A PRAGMA-OptIPlanet Collaboratory Partnership

Keynote

Pacific Rim Applications and Grid Middleware Assembly (PRAGMA) 14

Taichung, Taiwan

March 11, 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

UCSD

UCIrvine

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Abstract

The NSF-funded OptIPuter project has explored how new applications can be enabled by persistent 1-10 gigabit/s optical paths (lambdas) connecting people and devices on local, regional, national, and global scales. The appropriate termination devices are large scale visualization walls, termed "OptIPortals," containing tens to hundreds of millions of pixels, which create large "pixel real estate" for remote collaboration and multi-data type visualization and analysis. In 2008, many national and international sites will link up their OptIPortals over lambdas, with high definition video streams, creating a global-scale OptIPlanet Collaboratory. A number of PRAGMA sites will be early members of the collaboratory. Early applications include microbial metagenomics, coral reef observation, planetary sciences, hurricane prediction, and digital cinema. Middleware challenges for PRAGMA include generalizing cloud computing, virtualization, service oriented architectures, and "Green' cyberinfrastructure from the Gird to the LambdaGrid. This emerging partnership can rapidly advance global cooperation on critical problems facing our planet.

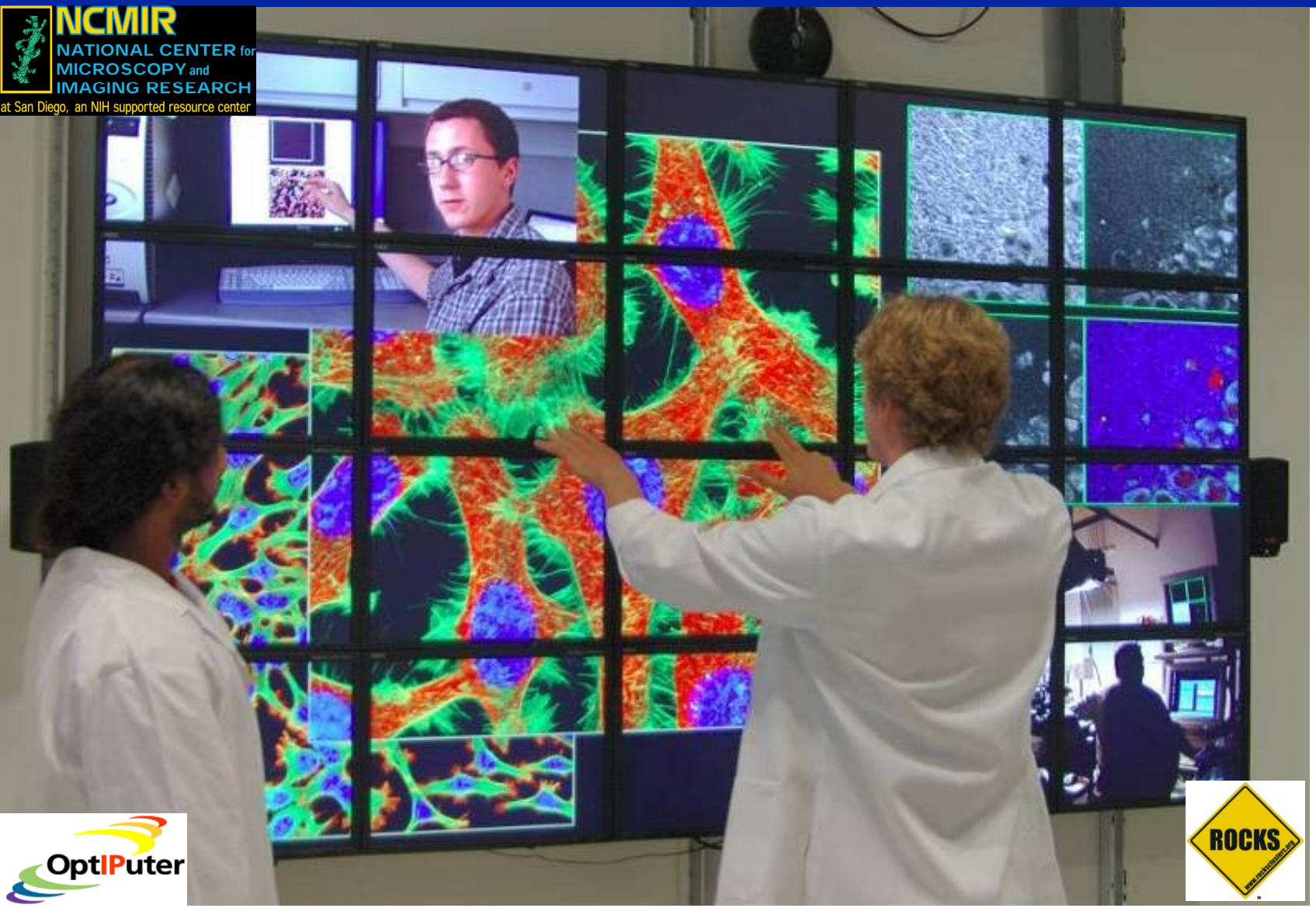
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PRAGMA Can Drive Creation of a Lambda-Integrated Planetary-Scale System

- Rapid Prototyping Driven By Multi-Country Science Teams
- Research Centers Joining GLIF and National LambdaRails
- Co-Developing LambdaGrid/Web Services Middleware
- Lambda Innovations in Distributed Storage
- Use of Scalable Displays, Virtual Reality, and Telepresence
- Opportunities for Joint Cal-(IT)^2/PRAGMA Collaboration
  - Cal-(IT)^2@UCSD Will Provide PRAGMA Space in New Building
  - Joining into US Funded Research Grants
  - iGRID 2005 Hosted by Cal-(IT)^2@UCSD, September 2005

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

Now in Sixth and Final Year

Picture Source: Mark Ellisman, David Lee, Jason Leigh

OptIPuter

ROCKS

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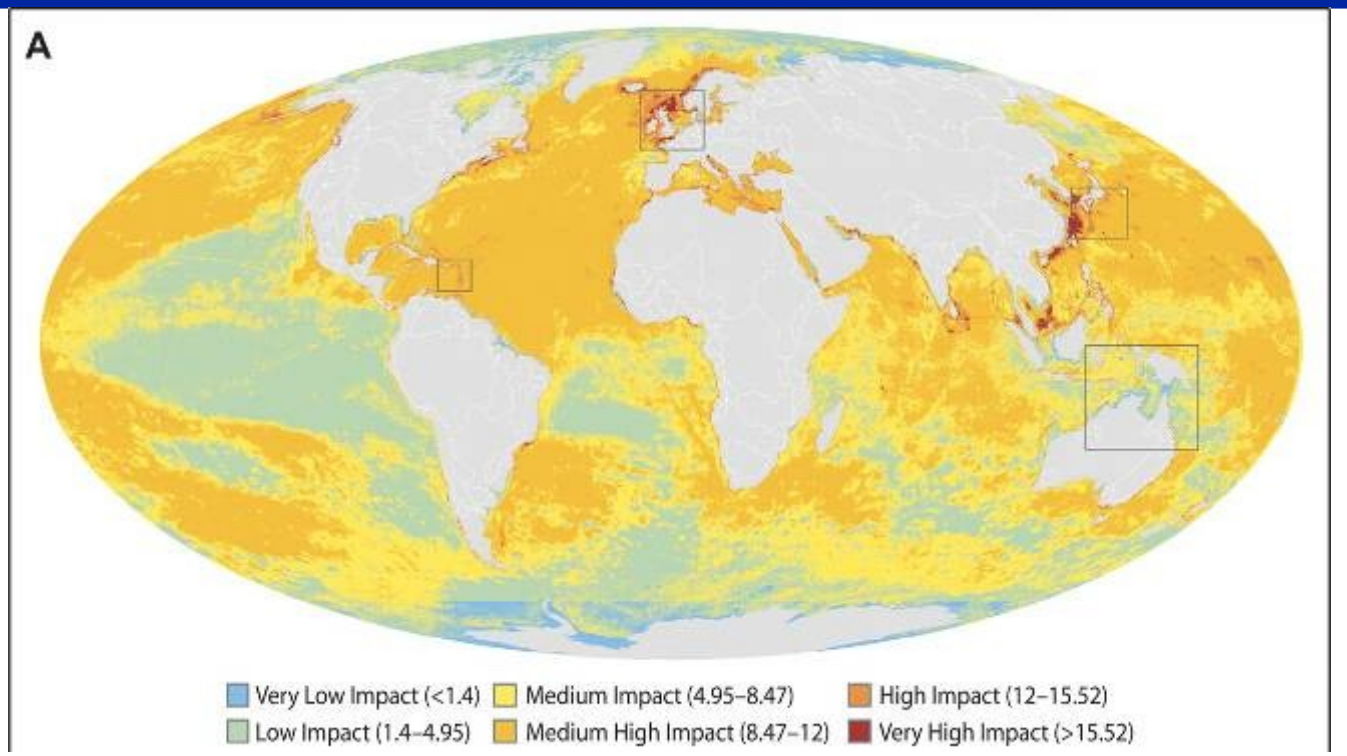
Calit2 (UCSD, UCI) and UIC Lead Campuses—Larry Smarr PI
Univ. Partners: SDSC, USC, SDSU, NW, TA&M, UvA, SARA, KISTI, AIST
Industry: IBM, Sun, Telcordia, Chiaro, Calient, Glimmerglass, Lucent

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International Threats to Coral Reefs and Ocean Biology -- Urgent Need for Extensive Sensornets



