# The Coming Revolution in Environmental Awareness


**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**


**www.calit2.net**

# Congratulations to AIMS for Hosting This Environmental Observatory Network Meeting



Coral Reef
Environmental
Observatory Network




**Workshop**
**29th to 31st**
**March 2006**
**Townsville,**
**Australia**

Australian Government | Australian Institute of Marine Science

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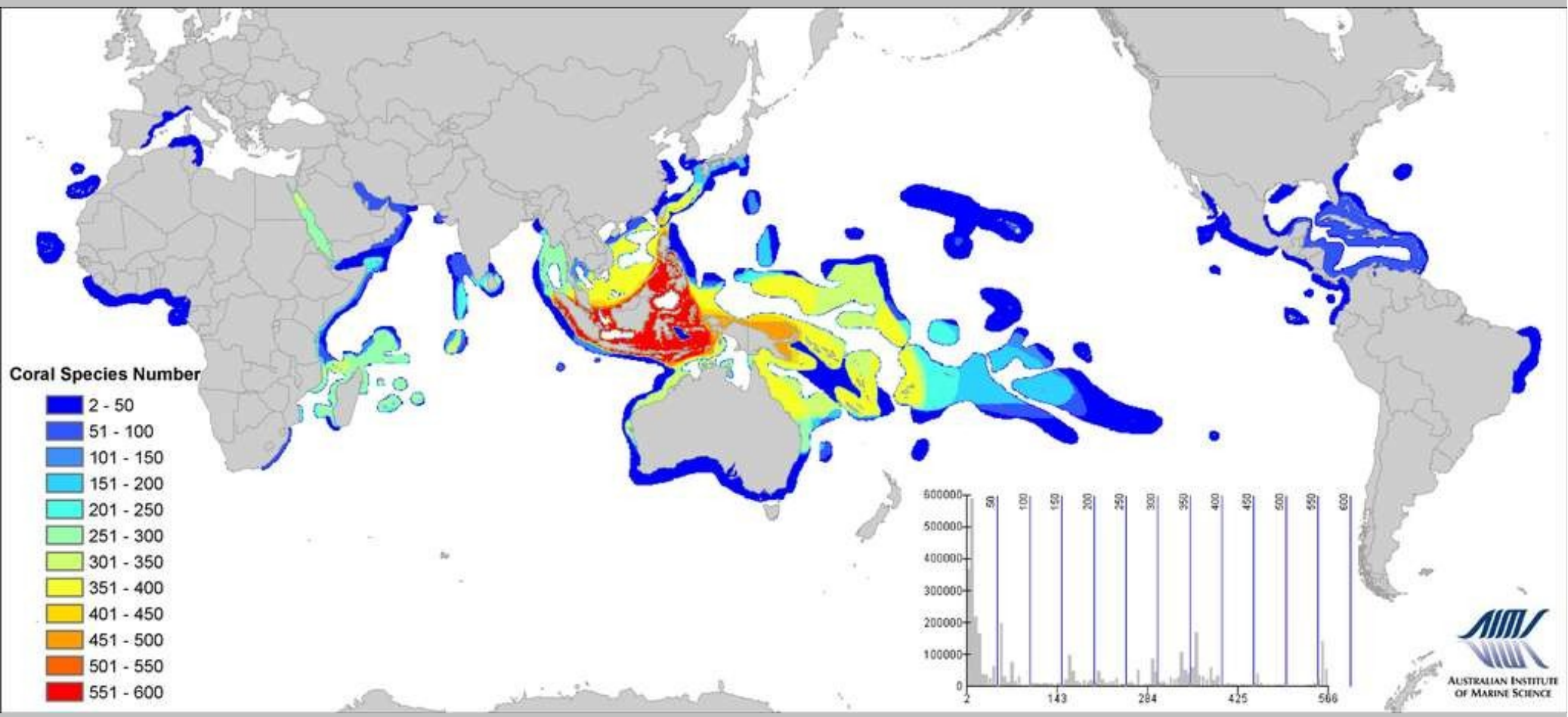
# Calit2, SDSC, and SIO are Building Environmental Observatory Control Rooms



## Opportunity to Partner with Australia On-Line Coral Reef Monitoring

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# Coral Reef Biodiversity Requires a Global Observatory




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# My Coral Reef Observatory in the 1990s
# 120 Gallon Marine Reef in my House



www.jacobsschool.ucsd.edu/~lsmarr/reefs/aquarium.html





# My Photo Observations of Coral Reefs

## Hawaii Reef By Day



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## Bonaire Reef At Night

www.jacobsschool.ucsd.edu/~lsmarr/reefs/photos.html

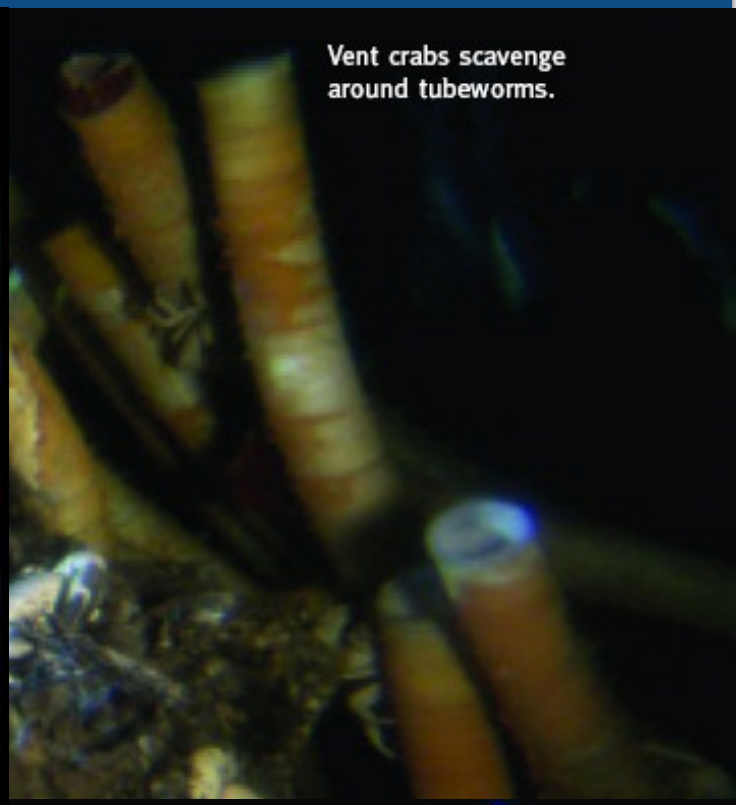
# My Video Observation of Coral Reefs Cancun, Mexico December 2004



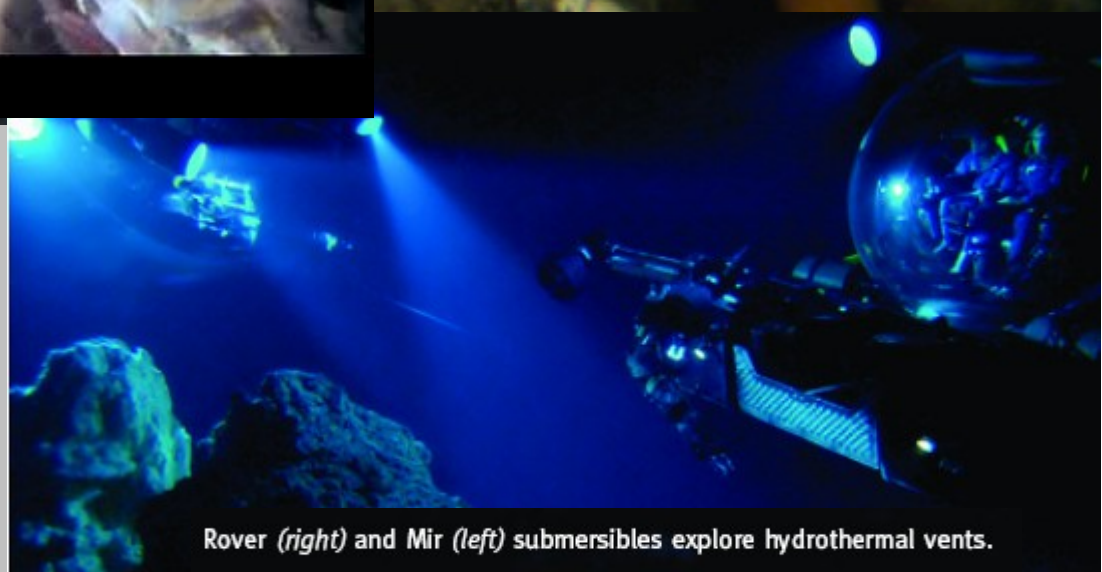
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# Goal – From Expedition to Cable Observatories with Streaming HDTV Robotic Cameras






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




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# Envisioning the Future of a Fiber Optic Infrastructure Supporting Interactive Visualization of Remote Data

**"What we have to do is eliminate distance between individuals who want to interact with other people and with other computers in a collaborative fashion. … This is a really a glimpse into that future"**
**— Larry Smarr, Director, NCSA**







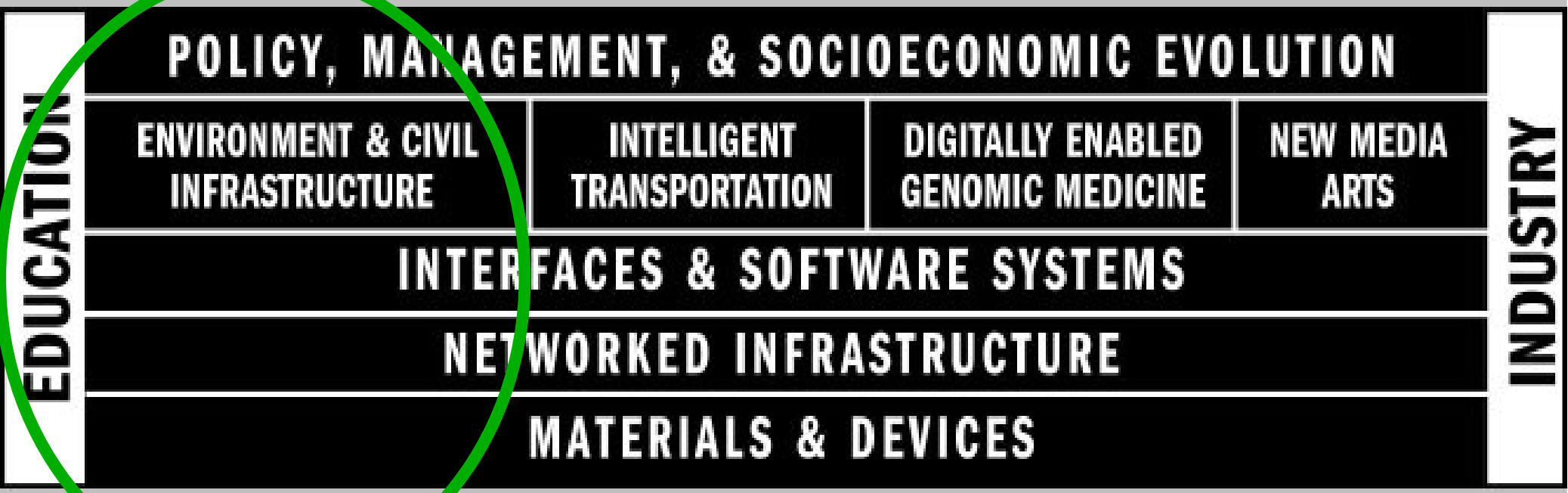


**"We're using satellite technology…to demo what It might be like to have high-speed fiber-optic links between advanced computers in two different geographic locations." — Al Gore, Senator**

