"How LambdaGrids are Transforming Science"

Keynote iGrid2005

Calit2@UCSD

La Jolla, CA

September 29, 2005

Dr. Larry Smarr

Director, California Institute for Telecommunications and Information Technology

Harry E. Gruber Professor,

Dept. of Computer Science and Engineering
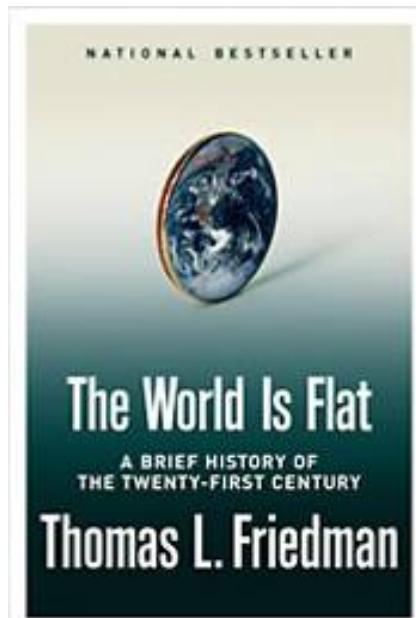
Jacobs School of Engineering, UCSD

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We Are Living Through A Fundamental Global Change—How Can We Glimpse the Future?

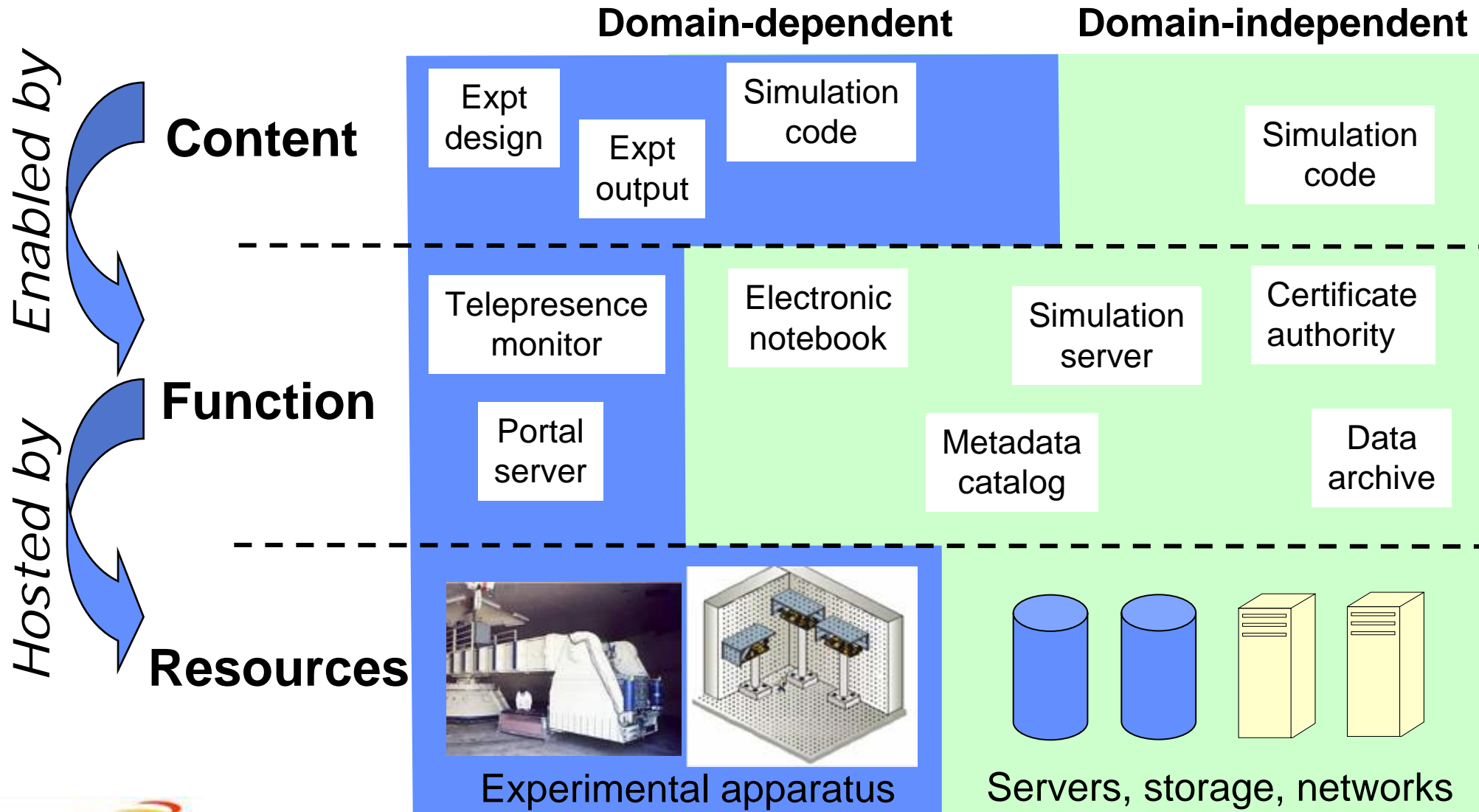**[The Internet] has created a [global] platform where intellectual work, intellectual capital, could be delivered from anywhere. It could be disaggregated, delivered, distributed, produced, and put back together again…**