Science December 14, 2007



A Global Map of Human Impact on Marine Ecosystems
Science February 15, 2008

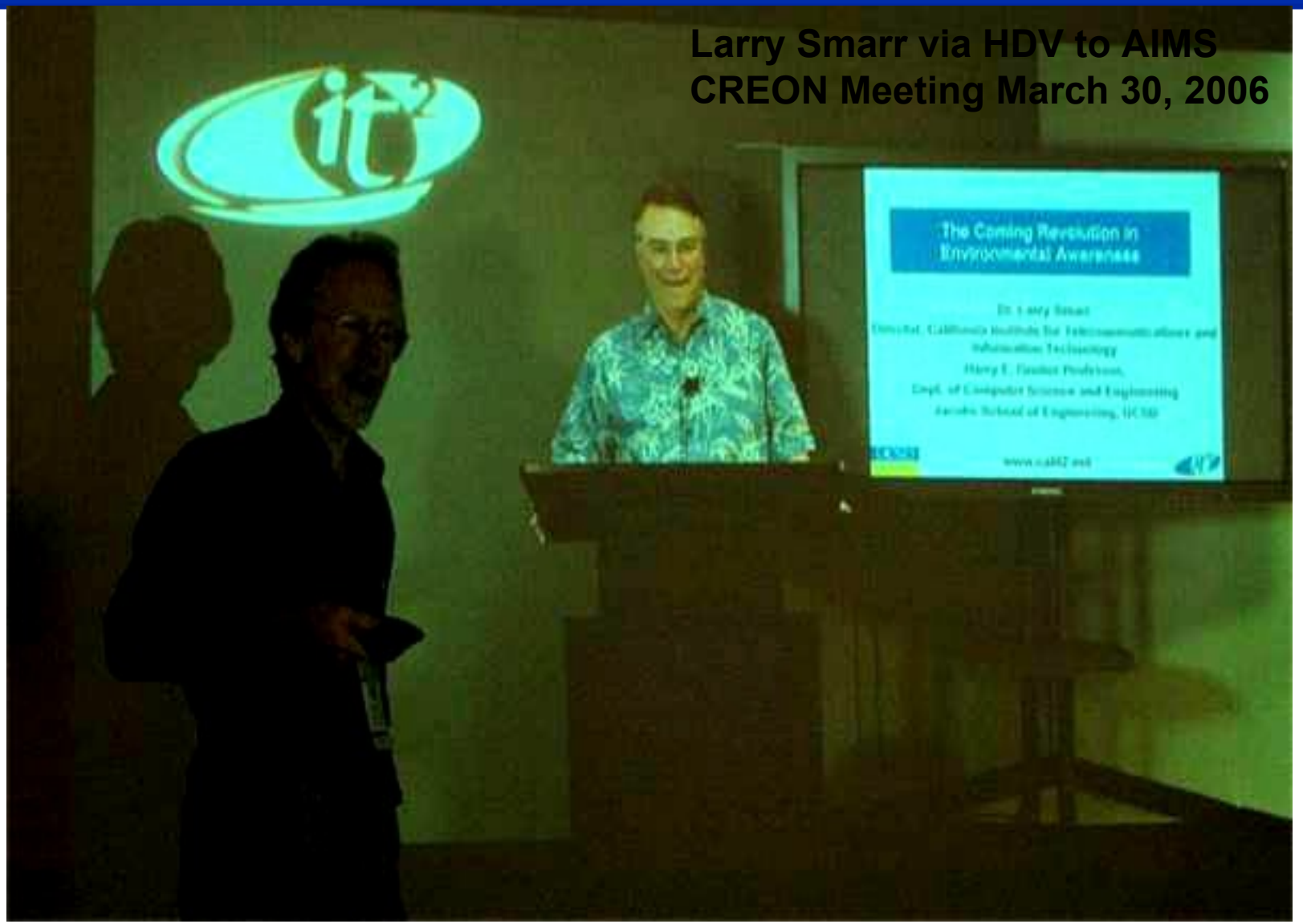


Science May 14, 2007

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PRAGMA/CREON Environmental Observatories Are Driving OptIPlanet Collaborations



Network Upgrade to 1 Gbps a Few Days Prior

Source: Bernard Pailthorpe, U Queensland

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CREON

Moorea Coral Reef LTER Site
Current Bandwidth ~ 10^5bps, But Fiber Optic Cable by 2010

- **LTER Established Sept. 2004**
  - **PIs: Russ Schmitt, Sally Holbrook, Pete Edmunds, Bob Carpenter**
    Deputy Director: Andy Brooks
- **20 Investigators**
  - **UC Santa Barbara**
  - **CSU Northridge**
  - **UC San Diego / Scripps**
  - **UC Santa Cruz**
  - **UC Davis / Bodega Marine Lab**
  - **University of Hawaii**
- **Field Operations Based from UC Berkeley Gump Research Station**







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Moorea's Coral Reef Houses a Vast Diversity of Fish, Invertebrates, and Corals









Photos: L Smarr, August 2007



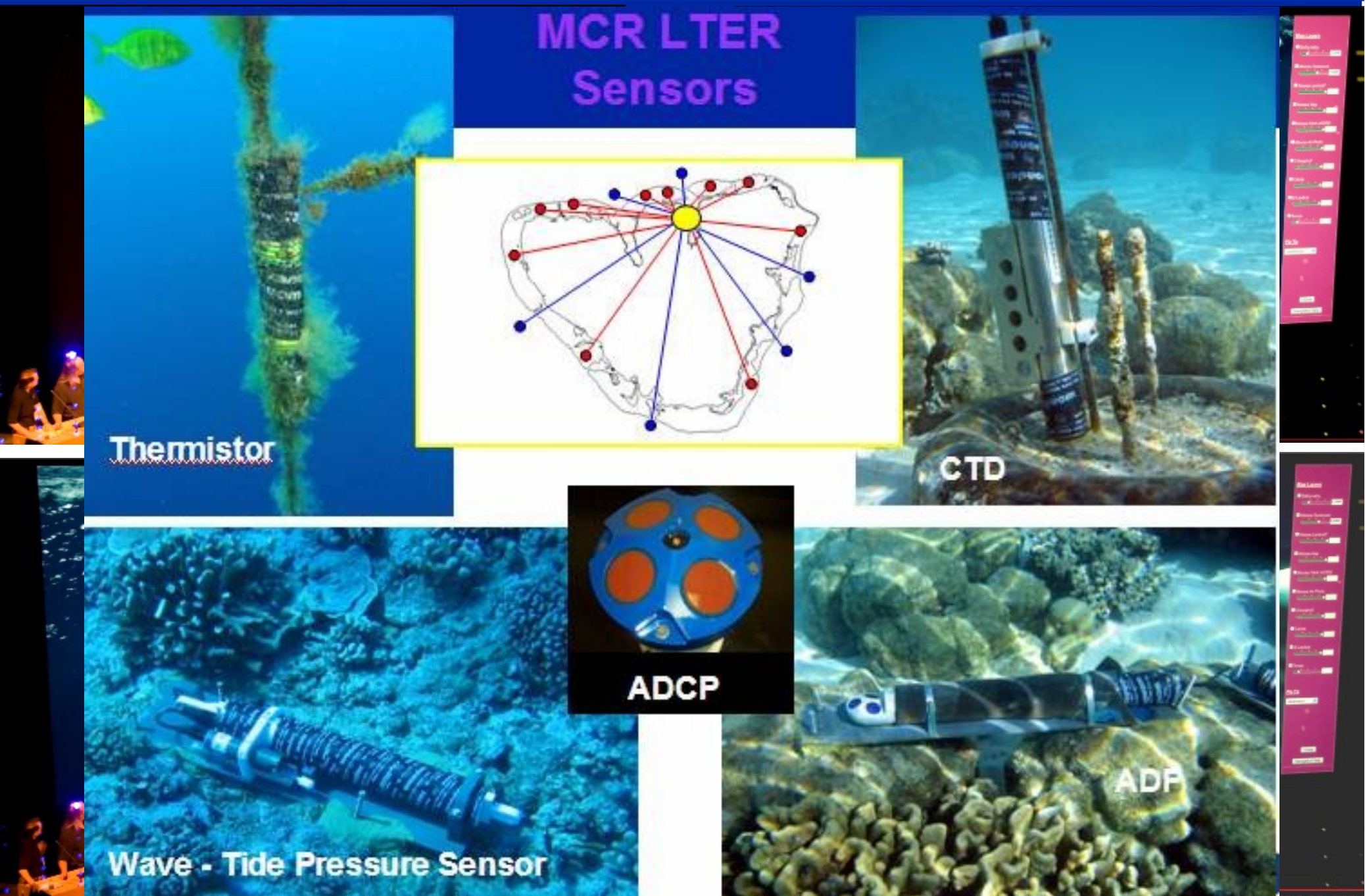


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Creating a Digital Moorea
Calit2 Collaboration at UC Gump Station (UCB, UCSB)



Taiwan's Kenting's Underwater Observatory

- **Deployed off Southern Taiwan 2004**
  - **Features 10 Underwater Cameras**
    - **Setup To Monitor Different Habitats on The Coral Reef**
  - **Currently Used by Academia Sinica and NMMBA in Taiwan**
- **On-Shore Video Servers are Used to Convert Analog Signals to Digital MJPEG Video Streams**
  - **Remote Observatory, Low Bandwidth (~10^6bps)**
  - **Video Resolution: 320x240 Pixels**
  - **Effective Transfer Rate: 2-3 Fps**

OPEN SOURCE DATA TURBINE INITIATIVE
Empowering the Scientific Community with Streaming Data Middleware



CREON



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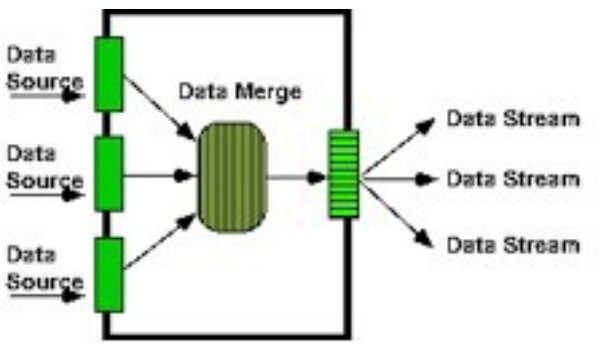
Source: Ebbe Strandell, NCHC

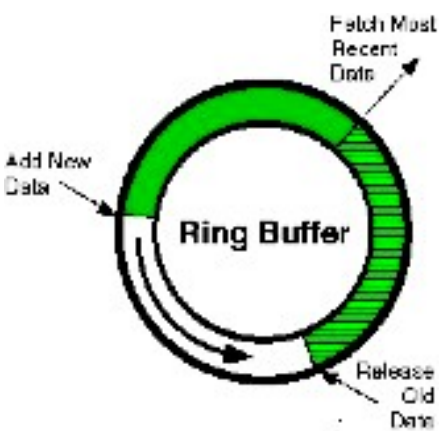
Open Source DataTurbine Initiative
www.dataturbine.org

RBNB
Data Turbine



- **In-Network Buffered Data Management and Archiving for Streaming Data**
  - **Scalable Support for In-Network Intelligent Routing, Data Processing, Filtering, and Topology Management**
  - **Robust Bridge Environment Between Diverse Data Sources and Distributed Data Destinations**
  - **Optimized for High-speed Streaming Data**
- **All-Software Solution (Java)**
  - **OPEN SOURCE SOFTWARE - Apache 2.0 License**
- **Used In NSF, NASA, NOAA, DOE Projects**
  - **Developed by Creare Inc., (www.creare.com)**
  - **NSF support from SDCI program (Sept 07)**





Source: Tony Fountain, Sameer Tilak

OPEN SOURCE DATA TURBINE INITIATIVE
Empowering the Scientific Community with Streaming Data Middleware

