“High Performance Collaboration – The Jump to Light Speed"

Invited Talk
National Center for Supercomputing Applications
University of Illinois, Urbana-Champaign
Urbana, IL
May 4, 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





Abstract

NCSA has been a leader in innovation of new modes of networked collaboration for over fifteen years. The vision painted in the 1989 Science by Satellite demonstration at Siggraph in which distance becomes eliminated is finally nearing reality. I will review highlights of NCSA's pioneering work and then describe some recent experiments that Calit2 has been involved in. With the emergence of dedicated 10 gigabit/s optical backplanes on a planetary scale, the notion of shared telepresence is becoming achievable.

OptIPuter

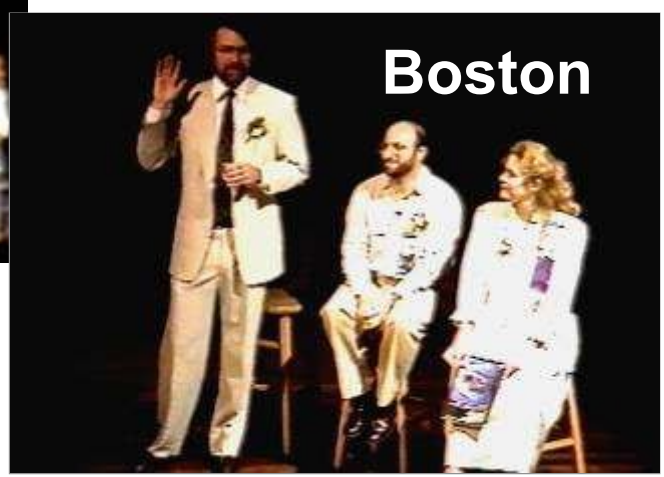
it²

Long-Term Goal: Dedicated Fiber Optic Infrastructure
Using Analog Communications to Prototype the Digital Future

"What we really have to do is eliminate distance between individuals who want to interact with other people and with other computers."
— Larry Smarr, Director, NCSA

- **Televisualization:**
  - **Telepresence**
  - **Remote Interactive Visual Supercomputing**
  - **Multi-disciplinary Scientific Visualization**







"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
Chair, US Senate Subcommittee on Science, Technology and Space

ATT & Sun

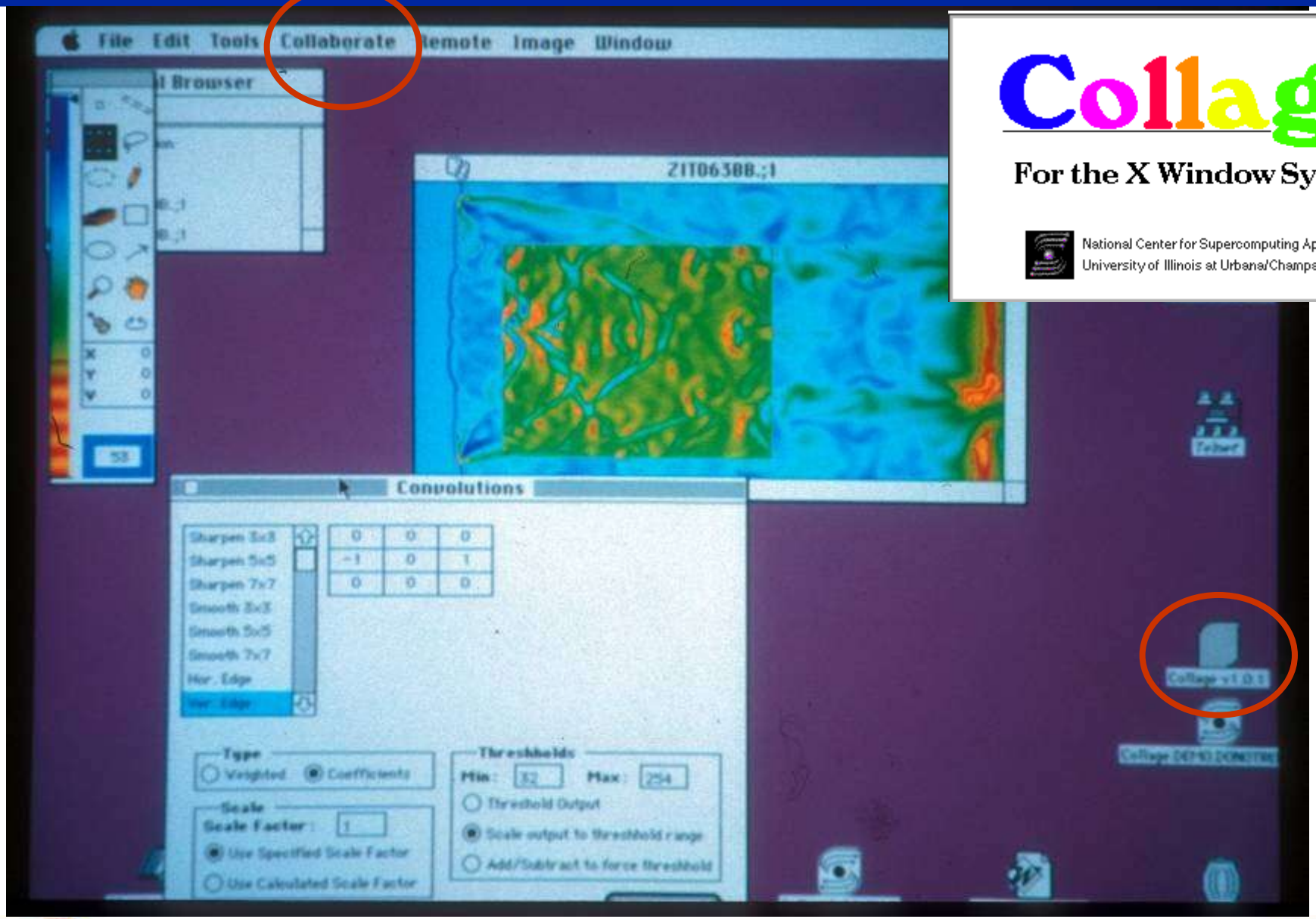
OptIPuter

SIGGRAPH 1989

NCSA

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NCSA Collage-a Cross Platform Desktop Collaboration Tool-Led to Mosaic



Source: Susan Hardin

The Move to a Single Software Platform Collaboration Tool

"Habanero™ was written to facilitate the use of real-time multi-user software tools in education and the sciences. Unlike earlier projects (such as NCSA Telnet, NCSA Collage, NCSA Mosaic), where different source code was used for each supported hardware platform, the Habanero framework supports multiple hardware platforms by virtue of implementation in the Java programming language from Sun Microsystems."

Java Object-Sharing in

HABANERO

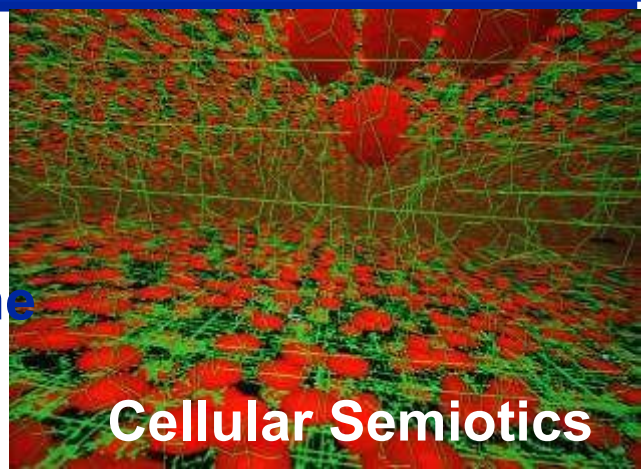
A new framework for collaborative tool development uses any platform that supports Java.

ANNIE CHABERT, ED GROSSMAN, LARRY JACKSON, STEPHEN PIETROWICZ, AND CHRIS SEGUIN

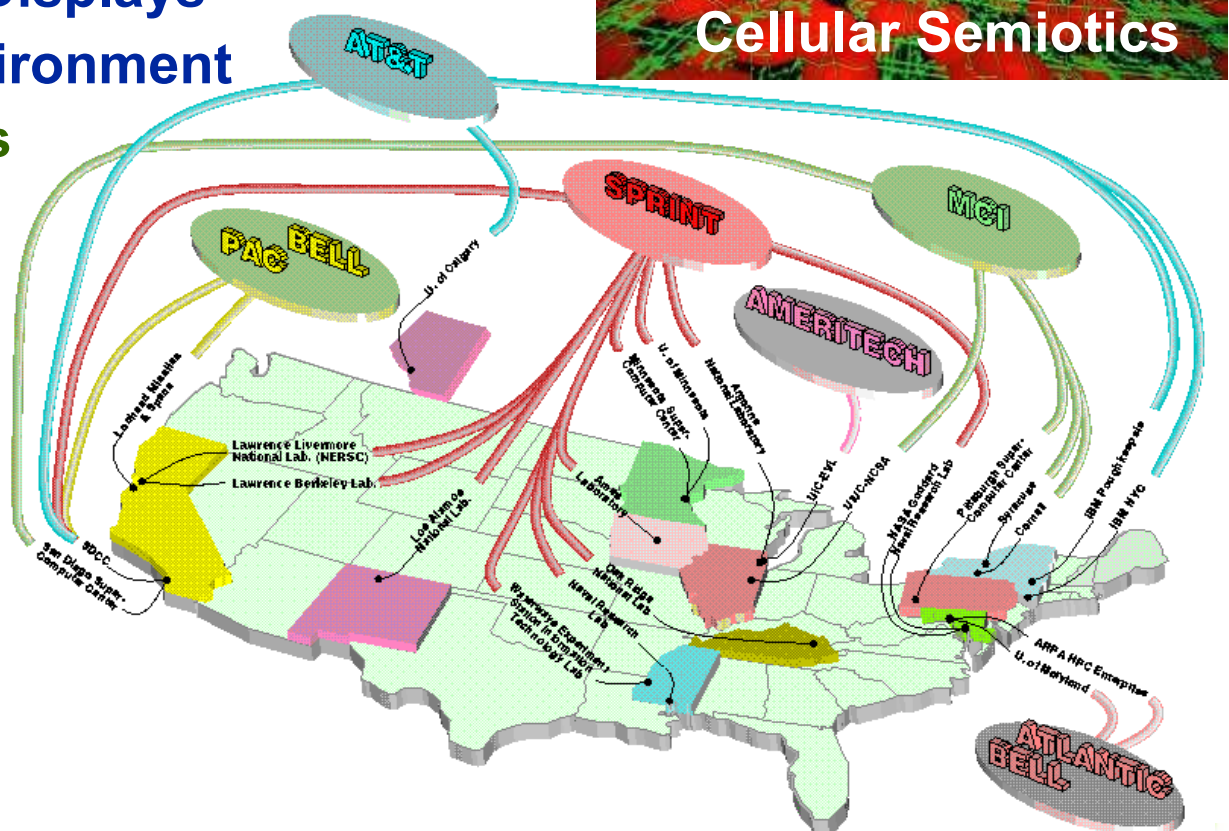
Supercomputing '95 I-WAY Project
First Working Prototype of a National-Scale Science Grid

- 60 National & Grand Challenge Computing Applications
- I-Way Featured:
  - IP over ATM with an OC-3 (155Mbps) Backbone
  - Large-Scale Immersive Displays
  - I-Soft Programming Environment
    - Led Directly to Globus

