“Cyberinfrastructure for Ocean Cabled Observatories"

Invited Talk
NEPTUNE Regional Cabled Ocean Observatory Workshop
Seattle, WA
November 15, 2005

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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Goal – From Expedition to Cabled Observatories with Streaming Stereo HDTV Robotic Cameras

http://disney.go.com/disneypictures/aliensofthedeep/alienseduguide.pdf





Scenes from The Aliens of the Deep, Directed by James Cameron & Steven Quale

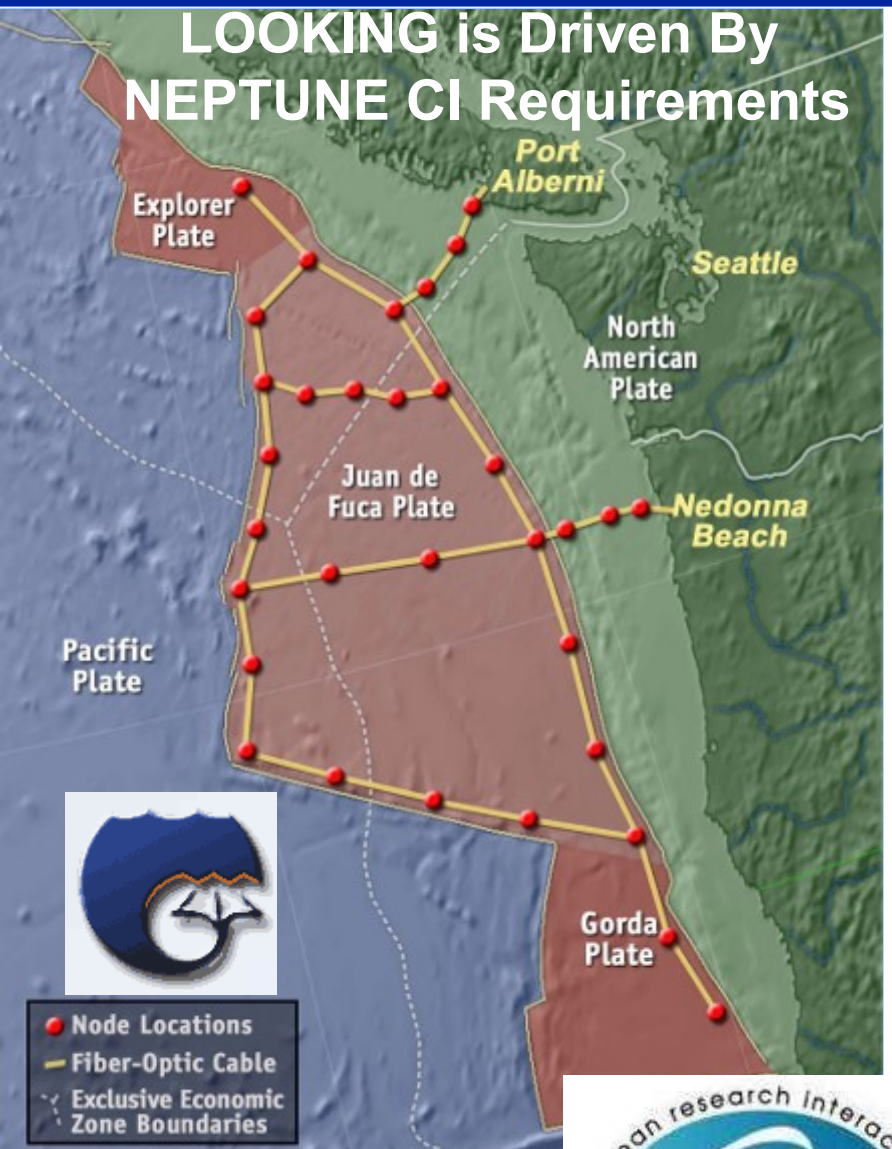
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A Near Future Metagenomics Fiber Optic Cable Observatory



Source John Delaney, UWash

Adding Web & Grid Services to Optical Channels to Provide Real Time Control of Ocean Observatories



LOOKING:
(Laboratory for the Ocean Observatory Knowledge Integration Grid)

http://lookingtosea.ucsd.edu/

- **Goal:**
  - Prototype Cyberinfrastructure for NSF's Ocean Research Interactive Observatory Networks (ORION) Building on OptIPuter
- **LOOKING NSF ITR with PIs:**
  - John Orcutt & Larry Smarr - UCSD
  - John Delaney & Ed Lazowska –UW
  - Mark Abbott – OSU
- **Collaborators at:**
  - MBARI, WHOI, NCSA, UIC, CalPoly, UVic, CANARIE, Microsoft, NEPTUNE-Canarie

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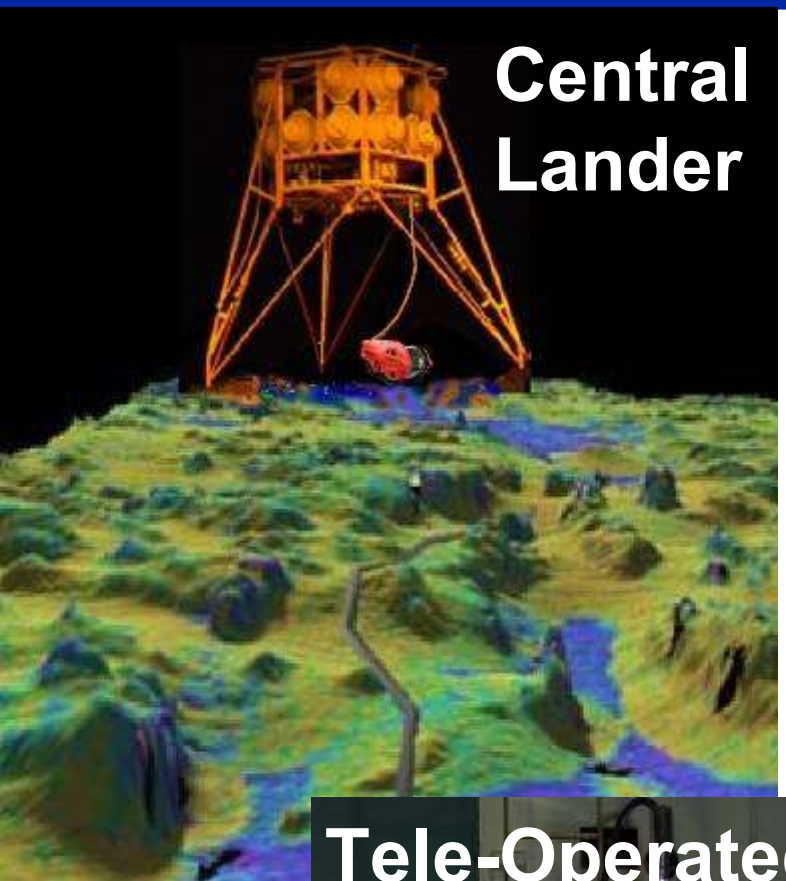
NSF

