“Cyberinfrastructure to Support Ocean Observatories"

Invited Talk at the
NCSA Booth
Supercomputing 2006
Tampa, FL
November 16, 2006

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

Chair, NASA Earth System Science and Applications Advisory Committee

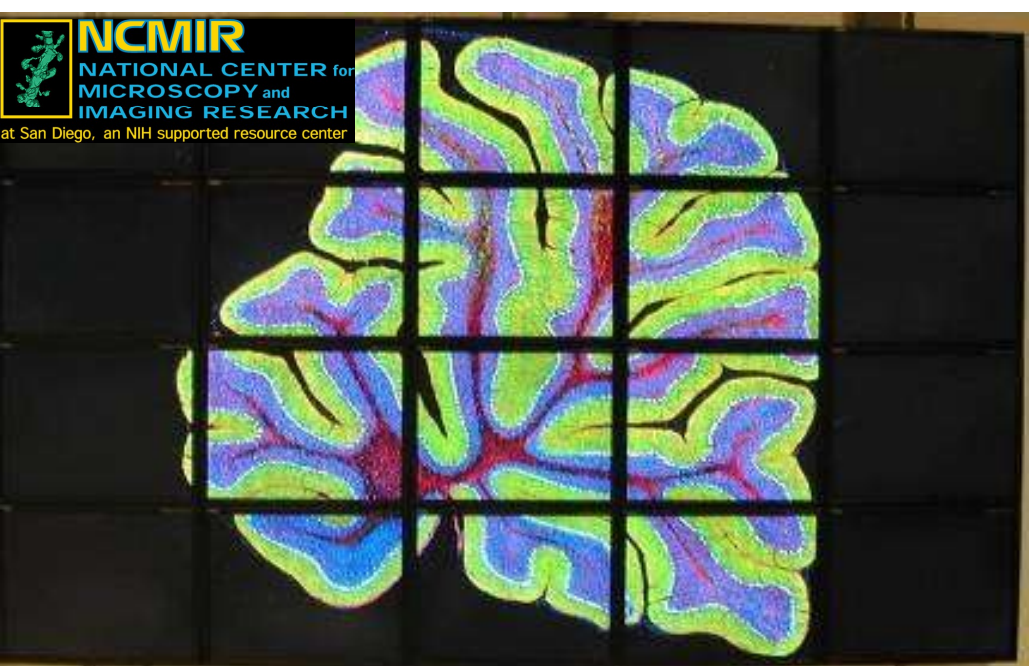
OptIPuter

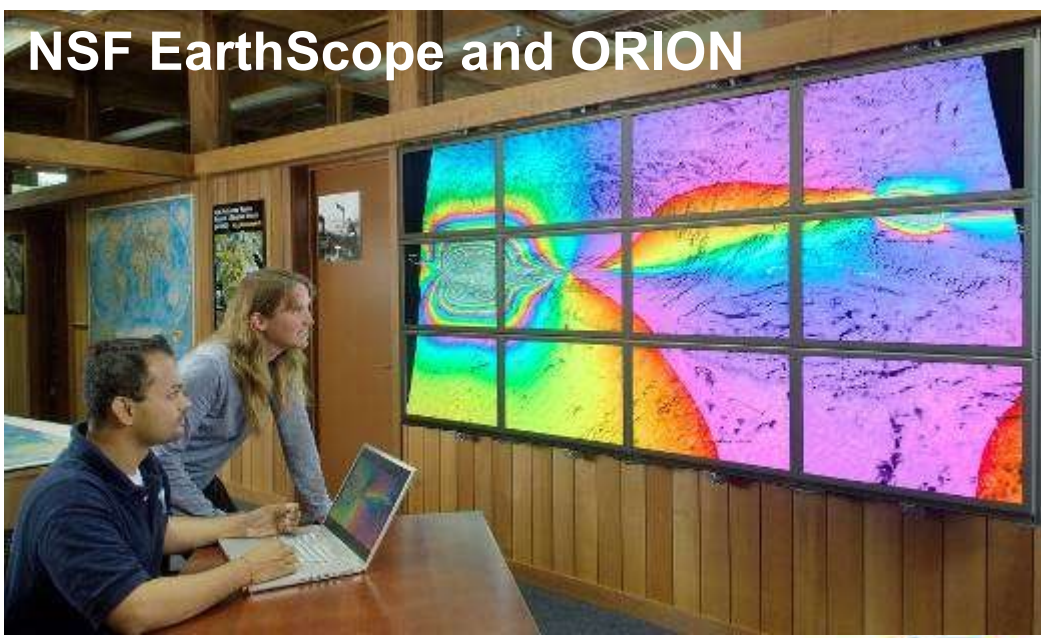
it²

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 Fifth Year

NIH Biomedical Informatics Research Network





SCRIPPS INSTITUTION OF OCEANOGRAPHY

Calit2 is Partnering with UCSD's Center for Earth Observations and Applications

- Viewing and Analyzing Earth Satellite Data Sets
- High Accuracy Topographic Measurements
- Project Atmospheric Brown Clouds
- Climate Modeling
- Coastal Zone Data Assimilation
- Ocean Observatories











Calit2, SDSC, and SIO are Creating Environmental Observatory Control Rooms



OptIPuter

it²

Groups are Forming to Monitor Remote Environments in Real Time



Coral Reef
Environmental
Observatory Network



global lake ecological observatory network

OptIPuter

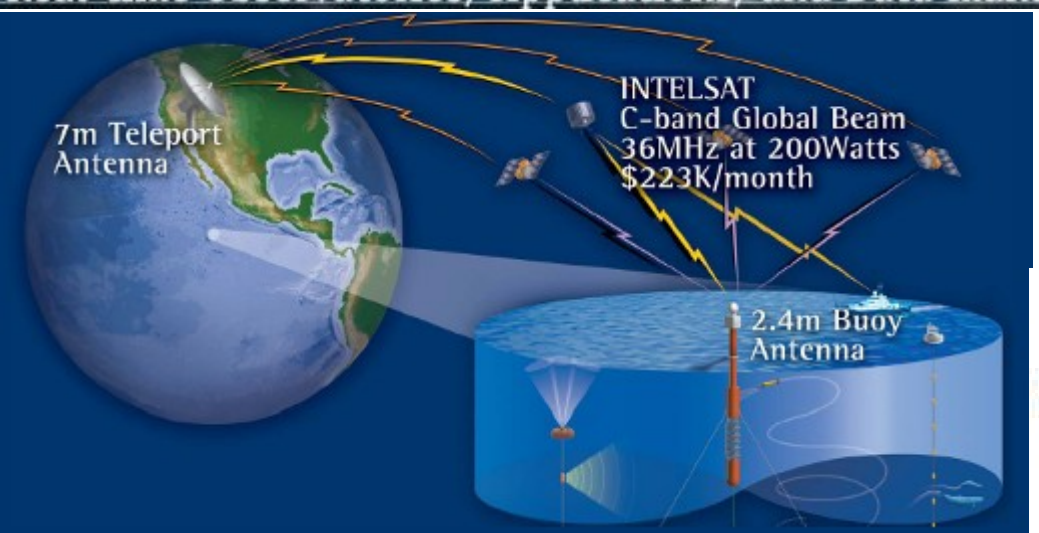
it²

ROADnet and HiSeasNet are Prototypes of the Future of *In Situ* Earth Observing Systems

