“Envisioning the Future”

Invited Talk UCSD CONNECT
2005 Life Sciences & High-Tech Financial Forum
San Diego, CA
April 14, 2005

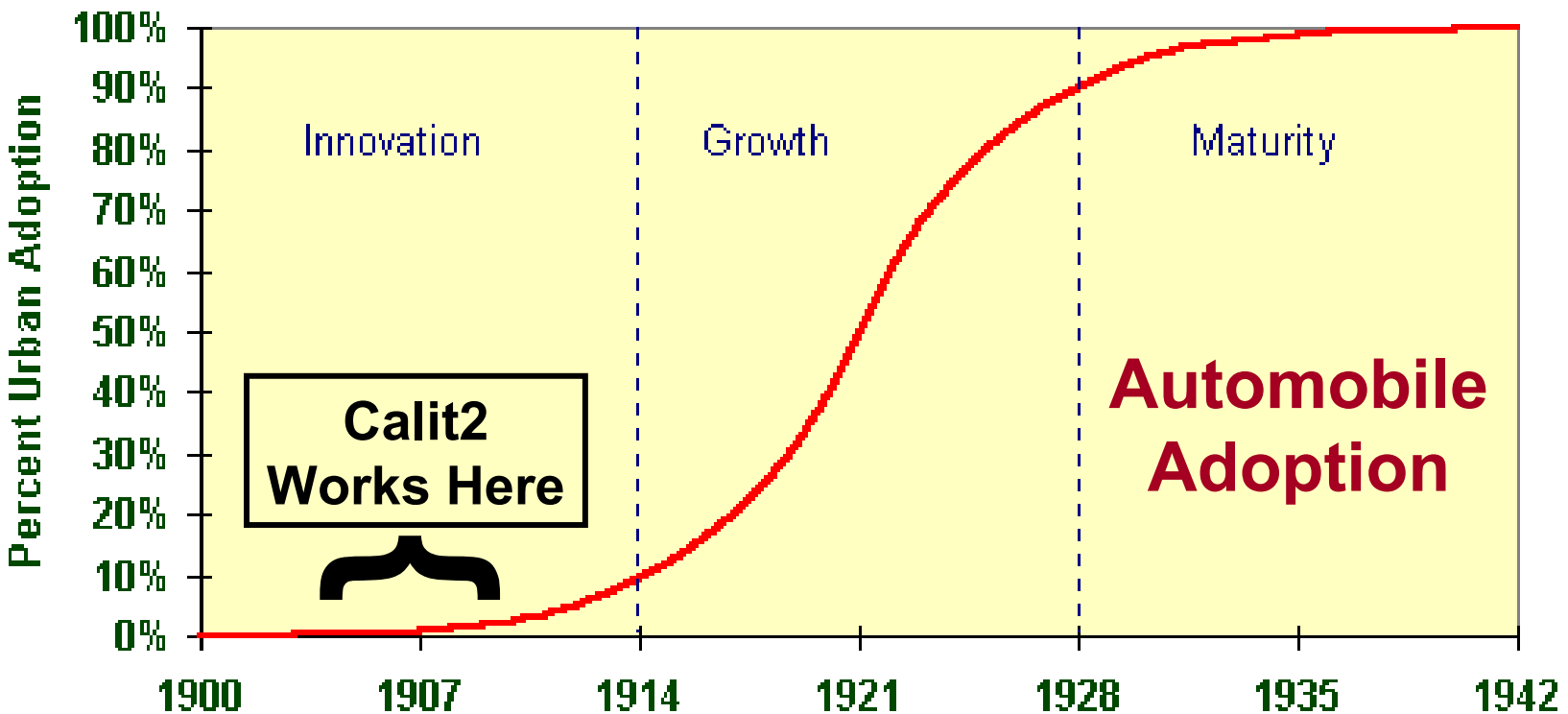
Dr. Larry Smarr
Director, California Institute for Telecommunications and Information Technology
Harry E. Gruber Professor,
Dept. of Computer Science and Engineering
Jacobs School of Engineering, UCSD

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From Elite Science to the Mass Market

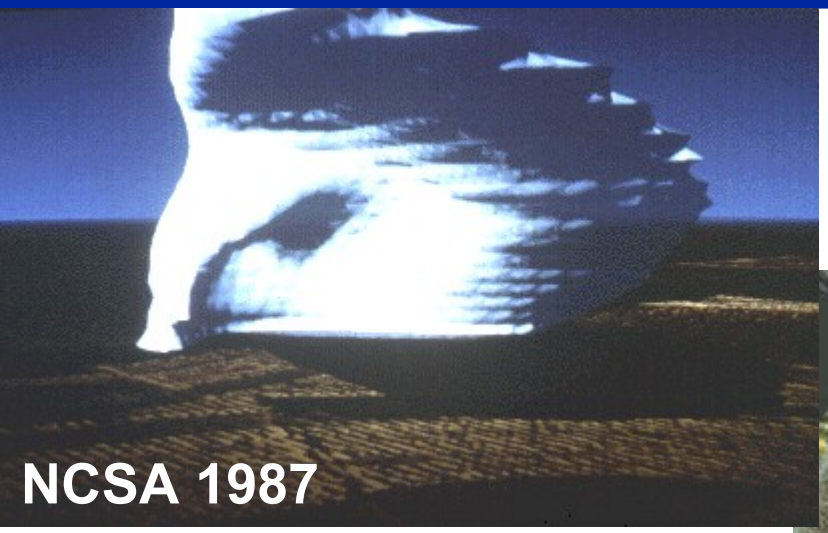
- **Four Examples I Helped "Mid-Wife":**
  - Scientific Visualization to Movie/Game Special Effects
  - CERN Preprints to WWW
  - Supercomputers to GigaHertz PCs
  - NSFnet to the Commercial Internet
- **Technologies Diffuse Into Society Following an S-Curve**



Source: Harry Dent, The Great Boom Ahead

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From Scientific Visualization of Supercomputing Science to Movie Special Effects



Stefen Fangmeier
Computer Graphics
From NCSA to ILM









http://access.ncsa.uiuc.edu/
http://movies.warnerbros.com/twister
www.jurassicpark.com
www.cinemenium.com/perfectstorm/

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Science Infrastructure Experiments Have Led to the Modern Web World



Licensing



SPYGLASS

100 Commercial Licensees

NCSA Programmers





CERN 1990

The world's largest particle physics laboratory ... where the web was born!

NCSA HTTPd

Open Source



Mac OS X Server



IBM WebSphere Software



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Fifteen Years from Bleeding Edge Research to Mass Consumer Market

- 1990 Leading Edge University Research Center-NCSA
  - Supercomputer GigaFLOPS Cray Y-MP ($15M)
  - Megabit/s NSFnet Backbone
- 2005 Mass Consumer Market
  - PCs are Multi-Gigahertz ($1.5k)
  - Megabit/s Home DSL or Cable Modem



"The future is already here, it's just not evenly distributed"
William Gibson, Author of Neuromancer

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Peering Into The Future
1000x Goals for 2015

- **Home Bandwidth**
  - Today: Mbit/s Cable/ DSL
  - 2015: Gbit/s to the Home
- **Information Appliances**
  - Today: GHz PCs
  - 2015: Terahertz Ubiquitous Embedded Computing
- **Personal Storage**
  - Today: 100 GBytes PC or Tivo
  - 2015: 100 TBytes Personal Storage Available Everywhere
- **Visual Interface**
  - Today: 1M Pixels PC Screen or HD TV
  - 2015: GigaPixel Wallpaper

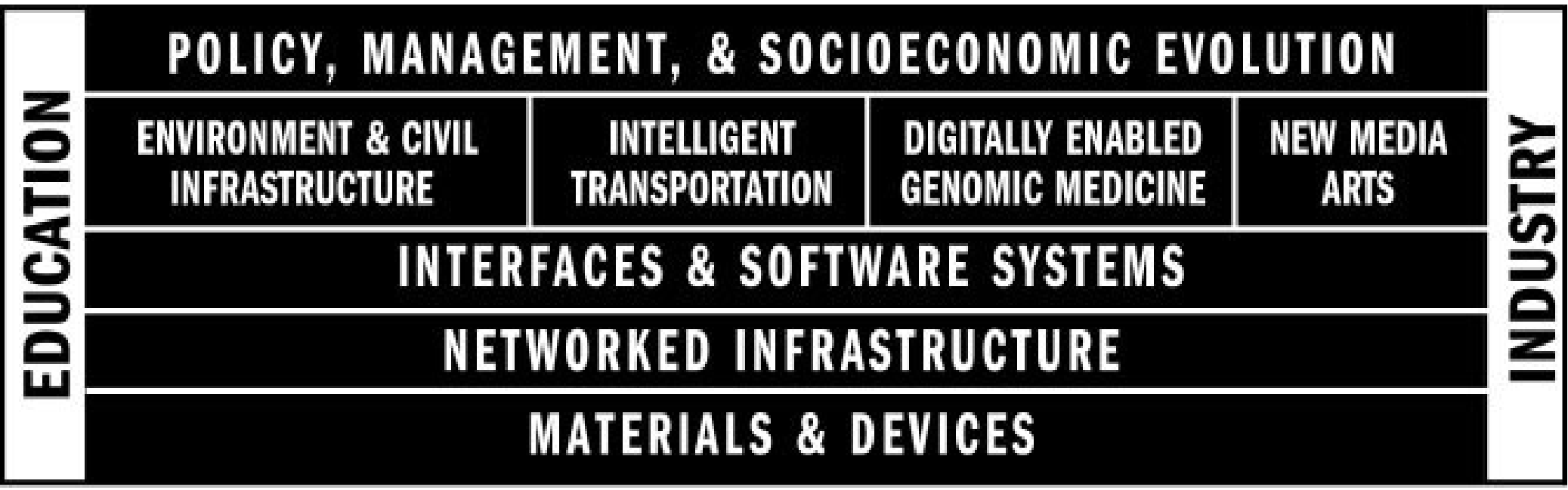
15 Years ~ 1000x with Moore's Law

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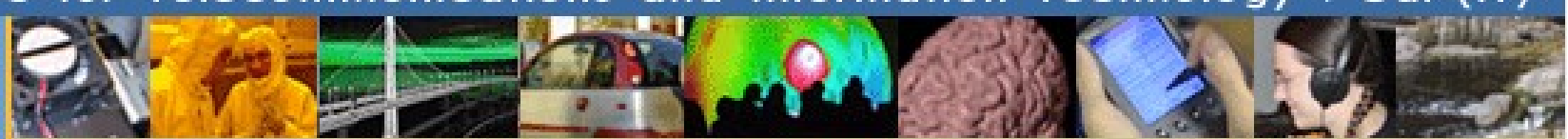
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Calit2 -- Research and Living Laboratories on the Future of the Internet