UI mcs NCSA







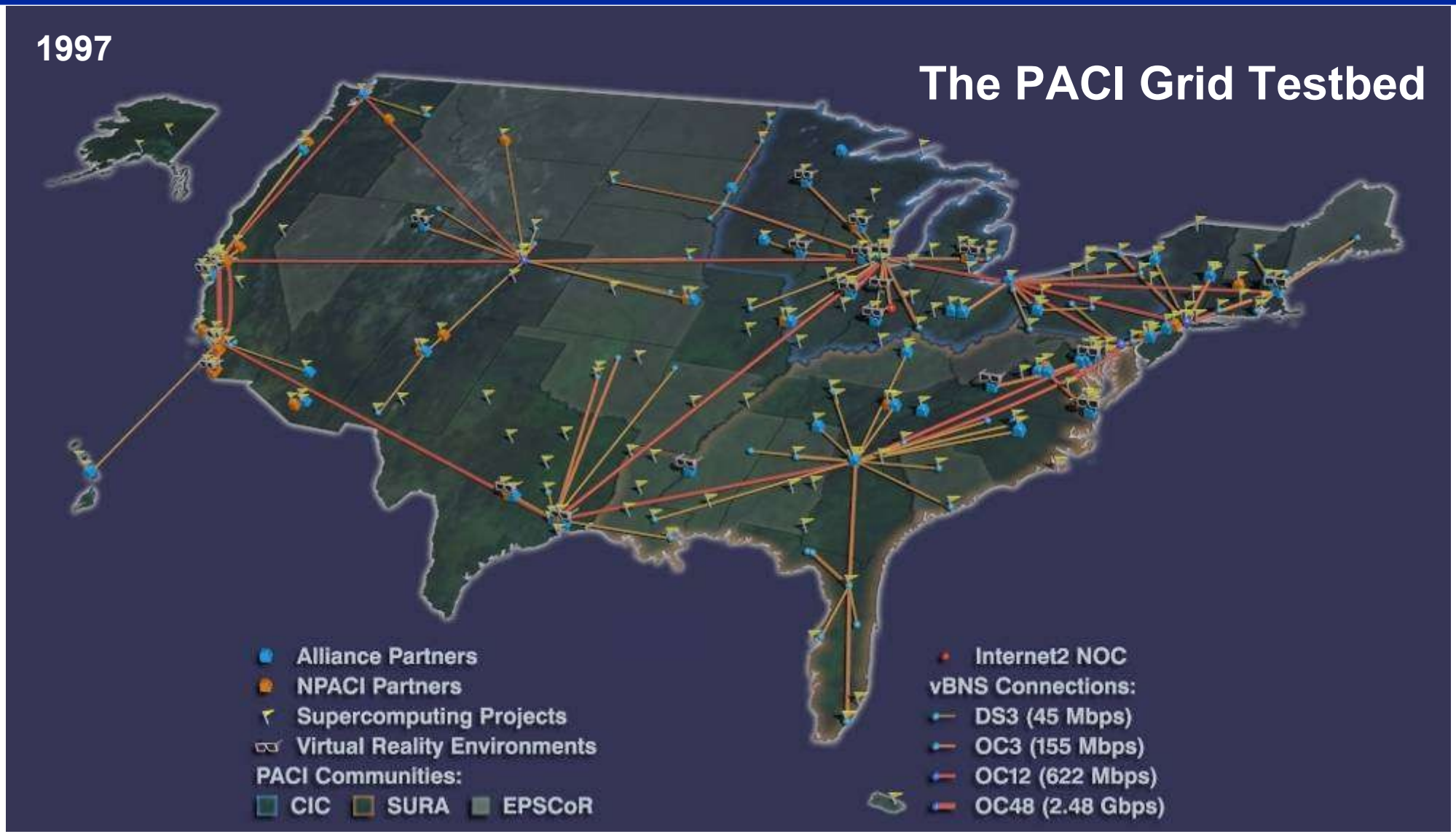
http://archive.ncsa.uiuc.edu/General/Training/SC95/GII.HPCC.html

Source: Larry Smarr, Rick Stevens, Tom DeFanti

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PACI is Prototyping America's 21st Century Information Infrastructure



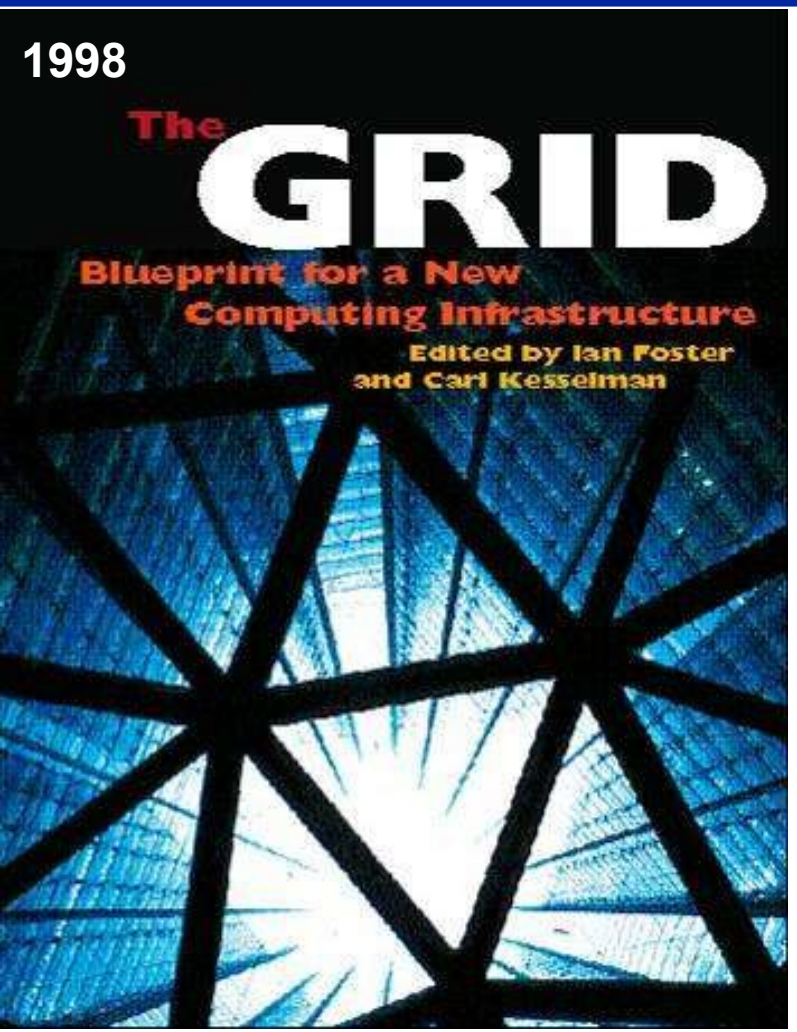
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NPACI

National Computational Science ALLIANCE

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Layered Software Approach to Building the Planetary Grid



"A source book for the history of the future" -- Vint Cerf

Science Portals & Workbenches

Twenty-First Century Applications

Access Grid	Computational Grid
Access Services & Technology	Computational Services

Grid Services
(resource independent)

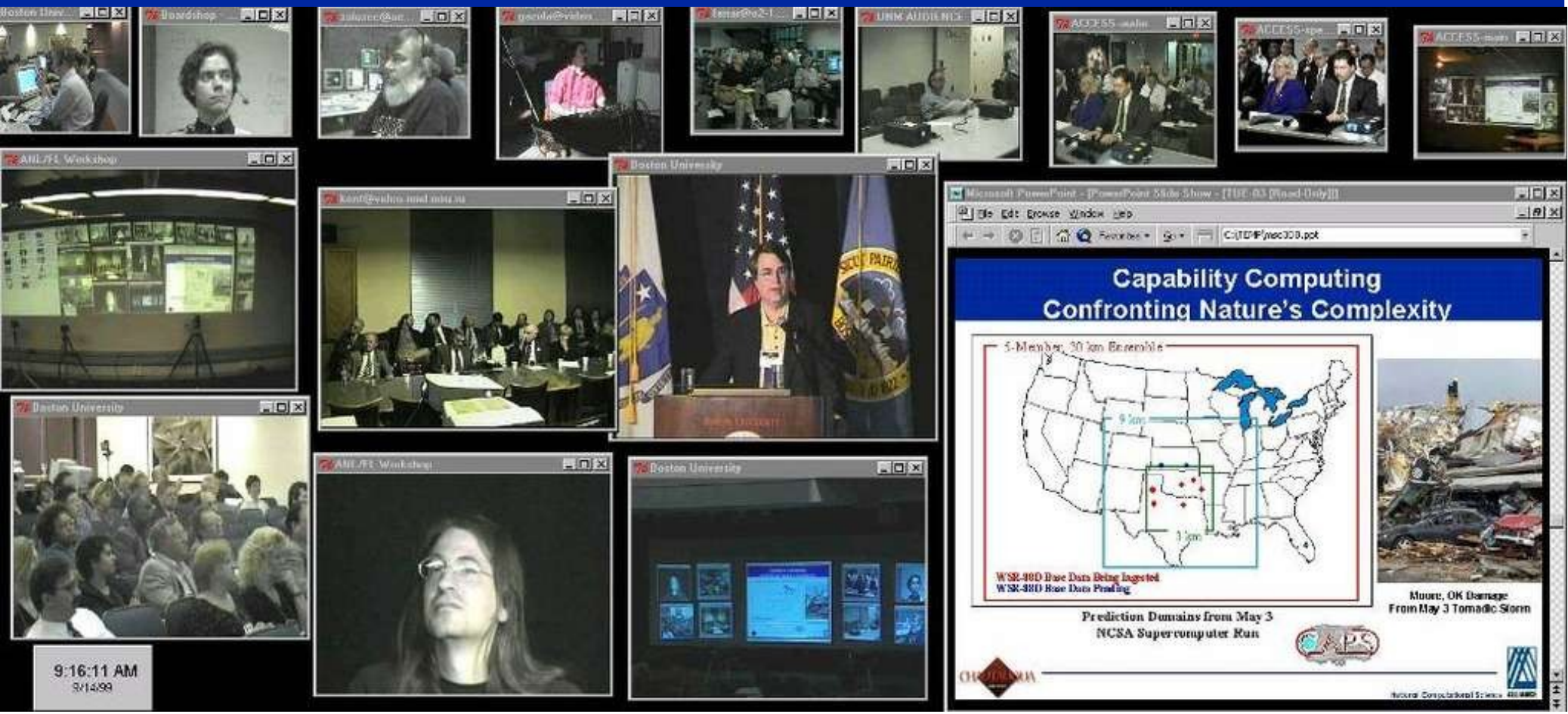
Grid Fabric
(resource dependent)

Networking, Devices and Systems

Performance

Edited by Ian Foster and Carl Kesselman
www.mkp.com/grids

From Telephone Conference Calls to Access Grid International IP Multicast



1999

CHAUTAUQUA ALLIANCE

National Computational Science ALLIANCE

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Access Grid Lead-Argonne
NSF STARTAP Lead-UIC's Elec. Vis. Lab

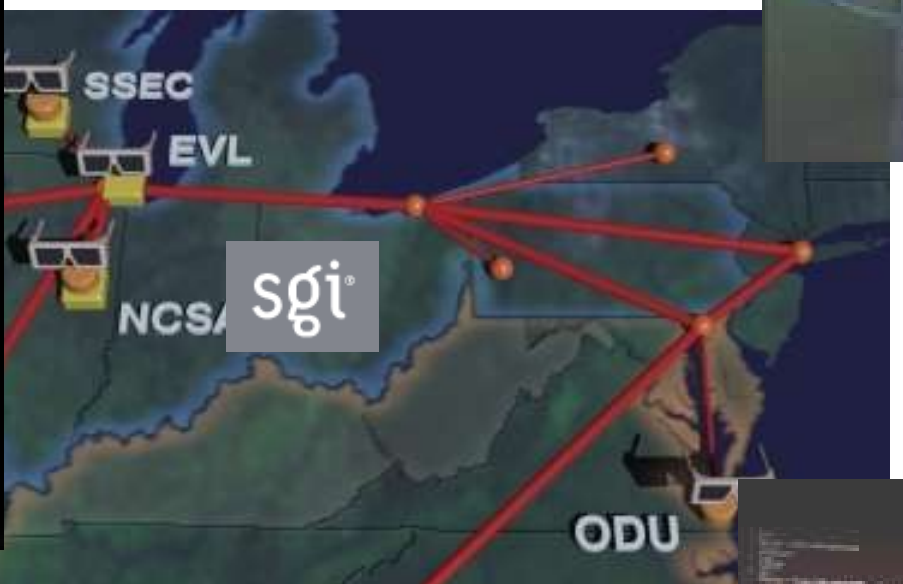
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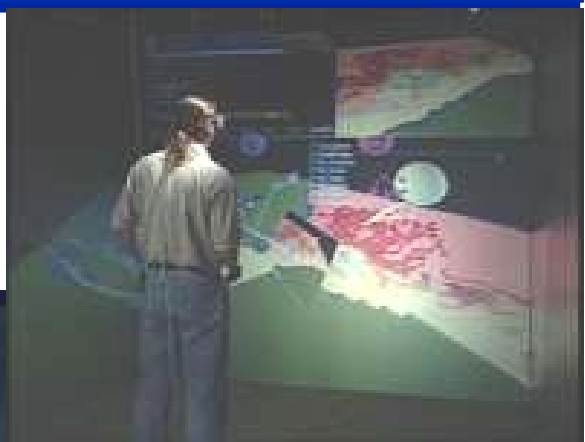
Alliance 1997: Collaborative Video Production via Tele-Immersion and Virtual Director