UCSD UCIrvine NCSA™ **SIGGRAPH 1989** **ATT & Sun** it²

# Calit2 -- Research and Living Laboratories on the Future of the Internet

## UC San Diego & UC Irvine Faculty Working in Multidisciplinary Teams With Students, Industry, and the Community




Sensor Nets

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www.calit2.net

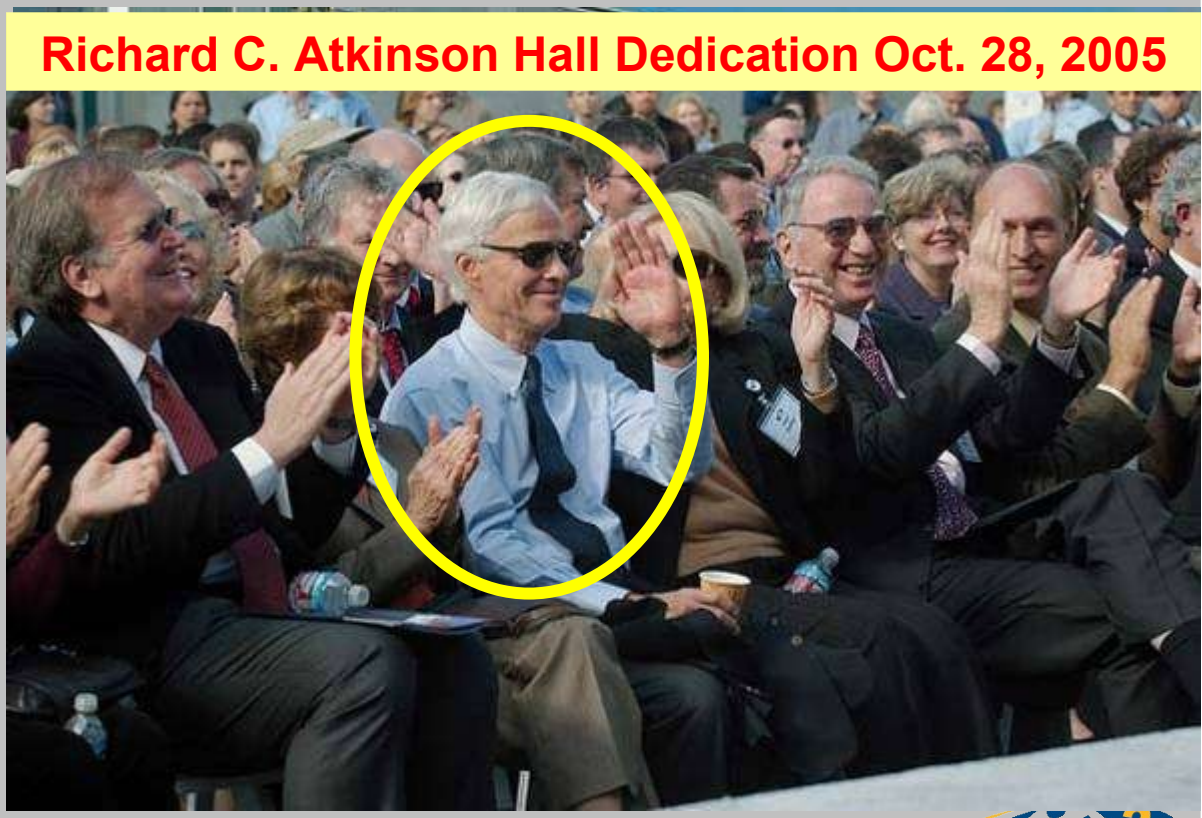
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# Two New Calit2 Buildings Will Provide Major New Laboratories to Their Campuses




- Over 1000 Researchers in Two Buildings
  - Linked via Dedicated Optical Networks

Richard C. Atkinson Hall Dedication Oct. 28, 2005



www.calit2.net

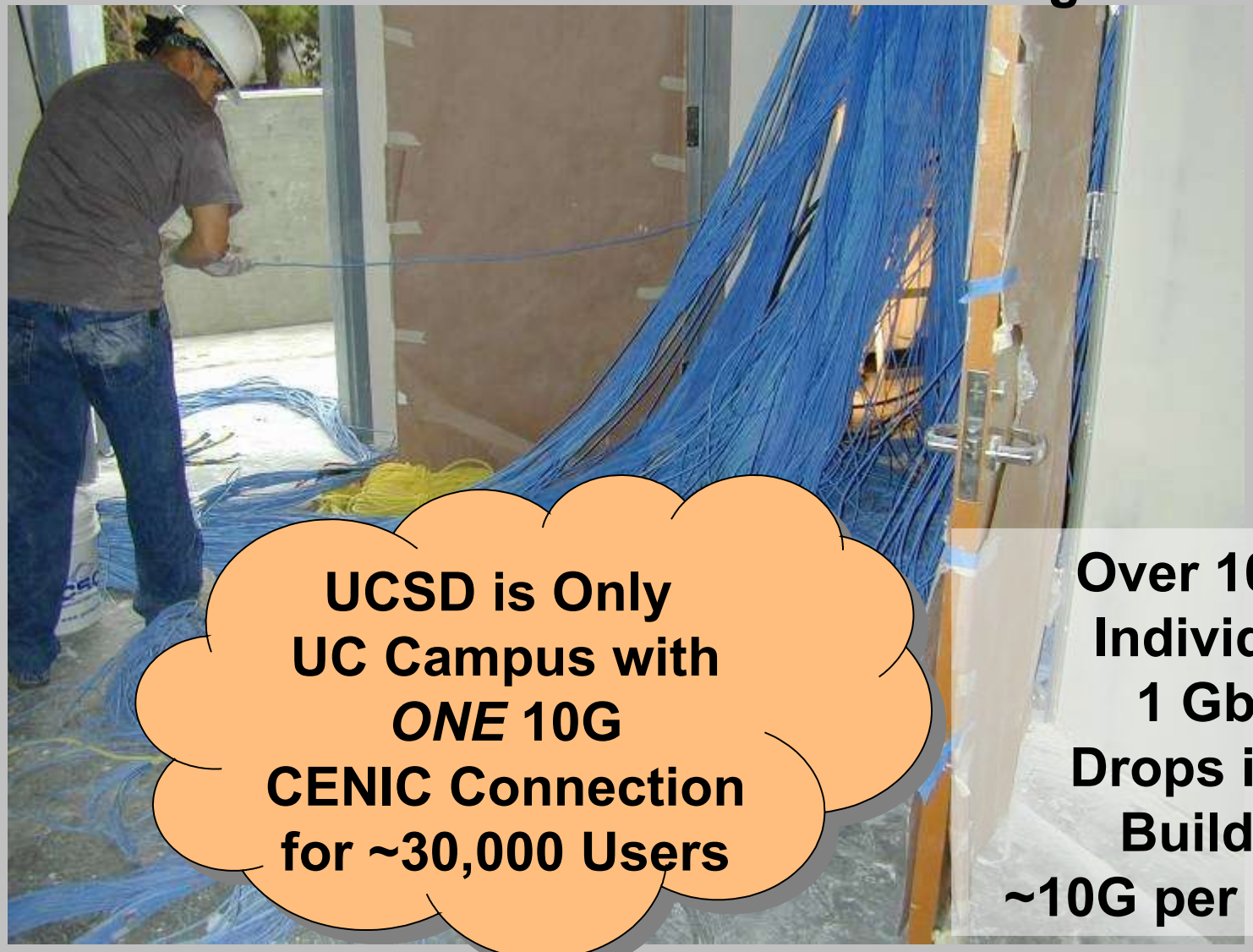
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Preparing for an World in Which Distance Has Been Eliminated…

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# The Calit2@UCSD Building is Designed for Prototyping Extremely High Bandwidth Applications

## 1.8 Million Feet of Cat6 Ethernet Cabling



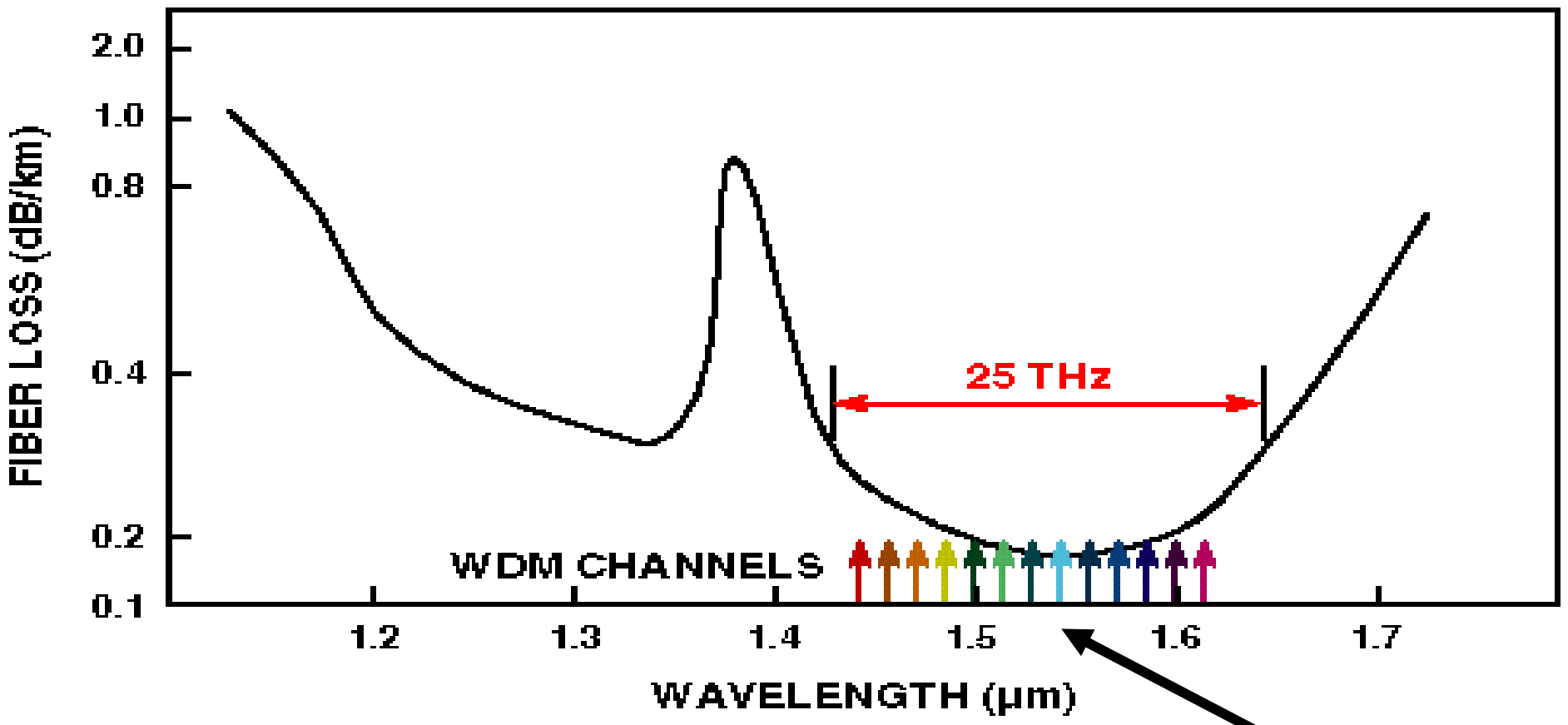
**UCSD is Only UC Campus with *ONE* 10G CENIC Connection for ~30,000 Users**