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



www.calit2.net



www.calit2.net

Robotics

Networks

Collaboration

Digital Culture

Federal Government

Performing Arts

Industry

Search

About Us
Vision
Leadership
Local Info
New Buildings
People
Recruitment

Education
Outreach
Grad Fellows
Ugrad Scholars

Events
Calendar

Multimedia
Webcasts
Image Gallery
Presentations

News
News Room
In the News
Highlights
Press Releases

Partners
Academic
Government
Industry

Publications
Book Club
Brochures
Newsletter

Research
Overview
Grants
Layers
Living Labs
Briefing Papers
Projects

Campuses
UC Irvine
UC San Diego
UC System

EVENTS

February 10
Social Robotics and Robotic Socialization--Who Knows?
Guest Speaker: Natalie Jeremijenki

February 10
Data Riding on Data--An Auxiliary Channel for Optically Routed Networks
Guest Speaker: Vinay A. Vaishampayan

February 11
Unified Activity as a Paradigm for Supporting Collaboration
Guest Speaker: Thomas P. Moran



HIGHLIGHT



RADAR
[More]



LIVING LABORATORY RESEARCH

Technology-driven



NSF Director Freeman Gets Close-up View of ResCUE Program
1.24.05 - Dr. Peter Freeman, assistant director of Computer and Information Science and Engineering (CISE) at the National Science Foundation, ga[illegible] new insight into Calit2's ResCUE project last week. Freeman spent Friday, Jan. 21, visiting with ResCUE investigators, viewing posters and demos, and discussing project details with investigators and graduate student researchers.
[More]

Application-driven



Faculty Members Brief Industry Partners at CNS Research Review
1.26.05 - UCSD's Center for Networked Systems (CNS) held its first formal research review since the center's launch last July. On January 19 and 20, faculty researchers updated delegates from CNS's five industry members on the status of the center's seven inaugural projects, and laid the groundwork for a new round of projects as well as the center's first summer research program that will send UCSD students to work in the labs of members AT&T, Alcatel, Hewlett Packard, QUALCOMM, and Sun Microsystems.
[More]

Culture-driven



HDNews Interviews Irvine Division Director at Beall Center Exhibit

NEWSROOM

- 01.31.2005 GRIDtoday- UCSD Expands Cyberinfrastructure Program to China, Thailand
- 01.27.2005 Irvine World News- Technology Transfers Debated
- 01.24.2005 Chicago Sun-Times- Major [illegible] put Chicago on map for grid computing
- 01.24.2005 Orange County Business Journal- Broadcom: Hope for Unrealized Ambitions

MULTIMEDIA



Calit2 @ UCI Ribbon-Cutting Ceremony
Please install the latest version of Real Player to view.
[Video]

HIGHLIGHT



UCI Division to Administer Nicholas Foundation Prize; Call for Proposals Issued
1.20.05 - Calit2 at UC Irvine will award as many as five grants for collaborative research under the auspices of the Nicholas Foundation Prize

Two New Calit2 Buildings Will Provide Persistent Collaboration Environment



- Will Create New Laboratory Facilities
- International Conferences and Testbeds
- Over 1000 Researchers in Two Buildings
- 150 Optical Fibers into UCSD Building

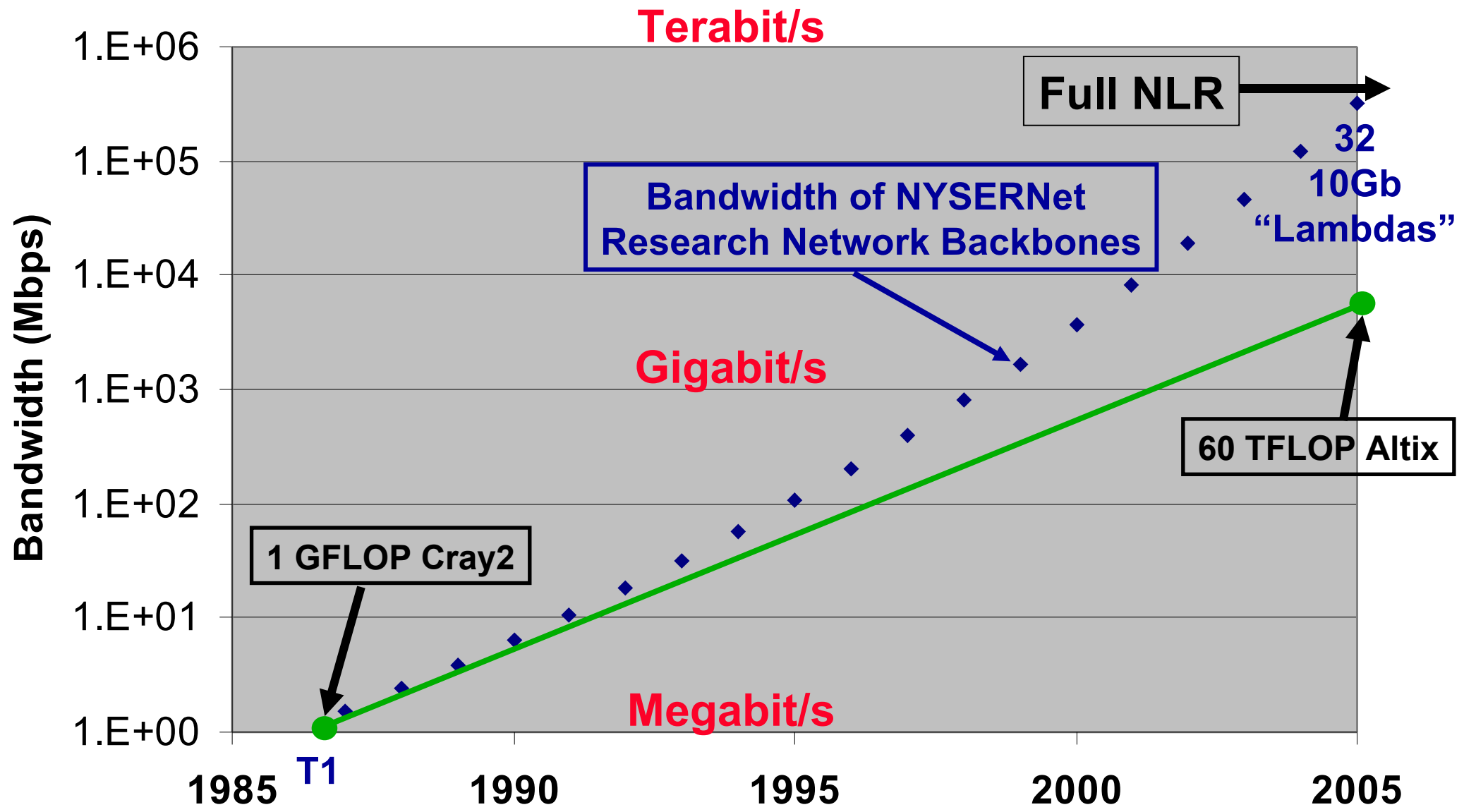


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California Provided $100M for Buildings
Industry Partners $85M, Federal Grants $250M

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



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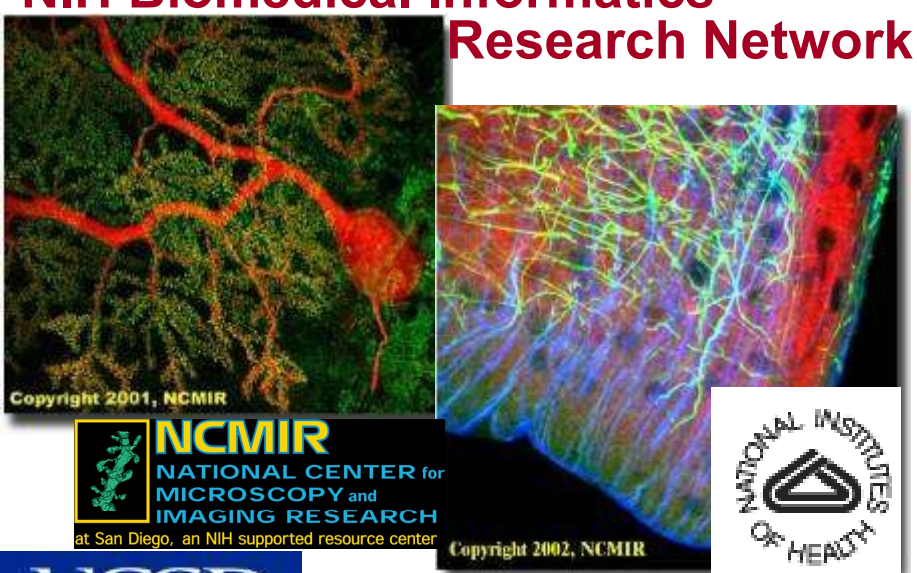
Source: Timothy Lance, President, NYSERNet

The OptIPuter Project –

Creating an Optical "Web" for Gigabyte Data Objects

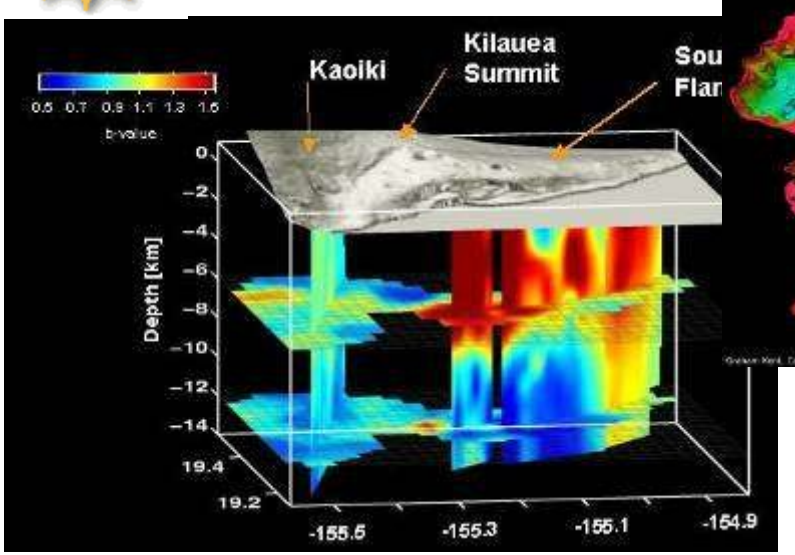
- **NSF Large Information Technology Research Proposal**
  - Calit2 (UCSD, UCI) and UIC Lead Campuses—Larry Smarr PI
  - Partnering Campuses: USC, SDSU, NW, TA&M, UvA, SARA, NASA
- **Industrial Partners**
  - IBM, Sun, Telcordia, Chiaro, Calient, Glimmerglass, Lucent
- **$13.5 Million Over Five Years**
- **Linking Global Scale Science Projects to User's Linux Clusters**

