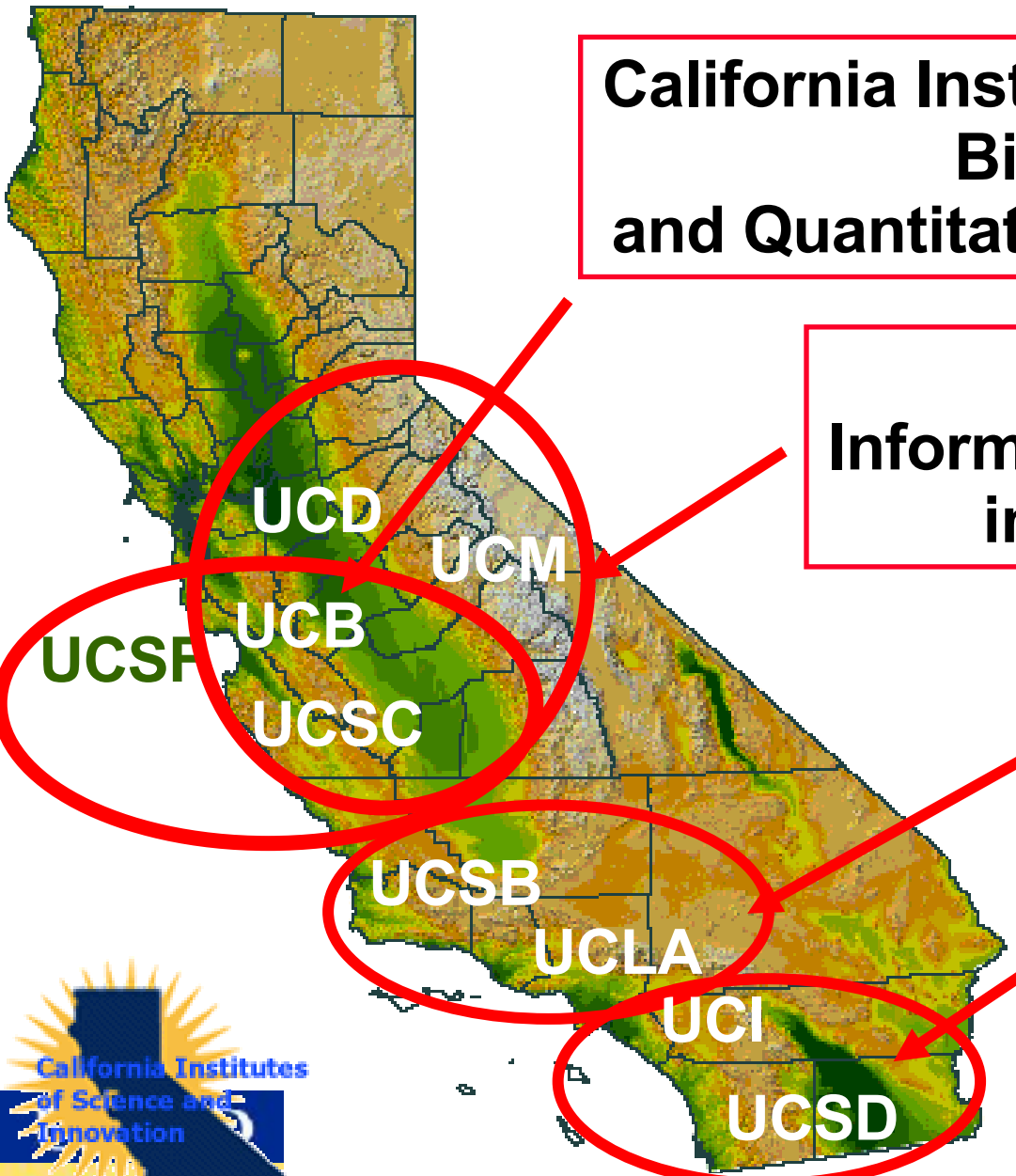
Global Telepresence in Support of Global Public Health

Briefing
University of California School of Global Health
All Campuses Planning Committee
Calit2 @ UCSD
La Jolla, CA
April 17, 2007

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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California's Institutes for Science and Innovation
A Bold Experiment in Collaborative Research



California Institute for Bioengineering, Biotechnology, and Quantitative Biomedical Research

Center for Information Technology Research in the Interest of Society

California NanoSystems Institute

California Institute for Telecommunications and Information Technology

California Institutes of Science and Innovation

UCHV

www.ucop.edu/california-institutes

Calit2 Continues to Pursue Its Initial Mission:

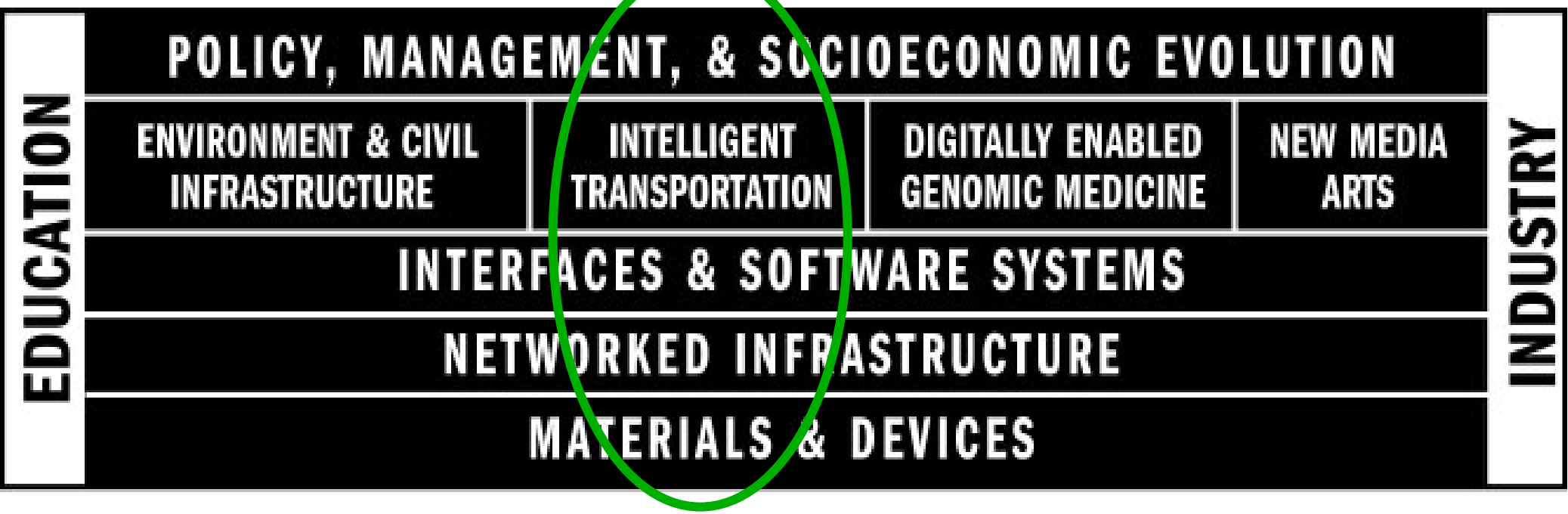
Envisioning How the Extension of Innovative Telecommunications and Information Technologies Throughout the Physical World will Transform Critical Applications Important to the California Economy and its Citizens' Quality Of Life.

Calit2 is a University of California "Institutional Innovation" Experiment on How to Invent a Persistent Collaborative Research and Education Environment that Provides Insight into How the UC, a Major Research University, Might Evolve in the Future.

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Calit2--A Systems Approach to the Future of the Internet and its Transformation of Our Society

Calit2 Has Assembled a Complex Social Network
of Over 350 UC San Diego & UC Irvine Faculty
From Two Dozen Departments
Working in Multidisciplinary Teams
With Staff, Students, Industry, and the Community



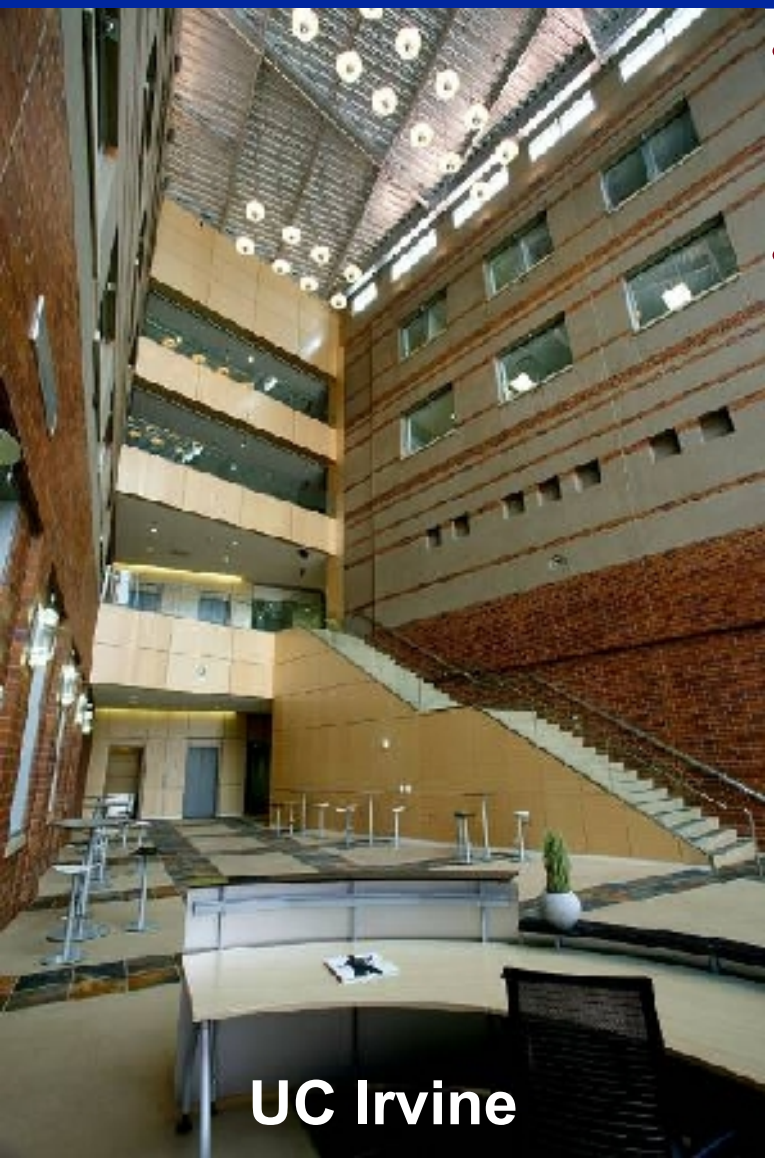
Integrating Technology Consumers and Producers
Into "Living Laboratories"

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www.calit2.net

it²

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



- "Convergence" Laboratory Facilities
  - Nanotech, BioMEMS, Chips, Radio, Photonics
  - Virtual Reality, Digital Cinema, HDTV, Gaming
- Over 1000 Researchers in Two Buildings
  - Linked via Dedicated Optical Networks



www.calit2.net

Preparing for a World in Which Distance is Eliminated…

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UCIrvine

President Kalam of India Believes Nanobioinfotech is the Future for 600,000 Villages

- Interactive Knowledge System
- Convergence of Info- Nano - Bio
- Make the Bandwidth Available with No Limits
- PURA--Societal Grid With Electronic Connection of a Billion People

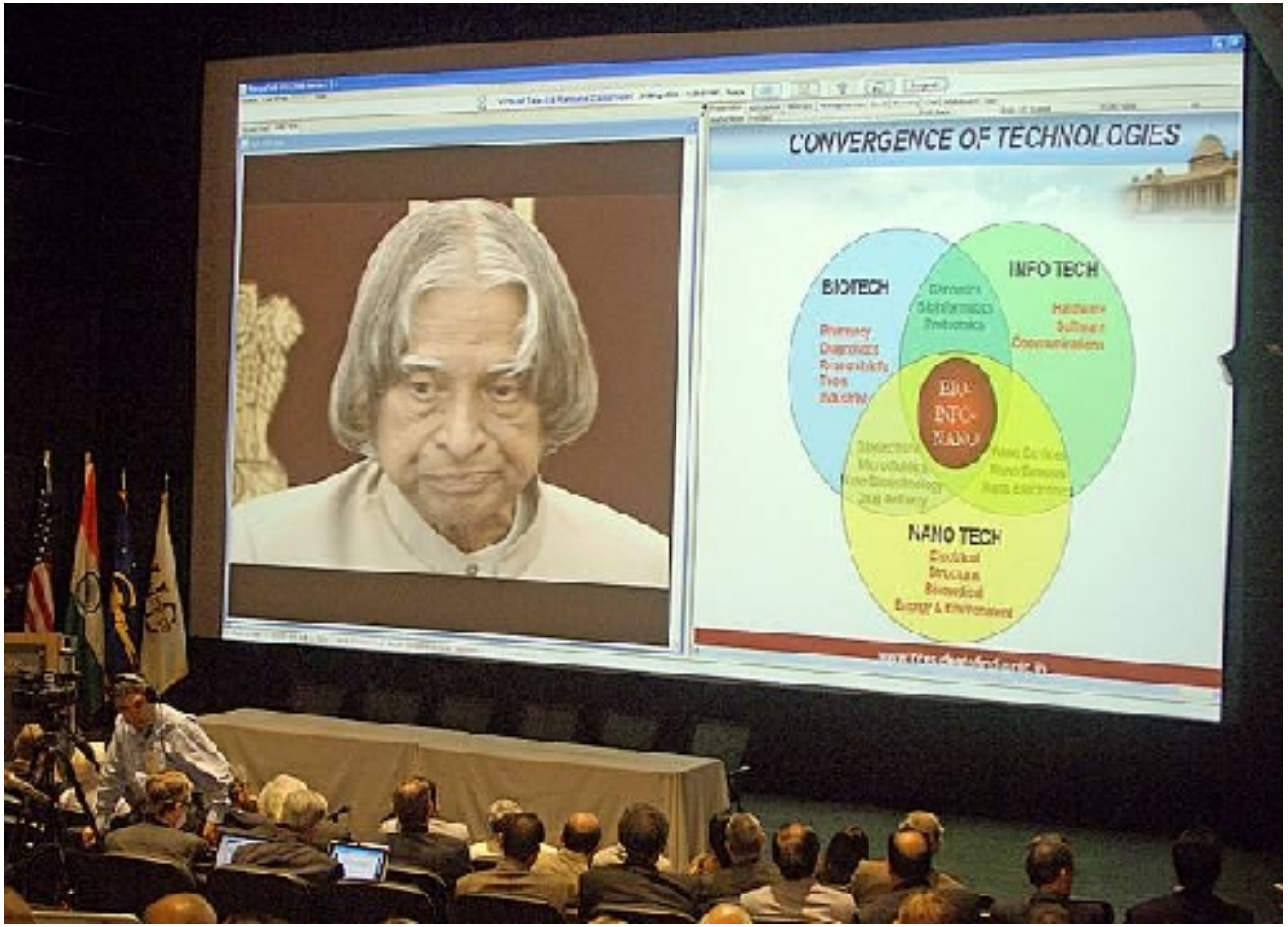


Photo: Alan Decker, UCSD

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Calit2 Brings Computer Scientists and Engineers Together with Biomedical Researchers