BRINGING THE INFORMATION SUPERHIGHWAY TO THE DIRT ROAD AND THE HIGH SEAS

http://roadnet.ucsd.edu

Real-time Observatories, Applications, and Data management Network ROADNet



Office of Naval Research

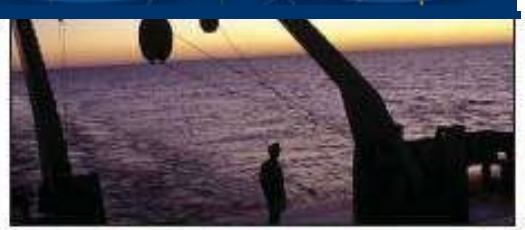
NSF

SDSU

SDSC
SAN DIEGO SUPERCOMPUTER CENTER

IGPP









HiSeasNet

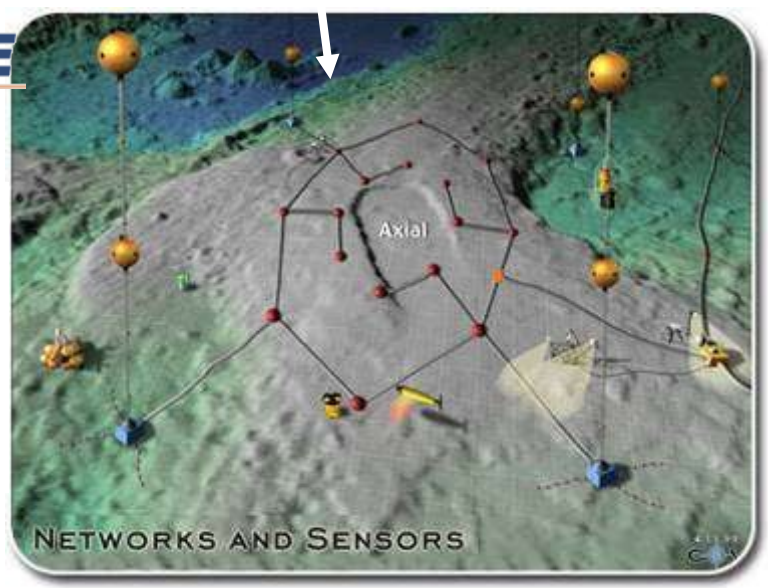
The Real-time Observatories, Applications and Data management Network is an interdisciplinary collaboration funded by the National Science Foundation and the Office of Naval Research. Participating institutions include Scripps Institution of Oceanography and the San Diego Supercomputer Center at the University of California, San Diego.

PROVIDING COMMUNICATIONS AND NETWORKING FOR THE ORION FLEET OF MOORED OCEAN OBSERVATORIES

NSF's Ocean Observatories Initiative (OOI) Envisions Global, Regional, and Coastal Scales



NEPTUNE



LEO15 Inset Courtesy of Rutgers University, Institute of Marine and Coastal Sciences

NSF

ocean research interactive ORION observatory networks

OptIPuter

it2

New OptIPuter Driver: Gigabit Fibers on the Ocean Floor -- Controlling Sensors and HDTV Cameras Remotely



LOOKING is Driven By NEPTUNE CI Requirements

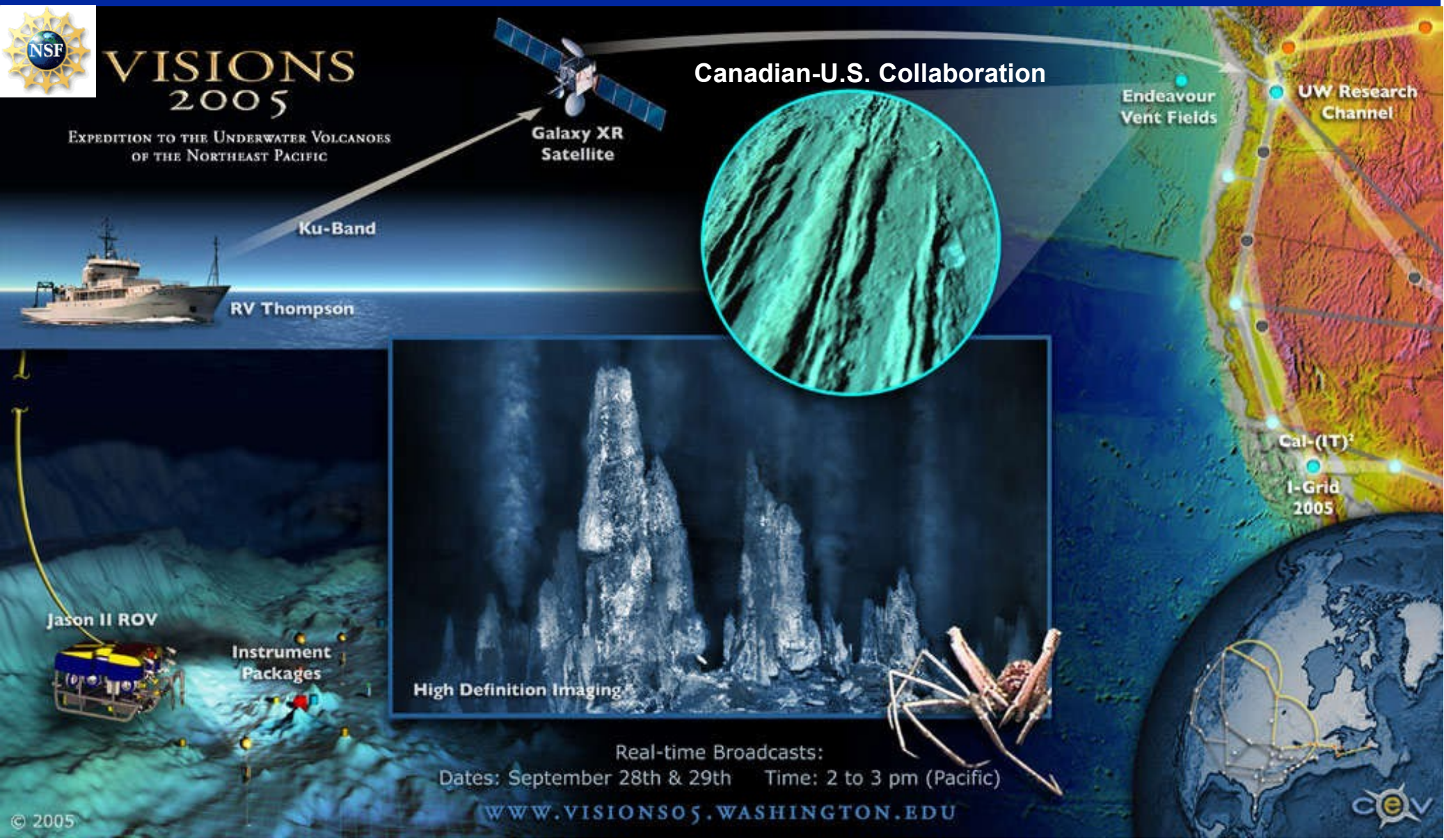
LOOKING:
(Laboratory for the Ocean Observatory Knowledge Integration Grid)