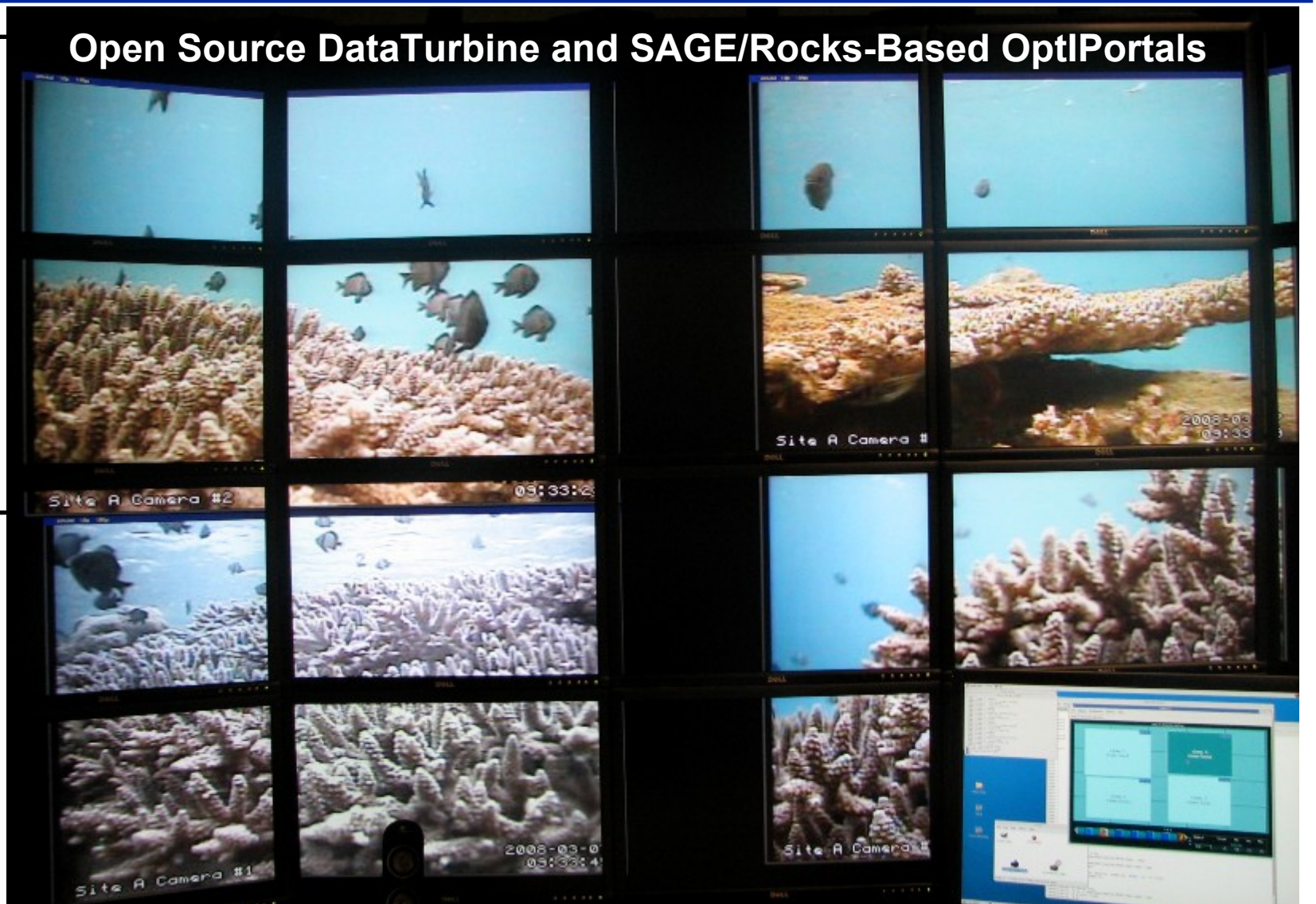
UCSD UCIrvine · Gordon and Betty MOORE FOUNDATION · CREON · GLEON global lake ecological observatory network · PRAGMA · it²

New Year's Challenge: Streaming Underwater Video From Taiwan's Kenting Reef to Calit2's OptIPortal

My next plan is to stream stable and quality underwater images to Calit2, hopefully by PRAGMA 14. -- Fang-Pang to LS Jan. 1, 2008

CREON

March 6, 2008 Plan Accomplished!



ROCKS

OptIPuter

OPEN SOURCE DATA TURBINE INITIATIVE

Empowering the Scientific Community with Streaming Data Middleware

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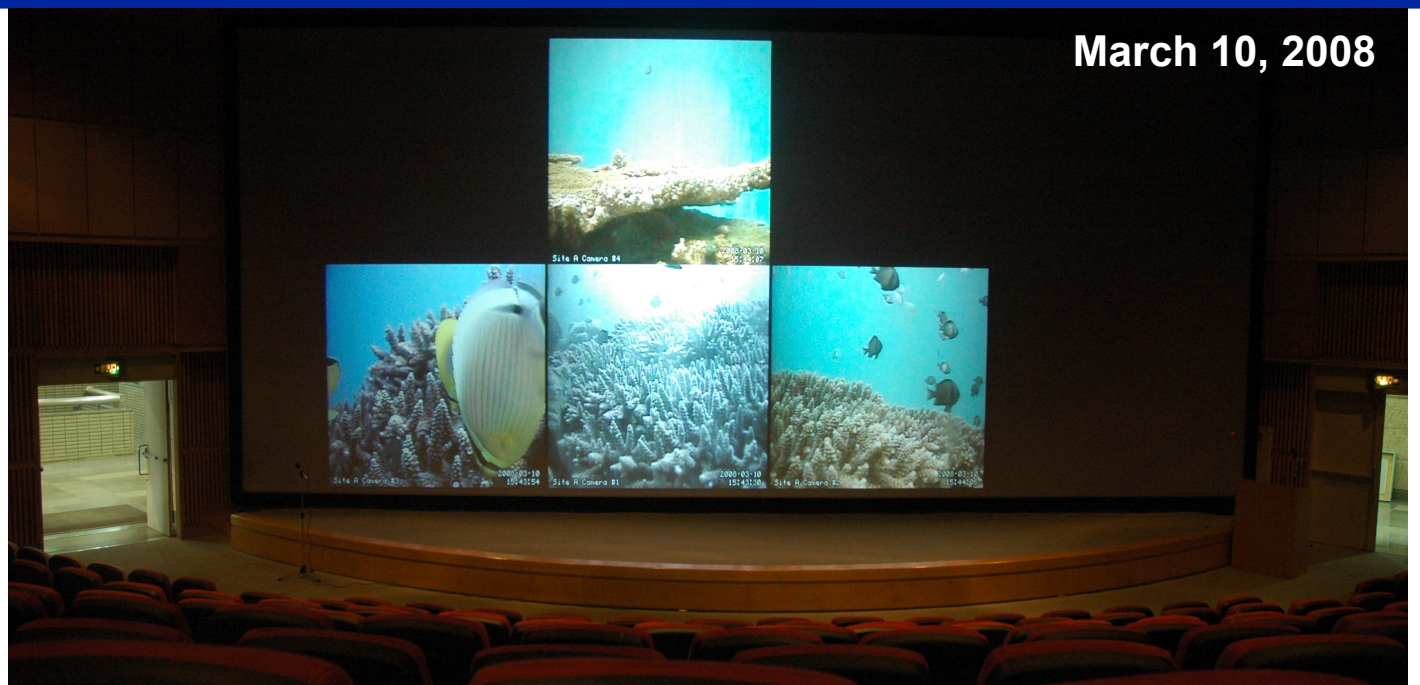
UCIrvine

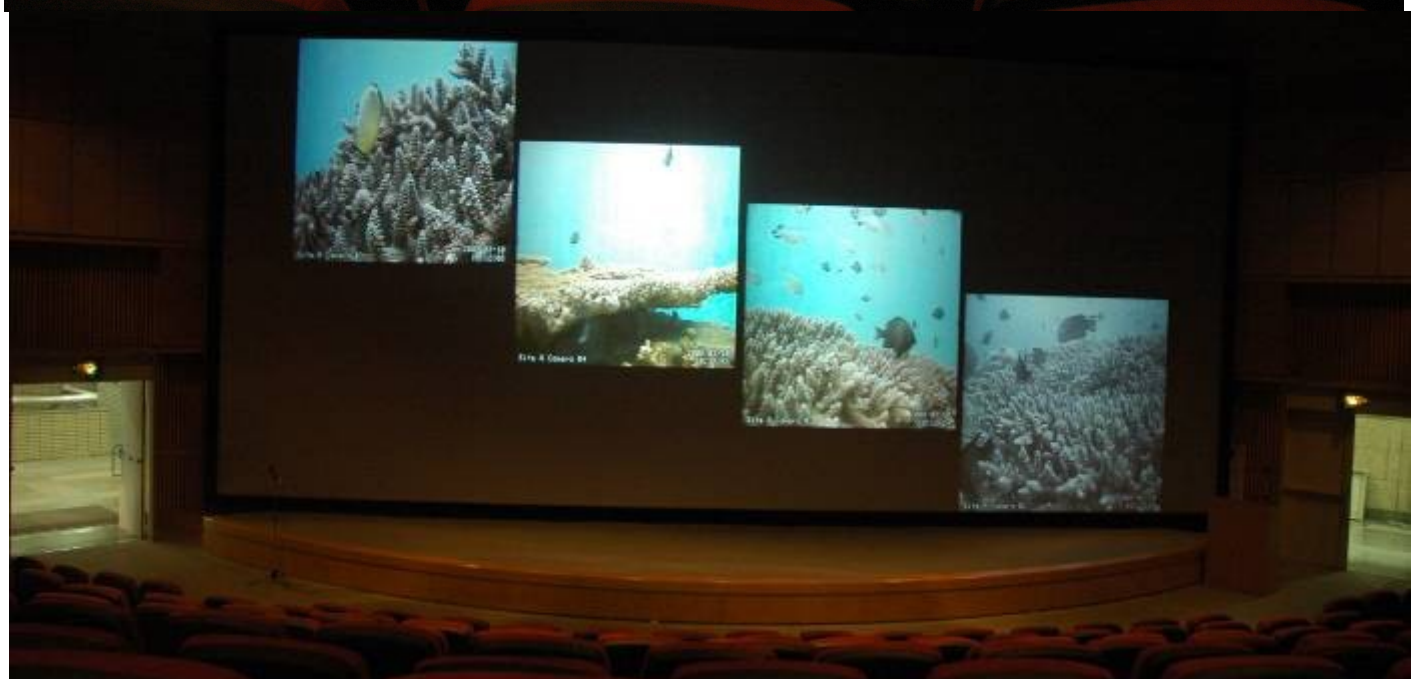
UCSD: Rajvikram Singh, Sameer Tilak, Jurgen Schulze, Tony Fountain, Peter Arzberger
NCHC : Ebbe Strandell, Sun-In Lin, Yao-Tsung Wang, Fang-Pang Lin

