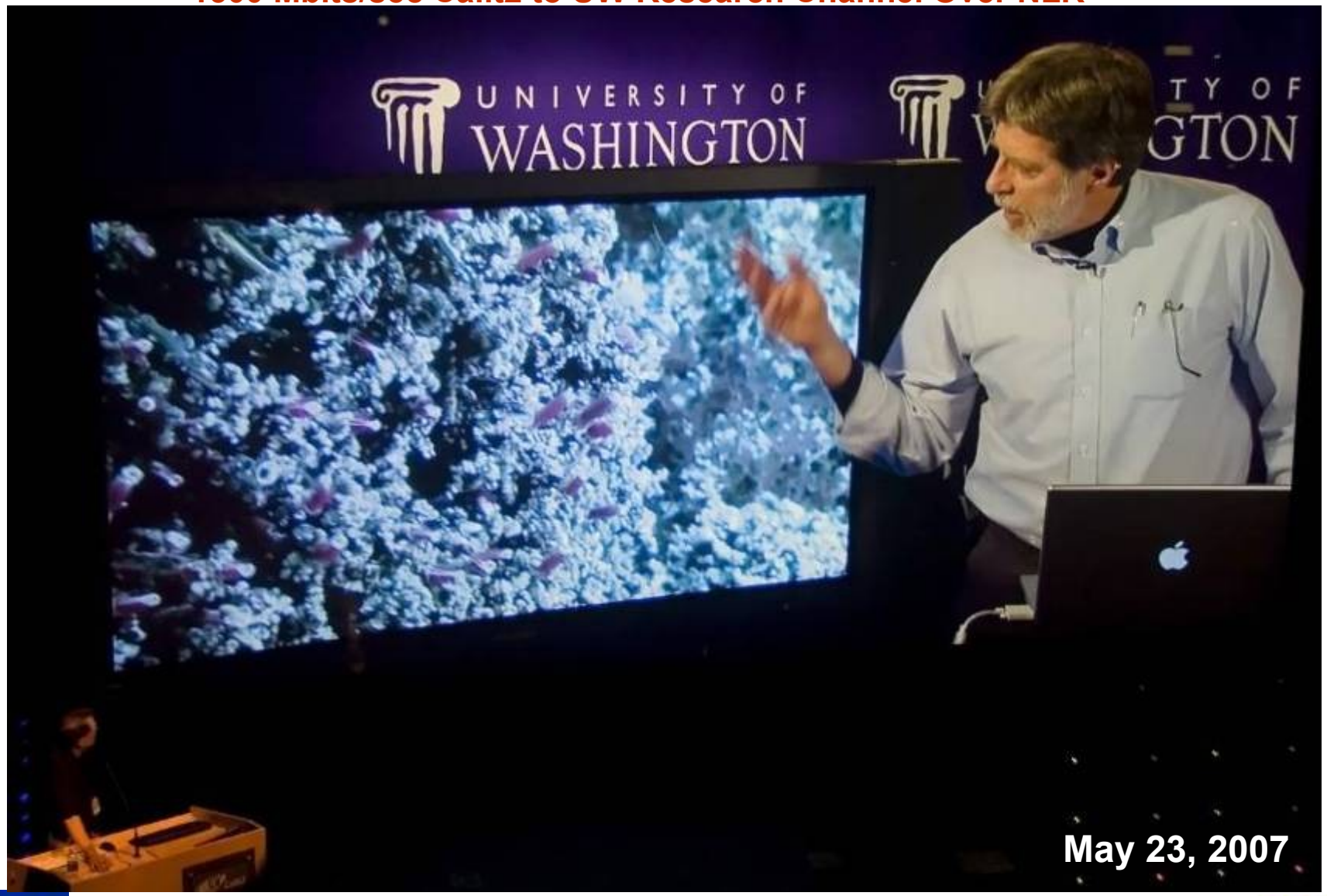
"I can see every hair on your head!"—Prof. Aoyama

