“Applying Photonics to User Needs: The Application Challenge"

Invited Talk to the
4th Annual ON*VECTOR International Photonics Workshop
Sponsored by NTT Network Innovation Laboratories
University of California, San Diego
La Jolla, CA
February 28, 2005

Dr. Larry Smarr

Director, California Institute for Telecommunications and Information Technology

Harry E. Gruber Professor,

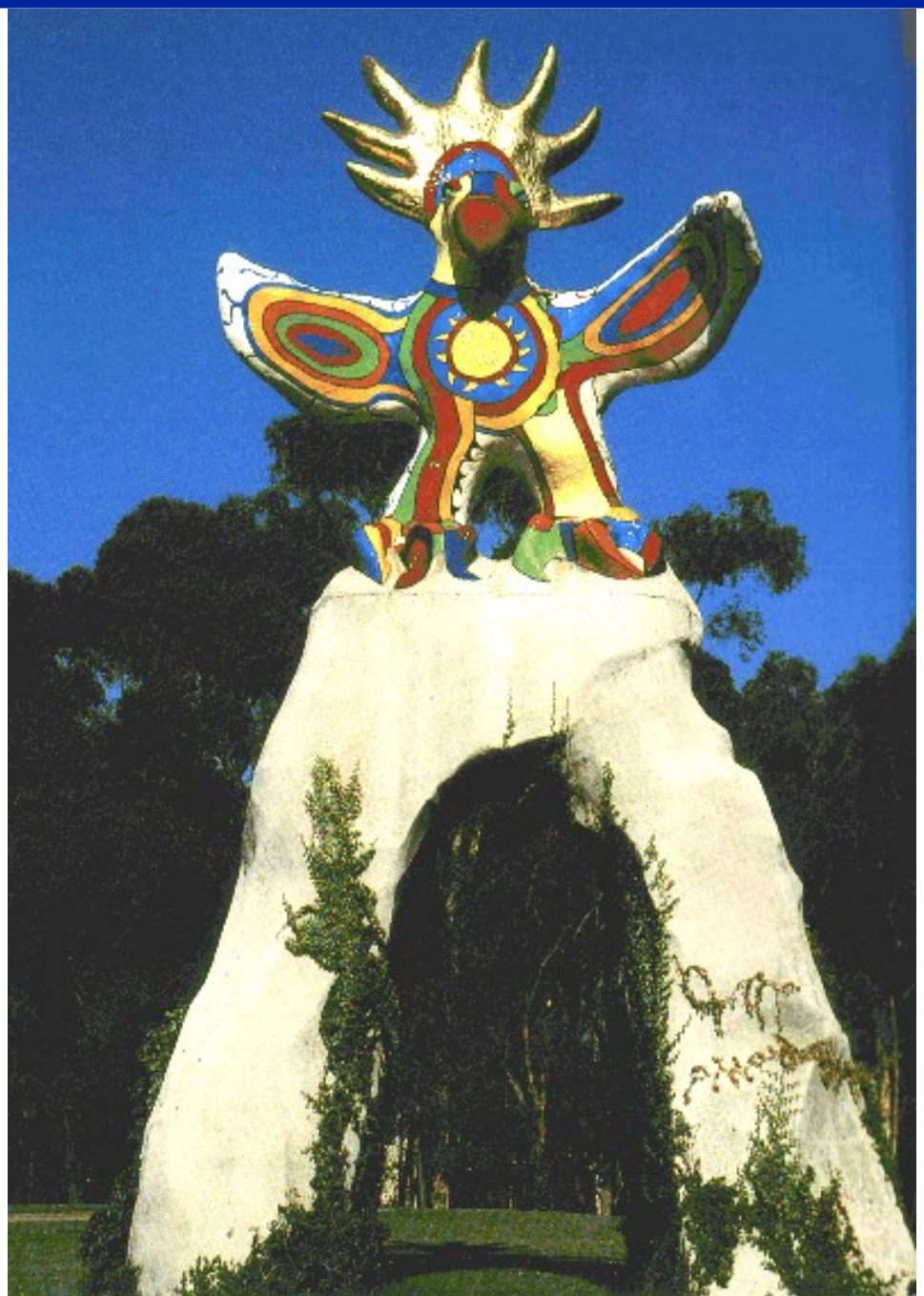
Dept. of Computer Science and Engineering

Jacobs School of Engineering, UCSD

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The ON*VECTOR International Photonics Workshop Gives Special Thanks to the UCSD Sun God



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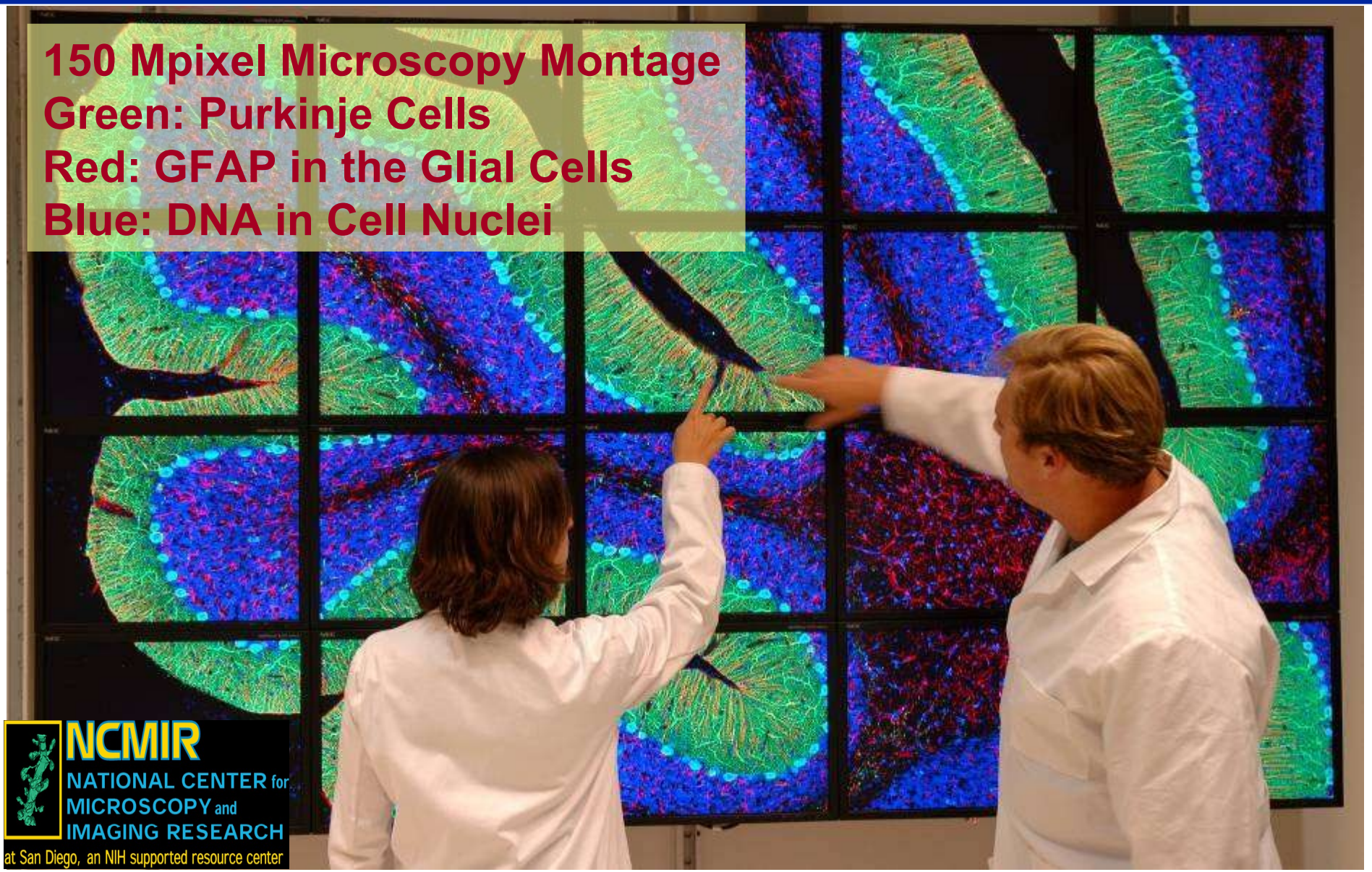
Four Classes of Applications are Driving the Optical Networked Virtual Environment for Collaborative Trans-Oceanic Research (ON*VECTOR)