- **Some Areas of Concentration:**
  - Algorithmic and System Biology
  - Bioinfomatics
  - Metagenomics
  - Cancer Genomics
  - Human Genomic Variation and Disease
  - Proteomics
  - Mitochondrial Evolution
  - Computational Biology
  - Multi-Scale Cellular Imaging
  - Information Theory and Biol
  - Telemedicine

CASB

INSTITUTE FOR GENOMICS AND BIOINFORMATICS
University of California, Irvine

NanoTumor Center

camera
Marine Microbial Ecology

ICSI

JCSG
Joint Center for Structural Genomics

NBCR
National Biomedical Computation Resource
an NIH supported resource center

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

BIOMEDICAL INFORMATICS RESEARCH NETWORK

WISARD

lifechips

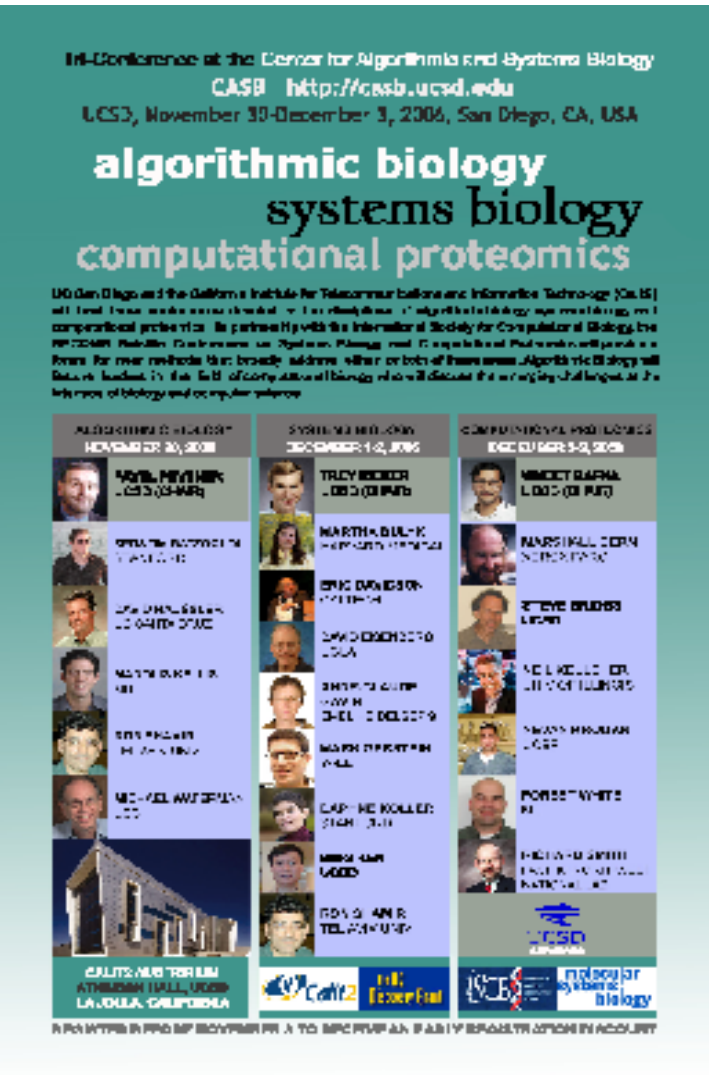
Information Theory and Applications

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Southern California Telemedicine Learning Center (TLC)

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Center for Algorithmic and Systems Biology@Calit2: Bringing World-Class Speakers to Conferences







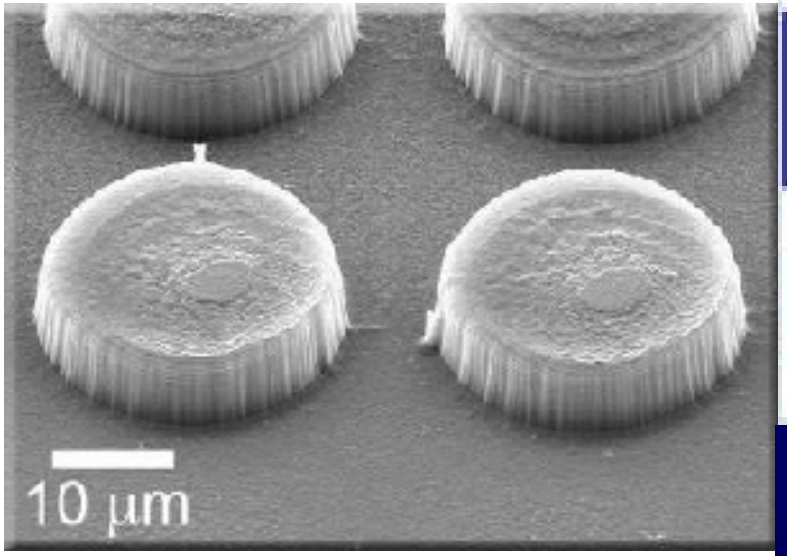


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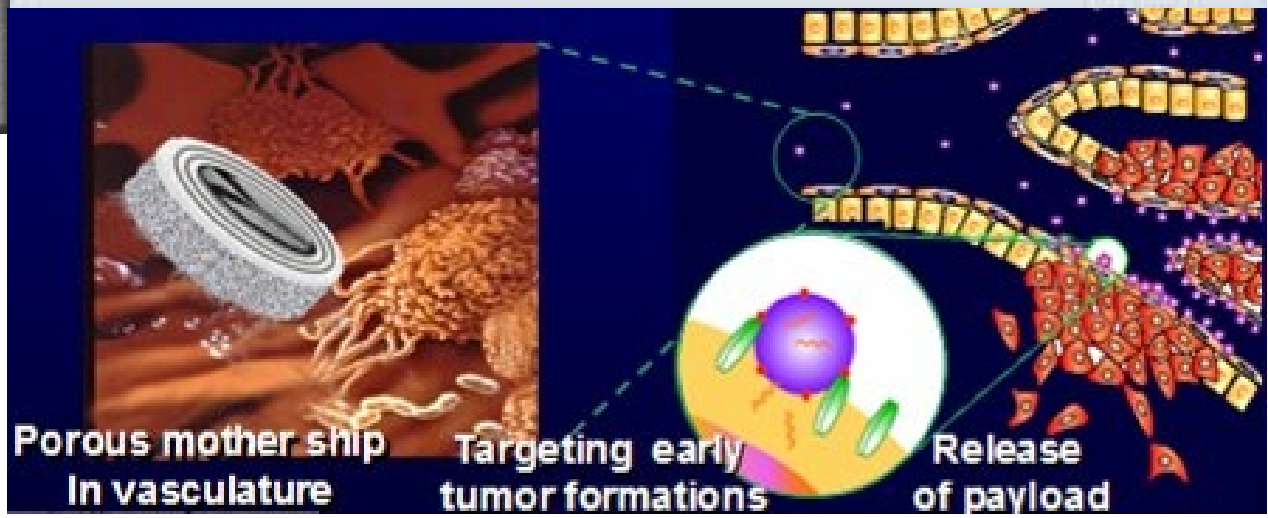
it2

Nano-Structured Porous Silicon Applied to Cancer Treatment

Nanodevices for In-vivo Detection & Treatment of Cancerous Tumors



Nanostructured “Mother Ships”
for Delivery of Cancer Therapeutics



Michael J. Sailor Research Group
Chemistry and Biochemistry

Calit2 Focuses on Three Modes of Telemedicine

- **Stage 1: Institutional Telemedicine**
  - Large Scale Data Sharing and Visualization Primarily Aimed at Medical Professionals
  - Collaborative Systems, Real-time Video, Database-on-Demand, Data Mining, Advanced Visualization, Distance Training, Robotic Surgery, etc.



- **Stage 2: Mobile Telemedicine**
  - Data Harvesting and Feedback at Point of Care Primarily Aimed at Medical Professionals.
  - Hospital Patient Tracking, Data Harvesting, Outpatient Monitoring, Medical Assistive Devices, Wearable Sensors, Field Deployable Units, Smart Forms, First Responder Units, etc.



- **Stage 3: Personalized Telemedicine**
  - Information Driven Medical Devices for Individualized Medicine
  - Smart Implants, Telemetric Microsensors, Remote Controlled Micro-robotics, Care-at-home Devices, Treatment Trackers, Personal Health Monitors

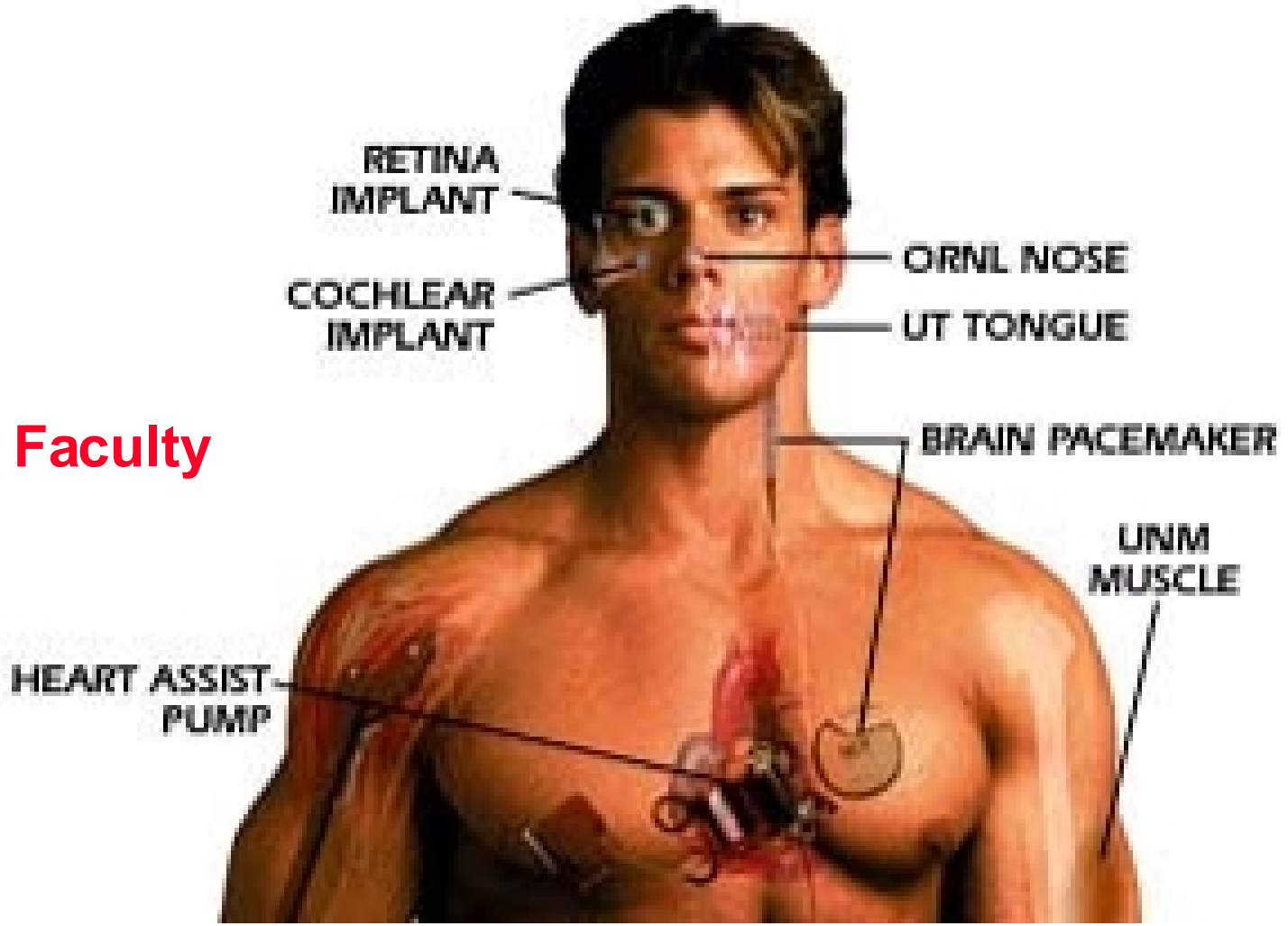


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Lifechips--Merging Two Major Industries: Microelectronic Chips & Life Sciences