Alliance Project Linking CAVE, ImmersaDesk, Power Wall, and Workstation

Alliance Application Technologies
Environmental Hydrology Team











NCSA™ UIC

sgi

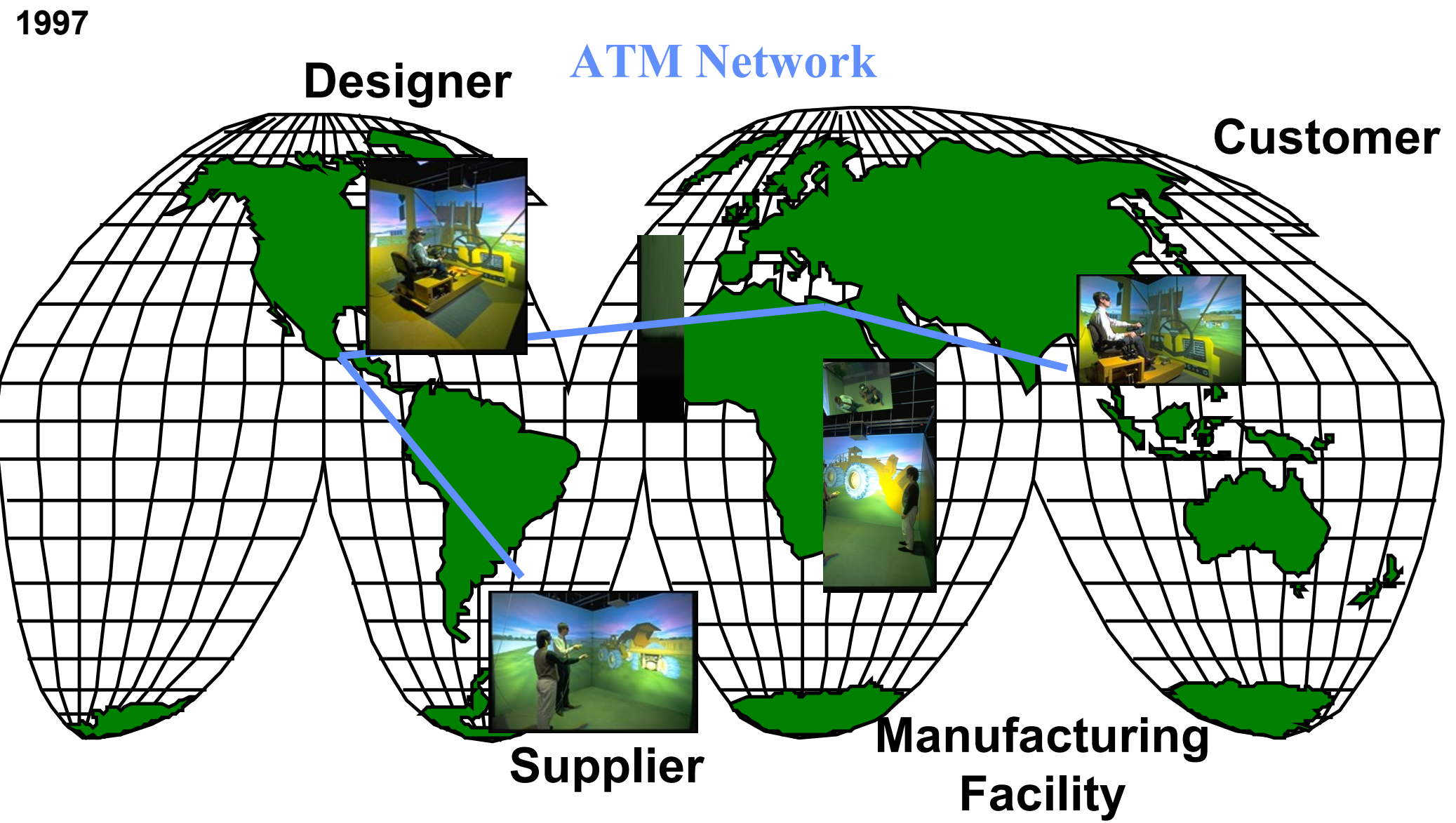
ALLIANCE

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Donna Cox, Robert Patterson, Stuart Levy, NCSA Virtual Director Team
Glenn Wheless, Old Dominion Univ.

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NCSA and Industrial Partner Caterpillar Prototyping Global Virtual Manufacturing

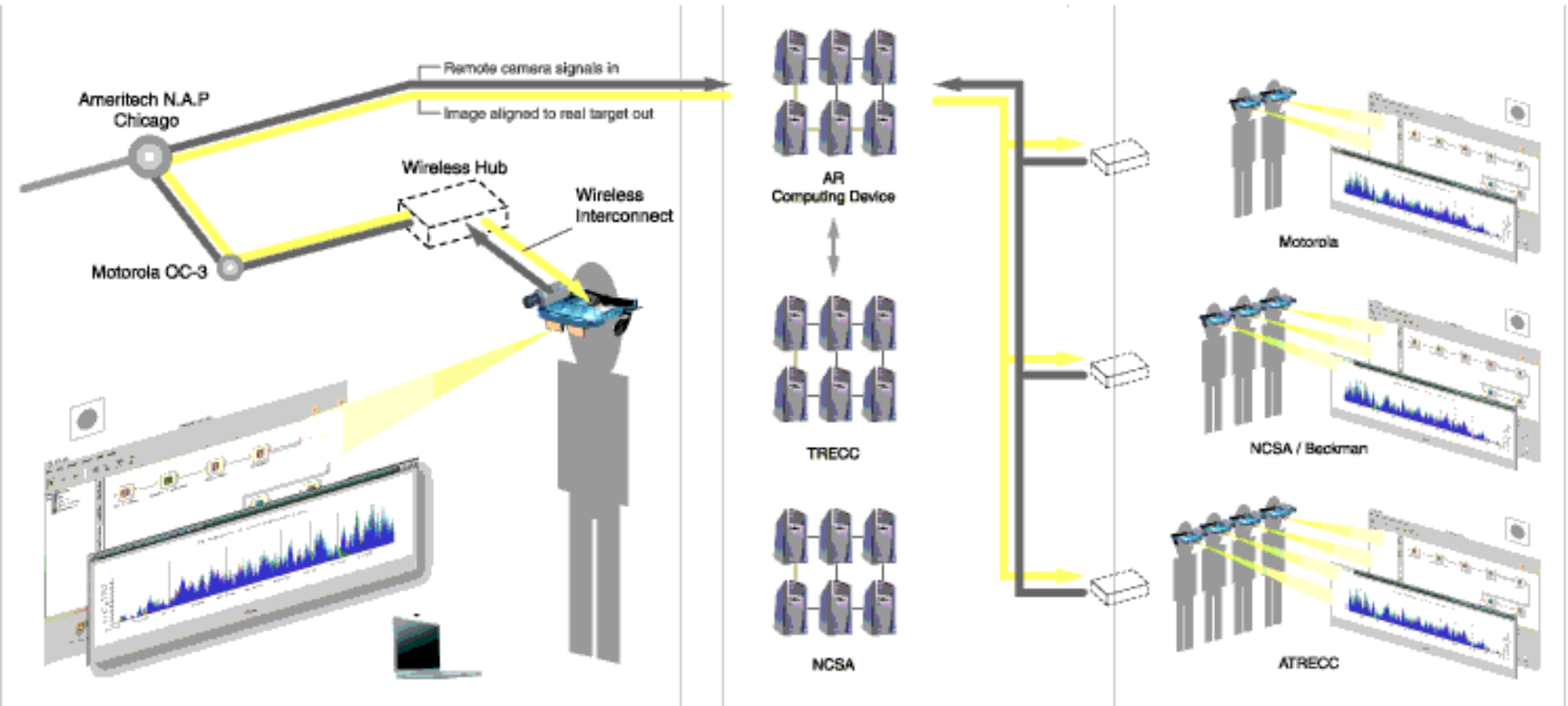


Source: Kem Ahlers, Caterpillar

HyperComputiCations—
a Joint Project of NCSA/Motorola/ TRECC

2003

Mirage II concept



MOTOROLA LABS

Source: Gerry Labedz, Motorola

Two New Calit2 Buildings Provide New Laboratories for "Living in the Future"



- Over 1000 Researchers in Two Buildings
  - Linked via Dedicated Optical Networks
  - International Conferences and Testbeds
- New Laboratories
  - Nanotechnology
  - Virtual Reality, Digital Cinema



www.calit2.net

Preparing for a World in Which Distance is Eliminated…

Calit2 is Experimenting with Open Reconfigurable Work Spaces to Enhance Collaboration







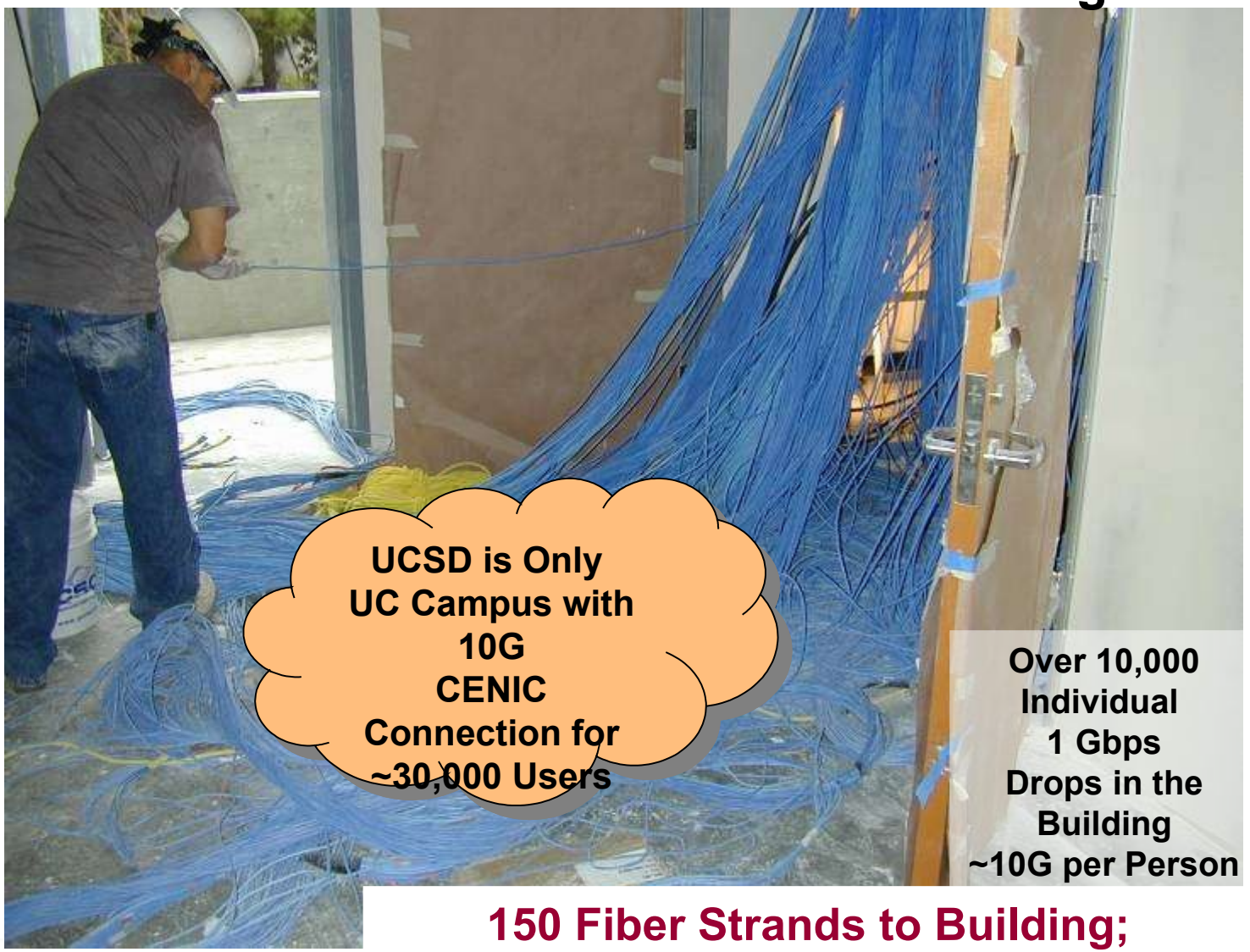
Over Two Dozen Departments in the Building