- **Browsing & Analysis of Multiple Large Remote Data Objects**
- **Telepresence, CineGrid, and Shared Virtual Reality**
- **Assimilating Data—Linking Supercomputers with Data Sets**
- **Interacting with Remote Scientific Instruments**

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Realizing the Dream: High Resolution Portals to Global Science Data



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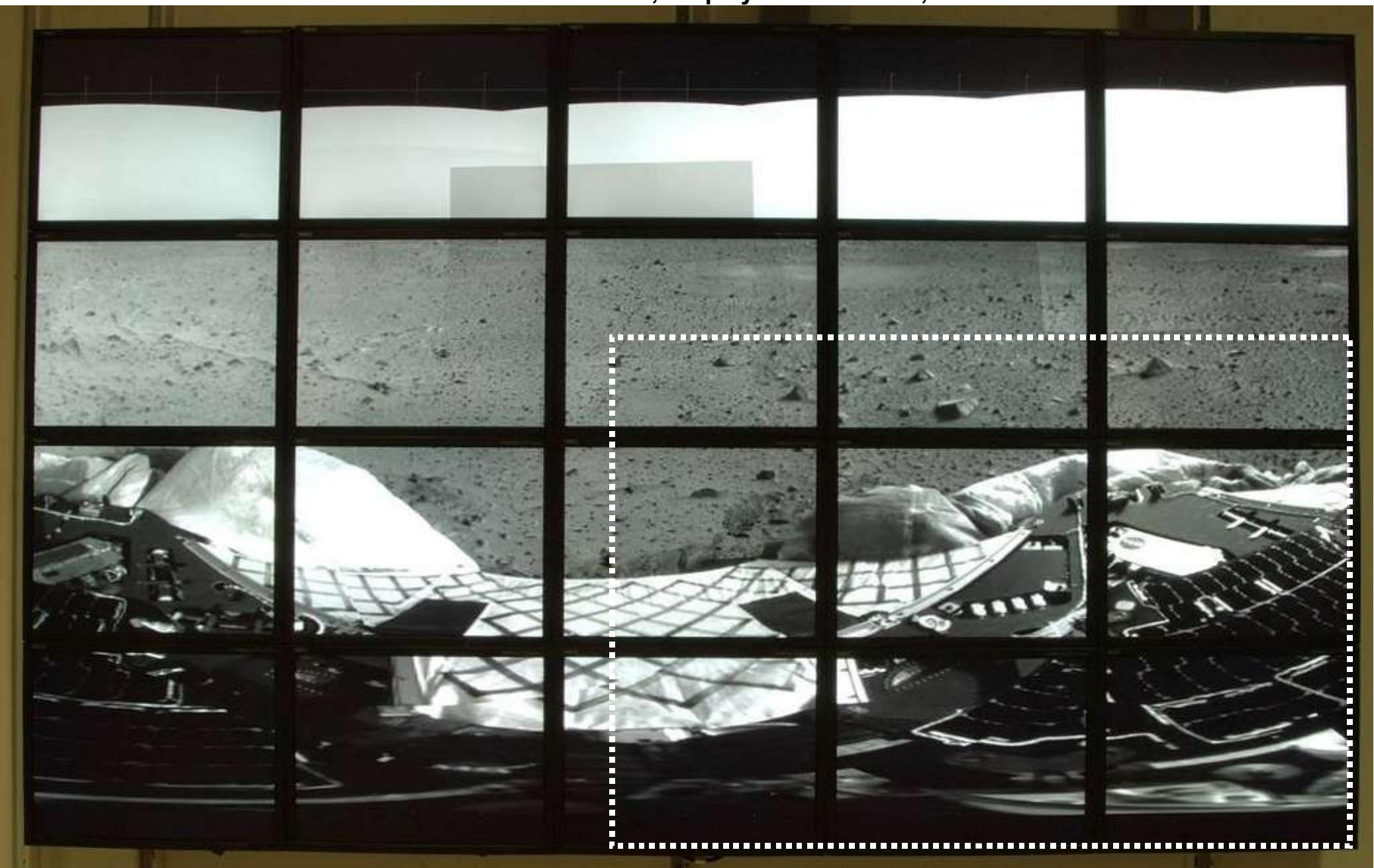
30 MPixel SunScreen Display Driven by a 20-node Sun Opteron Visualization Cluster

Source: Mark Ellisman, David Lee, Jason Leigh

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Tiled Displays Allow for Both Global Context and High Levels of Detail—150 MPixel Rover Image on 40 MPixel OptIPuter Visualization Node Display

"Source: Data from JPL/Mica; Display UCSD NCMIR, David Lee"



Interactively Zooming In Using EVL's JuxtaView on NCMIR's Sun Microsystems Visualization Node

"Source: Data from JPL/Mica; Display UCSD NCMIR, David Lee"