**Over 10,000 Individual 1 Gbps Drops in the Building ~10G per Person**

Photo: Tim Beach, Calit2

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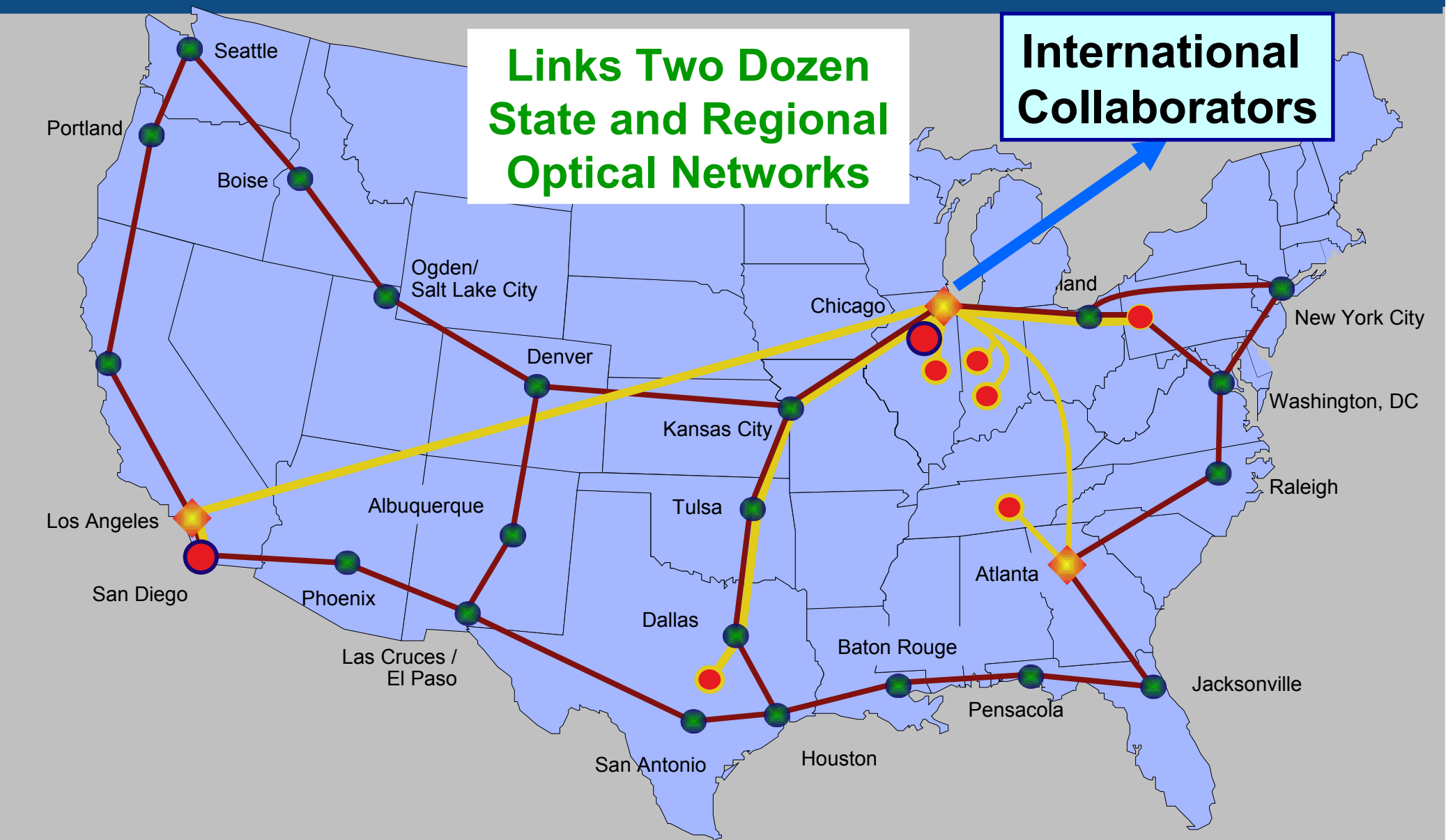
# Each Optical Fiber Can Now Carry Many Parallel Light Paths or "Lambdas"




"Lambdas"

Source: Steve Wallach, Chiaro Networks

# National LambdaRail (NLR) Provides Cyberinfrastructure Backbone for Researchers

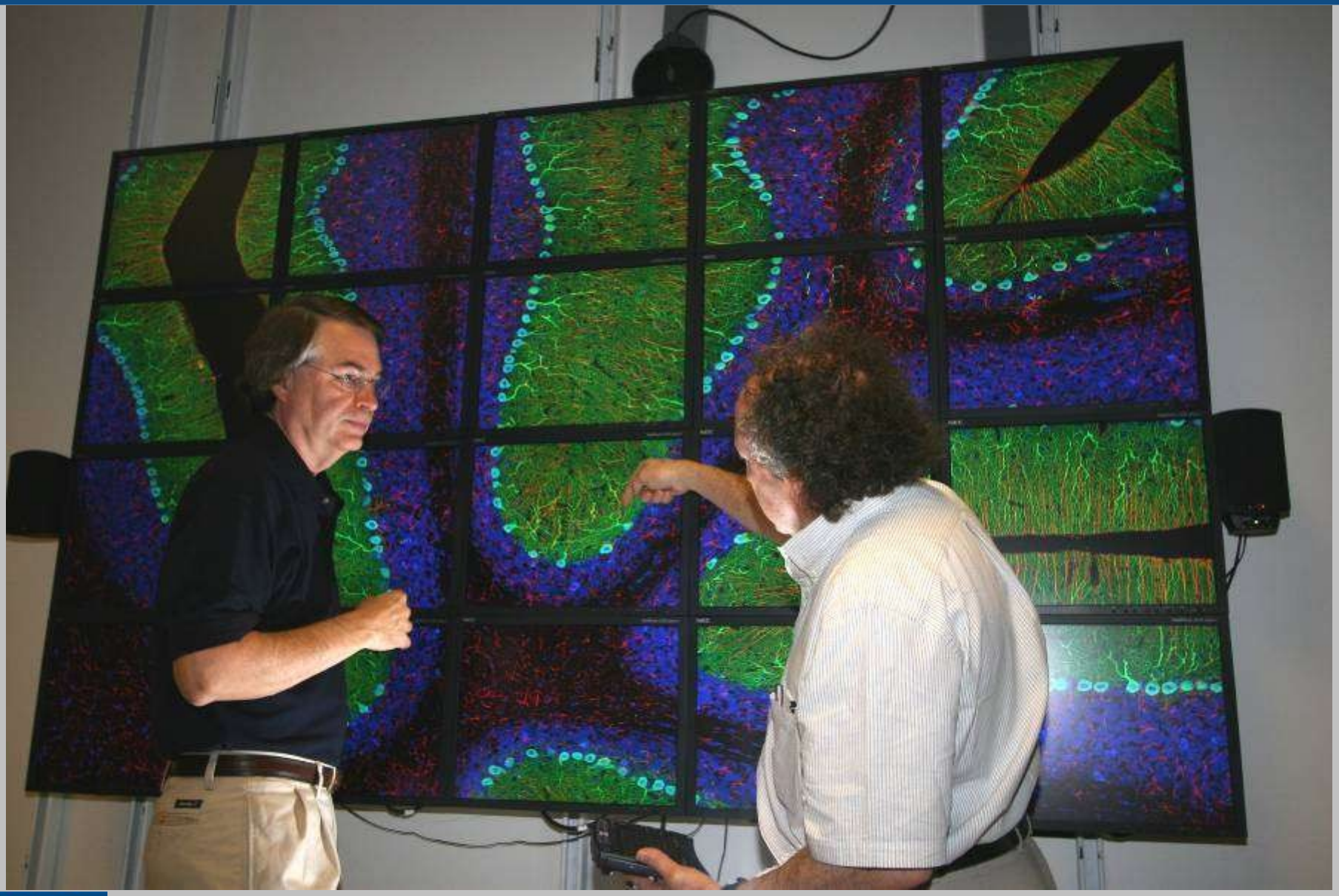



**NLR 4 x 10Gb Lambdas Initially Capable of 40 x 10Gb Wavelengths at Buildout**

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# The OptIPuter – Creating High Resolution Science Data Portals Over Dedicated Optical Channels



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Source: Mark Ellisman, OptIPuter co-PI