65 UCI Faculty



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lifechips
university of california, irvine
www.ifechips.org

it²

A SmartPhone Based System to Enhance Preventive Healthcare

- Diabetes
- Congestive Heart Failure (CHF)
- Cardiac
- Hypertension
- Asthmatics
- Congestive Obstructive Pulmonary Disease(COPD)
- Obesity
- Infection

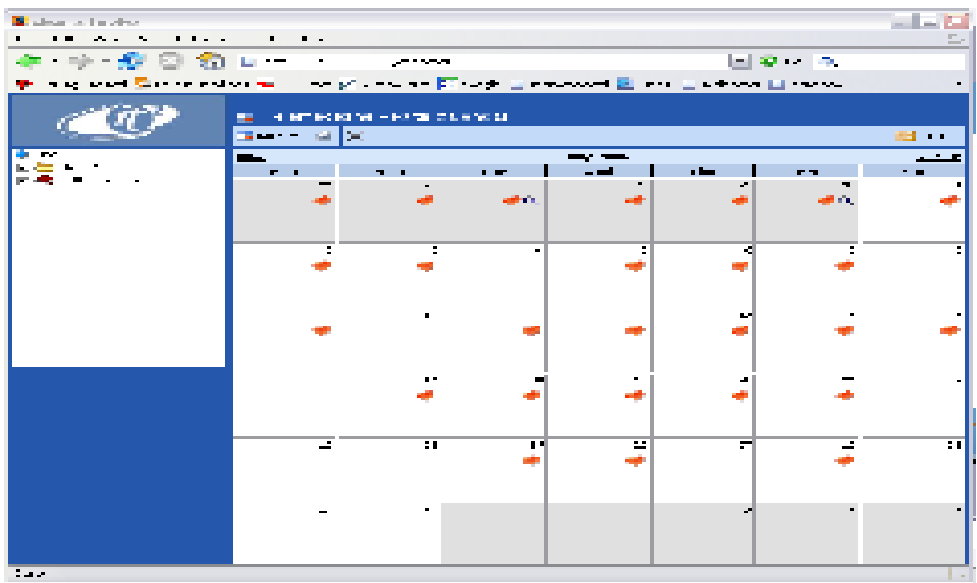
- …Any chronic illness.

- Blood Glucose
- Body Weight and Blood Pressure
- EKG / heart rhythms
- BP (Blood Pressure)
- Respiration
- Respiration & Blood Oxygenation
- Weight & Caloric intake
- Temperature

Can be easily measured / monitored
And therefore controlled before effects are catastrophic







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Source: Paul Blair, Calit2

Telemedicine/Life Science Outreach
Calit2@UCI



- Telemedicine Comes of Age – September 2006 Igniting Technology Panel Presentation at Calit2
- Director's Telemedicine Focus Group – November 2006 at Calit2 ~ 14 Participants

- Calit2 co-sponsored "International Imaging Genomics Conference" – Jan 2007 at Academy's Beckman Center
- Director's Telemedicine Workshop – July 2007 at Calit2 ~ 40 Participants

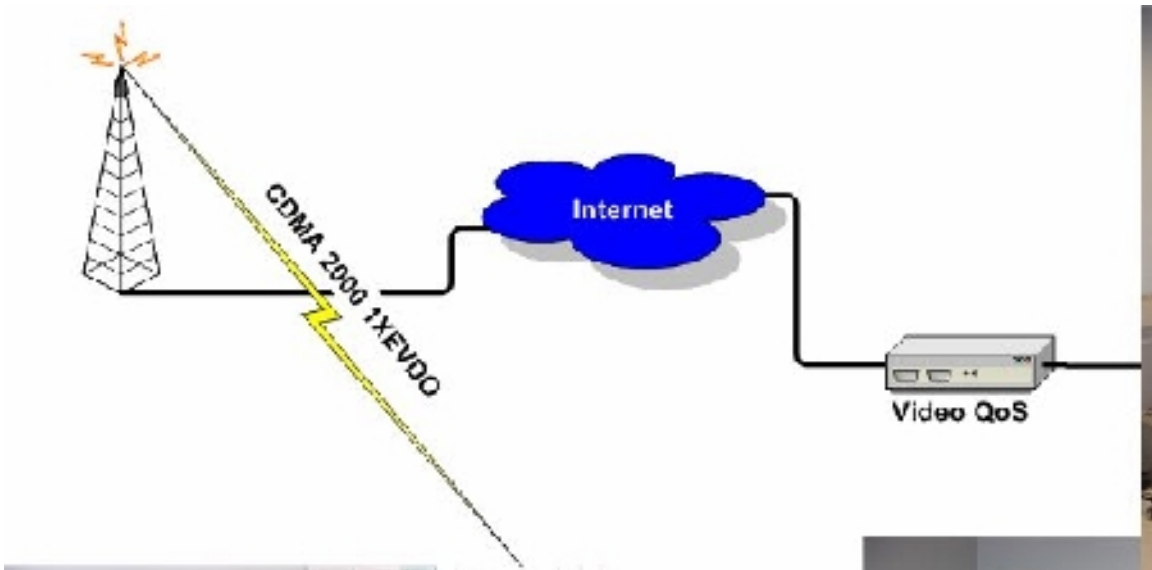


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High Resolution, Low Jitter Video Diagnosis Tool
Cal-(IT)², Qualcomm, Path 1, & UCSD Stroke Center

End-to-End QoS Management
Video Delivered Over CDMA 2000 1x EV-DO To Specialists
Viewing Station –Standard Laptop With 1xEV-DO Modems
Current Coverage 10 Mi. Around Campus









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Prototype Led to a $5-million, 5-Year Grant from the National Institute of Neurological Diseases and Stroke

it²

Wireless Internet Information System for Medical Response in Disasters

- **Funding Agency**
  - NIH's National Library of Medicine
- **Funding Level**
  - $4 million over 3 years
- **Project Description**
  - Sophisticated Wireless Systems to Coordinate and Enhance Care of Mass Casualties in a Natural Disaster
- **Key Team Members**
  - PI, Leslie Lenert, M.D., School of Medicine-Now CDC
  - Co-PI, Ramesh Rao, Division Director, Calit2
  - MMST, First Responders, Emergency Medical



Aug. 22, 2006 Disaster Drill at Atkinson Hall



WIISARD Technologies Tested in Decontamination Tent



Command Center System for Monitoring Disaster Site

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www.wiisard.org

Calit2 Has Introduced Innovative Wireless Systems to Support SoCal First Responders















Aug. 22, 2006 MMST Disaster Drill at Calit2@UCSD Involved Over 200 First Responders



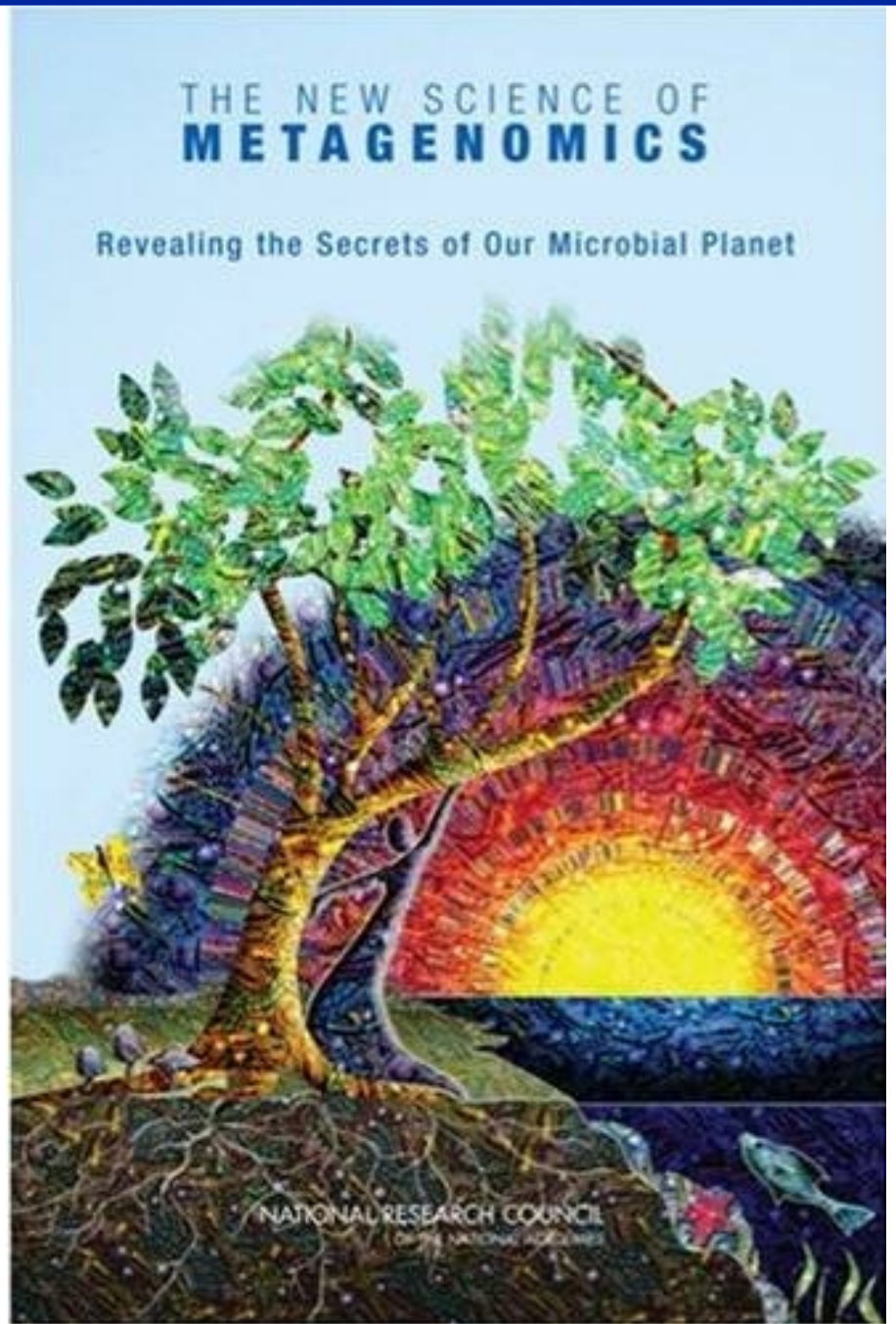




The New Science of Metagenomics

NRC Report:

Metagenomic data should be made publicly available in international archives as rapidly as possible.



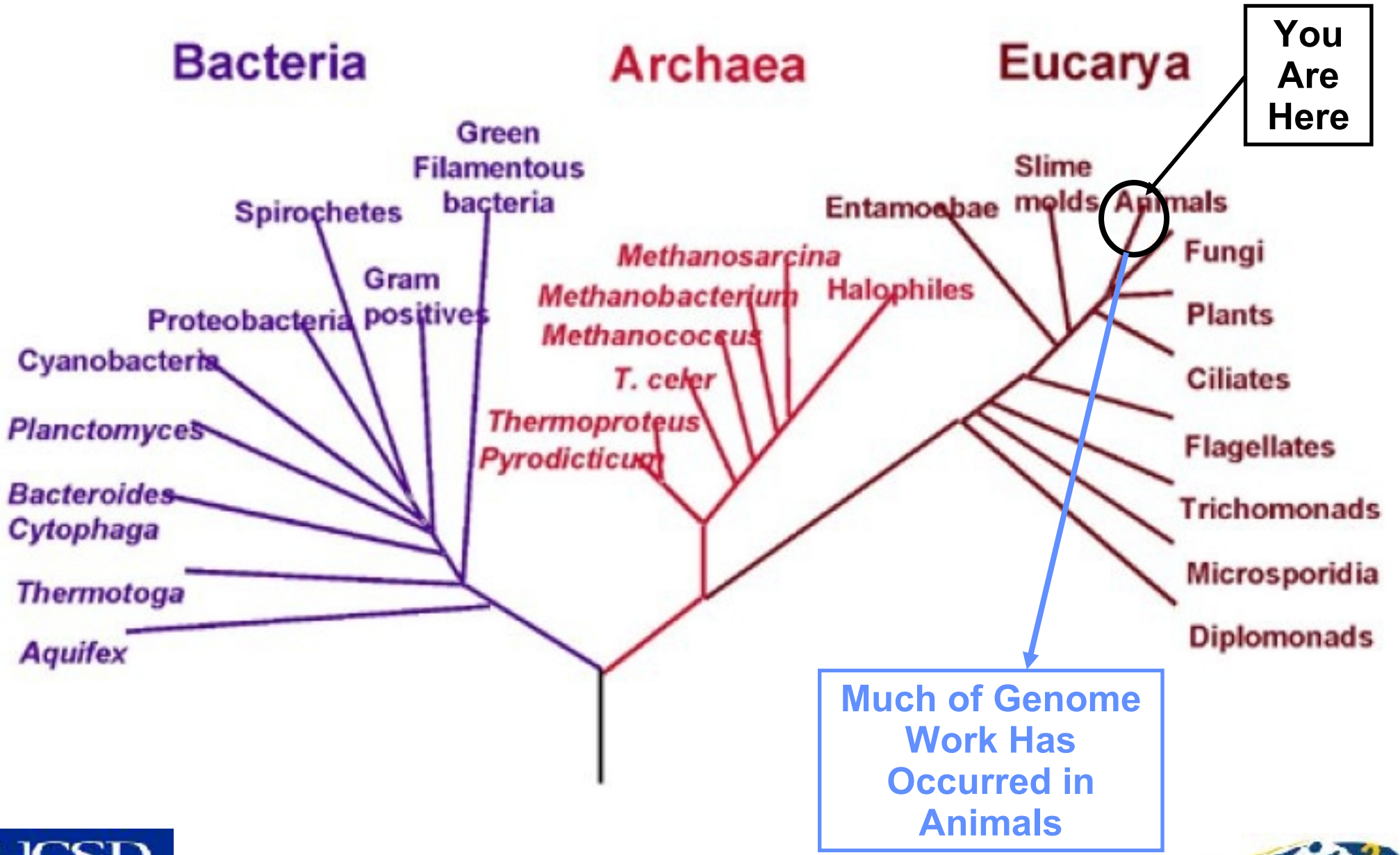
"The emerging field of metagenomics, where the DNA of entire communities of microbes is studied simultaneously, presents the greatest opportunity -- perhaps since the invention of the microscope – to revolutionize understanding of the microbial world." –