The playing field is being leveled."

Nandan Nilekani, CEO Infosys (Bangalore, India)

Service-Oriented Science: From the Grid to the LambdaGrid

Domain-dependent　　　**Domain-independent**

Enabled by

Hosted by

Content

- Expt design
- Expt output
- Simulation code
- Simulation code

Function

- Telepresence monitor
- Electronic notebook
- Simulation server
- Certificate authority
- Portal server
- Metadata catalog
- Data archive

Resources

Experimental apparatus

Servers, storage, networks

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What are the iGrid2005 Demos Defining as Services on a LambdaGrid?

- **Lambda Services**

- **Supercomputing Services**

- **Video Streaming Services**

- **Visualization Services**

- **Scientific Instrument Services**

I Will Give One iGrid2005 Example of Each Service

Lambda Services Enable 10Gb Line-Speed Security

- **In the Real World, Users will Demand Secure Lambdas**
- **They Require it to be Invisible and Add No Perceptible Latency**

- **Nortel Prototype Demoed**
- **AES-256 Encryption [e.g. NSA Approved for U.S. Top Secret]**
- **Less than 500 nsecs Latency Added**
- **Optical Multi-service Edge (OME) Switching Hardware**
- **Used on Lightpaths from Amsterdam and Canada thru Starlight to San Diego**

At iGrid, Nortel demonstrated 256-bit AES encryption at 10 Gbps line speeds -- integrated into a standard Nortel Optical Multiservice Edge (OME) 6500 switch.