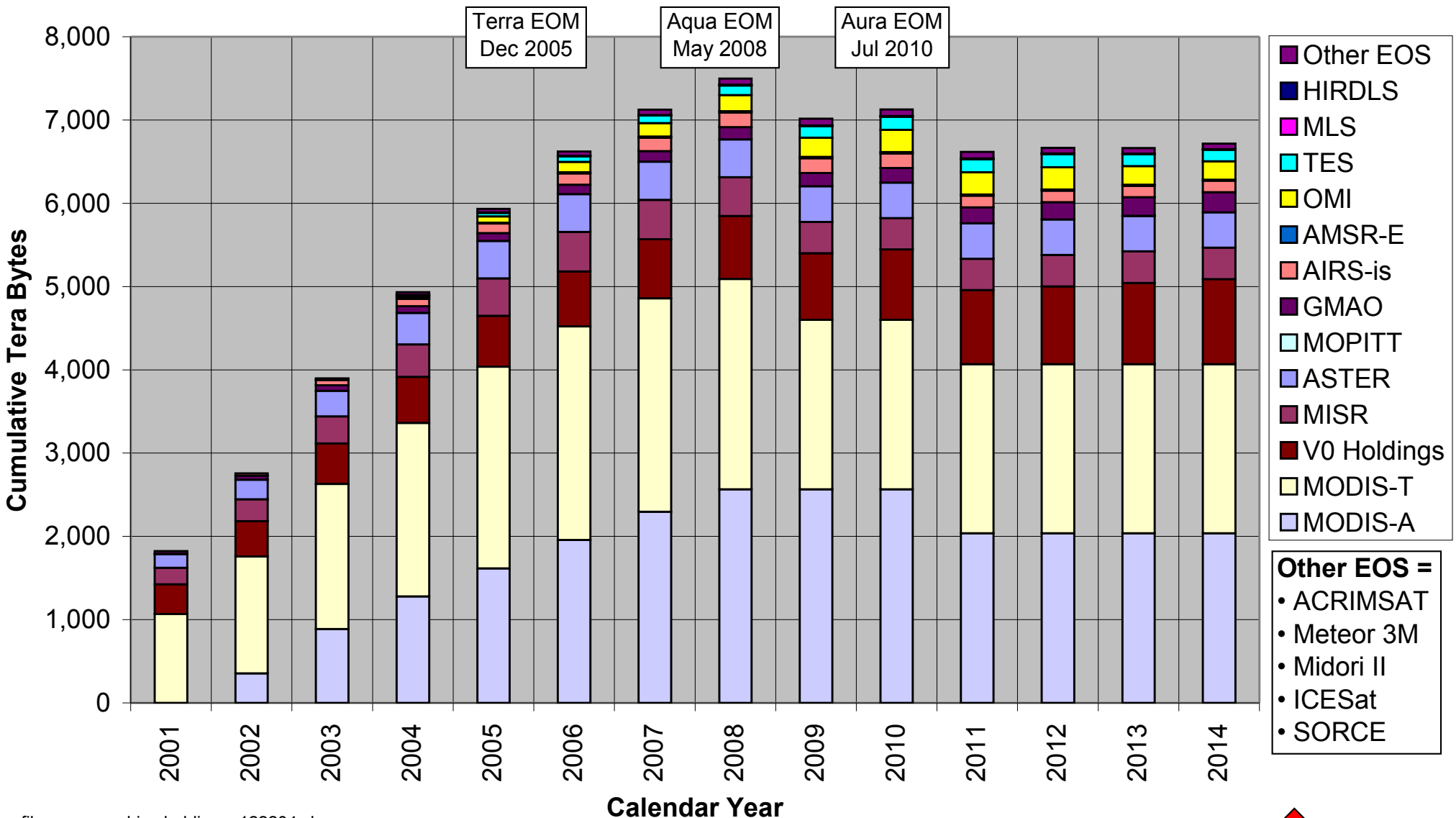


Highest Resolution Zoom on NCMIR 40 MPixel OptIPuter Display Node

"Source: Data from JPL/Mica; Display UCSD NCMIR, David Lee"



Cumulative EOSDIS Archive Holdings--Adding Several TBs per Day



file name: archive holdings_122204.xls
tab: all instr bar

NOTE: Data remains in the archive pending transition to LTA

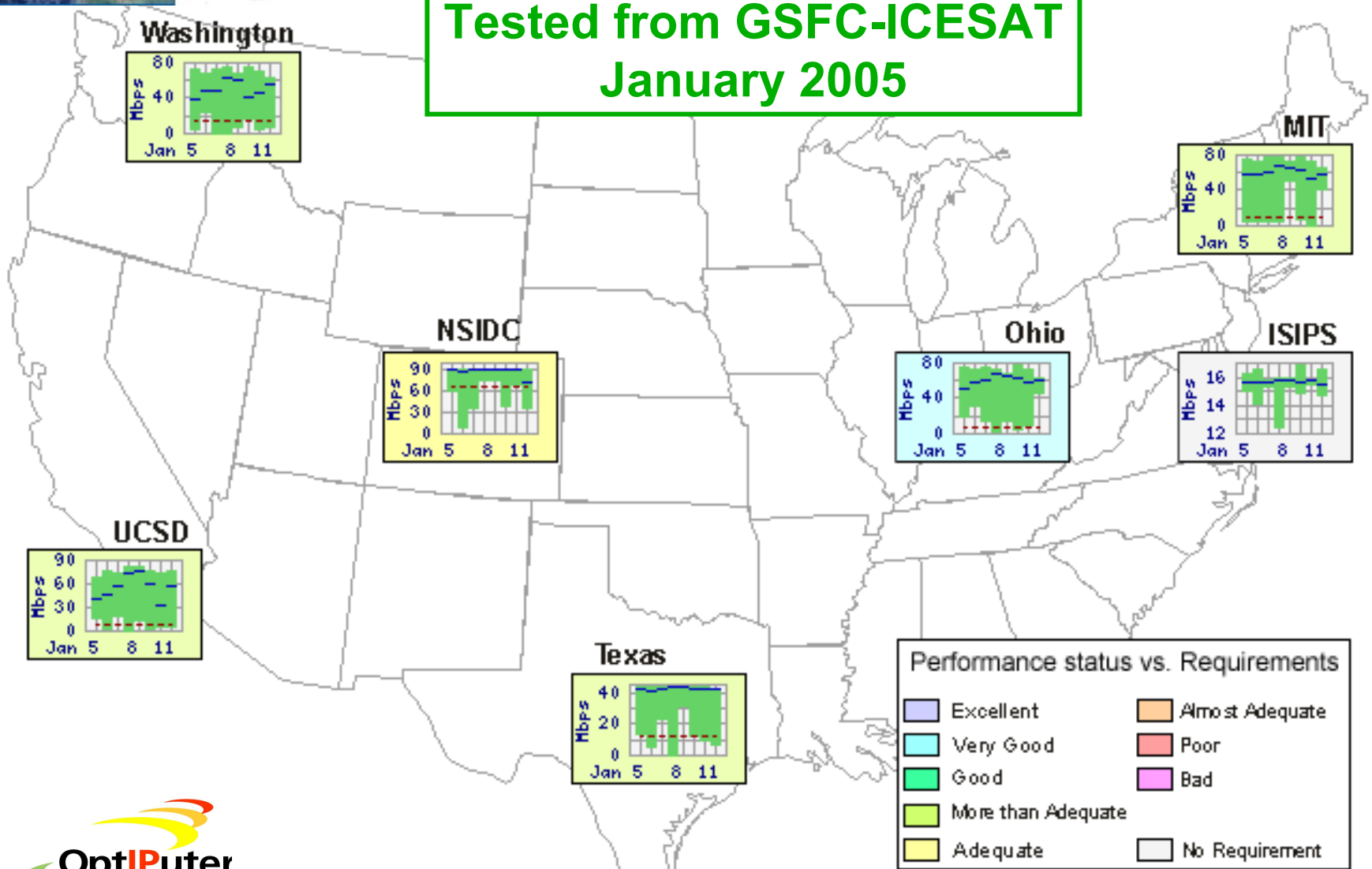
Source: Glenn Iona, EOSDIS Element Evolution Technical Working Group January 6-7, 2005

Challenge: Average Throughput of NASA Data Products to End User is Only < 50 Megabits/s



ENSIGHT Active Testing ICESat Destinations

Tested from GSFC-ICESAT January 2005



http://ensight.eos.nasa.gov/Missions/icesat/index.shtml

Interactive Retrieval and Hyperwall Display of Earth Sciences Images Using NLR

Enables Scientists To Perform Coordinated Studies Of Multiple Remote-Sensing Datasets

Source: Milt Halem & Randall Jones, NASA GSFC
& Maxine Brown, UIC EVL





Earth science data sets created by GSFC's Scientific Visualization Studio were retrieved across the NLR in real time from OptIPuter servers in Chicago and San Diego and from GSFC servers in McLean, VA, and displayed at the SC2004 in Pittsburgh

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http://esdcd.gsfc.nasa.gov/LNetphoto3.html

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High Resolution Aerial Photography Generates Images With 10,000 Times More Data than Landsat7

Landsat7 Imagery
100 Foot Resolution
Draped on elevation data





New USGS Aerial Imagery
At 1-Foot Resolution

~10x10 square miles of 350 US Cities
2.5 Billion Pixel Images Per City!