ocean research interactive ORION observatory networks

Making Management of Gigabit Flows Routine

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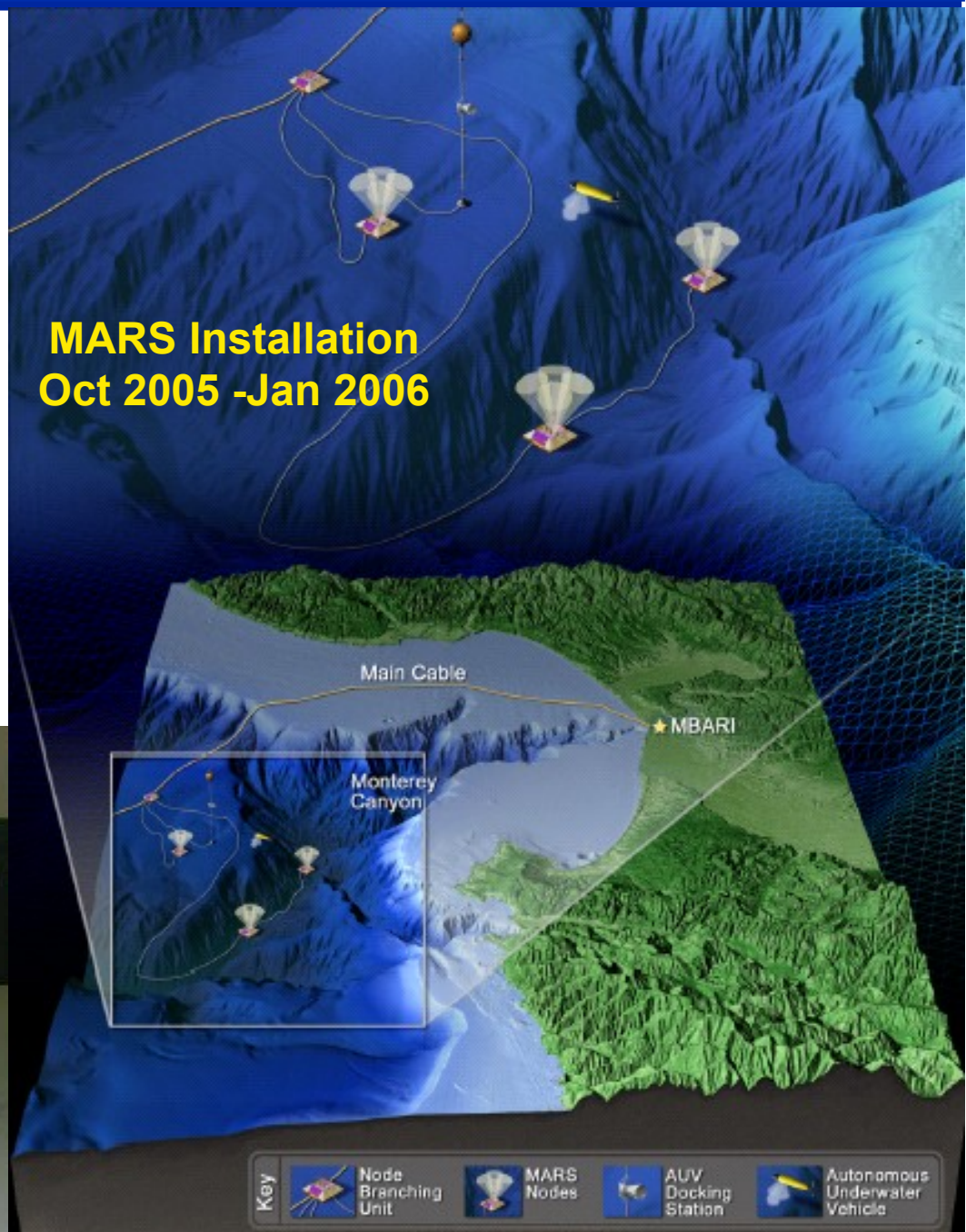
MARS Cable Observatory Testbed – LOOKING "Living Laboratory"





Source:
Jim
Bellingham,
MBARI

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Grand Challenge: A Total Knowledge Integration System for the Coastal Zone

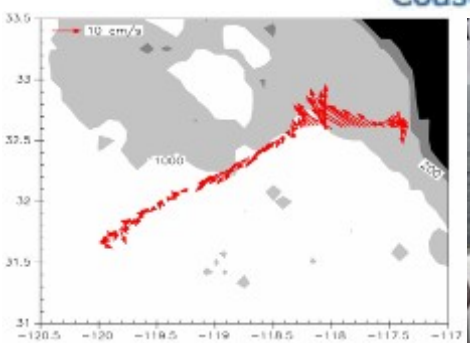
- Moorings
- Ships
- Autonomous Vehicles
- Satellite Remote Sensing
- Drifters
- Long Range HF Radar
- Near-Shore Waves/Currents (CDIP)
- COAMPS Wind Model
- Nested ROMS Models
- Data Assimilation and Modeling
- Data Systems