National Research Council
March 27, 2007

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

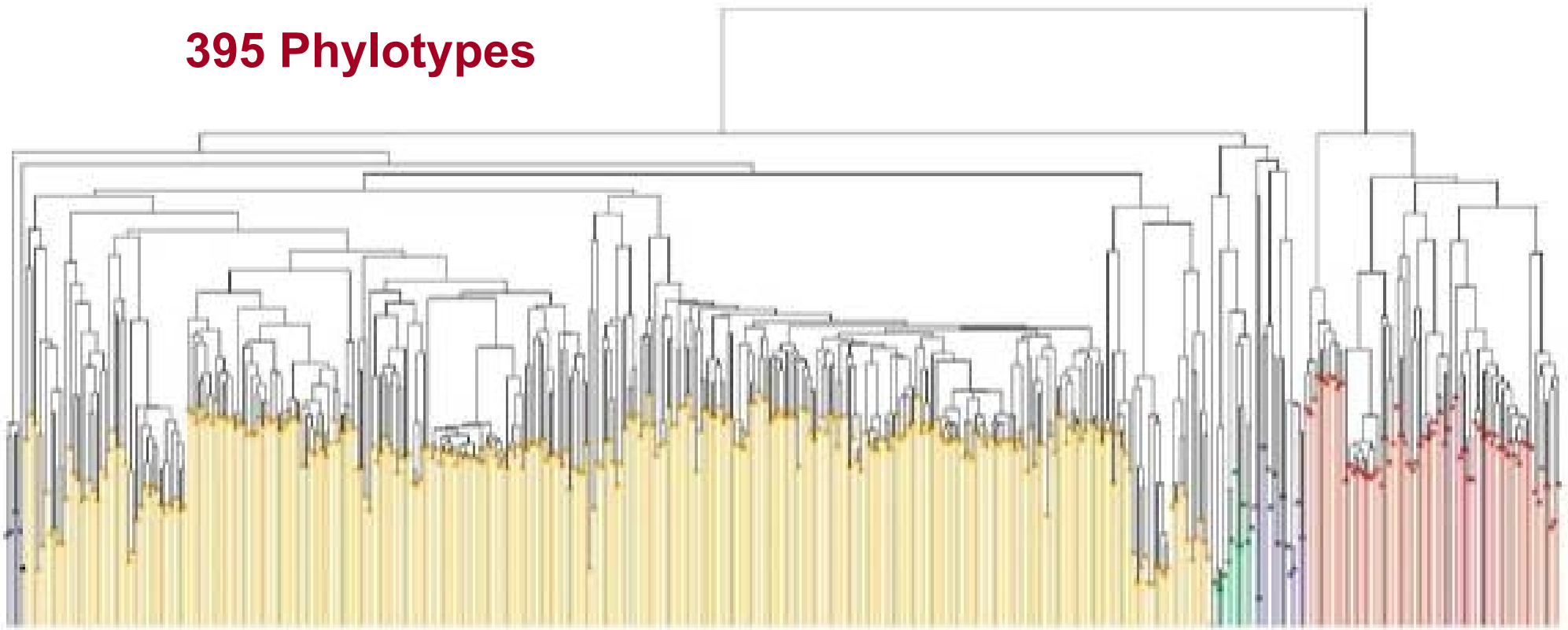


Source: Carl Woese, et al

The Human Microbiome is the Next Large NIH Drive to Understand Human Health and Disease

- "A majority of the bacterial sequences corresponded to uncultivated species and novel microorganisms."
- "We discovered significant inter-subject variability."
- "Characterization of this immensely diverse ecosystem is the first step in elucidating its role in health and disease."

395 Phylotypes



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"Diversity of the Human Intestinal Microbial Flora"
Paul B. Eckburg, et al *Science* (10 June 2005)

it²

Community Cyberinfrastructure for Advanced Marine Microbial Ecology Research and Analysis



http://camera.calit2.net/

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J. Craig Venter INSTITUTE

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Marine Genome Sequencing Project – Measuring the Genetic Diversity of Ocean Microbes

Plus 155 Marine Microbial Genomes



Each Sample ~2000 Microbial Species

Specify Ocean Data

Sorcerer II Data Will Double Number of Proteins in GenBank!

camera
Marine Microbial Ecology

MARINE MICROBIOLOGY INITIATIVE

Gordon and Betty MOORE FOUNDATION

J. Craig Venter INSTITUTE

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CAMERA's Global Microbial Metagenomics CyberCommunity—Can We Employ Social Network Software?

Over 1850 Registered Users From Over 50 Countries



camera

J. Craig Venter INSTITUTE

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TV and Movies of 40 Years Ago Envisioned Telepresence Displays









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Source: Star Trek 1966-68; Barbarella 1968

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Cisco Telepresence Provides Leading Edge Commercial VTC

- 191 Cisco TelePresence in Major Cities Globally
  - US/Canada: 83 CTS 3000, 46 CTS 1000
  - APAC: 17 CTS 3000, 4 CTS 1000
  - Japan: 4 CTS 3000, 2 CTS 1000
  - Europe: 22 CTS 3000, 10 CTS 1000
  - Emerging: 3 CTS 3000
- Overall Average Utilization is 45%

- 85,854 TelePresence Meetings Scheduled to Date
  - Weekly Average is 2,263 Meetings
- 108,736 Hours
  - Average is 1.25 Hours

- 13,450 Meetings Avoided Travel
  Average to Date
  (Based on 8 Participants)

  ~$107.60 M To Date
- Cubic Meters of Emissions Saved 16,039,052 (6,775 Cars off the Road)

Uses QoS Over Shared Internet ~ 15 mbps

Cisco Bought WebEx





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Source: Cisco 3/22/08

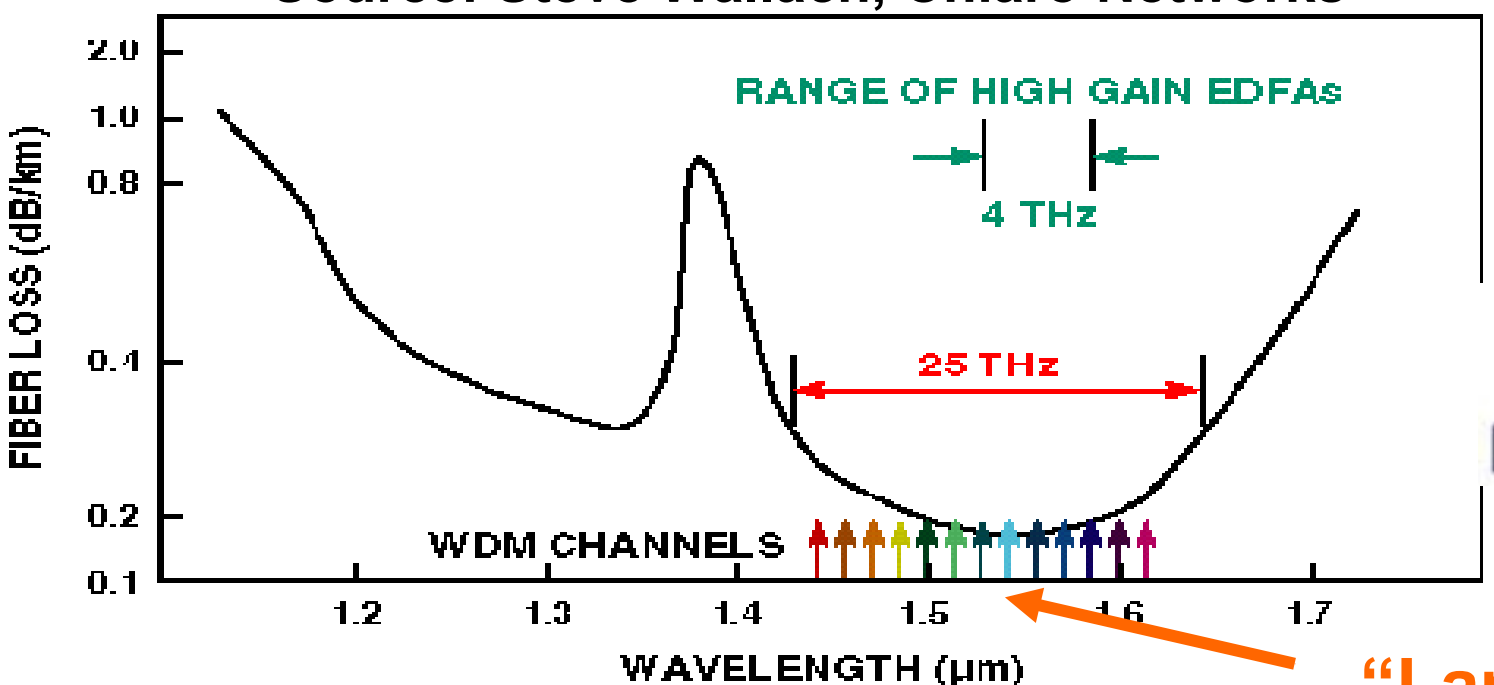
Dedicated Optical Channels Makes High Performance Cyberinfrastructure Possible

WAVELENGTH DIVISION MULTIPLEXING (WDM)

10 Gbps per User ~ 500x Shared Internet Throughput

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

Source: Steve Wallach, Chiaro Networks



"Lambdas"

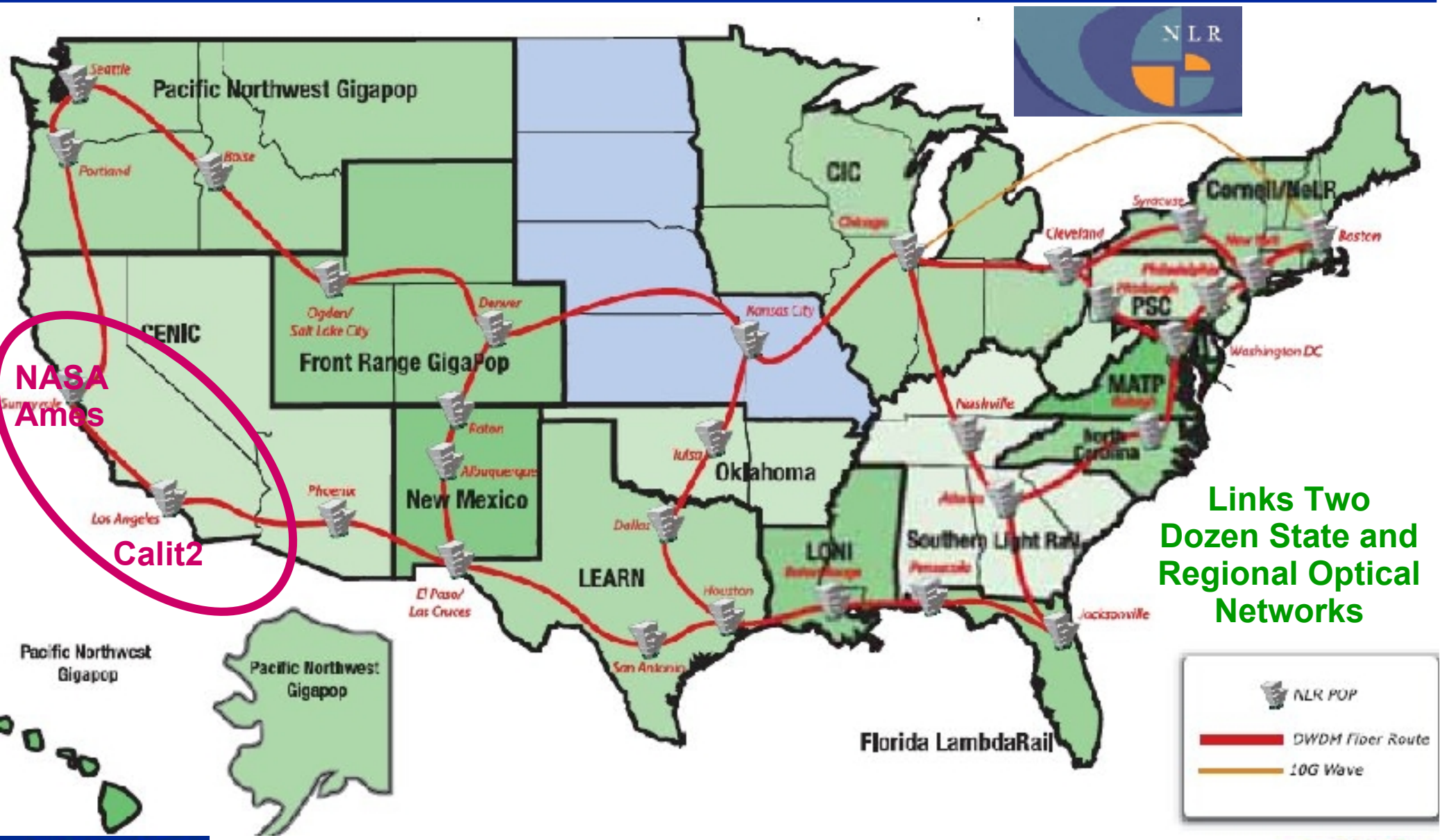
Single 10G Lightpath to Individual Users Enables Data-Intensive Science with High Performance Collaboration