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Multi-Gigapixel Images are Available from Film Scanners Today



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The Gigapxl Project
http://gigapxl.org

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Large Image with Enormous Detail Require Interactive LambdaVision Systems



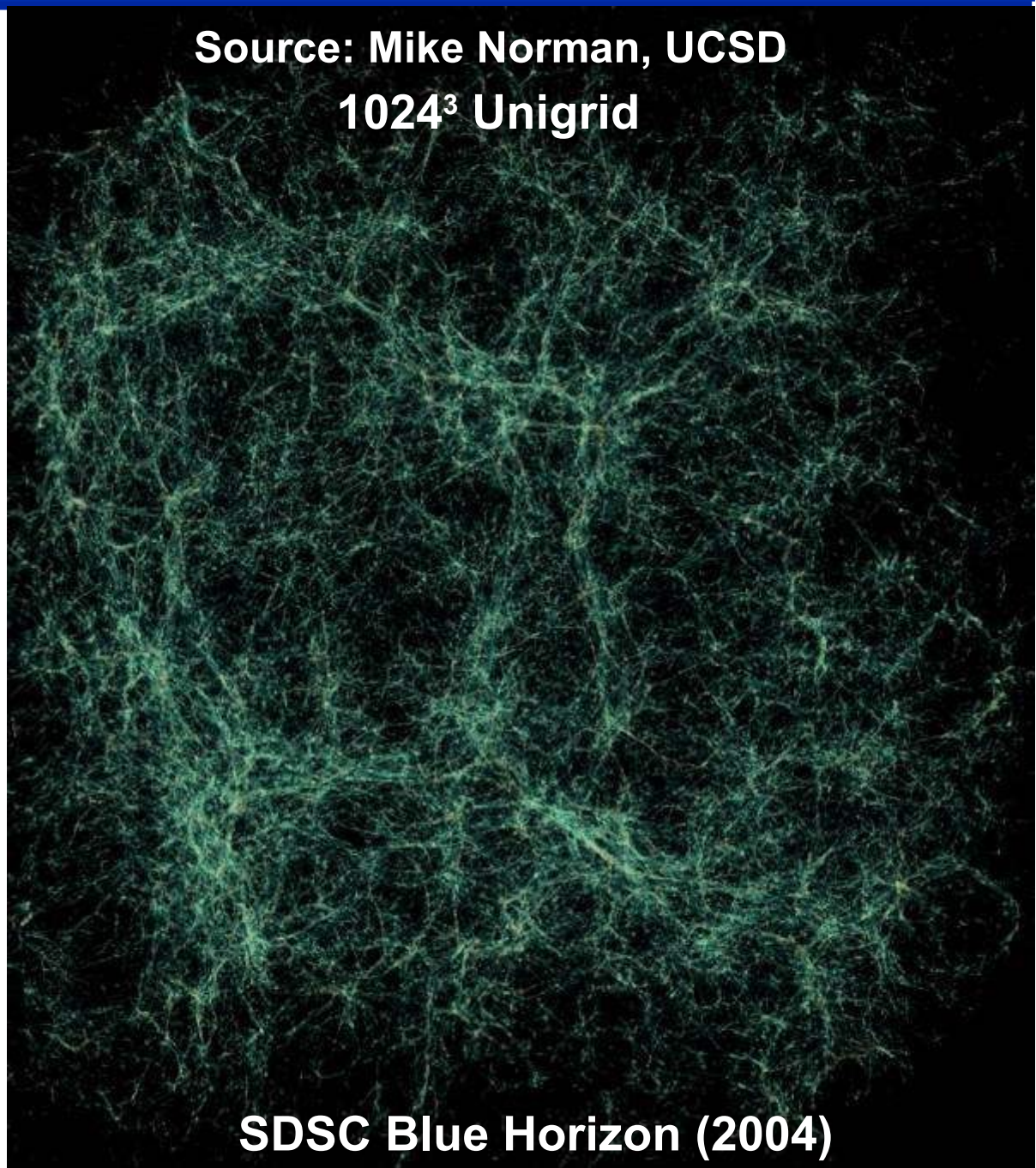
The OptIPuter Project is Pursuing Obtaining some of these Images for LambdaVision 100M Pixel Walls

One Square Inch Shot From 100 Yards

Cosmic Simulator with a Billion Zone and Gigaparticle Resolution

- 512^3 AMR or 1024^3 Unigrid
- 8-64 Times Mass Resolution
- Can Simulate First Galaxies
- One Gigazone Run:
  - Output ~10 TeraByte
  - "Snapshot" is 100 GB
  - Must Visually Analyze

To a LambdaGrid, a Supercomputer is Just Another High Performance Data Generator



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Four Classes of LambdaGrid Applications

- Browsing & Analysis of Multiple Large Remote Data Objects
- Telepresence, CineGrid, and Shared Virtual Reality
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- Interacting with Remote Scientific Instruments

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Telepresence Using Uncompressed HDTV Streaming Over IP on Fiber Optics







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JGN II Workshop
January 2005

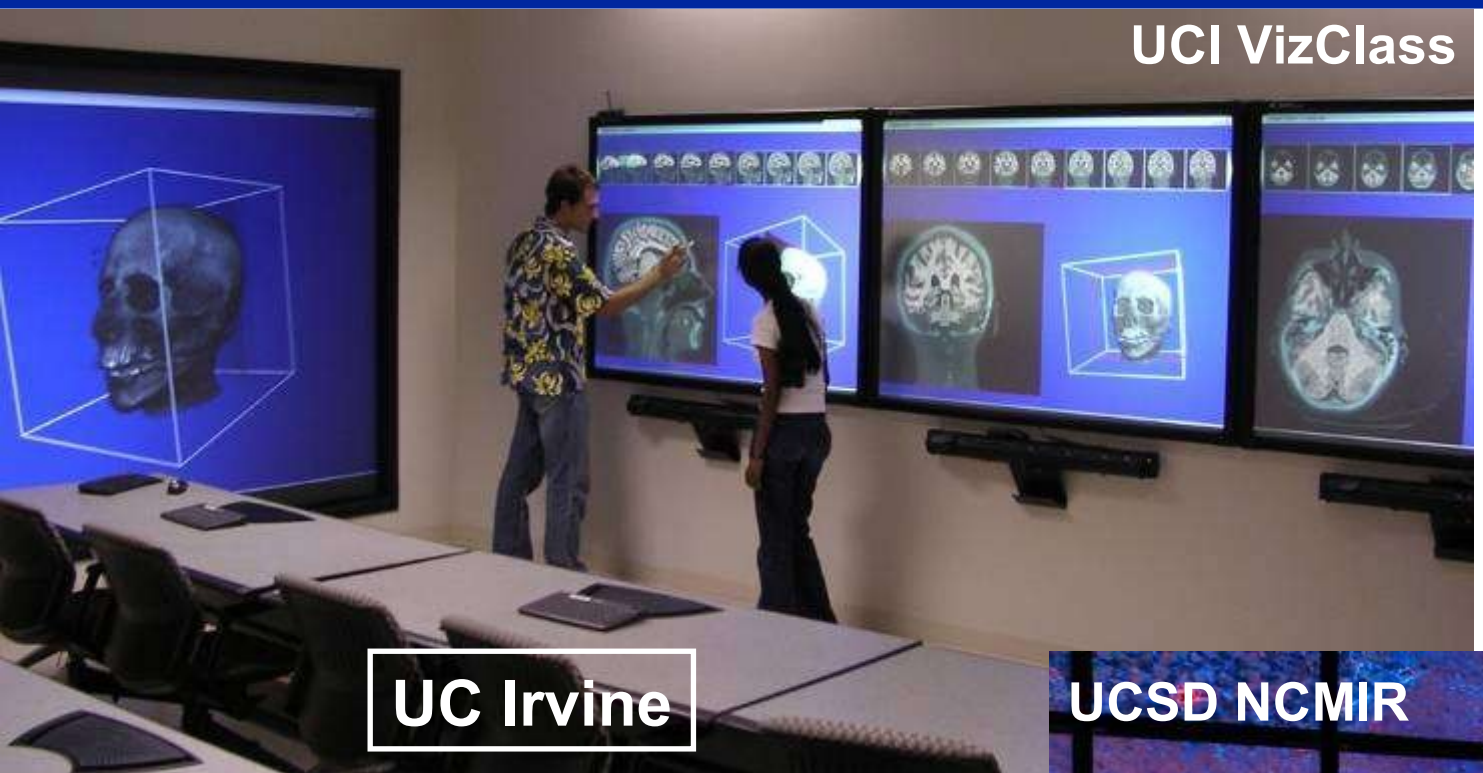
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Goal—Upgrade Access Grid to HD Streams Over IP on Dedicated Lambdas