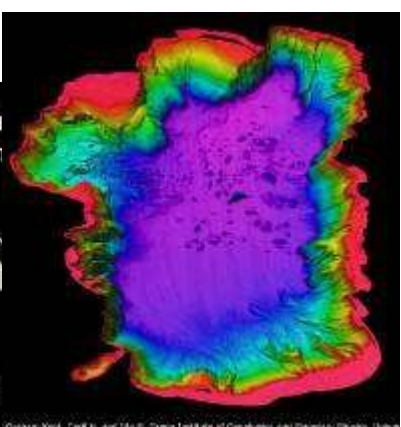
NIH Biomedical Informatics Research Network



http://ncmir.ucsd.edu/gallery.html

NSF EarthScope and ORION



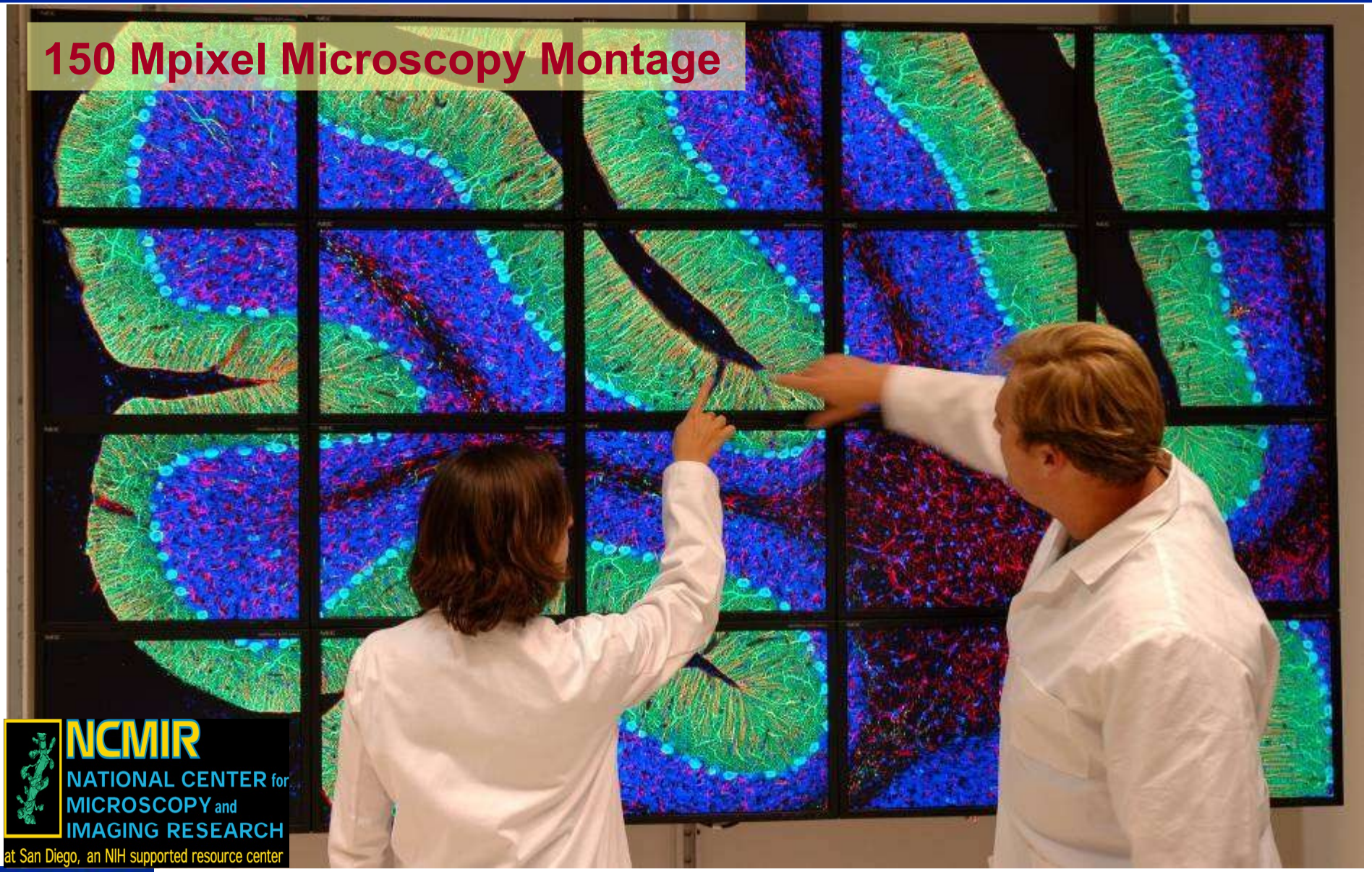


siovizcenter.ucsd.edu/library/gallery/shoot1/index.shtml

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Realizing the Dream: High Resolution Portals to Global Science Data



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30 MPixel SunScreen Display Driven by a 20-node Sun Opteron Visualization Cluster

Source: Mark Ellisman, David Lee, Jason Leigh

it²

In Academia, the OptIPuter Project is Prototyping the PC of 2010

- Terabits to the Desktop…

NSF LambdaVision MRI@UIC

- 100 Megapixels Display
  - 55-LCD Panels
- 1/3 Terabit/sec I/O
  - 30 x 10GE Interfaces
  - Linked to OptIPuter
- 1/4 TeraFLOP
  - Driven by 30 Node Cluster of 64 -Bit Dual Opterons
- 1/8 TB RAM
- 60 TB Disk



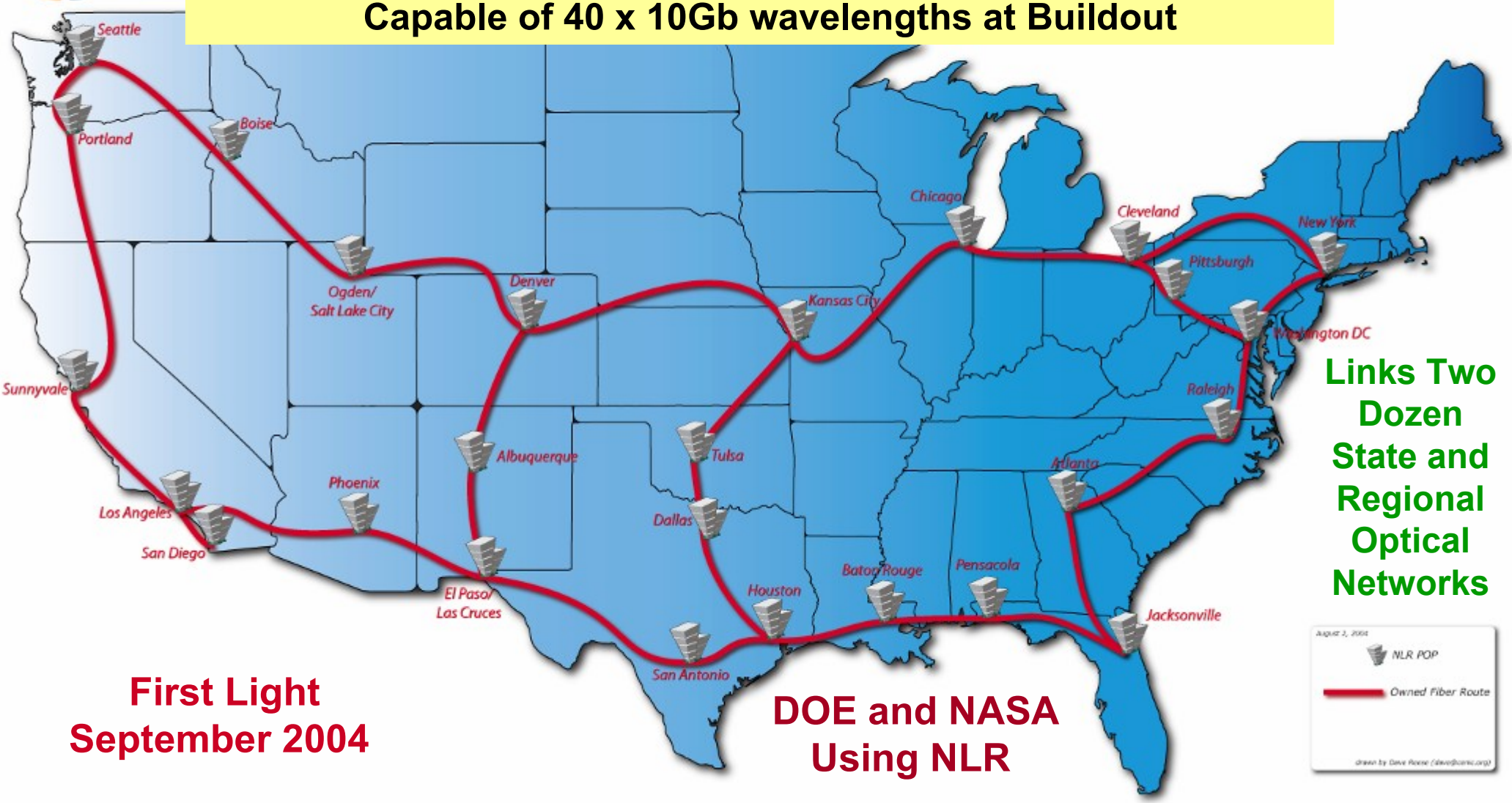
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Source: Jason Leigh, Tom DeFanti, EVL@UIC
OptIPuter Co-PIs

NLR Will Provide an Experimental Network Infrastructure for U.S. Scientists & Researchers

"National LambdaRail" Partnership

Serves Very High-End Experimental and Research Applications
4 x 10Gb Wavelengths ("Lambdas") Initially
Capable of 40 x 10Gb wavelengths at Buildout



Links Two Dozen State and Regional Optical Networks

First Light September 2004

DOE and NASA Using NLR

For more information regarding NLR see http://www.nlr.net or contact info@nlr.net