Southern California Coastal Ocean Observing System

ROADNet

COCMP
Coastal Ocean Currents Monitoring Program





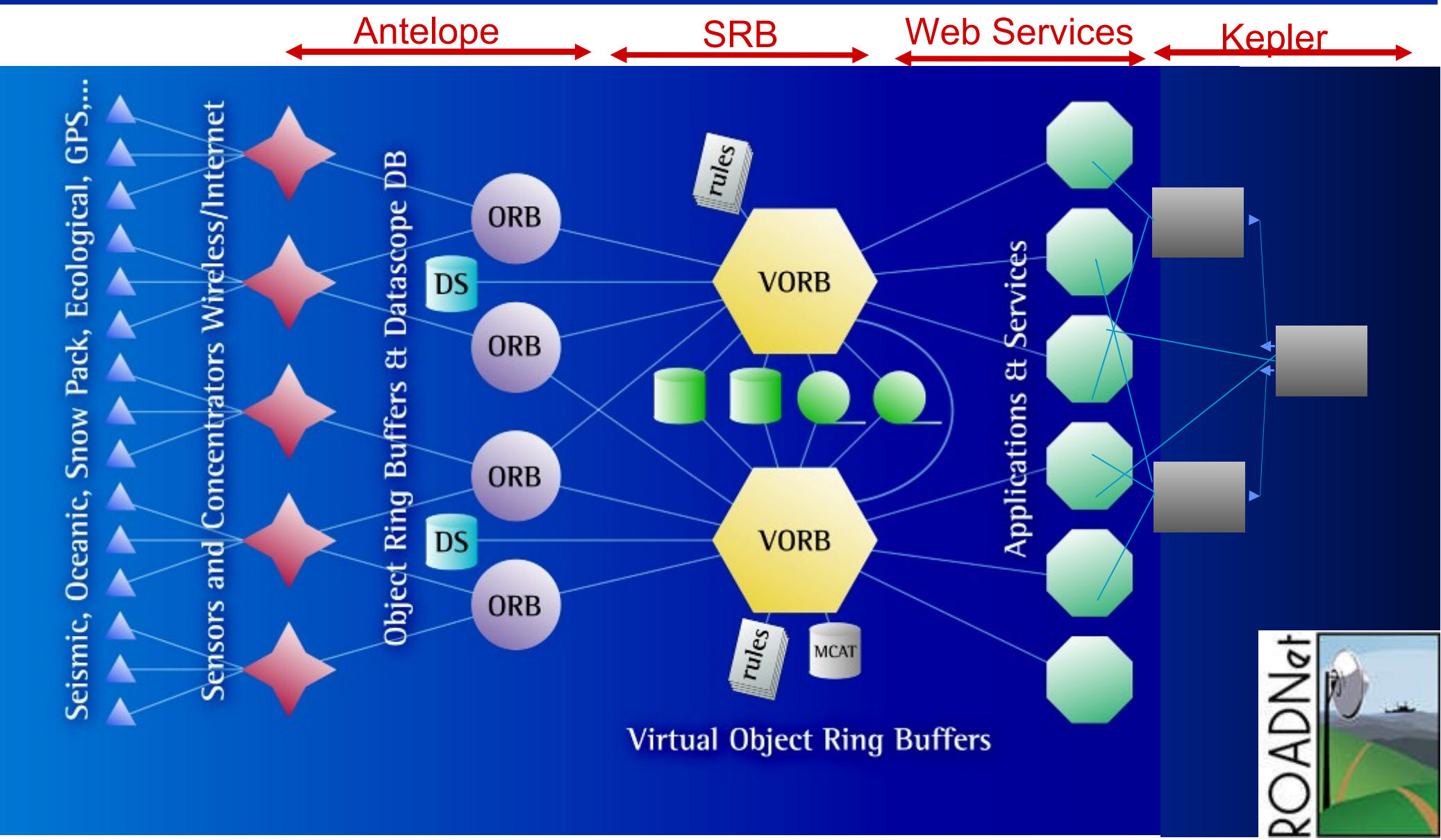
OptIPuter

www.sccoos.org/

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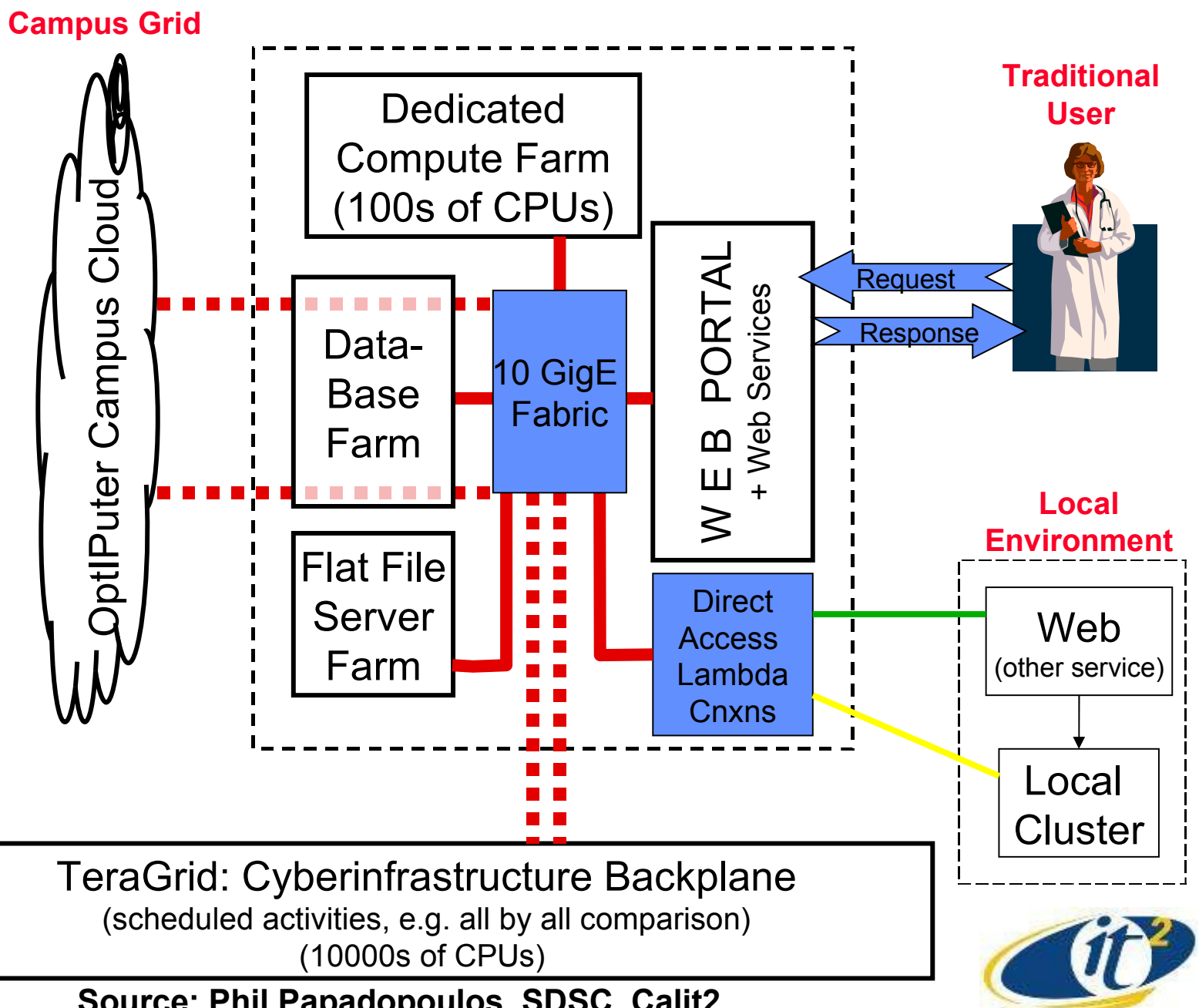
ROADNet Architecture:

SensorNets, Storage Research Broker, Web Services, Work Flow



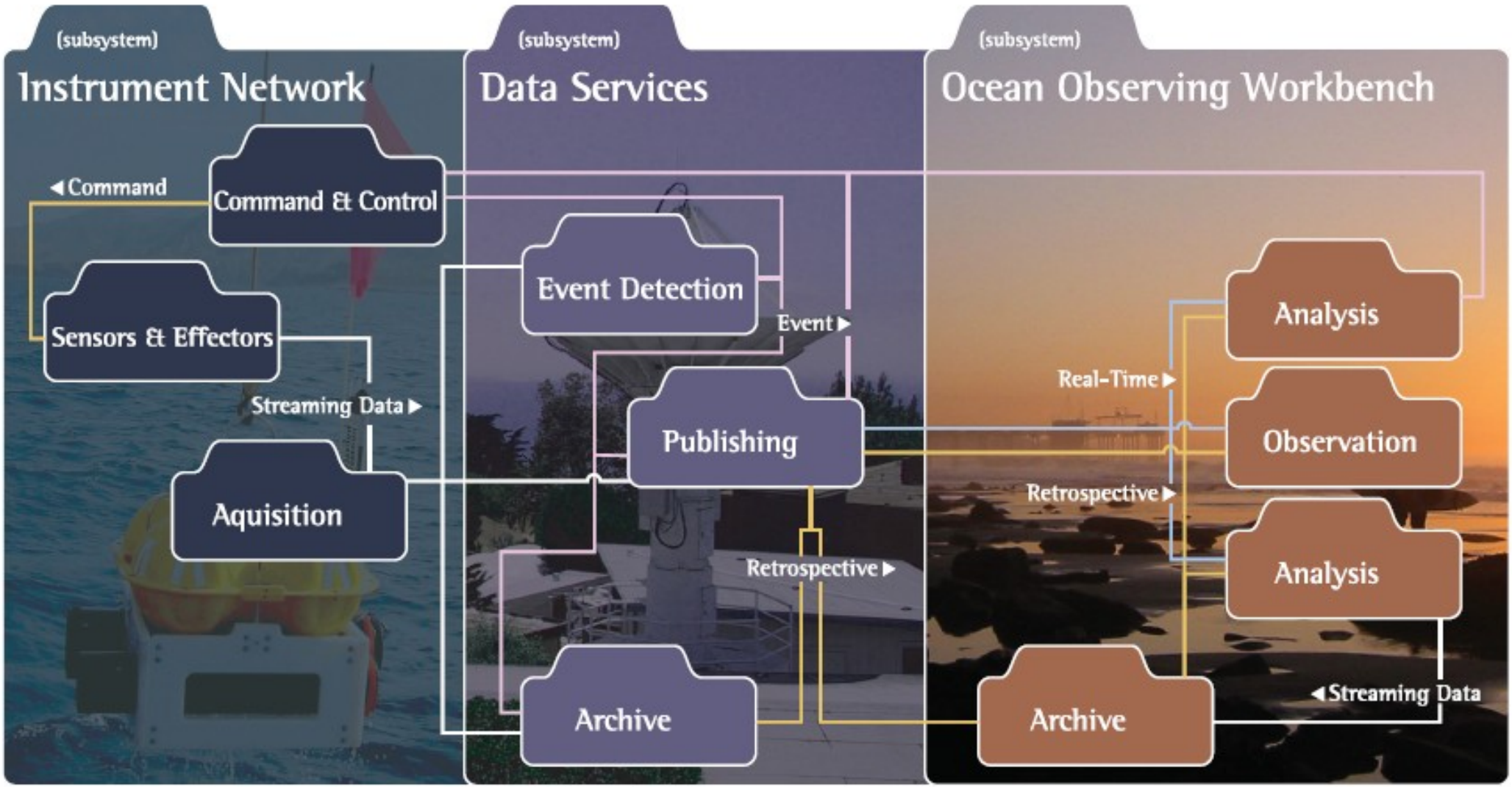
Frank Vernon, SIO; Tony Fountain, Ilkay Altintas, SDSC

Calit2's Direct Access Core Architecture Supporting Massive Instrumental Datasets