Source: Kim RobertsNortel

Supercomputing Services Enable Distributed Cosmology Simulations

- **Uses ENZO Computational Cosmology Code**
  - Grid-Based Adaptive Mesh Refinement Simulation Code
  - Developed by Mike Norman, UCSD
- **Distributing Code Using Layer 3 Routers Fails**
- **Instead Using Layer 2, Essentially Same Performance as Running on Single Supercomputer**
  - Using Dynamic Lightpath Provisioning
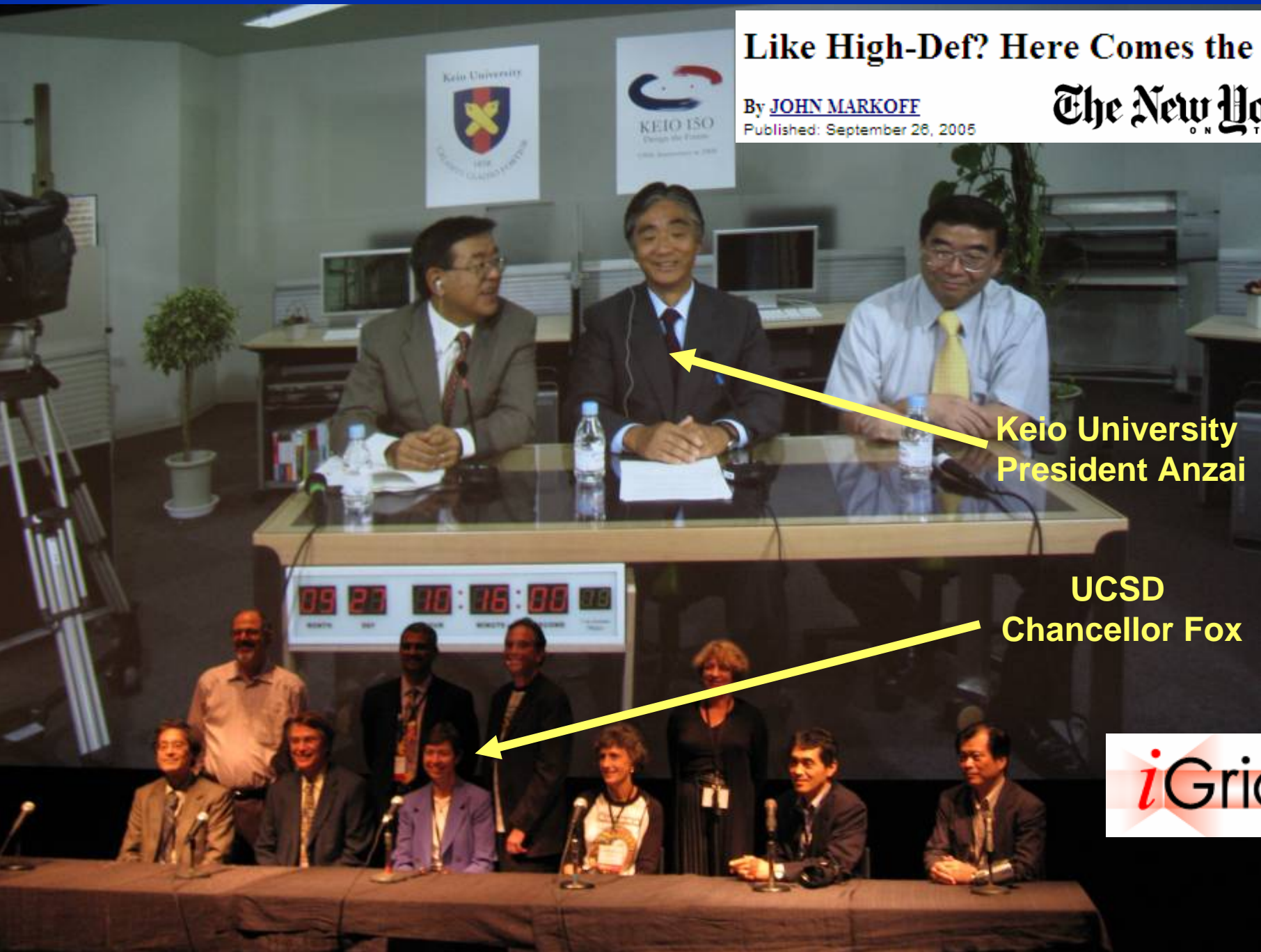

Source: Joe Mambretti, Northwestern U
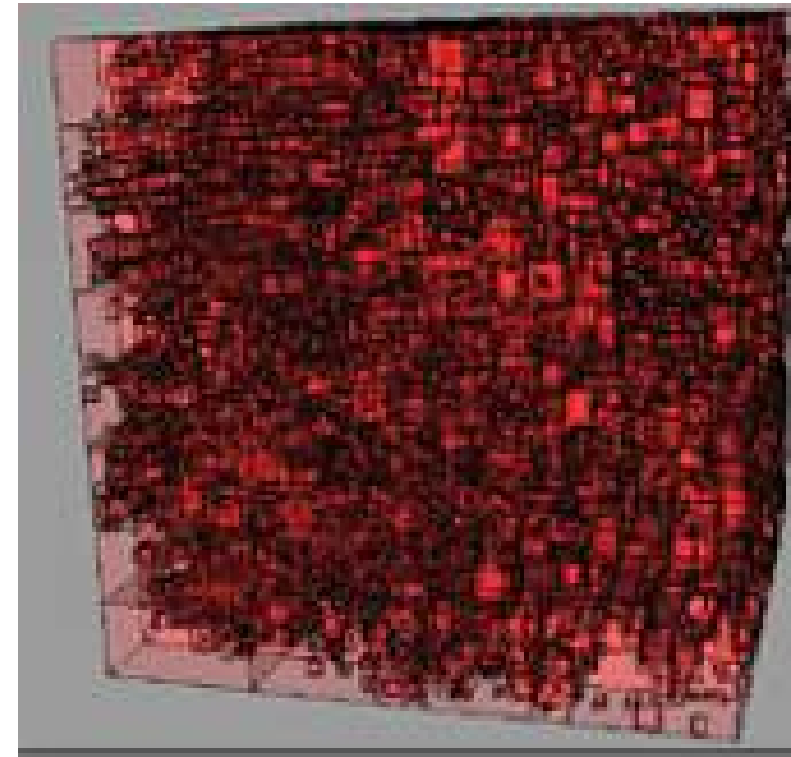
Lambda Services Enable the First Trans-Pacific Super High Definition Telepresence Conference