# Accelerator: Global Connections Between University Research Centers at 10Gbps

Maxine Brown, Tom DeFanti, Co-Chairs

## iGrid 2005

THE GLOBAL LAMBDA INTEGRATED FACILITY

www.igrid2005.org



**September 26-30, 2005**

**Calit2 @ University of California, San Diego**

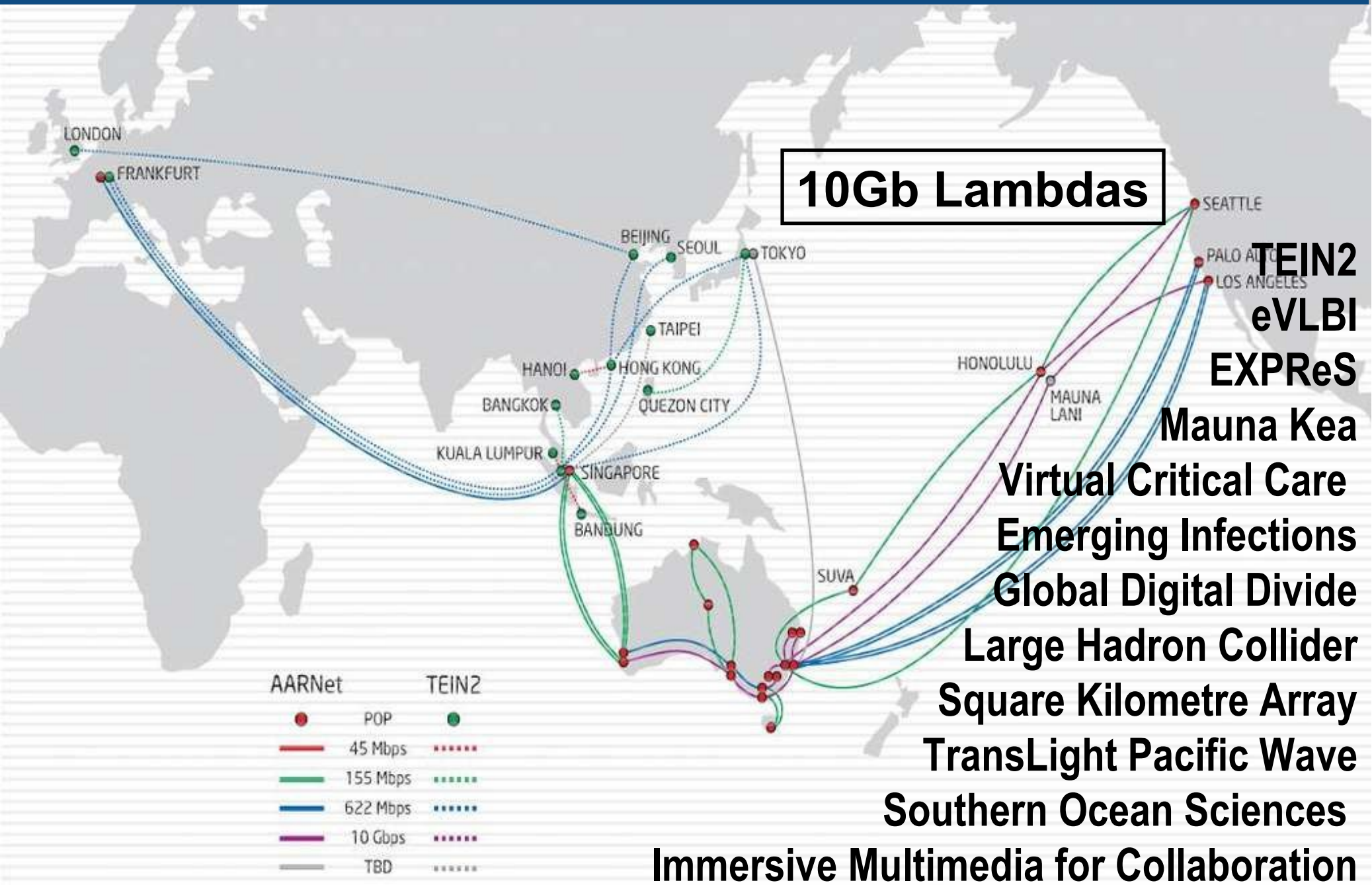
**California Institute for Telecommunications and Information Technology**



**21 Countries Driving**
**50 Demonstrations**
**1 or 10Gbps to Calit2@UCSD**

# Fiber Optics Position Australia for Global Collaboration

AARNet




**10Gb Lambdas**

**TEIN2**

**eVLBI**

**EXPReS**

**Mauna Kea**

**Virtual Critical Care**

**Emerging Infections**

**Global Digital Divide**

**Large Hadron Collider**

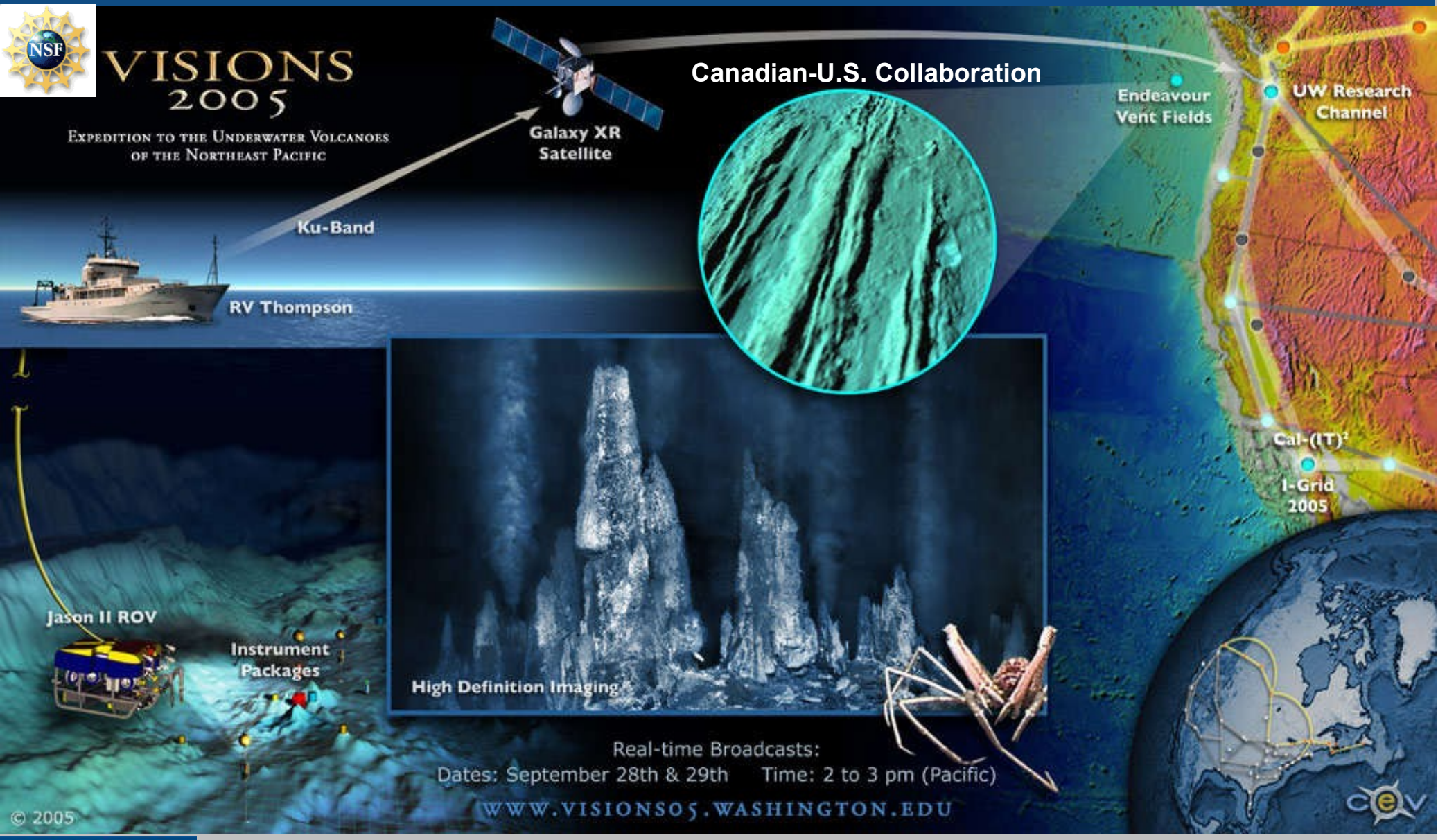
**Square Kilometre Array**

**TransLight Pacific Wave**

**Southern Ocean Sciences**

**Immersive Multimedia for Collaboration**

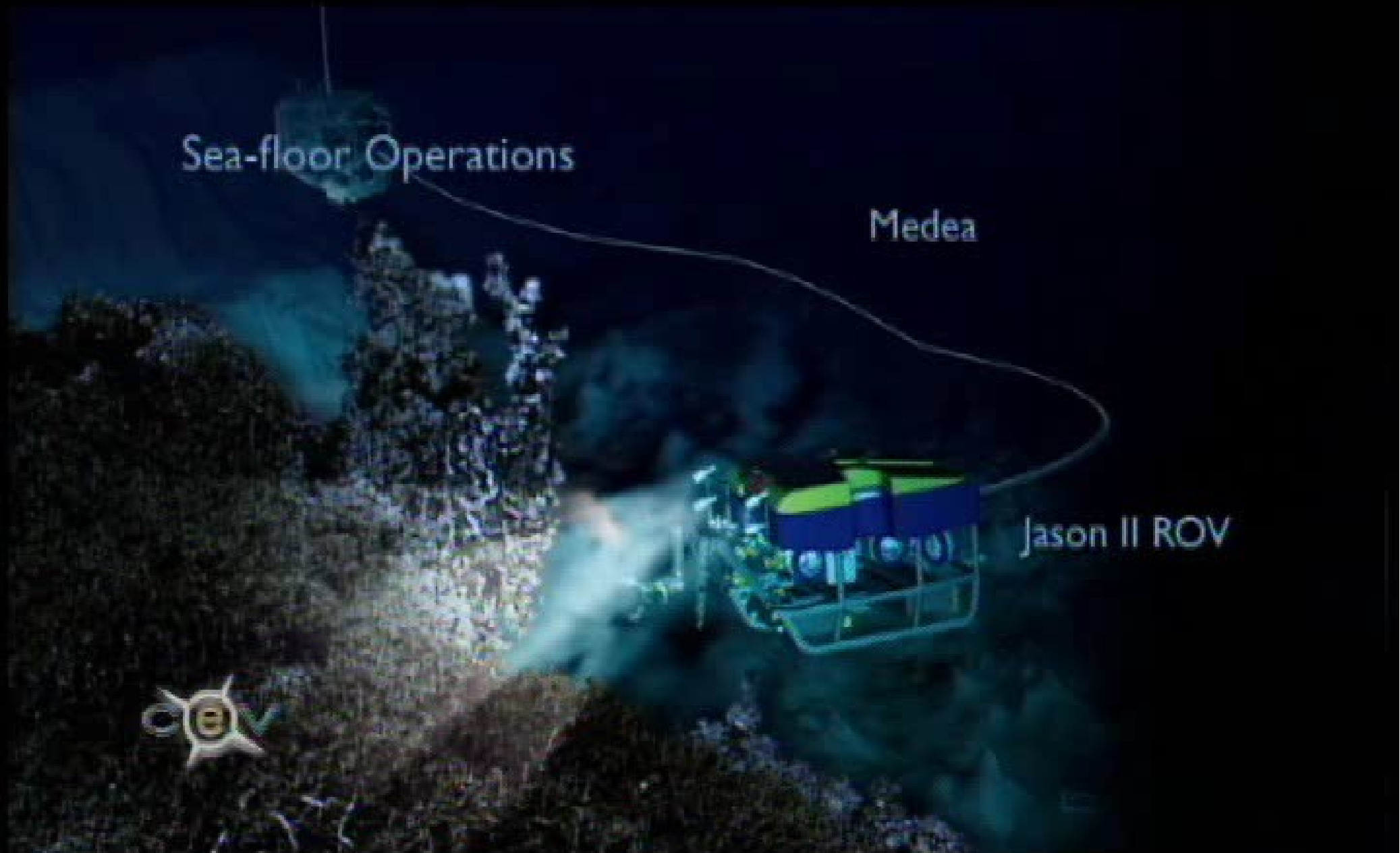
# iGrid Scientific Instrument Services: Enable Remote Interactive HD Imaging of Deep Sea Vent