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CHIARO

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



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

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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

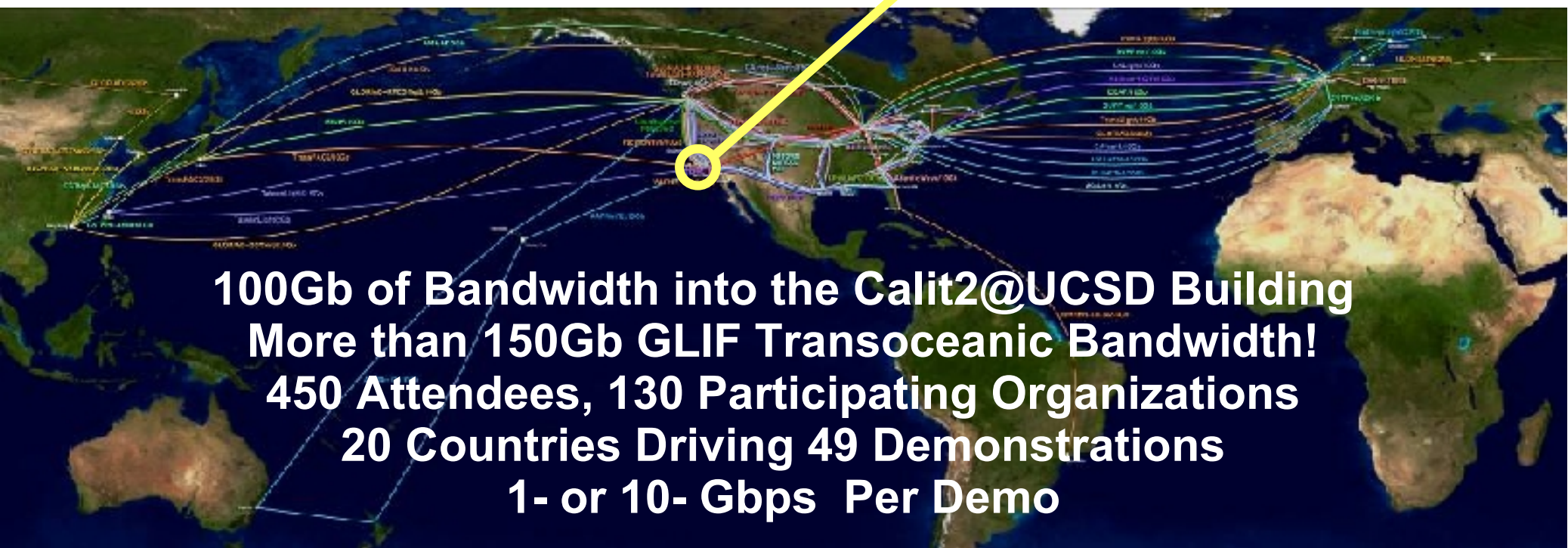


the UC Discovery Grant

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

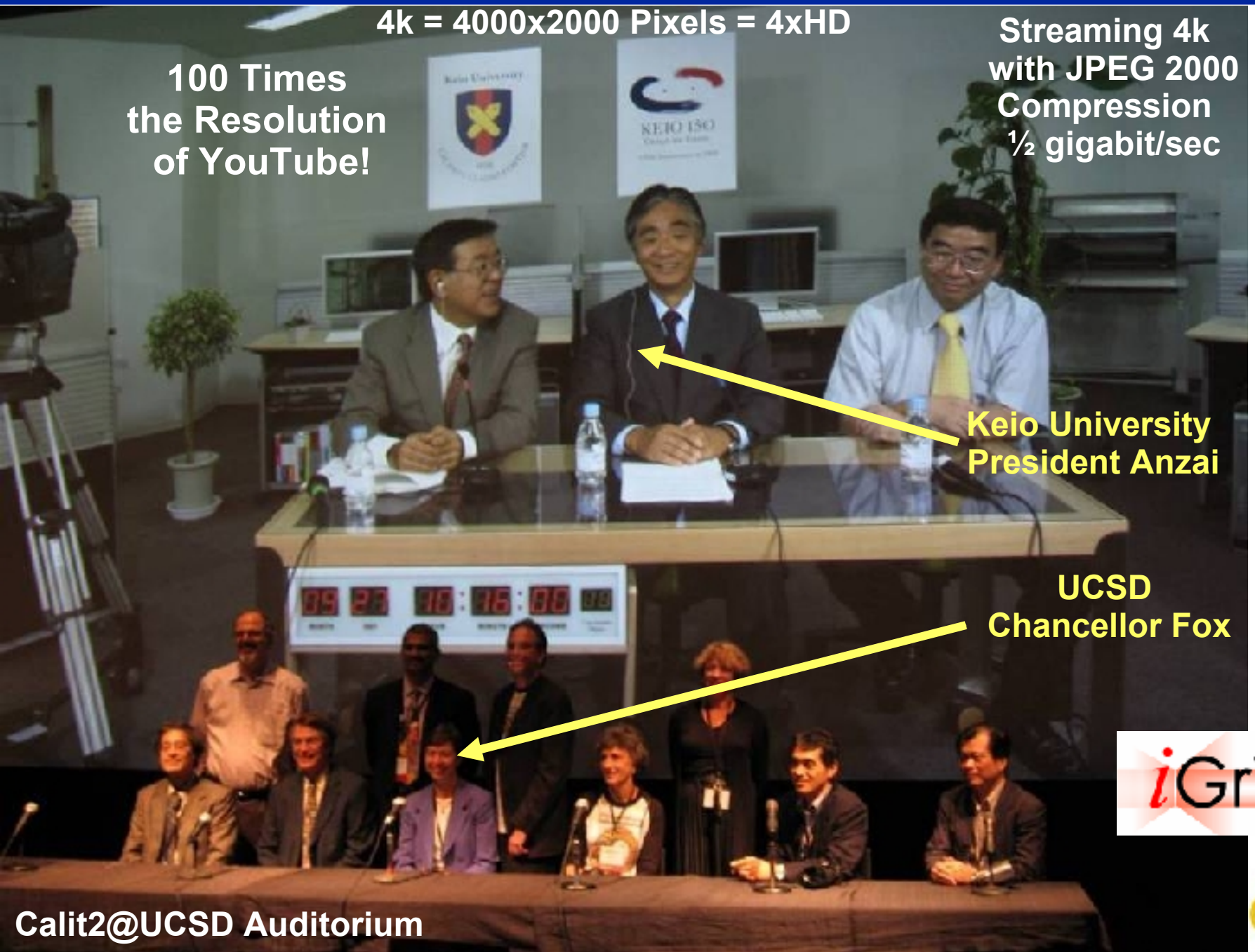
More than 150Gb GLIF Transoceanic Bandwidth!

450 Attendees, 130 Participating Organizations

20 Countries Driving 49 Demonstrations

1- or 10- Gbps Per Demo

First Trans-Pacific Super High Definition Telepresence Meeting Using Digital Cinema 4k Streams