Like High-Def? Here Comes the Next Level

By JOHN MARKOFF
Published: September 26, 2005

The New York Times
ON THE WEB

Keio University
President Anzai

UCSD
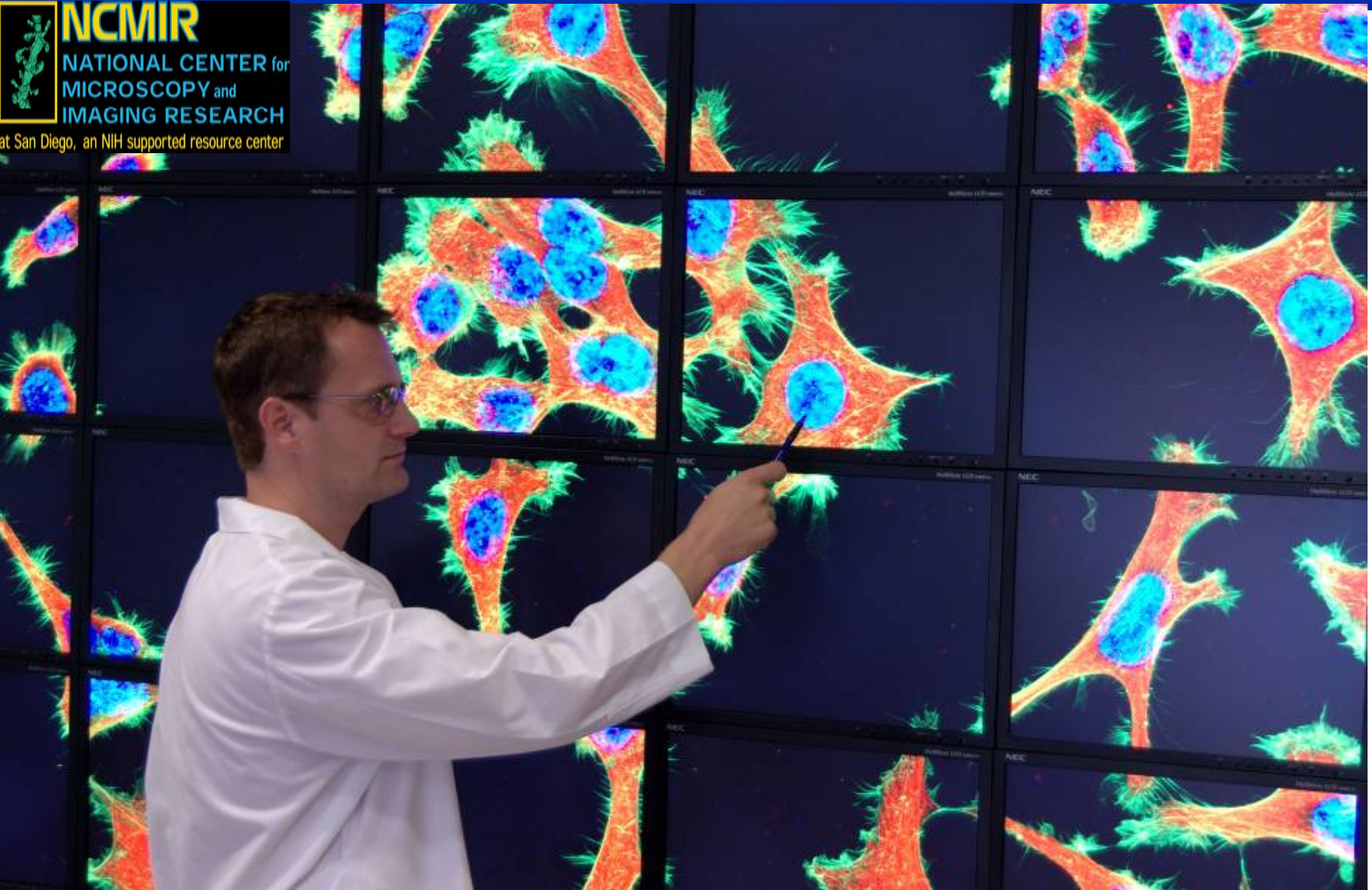Chancellor Fox

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Visualization Services Create
High Resolution Portals to Global Science Data

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

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

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