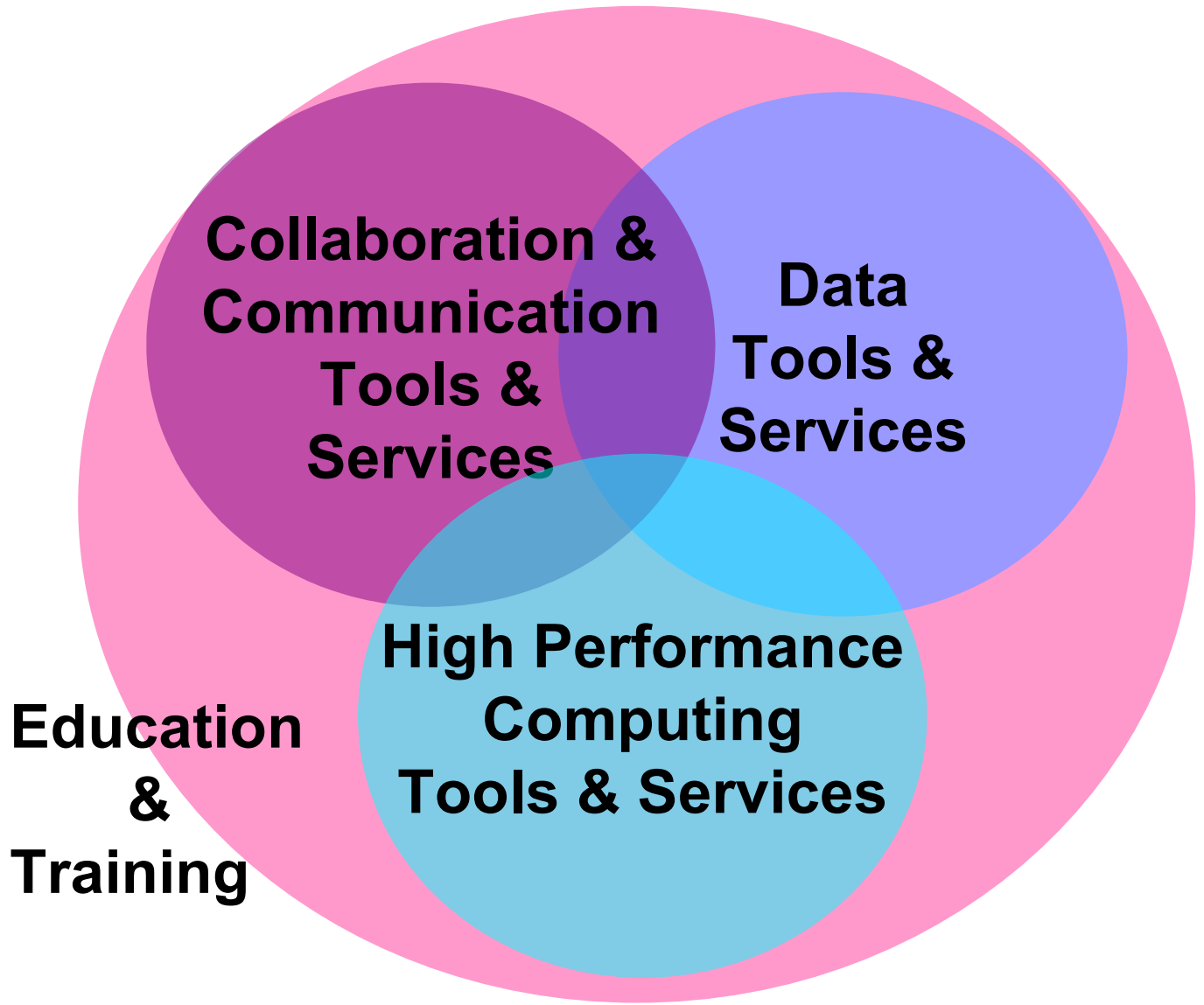
Source: Phil Papadopoulos, SDSC, Calit2

Looking High Level
LOOKING Service System Architecture



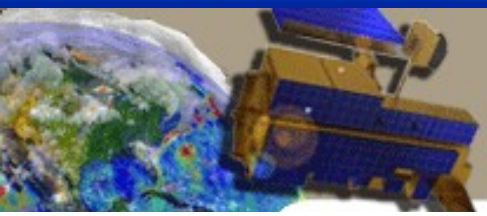
Source: Matthew Arrott, Calit2

A National Cyberinfrastructure is Emerging for Data Intensive Science



Source: Guy Almes,
Office of Cyberinfrastructure, NSF

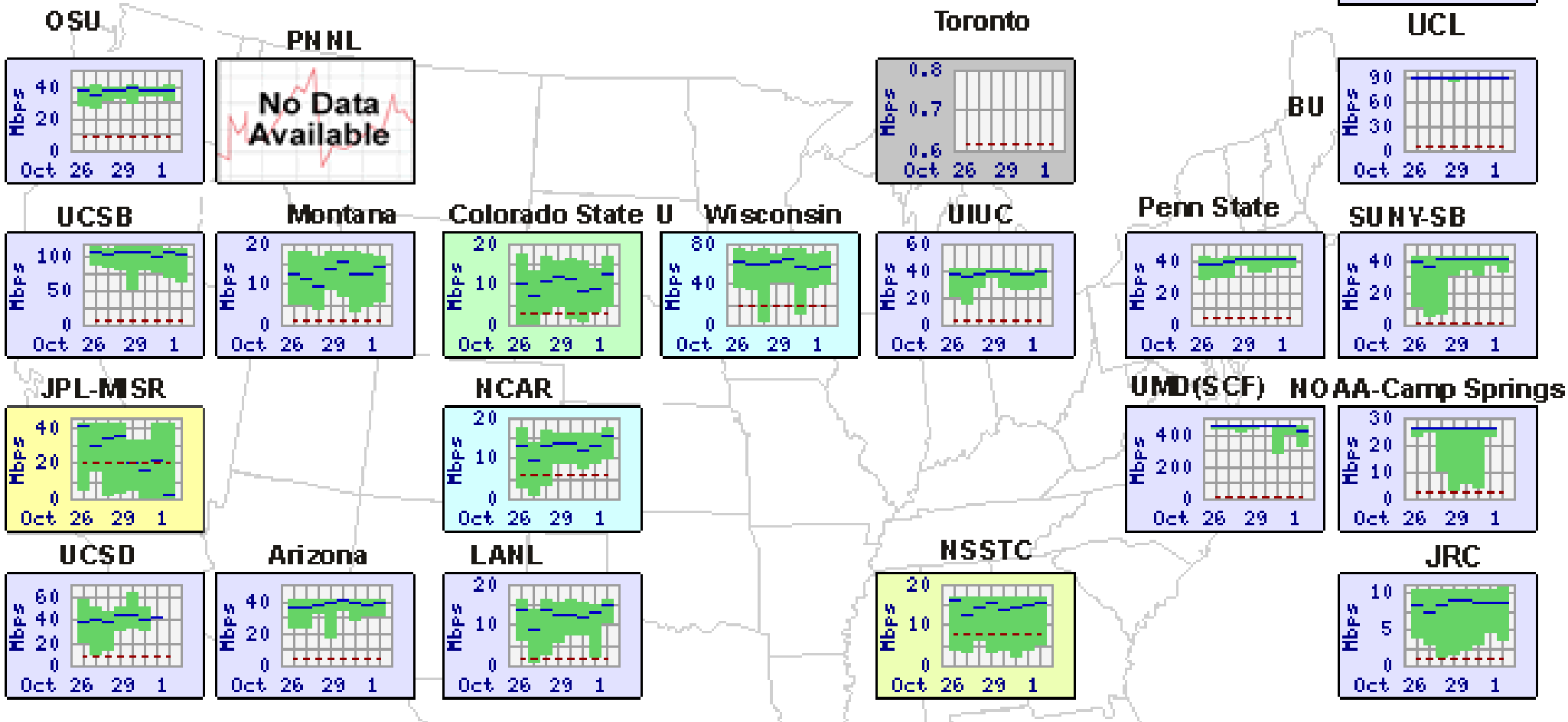
Challenge: Average Throughput of NASA Data Products to End User is < 50 Mbps