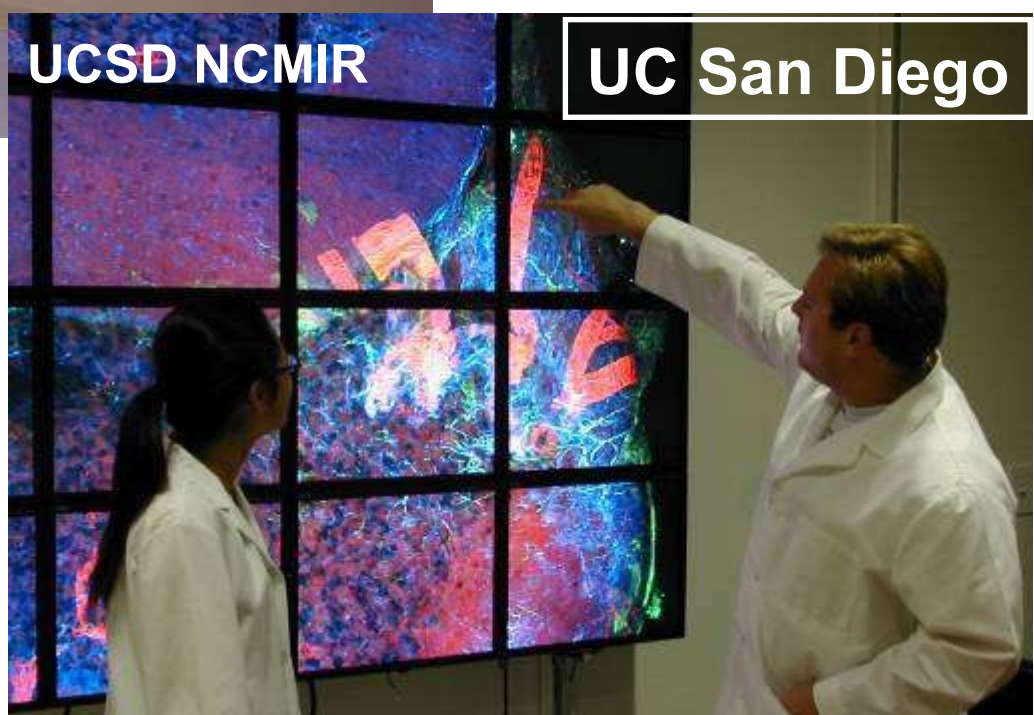
Access Grid Talk with 35 Locations on 5 Continents—SC Global Keynote Supercomputing 04

Calit2 Collaboration Rooms Testbed
UCI to UCSD



Source: Falko Kuester, UCI
& Mark Ellisman, UCSD

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In 2005 Calit2 will Link Its Two Buildings via CENIC-XD Dedicated Fiber over 75 Miles Using OptIPuter Architecture to Create a Distributed Collaboration Laboratory

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Applying the OptIPuter to Digital Cinema
The Calit2 CineGrid Project

- **Connect a Global Community of Users and Researchers**
  - Engineering a Camera-to-Theatre Integrated System
  - Create Digital CineGrid Production & Teaching Tools
  - Engage Artists, Producers, Scientists, Educators
- **Educational & Research Testbed Using OptIPuter Architecture**
  - Scaling to 4K SHD and Beyond!
  - Distributed Computing, Storage, Visualization & Collaboration
  - CAVEwave and Global Lambda Infrastructure Facility (GLIF)
  - Support CineGrid Network Operations from Calit2
- **Develop Partnerships with Industry and Universities, e.g.:**
  - USC School of Cinema-Television
  - DCTF in Japan
  - National School of Cinema in Italy

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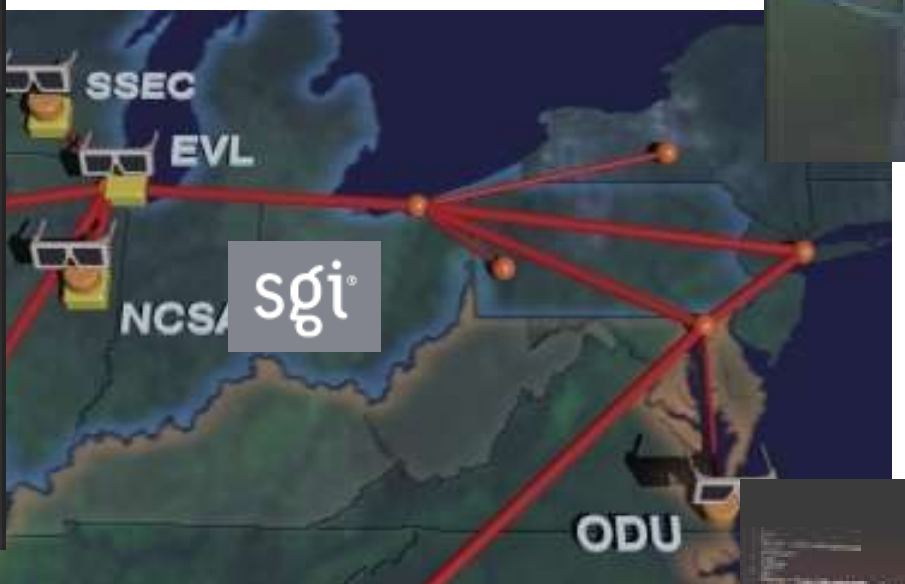
Source: Laurin Herr, Pacific-Interface

it²

Alliance 1997: Collaborative Video Production -- Upgrade to OptIPuter and CineGrid

Alliance Project Linking CAVE, Immersadesk, Power Wall, and Workstation via Tele-Immersion and Virtual Director











NCSA™ UIC

sgi

ALLIANCE

OptIPuter

Donna Cox, Bob Patterson, Stuart Levy, Glen Wheless
www.ncsa.uiuc.edu/People/cox/

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Four Classes of LambdaGrid Applications