OptIPuter

Photos by John Durant; Barbara Haynor, Calit2

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

1.8 Million Feet of Cat6 Ethernet Cabling



24 Fiber Pairs to Each Lab

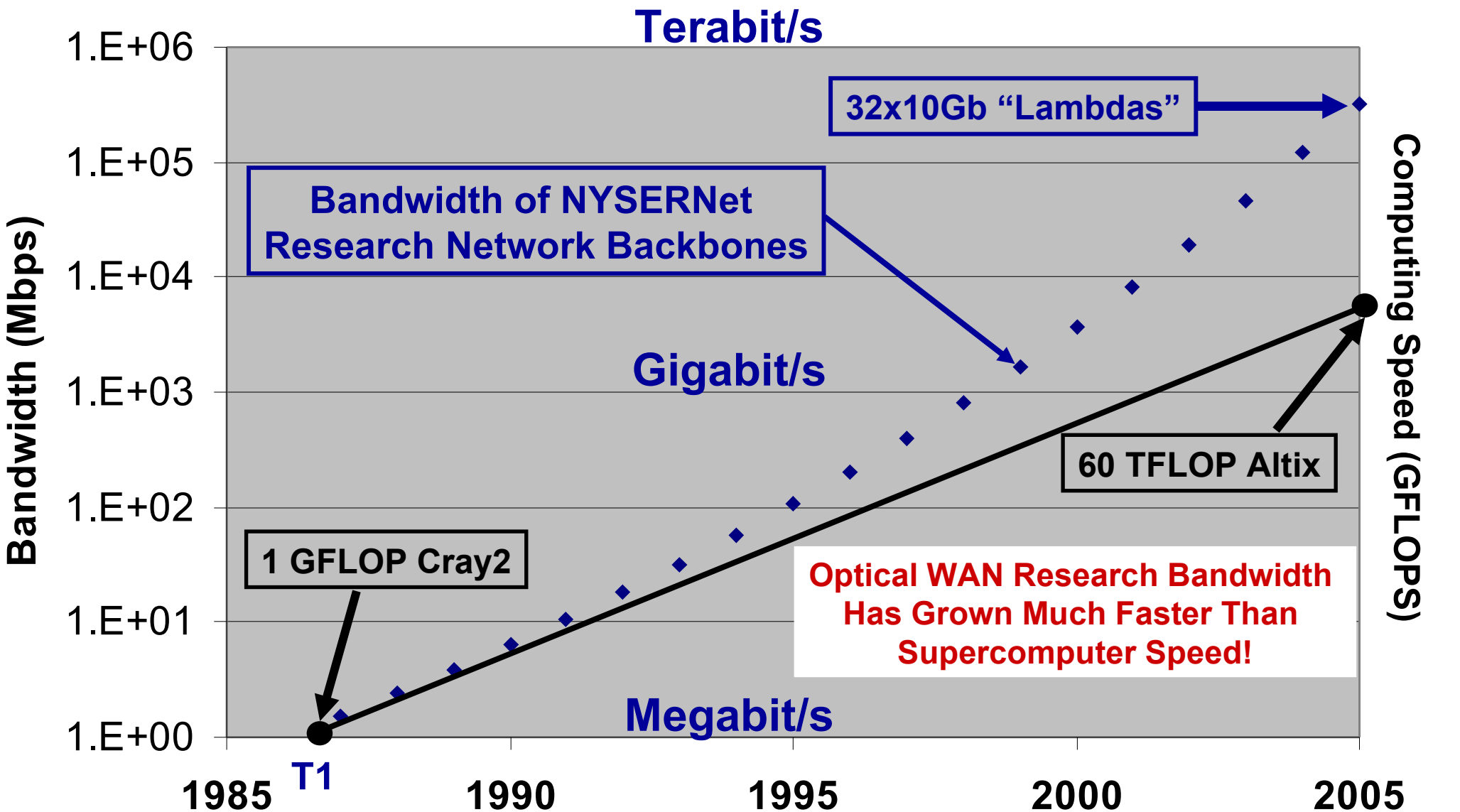
150 Fiber Strands to Building;
Experimental Roof Radio Antenna Farm
Ubiquitous WiFi

Photo: Tim Beach, Calit2

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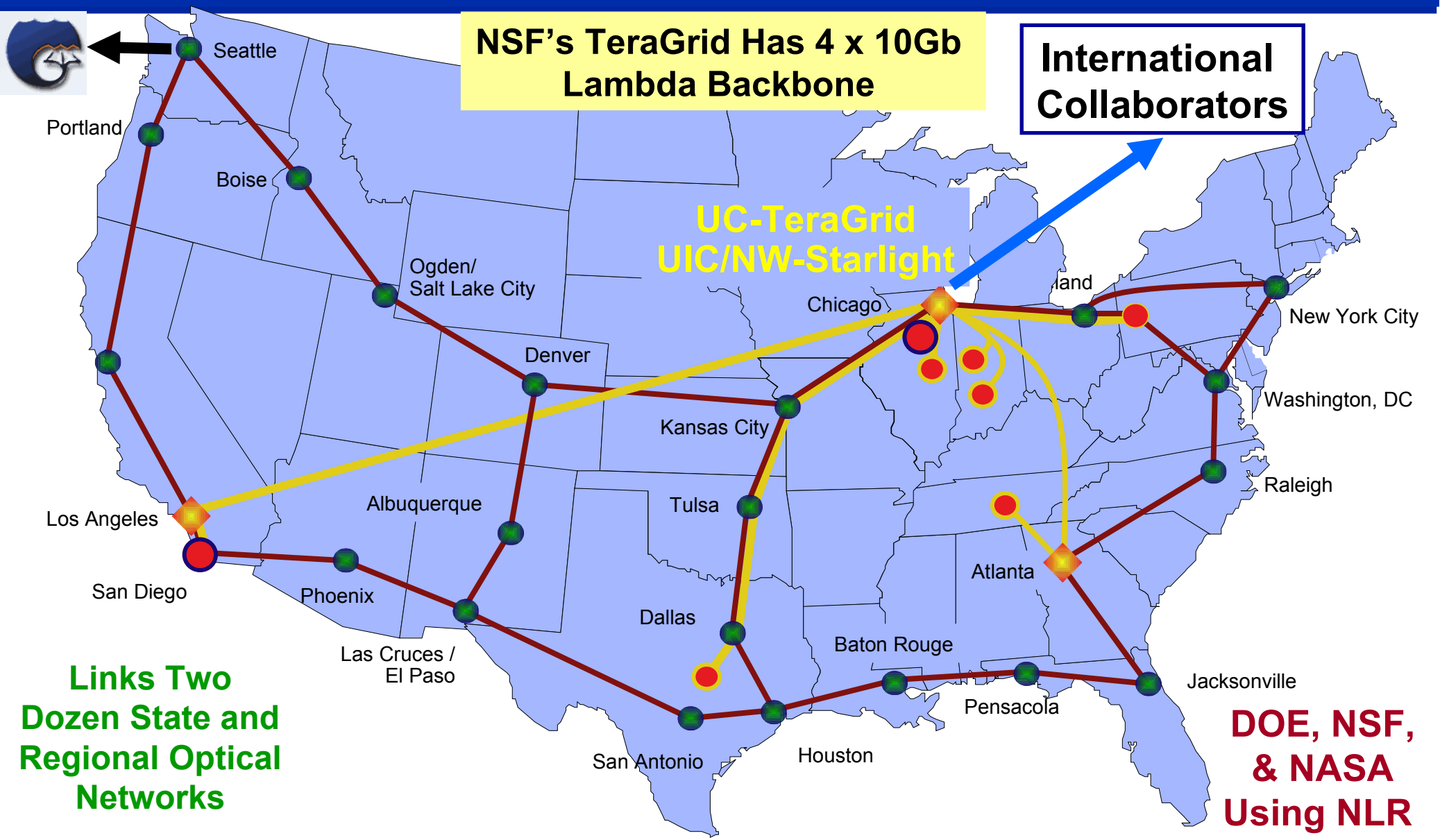
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From "Supercomputer–Centric" to "Supernetwork-Centric" Cyberinfrastructure

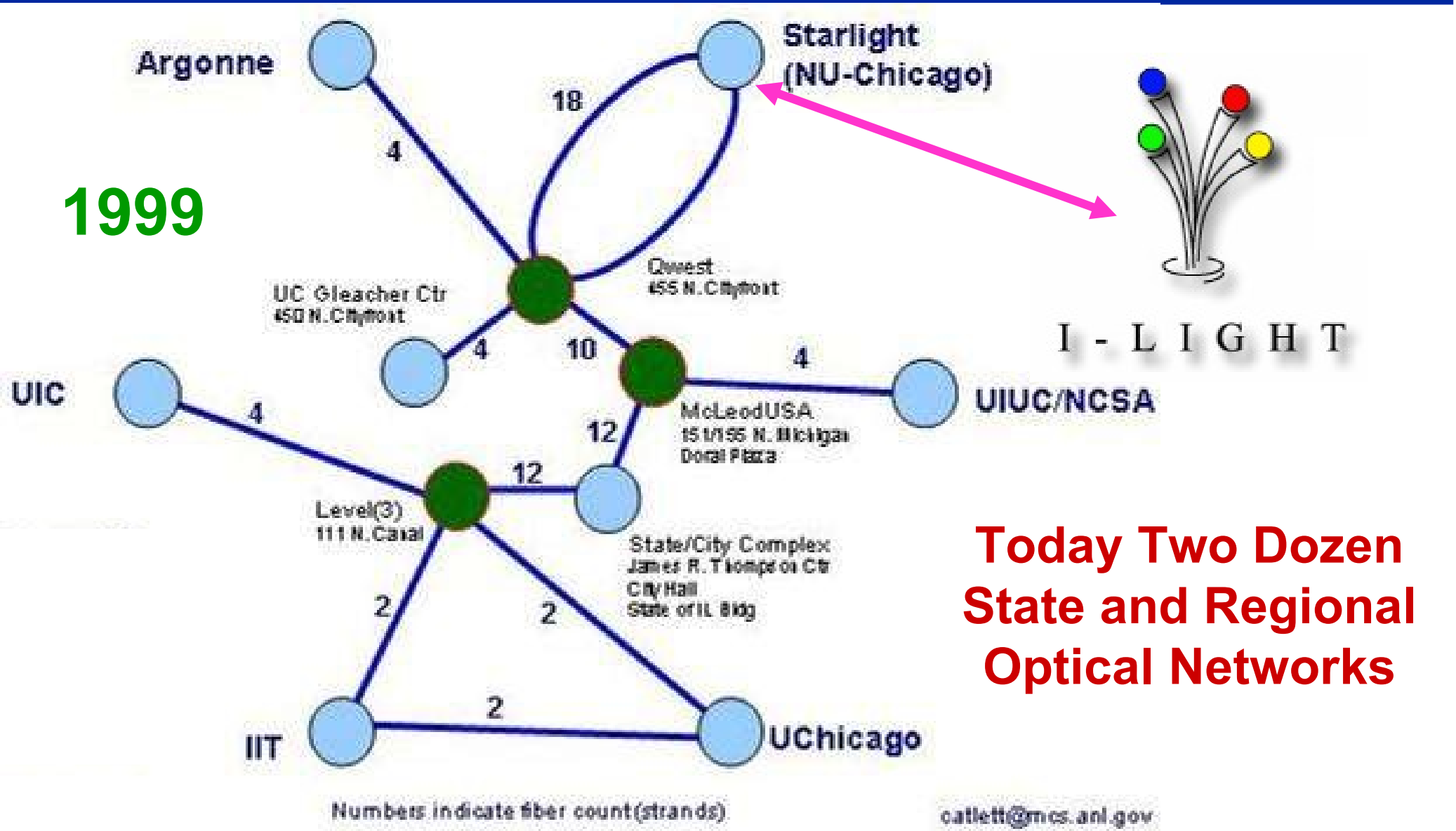


Network Data Source: Timothy Lance, President, NYSERNet

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



States are Acquiring Their Own Dark Fiber Networks -- Illinois's I-WIRE and Indiana's I-LIGHT



Today Two Dozen State and Regional Optical Networks

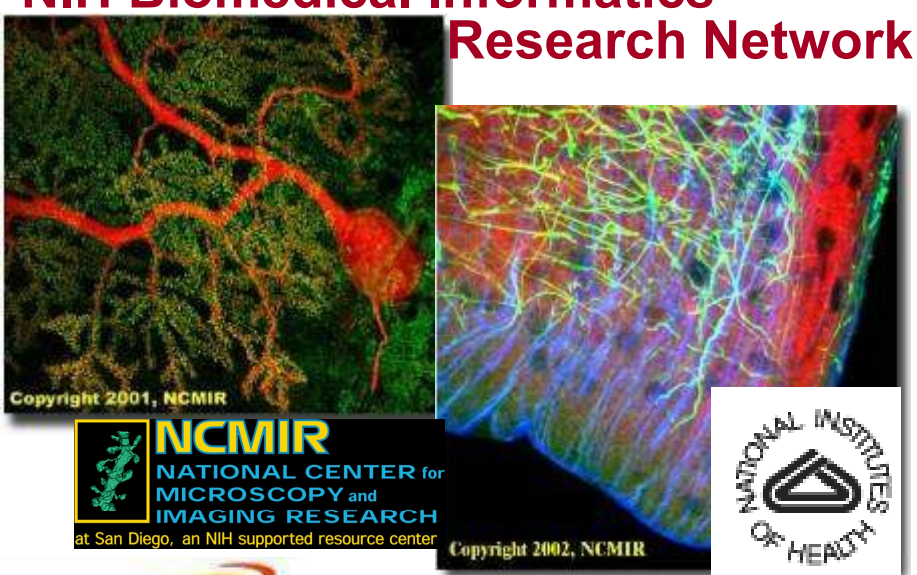
Source: Larry Smarr, Rick Stevens, Tom DeFanti, Charlie Catlett

The OptIPuter Project –

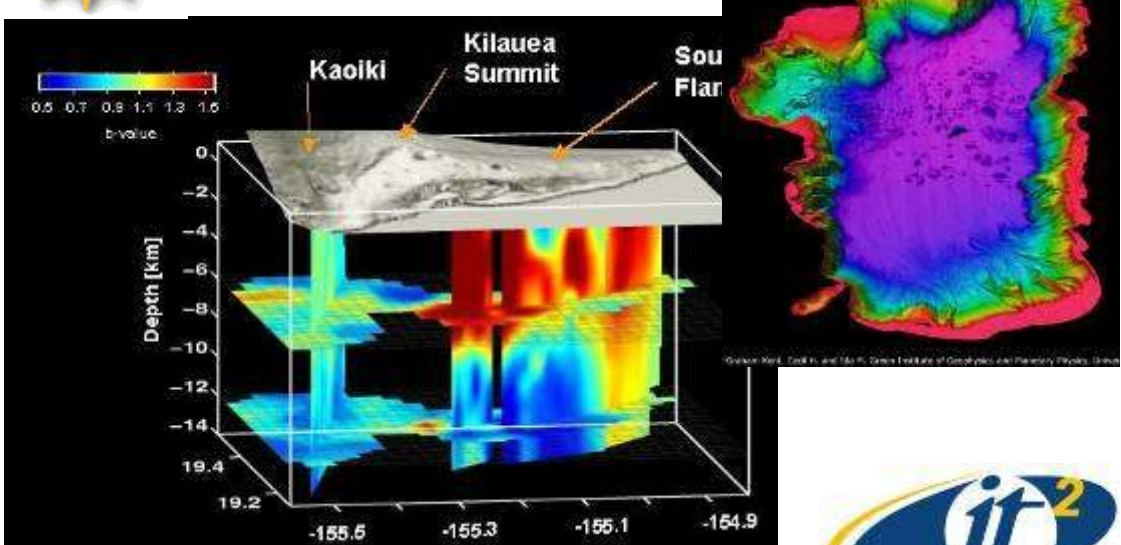
Linking Global Scale Science Projects to User's Linux Clusters

- **NSF Large Information Technology Research Proposal**
  - Calit2 (UCSD, UCI) and UIC Lead Campuses—Larry Smarr PI
  - Partnering Campuses: USC, SDSU, NCSA, NW, TA&M, UvA, SARA, NASA Goddard, KISTI, AIST
- **Industrial Partners**
  - IBM, Sun, Telcordia, Chiaro, Calient, Glimmerglass, Lucent
- **$13.5 Million Over Five Years**

NIH Biomedical Informatics Research Network



NSF EarthScope and ORION



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What is the OptIPuter?