ENSIGHT Active Testing TERRA Destinations

Tested October 2005

Internet2 Backbone is 10,000 Mbps!
Throughput is < 0.5% to End User

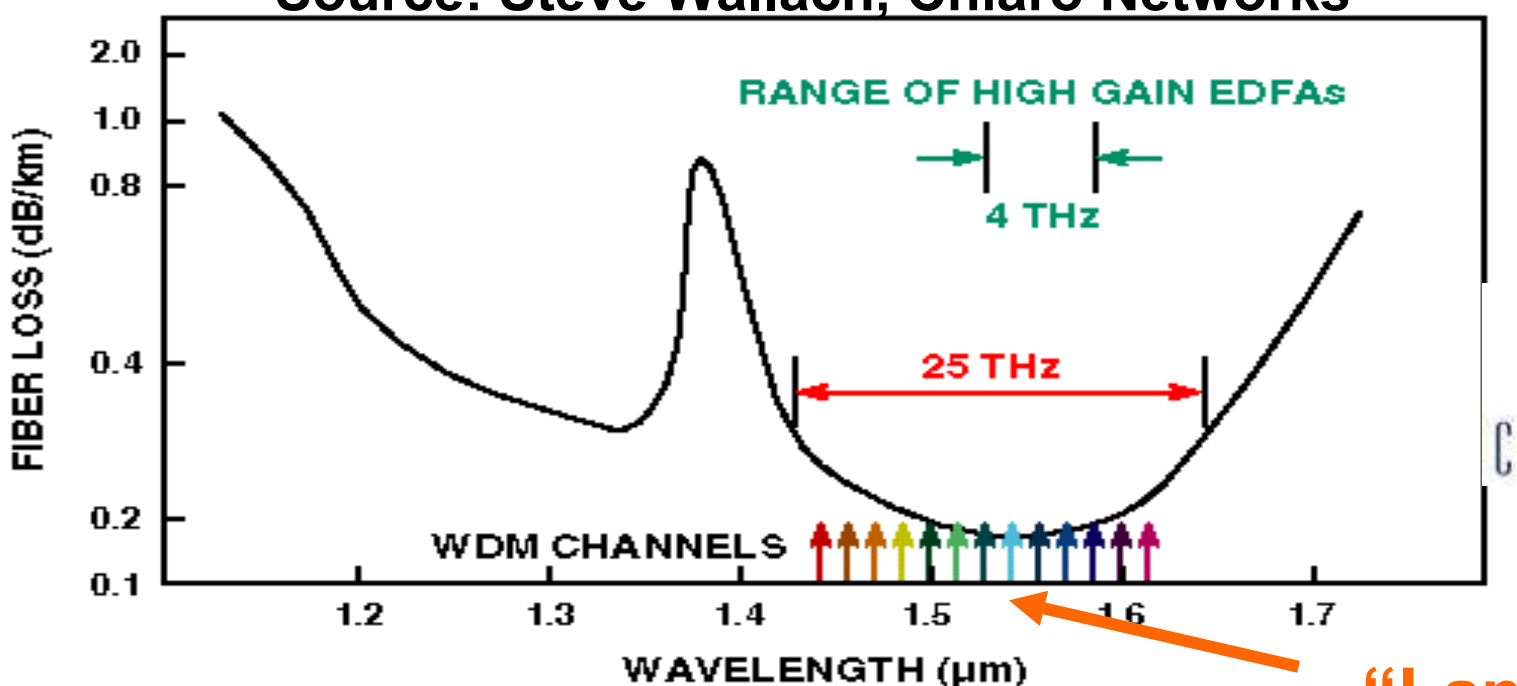


Dedicated Optical Channels Makes High Performance Cyberinfrastructure Possible

WAVELENGTH DIVISION MULTIPLEXING (WDM)

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

Source: Steve Wallach, Chiaro Networks



CHIARO

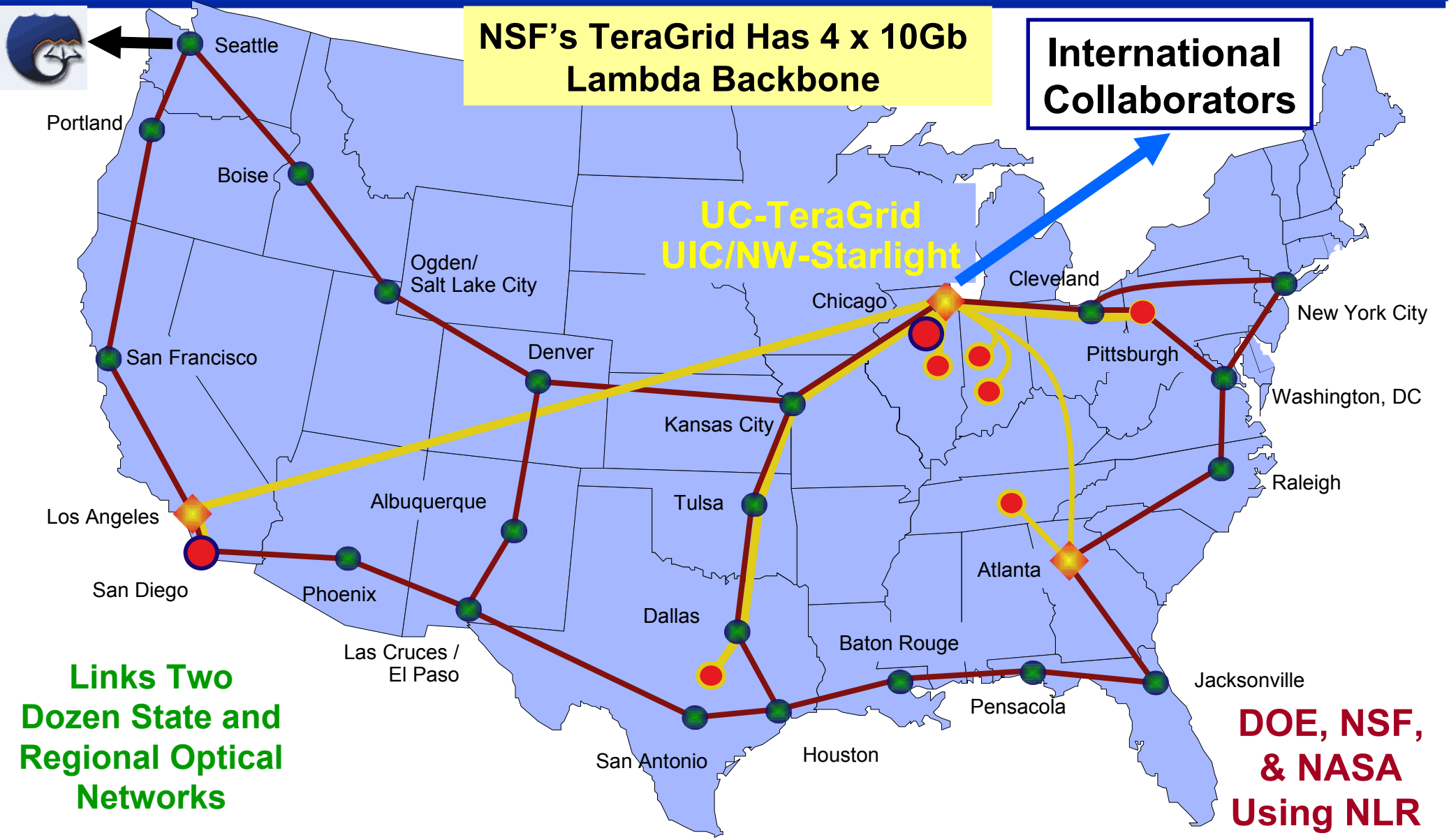
"Lambdas"

Parallel Lambdas are Driving Optical Networking The Way Parallel Processors Drove 1990s Computing