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Using SAGE to Control Kenting Coral Reef Video Streams Within Taichung 4k Projection

CREON





Source: Ebbe Strandell, NCHC

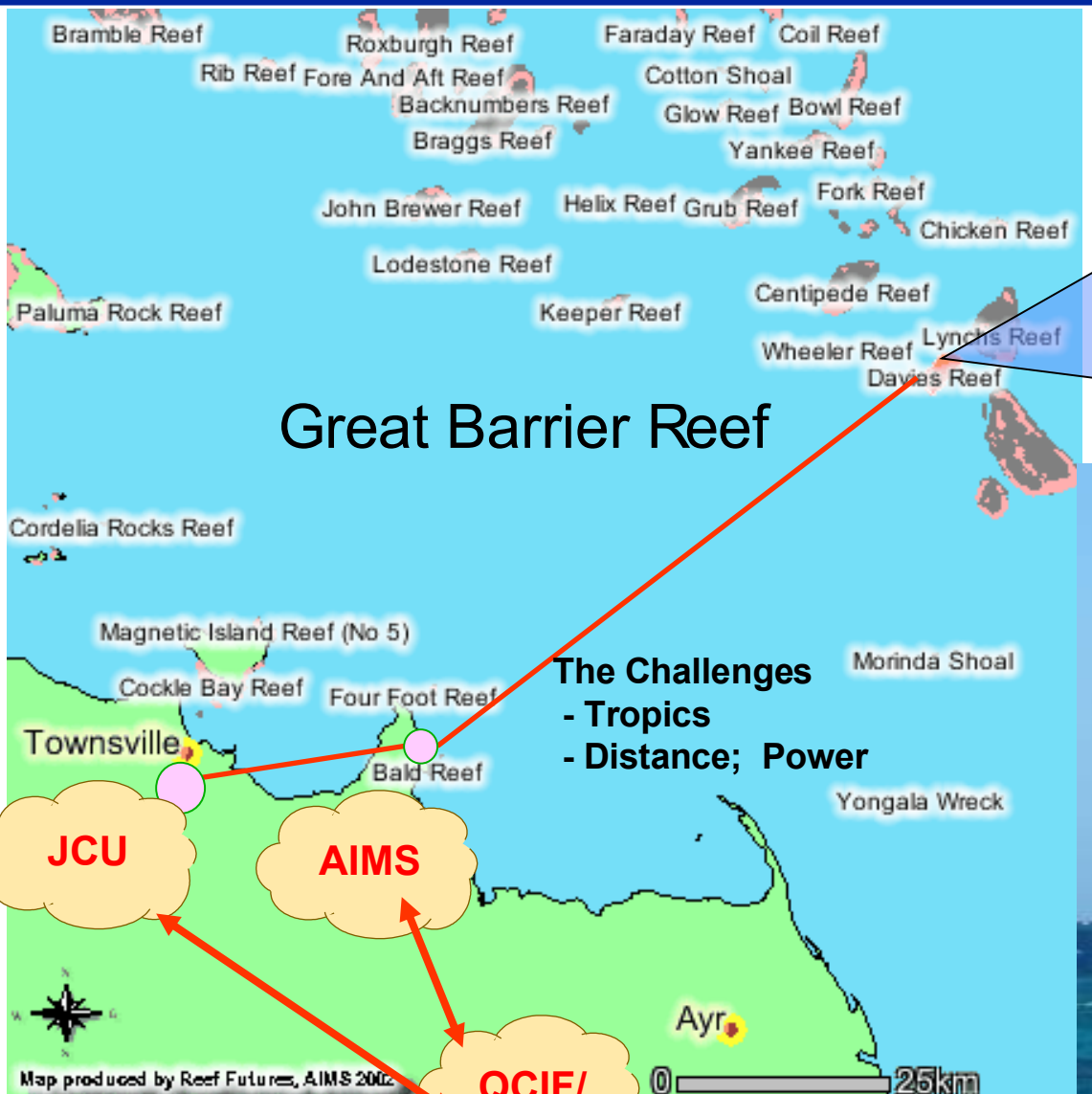
Raj Singh, UCSD

Note-Use of OptIPortals Over Normal Shared Internet

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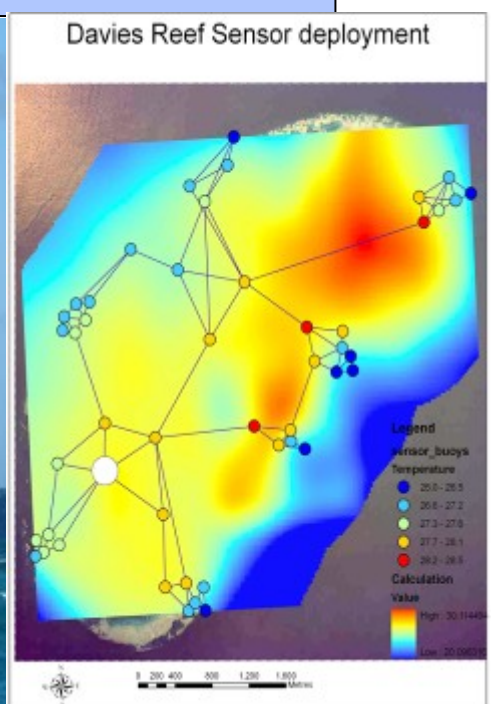
Realtime Sensornets on the Davis Reef Australia With High Speed Wireless Link



The Challenges
- **Tropics**
- **Distance; Power**





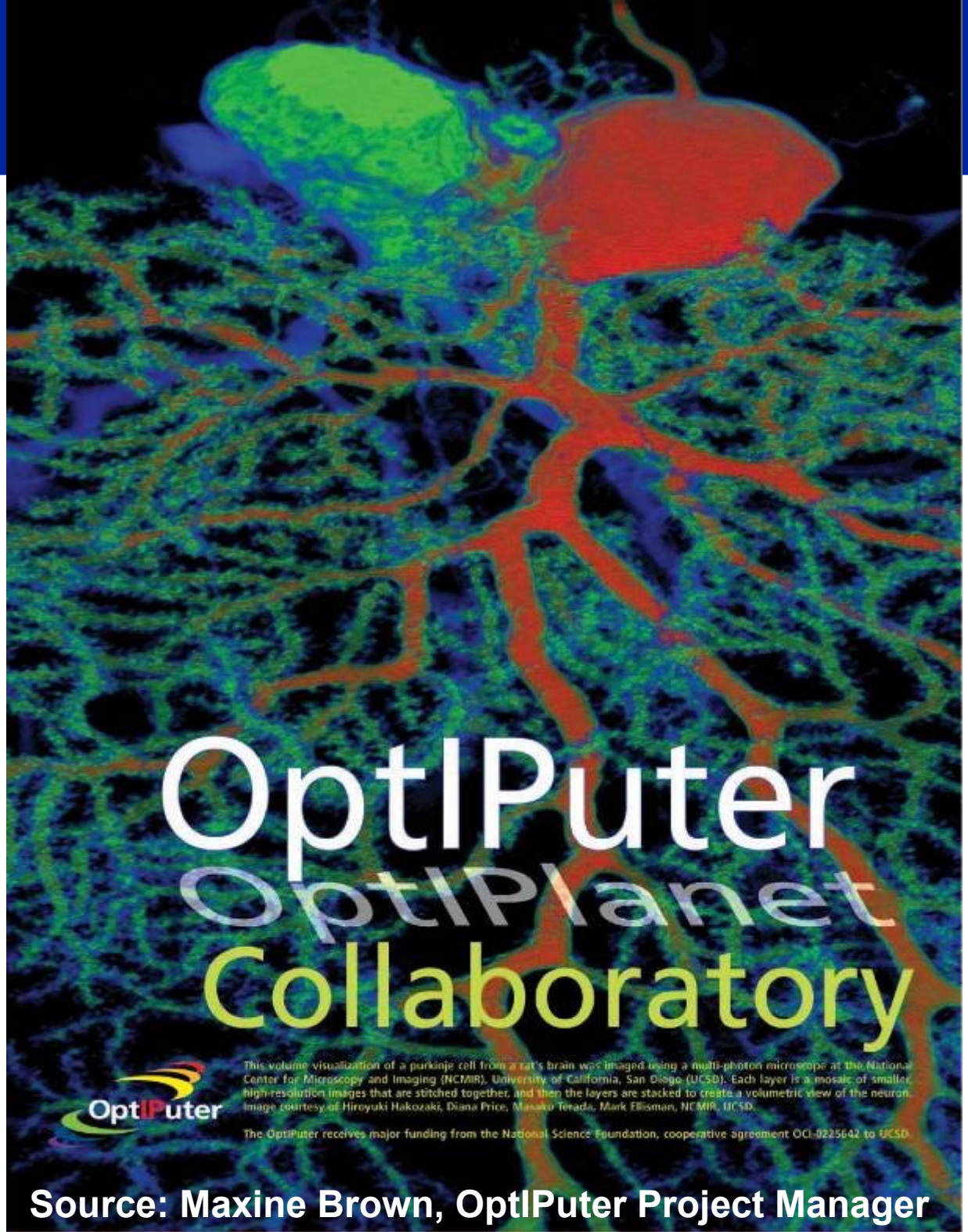


10^7bps on 10.5 GHz Carrier
~ 70km over Water

Source: Stuart Kininmonth, Scott Bainbridge, AIMS Australia.