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

Making Management of Gigabit Flows Routine

First Remote Interactive High Definition Video Exploration of Deep Sea Vents



OptIPuter

Source John Delaney & Deborah Kelley, UWash

it²

High Definition Still Frame of Hydrothermal Vent Ecology 2.3 Km Deep

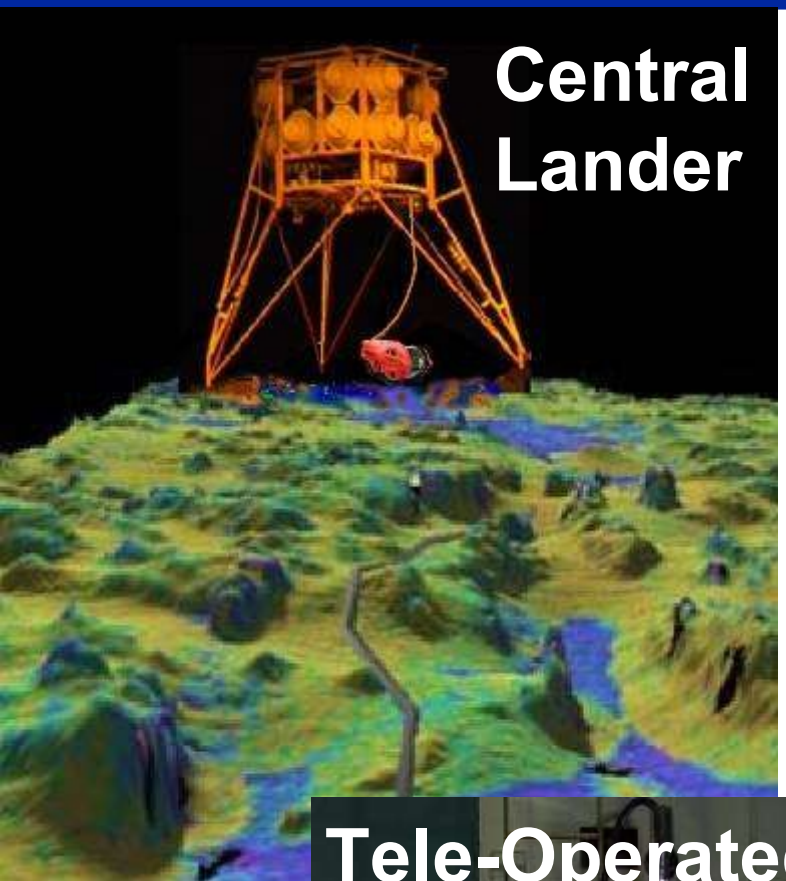


White Filamentous Bacteria on 'Pill Bug' Outer Carapace

OptIPuter