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



Brain Imaging Collaboration -- UCSD & Osaka Univ. Using Real-Time Instrument Steering and HDTV

Most Powerful Electron Microscope in the World -- Osaka, Japan





HDTV

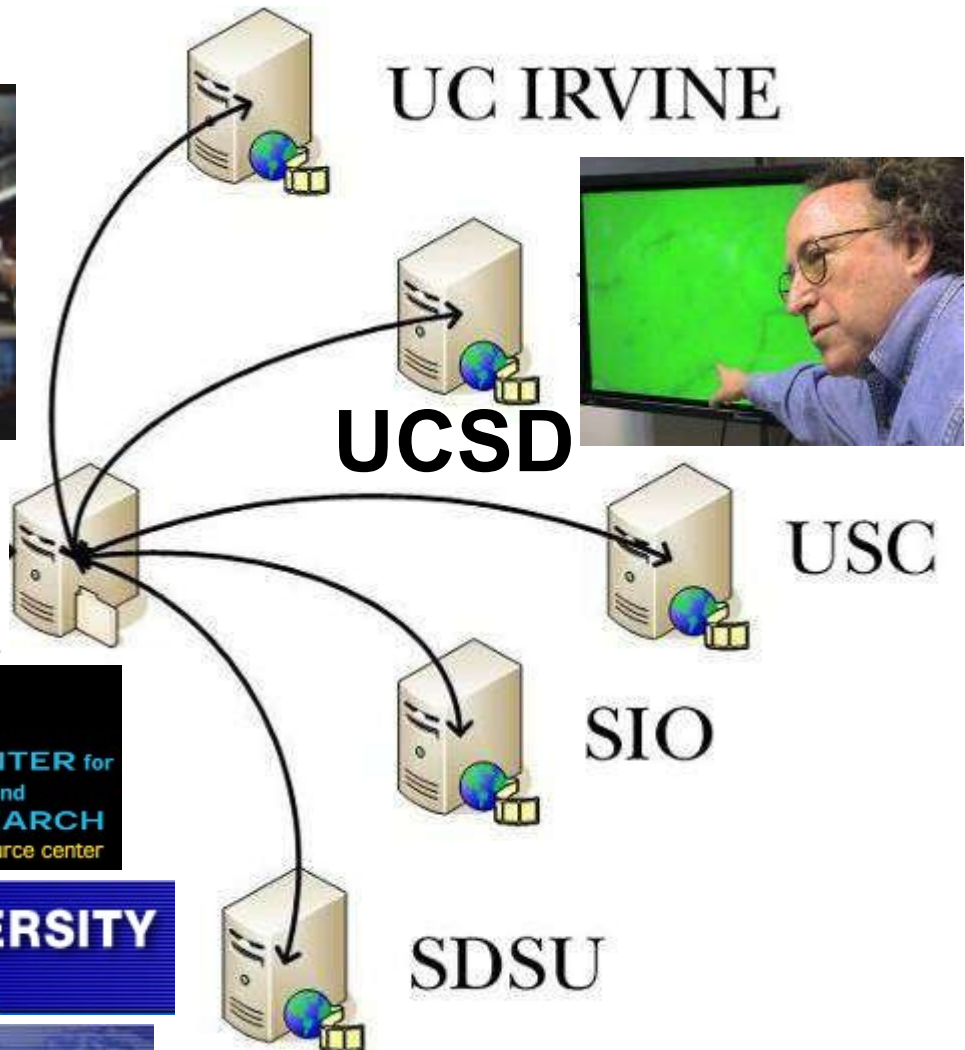
NBCR

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

OSAKA UNIVERSITY

KDDI GROUP KDDI Labs USA

Southern California OptIPuter



Source: Mark Ellisman, UCSD

Multiple HD Streams Over Lambdas Will Radically Transform Global Collaboration





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



Source: U Washington Research Channel

Calit2@UCSD Is Connected to the World 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



50 Demonstrations, 20 Counties, 10 Gbps/Demo

Prototyping Cabled Ocean Observatories Enabling High Definition Video Exploration of Deep Sea Vents



iGrid 2005

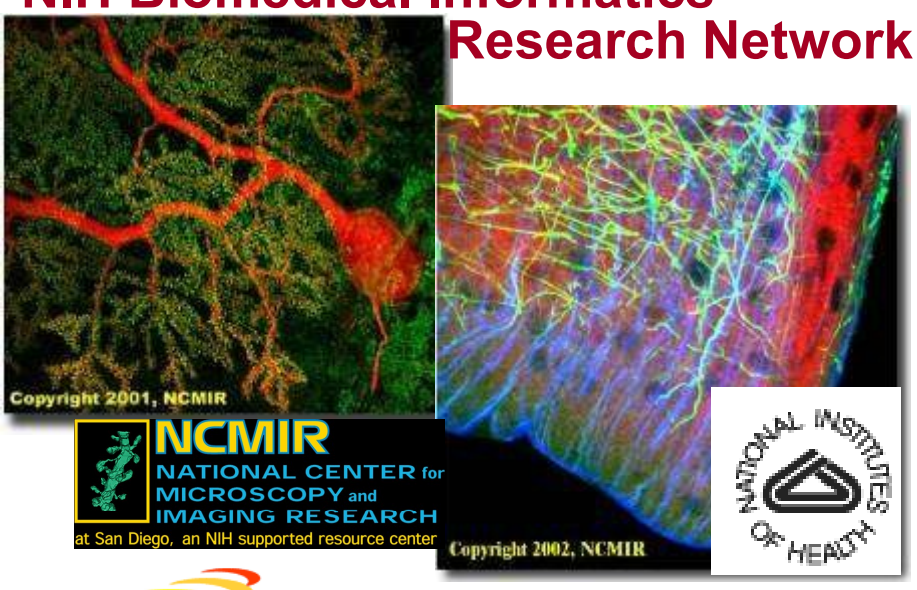
Source John Delaney & Deborah Kelley, UWash

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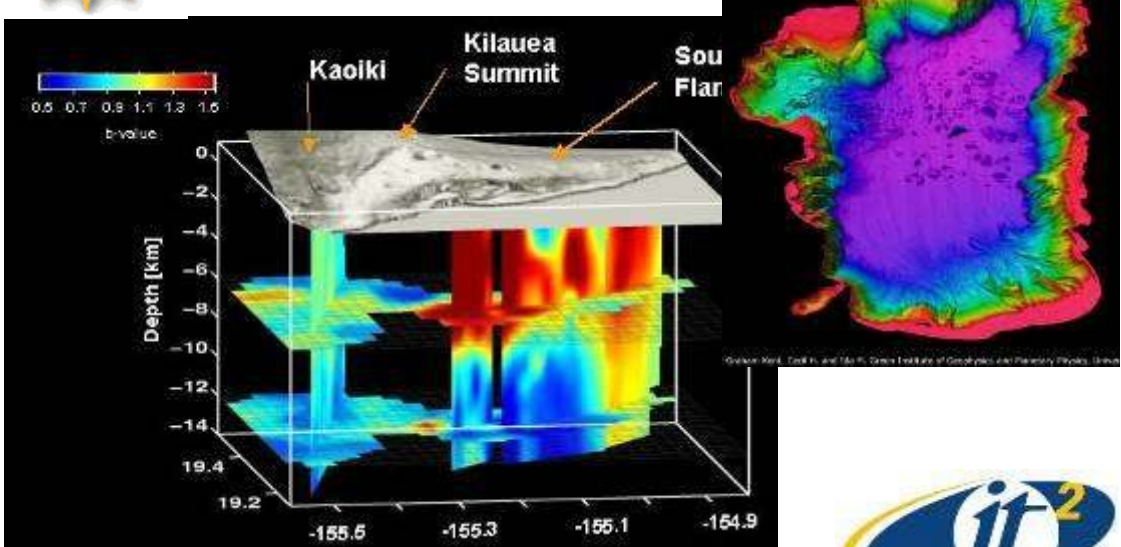
The OptIPuter Project – Linking Global Scale Science Resources to User's Linux Clusters