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Source John Delaney & Deborah Kelley, UWash

# High Definition Video - 2.5 km Below the Ocean Surface



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

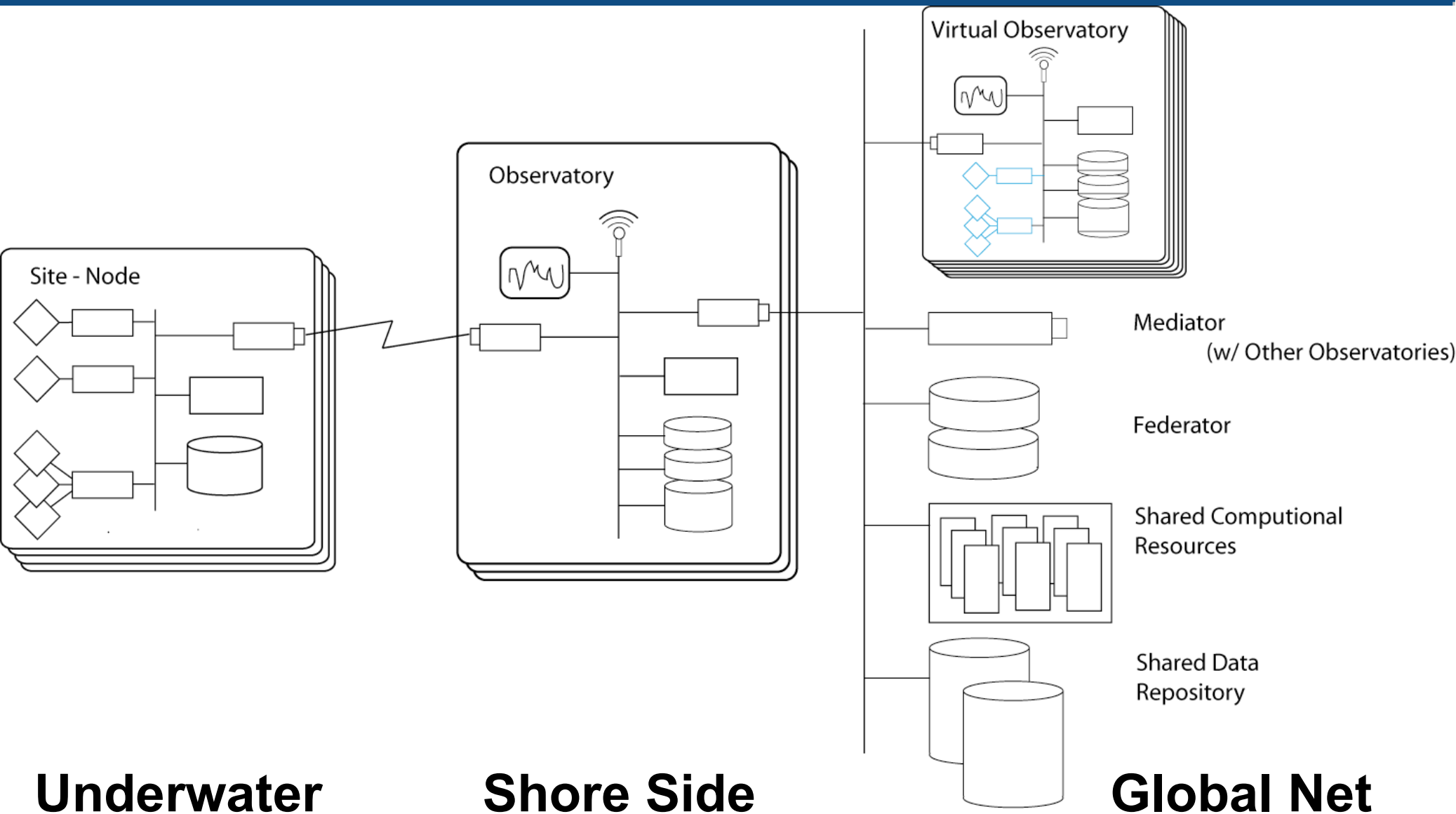



- National Science Foundation Is Planning a New Generation of Ocean Observatories
  - Ocean Research Interactive Observatory Networks
- Fibered Observatories Linked to Land Fiber Infrastructure
- Laboratory for the Ocean Observatory Knowledge Integration Grid (LOOKING)
  - Building a Prototype Based on OptIPuter Technologies Plus Web/Grid Services
  - HDTV Streams Over IP Will be a Major Driver

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(Funded by NSF ITR-John Delaney, UWash, PI)

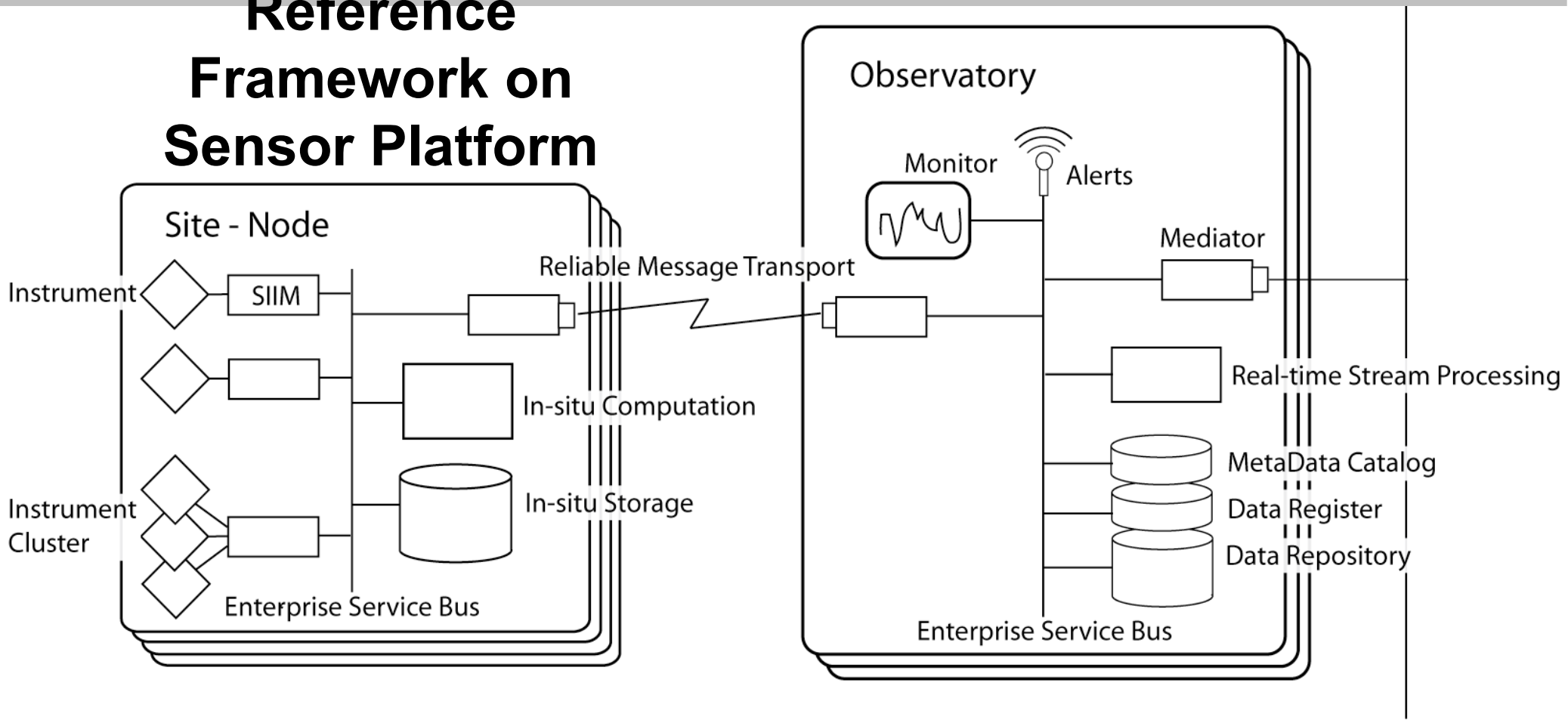
# LOOKING LambdaGrid Architecture




Source: Matthew Arrott, Calit2

# Service Oriented Architecture—On Site and Shore Side

## Web Services Reference Framework on Sensor Platform



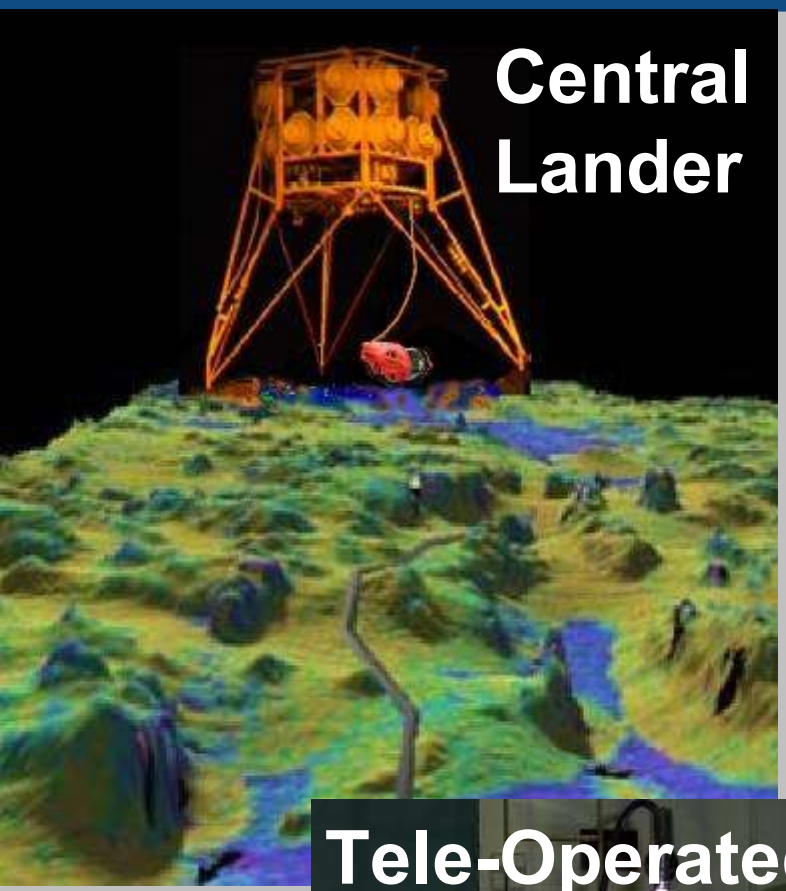

## A Major Focus is Streaming Data Types

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Source: Matthew Arrott, Calit2