Source: U Washington Research Channel

it²

e-Science Collaboratory Without Walls Enabled by Uncompressed HD Telepresence

1500 Mbits/sec Calit2 to UW Research Channel Over NLR

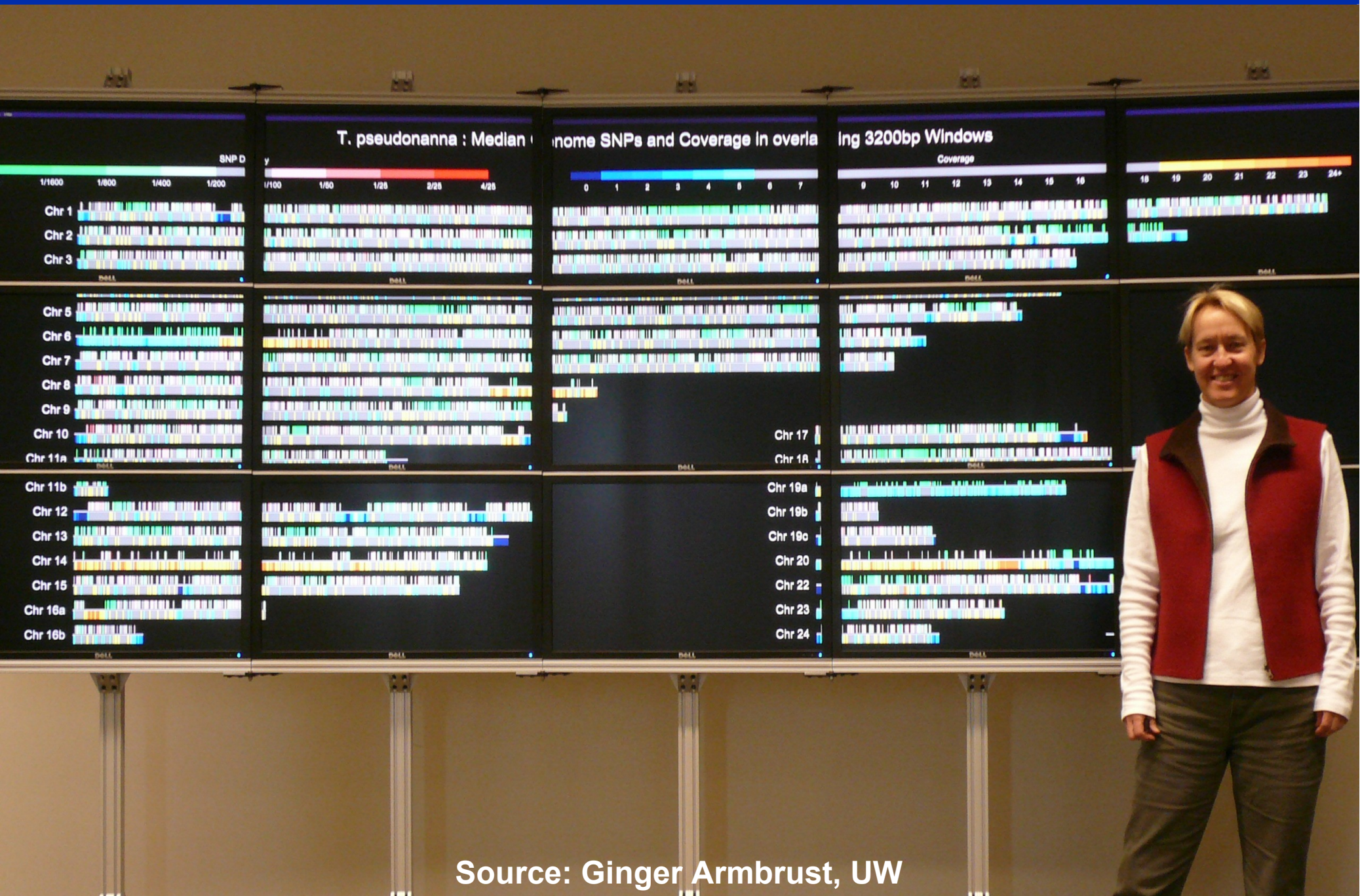


John Delaney, PI LOOKING, Neptune

Photo: Harry Ammons, SDSC

UCSD
UCIrvine

New Genome Wall at UWashington
Chromosomes of Marine Diatom Thallasiosira Pseudonanna