- Applications Drivers → Interactive Analysis of Large Data Sets
- OptIPuter Nodes → Scalable PC Clusters with Graphics Cards
- IP over Lambda Connectivity →Predictable Backplane
- Open Source LambdaGrid Middleware→ Network is Reservable
- Data Retrieval and Mining → Lambda Attached Data Servers
- High Defn. Vis., Collab. SW → High Performance Collaboratory

www.optiputer.net

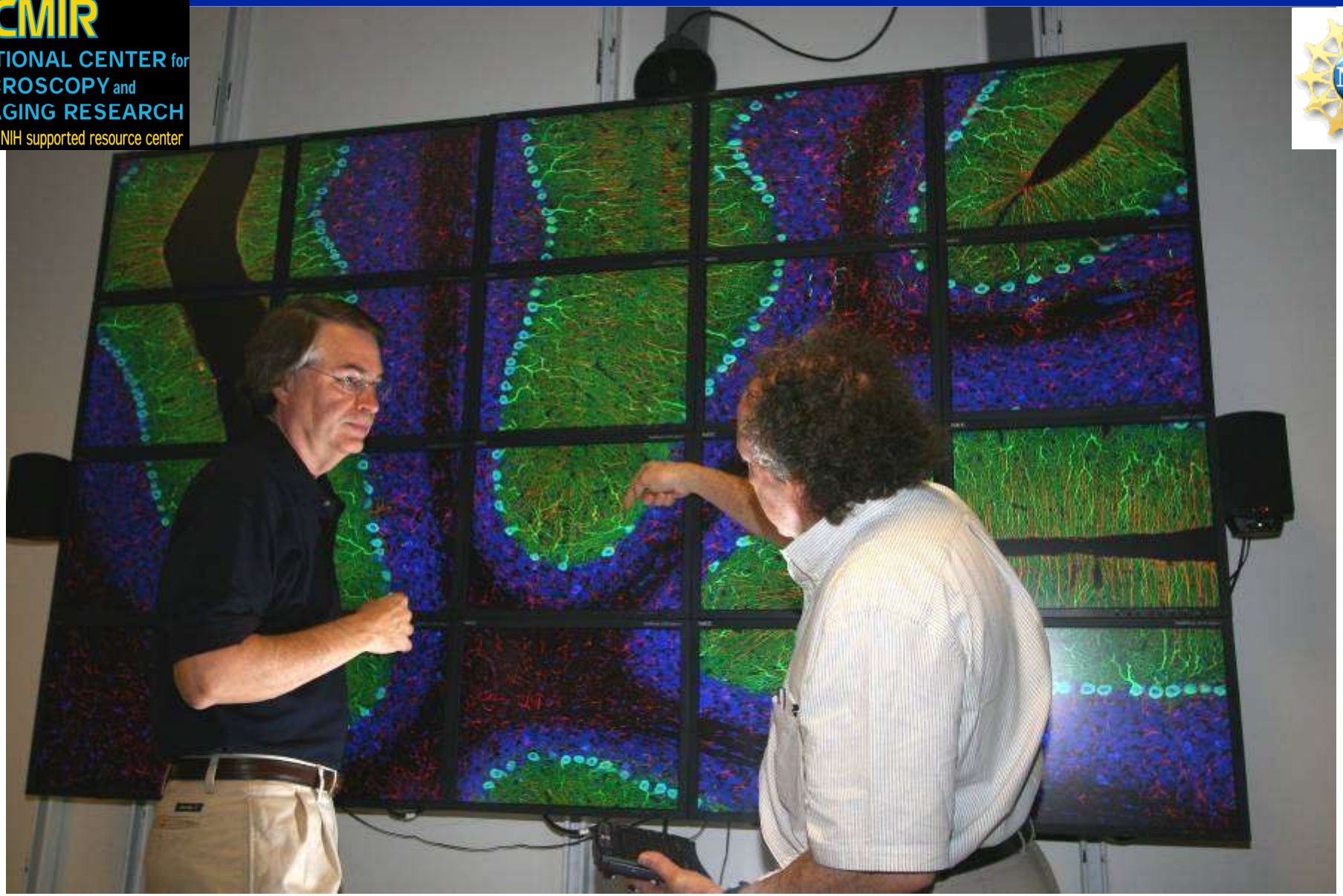
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See Nov 2003 Communications of the ACM for Articles on OptIPuter Technologies

it²

End User Device: Tiled Wall Driven by OptIPuter Graphics Cluster

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



NSF

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Borderless Collaboration Between Global University Research Centers at 10Gbps

Maxine Brown, Tom DeFanti, Co-Chairs

iGrid 2005

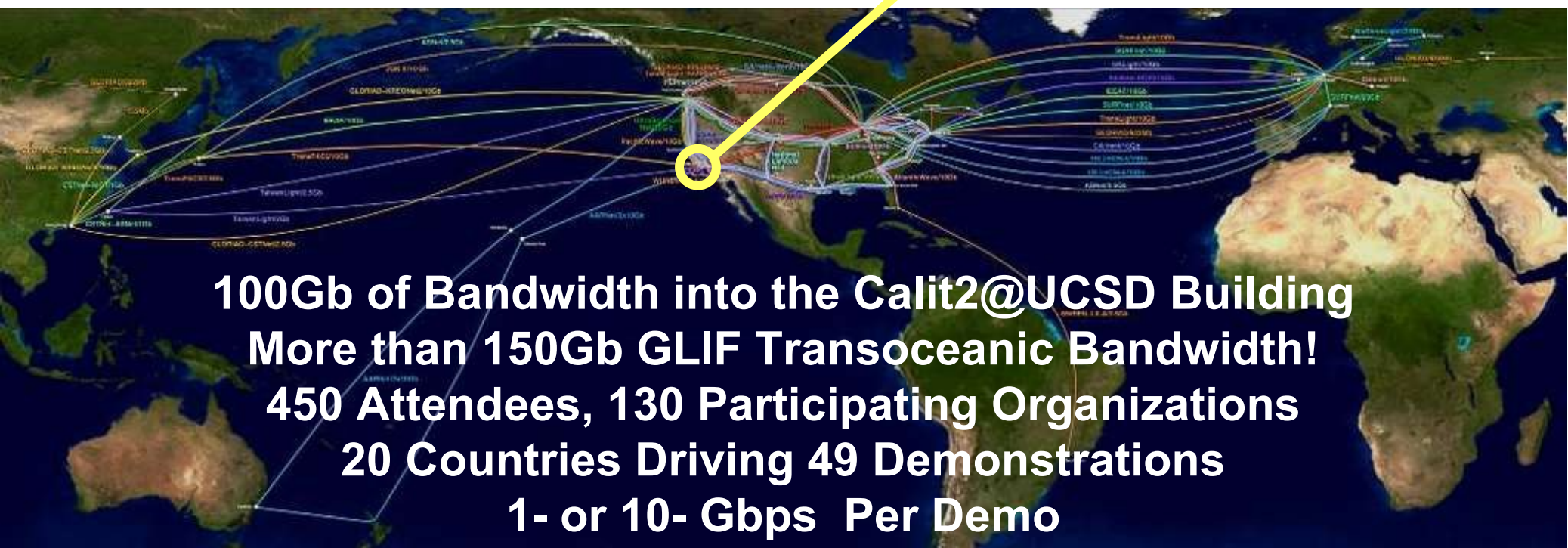
THE GLOBAL LAMBDA INTEGRATED FACILITY

www.igrid2005.org



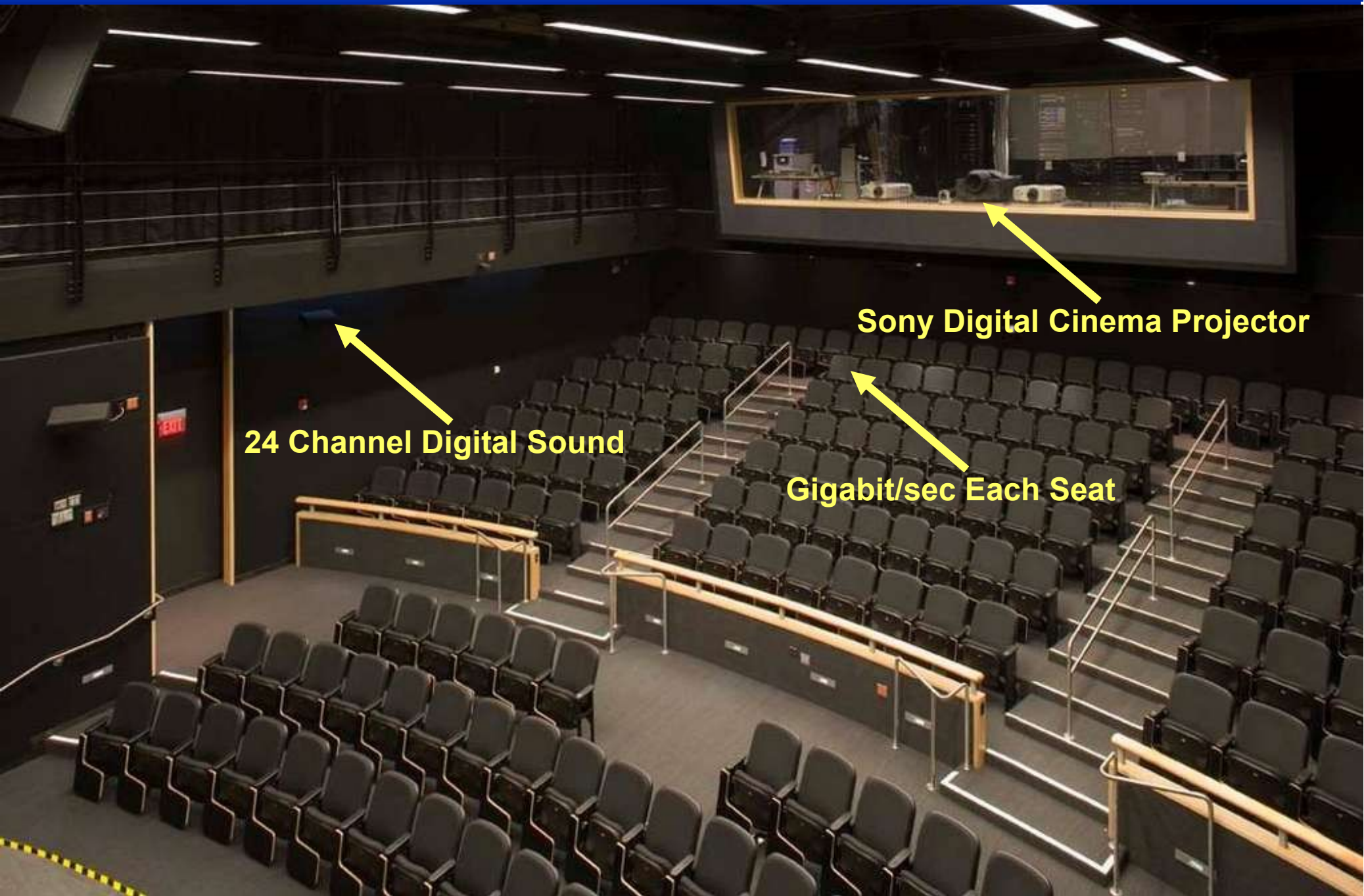
the UC Discovery Grant

September 26-30, 2005
Calit2 @ University of California, San Diego
California Institute for Telecommunications and Information Technology