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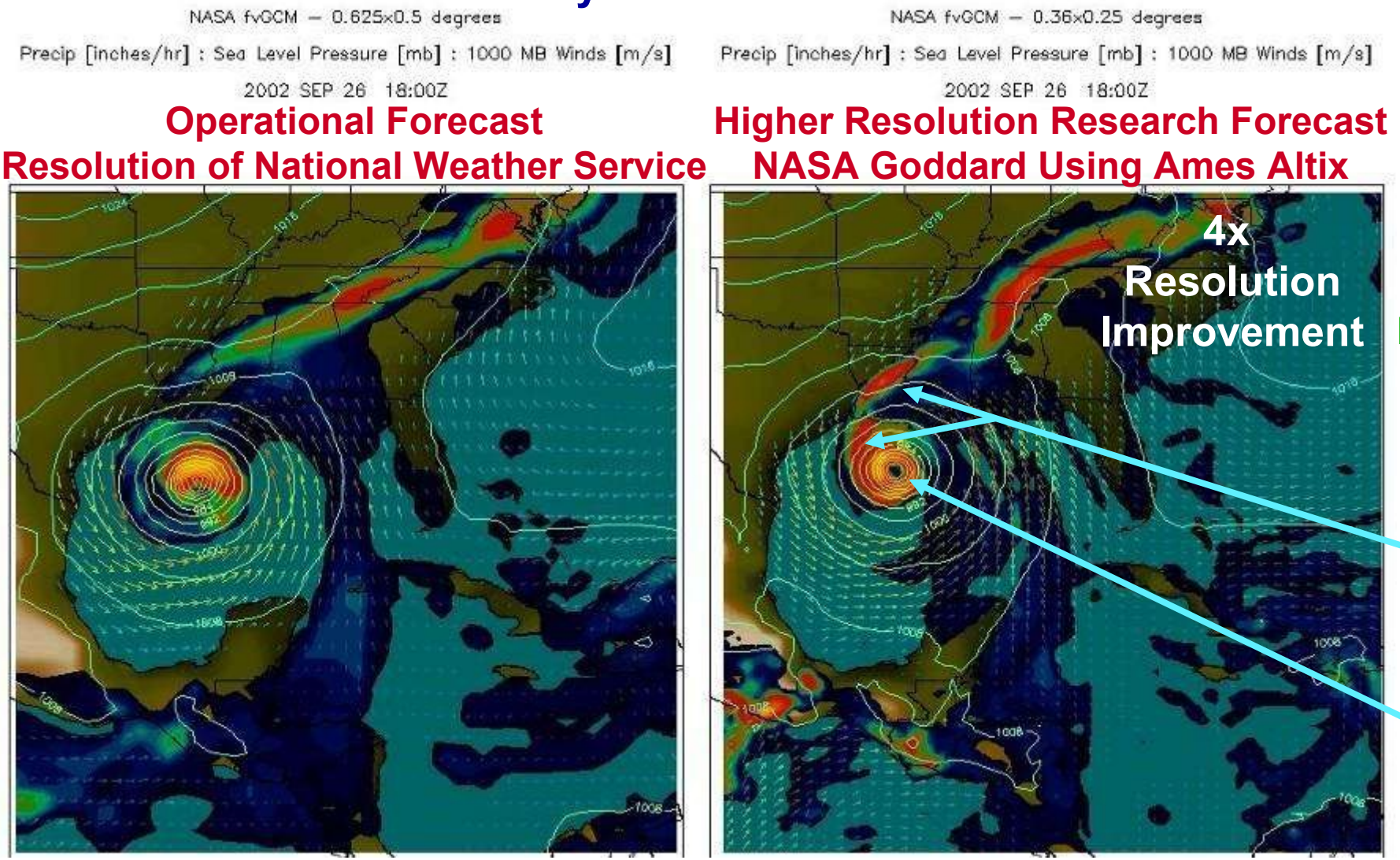
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Increasing Accuracy in Hurricane Forecasts

Real Time Diagnostics in GSFC of Ensemble Runs on ARC Project Columbia

5.75 Day Forecast of Hurricane Isidore



Operational Forecast Resolution of National Weather Service

Higher Resolution Research Forecast NASA Goddard Using Ames Altix

NLR will Remove the InterCenter Networking Bottleneck

Intense Rain-Bands

Resolved Eye Wall

Source: Bill Putman, Bob Atlas, GFSC

OptIPuter

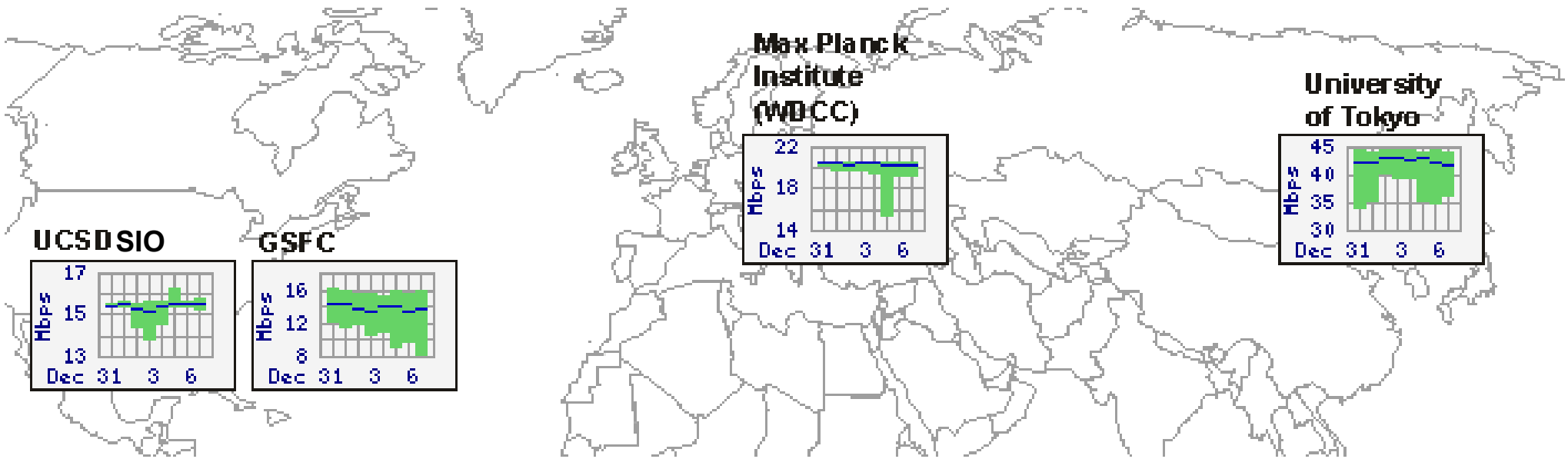
Project Contacts: Ricky Rood, Bob Atlas, Horace Mitchell, GSFC; Chris Henze, ARC

it2

Next Step: OptIPuter, NLR, and Starlight Enabling Coordinated Earth Observing Program (CEOP)

Source: Milt Halem, NASA GSFC

Accessing 300TB's of Observational Data in Tokyo and 100TB's of Model Assimilation Data in MPI in Hamburg -- Analyzing Remote Data Using GRaD-DODS at These Sites Using OptIPuter Technology Over the NLR and Starlight



Note Current Throughput 15-45 Mbps: OptIPuter 2005 Goal is ~1-10 Gbps!

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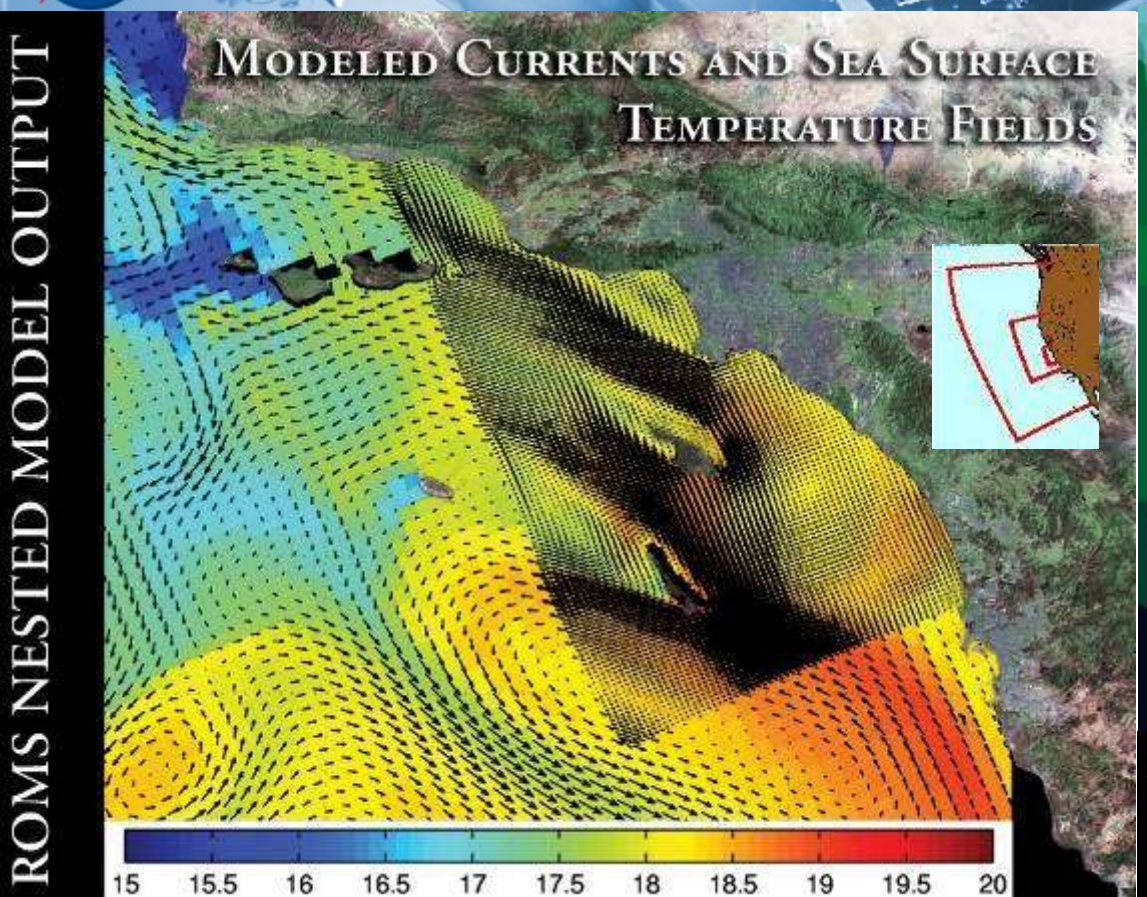
http://ensight.eos.nasa.gov/Organizations/ceop/index.shtml