Source: Ginger Armbrust, UW

Goal for SC'07
iHDTV Integrated into OptIPortal

SC07 is the International Conference for High Performance Computing, Networking, Storage and Analysis

Moving from Compressed HD to Uncompressed iHDTV Reno to UW in Seattle



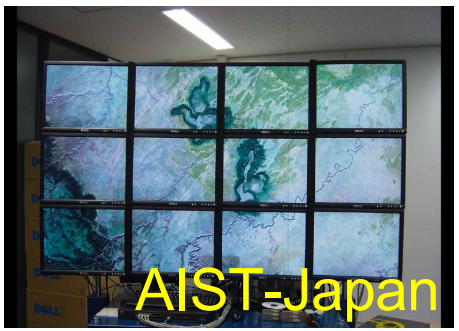


Source: Michael Wellings
Research Channel
Univ. Washington

UCSD
UCIrvine

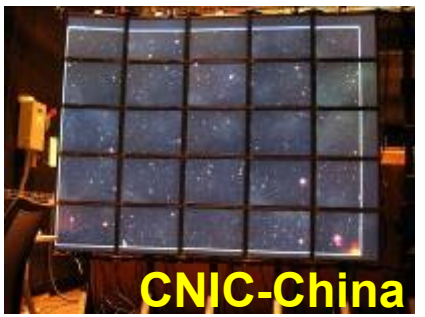
it²

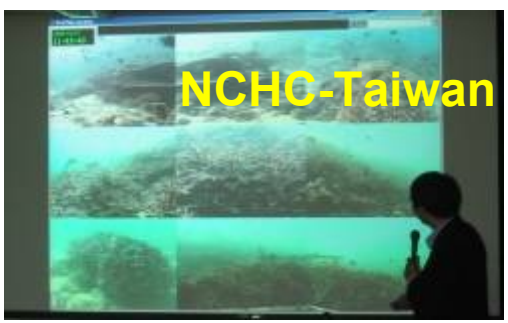
Rocks / SAGE OptIPortals Are Being Adopted Globally





