“Is it Live or is it Telepresence?"

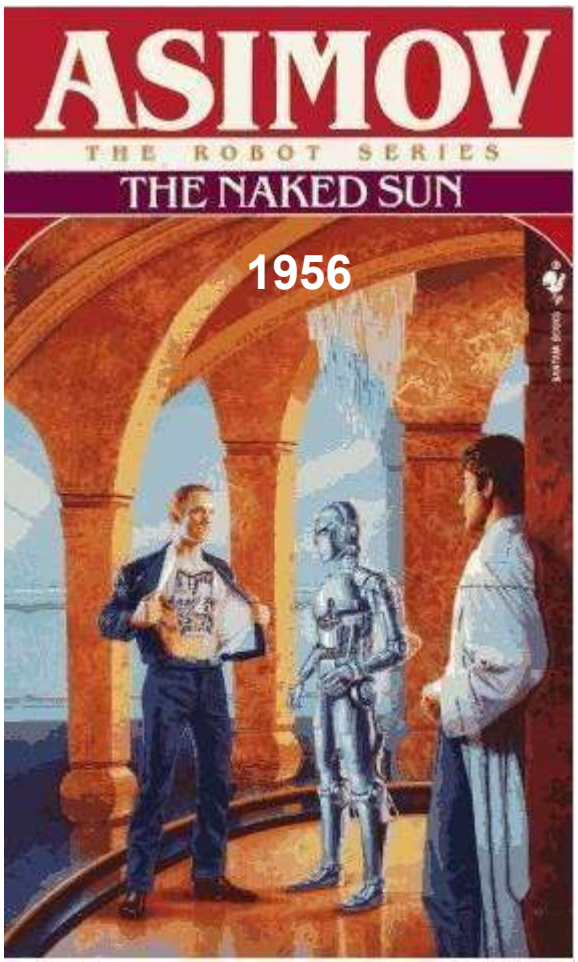
Keynote Talk
2006 Technology Horizons Spring Exchange
Science & Technology in 10, 20, & 50 Years
Institute for the Future
San Mateo
May 23, 2006

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

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Fifty Years Ago, Asimov Described a World of Telepresence



A policeman from Earth, where the population all lives underground in close quarters, is called in to investigate a murder on a distant world. This world is populated by very few humans, rarely if ever, coming into physical proximity of each other. Instead the people "View" each other with trimensional “holographic” images.

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The Beginnings of Commercialization: PicturePhone Introduced 40 Years Ago



NEW LOOK PICTUREPHONE

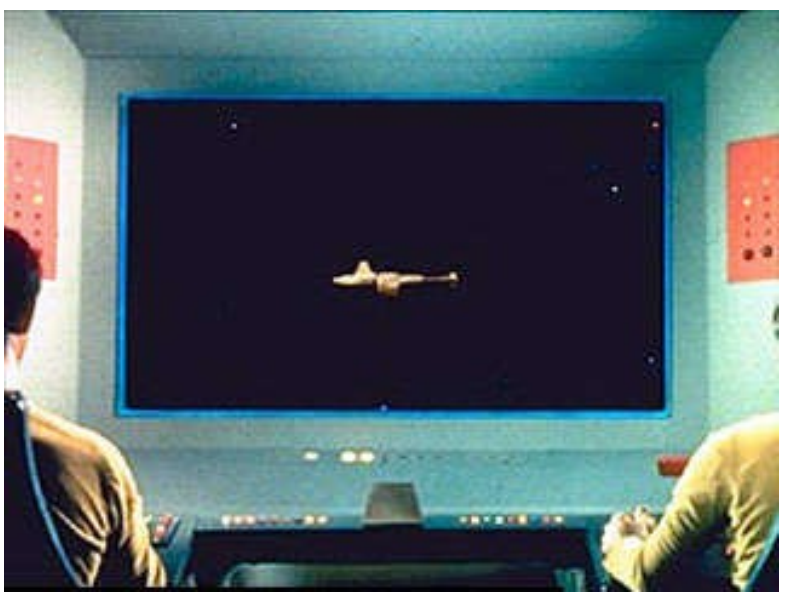
Now you can *see* as well as talk The Picturephone has Touch-Tone controls to make calls and control the television screen so you can see the person you're talking to, be seen yourself, or have a darkened screen. Attended service between New York, Washington and Chicago began in 1964.

www.bellsystemmemorial.com/telephones-picturephone.html

TV and Movies of 40 Years Ago Envisioned Telepresence Displays









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Source: Star Trek 1966-68; Barbarella 1968

it²

The Bellcore VideoWindow -- A Working Telepresence Experiment



(1989)

"Imagine sitting in your work place lounge having coffee with some colleagues. Now imagine that you and your colleagues are still in the same room, but are separated by a large sheet of glass that does not interfere with your ability to carry on a clear, two-way conversation. Finally, imagine that you have split the room into two parts and moved one part 50 miles down the road, without impairing the quality of your interaction with your friends."

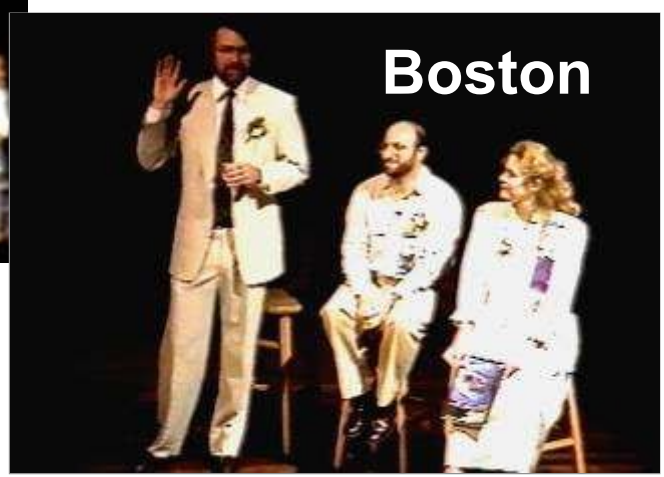
Source: Fish, Kraut, and Chalfonte-CSCW 1990 Proceedings

A Simulation of Telepresence
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

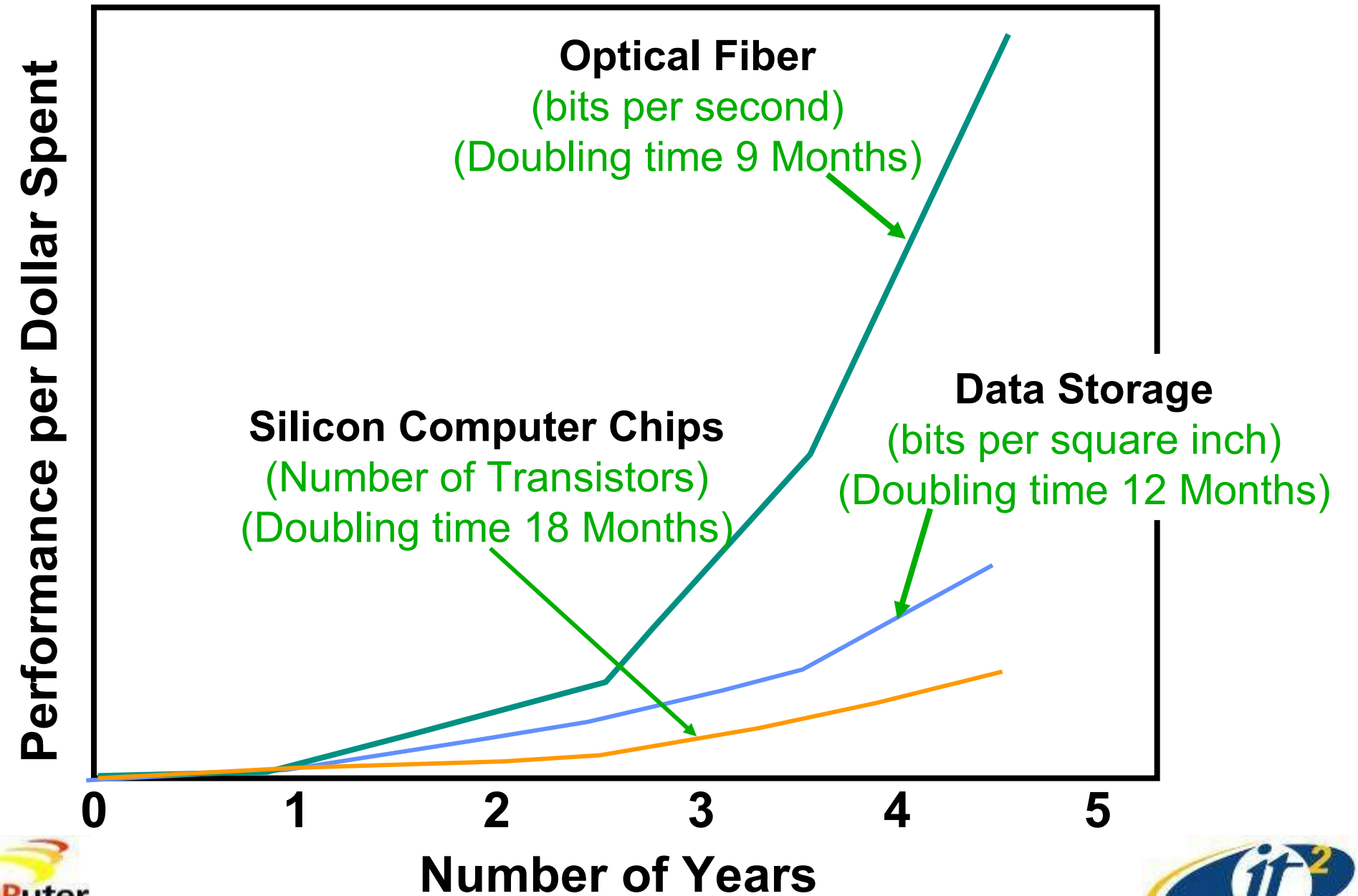
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SIGGRAPH 1989