CineGrid

Lays Technical Basis for Global Digital Cinema

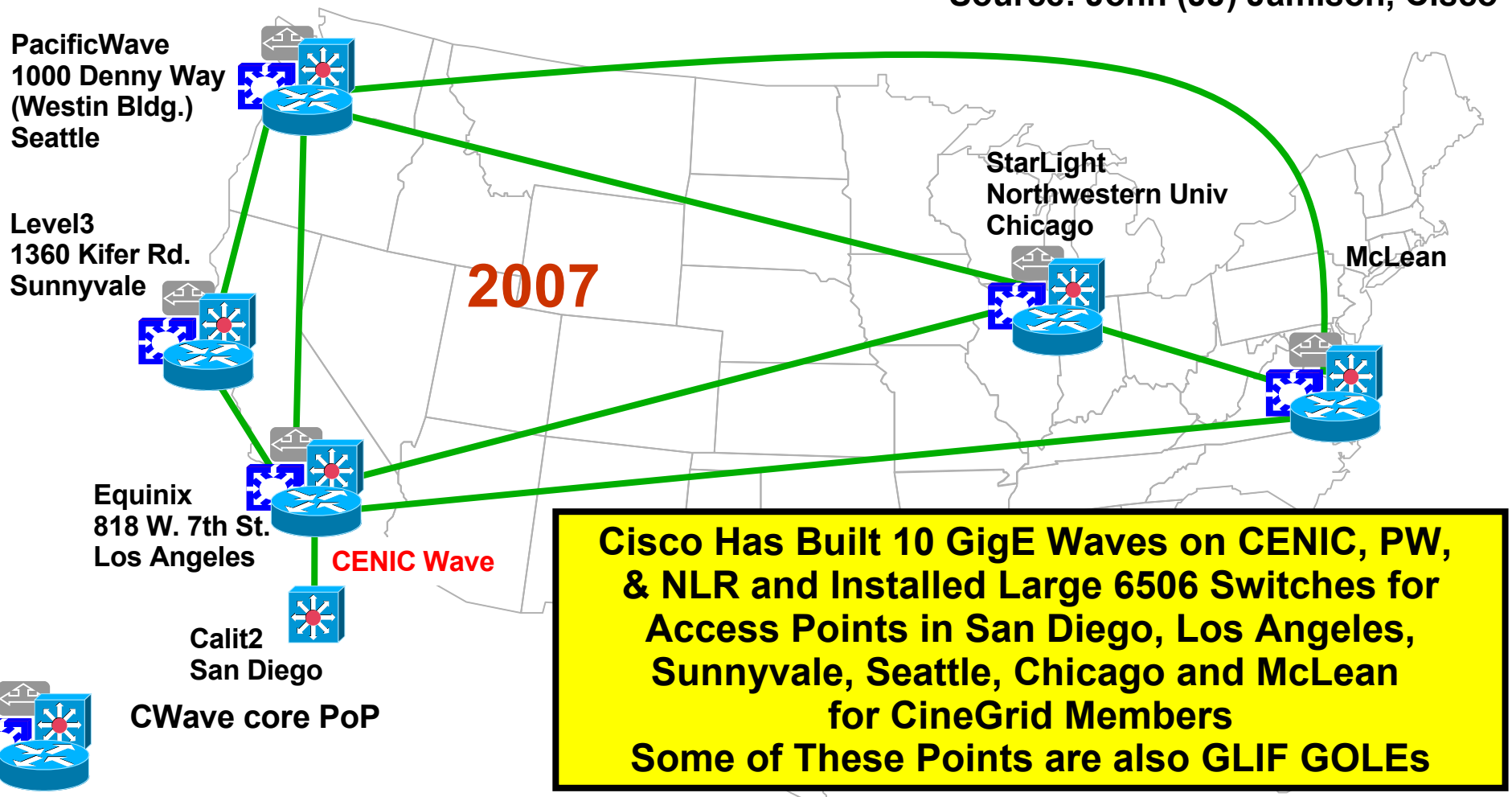
Sony
NTT
SGI

iGrid 2005

it²

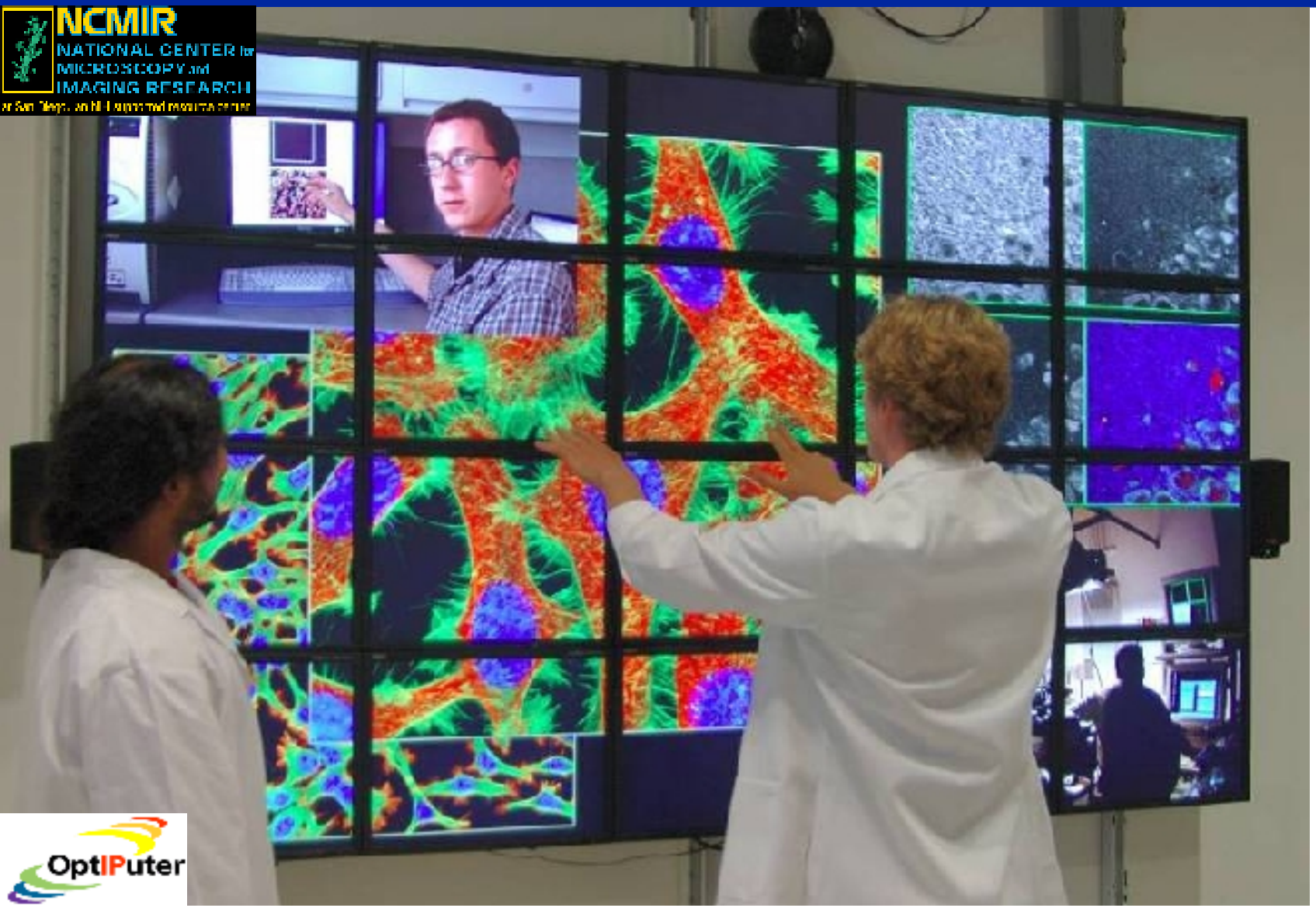
Cisco CWave for CineGrid: A New Cyberinfrastructure for High Resolution Media Streaming*

Source: John (JJ) Jamison, Cisco



Cisco Has Built 10 GigE Waves on CENIC, PW, & NLR and Installed Large 6506 Switches for Access Points in San Diego, Los Angeles, Sunnyvale, Seattle, Chicago and McLean for CineGrid Members
Some of These Points are also GLIF GOLEs

The OptIPuter Project: Creating High Resolution Portals Over Dedicated Optical Channels to Global Science Data



Scalable Adaptive Graphics Environment (SAGE)

$13.5M Over Five Years

Picture Source: Mark Ellisman, David Lee, Jason Leigh

Calit2 (UCSD, UCI) and UIC Lead Campuses—Larry Smarr PI
Univ. Partners: SDSC, USC, SDSU, NW, TA&M, UvA, SARA, KISTI, AIST
Industry: IBM, Sun, Telcordia, Chiaro, Calient, Glimmerglass, Lucent

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

evl electronic visualization laboratory





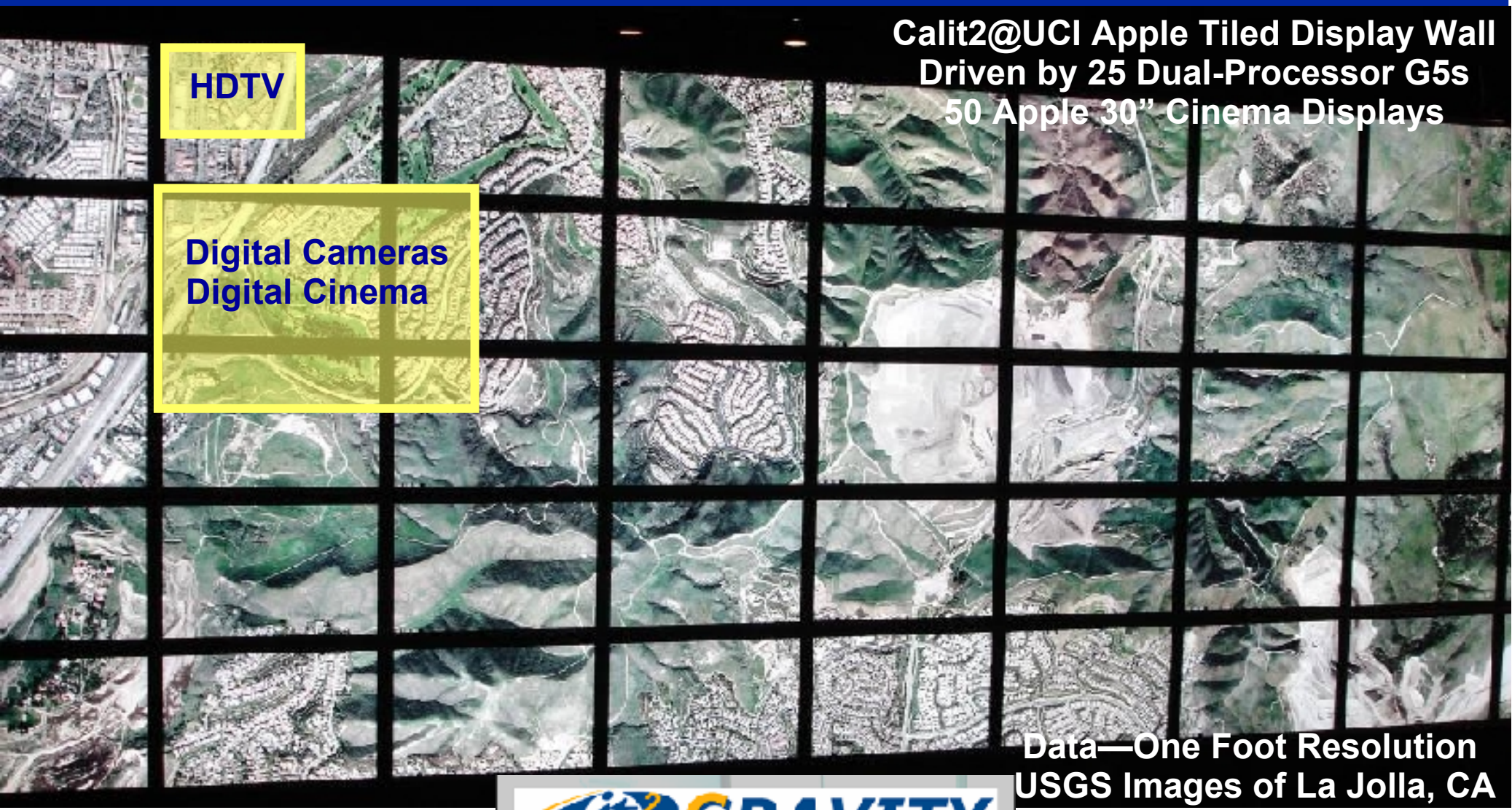
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Powered by Rocks ROCKS

Source: Phil Papadopoulos SDSC, Calit2

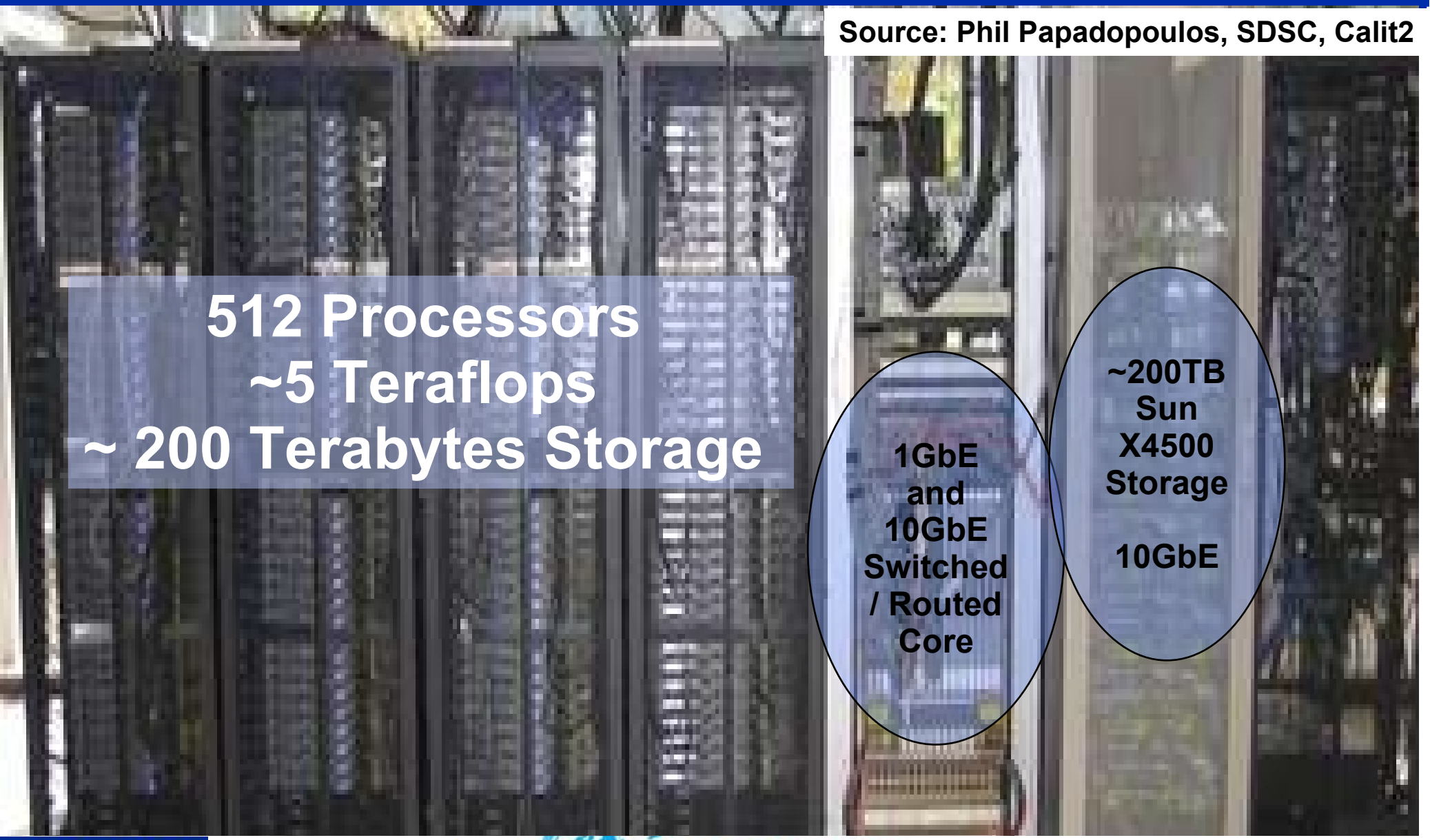
it²

Beyond 4k –
From 8 Megapixels Towards a Billion Pixels



Source: Falko Kuester, Calit2@UCI
NSF Infrastructure Grant

Calit2 Microbial Metagenomics Cluster- Next Generation Optically Linked Science Data Server



Source: Phil Papadopoulos, SDSC, Calit2

UCSD UCIrvine SDSC ROCKS camera Marine Microbial Ecology J. Craig Venter INSTITUTE it2

OptIPlanet Collaboratory Persistent Infrastructure Supporting Microbial Research



iHDTV: 1500 Mbits/sec Calit2 to UW Research Channel Over NLR

OptIPuter

Ginger Armbrust's Diatoms: Micrographs, Chromosomes, Genetic Assembly

ROCKS







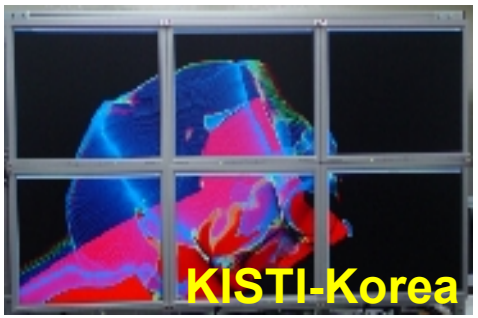
UW's Research Channel Michael Wellings

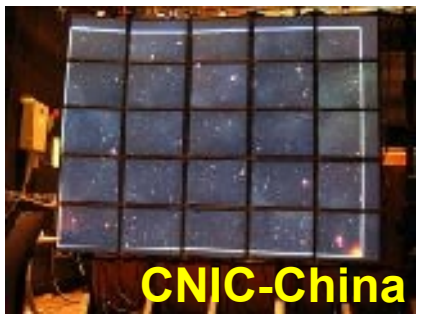
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OptIPortals
Are Being Adopted Globally