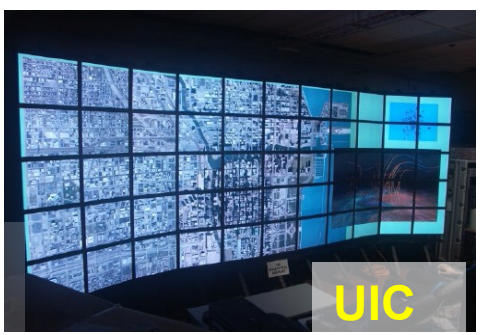








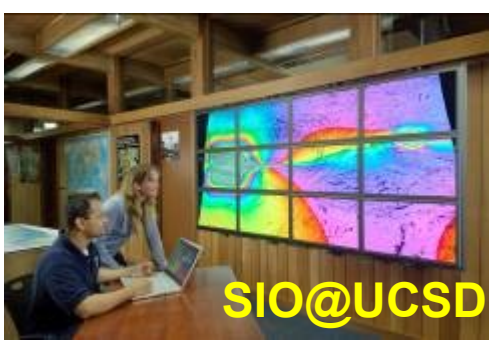












UCSD
UCIrvine

Powered by Rocks ROCKS

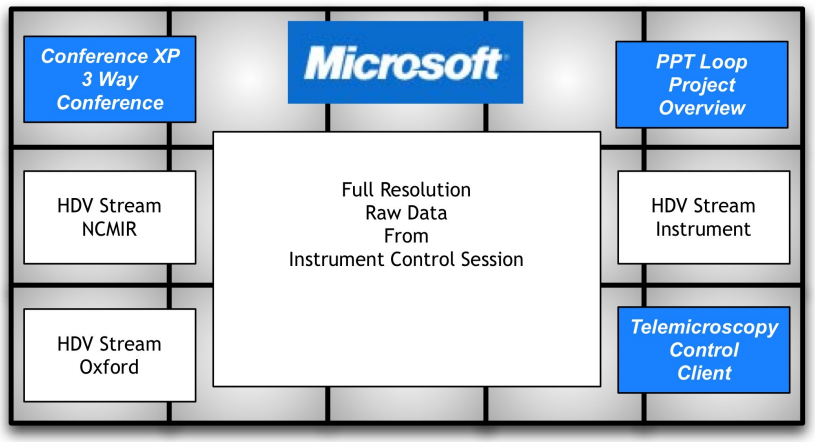
evl electronic visualization laboratory

it2

Intercontinental Telemicroscopy over Lambda Network

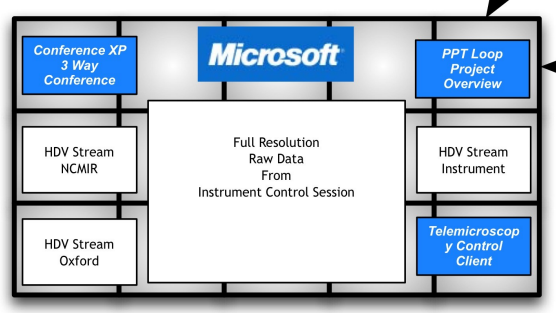
- Remote Control of High End Instrumentation
- Ultra-high Resolution Tiled Displays
- HPC Parallel Computing
- Multi-cast HDTV Streaming