NCSA™

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Optical Networks Are the Neglected 21st Century Driver



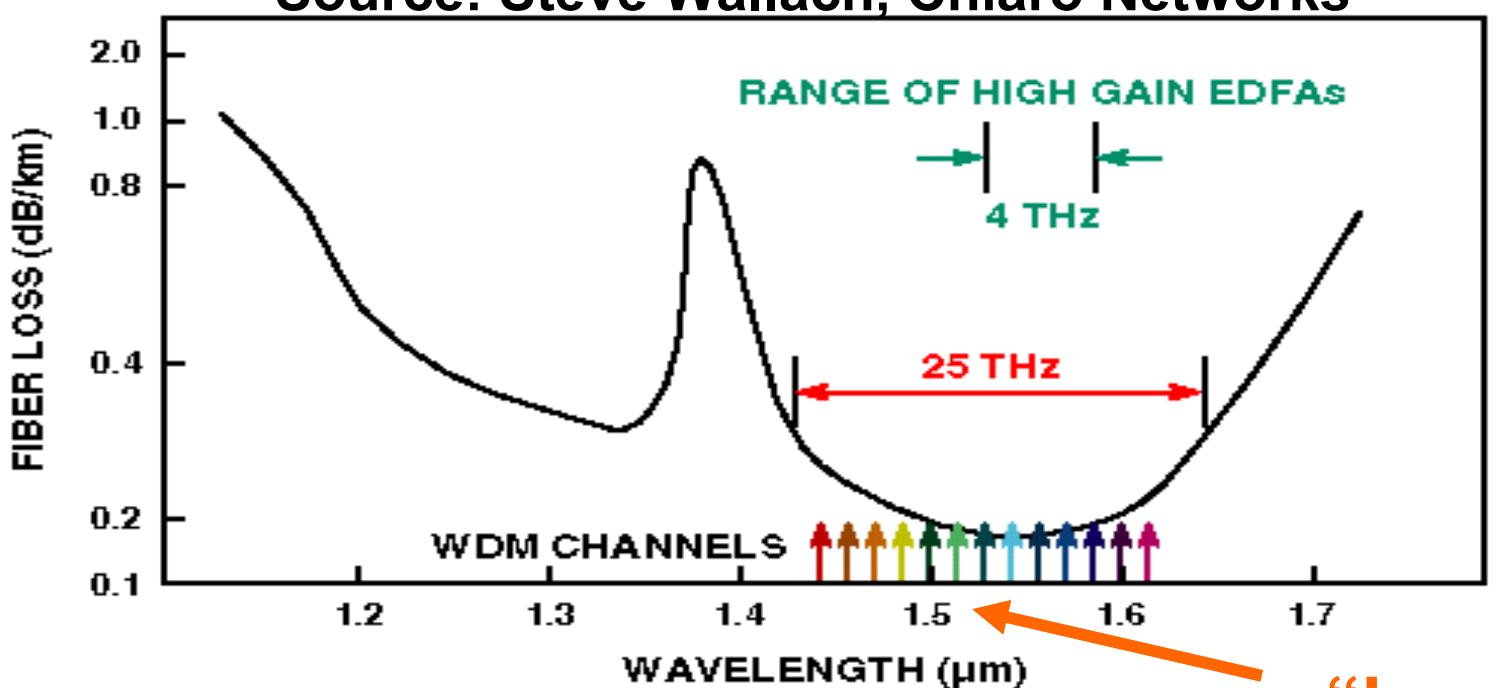
Scientific American, January 2001

Dedicated Optical Channels Makes High Performance Cyberinfrastructure Possible

WAVELENGTH DIVISION MULTIPLEXING (WDM)

- EXPLOITS
  - ENORMOUS BANDWIDTH OF SILICA FIBER
  - HIGH-GAIN WIDEBAND OPTICAL AMPLIFIERS

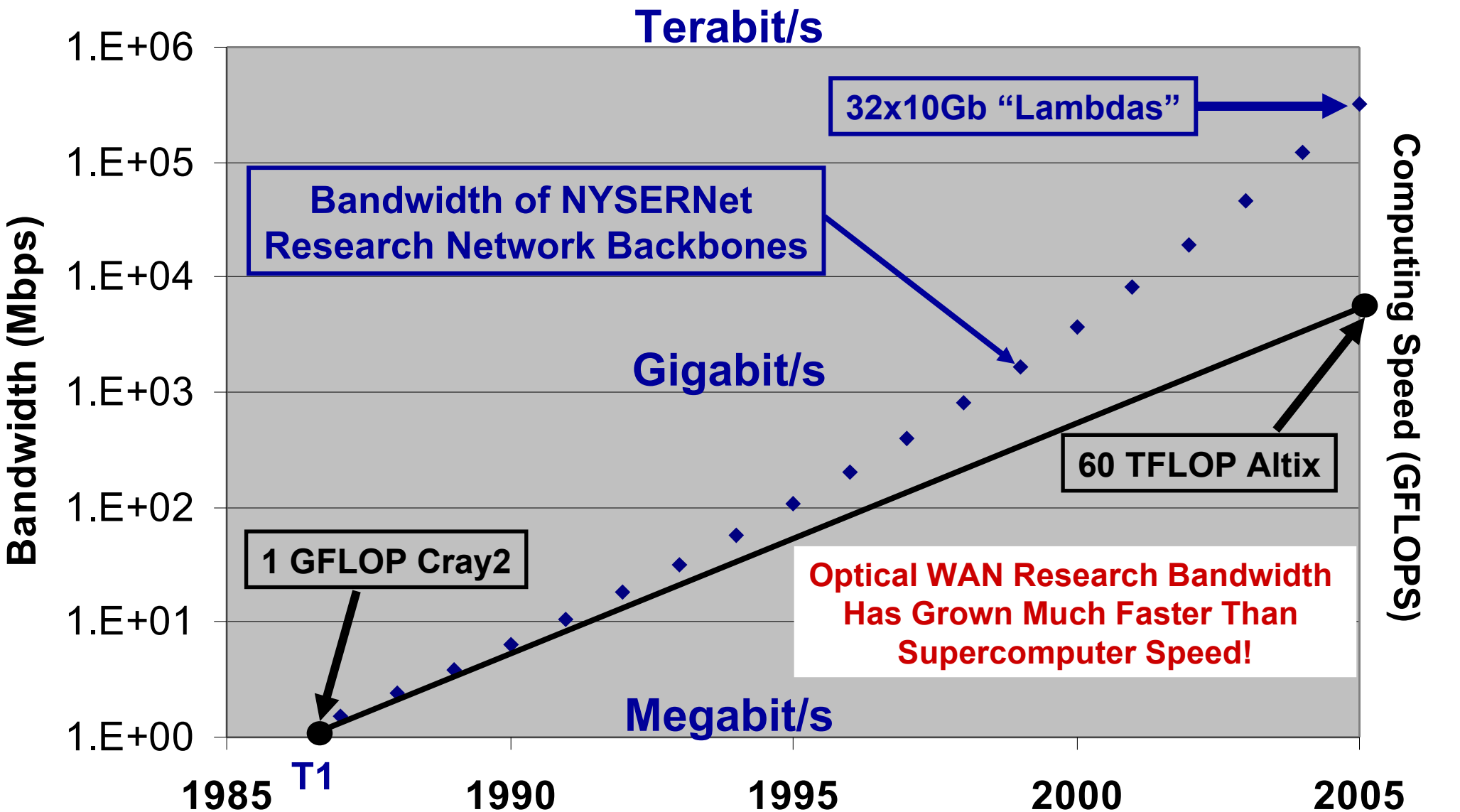
Source: Steve Wallach, Chiaro Networks



"Lambdas"

Parallel Lambdas are Driving Optical Networking The Way Parallel Processors Drove 1990s Computing