Lambdas Provide Global Access to Large Data Objects and Remote Instruments

Global Lambda Integrated Facility (GLIF)
Integrated Research Lambda Network

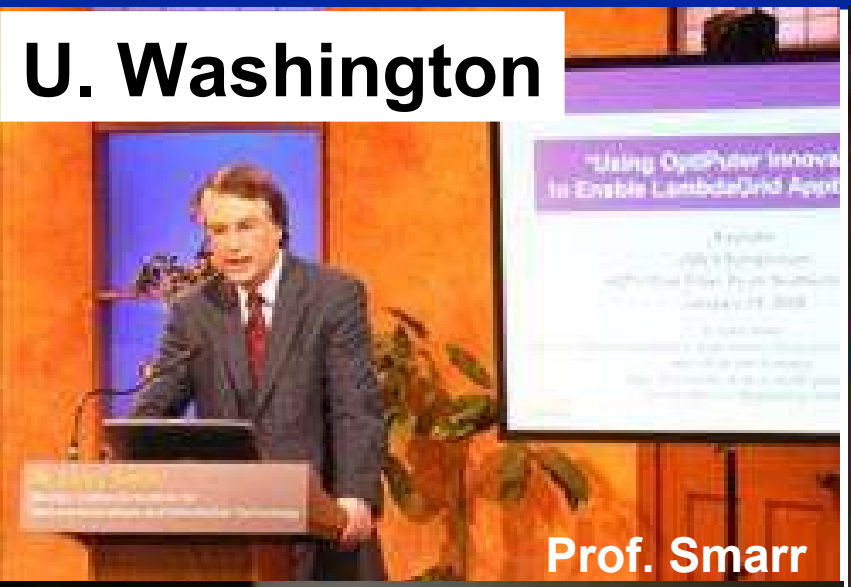


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Visualization courtesy of
Bob Patterson, NCSA

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Multiple HD Streams Over Lambdas Will Radically Transform Campus Collaboration







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Source: U Washington Research Channel

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Goal—Upgrade Access Grid to HD Streams Over IP on Dedicated Lambdas



Access Grid Talk with 35 Locations on 5 Continents— SC Global Keynote Supercomputing 04

Calit2 CineGrid Auditorium
Networked Digital Cinema and Global Collaboratorium

- We will Open in 2005 with a 2K Projector
- Plan to Add SHD (4K) Projector for Digital Cinema and Quad HDTV
  - 4 x HD Resolution
- Mono and Stereo Viewing



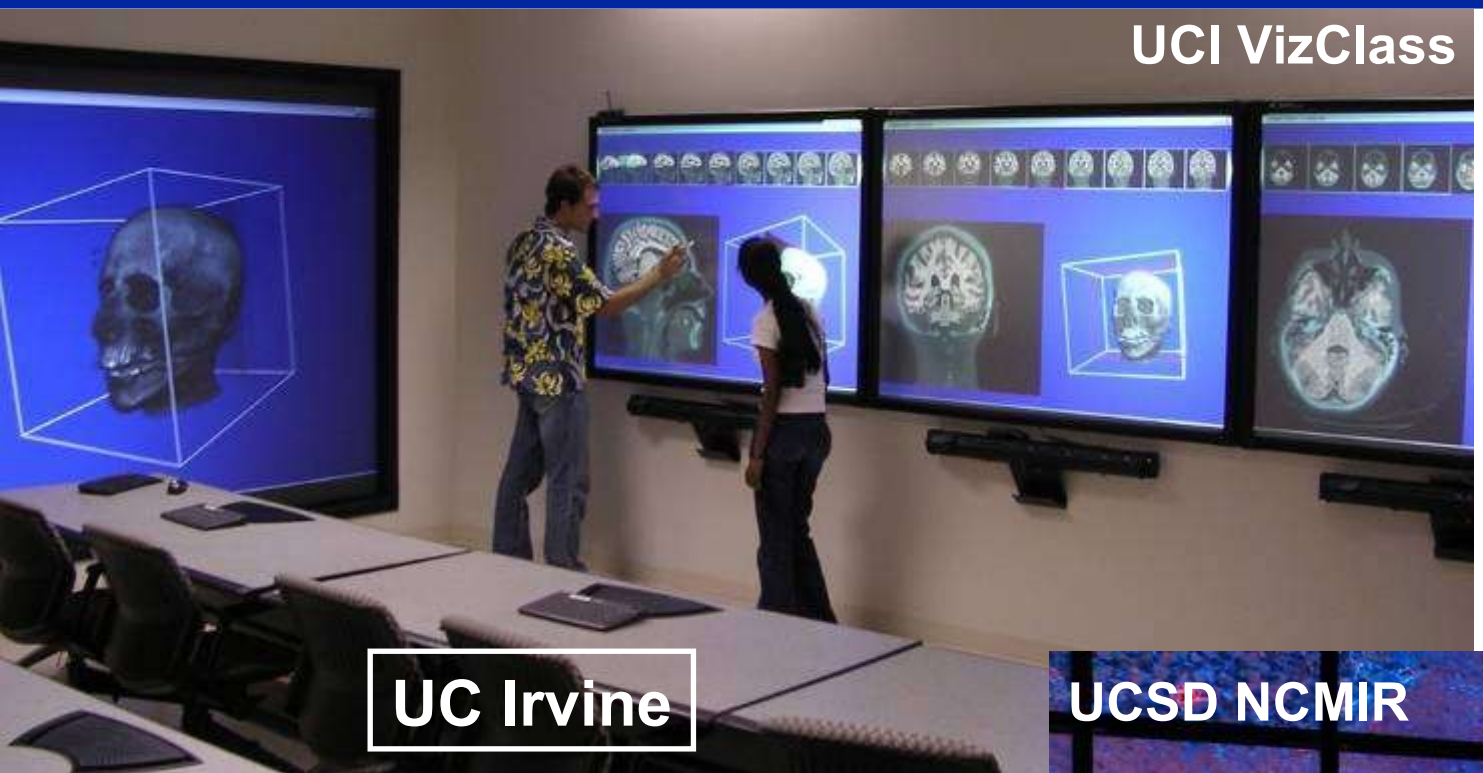


- 200-Seat Auditorium
- Digital Cinema or Scientific Visualization
- Bi-directional Tele-presence Conferencing
- Robotic Camera System for Live Events
- THX 10.2 Sound
- Multi-Modal Projection Capabilities
- Multi-Fiber Hi-Speed Network Connectivity

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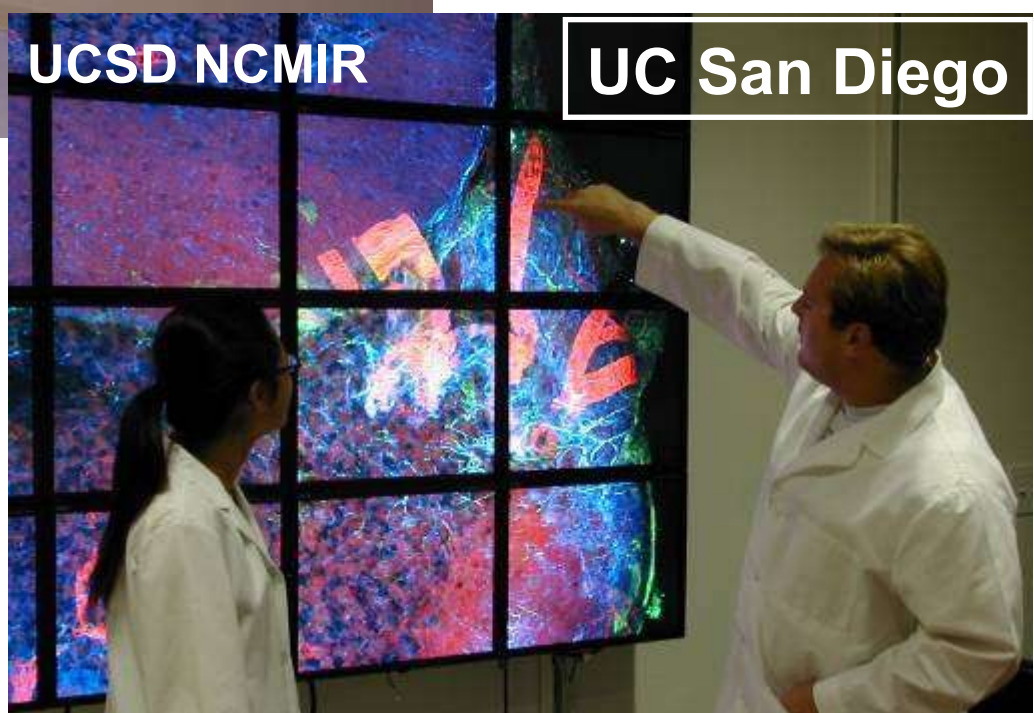
Source: Sheldon Brown, CRCA, UCSD

Calit2 Collaboration Rooms Testbed
UCI to UCSD



Source: Falko Kuester, UCI & Mark Ellisman, UCSD

OptIPuter



In 2005 Calit2 will Link Its Two Buildings via CENIC-XD Dedicated Fiber over 75 Miles Using OptIPuter Architecture to Create a Distributed Collaboration Laboratory

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Multi-Gigapixel Images (500 x HD Resolution!) 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

High Resolution Aerial Photography Generates Images With 10,000 Times More Data than Landsat7