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



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January 15, 2008

OptIPuter

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

Protein Visualizations on OzlPortal
Created with Covise Software Displayed with CGLX



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Covise, Phil Weber, Jurgen Schulze, Calit2
CGLX, Kai-Uwe Doerr , Calit2
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" Being Extended to Monash Univ., UQ, CSIRO…



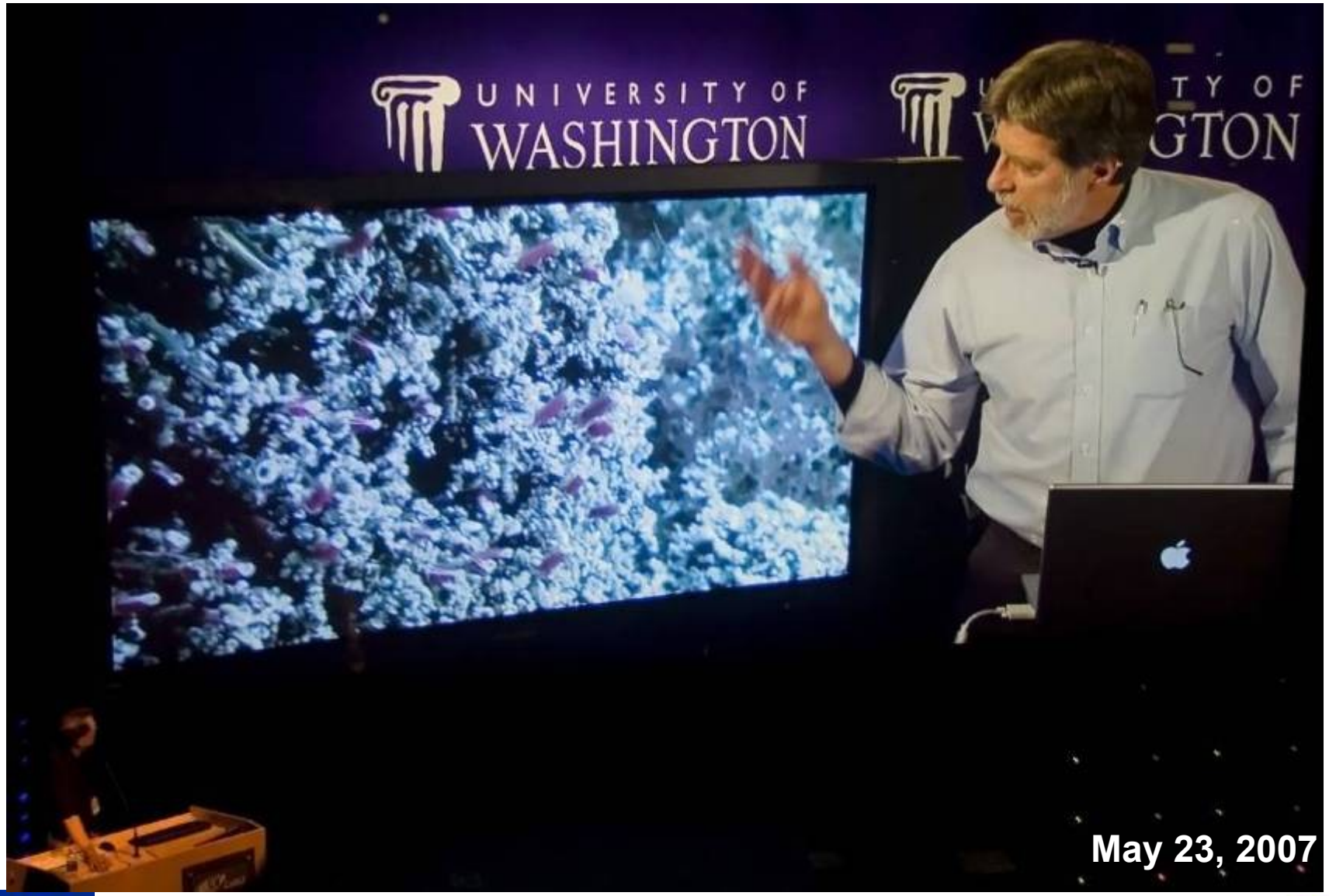
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No Calit2 Person Physically Flew to Australia to Bring This Up!

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

e-Science Collaboratory Without Walls Enabled by Uncompressed HD Telepresence Over 10^{10}bps

iHDTV: 1500 Mbits/sec Calit2 to UW Research Channel Over NLR



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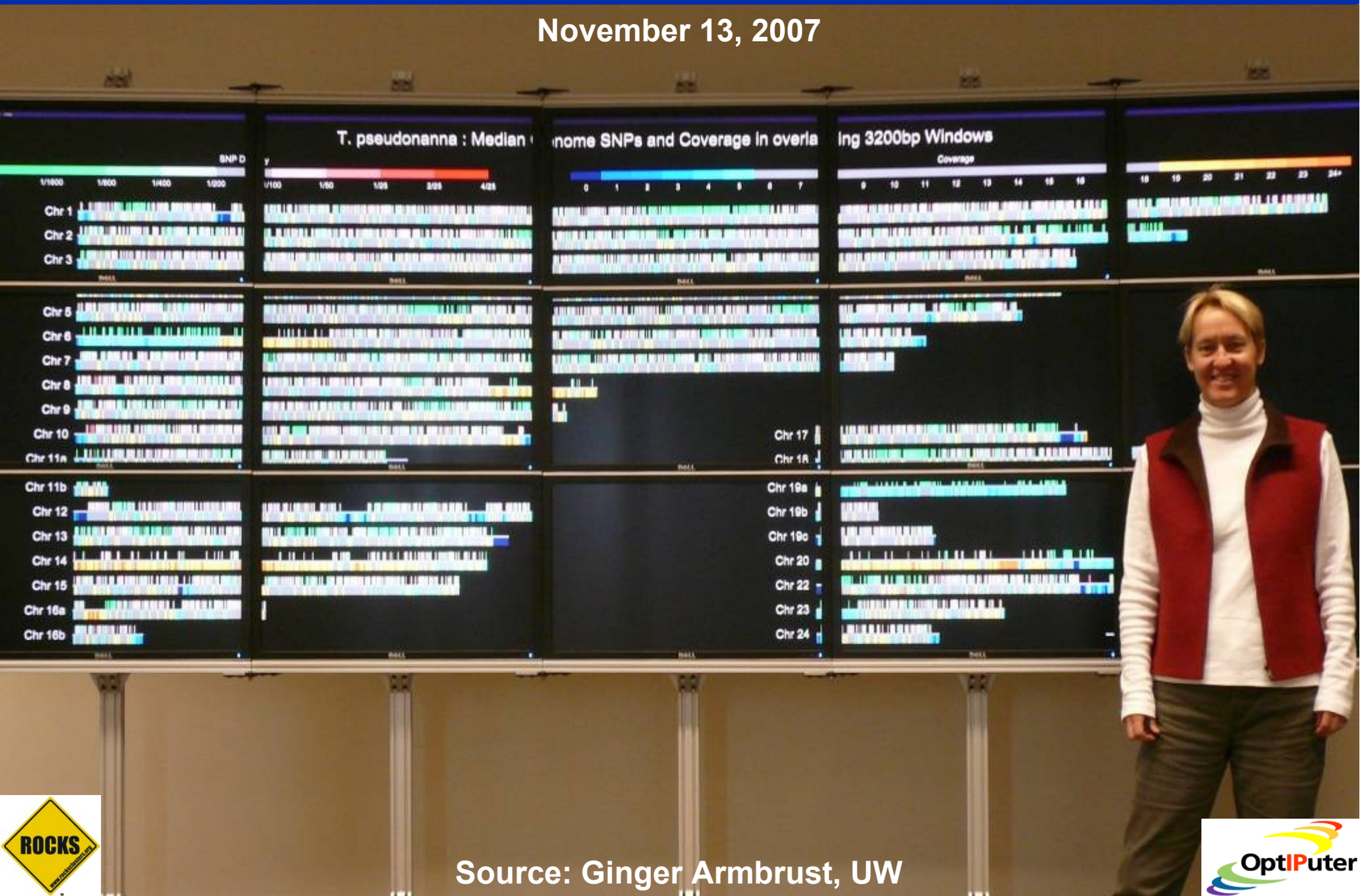
John Delaney, PI LOOKING, Neptune

Photo: Harry Ammons, SDSC

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New Genome Wall at UWashington
Chromosomes of Marine Diatom Thallasiosira Pseudonanna

November 13, 2007



Source: Ginger Armbrust, UW

SC07 Demo of Embedded iHDTV in an OptIPortal Enabling Collaboration Over 10G Pacific Wave Link



Larry Smarr in Reno

Ginger Armbrust in Seattle

iHDTV Being Integrated with SAGE

Source: Michael Wellings
Research Channel
Univ. Washington

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OptIPlanet Collaboratory Persistent Infrastructure Between Calit2 and U Washington



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

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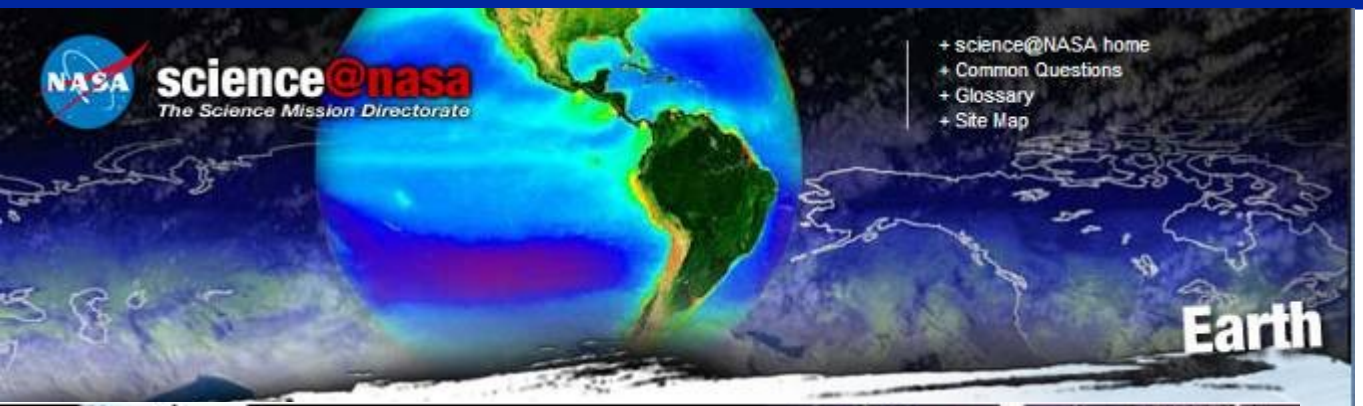