Featuring:
Winccs, .NET, MS-SAGE

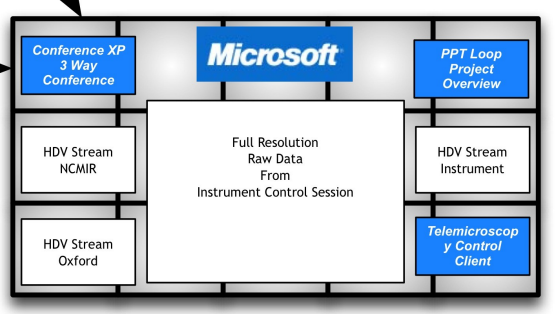


SC2007 - Telemicroscopy Experiment Control Center

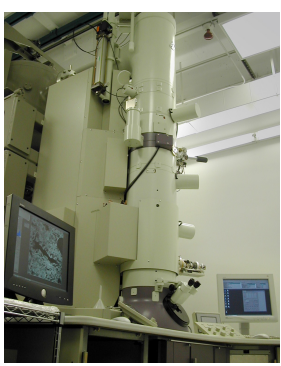




NCMIR - Telemicroscopy Experiment Control Center



Oxford - Telemicroscopy Experiment Control Center



UCSD
UCIrvine

NCMIR

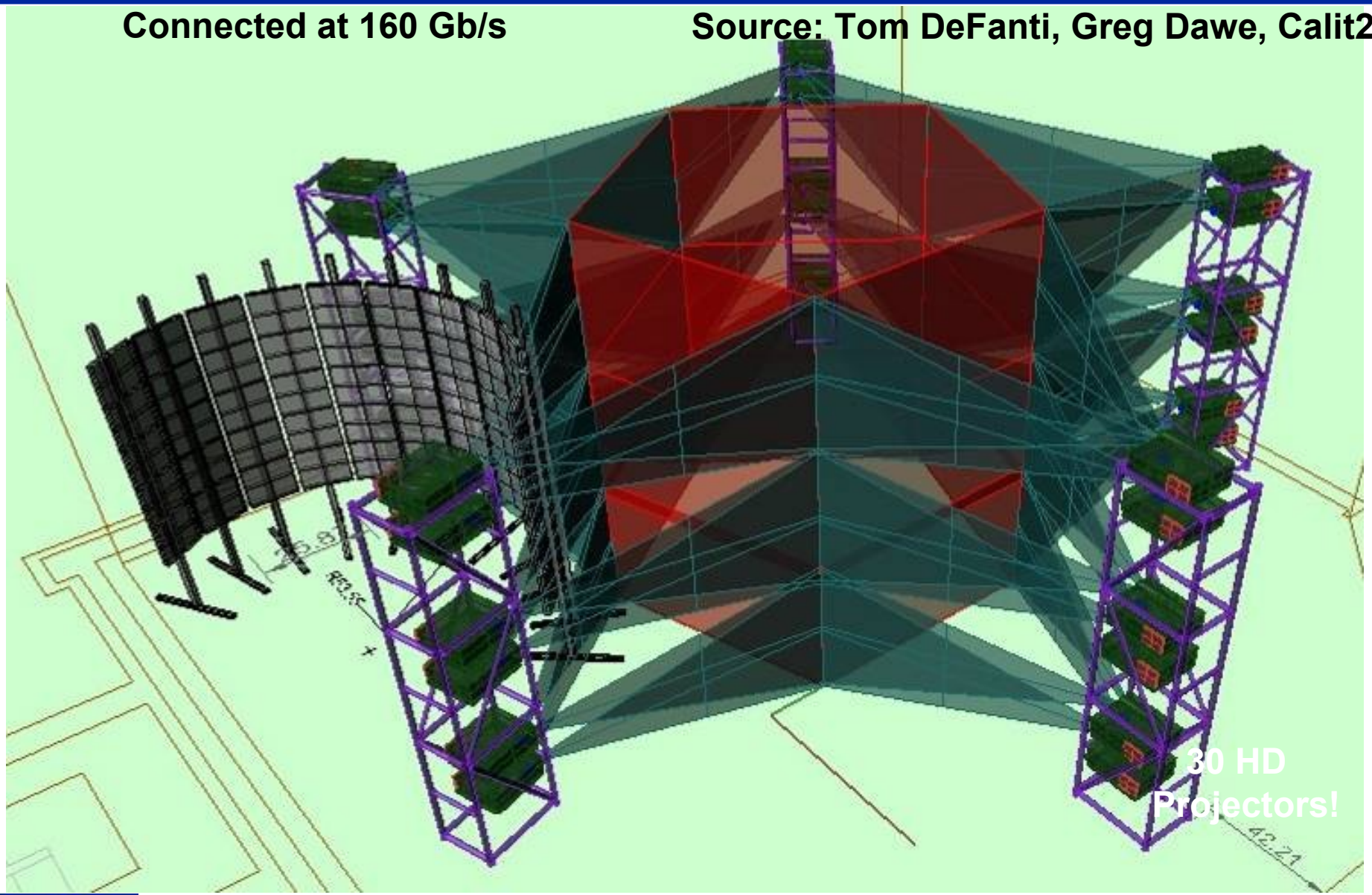
oerc
Oxford e-Research Centre

it2

3D OptIPortals: Calit2 StarCAVE and Varrier Alpha Tests of Telepresence "Holodecks"