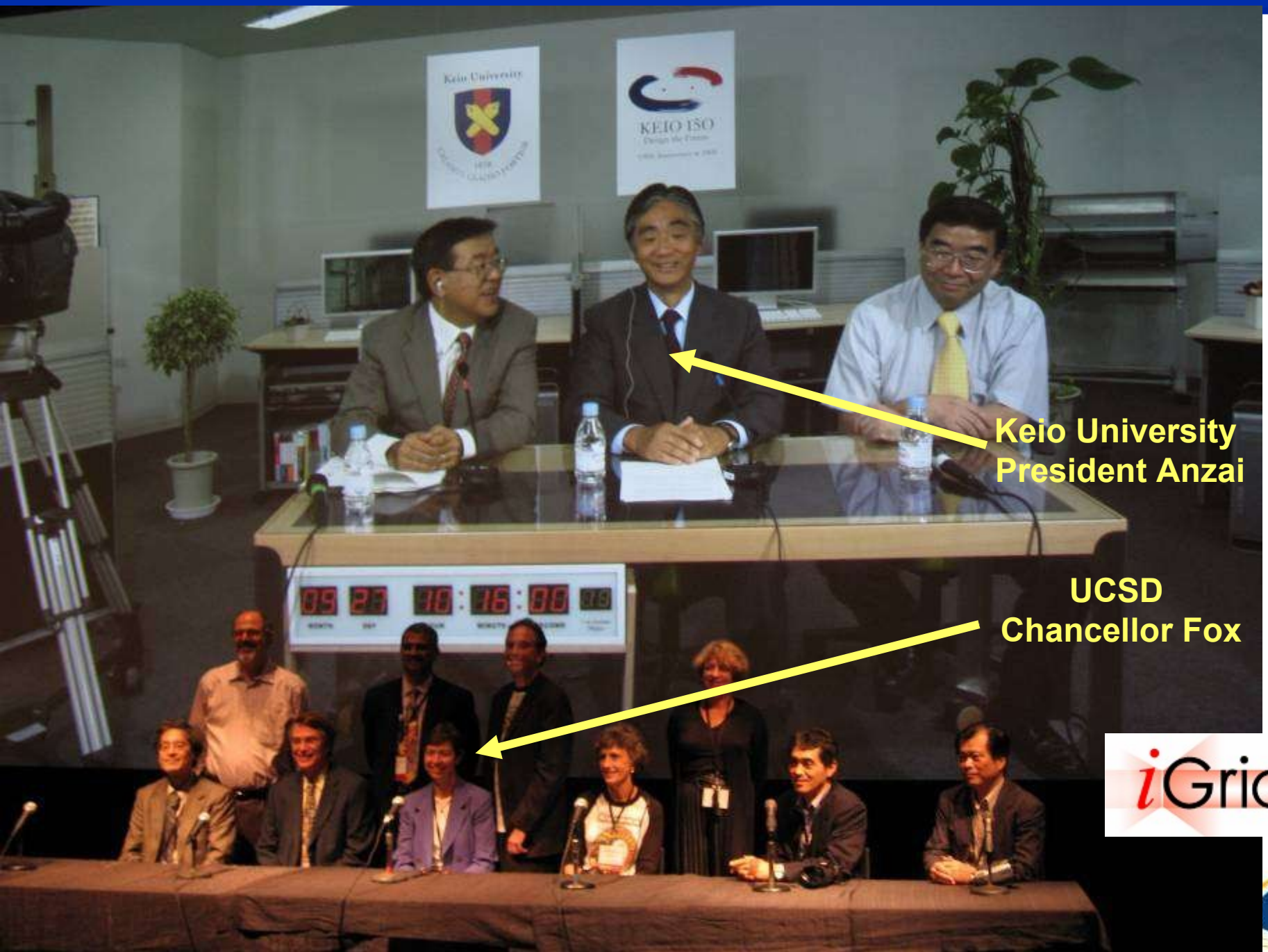


100Gb of Bandwidth into the Calit2@UCSD Building
More than 150Gb GLIF Transoceanic Bandwidth!
450 Attendees, 130 Participating Organizations
20 Countries Driving 49 Demonstrations
1- or 10- Gbps Per Demo

Building a Global Collaboratorium



First Trans-Pacific Super High Definition Telepresence Meeting in New Calit2 Digital Cinema Auditorium



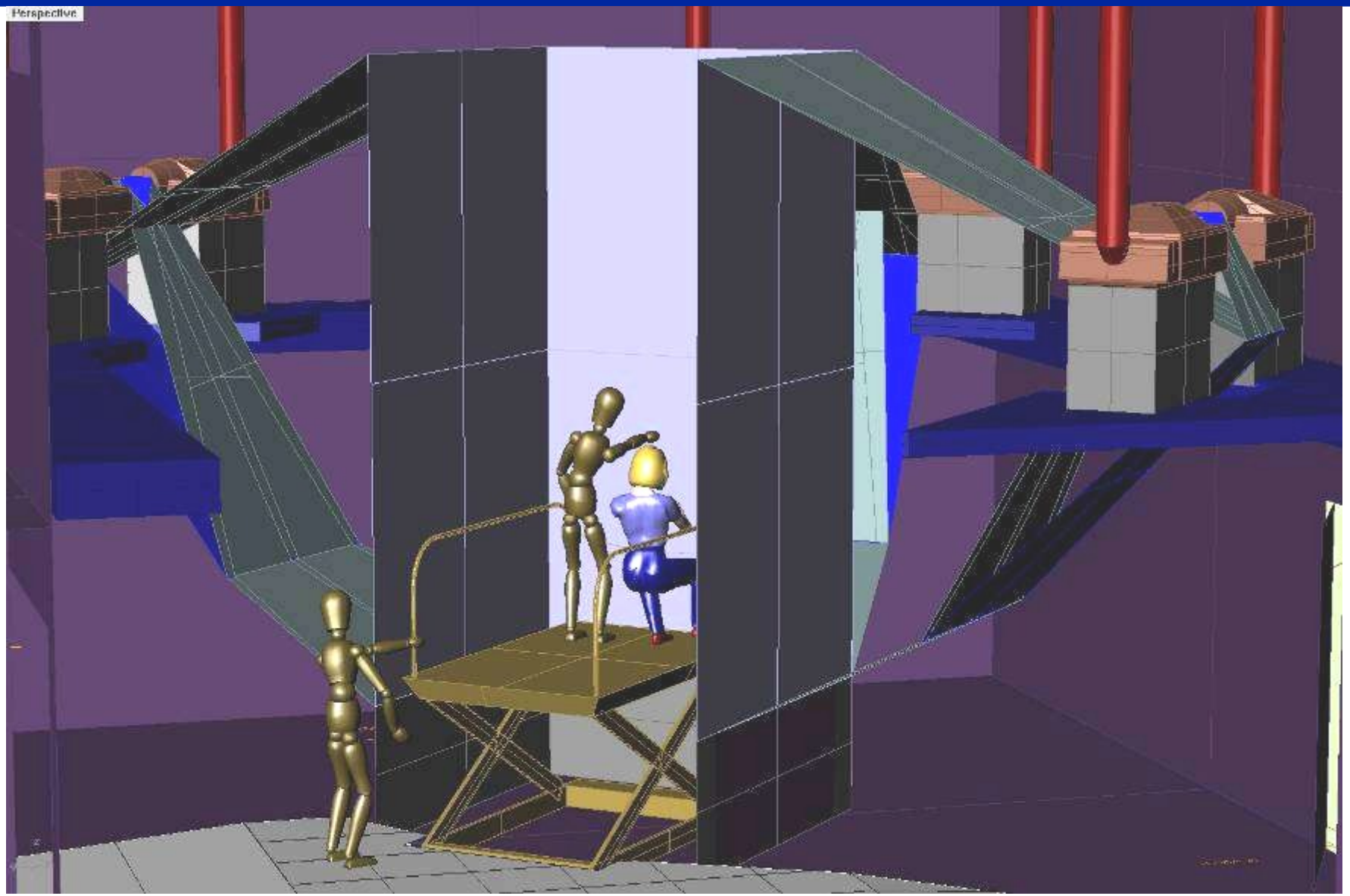
Lays Technical Basis for Global Digital Cinema

Sony
NTT
SGI

iGrid 2005

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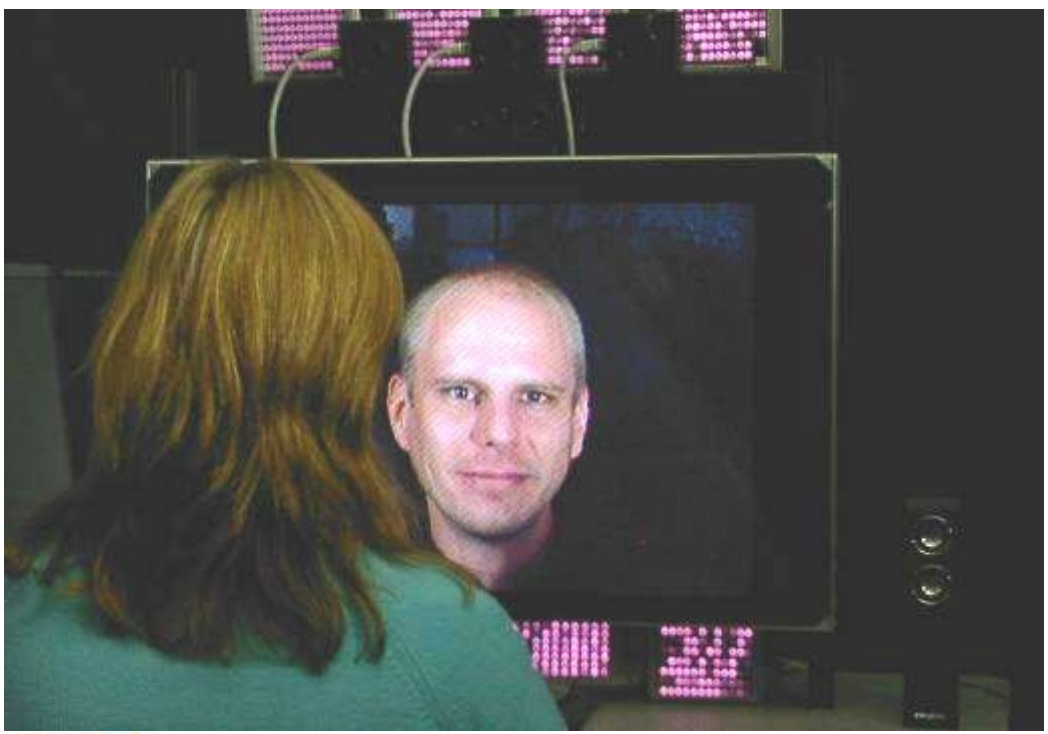
Using Digital Cinema Projectors To Create the Next Generation of Virtual Reality

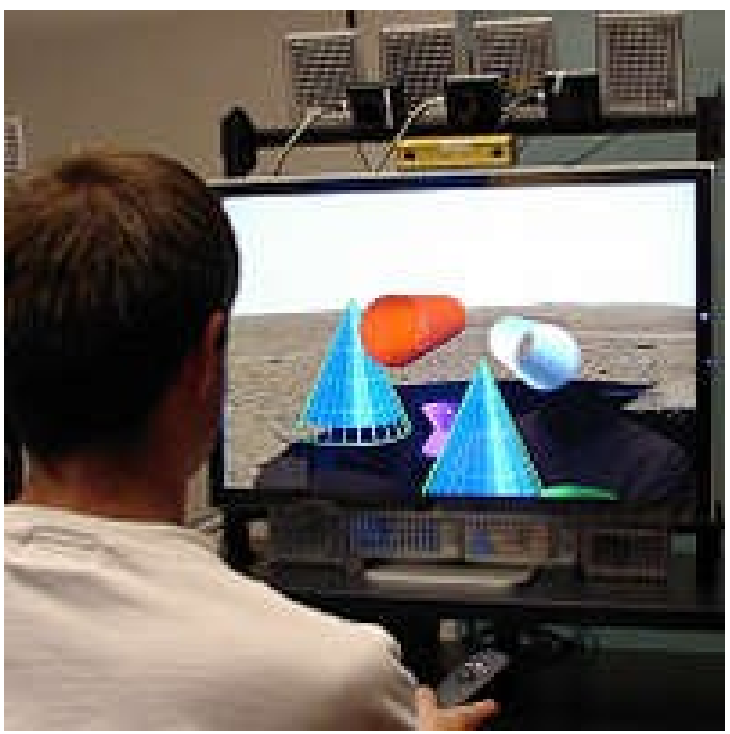


4KAVE—24 Megapixel Virtual Reality
Design: Greg Dawe, Calit2

iGrid Lambda Visualization Services: 3D Videophones Are Here! The Personal Varrier Autostereo Display