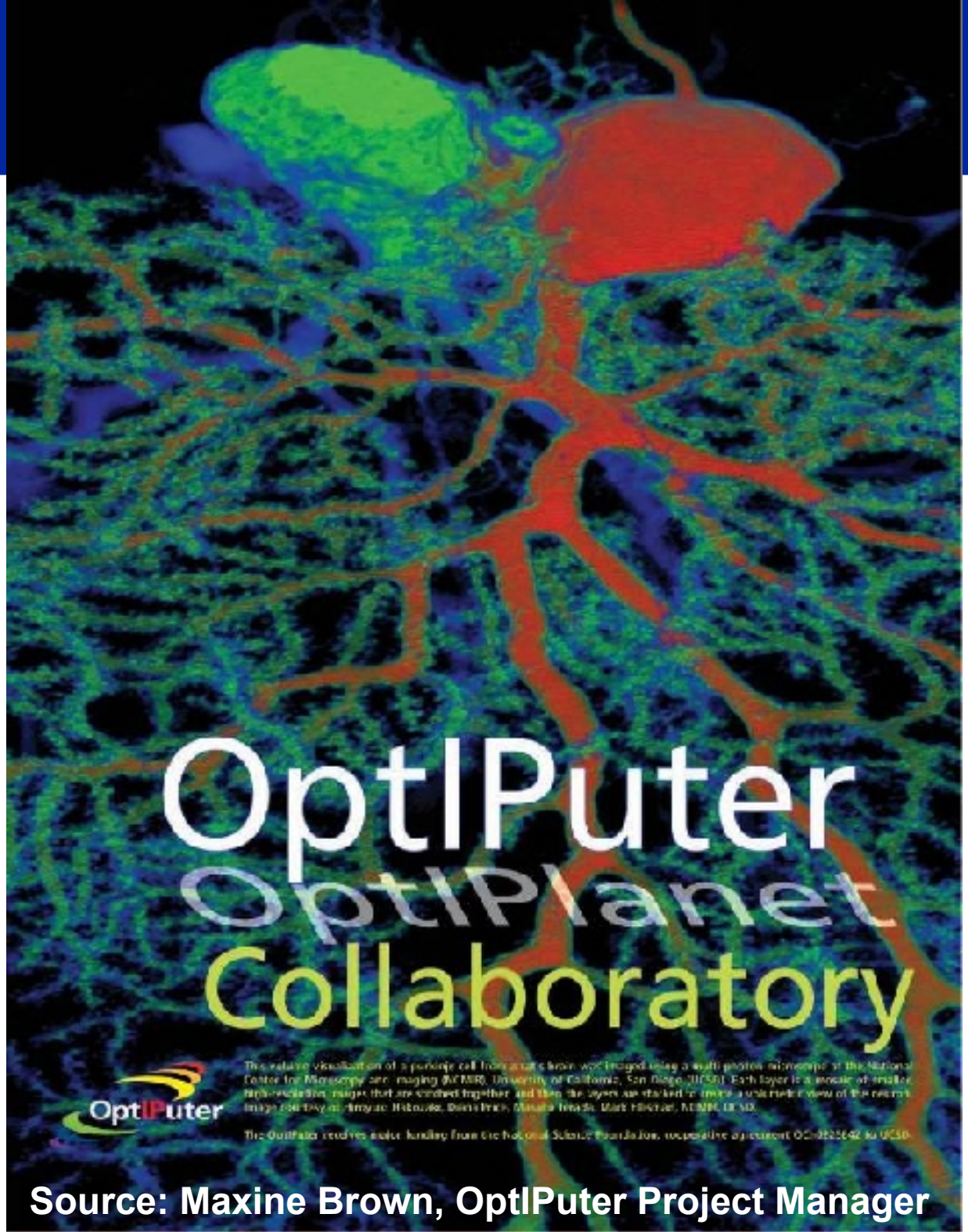


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Powered by Rocks ROCKS

evl electronic visualization laboratory

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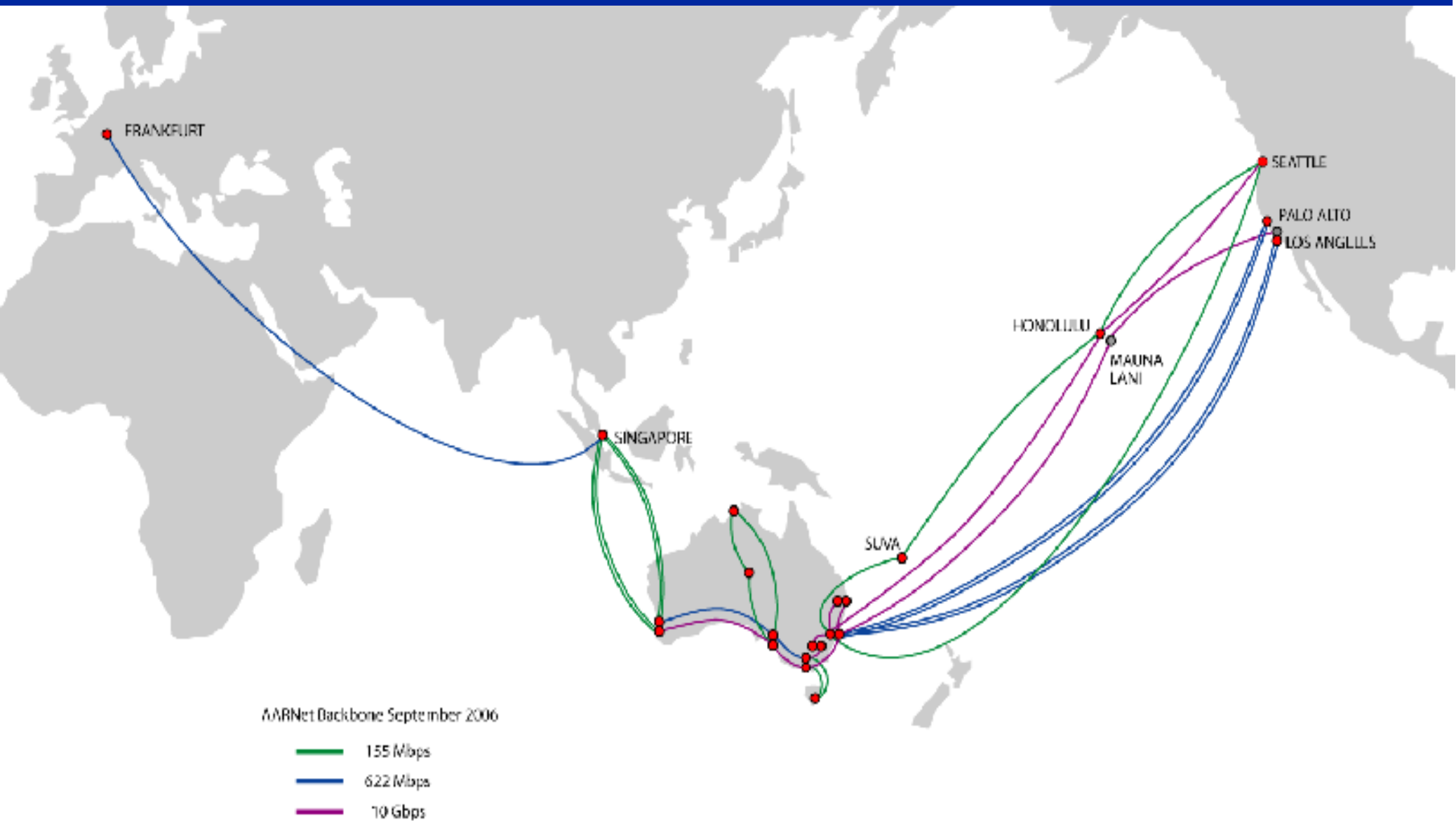
Source: Maxine Brown, OptIPuter Project Manager

Green Initiative:

Can Optical Fiber Replace Airline Travel for Continuing Collaborations ?

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AARNet International Network



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"Using the Link to Build the Link"
Calit2 and Univ. Melbourne Technology Teams

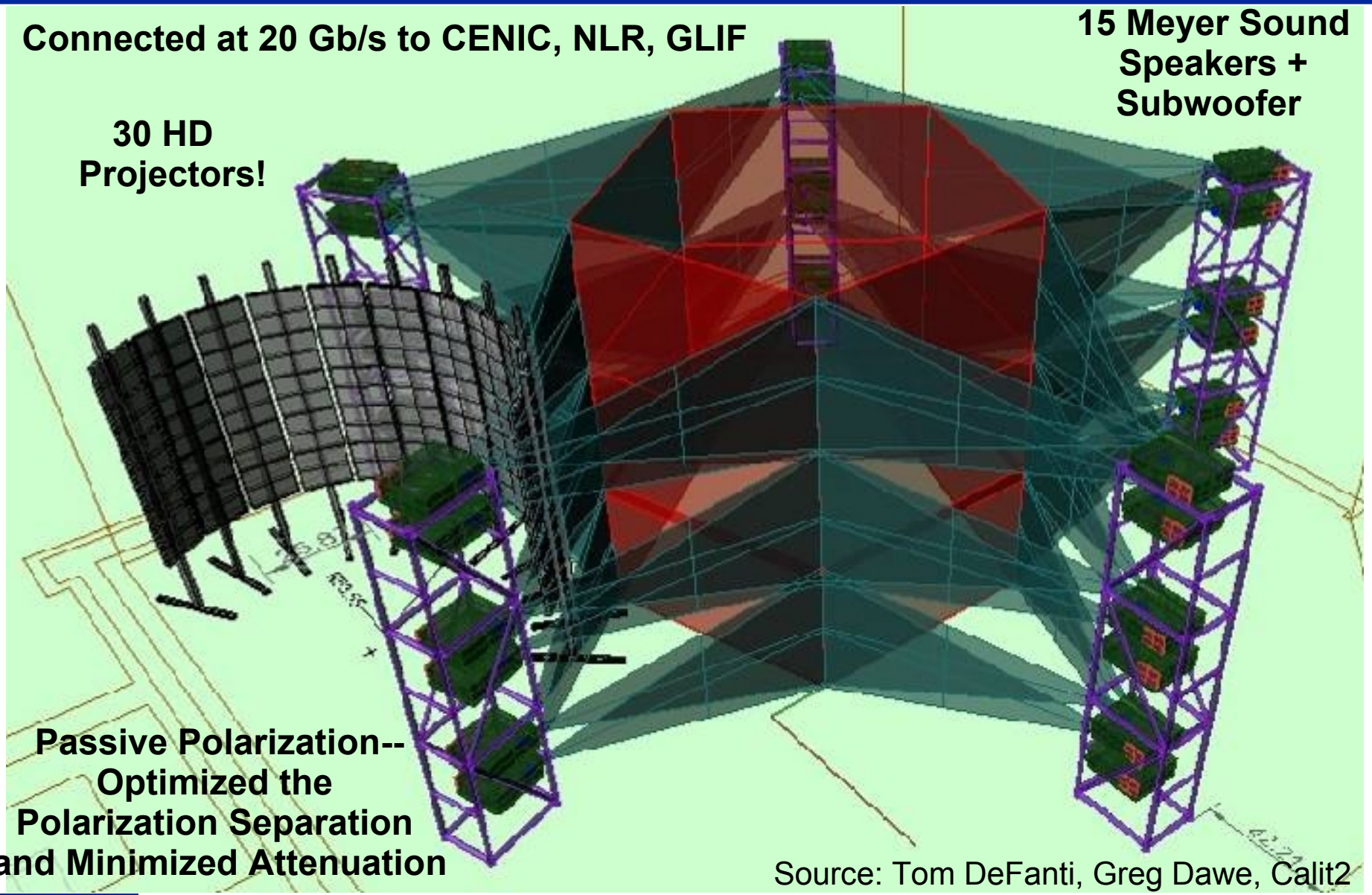


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No Calit2 Person Physically Flew to Australia to Bring This Up!

www.calit2.net/newsroom/release.php?id=1219

3D OptIPortals: Calit2 StarCAVE and Varrier Alpha Tests of Telepresence "Holodecks"



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Cluster with 30 Nvidia 5600 cards-60 GB Texture Memory

it2

StarCAVE Panoramas









Calit2/SDSC Proposal to Create a UC Cyberinfrastructure of OptIPuter "On-Ramps" to Global Resources