Connected at 160 Gb/s

Source: Tom DeFanti, Greg Dawe, Calit2



UCSD
UCIrvine

60 GB Texture Memory,
Renders Images 3,200 Times the Speed of Single PC

StarCAVE Panoramas

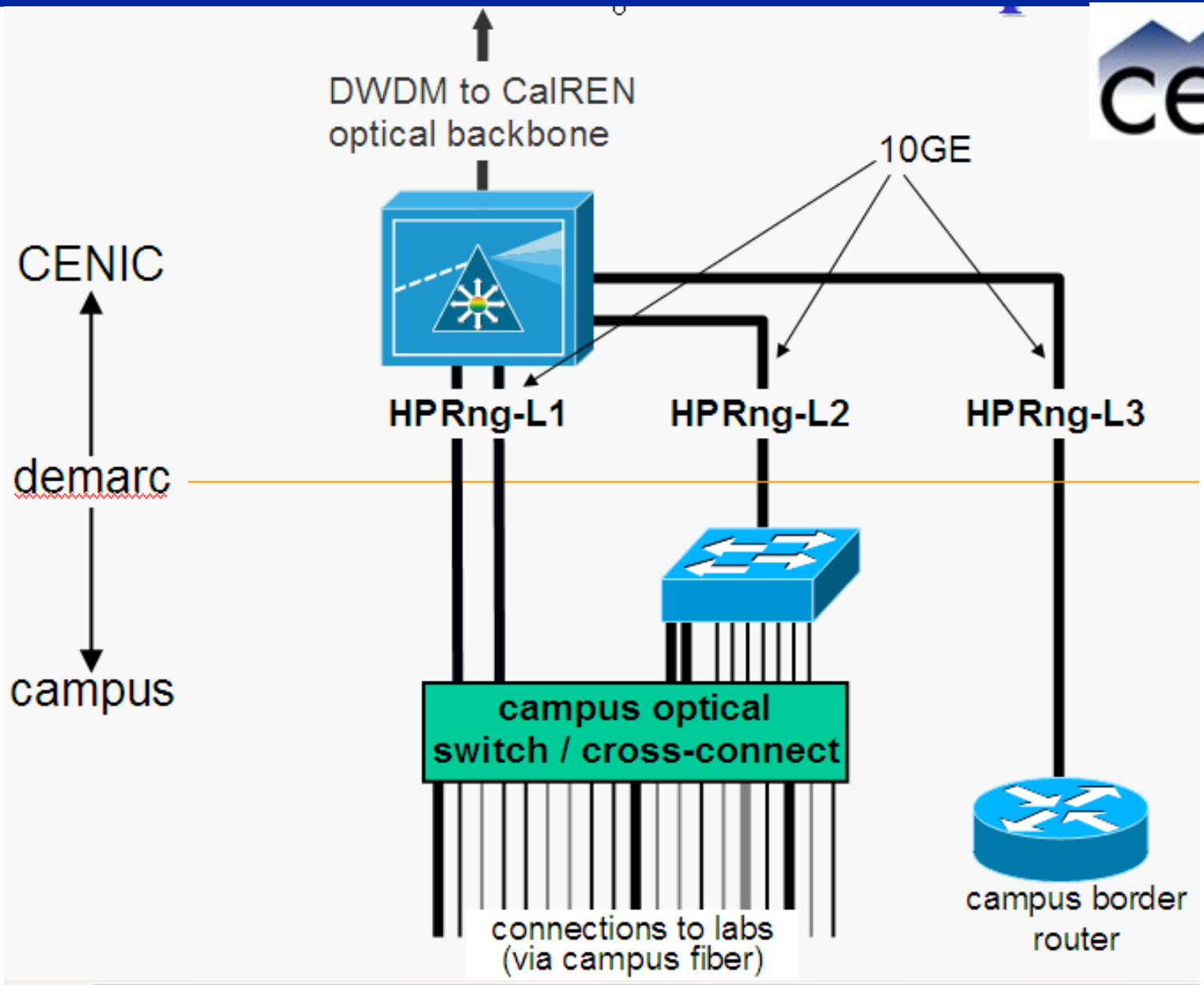






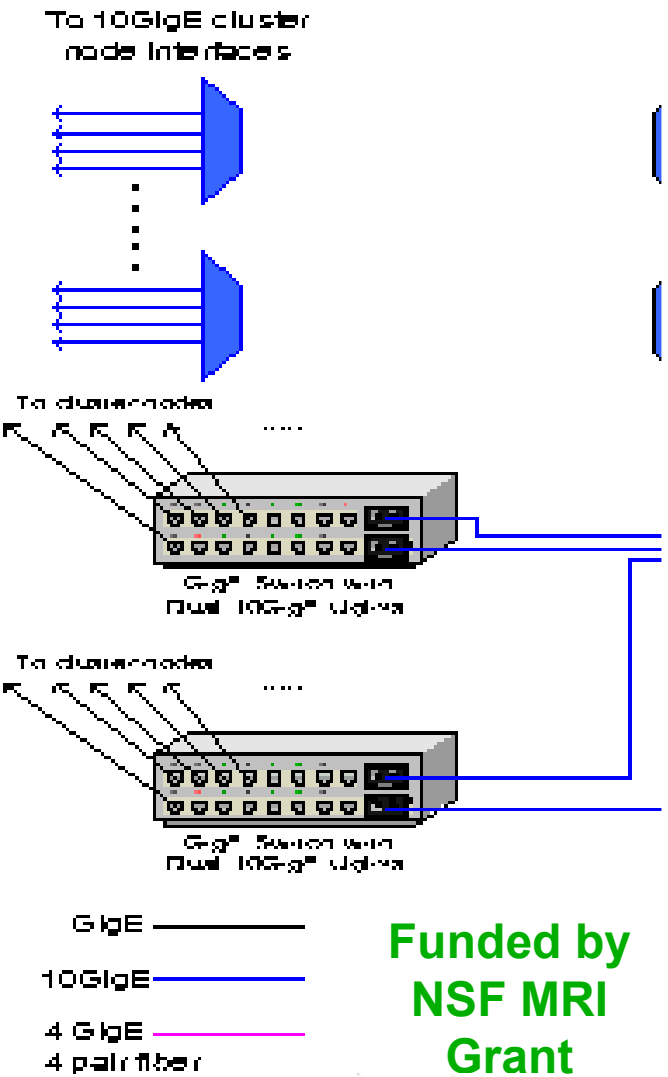