- **NSF Large Information Technology Research Proposal**
  - Calit2 (UCSD, UCI) and UIC Lead Campuses—Larry Smarr PI
  - Partnering Campuses: USC, SDSU, NW, TA&M, UvA, SARA, NASA
- **Industrial Partners**
  - IBM, Sun, Telcordia, Chiaro, Calient, Glimmerglass, Lucent
- **$13.5 Million Over Five Years—Entering 4th Year**
- **Creating a LambdaGrid "Web" for Gigabyte Data Objects**

NIH Biomedical Informatics Research Network



NSF EarthScope and ORION

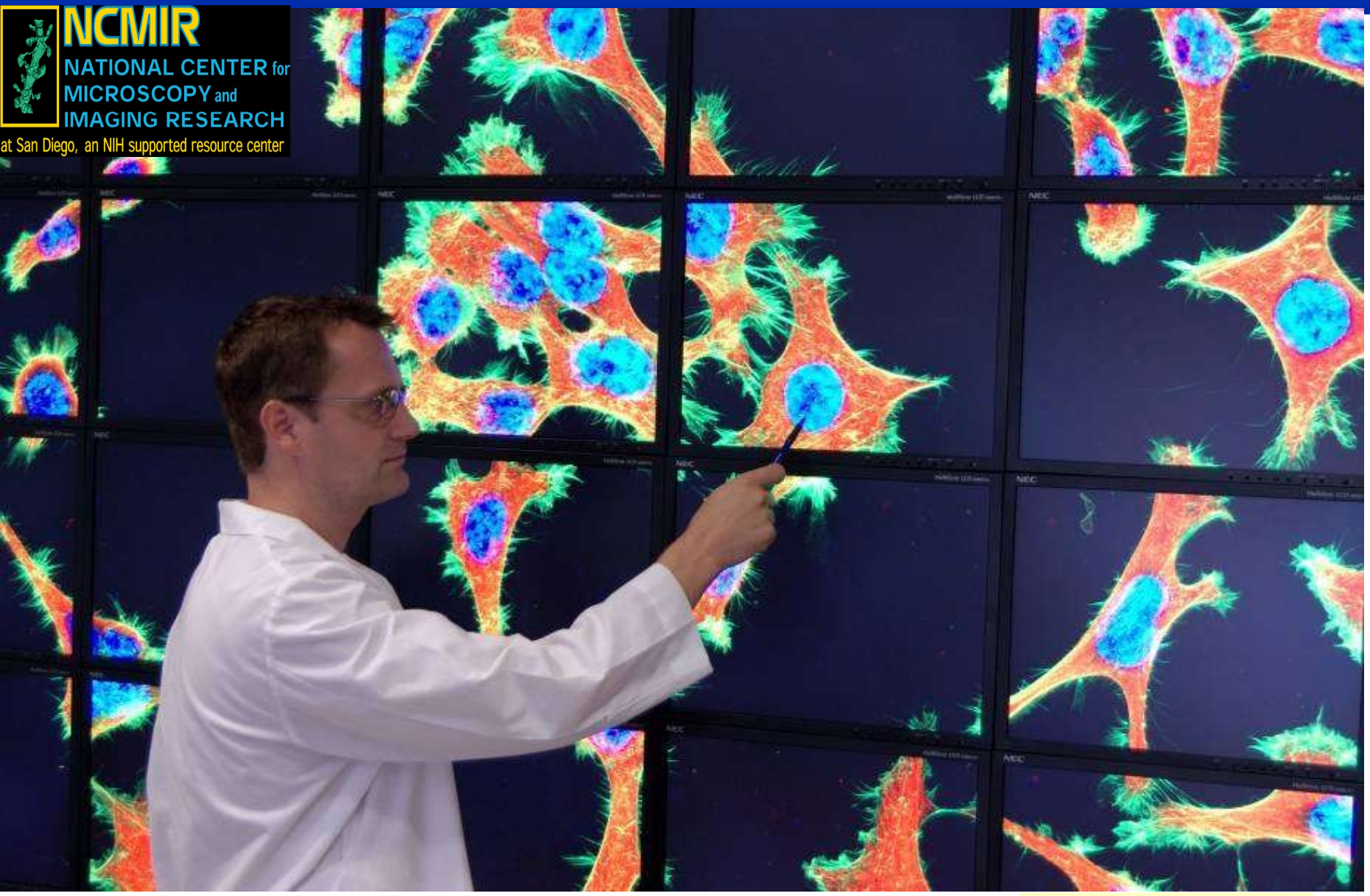


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SDSC SAN DIEGO SUPERCOMPUTER CENTER

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Increasing Data Rate into Lab by 100x, Requires High Resolution Portals to Global Science Data



Source: Mark Ellisman, David Lee, Jason Leigh, Tom Deerinck

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650 Mpixel 2-Photon Microscopy
Montage of HeLa Cultured Cancer Cells

Green: Actin
Red: Microtubles
Light Blue: DNA

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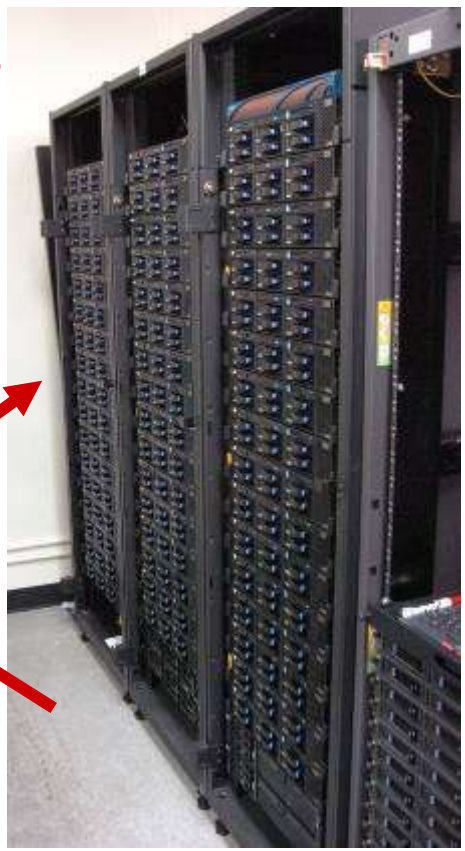
Campuses Must Provide Fiber Infrastructure to End-User Laboratories & Large Rotating Data Stores