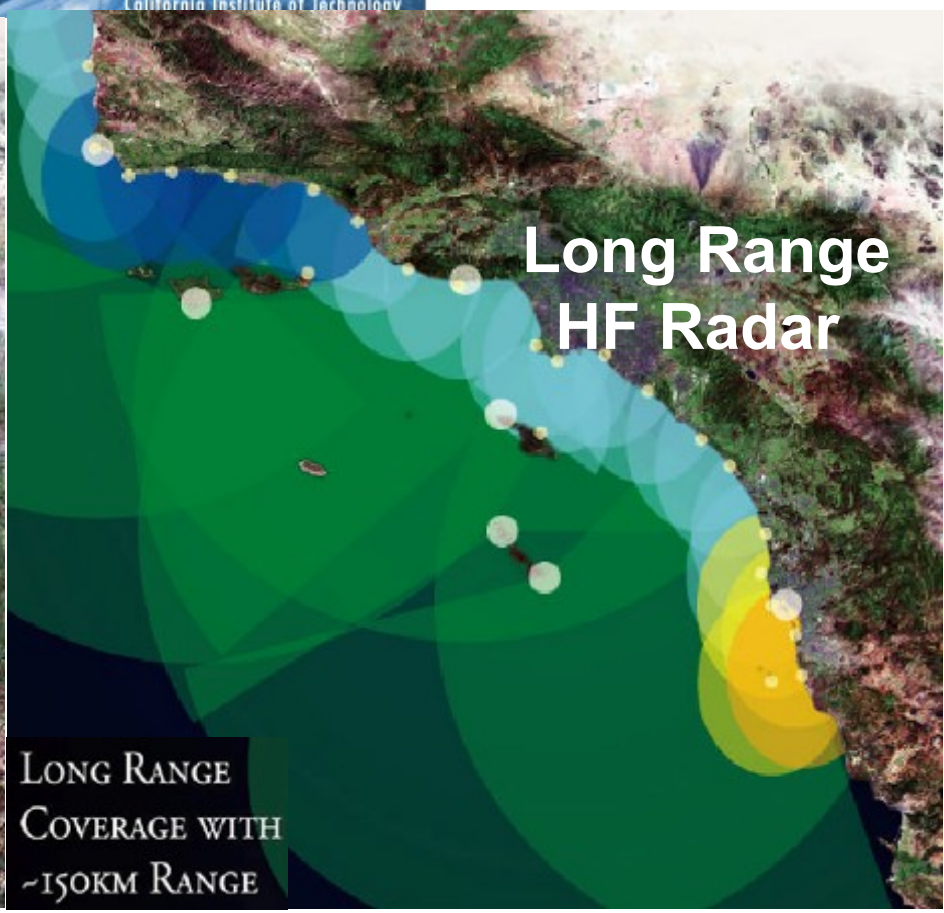
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Use OptIPuter to Couple Data Assimilation Models to Remote Data Sources and Analysis in Near Real Time



Goal is Real Time Local Digital Ocean Models





JPL ONR MBARI

OptIPuter

Regional Ocean Modeling System (ROMS)

http://ourocean.jpl.nasa.gov/

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Four Classes of LambdaGrid Applications

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- Interacting with Remote Scientific Instruments

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

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





HDTV



Southern California OptIPuter

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

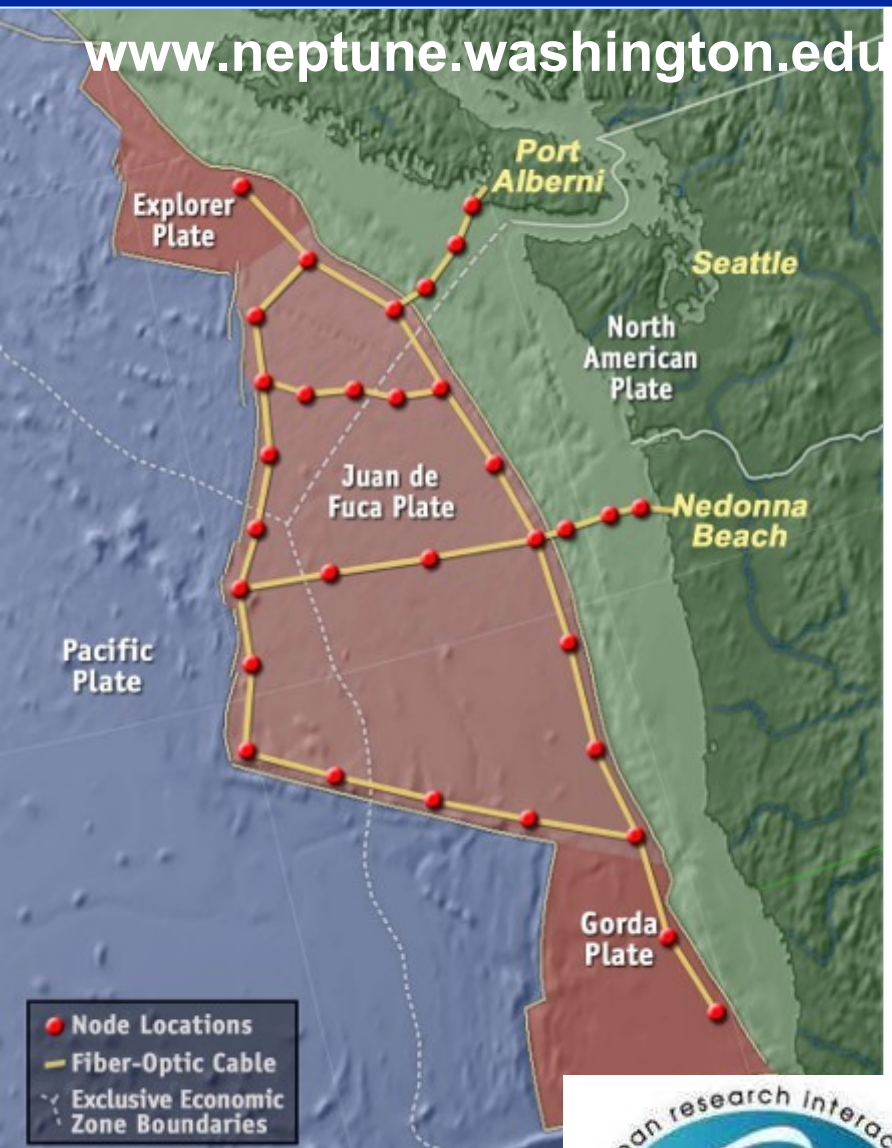
OSAKA UNIVERSITY

KDDI GROUP KDDI Labs USA

Source: Mark Ellisman, UCSD

it²

New OptIPuter Application Driver: Gigabit Fibers on the Ocean Floor



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

- **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**
- **Goal: Prototype Cyberinfrastructure for NSF ORION**