Campus Preparations Needed to Create Lambda "On-Ramps" to Their Campus Researchers



Source: Jim Dolgonas, CENIC

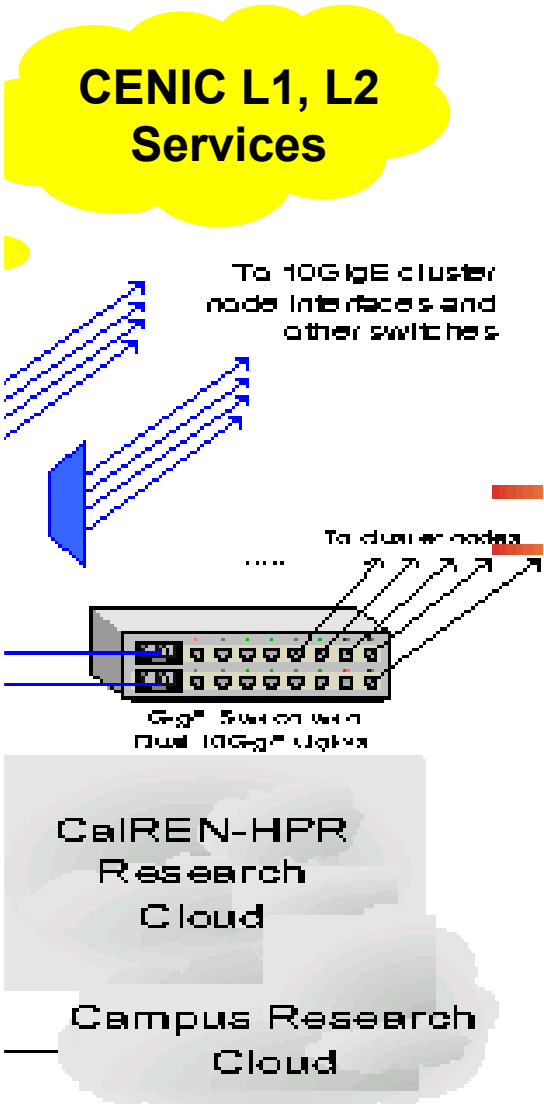
Current UCSD Experimental Optical Core: Ready to Couple to CENIC L1, L2, L3 Services