UW's Research Channel Michael Wellings

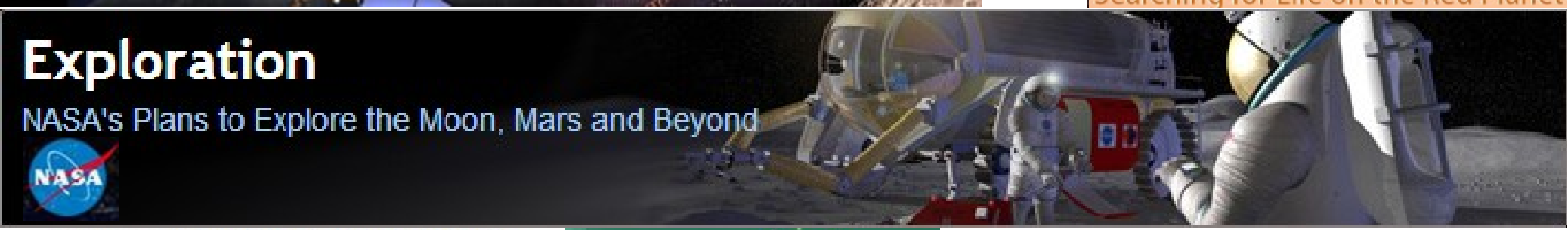
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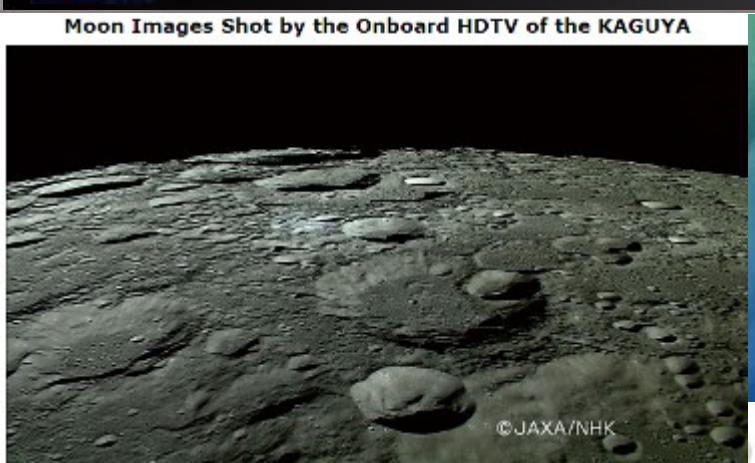
International Earth, Moon, Mars, and Beyond Sensors -- Major Data Visualization Challenges













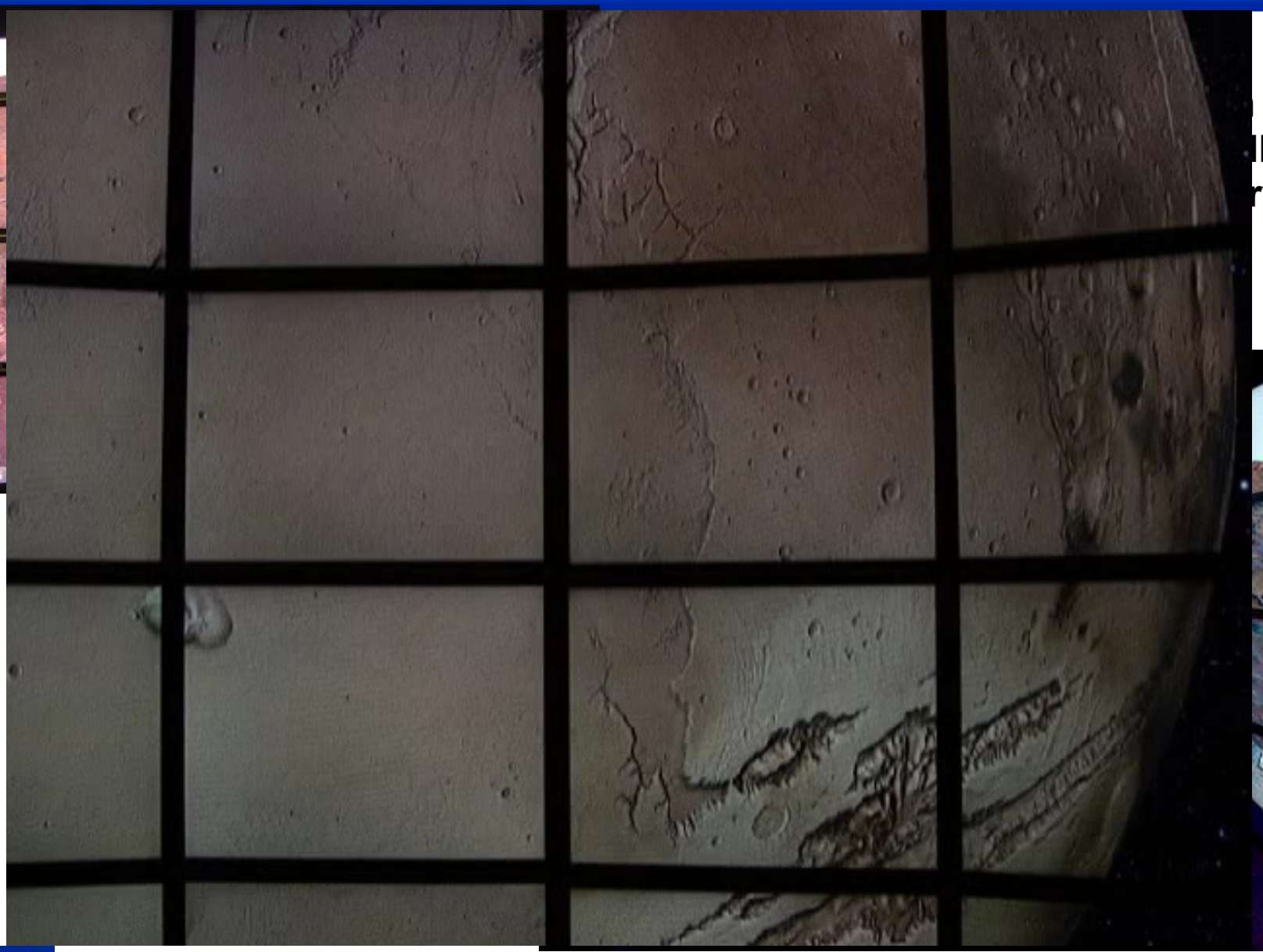


Indian Space Research Organisation

it2

Towards The OptIPlanet Planetary Collaboratory: Exploring Mars with OptIPortals







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Varrier: Dan Sandin, EVL/ Calit2
Rover Data Courtesy of Michael Sims,
NASA Ames Research Center

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The Calit2 Great Walls at UCSD and UCI Use CGLX and Are Now a 10^9bit/s HD Collaboratory



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OptIPortals Used to Visually Study Very Large Collages of NASA Space Observatories

VISIT - University of Michigan

- The University of Michigan School of Information Virtual Space Interaction Testbed (VISIT)
  - Explores the Use and Evaluation of Advanced Cyberinfrastructure for Human-Centered Computing
  - Leading Researchers on the Social Aspects of Collaboration
- Creating a Testbed of OptIPortal-Based Collaboration Systems
- Developing Techniques to Measure Social Impact



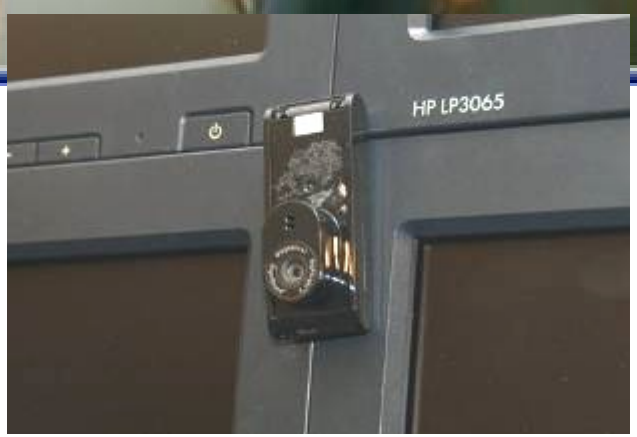


Source: Erik Hofer, UMich

Instrumenting OptIPortal Systems 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





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Source: Erik Hofer, UMich

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Understanding Organizational Impact Via Visualizing Noise Sensors

- Sensor Network Testbed Collects Audio Levels Throughout an Office Building
  - Noise is a Good Measure of Social Activity
- Visualize these Data to Create Representations of Social Activity in Physical Space
- Examine how Deploying Systems like OptIPortals Change these Social Patterns over Time