UC Research Council Subcommittee of VCRs/CIOs Are Planning UC-Wide Buildout



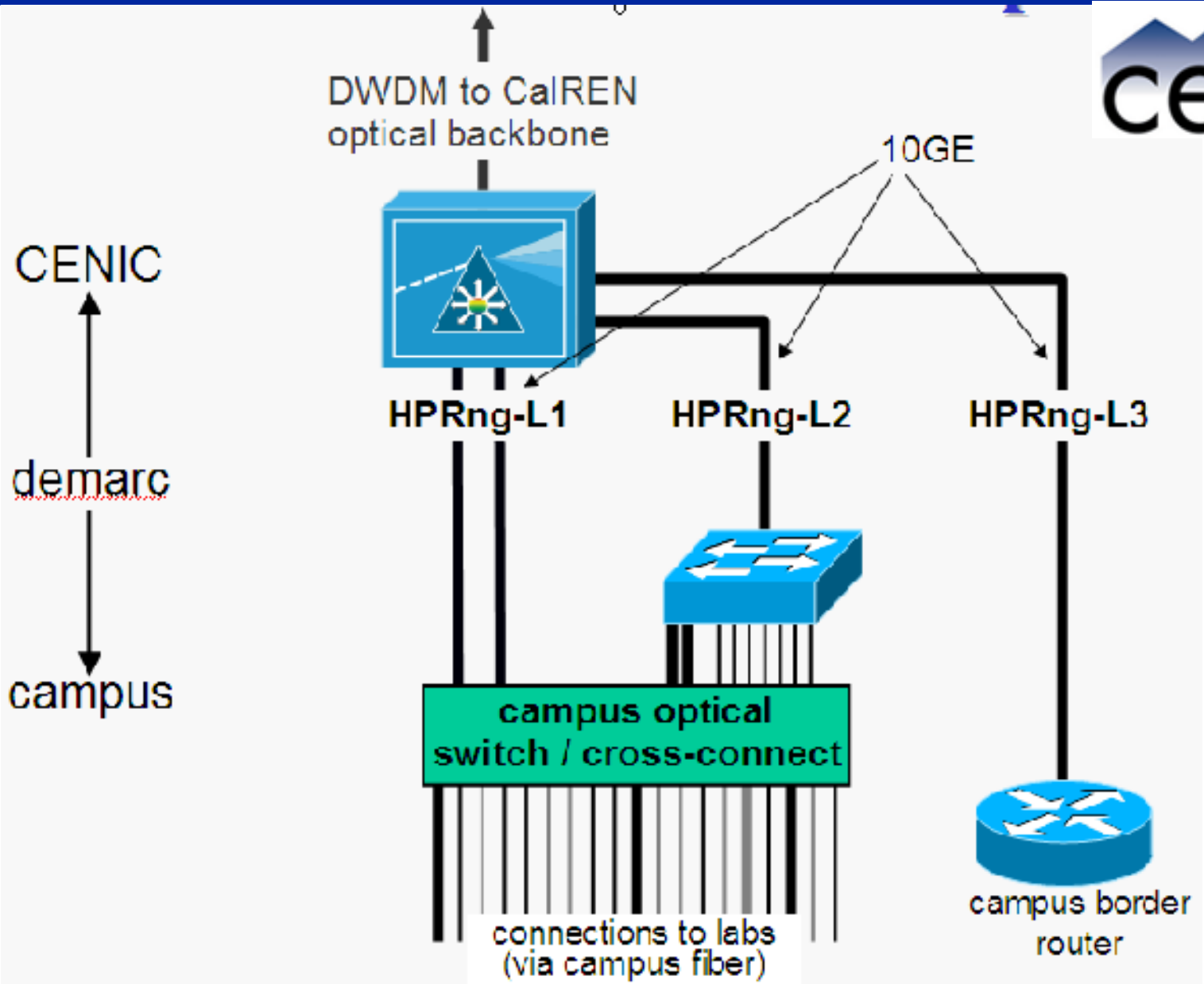
Creating a Critical Mass of End Users on a Secure LambdaGrid

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Source: Fran Berman, SDSC , Larry Smarr, Calit2

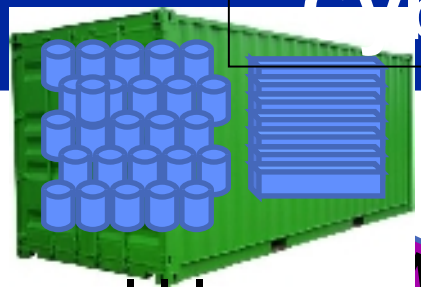
it2

Campus Preparations Needed to Accept CENIC CalREN Handoff to Campus

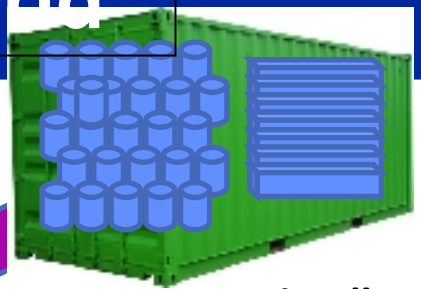


Source: Jim Dolgonas, CENIC

Planned UCSD Research Cyberinfrastructure LambdaGrid



Active Data Replication



Eco-Friendly
Storage and Compute

V x 10 Gbit

N x 10 Gbit



10 Gigabit
L2/L3 Switch

"Network in a box"
- > 200 Connections
- DWDM or Gray Optics

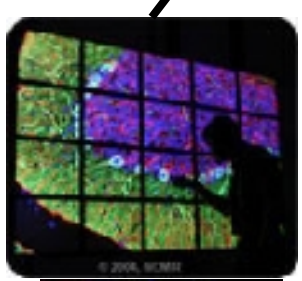
Wide-Area 10G
- Cenic/HPR
- NLR Cavewave
- Cinegrid
- …

On-Demand Physical Connections

OptIPuter



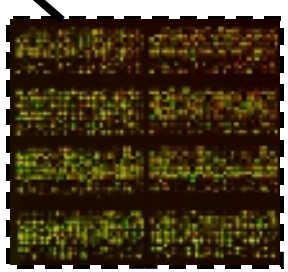
camera



NCMIR



NBCR



Microarray

Your Lab Here

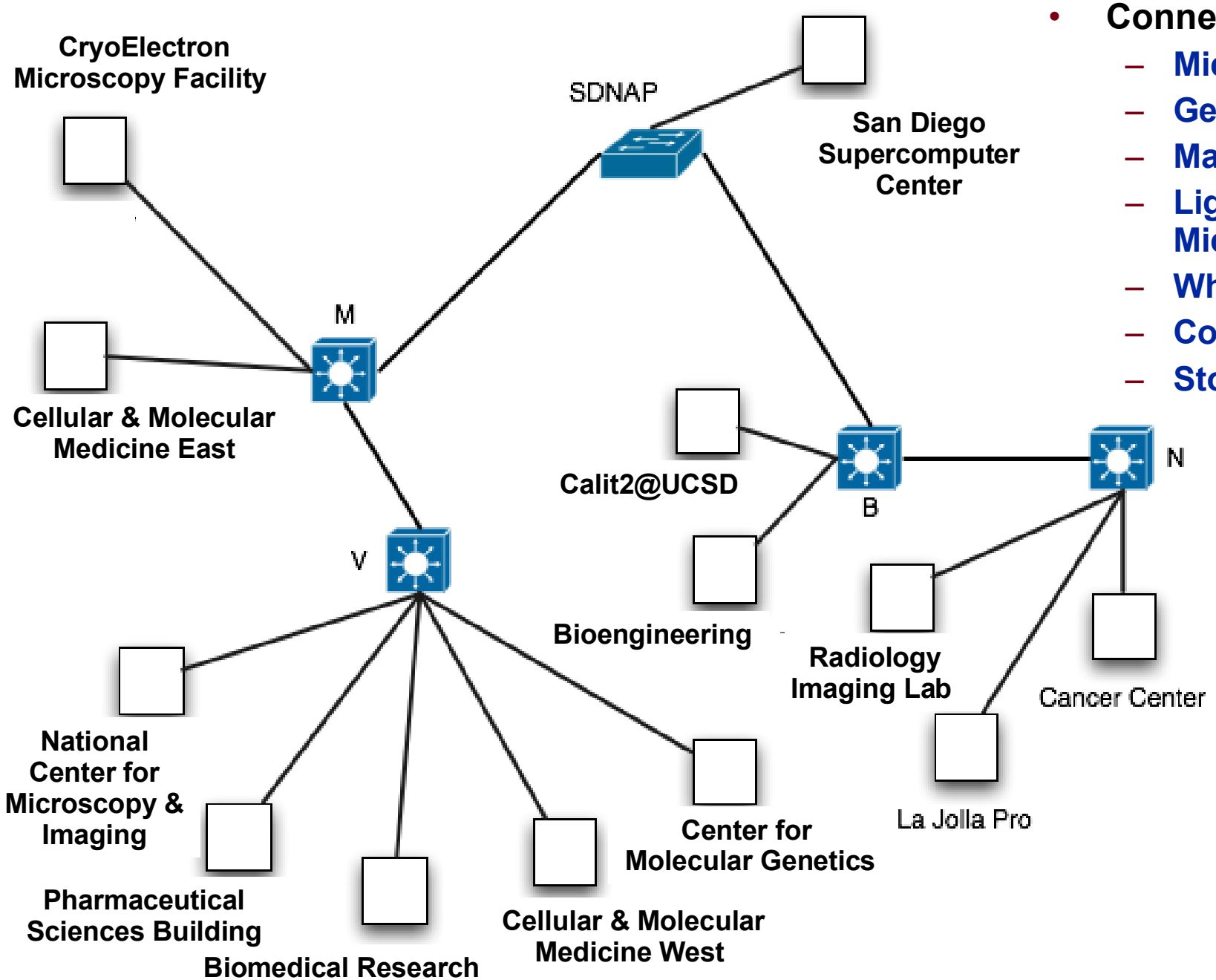
UCSD
UCIrvine

ROCKS

Source:Phil Papadopoulos, SDSC/Calit2

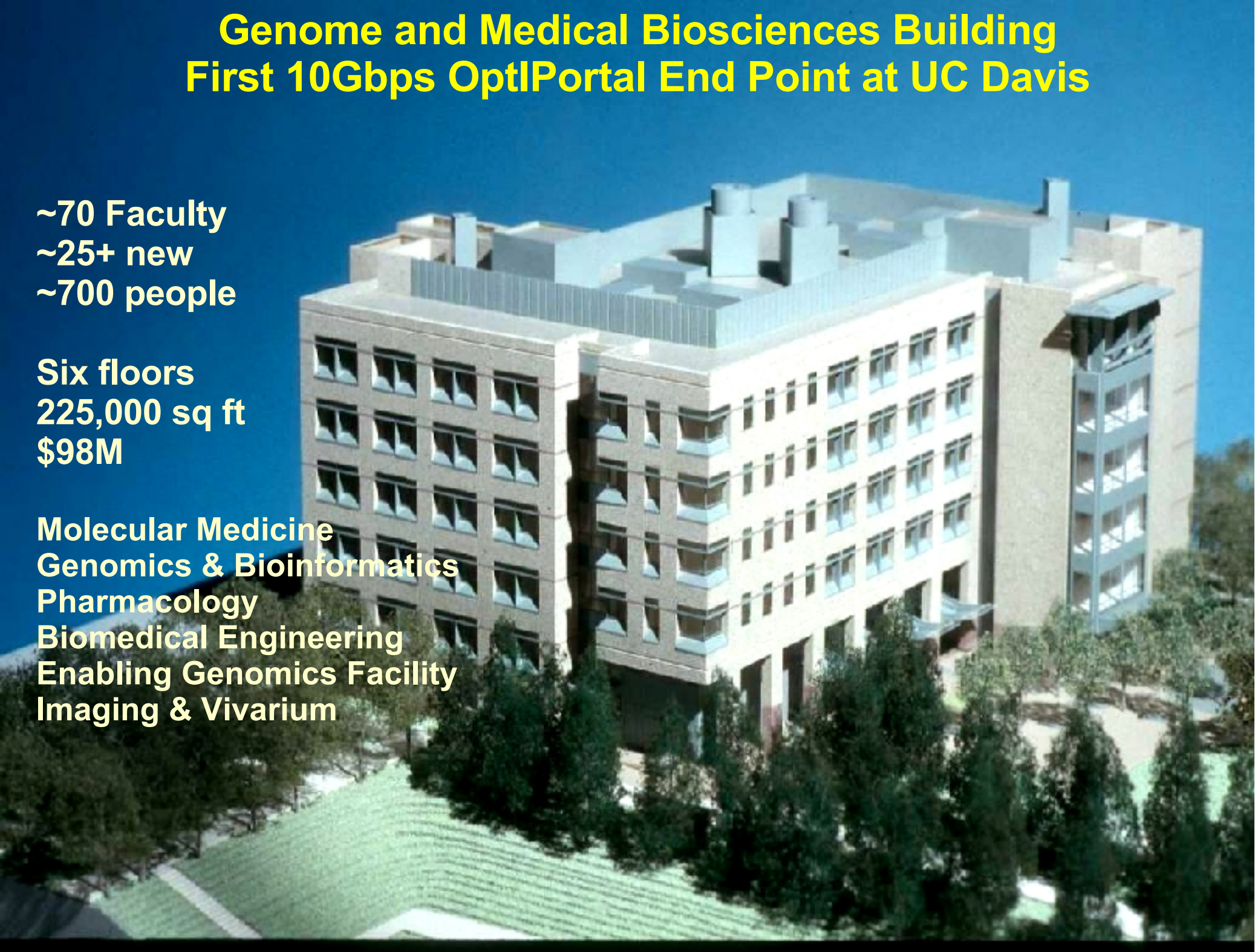
it²

UCSD Planned Optical Networked Biomedical Researchers and Instruments



- **Connects at 10 Gbps :**
  - **Microarrays**
  - **Genome Sequencers**
  - **Mass Spectrometry**
  - **Light and Electron Microscopes**
  - **Whole Body Imagers**
  - **Computing**
  - **Storage**

Genome and Medical Biosciences Building
First 10Gbps OptIPortal End Point at UC Davis



~70 Faculty
~25+ new
~700 people

Six floors
225,000 sq ft
$98M

Molecular Medicine
Genomics & Bioinformatics
Pharmacology
Biomedical Engineering
Enabling Genomics Facility
Imaging & Vivarium