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# Monterey Accelerated Research System (MARS) Cable Observatory Testbed for Innovative Instruments

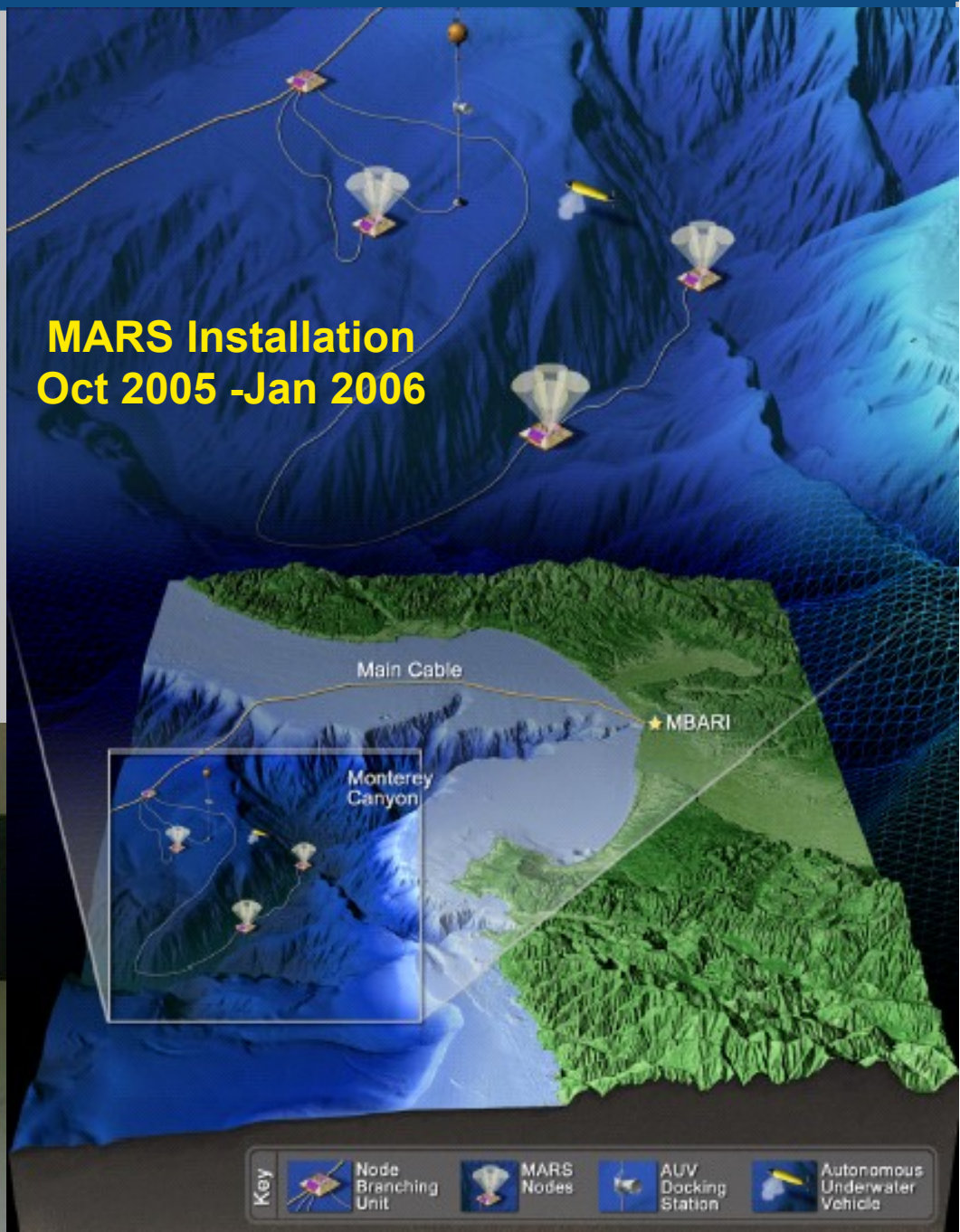






Source:
Jim
Bellingham,
MBARI

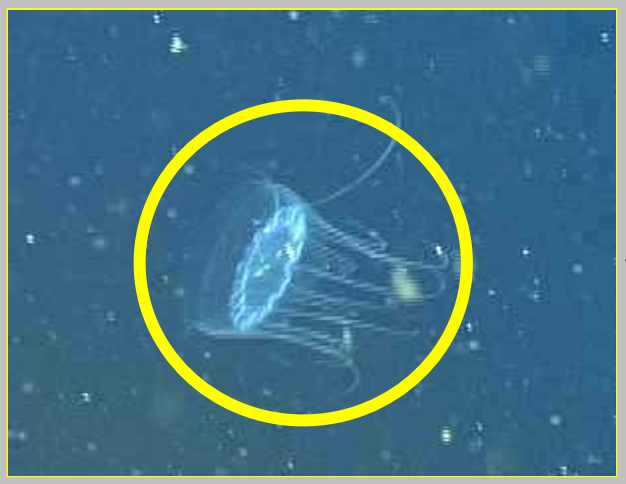
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# Embedding Machine Vision into Stream Analysis Over Fiber Network



Video Collected by ROV



Detection & Classification

Source: MBARI and Dr. Laurent Itti of USC's iLab



SDI Over Fiber



Sony Digital BetaCAM Recorder

SDI Over Fiber



Capture Control

Processing on Cluster

SDI = Serial Digital Interface

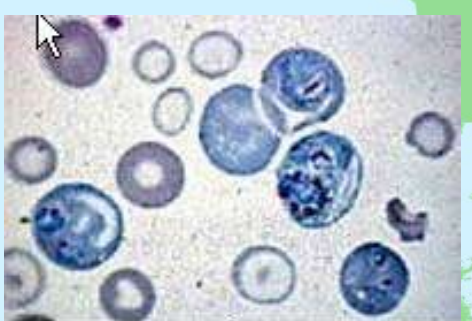
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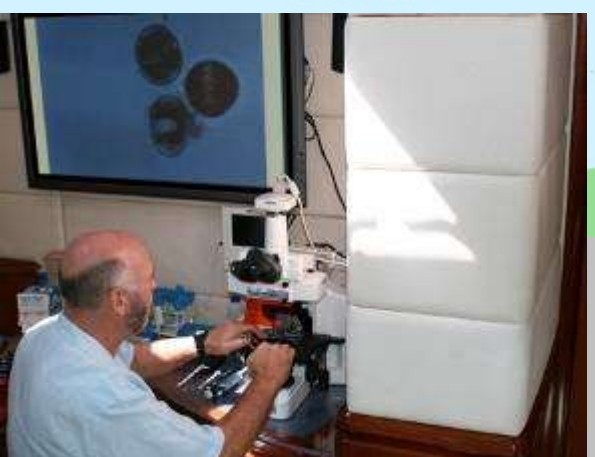
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# Global Ocean Sampling Project
# Measuring the Genetic Diversity of Marine Microbes



Canada
United States
Mexico
Puerto Rico
Honduras
Costa Rica
Panama
Galapagos Islands
x 10 samples
Tanzania/
Zanzibar
x 7 samples
Seychelles
Madagascar
South Africa
Cocos
Keeling I
Australia
x 17 samples
x 8 samples
Fiji
Tonga
French
Polynesia
Cook
Islands
Analyzed
Sampled, but not Analyzed





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MARINE
MICROBIOLOGY
INITIATIVE

Gordon and Betty
MOORE
FOUNDATION

J. Craig Venter
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# 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

Joint Partnership of:

PI Larry Smarr

# Building On Centers of Excellence and Achievement













Powered by Rocks













The Scripps Genome Center

## Supported by:













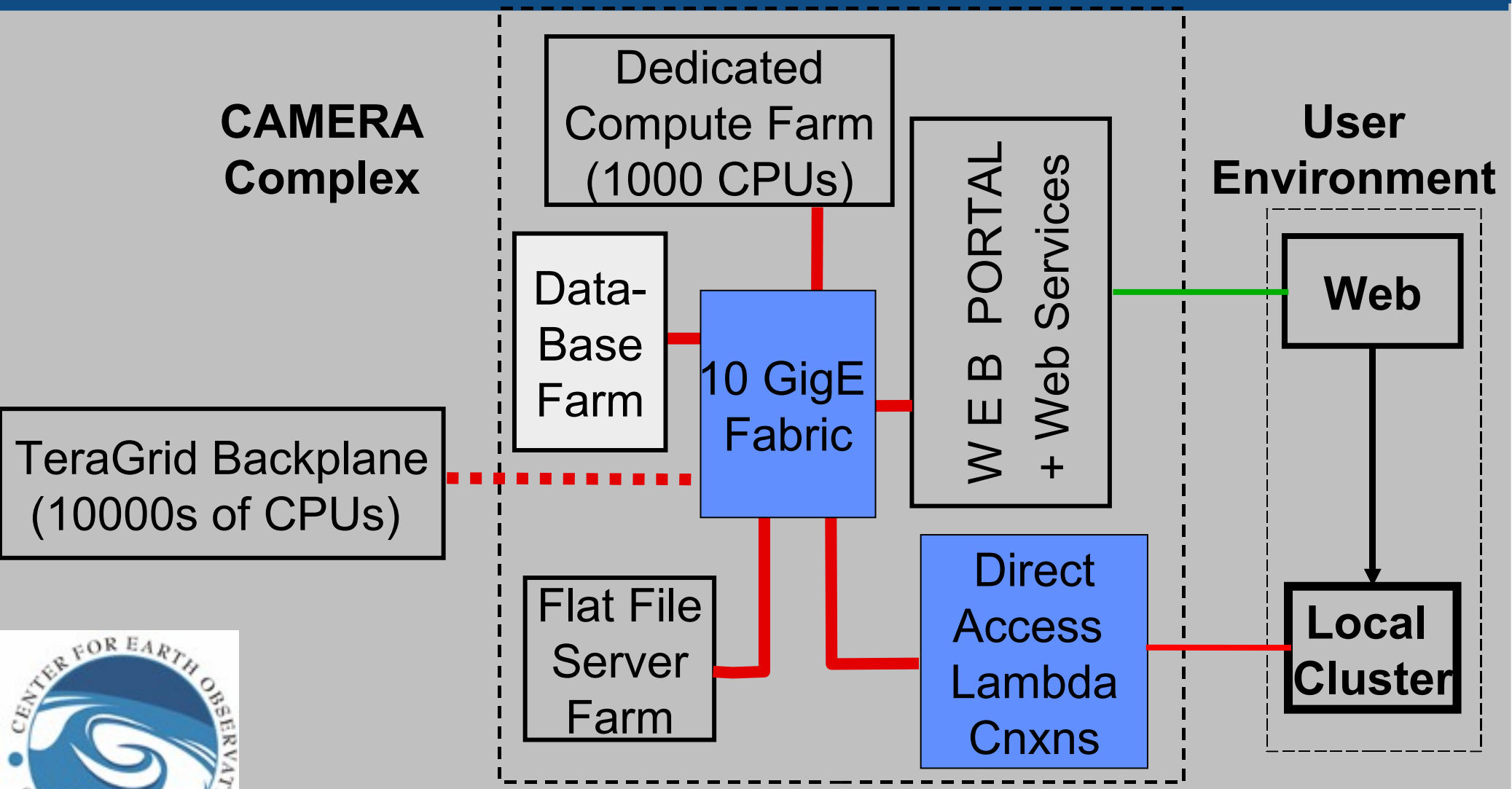


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**Announced January 17, 2006**
**$24.5 M Over Seven Years**