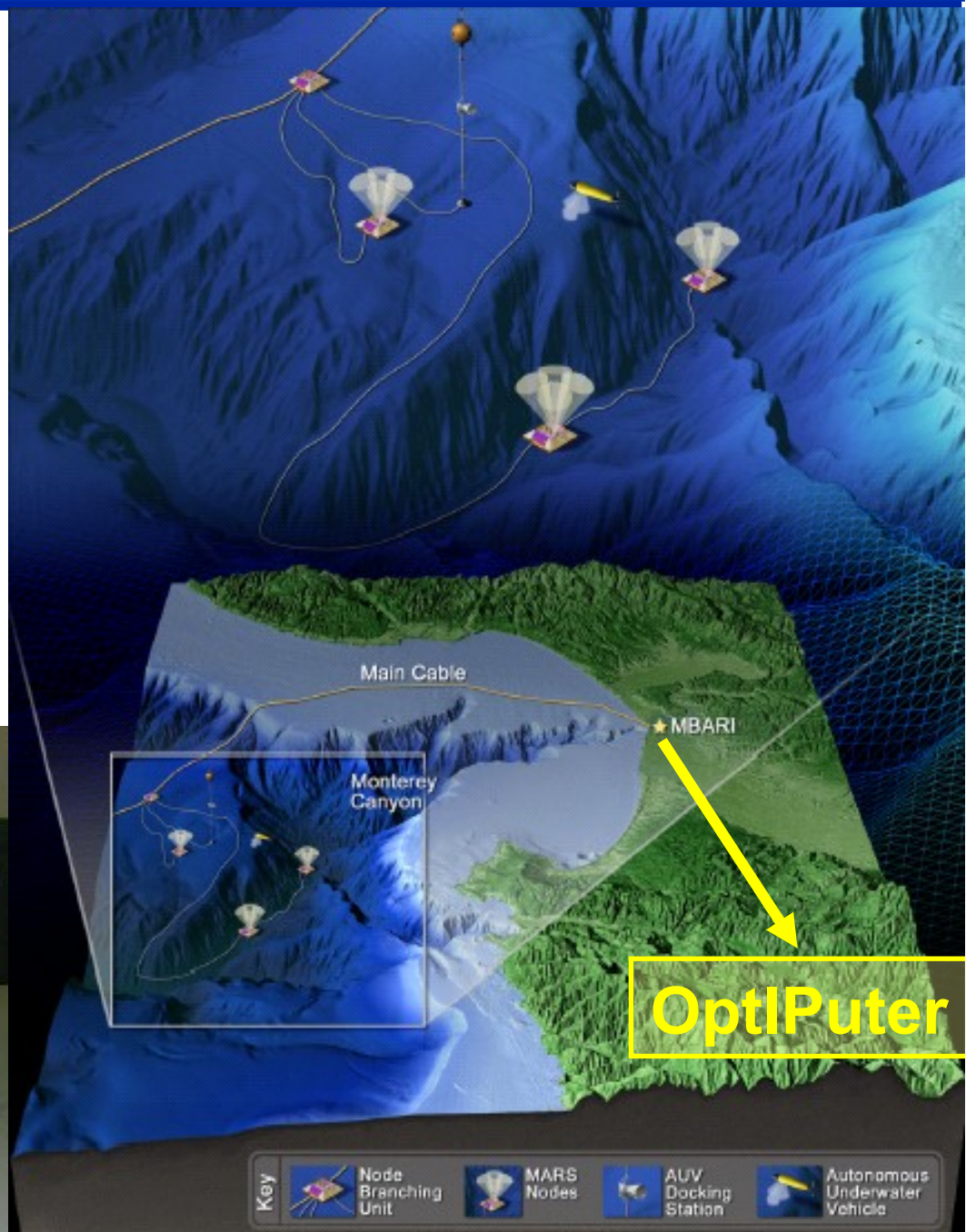
it2

MARS Cable Observatory Testbed – LOOKING Living Laboratory

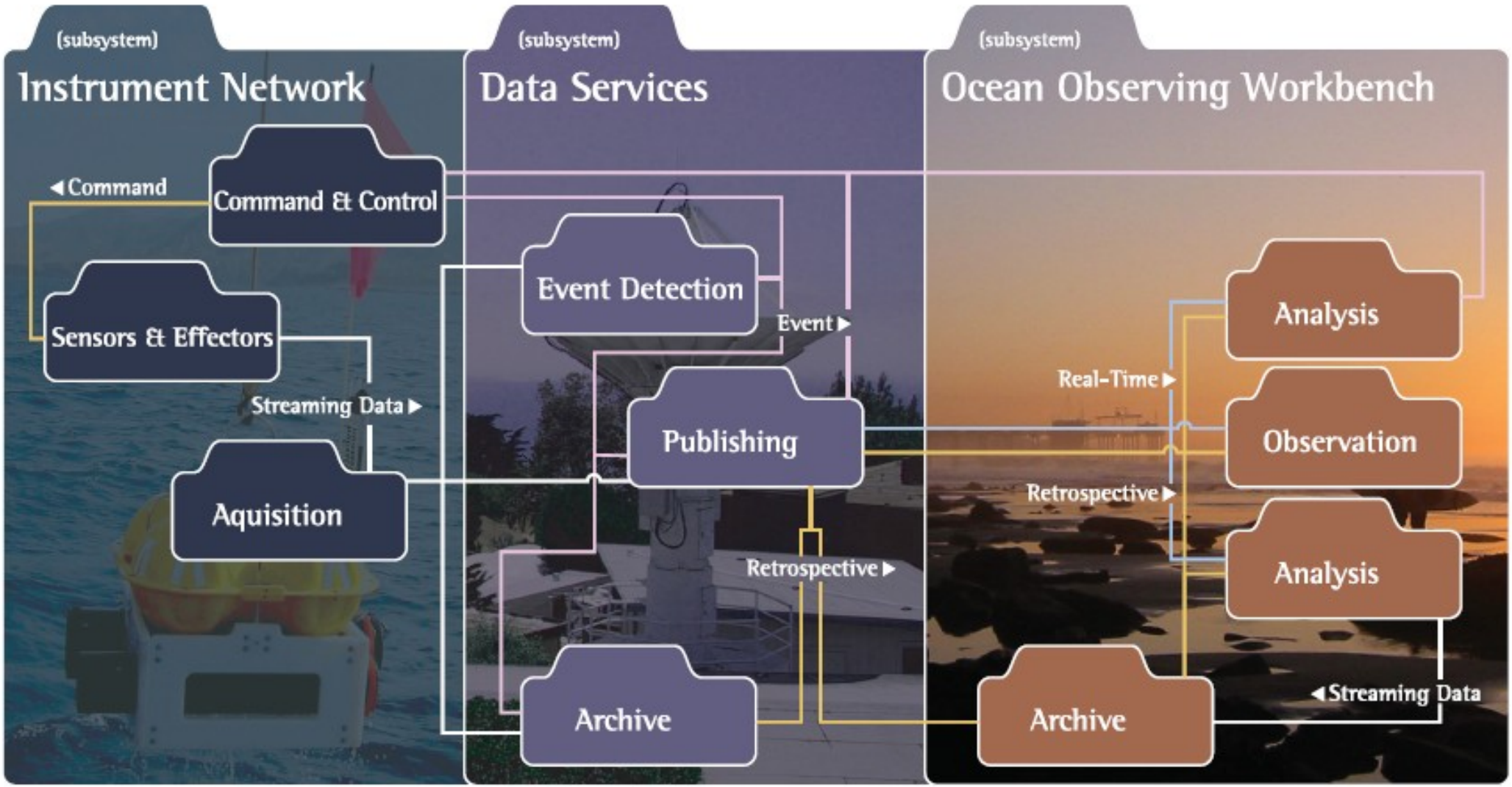




Source:
Jim
Bellingham,
MBARI



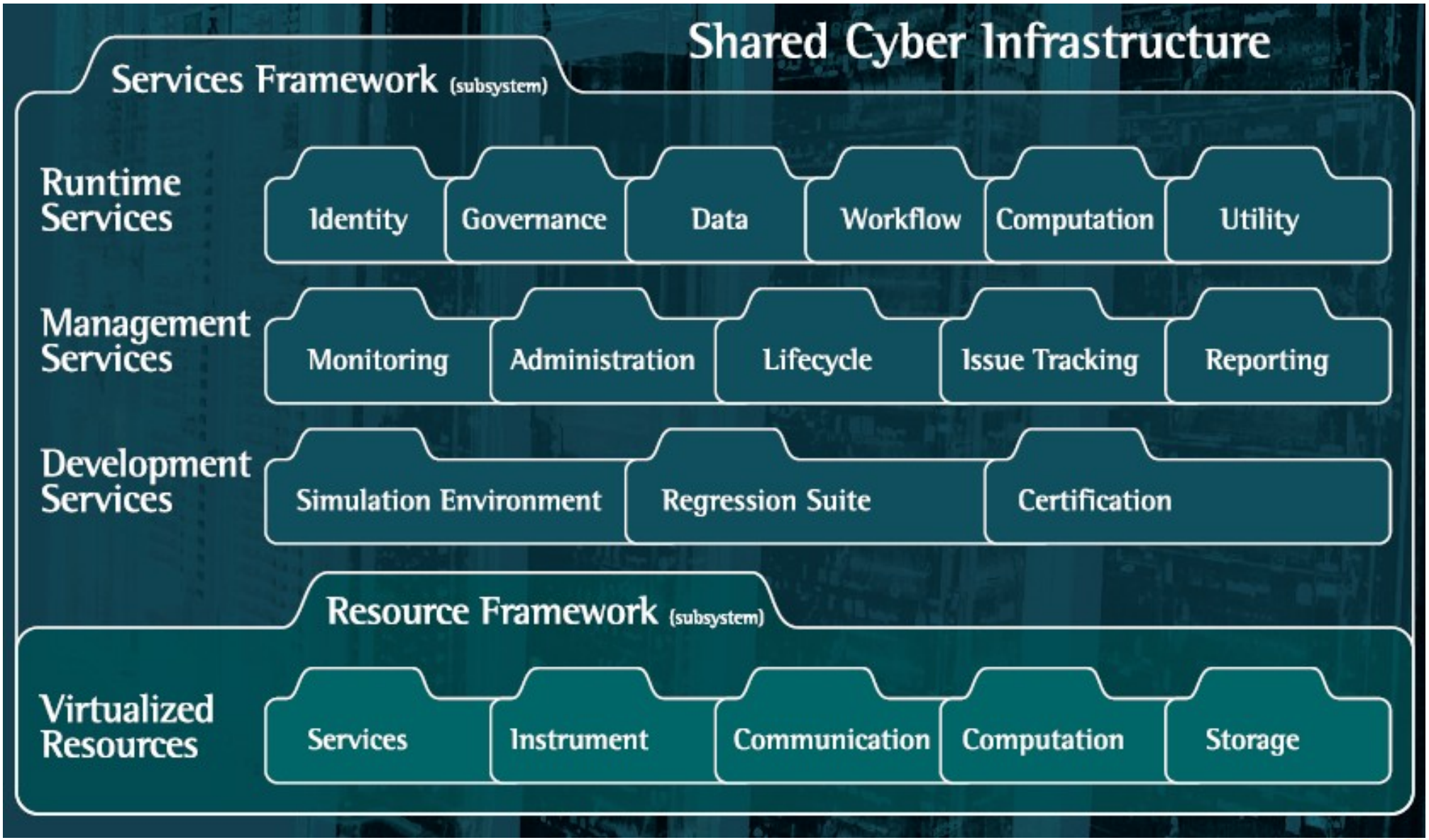
Looking High Level System Architecture



OptIPuter

it2

LOOKING Service Architecture



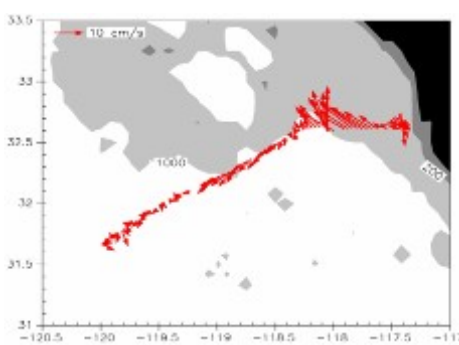
OptIPuter

it2

LOOKING Builds on SCCOOS as a Prototype for Coastal Zone Data Assimilation Testbed