SIO Ocean Supercomputer



UCSD Campus LambdaStore Architecture

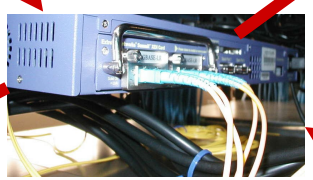
IBM Storage Cluster



Streaming Microscope

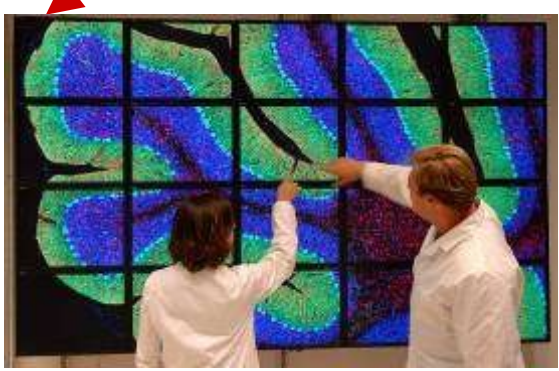






2 Ten Gbps Campus Lambda Raceway







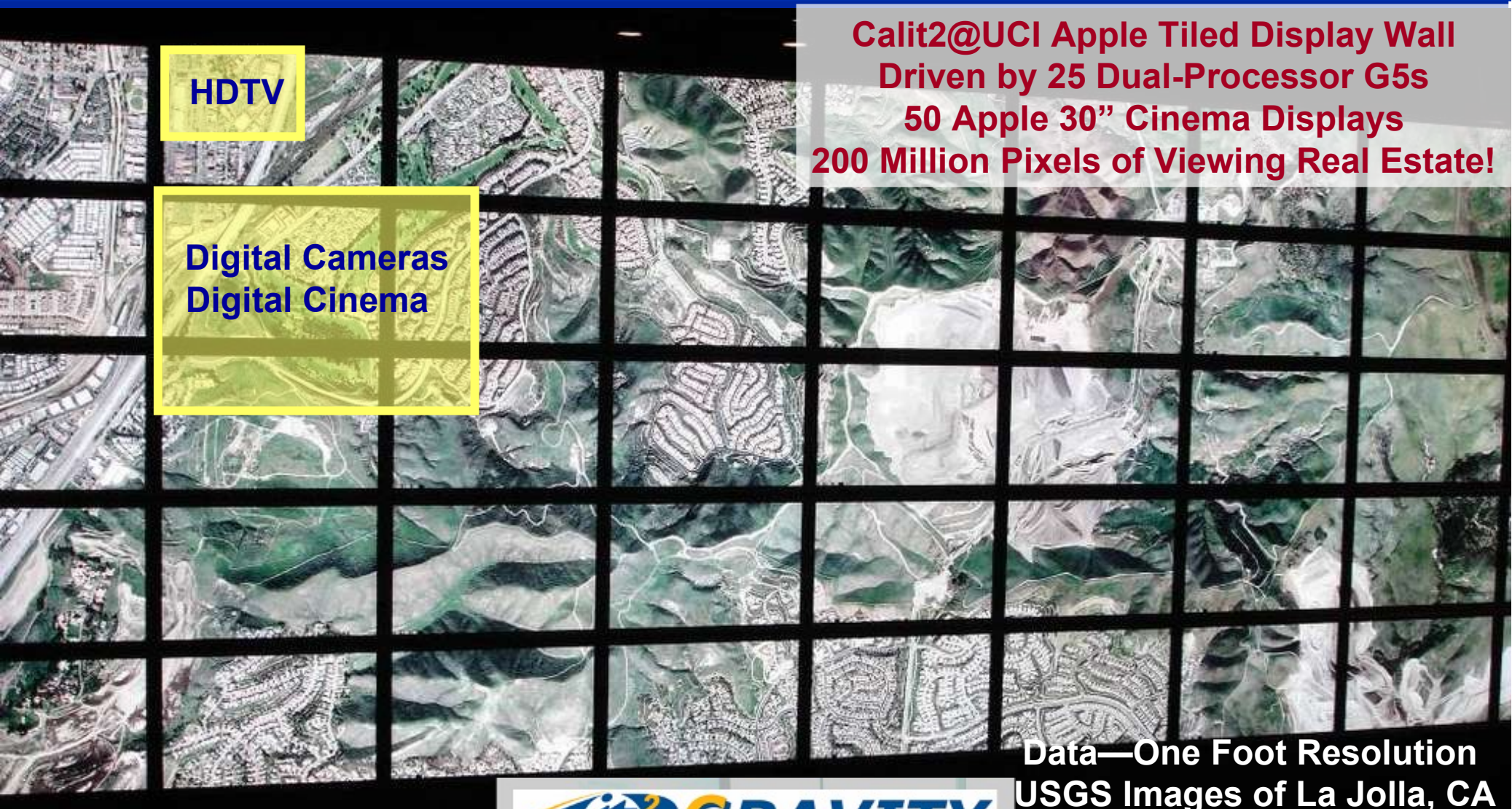
Global LambdaGrid

Source: Phil Papadopoulos, SDSC, Calit2

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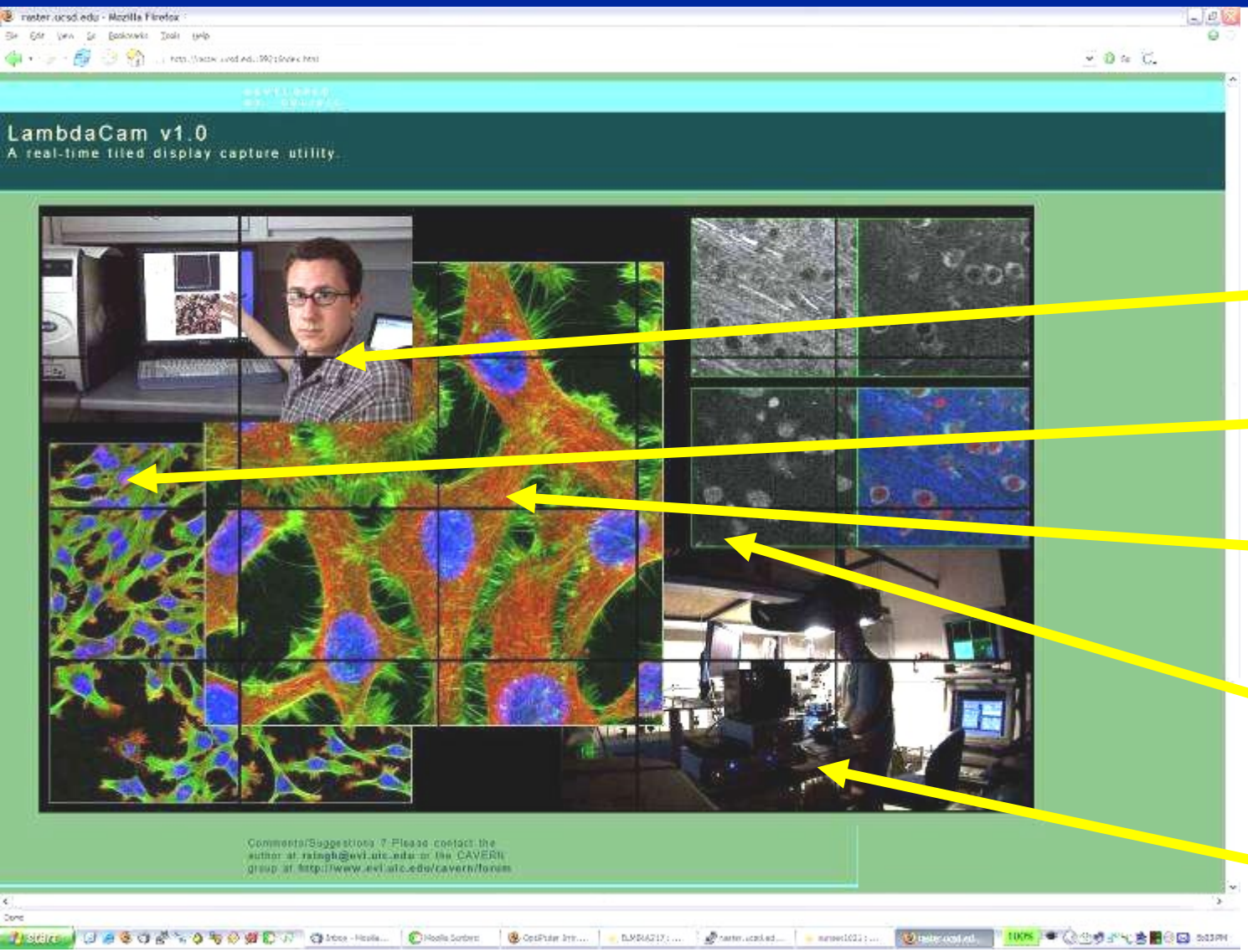
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Tiled Walls Allow for Integration of Streaming High Resolution Video



Source: Falko Kuester, Calit2@UCI
NSF Infrastructure Grant

OptIPuter Scalable Adaptive Graphics Environment (SAGE) Allows Integration of HD Streams



SAGE Developed Under Jason Leigh, EVL

- HD Video from BIRN Trailer
- Macro View of Montage Data
- Micro View of Montage Data
- Live Streaming Video of the RTS-2000 Microscope
- HD Video from the RTS Microscope Room

LambdaCam Used to Capture the Tiled Display on a Web Browser

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evl electronic visualization laboratory

Source: David Lee, NCMIR, UCSD

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

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Combining Telepresence with Remote Interactive Analysis of Data Over NLR

www.calit2.net/articles/article.php?id=660