Source John Delaney & Deborah Kelley, UWash

Tiled Walls Allow for Integration of Streaming High Resolution Video

HDTV

Digital Cameras
4k Digital Cinema

Calit2@UCI Apple Tiled Display Wall
Driven by 25 Dual-Processor G5s
50 Apple 30" Cinema Displays
200 Million Pixels of Viewing Real Estate!

Data—One Foot Resolution
USGS Images of La Jolla, CA

it² GRAVITY
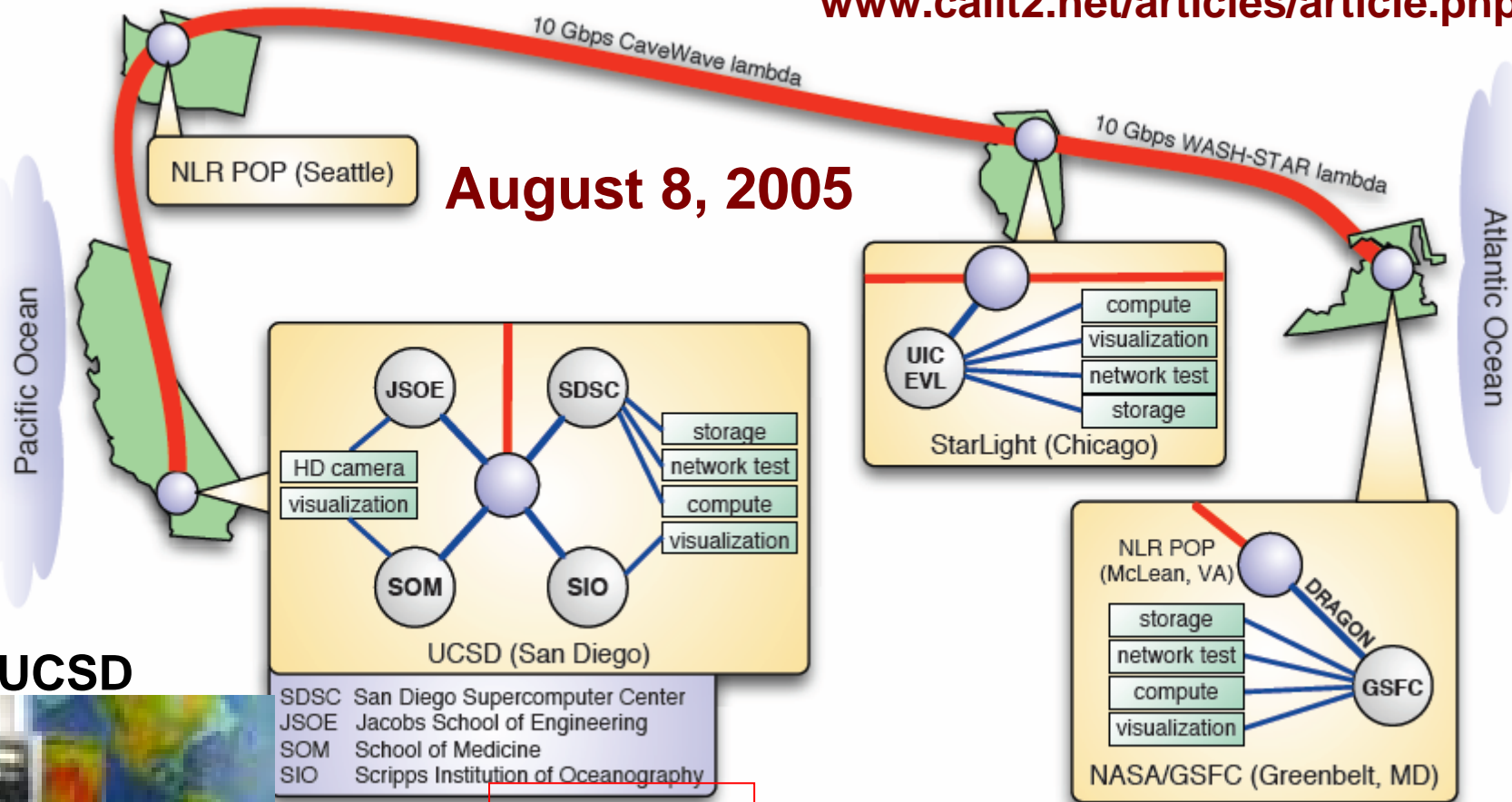Center of Graphics, Visualization and Imaging Technology