- **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

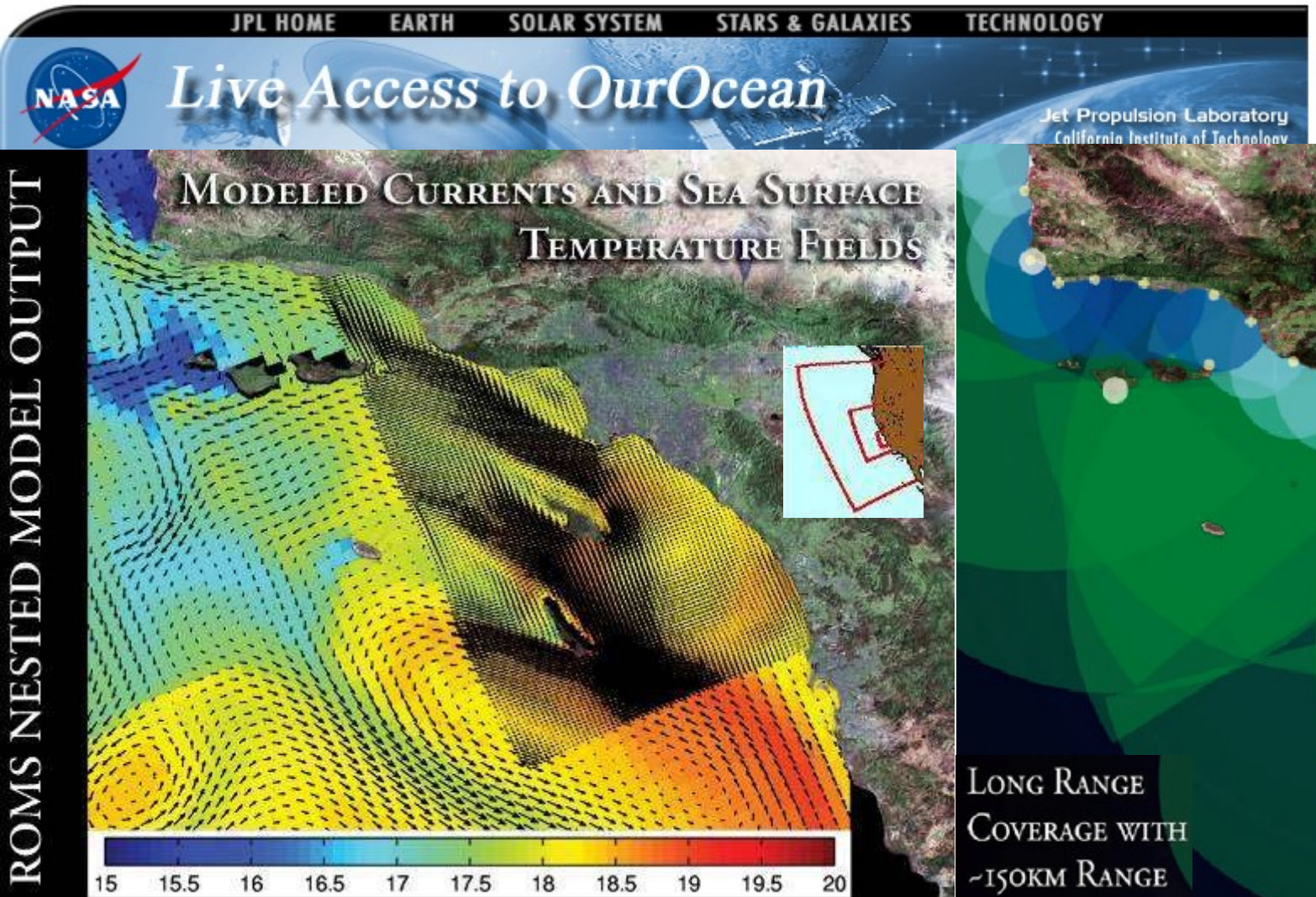
NSF

ROADNet

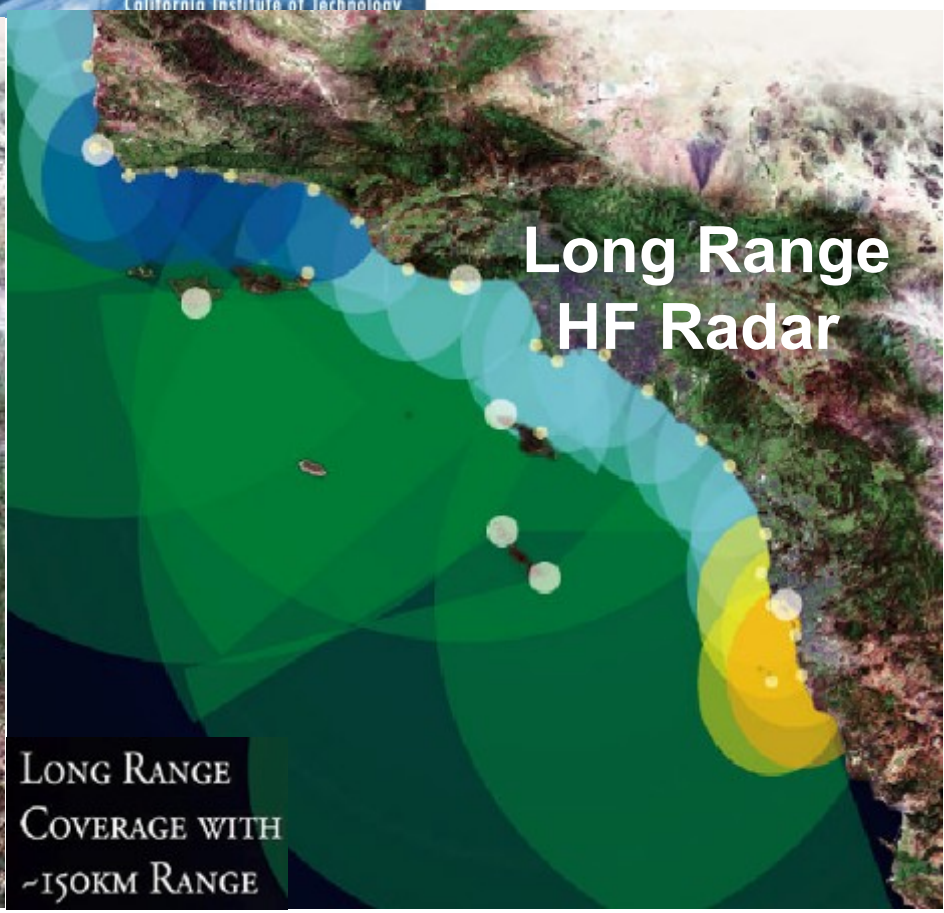
NOAA

it²

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 California Institute of Technology

Similar Work on SoCal Coast at SIO

OptIPuter

Regional Ocean Modeling System (ROMS)

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

it2

Interactive Remote Data and Visualization Services

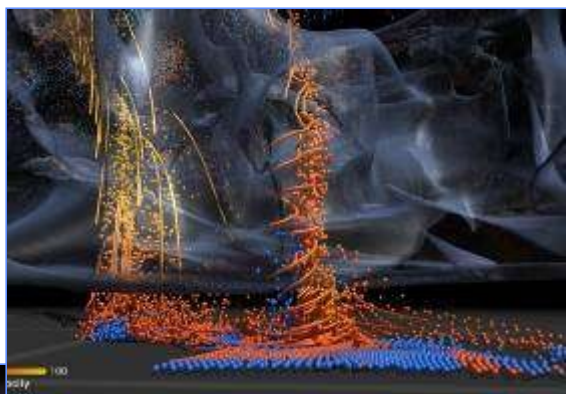


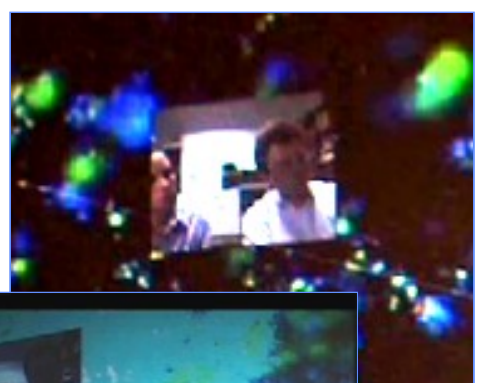
- Scientific-Info Visualization
- AMR Volume Visualization