Landsat7 Imagery
100 Foot Resolution
Draped on elevation data





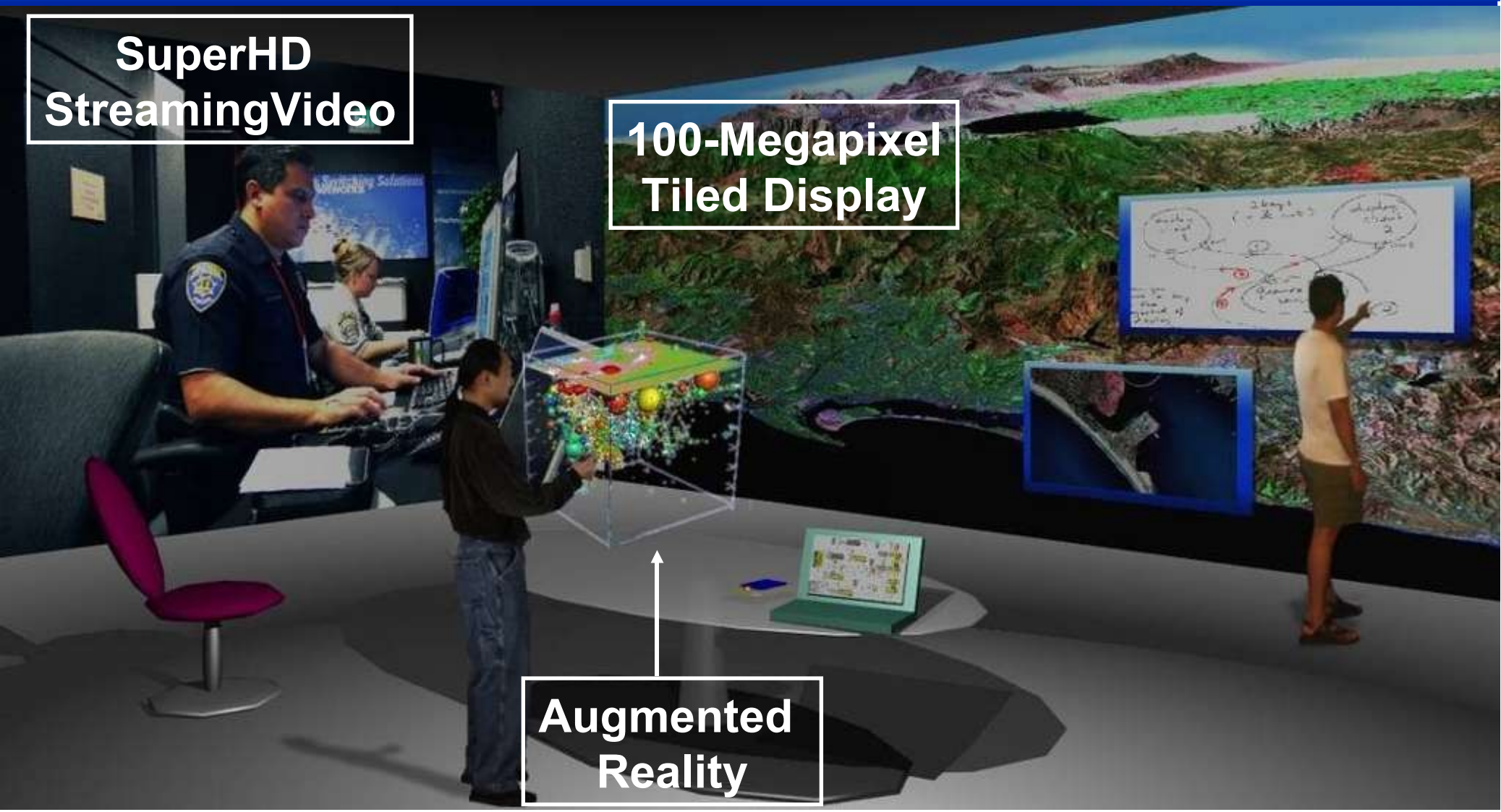
New USGS Aerial Imagery
At 1-Foot Resolution

~10x10 square miles of 150 US Cities
2.5 Billion Pixel Images Per City!

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A High Definition Access Grid as Imagined In 2007 In A HiPerCollab



ENDfusion Project

Source: Jason Leigh, EVL, UIC

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The Networking Double Header of the Century Will Be Driven by LambdaGrid Applications

Maxine Brown, Tom DeFanti, Co-Organizers



iGrid 2005

THE GLOBAL LAMBDA INTEGRATED FACILITY



www.startap.net/igrid2005/

September 26-30, 2005

University of California, San Diego

California Institute for Telecommunications and Information Technology



SC|05 Gateway to Discovery

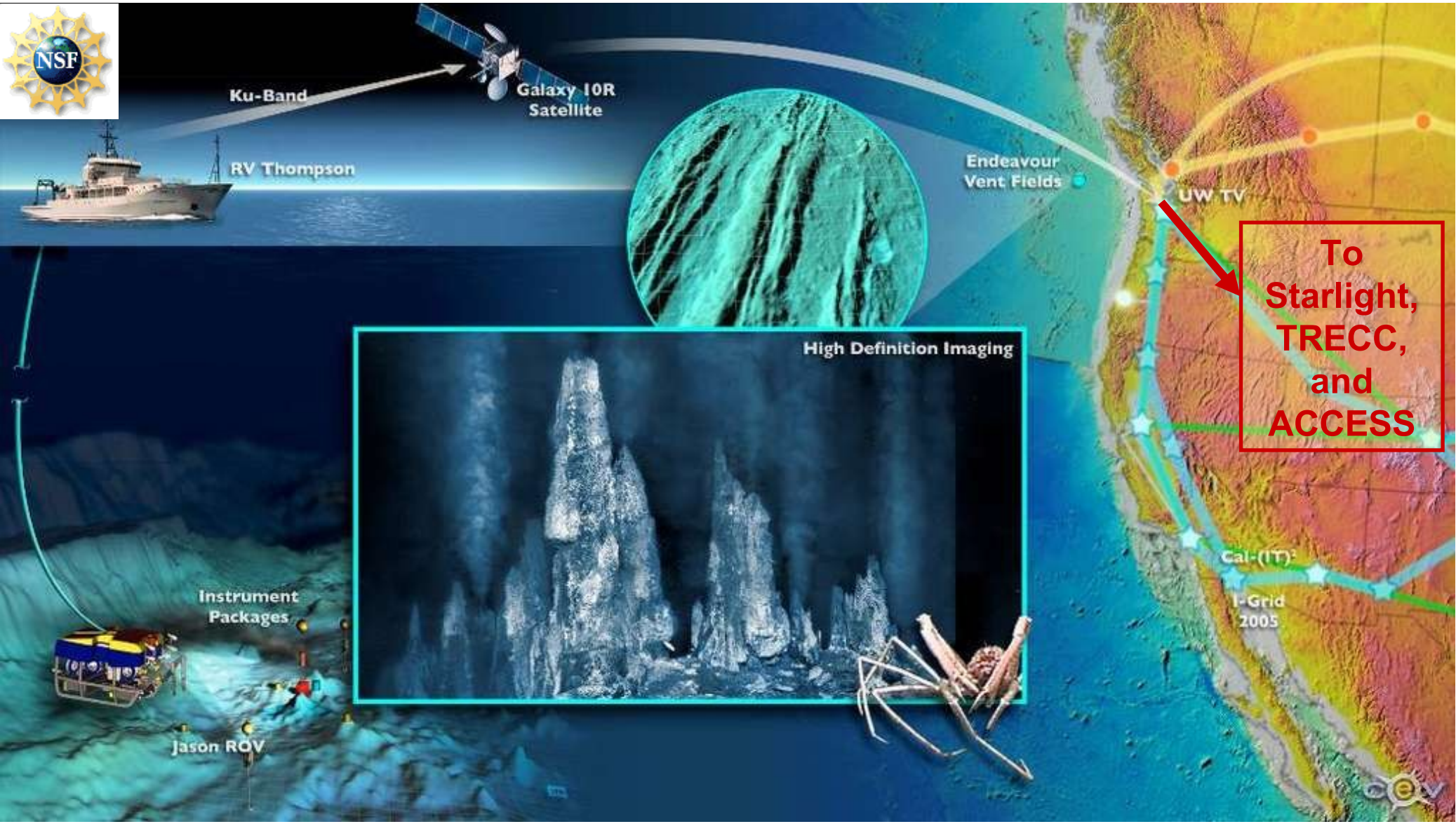
Washington State Convention and Trade Center Seattle, WA
November 12-18 2005

http://sc05.supercomp.org

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Proposed Experiment for iGrid 2005 – Remote Interactive HD Imaging of Deep Sea Vent



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NEPTUNE

Source John Delaney & Deborah Kelley, UWash

it²

The Internet Is Extending Throughout the Physical World
A Mobile Internet Powered by a Planetary Computer

- **Wireless Access--Anywhere, Anytime**
  - Broadband Speeds
  - "Always Best Connected"
- **Billions of New Wireless Internet End Points**
  - Information Appliances
  - Sensors and Actuators
  - Embedded Processors
- **Emergence of a Distributed Planetary Computer**
  - Parallel Lambda Optical Backbone
  - Storage of Data Everywhere
  - Scalable Distributed Computing Power
- **Brilliance is Distributed Throughout the Grid**

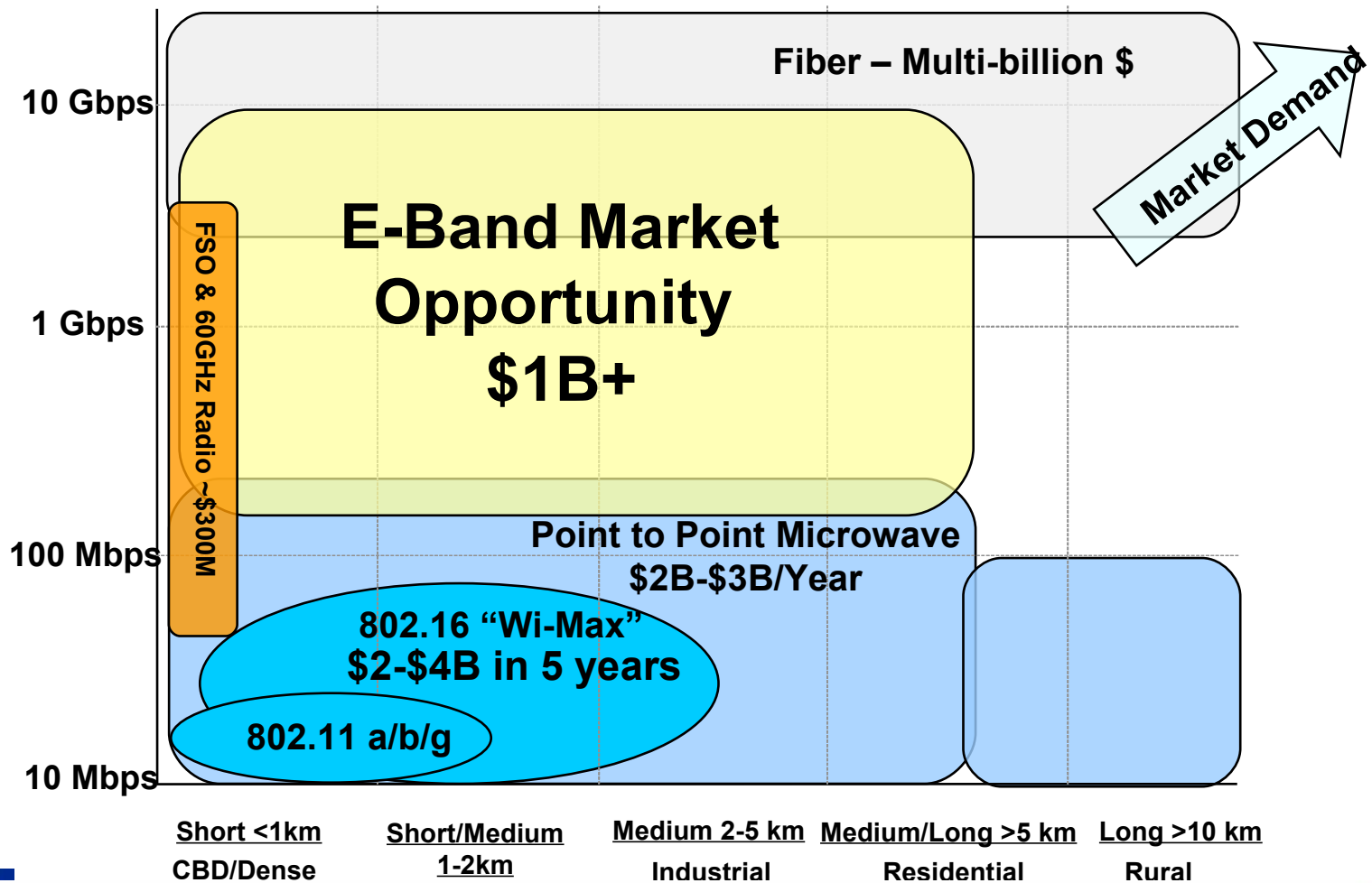
"The all optical fibersphere in the center finds its complement in the wireless ethersphere on the edge of the network."
--George Gilder