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




Source: Phil Papadopoulos, SDSC, Calit2

# Metagenomics Data Housed in the CAMERA Complex

Sargasso Sea Data

Sorcerer II Expedition (GOS)

JGI Community Sequencing Project

Moore Marine Microbial Project

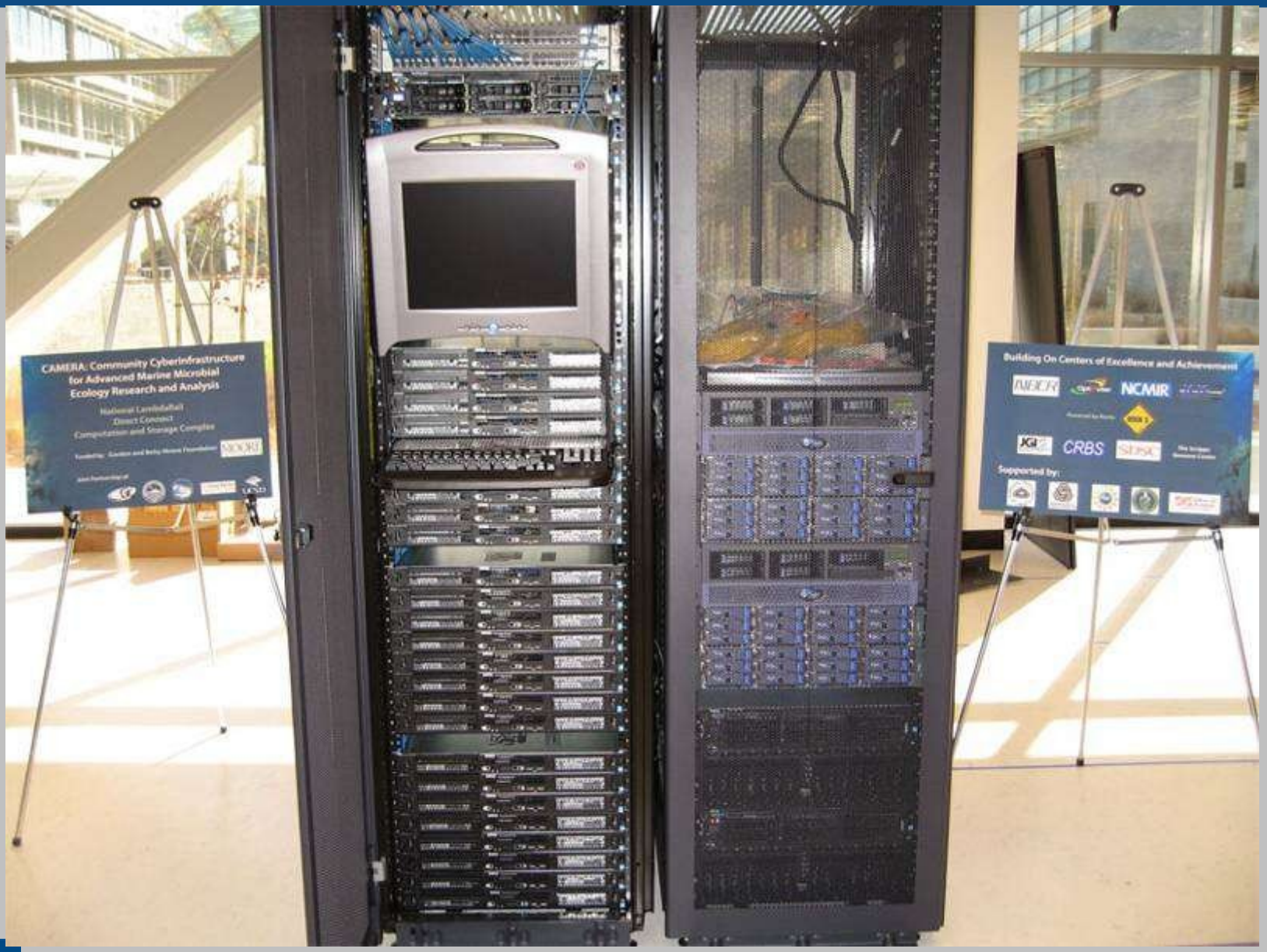
NASA Goddard Satellite Data

Community Microbial Metagenomics Data

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# First Implementation of the CAMERA Complex



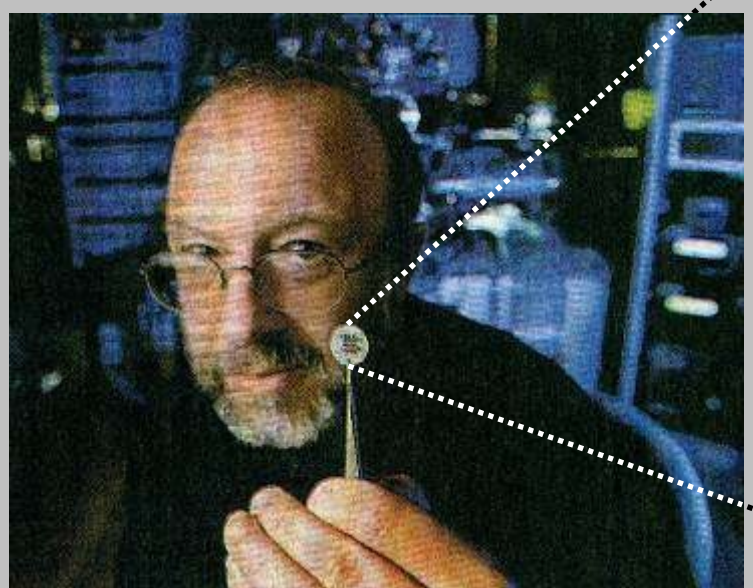

Compute

Database & Storage

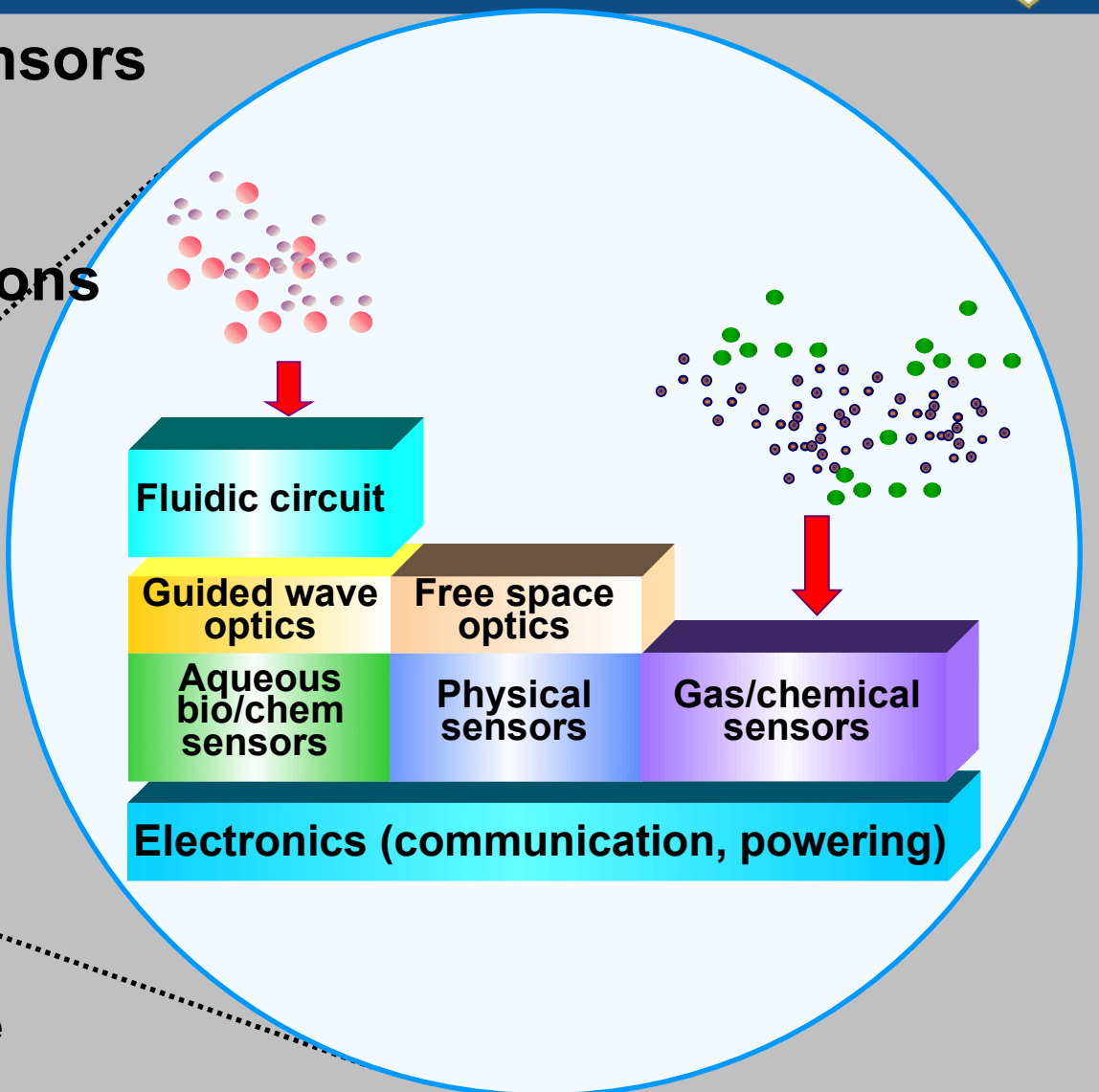
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# A World of Distributed Sensors Starts with Integrated Nanosensors