- Glyph and Feature Vis
- Visualization Services

- Multiple Scalable Displays
- Hardware Pixel Streaming
- Distributed Collaboration

NCSA Altix Data and Vis Server



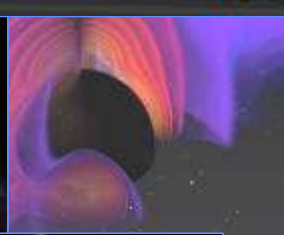


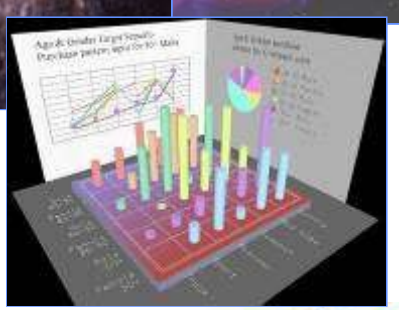












Linking to OptIPuter

- Data Mining for Areas of Interest
- Analysis and Feature Extraction
- Data Mining Services

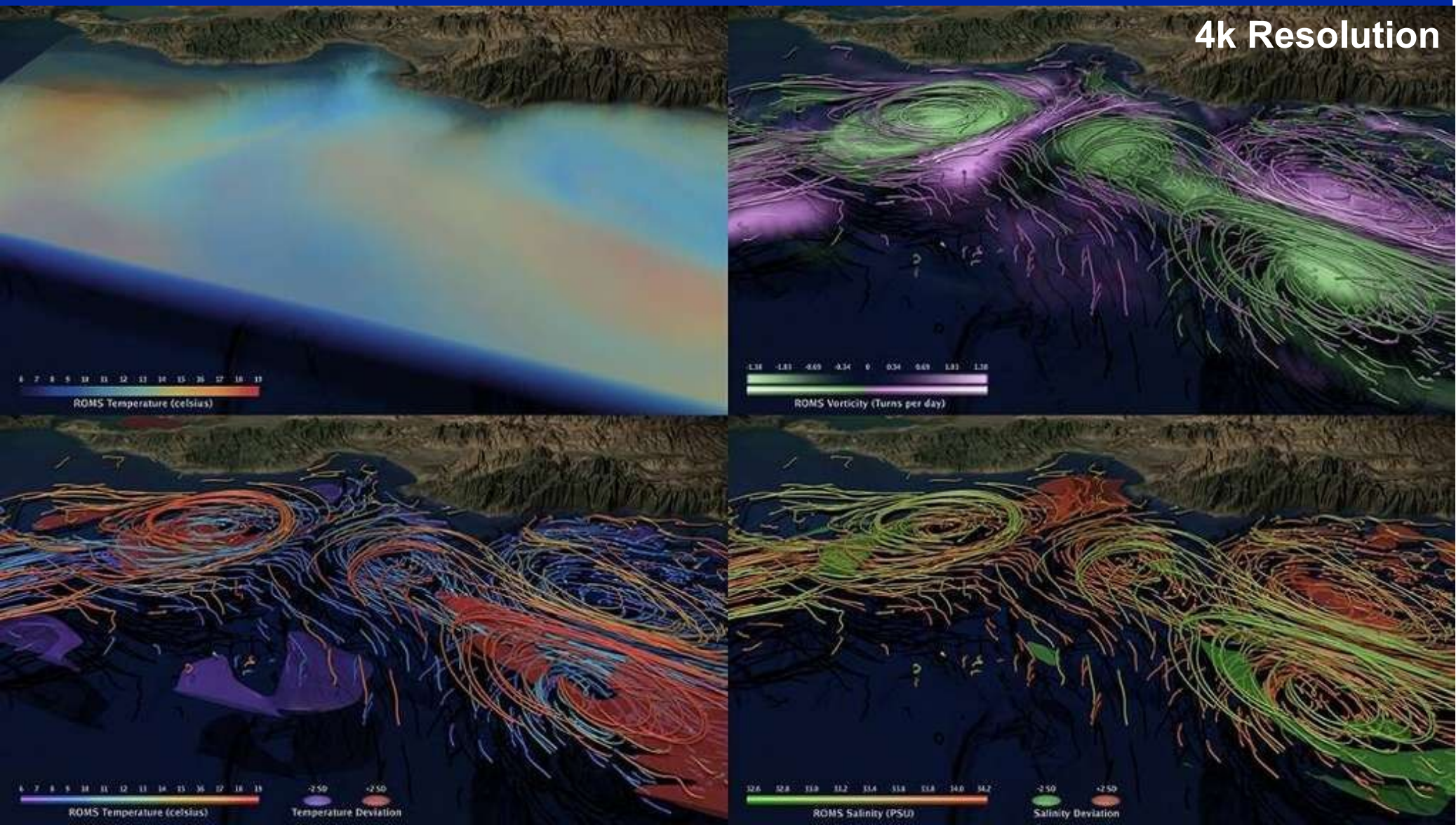
OptIPuter

National Laboratory for Advanced Data Research

An SDSC/NCSA Data Collaboration

it2

The Synergy of Digital Art and Science
Visualization of JPL Simulation of Monterey Bay