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Gigabit/s Wireless is Already a Product!

E-Band mmW radio fills the gap between current broadband access technologies and enables Next Generation networking



The Calit2@UCSD Building Was Designed for the Wireless Age

- **Nine Antenna Pedestals on Roof**
  - Can Support Ericsson's Latest Compact Base Station
  - Or Antennas for a Macro Base Station
- **Rooftop Research Shack**
  - Vector Network Analyzers
  - Spectrum Analyzers
  - CDMA Air Interface Software Test Tools
- **Dedicated Fiber Optic and RF connections Between Labs**
- **Network of Interconnected Labs**
  - Antenna Garden, e.g. Roof Top
  - Radio Base Station Lab, e.g. 6th floor
  - Radio Network Controller Lab, e.g. 5th floor
  - Always Best Connected & Located—Throughout Building
- **GPS Re-Radiators in Labs**
  - Distribution of Timing Signals

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Building Materials Were Chosen To Maximize Radio Penetration

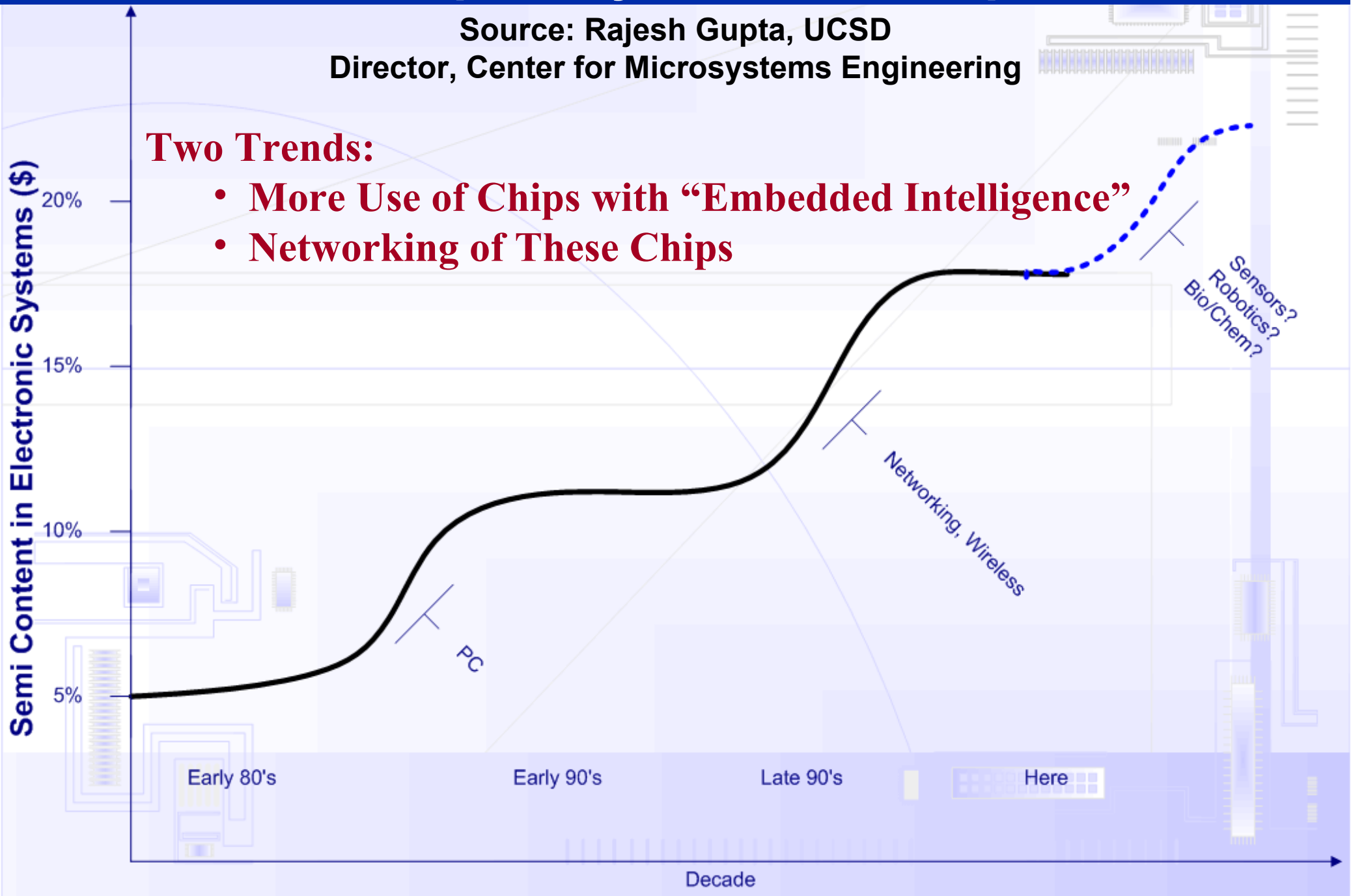
it^2

Network Endpoints Are Becoming Complex Systems-on-Chip

Source: Rajesh Gupta, UCSD
Director, Center for Microsystems Engineering

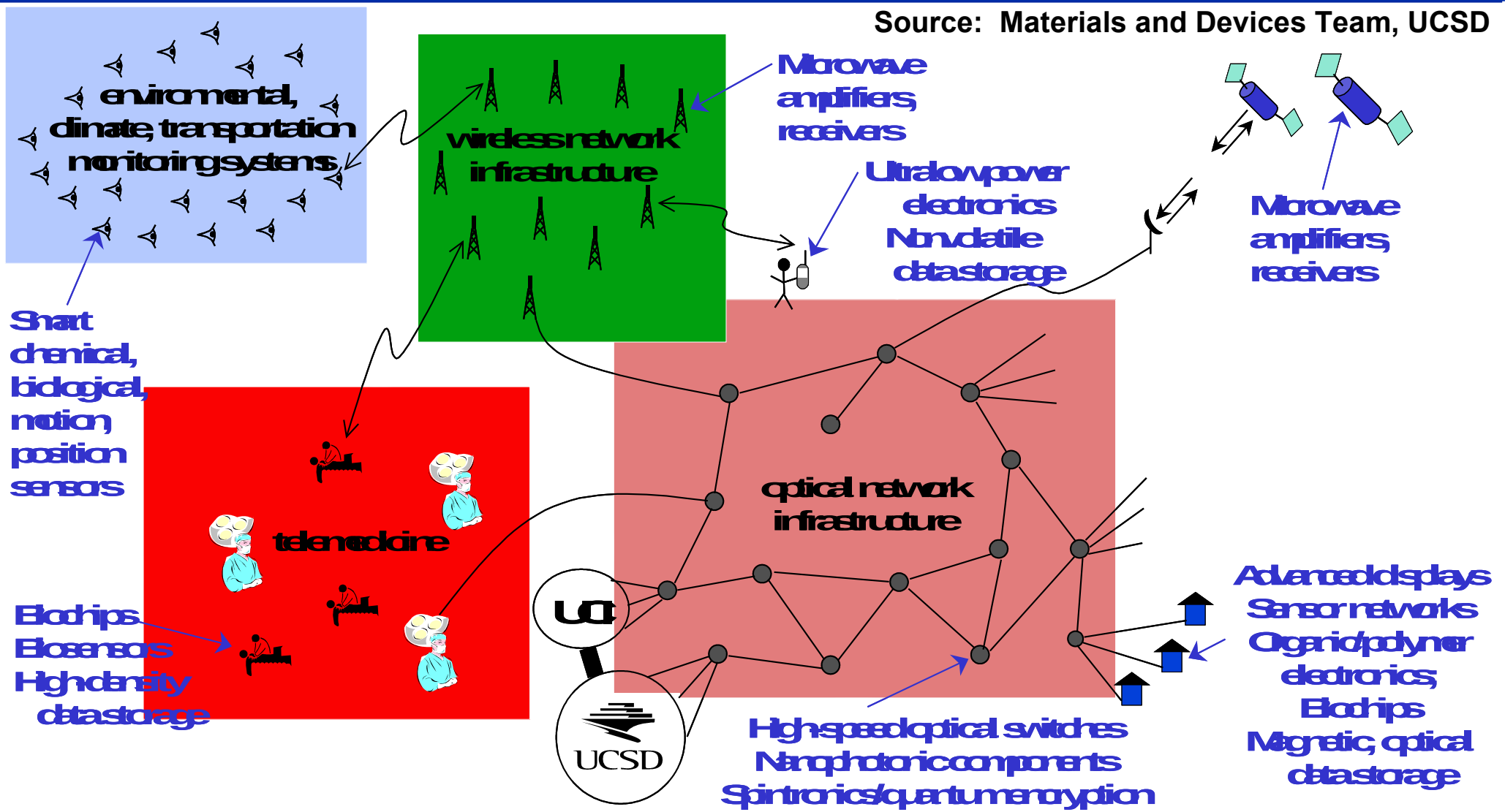
Two Trends:

- **More Use of Chips with "Embedded Intelligence"**
- **Networking of These Chips**



Novel Materials and Devices are Needed in Every Part of the New Internet

Source: Materials and Devices Team, UCSD



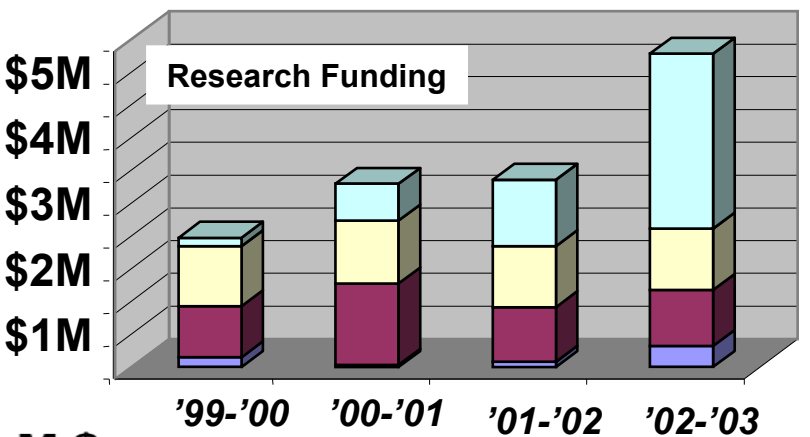
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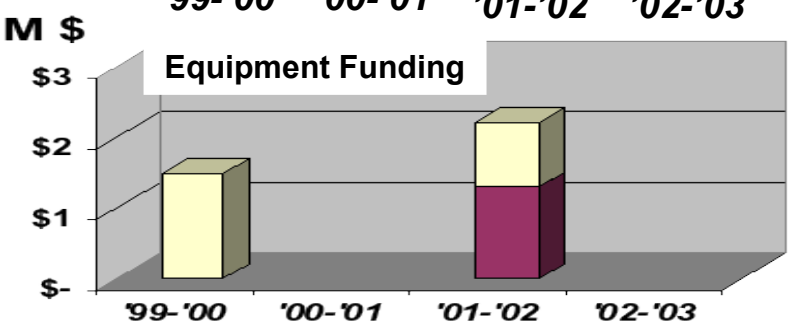
Clean Rooms for NanoScience and BioMEMS in the two Calit2 Buildings

UC Irvine Integrated Nanoscale Research Facility – Materials and Devices Collaboration with Industry

- **Collaborations with Industry**
  - **Joint Research With Faculty**
  - **Shared Facility Available For Industry Use**
- Working with UCI OTA to Facilitate Tech Transfer
- Industry and VC Interest in Technologies Developed at INRF

Agilent Technologies
TAMARACK scientific co., inc.
Raytheon
Auxora
VERSA TECHNOLOGY, INC.
RFIC
Tanner RESEARCH
Conventor
IRVINE SENSORS
hp invent
GCS
BROADCOM.
SKYWORKS
DRS
POC Physical Optics Corporation
TEXAS INSTRUMENTS
nexgen
BMR
MICROTEK
SWT ASSOCIATES
WIN Semiconductors Corp.
ROCKWELL SCIENTIFIC
delivering the winning technical edge
GENERAL MONITORS
ENDEVCO
SEQUENOM
ALPINE SEMICONDUCTOR
SST
MetroLaser, Inc.
MOOG
CONEXANT
IntelliEPI
VSK Photonics
COHERENT
PRINTRONIX
ASI
IJ Research, Inc.
XTAL
TRW
Umachines
Broadley-James
NUMERICAL TECHNOLOGIES, INC. GET THERE
Microsemi
OPLINK
NORTHROP GRUMMAN
UCSD
UCIrvine



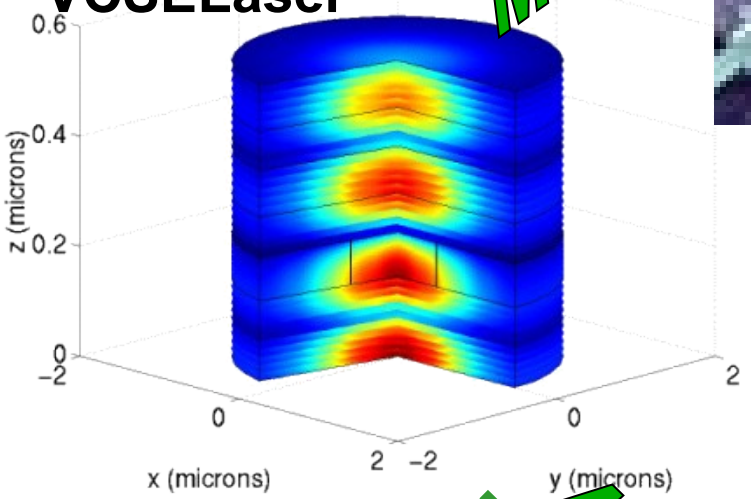


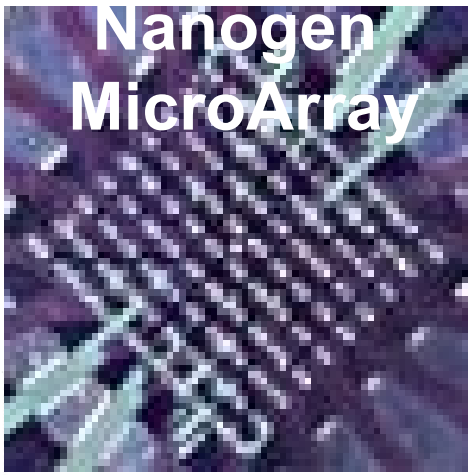
The Perfect Storm:
Convergence of Engineering with Bio, Physics, & IT

500x Magnification

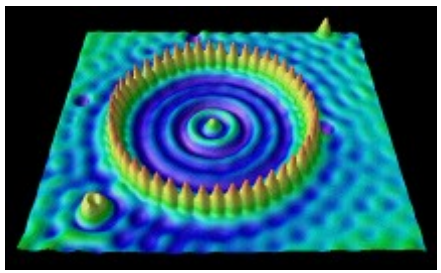
MEMS

VCSELaser

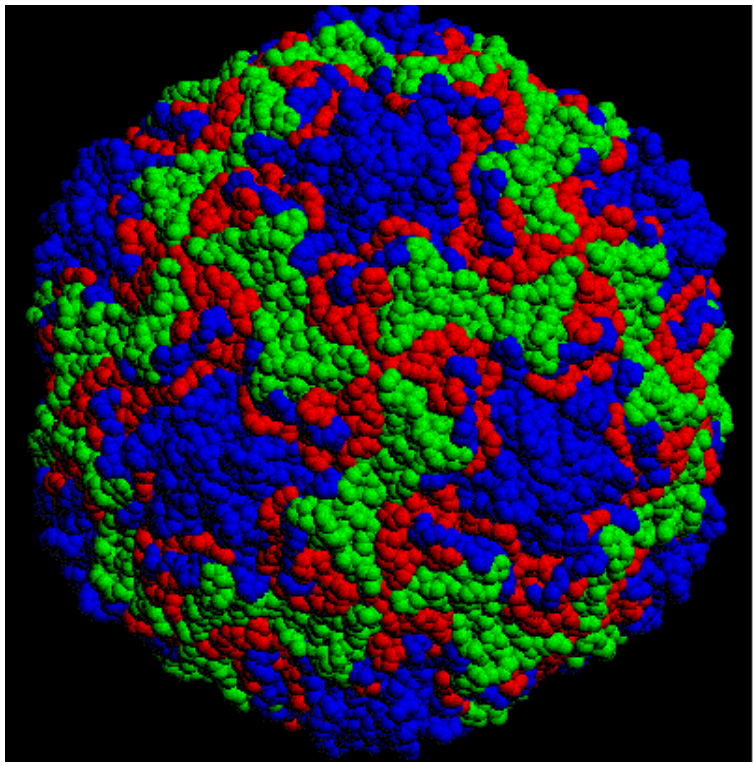




2 mm



IBM Quantum Corral
Iron Atoms on Copper



Human Rhinovirus

400x Magnification

NANO

5 nanometers

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Nanobioinfotechnology

it²

As Our Bodies Move On-Line
Bioengineering and Bioinformatics Merge





- **New Sensors—Israeli Video Pill**
  - Battery, Light, & Video Camera
  - Images Stored on Hip Device
- **Next Step—Putting You On-Line!**
  - Key Metabolic and Physical Variables
  - Wireless Internet Transmission
  - Model -- Dozens of 25 Processors and 60 Sensors / Actuators Inside of our Cars
- **Post-Genomic Individualized Medicine**
  - Combine Your Genetic Code & Imaging, with Your Body's Data Flow
  - Use Powerful AI Data Mining Techniques