- Varrier is a Head-Tracked Autostereo Virtual Reality Display
  - 30” LCD Widescreen Display with 2560x1600 Native Resolution
  - A Photographic Film Barrier Screen Affixed to a Glass Panel
    - The Barrier Screen Reduces the Horizontal Resolution To 640 Lines
- Cameras Track Face with Neural Net to Locate Eyes
- The Display Eliminates the Need to Wear Special Glasses





Source: Daniel Sandin, Thomas DeFanti, Jinghua Ge, Javier Girado, Robert Kooima, Tom Peterka—EVL, UIC

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

National LambdaRail
Direct Connect
Computation and Storage Complex

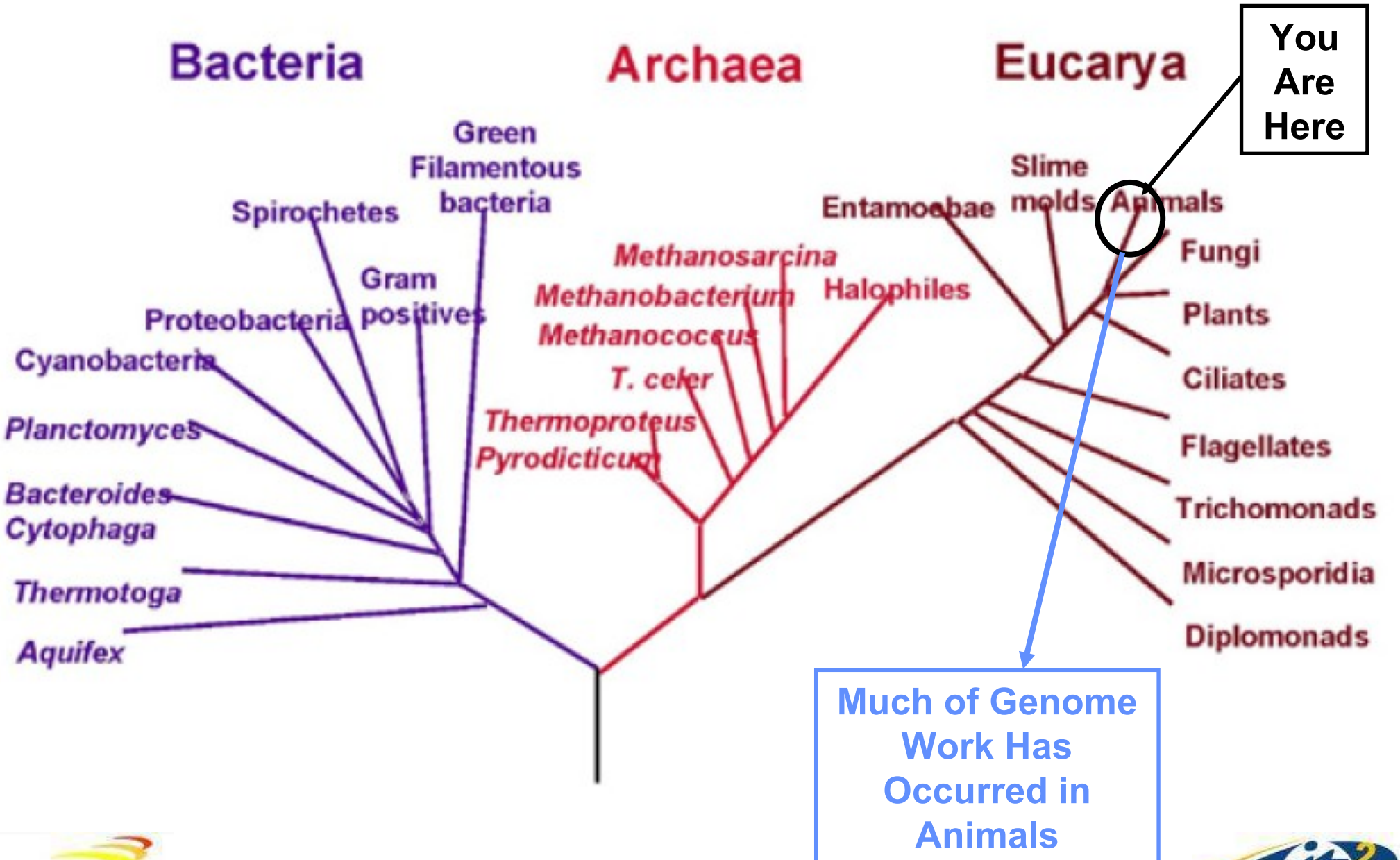
Funded by: Gordon and Betty Moore Foundation

Joint Partnership of:

OptIPuter

PI Larry Smarr

Evolution is the Principle of Biological Systems: Most of Evolutionary Time Was in the Microbial World



Source: Carl Woese, et al

Marine Genome Sequencing Project
Measuring the Genetic Diversity of Ocean Microbes



CAMERA will include
All Sorcerer II Metagenomic Data

MARINE MICROBIOLOGY INITIATIVE

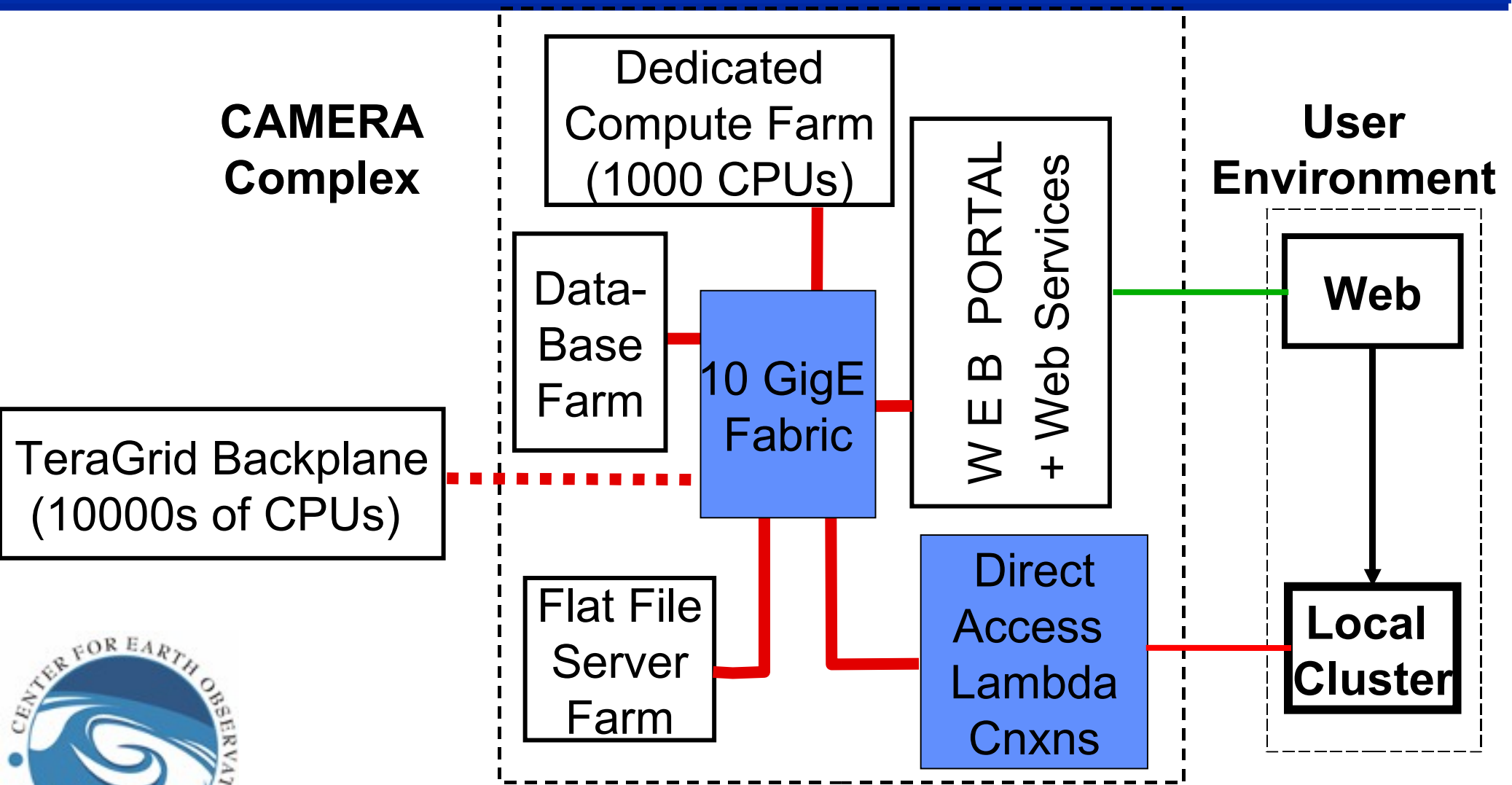
Gordon and Betty MOORE FOUNDATION

OptIPuter

J. Craig Venter INSTITUTE

it²

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



Source: Phil Papadopoulos, SDSC, Calit2

Interactive Remote Data and Visualization Services

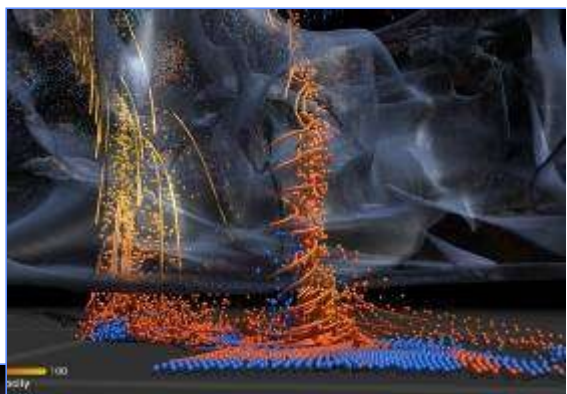


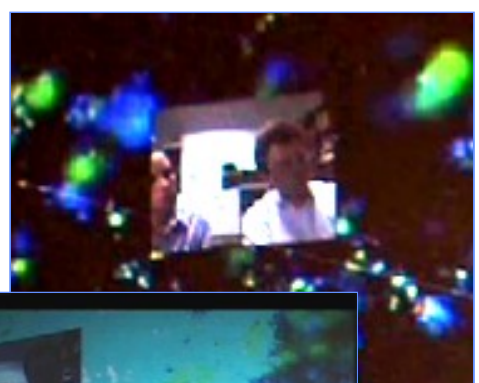
- Scientific-Info Visualization
- AMR Volume Visualization
- Glyph and Feature Vis
- Visualization Services

- Multiple Scalable Displays
- Hardware Pixel Streaming
- Distributed Collaboration

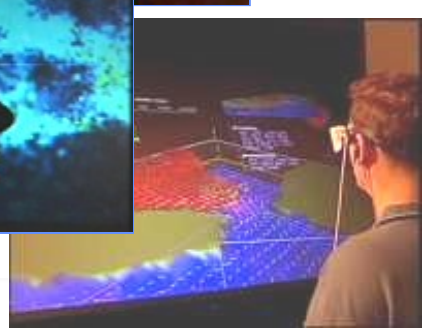
NCSA Altix Data and Vis Server



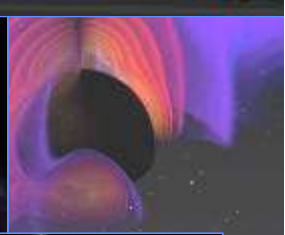


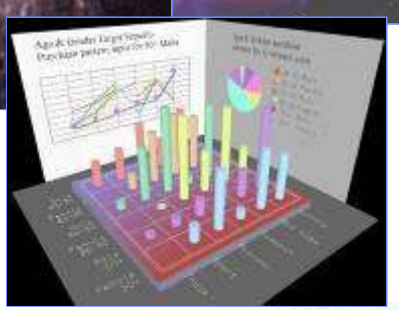












Linking to OptIPuter

- 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

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Alliance National Technology Grid
Vision For Workshop and Training Facilities