OptIPuter

Source: Donna Cox, Robert Patterson, NCSA
Funded by NSF LOOKING Grant

it²

Integrating HD and Supercomputer visualization of Oceans in a Collaborative Environment



OptIPuter

it²

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!

OptIPuter

J. Craig Venter INSTITUTE

it²

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

National LambdaRail
Direct Connect
Computation and Storage Complex

Funded by: Gordon and Betty Moore Foundation

PI Larry Smarr

Joint Partnership of:

Announced January 17, 2006
$24.5M Over Seven Years

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





OptIPuter

Powered by Rocks ROCKS

Source: Phil Papadopoulos SDSC, Calit2

it²

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

Gordon and Betty MOORE FOUNDATION

Sargasso Sea Data

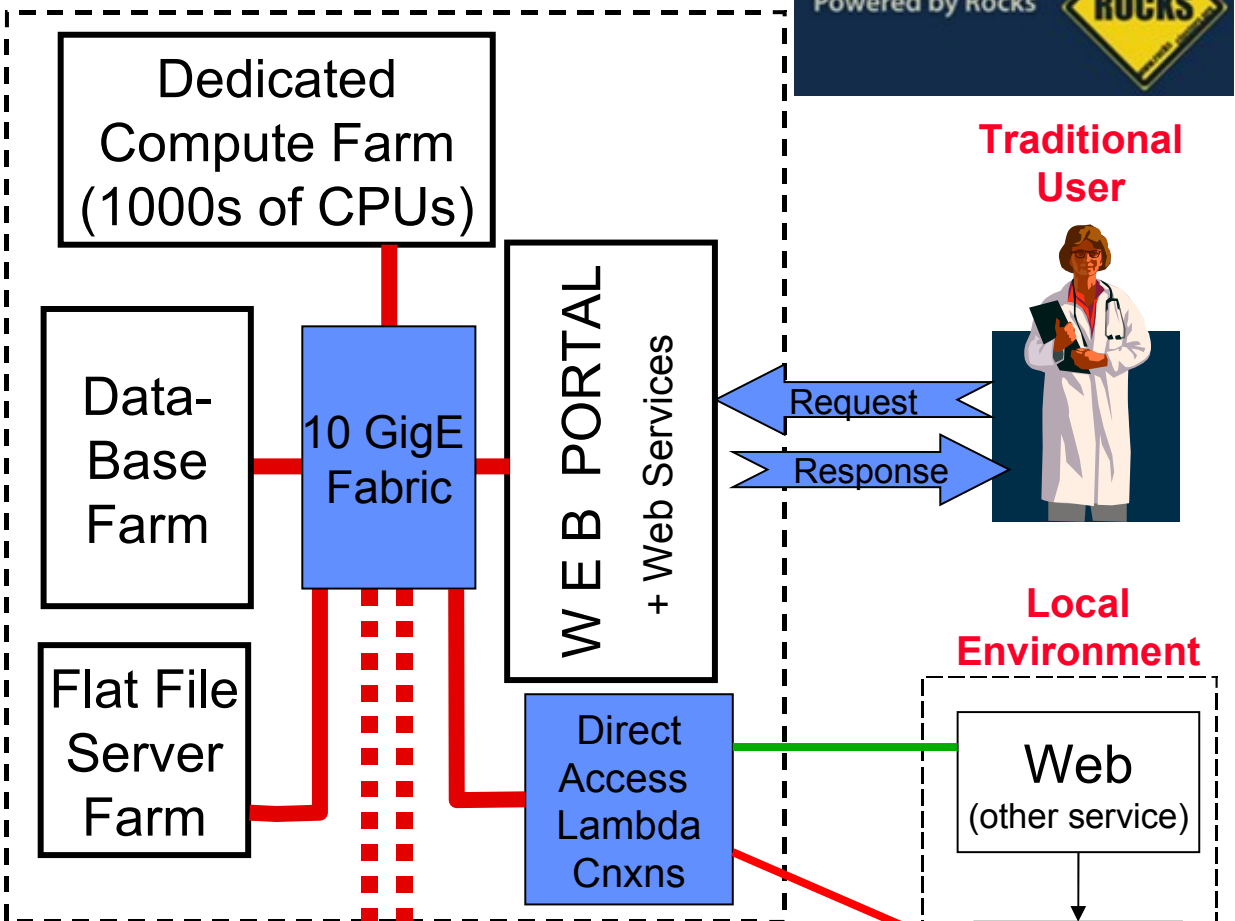
Sorcerer II Expedition (GOS)

JGI Community Sequencing Project

Moore Marine Microbial Project

NASA and NOAA Satellite Data

Community Microbial Metagenomics Data



CENTER FOR EARTH OBSERVATIONS & APPLICATIONS

SCRIPPS INSTITUTION OF OCEANOGRAPHY

SDSC SAN DIEGO SUPERCOMPUTER CENTER

OptIPuter

J. Craig Venter INSTITUTE

Source: Phil Papadopoulos, SDSC, Calit2

it²

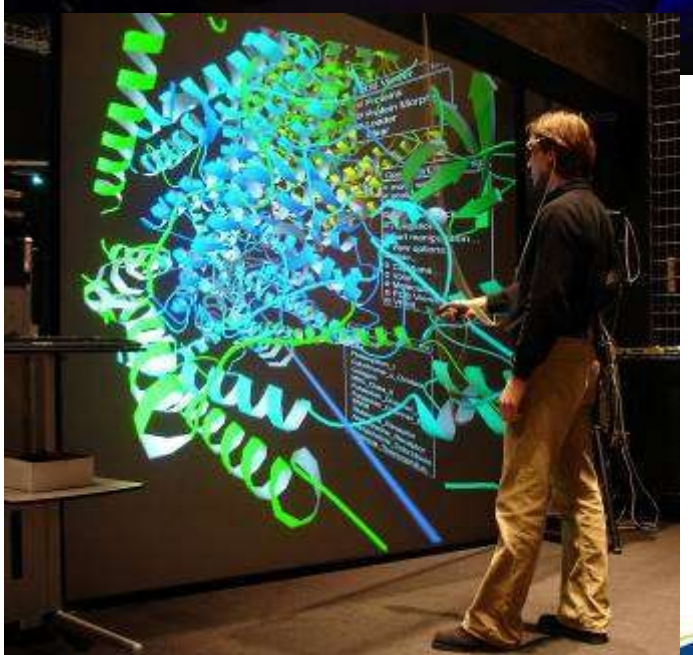
Calit2 is Now OptIPuter Connecting Remote Moore-Funded Microbial Researchers