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



Network Data Source: Timothy Lance, President, NYSERNet

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

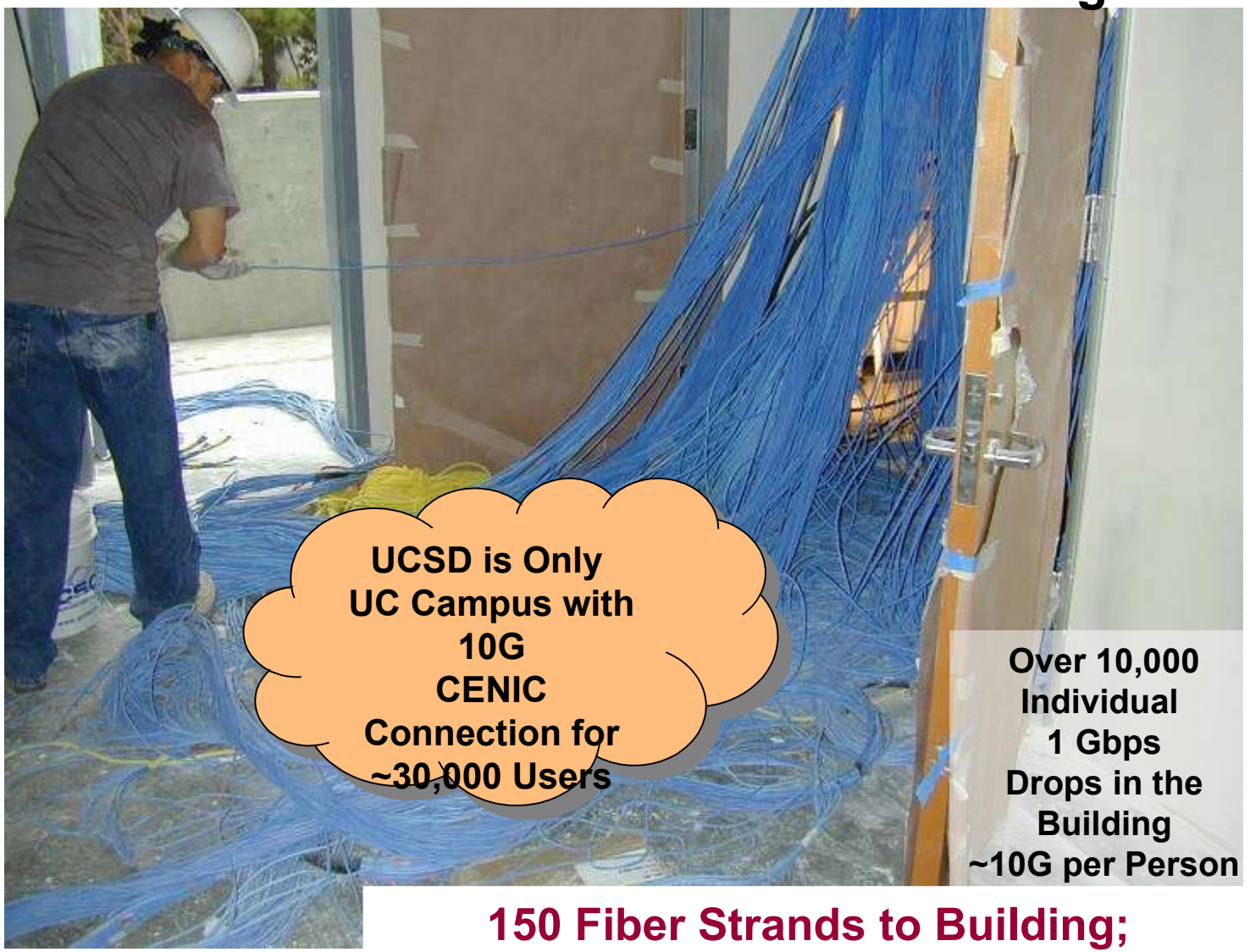


www.calit2.net

Preparing for a World in Which Distance is Eliminated…

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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The Input Rate to the Human Eye-Brain System is Roughly a GigaByte/sec

8 Megapixel/Frame x 3 Bytes/Pixel x 40 Frames/Sec

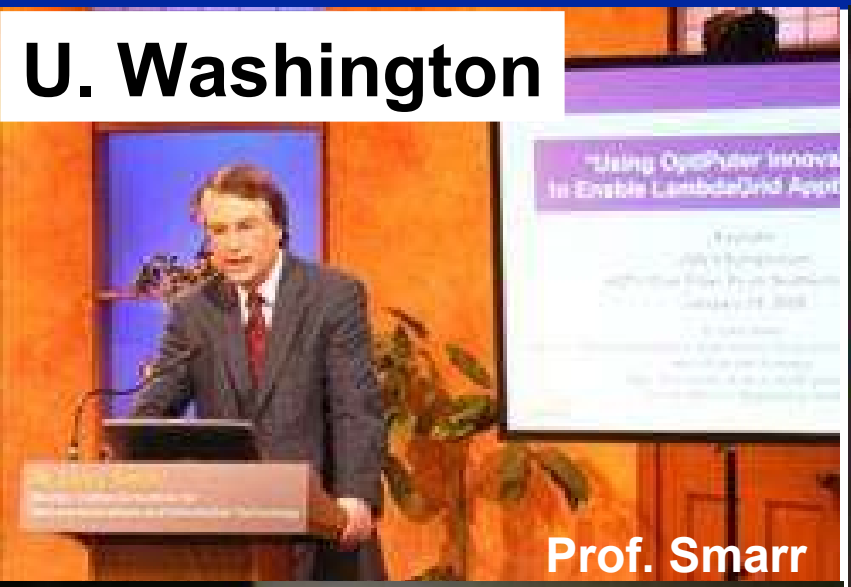
~ 1 GigaByte/Sec

We are Exponentially Crossing this Threshold Today!

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Multiple Gigabit HD Streams Over Lambdas Will Radically Transform Global Collaboration





Telepresence Using Uncompressed 1.5 Gbps HDTV Streaming Over IP on Fiber Optics--
75x Home Cable "HDTV" Bandwidth!



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"I can see every hair on your head!"—Prof. Aoyama