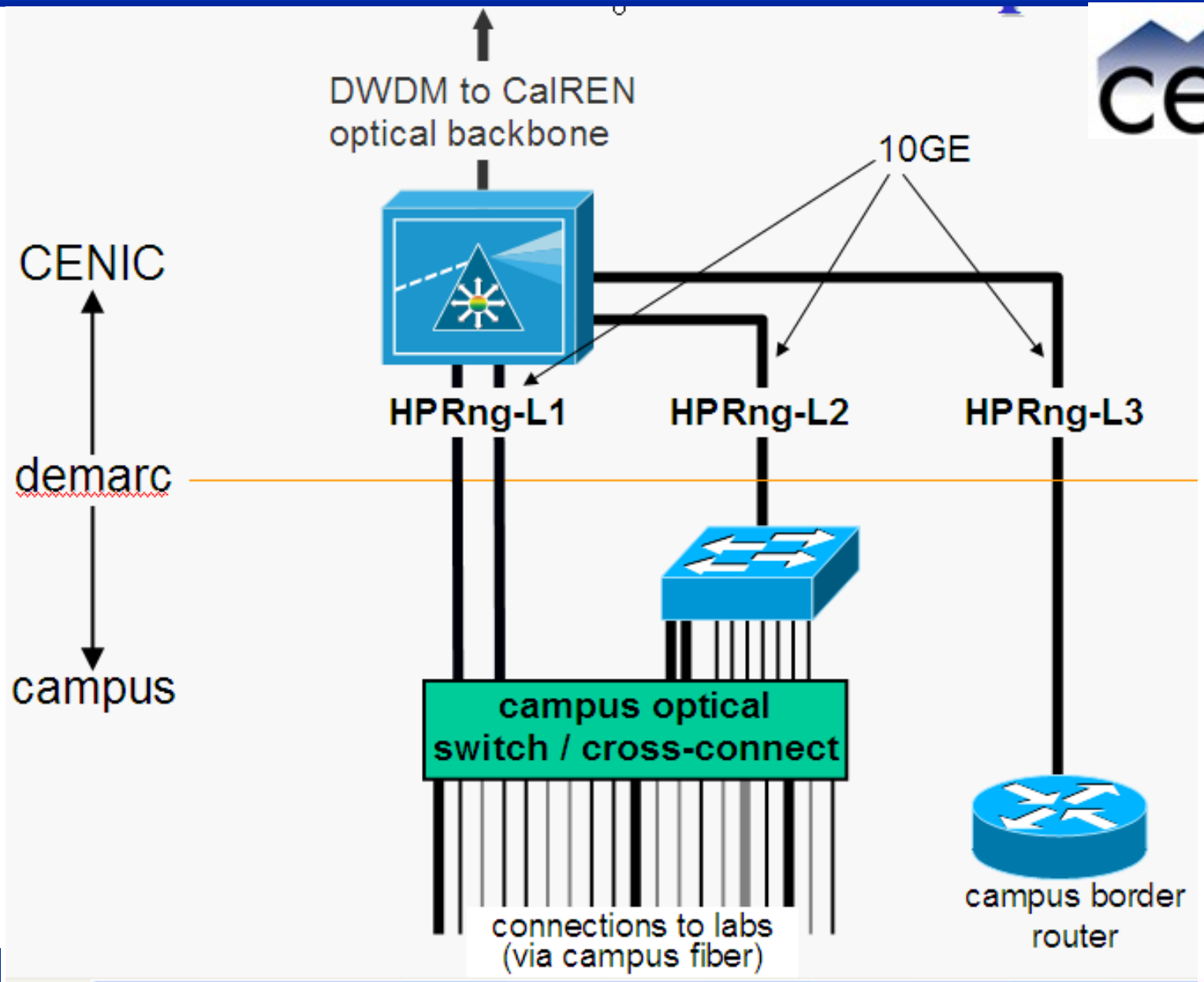


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Source: Erik Hofer, UMich

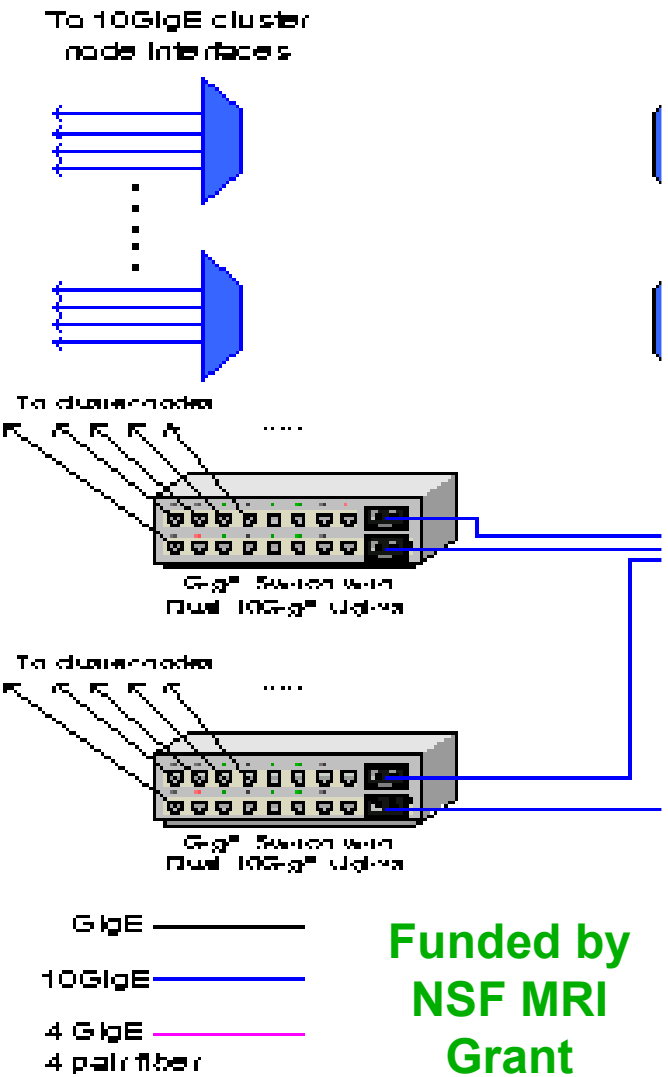
it²

PRAGMA Campus Preparations Needed to Accept OptIPuter Handoff



Source: Jim Dolgonas, CENIC

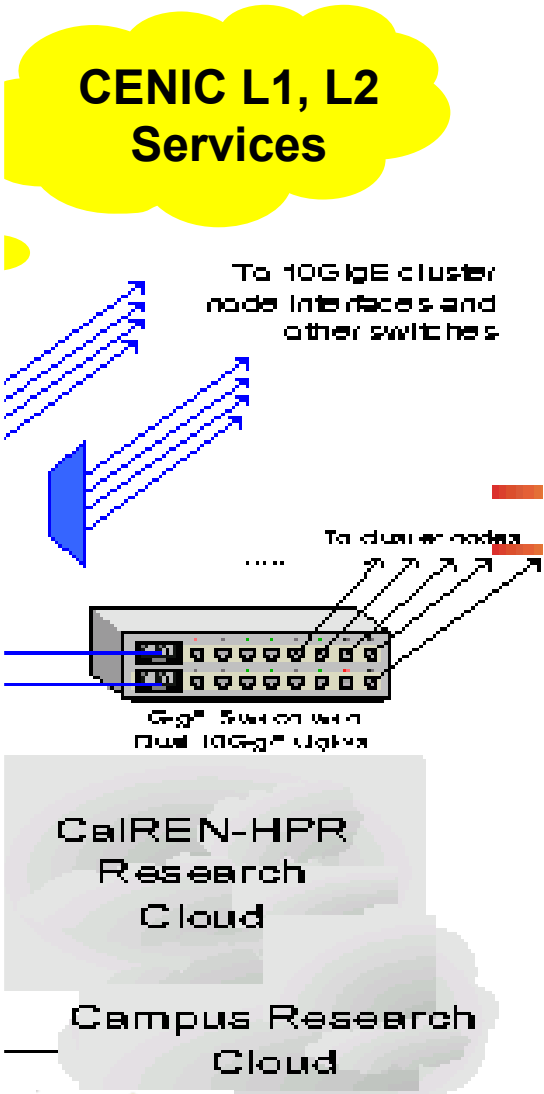
Current UCSD Experimental Optical Core: Ready to Couple to CENIC L1, L2, L3 Services



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)

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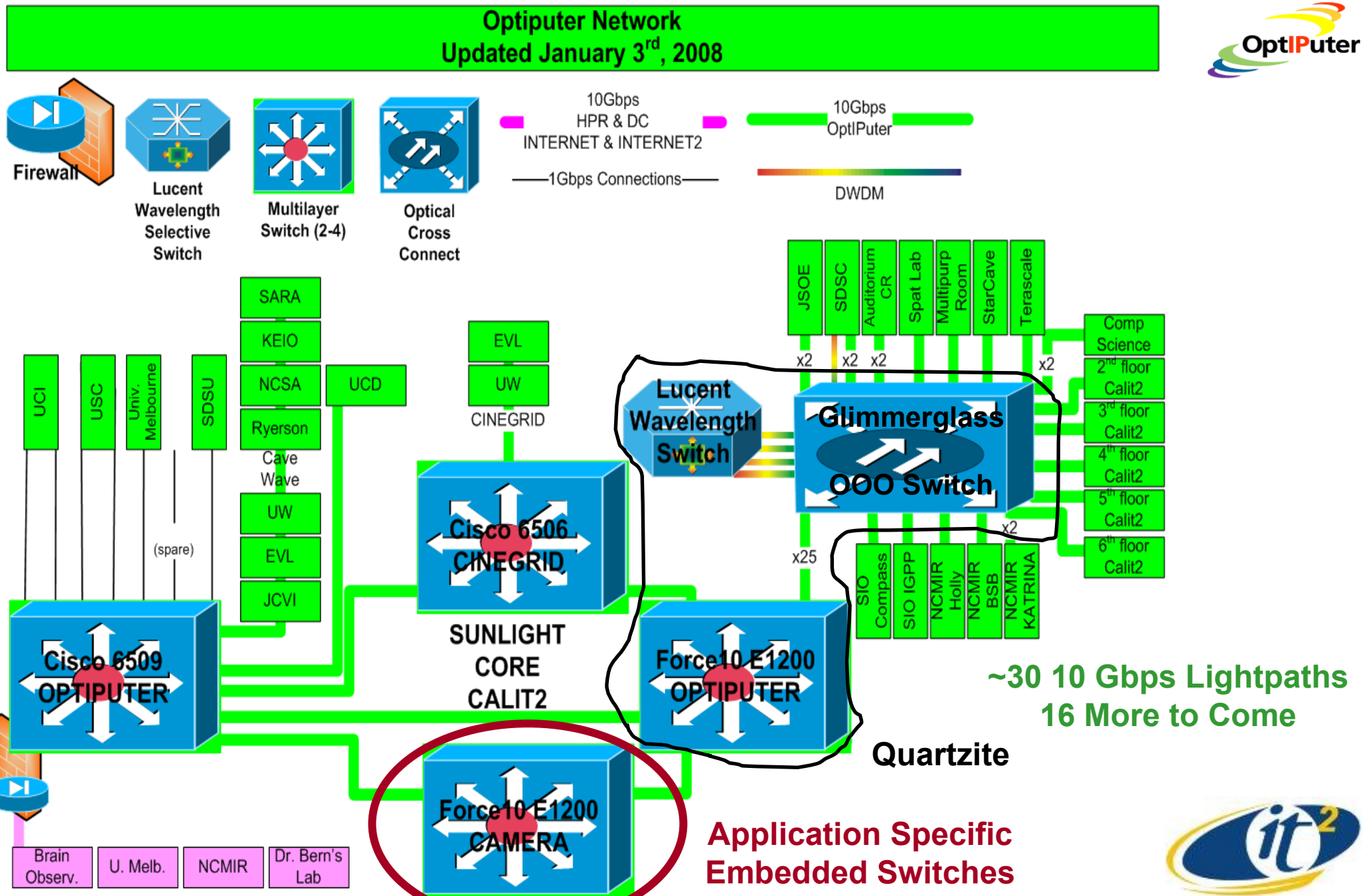
Calit2 Sunlight Optical Exchange Contains Quartzite