## Developing Multiple Nanosensors on a Single Chip, with Local Processing and Wireless Communications



I. K. Schuller Holding the First Prototype



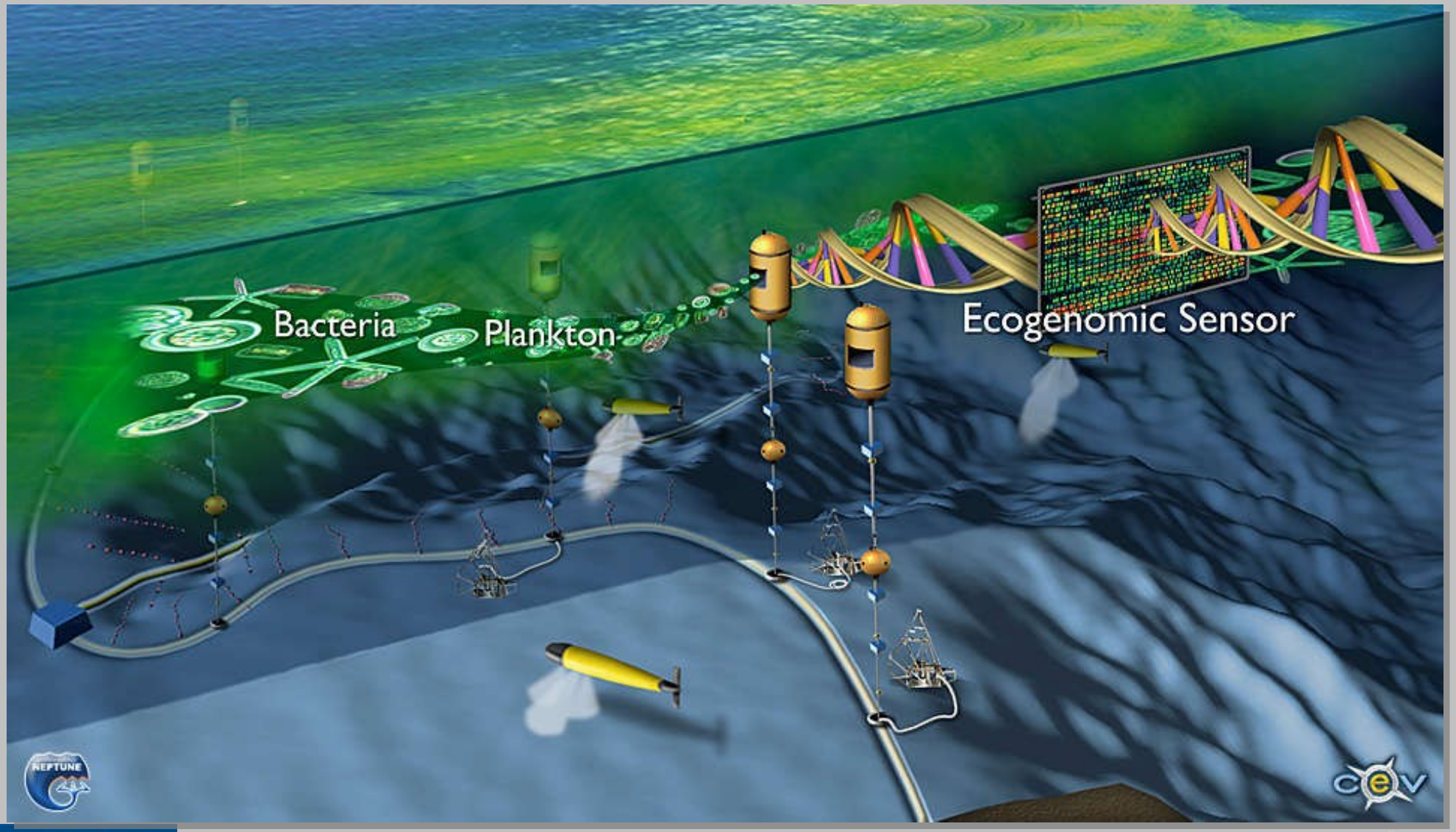

I. K. Schuller, A. Kummel, M. Sailor, W. Trogler, Y-H Lo

# A Near Future High Definition 3D Fiber Optic Cable Observatory




Source: John Delaney & CEV, UWash

# A Farther Future Fiber Optic Cabled Metagenomics Observatory

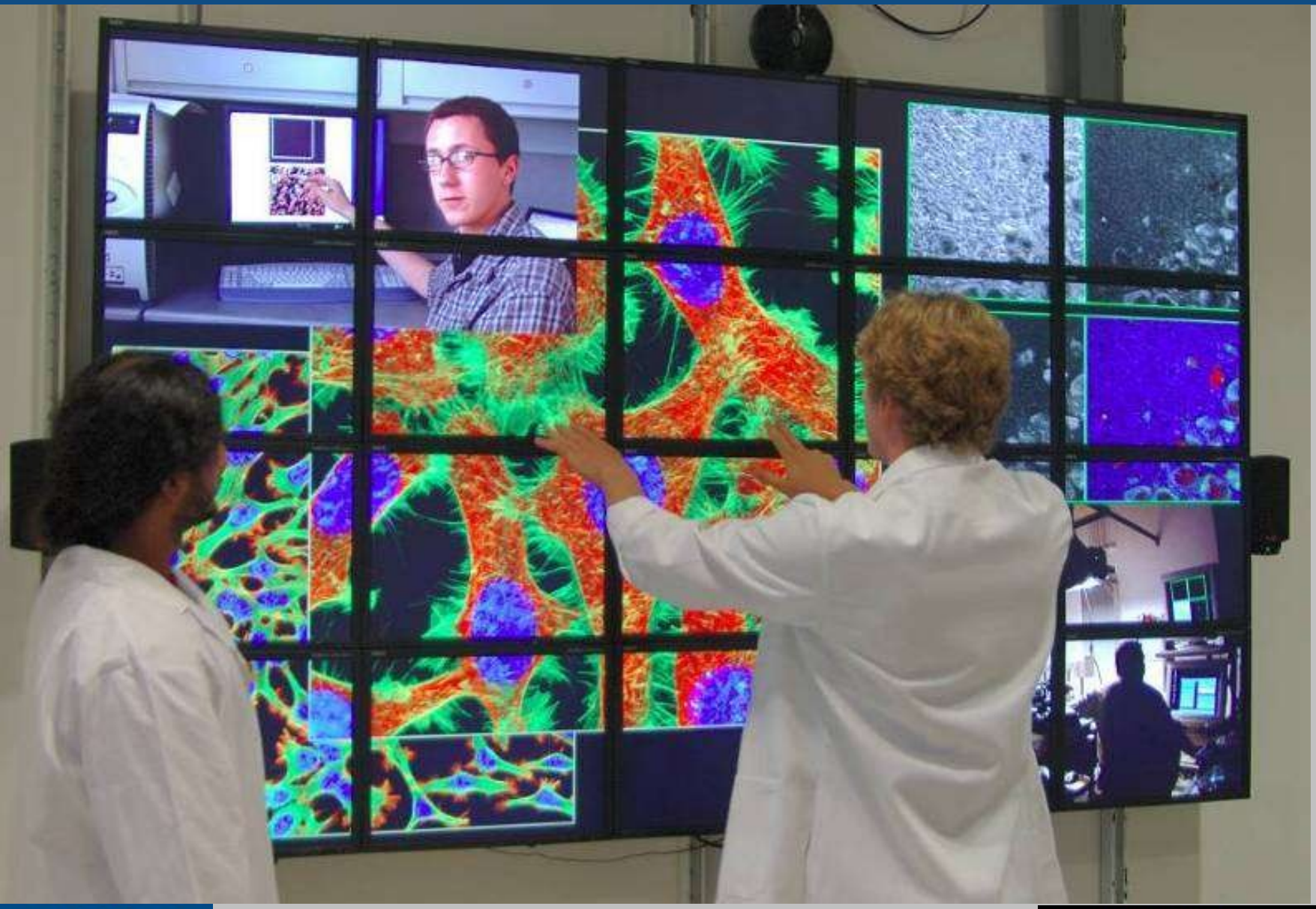



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Source: John Delaney & CEV, UWash

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



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evl electronic visualization laboratory

Source: David Lee, NCMIR, UCSD

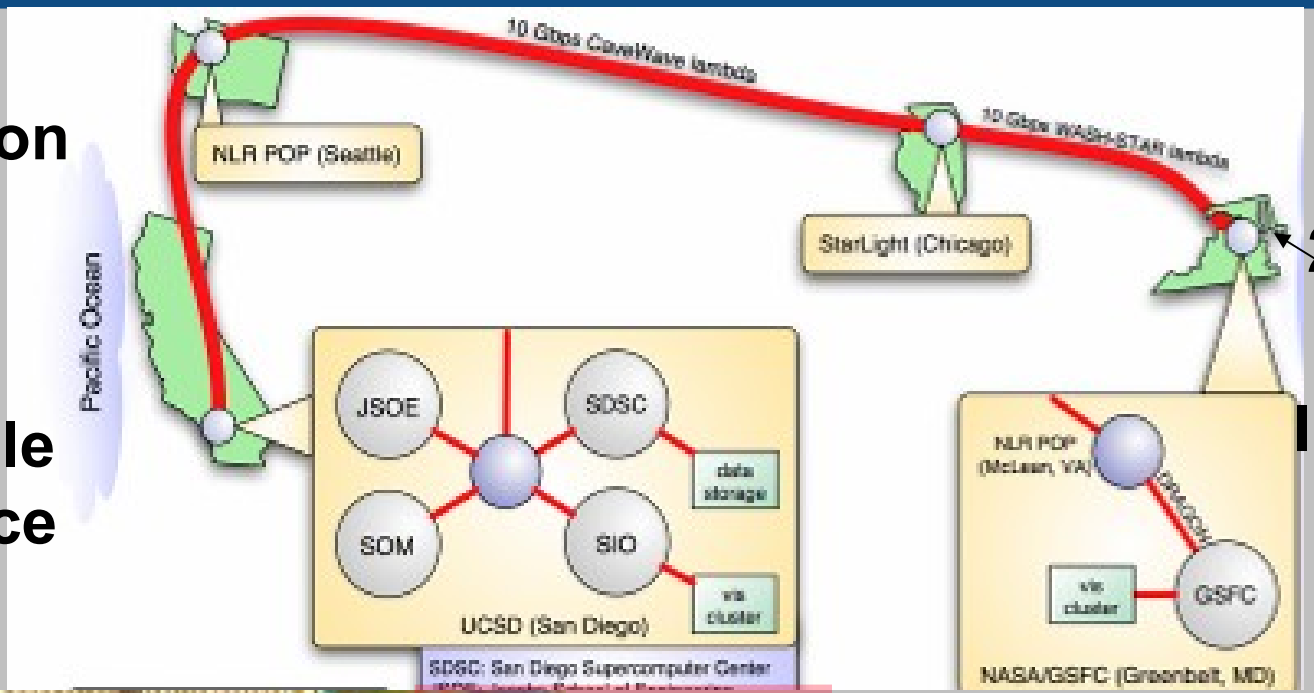
NCMIR NATIONAL CENTER for MICROSCOPY and IMAGING RESEARCH at San Diego, an NIH supported resource center

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# Calit2 and the Venter Institute Will Combine Telepresence with Remote Interactive Analysis

**Live Demonstration**

**of 21st Century National-Scale Team Science**




**25 Miles**

**Venter Institute**



**OptIPuter Visualized Data**

**HDTV Over Lambda**



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