LOOKING--
Integrate Instruments & Sensors
(Real Time Data Sources)
Into a LambdaGrid
Computing Environment
With Web Services Interfaces

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NSF

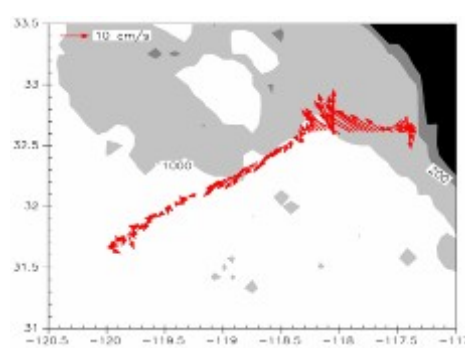
ocean research interactive ORION observatory networks

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LOOKING Builds on the Multi- Institutional SCCOOS Program, OptIPuter, and CENIC-XD

- **SCCOOS is Integrating:**
  - 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

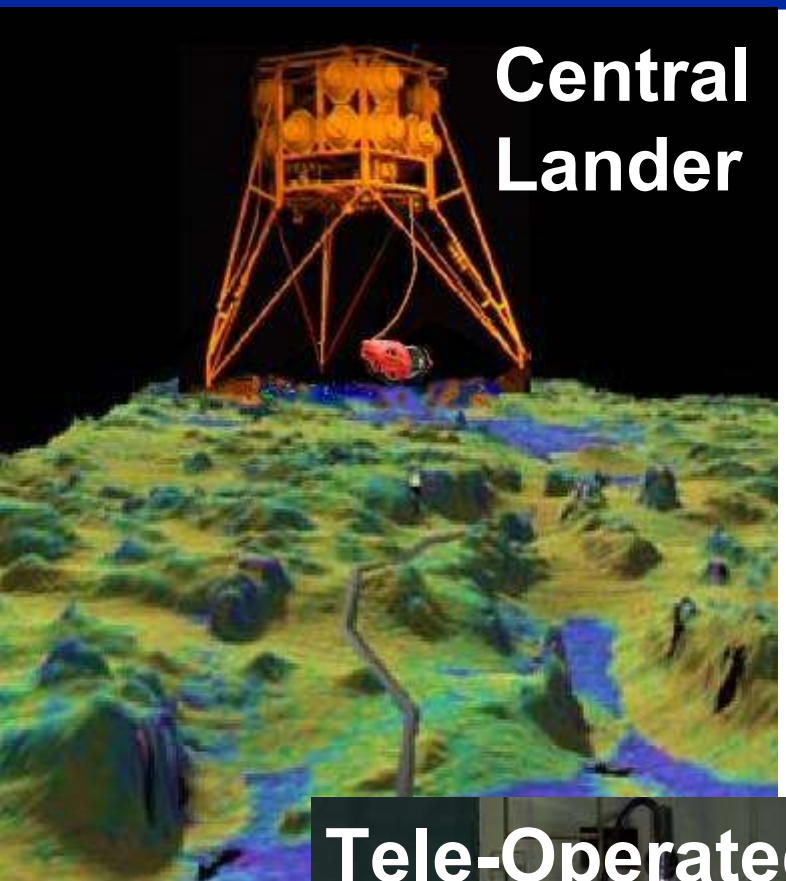






OptIPuter NSF ROADNet

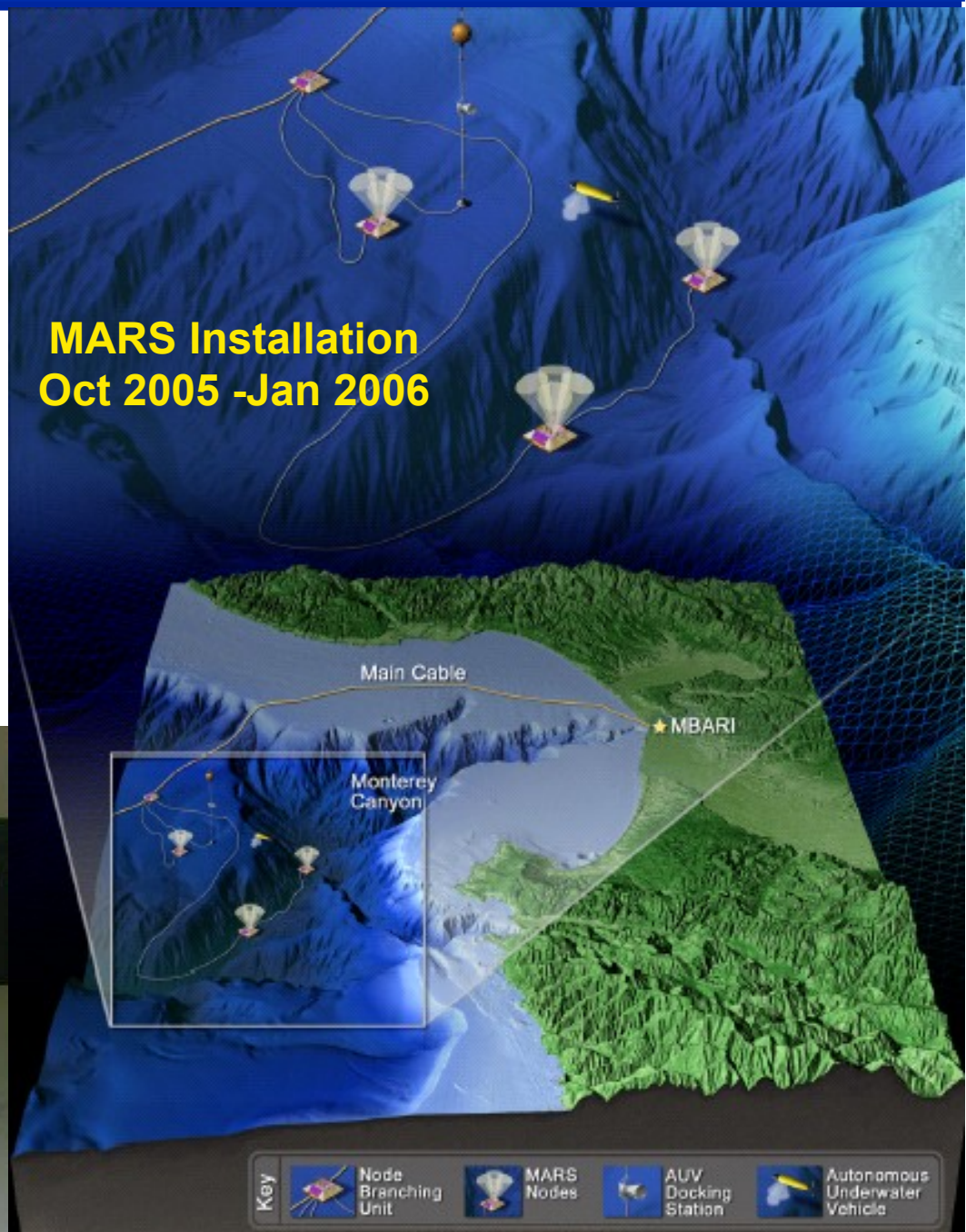
MARS New Gen Cable Observatory Testbed - Capturing Real-Time Basic Environmental Data





Source:
Jim
Bellingham,
MBARI

OptIPuter



Goal – From Expedition to Cable 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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The Networking Double Header of the Century Will Be Driven by LambdaGrid Applications

Maxine Brown, Tom DeFanti, Co-Organizers



iGrid 2005

THE GLOBAL LAMBDA INTEGRATED FACILITY



www.startap.net/igrid2005/

September 26-30, 2005

University of California, San Diego

California Institute for Telecommunications and Information Technology



SC|05 Gateway to Discovery

Washington State Convention and Trade Center Seattle, WA
November 12-18 2005

http://sc05.supercomp.org

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