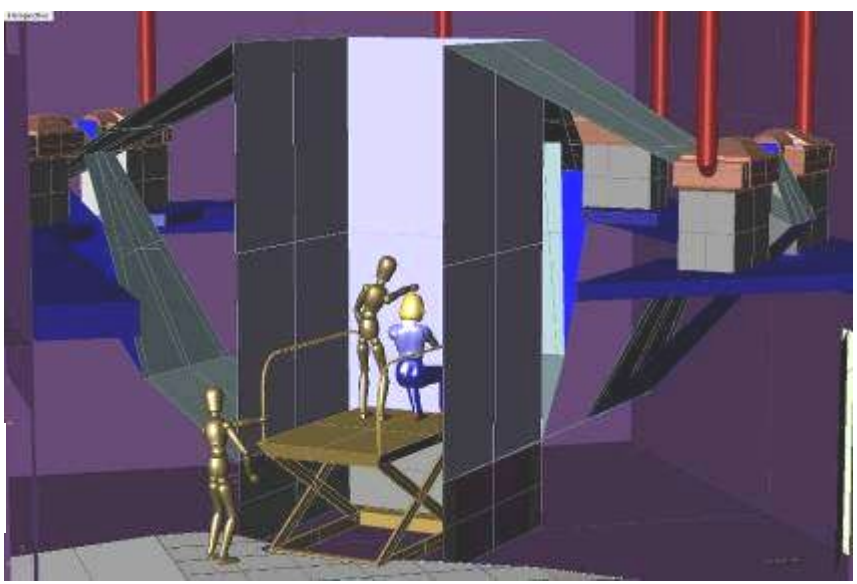


Partnering with UIC Electronic Visualization Lab to Create Next Generation 3D OptIPortals

- Varrier Autostereo Virtual Reality
  - Head-Tracked No Need for Glasses
  - 65 High Resolution LCD Tiles
  - 45 Mpixels/eye of Visual Stereo
- 4KAVE—Digital Cinema Quality VR
  - Working Prototype 4 Mpixel Wall
  - Full Scale 4KAVE Being Designed
    - Two Sony 4K Projectors Per Wall
    - 32 Mpixel/eye of Stereo w/4-Walls







evl electronic visualization laboratory

OptIPuter

Dan Sandin, Greg Dawe, Tom Peterka, Tom DeFanti, Jason Leigh, Jinghua Ge, Javier Girado, Bob Kooima, Todd Margolis, Lance Long, Alan Verlo, Maxine Brown, Jurgen Schulze, Qian Liu, Ian Kaufman, Bryan Glogowski

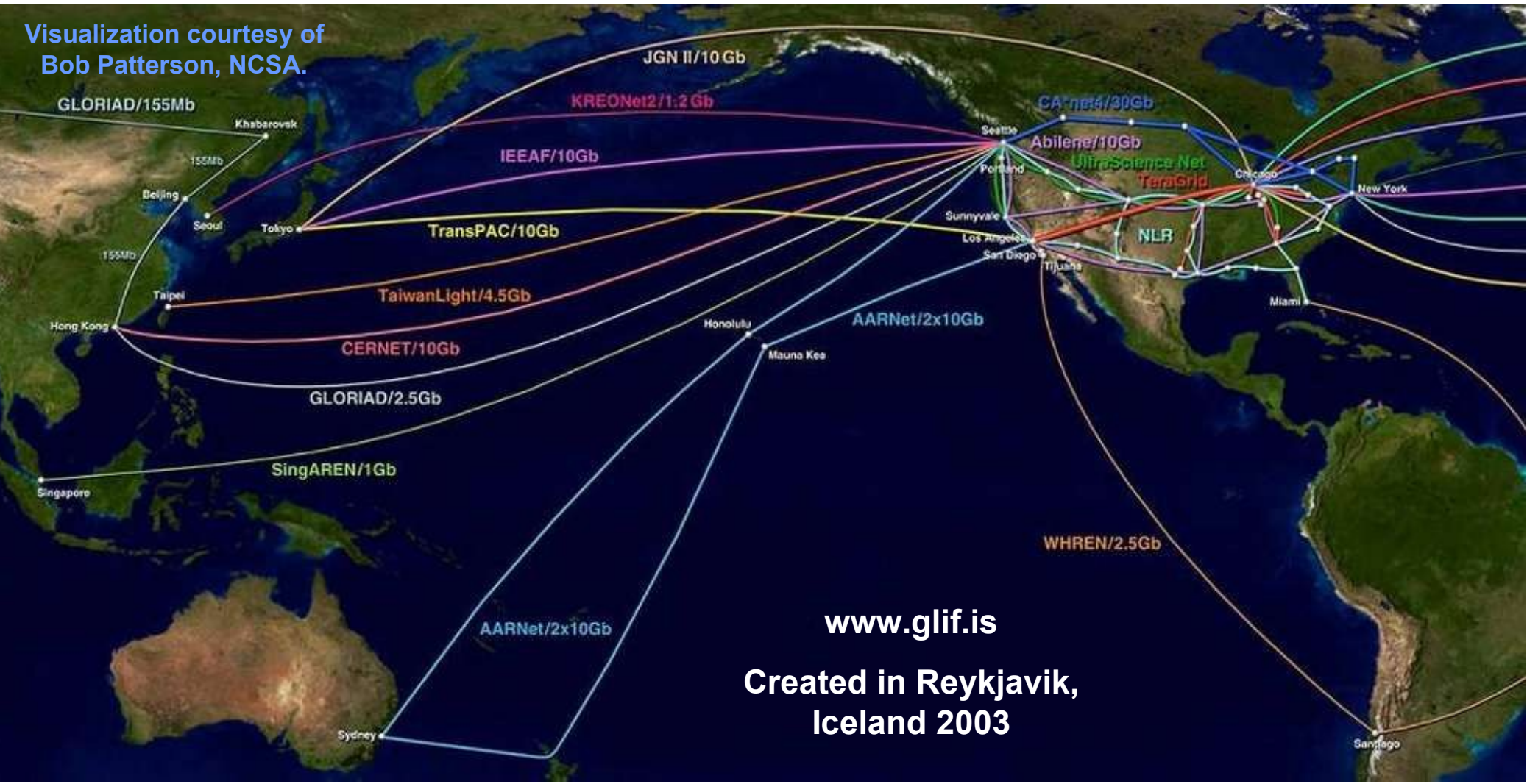
it2

A Near Future Metagenomics Fiber Optic-Enabled Data Generator



Source John Delaney, UWash

Countries are Aggressively Creating Gigabit Services: Interactive Access to CAMERA and LOOKING Systems



OptIPuter

it2