Source: U Washington Research Channel

it²

Borderless Collaboration Between Global University Research Centers at 10Gbps

Maxine Brown, Tom DeFanti, Co-Chairs

iGrid 2005

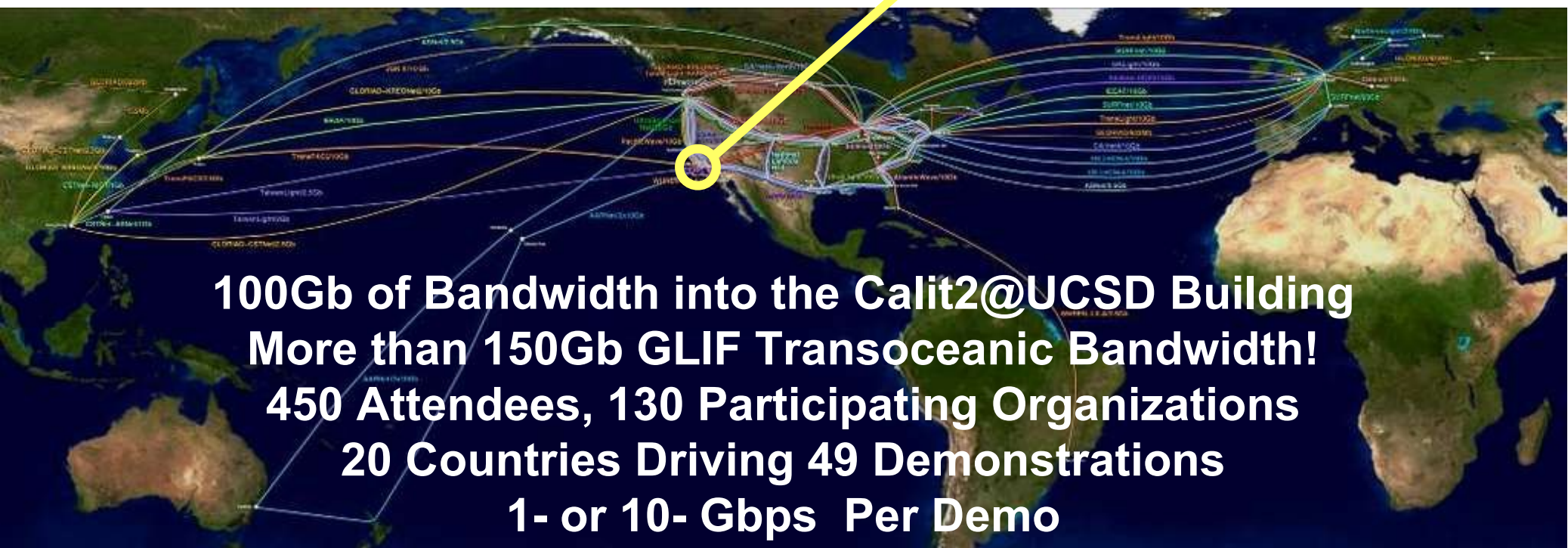
THE GLOBAL LAMBDA INTEGRATED FACILITY

www.igrid2005.org



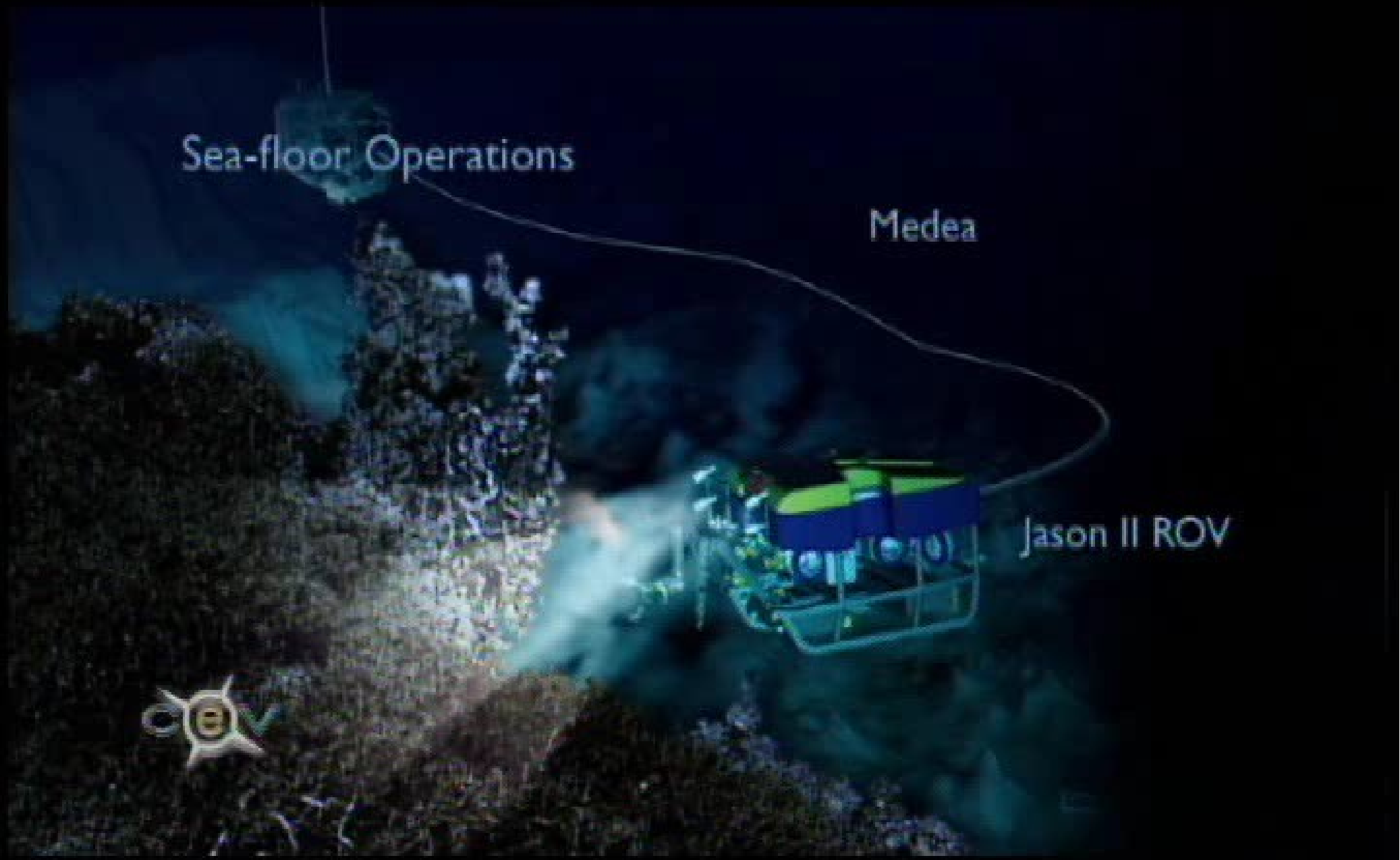
the UC Discovery Grant

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



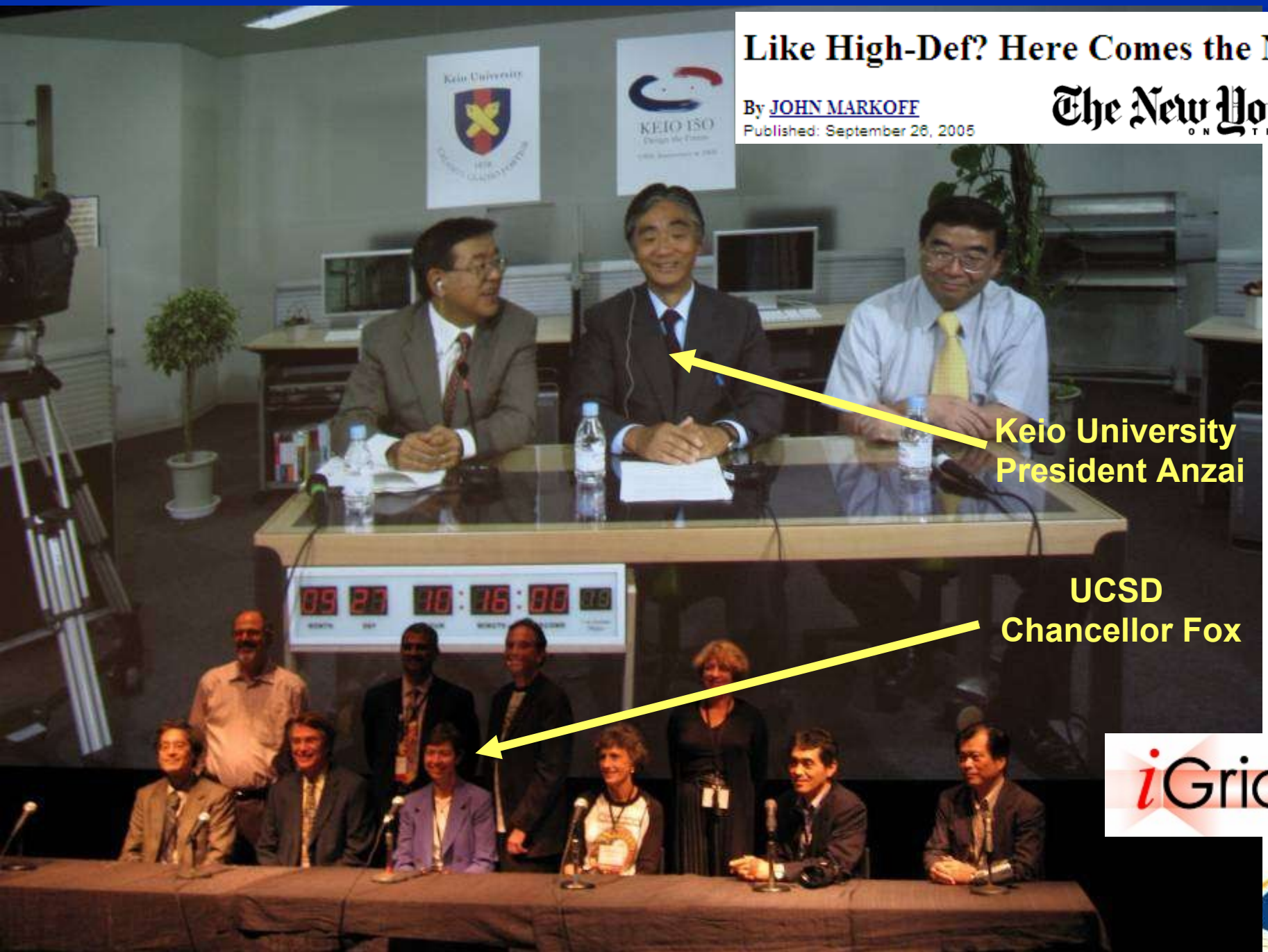
100Gb of Bandwidth into the Calit2@UCSD Building
More than 150Gb GLIF Transoceanic Bandwidth!
450 Attendees, 130 Participating Organizations
20 Countries Driving 49 Demonstrations
1- or 10- Gbps Per Demo

High Definition Video - 2.5 km Below the Ocean Surface



Watching the image gave the impression of floating right outside of the vent
--PC Mag May 19, 2006

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



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

Lays Technical Basis for Global Digital Cinema

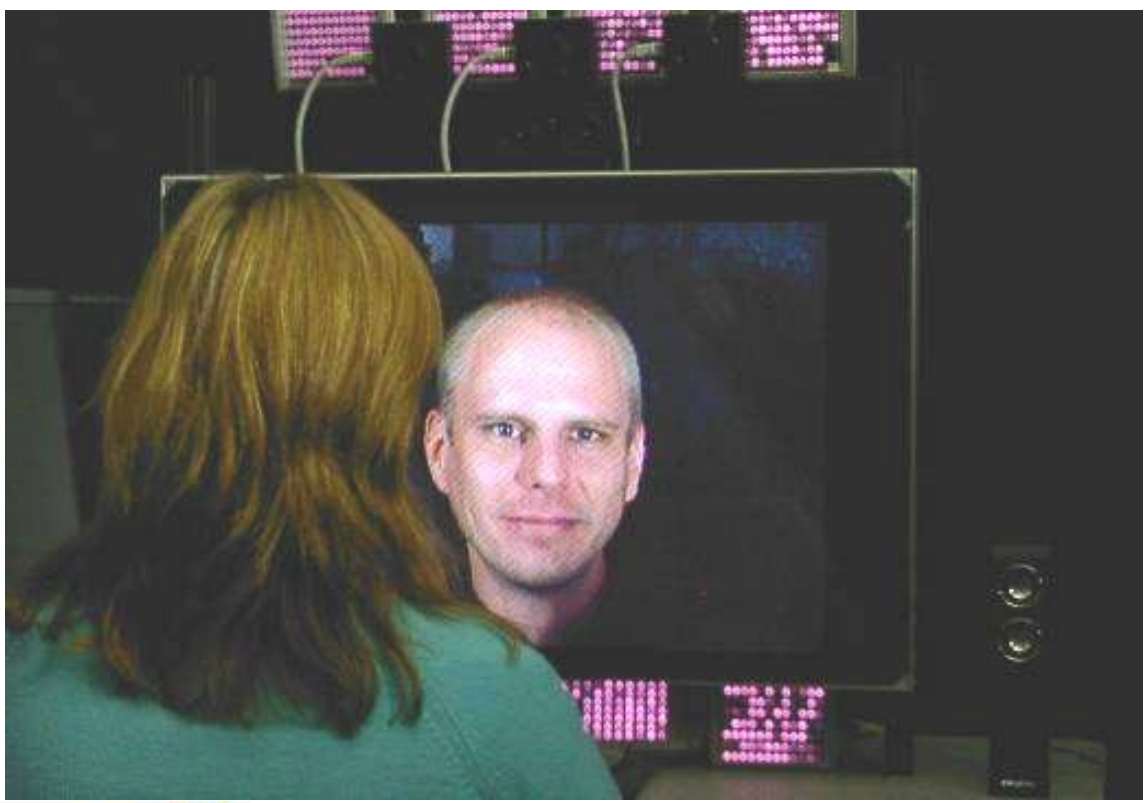
Sony
NTT
SGI

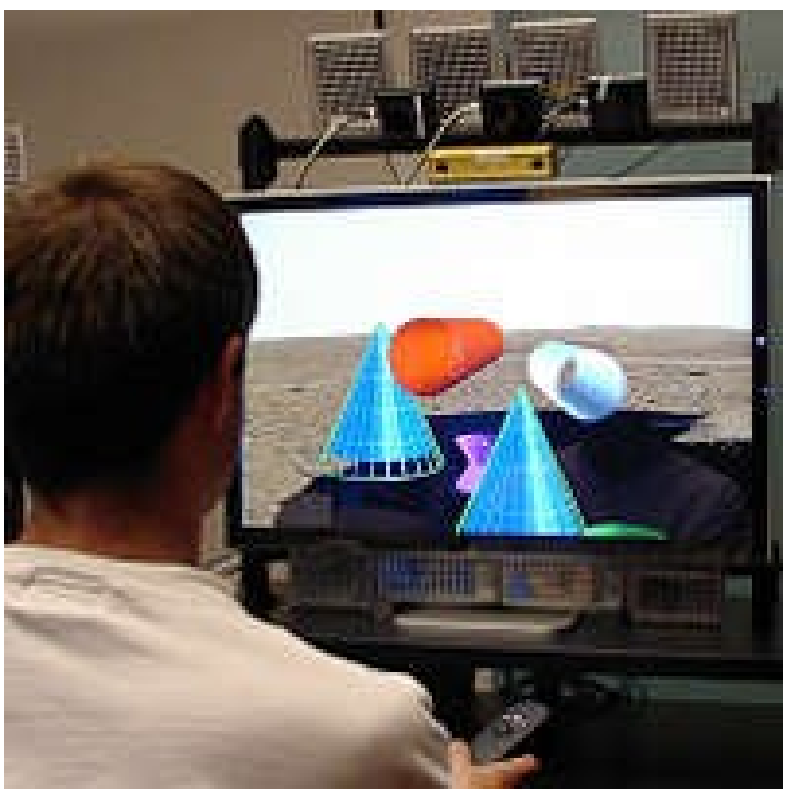
iGrid 2005

it²

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
- Cameras Track Face with Neural Net to Locate Eyes
- The Display Eliminates the Need to Wear Special Glasses