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Source: Falko Kuester, Calit2@UCI
NSF Infrastructure Grant

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Combining Telepresence with Remote Interactive Analysis of Data Over NLR
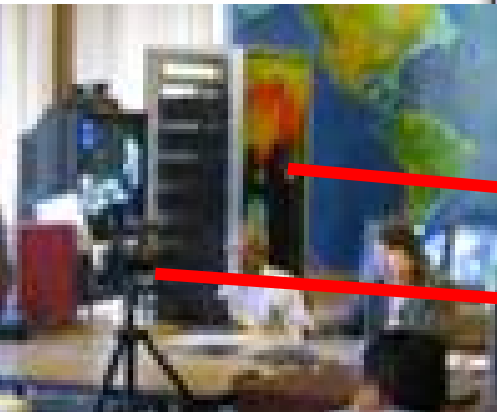
Calit2 is Partnering with GLIF Innovation Centers to Drive LambdaGrid Services and Applications

- **OptIPuter Partners**
  - **Netherlands**
    - **Univ. of Amsterdam--LambdaServices**
    - **SARA—Remote Visualization and VR**
  - **Japan**
    - **AIST—Telepresence**
    - **Keio Univ—Digital Cinema**
  - **Korea**
    - **KISTI—Telemicroscopy**
  - **Mexico**
    - **CICESE—Earth Sciences**
  - **Canada**
    - **NEPTUNE/CANARIE—Ocean Observing**

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

Terabit/s

32x10Gb "Lambdas"

Bandwidth of NYSERNet Research Network Backbones

Gigabit/s

60 TFLOP Altix

1 GFLOP Cray2

Optical WAN Research Bandwidth Has Grown Much Faster Than Supercomputer Speed!

Megabit/s

Bandwidth (Mbps)

Computing Speed (GFLOPS)

1.E+06
1.E+05
1.E+04
1.E+03
1.E+02
1.E+01
1.E+00

1985 1990 1995 2000 2005
T1

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Network Data Source: Timothy Lance, President, NYSERNet

Analogies Between Bringing Applications to Supercomputers and to LambdaGrids

- **Pioneering Phase:**
  - **At first there was hardly any "real" science being done.**
  - **Rather, a few pioneer scientists were allowing their codes to be used to understand how to restructure the code to take advantage of the high performance hardware or to set up visualization capabilities or remote interactive control of the supercomputer**

- **Homesteader Phase:**
  - **Gradually as those pioneers allowed the hardware and software of the infrastructure to mature, a second generation of "homesteaders" showed up and started using the infrastructure to do science…**

- **iGrid2005--Pioneering Phase**
- **GLIF 2006 in Tokyo Should be all about Homesteading Science that can be done with a Global Optical Grid...**