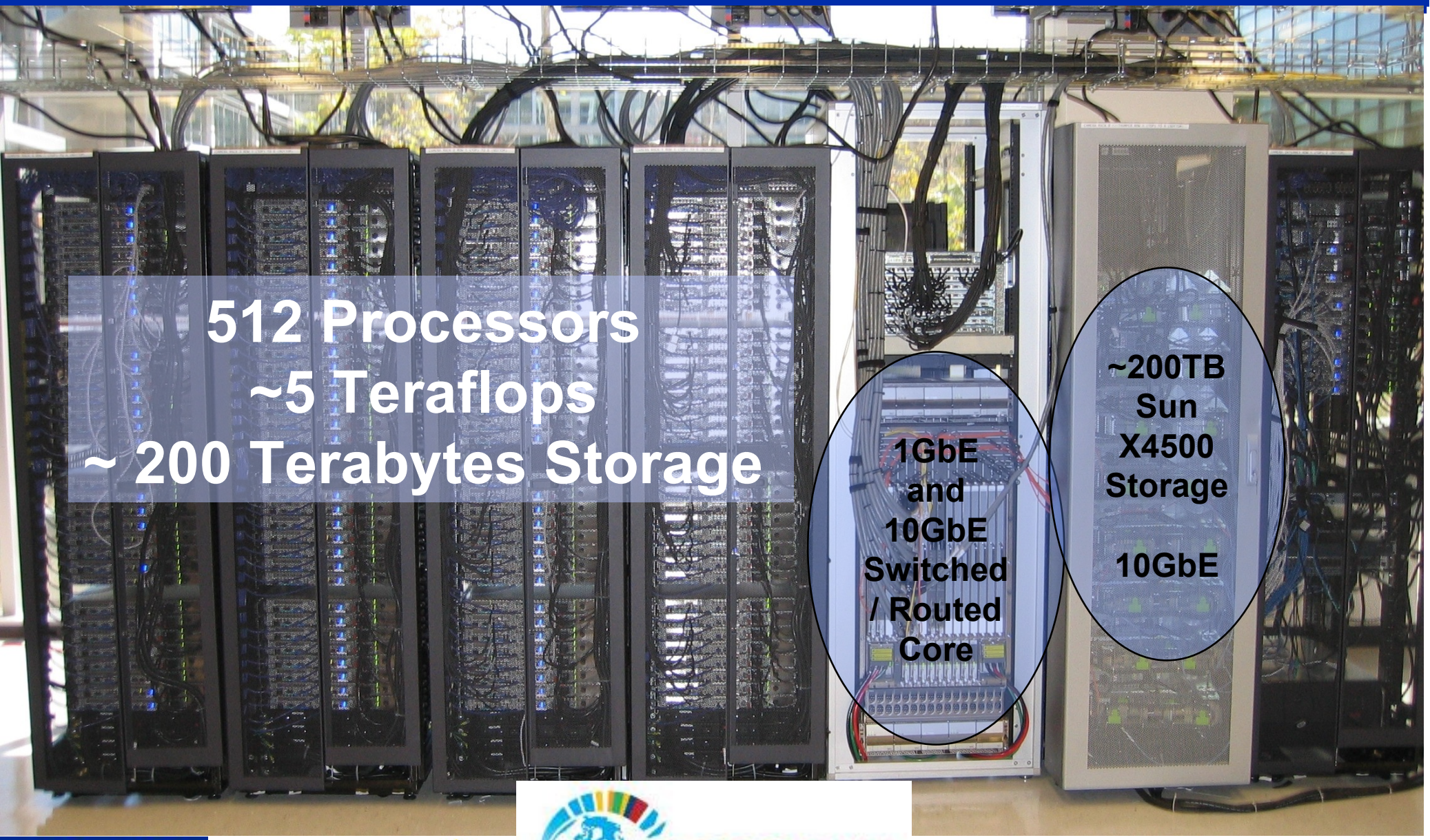
10:45 am
Feb. 21, 2008

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Block Layout of Quartzite/OptIPuter Network



Calit2 Microbial Metagenomics Cluster Production System



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

Beyond Cloud Computing--
LambdaGrid Computational Science

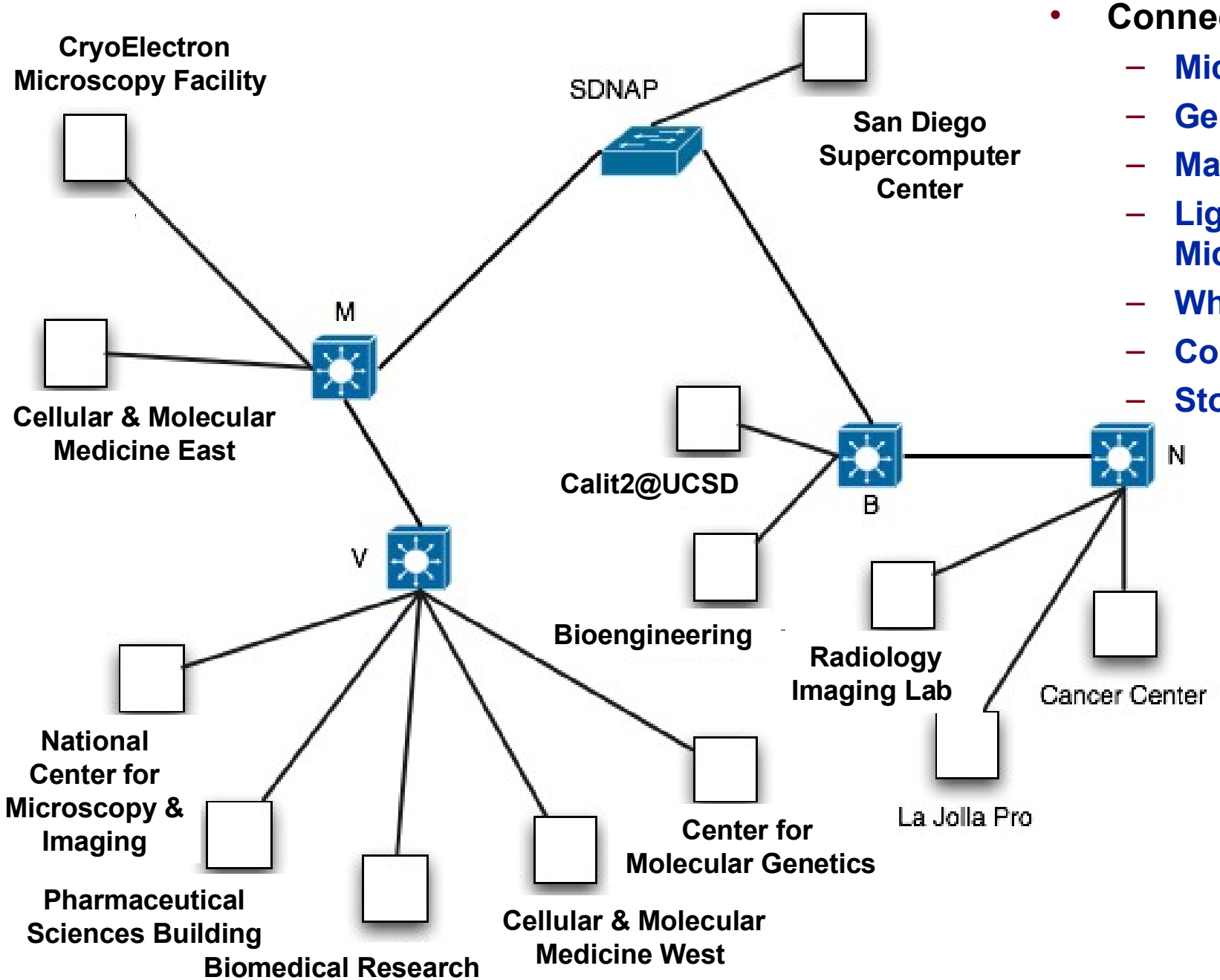
- **Computational Challenge**
  - Needed to Run a Large Number of Pre-computed BLAST Sequence Alignments for JCVI Fragment Recruitment Viewer (FRV)
  - CAMERA Development and Batch Clusters Oversubscribed
  - Had Spare Capacity in SDSC Cluster Connected to Quartzite
- **LambdaGrid Solution**
  - Reconfigure Private Side of Network to "Attach" Nodes in SDSC Rockstar Cluster to CAMERA Ikelite Cluster for Batch Processing
    - Direct Network Connection to CAMERA X4500 Thumper Storage
    - No Changes to Application Software or Paths
    - Rockstar Nodes Reconfigured to Support FRV Needs
  - Rockstar (SDSC) Nodes Integrated as Part of Ikelite (Calit2) Batch System
    - ~2000 CPU-Days Dedicated Computing over Previous 14 Days
    - O(2TB) of Output
    - Running Right Now

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UCIrvine SDSC

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

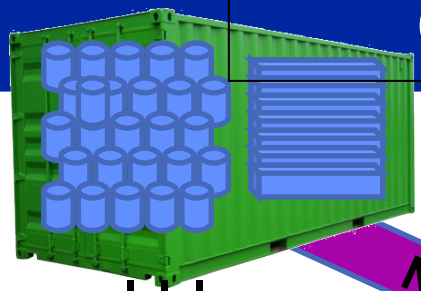
OptIPuter
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UCSD Planned Optical Networked Biomedical Researchers and Instruments

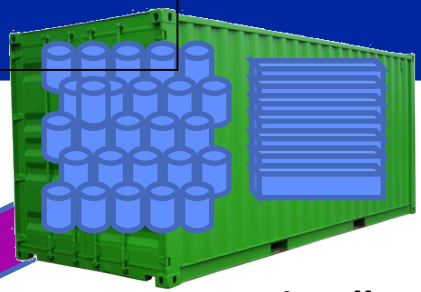


- **Connects at 10 Gbps :**
  - **Microarrays**
  - **Genome Sequencers**
  - **Mass Spectrometry**
  - **Light and Electron Microscopes**
  - **Whole Body Imagers**
  - **Computing**
  - **Storage**

Quartzite – Influencing Next-Generation UCSD Network



Active Data Replication



N x 10 Gbit

N x 10 Gbit

Eco-Friendly
Storage and Compute

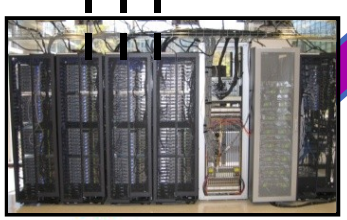
"Network in a box"
- > 200 Connections
- DWDM or Gray Optics



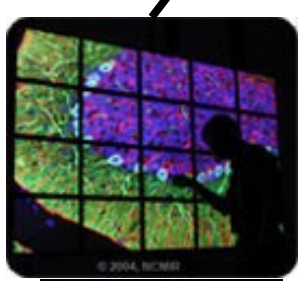
10 Gigabit
L2/L3 Switch

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

On-Demand Physical Connections



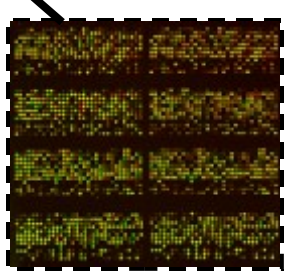
camera
Marine Microbial Ecology



NCMIR
NATIONAL CENTER for MICROSCOPY and IMAGING RESEARCH



NBCR



Microarray

Your Lab Here

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Source:Phil Papadopoulos, SDSC/Calit2

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PRAGMA – OptIPlanet Collaboratory Partnership Opportunities

- Grow Number of 10G Lambdas Between PRAGMA Sites
- Link up PRAGMA OptIPortals with Lambdas
- Establish HD and 4k Persistent PRAGMA Telepresence
- Generalize PRAGMA Middleware to LambdaGrid
- Create Global PRAGMA LambdaCloud Computing & Storage
- Connect Remote Users' OptIPortals to Supercomputers
- Collectively Attack Major Global Applications
  - CREON
  - GLEON
  - Global Health
  - Earth and Planetary Science
- Engage Social and Behavioral Researchers In Each Project

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