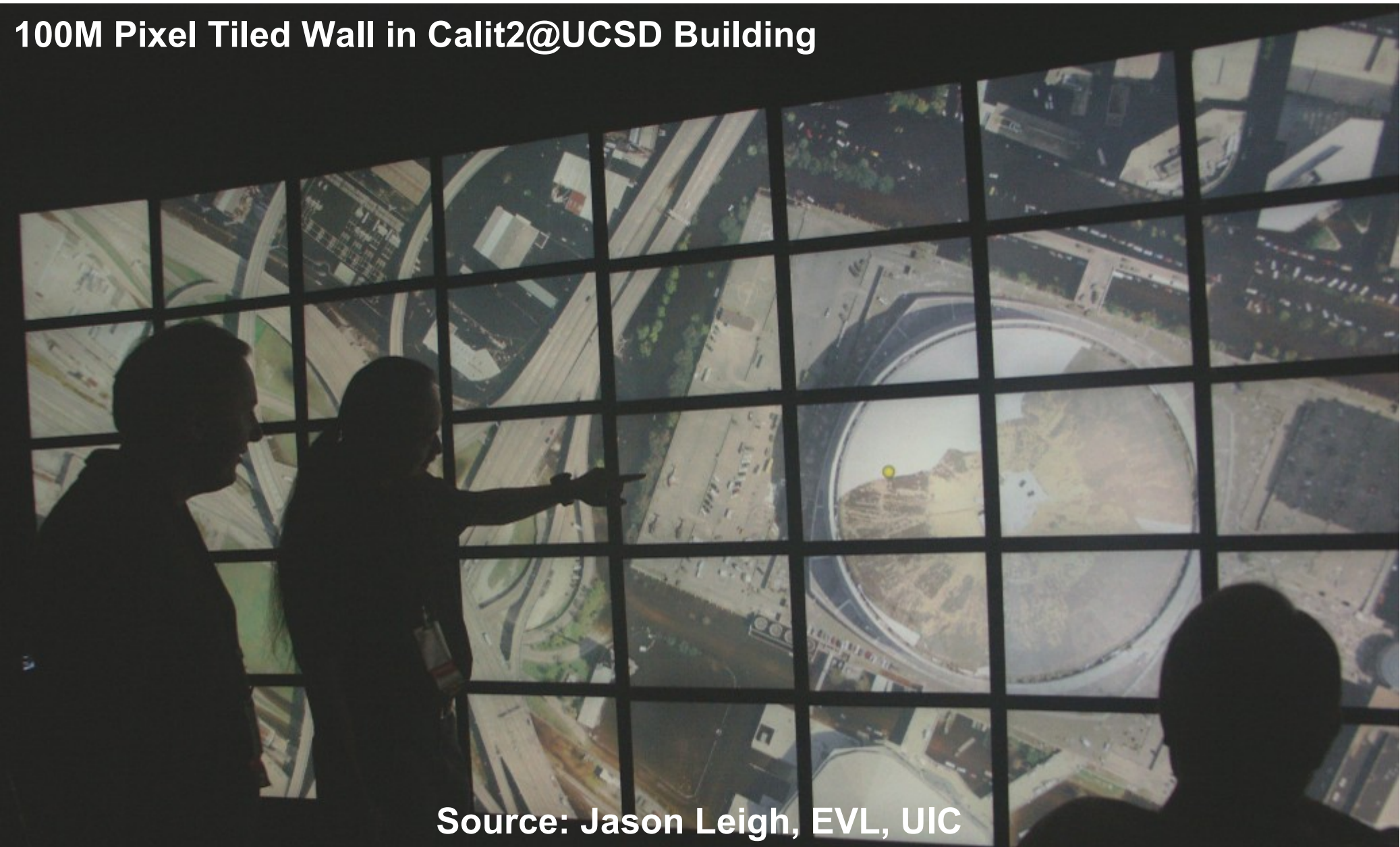


Source: Daniel Sandin, Thomas DeFanti, Jinghua Ge, Javier Girado, Robert Kooima, Tom Peterka—EVL, UIC

Prototyping the PC of 2015
One Hundred Million Pixels Connected at 10Gbps

Calit2 Working with NASA, USGS, NOAA, NIEHS, EPA, SDSU, SDSC, Duke, …

100M Pixel Tiled Wall in Calit2@UCSD Building



Source: Jason Leigh, EVL, UIC

Combining Ultra Resolution with Interactive 3D



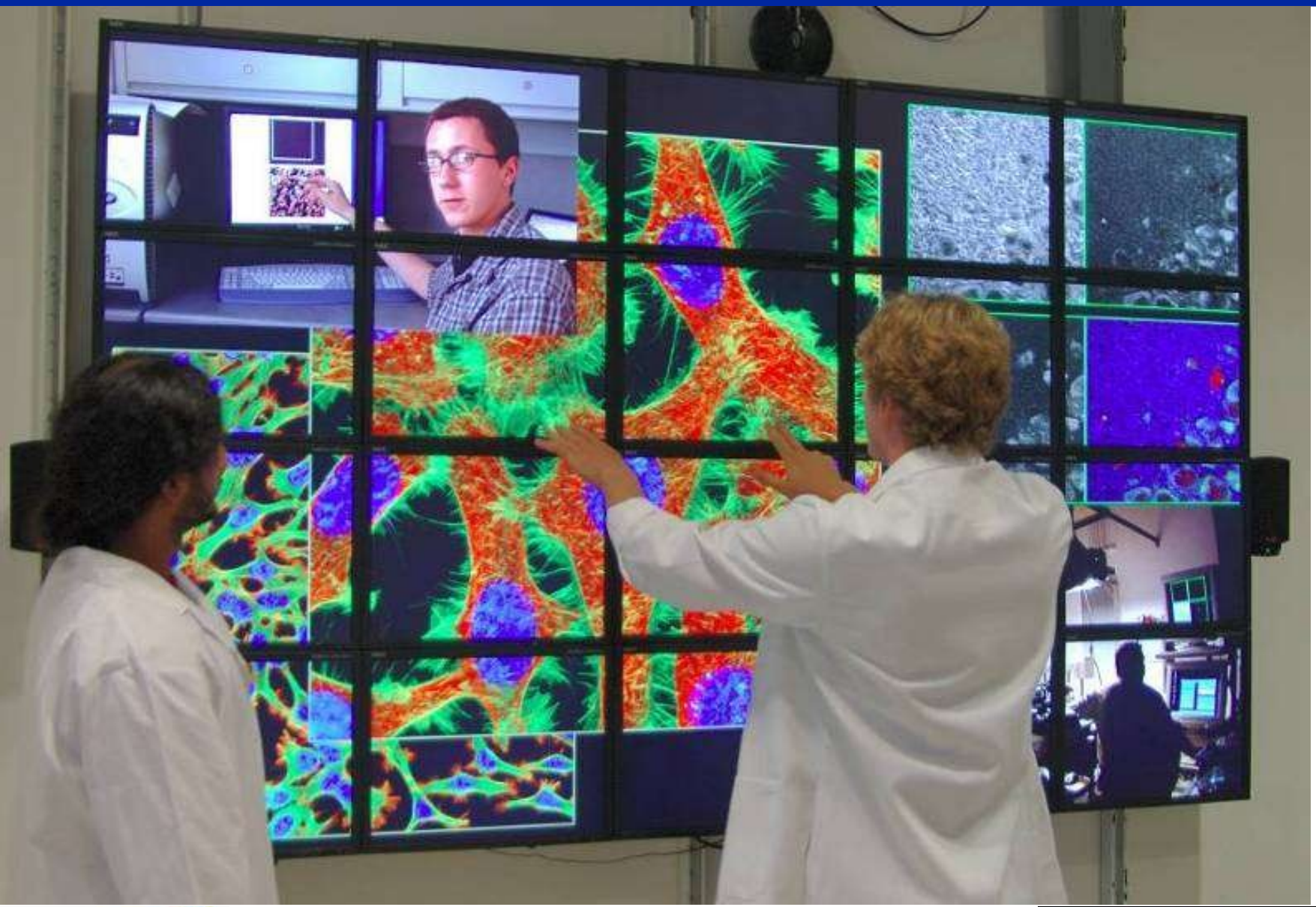
evl electronic visualization laboratory

OptIPuter

Source: Dan Sandin, EVL, UIC

it²

Integration of High Definition Video Streams with Large Scale Image Display Walls