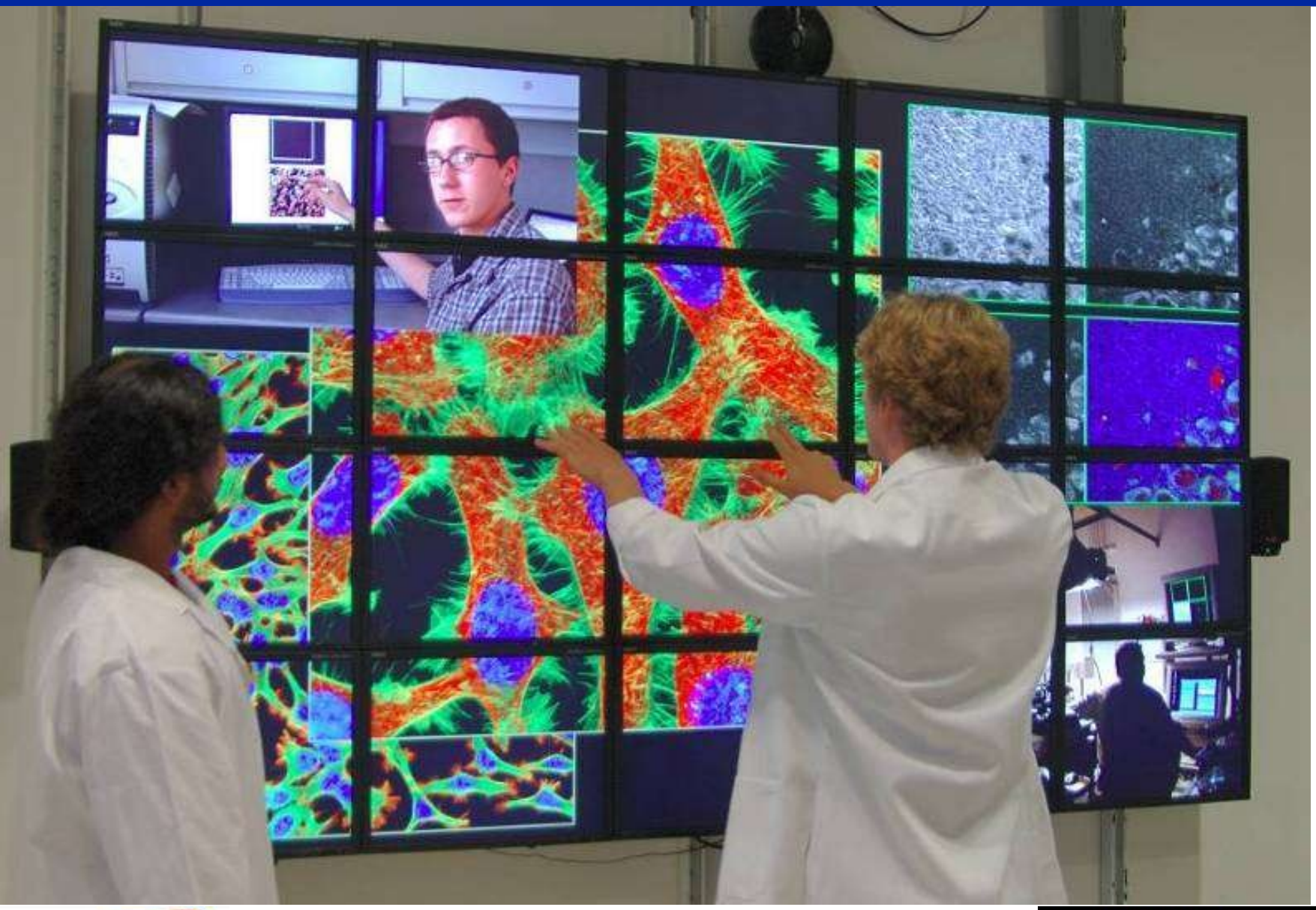
Being Deployed Across the Alliance

OptIPuter

Jason Leigh and Tom DeFanti, EVL; Rick Stevens, ANL

it²

OptIPuter Scalable Adaptive Graphics Environment Enables Integration of HD Streams into Tiled Displays



SAGE Developed by Jason Leigh et al. EVL, UIC

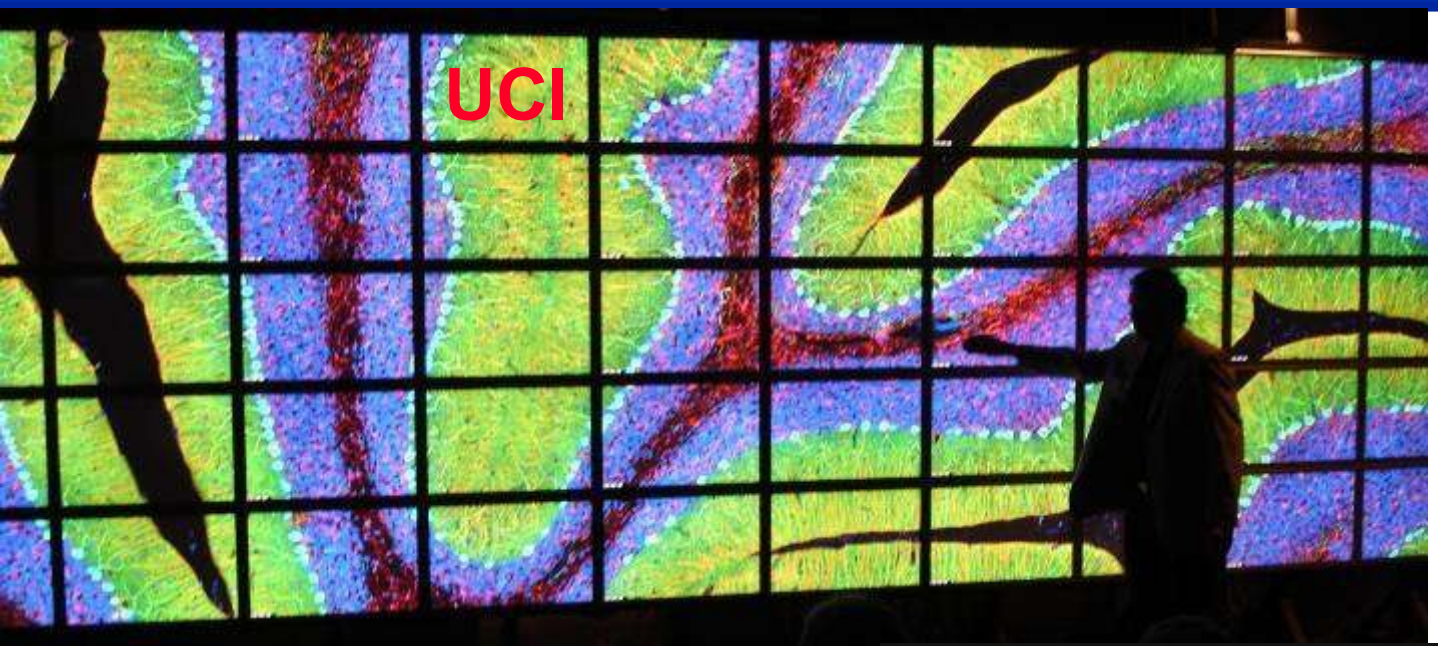
OptIPuter evl electronic visualization laboratory

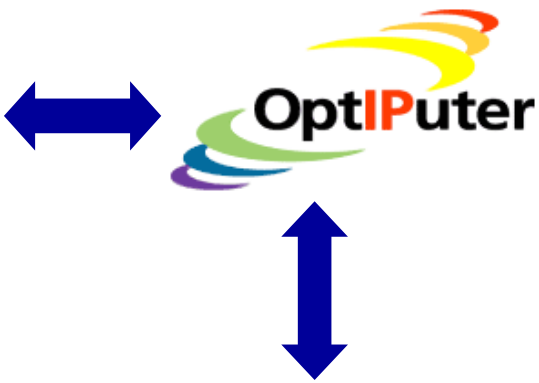
Image Source: David Lee, NCMIR, UCSD

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

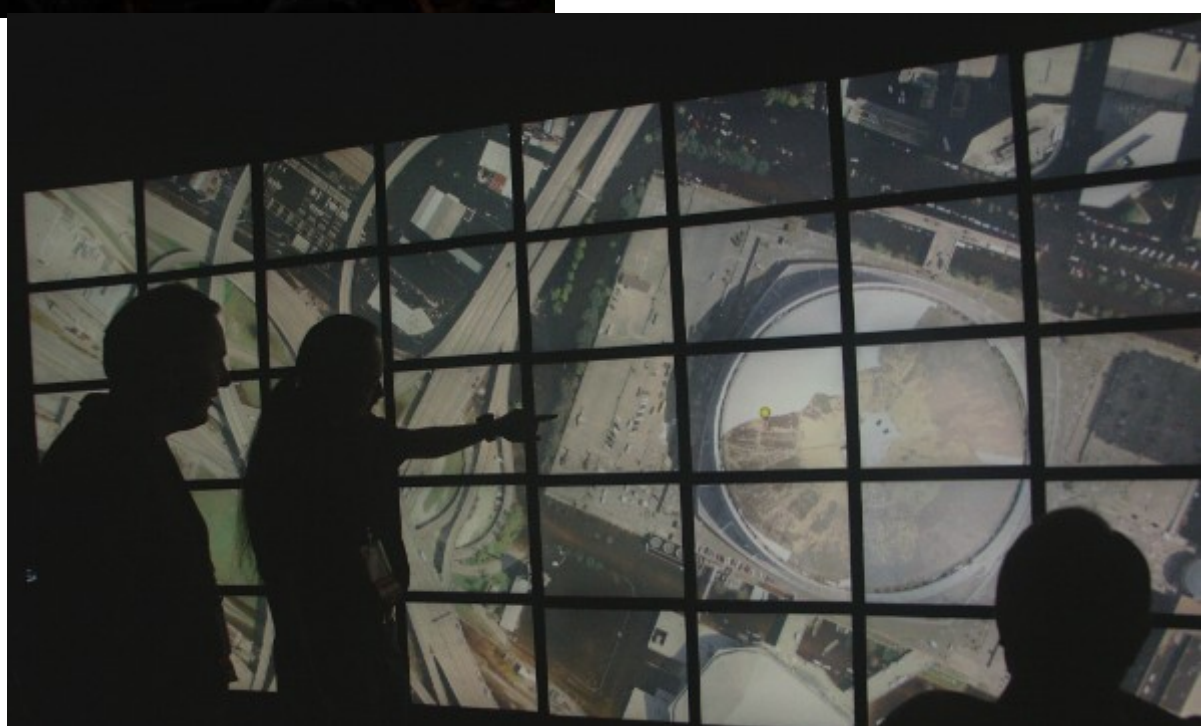
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The OptIPuter Enabled Collaboratory: Remote Researchers Jointly Exploring Complex Data





OptIPuter will Connect The Calit2@UCI 200M-Pixel Wall to the 100M-Pixel Display at Calit2@UCSD With Shared Fast Deep Storage

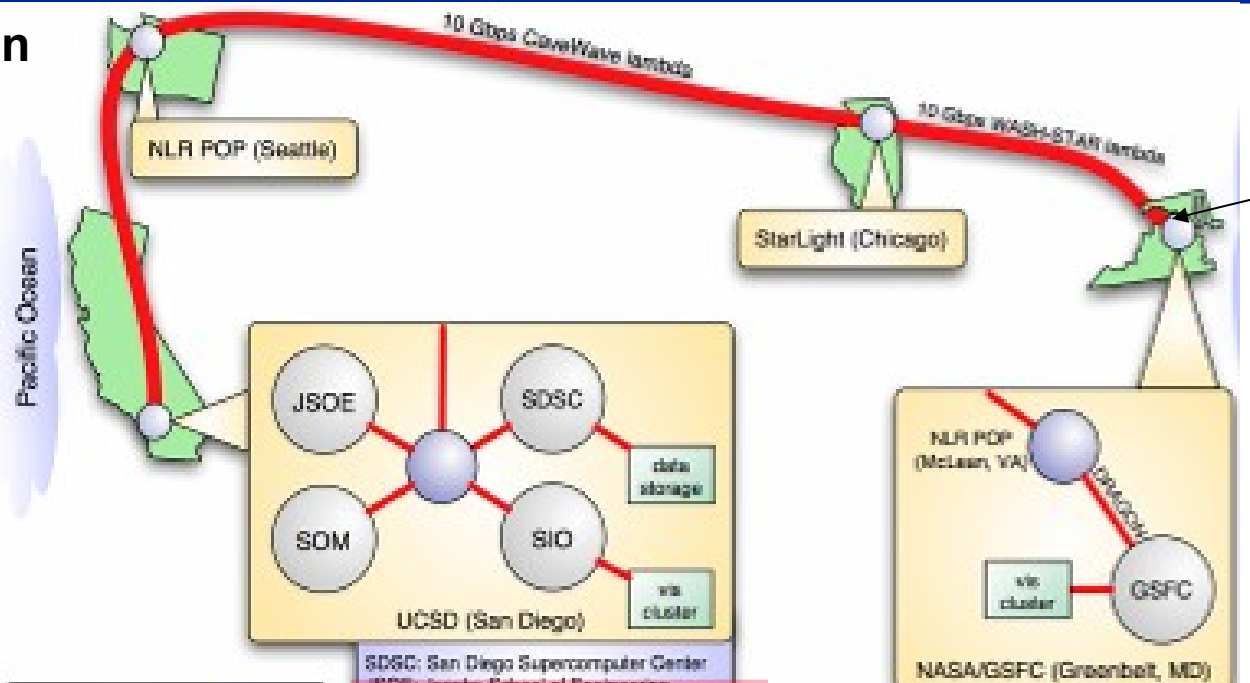


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Calit2 and the Venter Institute Will Combine Telepresence with Remote Interactive Analysis

Live Demonstration

of 21st Century National-Scale Team Science



25 Miles

Venter Institute

ACCESS DC?



OptIPuter Visualized Data

HDTV Over Lambda



OptIPuter

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Ten Years Old Technologies--the Shared Internet & the Web--Have Made the World "Flat"

- But Today's Innovations
  - Dedicated Fiber Paths
  - Streaming HD TV
  - Large Display Systems
  - Massive Computing and Storage
- Are Reducing the World to a "Single Point"