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www.givenimaging.com

it²

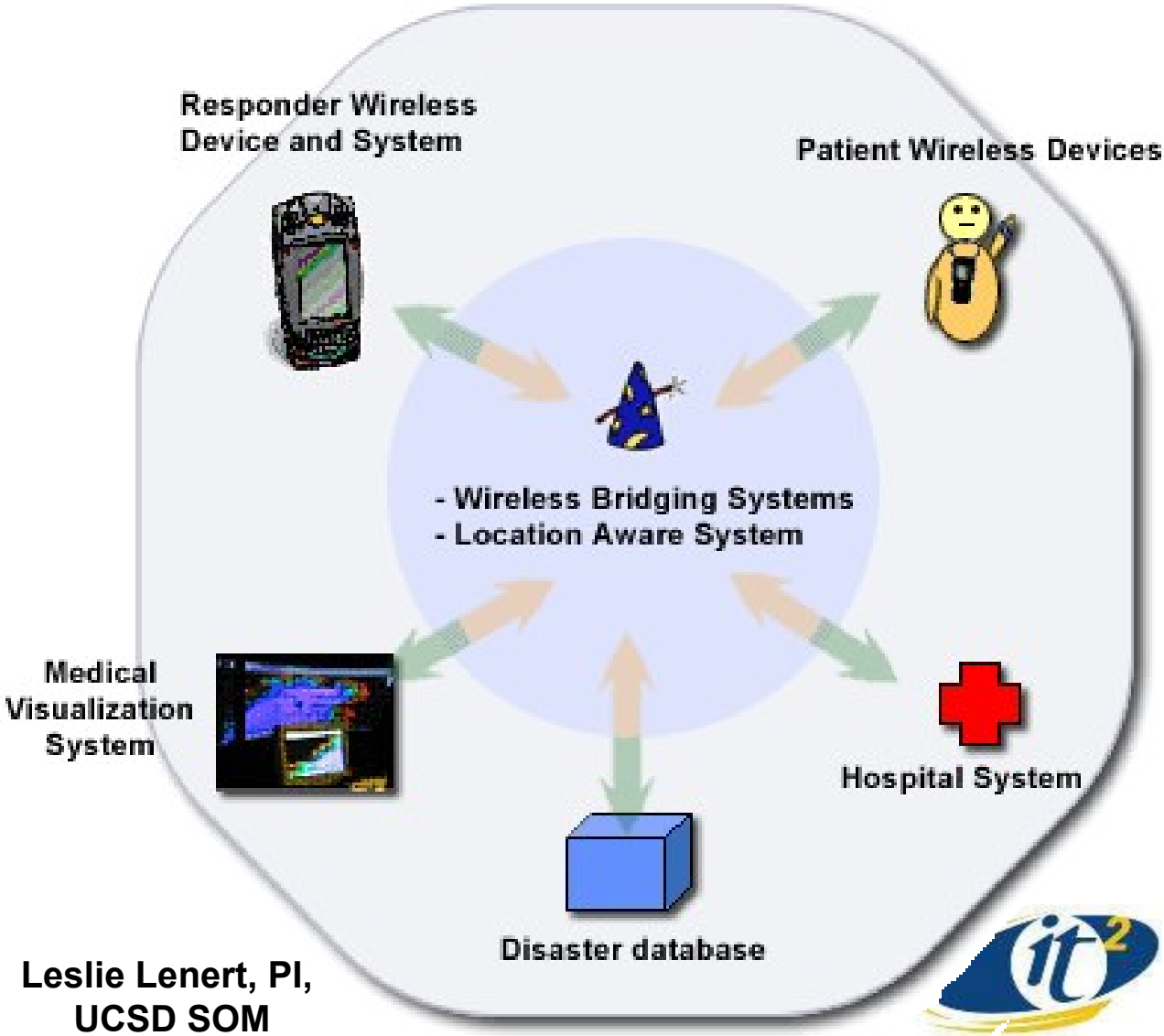
Wireless Internet Information System for Medical Response in Disasters (WIISARD)

- **First Responder Wireless Location Aware Systems For Nuclear, Chemical & Radiologic Attacks**
  - **Total NIH Award: $4.1 Million.**
  - **Duration 10/03 To 10/06**





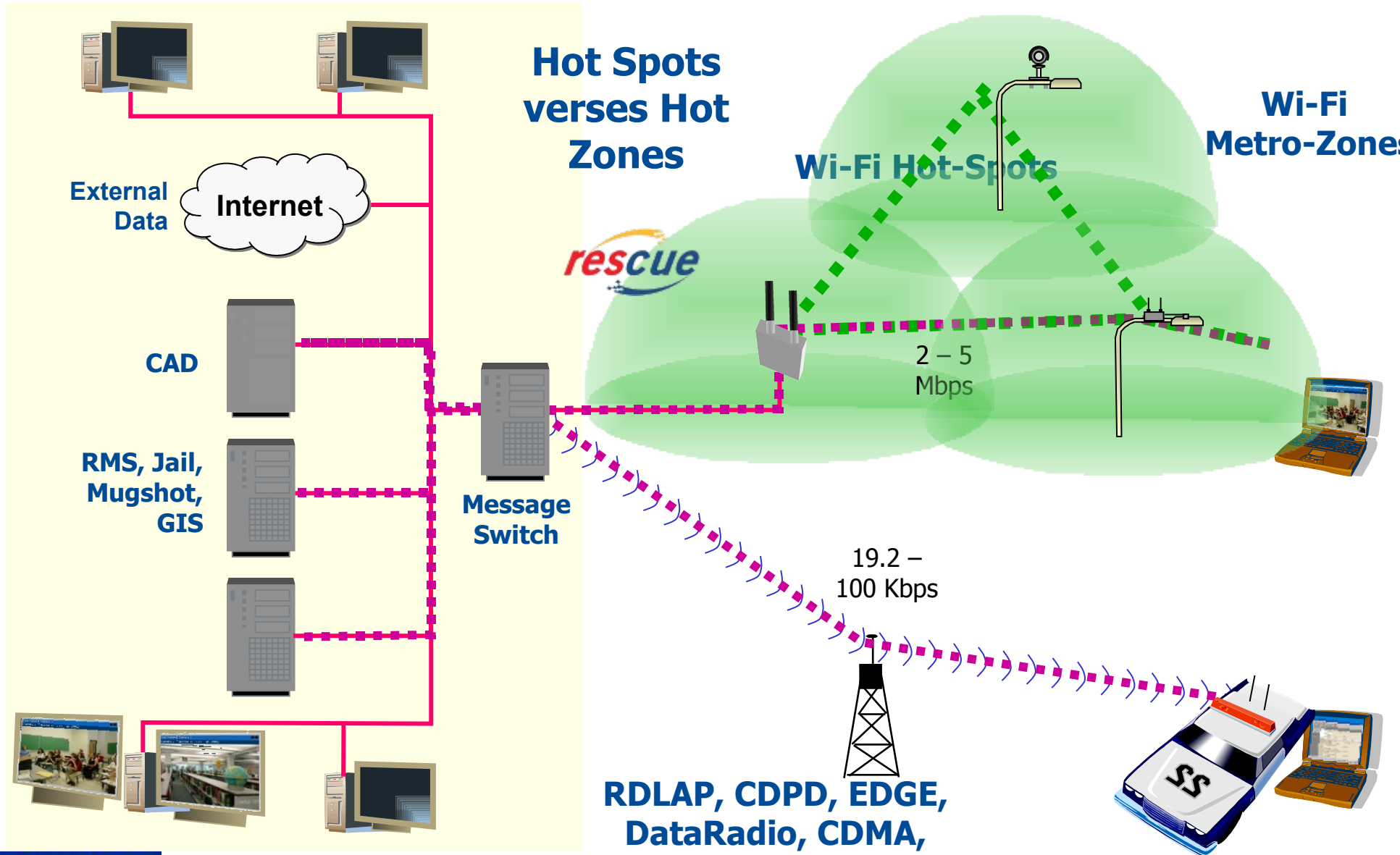
WIISARD Drill 3/16/04



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Leslie Lenert, PI, UCSD SOM

Calit2 RESCUE Grant
Gaslamp Quarter Infrastructure



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www.itr-rescue.org www.responsphere.org

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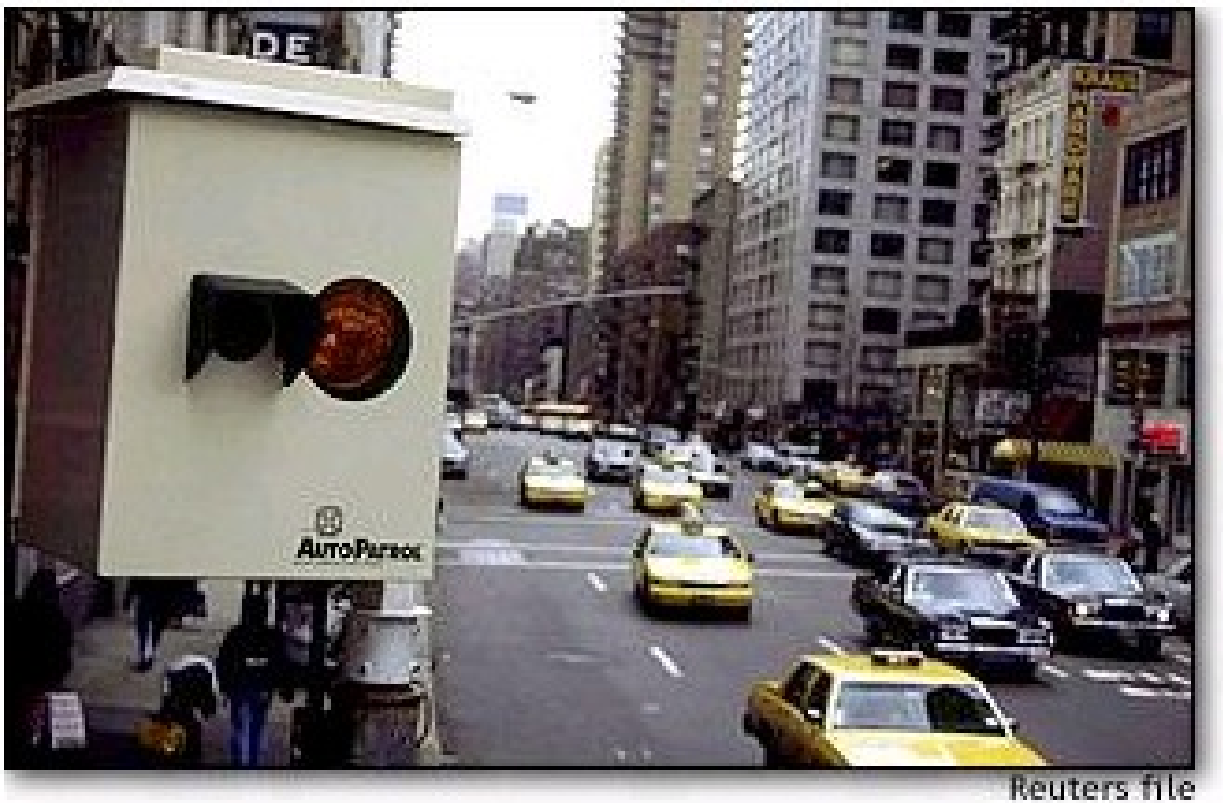
Millions of Video Cameras Are Attaching to the Net

- **London Underground**
  - Initially 25,000 Video Cameras
  - Expansion to 250,000 Possible
  - British Transport Police Switch to Any Camera in 1 Sec.
    - Source: Telindus
- **British CCTV System**
  - Currently 2.5 Million CCTV Cameras Installed (NY Times)
    - Average London Citizen is Seen by 300 Cameras Per Day
  - Face Recognition Software Added in High Crime Areas
- **Up to 6 Million Surveillance Cameras Across the USA in 5-7 Years**
  - Privacy International Prediction

However, Broad Debate Is Needed to Avoid Citizen Revolt Against Privacy Violations

Red light cams be damned

The way we're using cameras to catch stoplight offenders doesn't aid safety and threatens rights



Reuters file

The cameras do have benefits, but cities aren't being upfront about what they're really used for.

OPINION

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