Collaborative Analysis of Large Scale Images of Cancer Cells

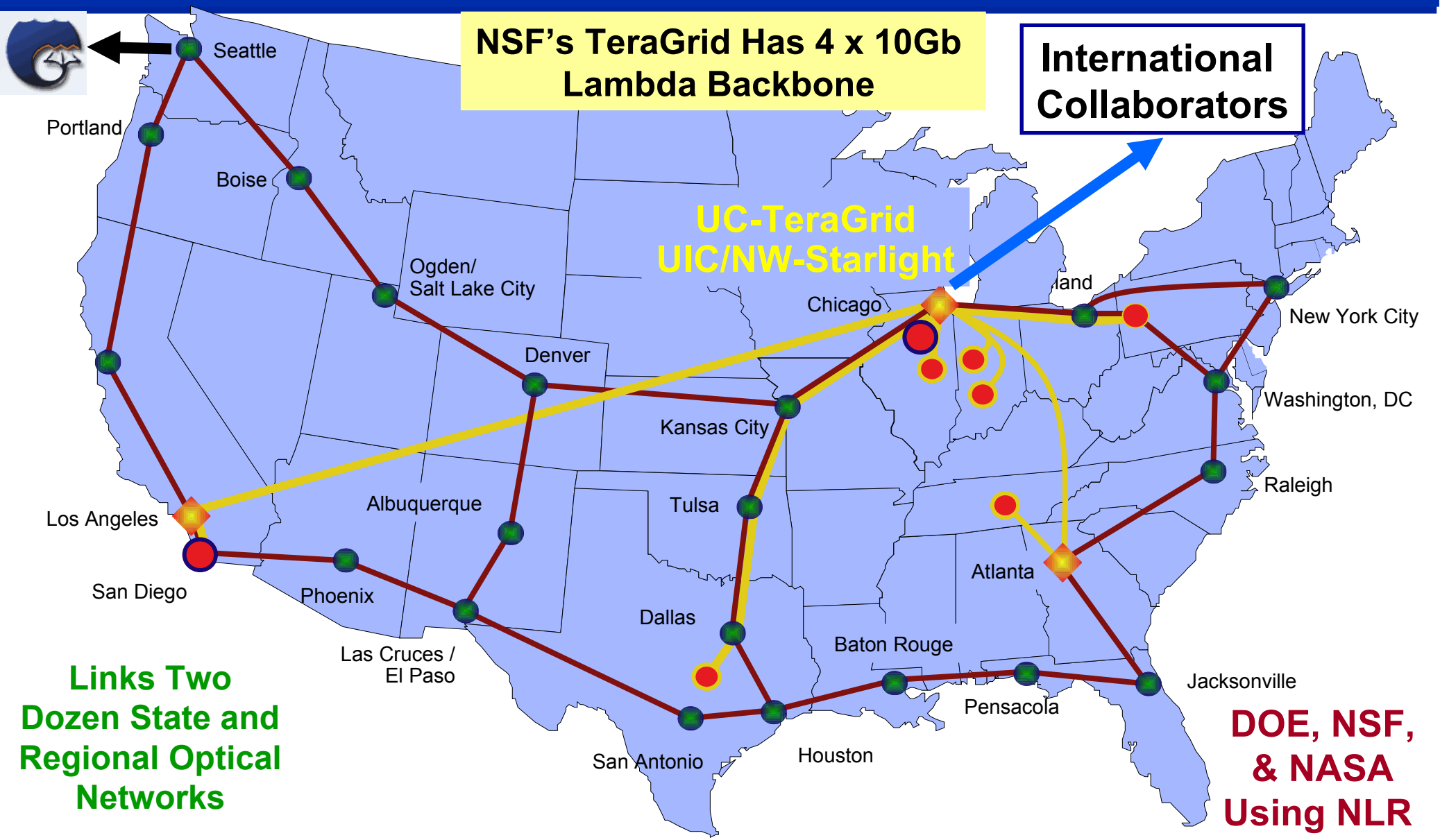
OptIPuter evl electronic visualization laboratory

Source: David Lee, Mark Ellisman NCMIR, UCSD

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

it2

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

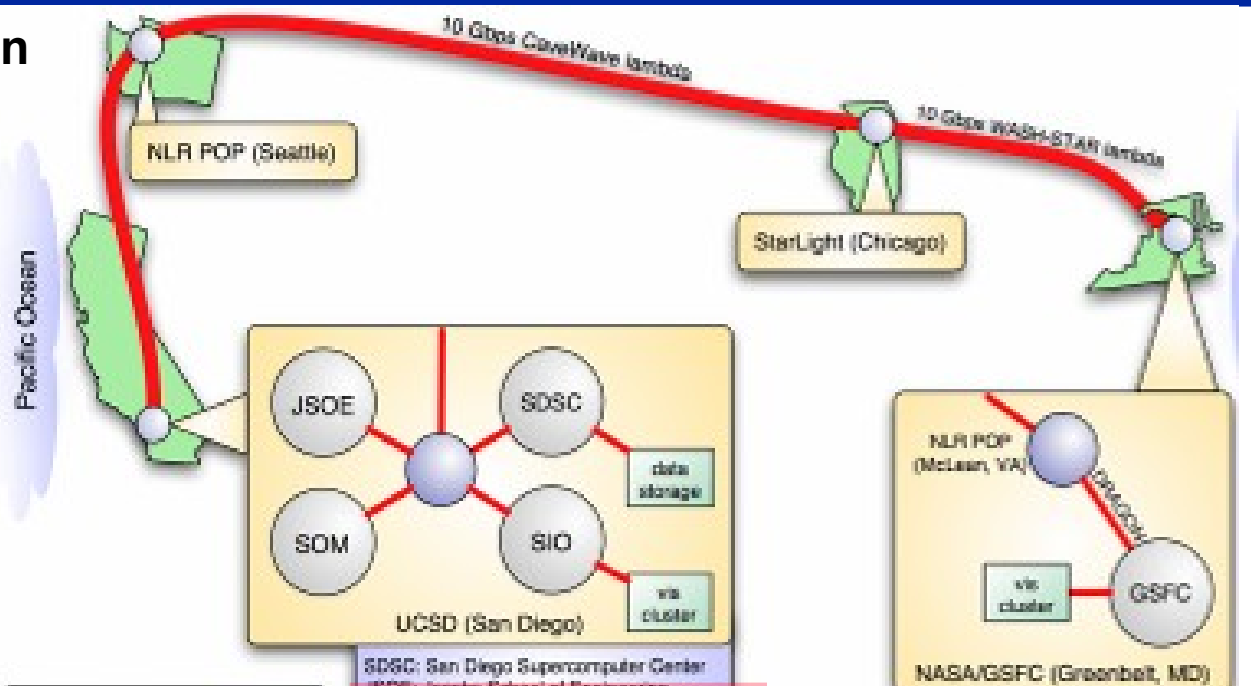


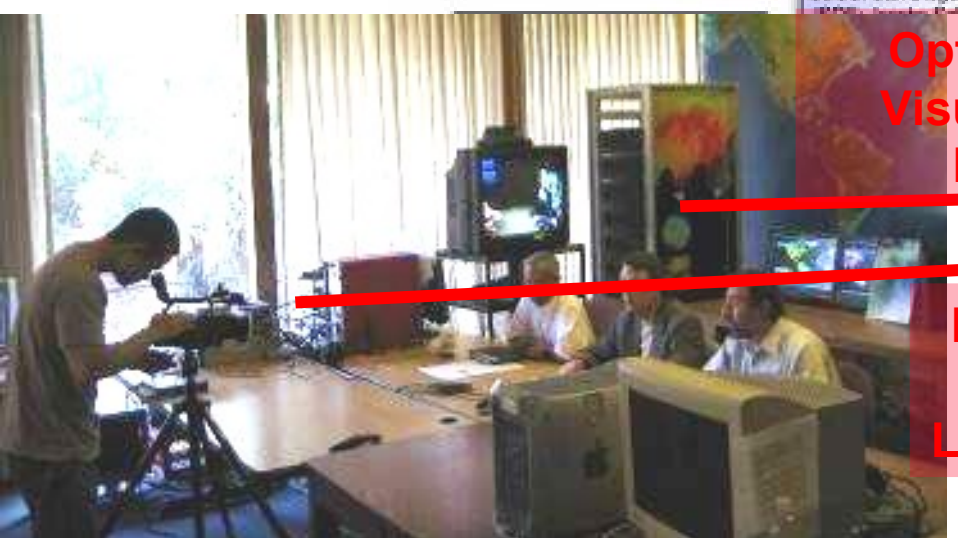
Calit2 and Goddard Spaceflight Center Are Combining Telepresence with Remote Interactive Analysis

Live Demonstration

of 21st Century National-Scale Team Science

August 2005





OptIPuter Visualized Data

HDTV Over Lambda



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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

it²

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

Where Are We Today?
What About in Ten Years?

The HP HALO Collaboration Studio is the Leading Edge Commercially Today

- $500,000 per room
- 45 mbps
- Uses TCP/IP protocols
- Developed with Dreamworks
- Announced by HP Dec 2005
- HP Plans 40 Internally by End of 2006
- Dreamworks, AMD, PepsiCo are Customers