Goals by 2008:

- >= 50 endpoints at 10 GigE
- >= 32 Packet switched
- >= 32 Switched wavelengths
- >= 300 Connected endpoints

Approximately 0.5 TBit/s Arrive at the "Optical" Center of Campus Switching will be a Hybrid Combination of: Packet, Lambda, Circuit -- OOO and Packet Switches Already in Place

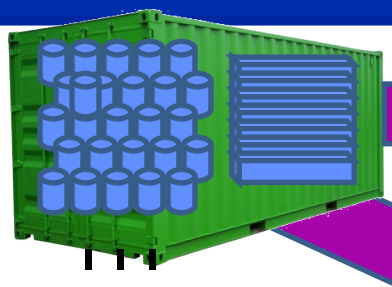


Funded by NSF MRI Grant

OptIPuter Border Router

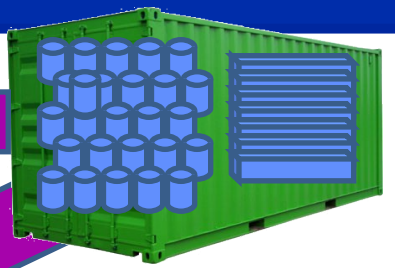
Source: Phil Papadopoulos, SDSC/Calit2 (Quartzite PI, OptIPuter co-PI)

Planned UCSD Production Campus Cyberinfrastructure Supporting Data Intensive Biomedical Research



Active Data Replication

N x 10 Gbit



N x 10 Gbit

N x 10 Gbit



10 Gigabit L2/L3 Switch

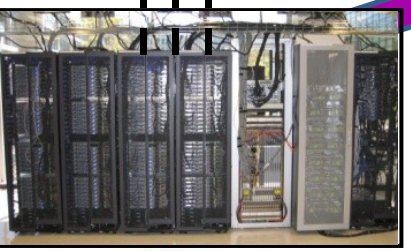
Eco-Friendly Storage and Compute

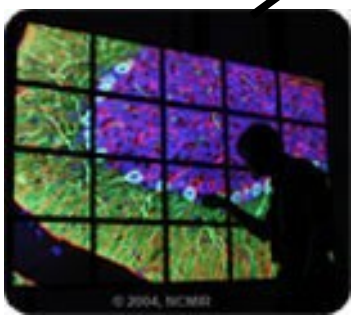
"Network in a box"
- > 200 Connections
- DWDM or Gray Optics

On-Demand Physical Connections

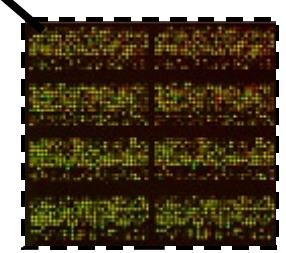
Wide-Area 10G
- CENIC/HPRng
- NLR Cavewave
- I2 NewNet
- Cinegrid
- …

Single 10 Gbit









Microarray

Your Lab Here

camera
Marine Microbial Ecology

NCMIR
NATIONAL CENTER for MICROSCOPY and IMAGING RESEARCH

NBCR

UCSD
UCIrvine

Source: Phil Papadopoulos, SDSC/Calit2; Elazar Harel, UCSD

it2

Calit2/SDSC Proposal to Create a UC Cyberinfrastructure of OptIPuter "On-Ramps" to TeraGrid Resources



OptIPuter + CalREN-XD + TeraGrid = "OptiGrid"



Creating a Critical Mass of End Users on a Secure LambdaGrid

UCSD
UCIrvine

Source: Fran Berman, SDSC , Larry Smarr, Calit2