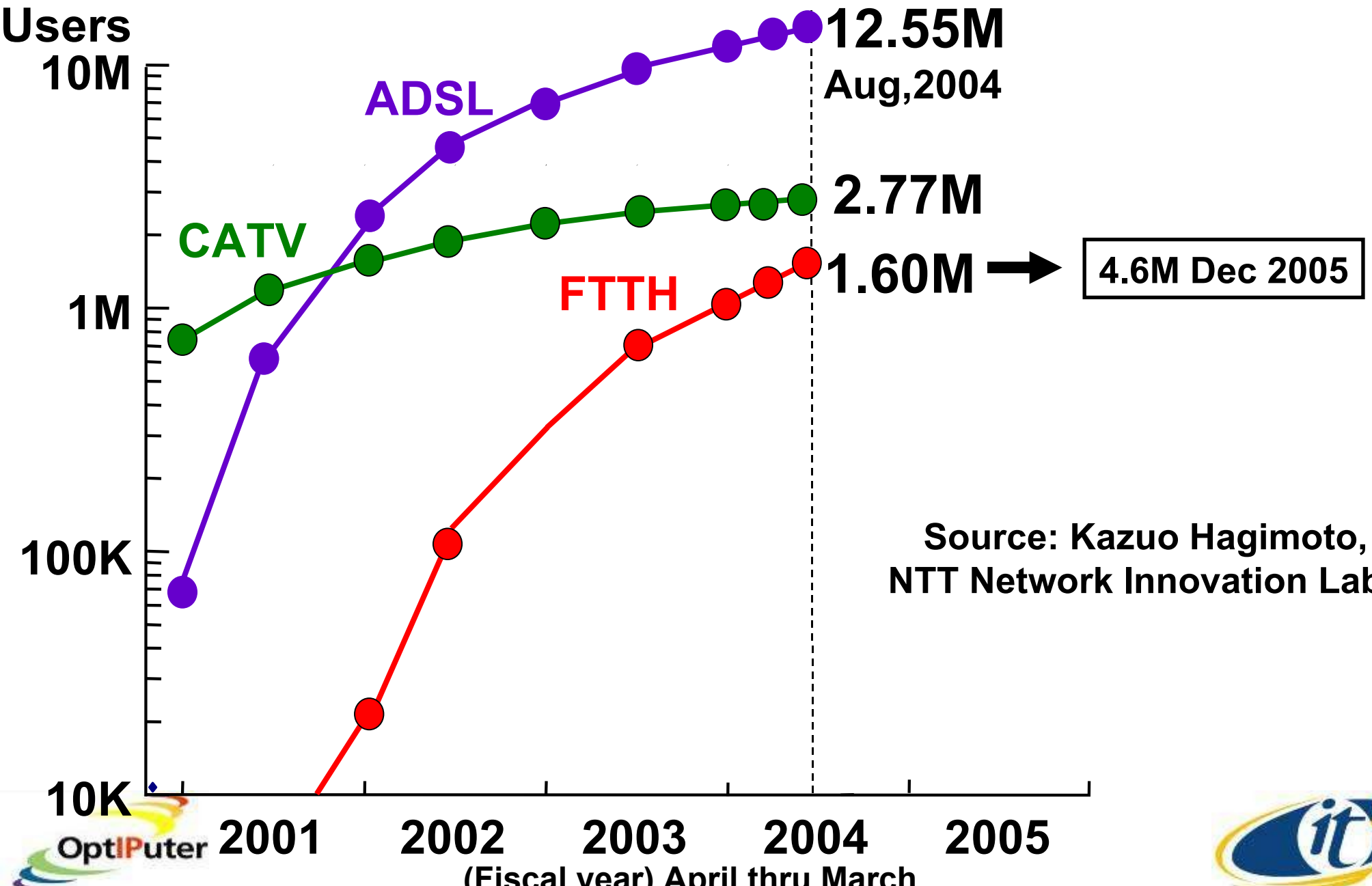


The Halo studios are designed to exact specifications, so that participants on the other side of the video conference appear to be in the same room

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Broadband Service Users in Japan: Moving Quickly to Fiber to the Home

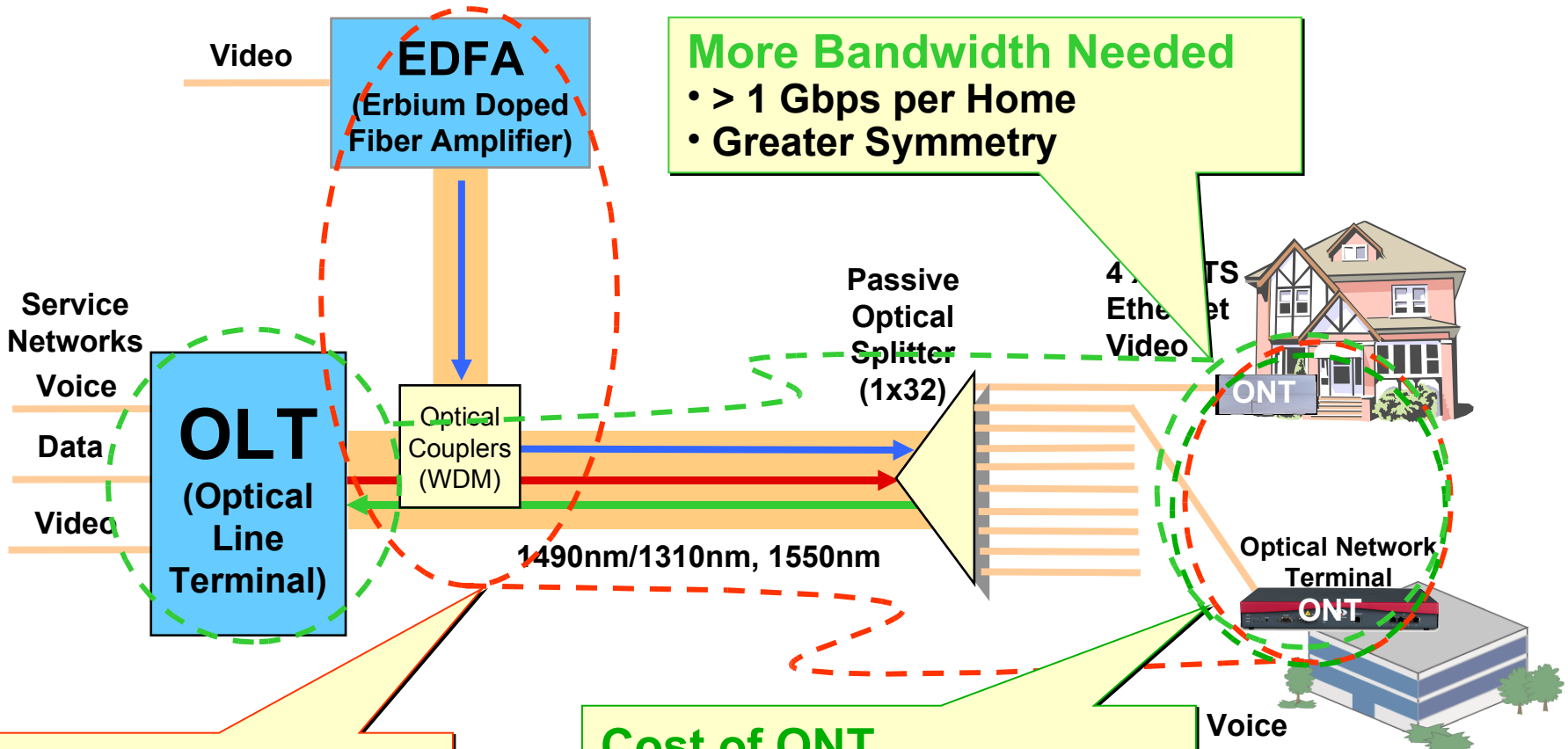


Source: Kazuo Hagimoto, NTT Network Innovation Labs

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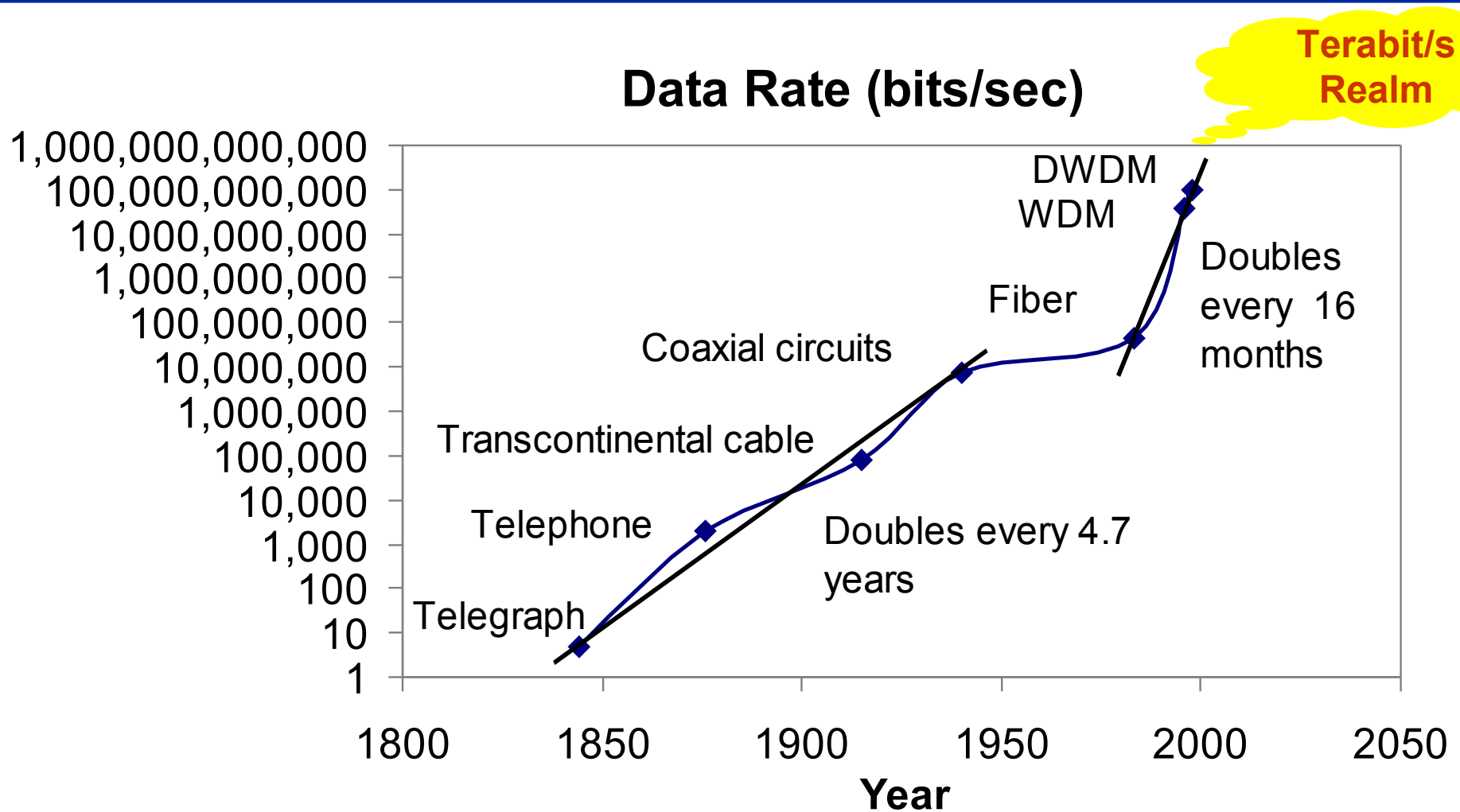
it²

Verizon Fiber to the Premise: Bringing Gigabit/s to the Home



Source: Stuart Elby
VP – Network Architecture, Verizon Technology Org
© Verizon 2005, All Rights Reserved
Information contained herein is subject to change without notice.

The Relentless Exponential of Bandwidth



Will this continue? How?

Source: John Bowers, UCSB

Inventing the Optics World of 2015
From Gigabits/s to Terabits/s



UCSD Photonics

ECE Testbed Faculty



Stojan Radic
Optical communication networks; all-optical processing; parametric processes in high-confinement fiber and semiconductor devices.



George Papen
Advanced photonic systems including optical communication systems, optical networking, and environmental and atmospheric remote sensing.



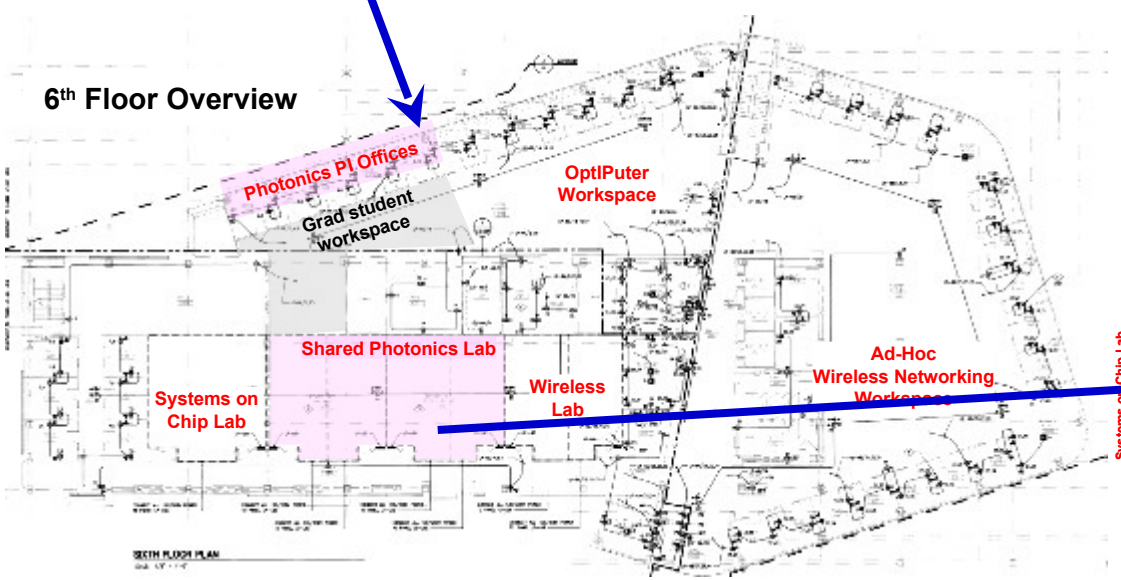
Joseph Ford
Optoelectronic subsystems integration (MEMS, diffractive optics, VLSI); Fiber optic and free-space communications.

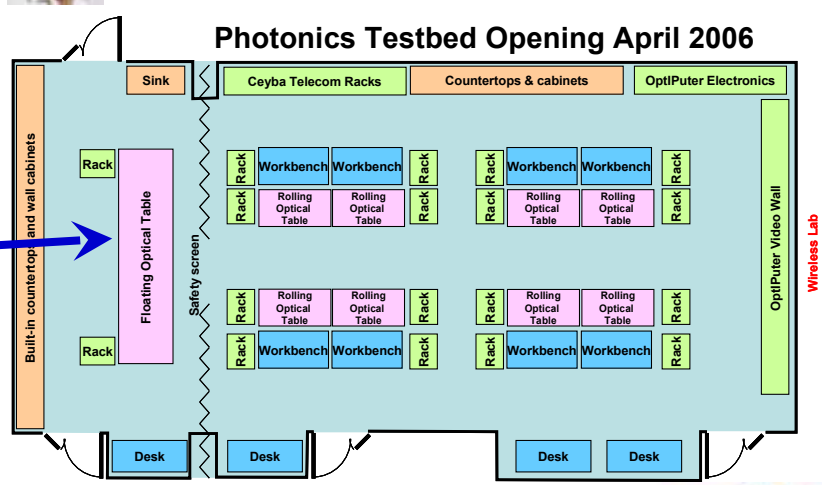


Shaya Fainman
Nanoscale science and technology; ultrafast photonics and signal processing



Shayan Mookherjea
Optical devices and optical communication networks, including photonics, lightwave systems and nano-scale optics.



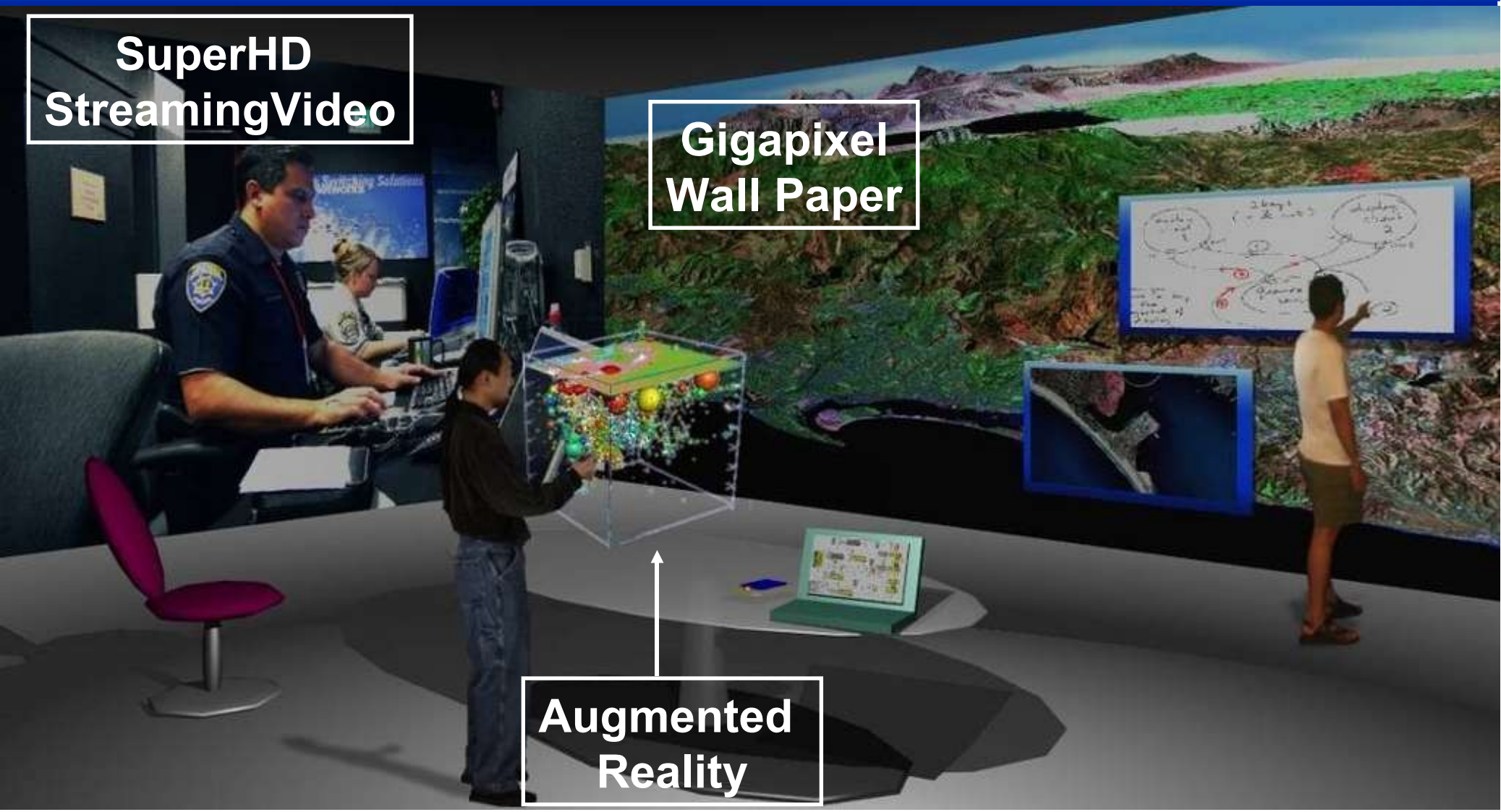


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Multi-Wavelength Array For 1000+ Channel Systems
Multichannel Operation To 55 Gb/s

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A Vision for the Future: Towards Gigapixel Displays



1 GigaPixel x 3 Bytes/pixel x 8 bits/byte x 30 frames/sec ~ 1 Terabit/sec!

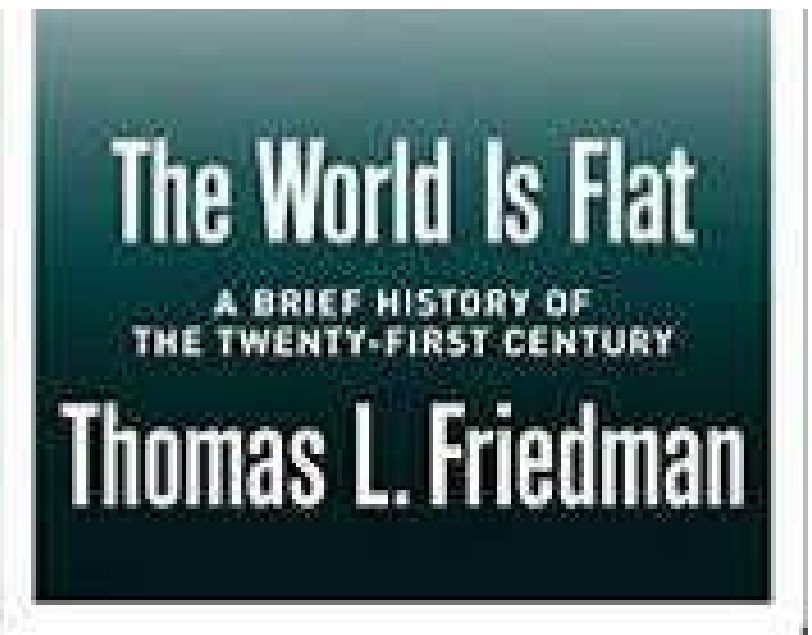
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Source: Jason Leigh, EVL, UIC

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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"
  - How Will Our Society Reorganize Itself?



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