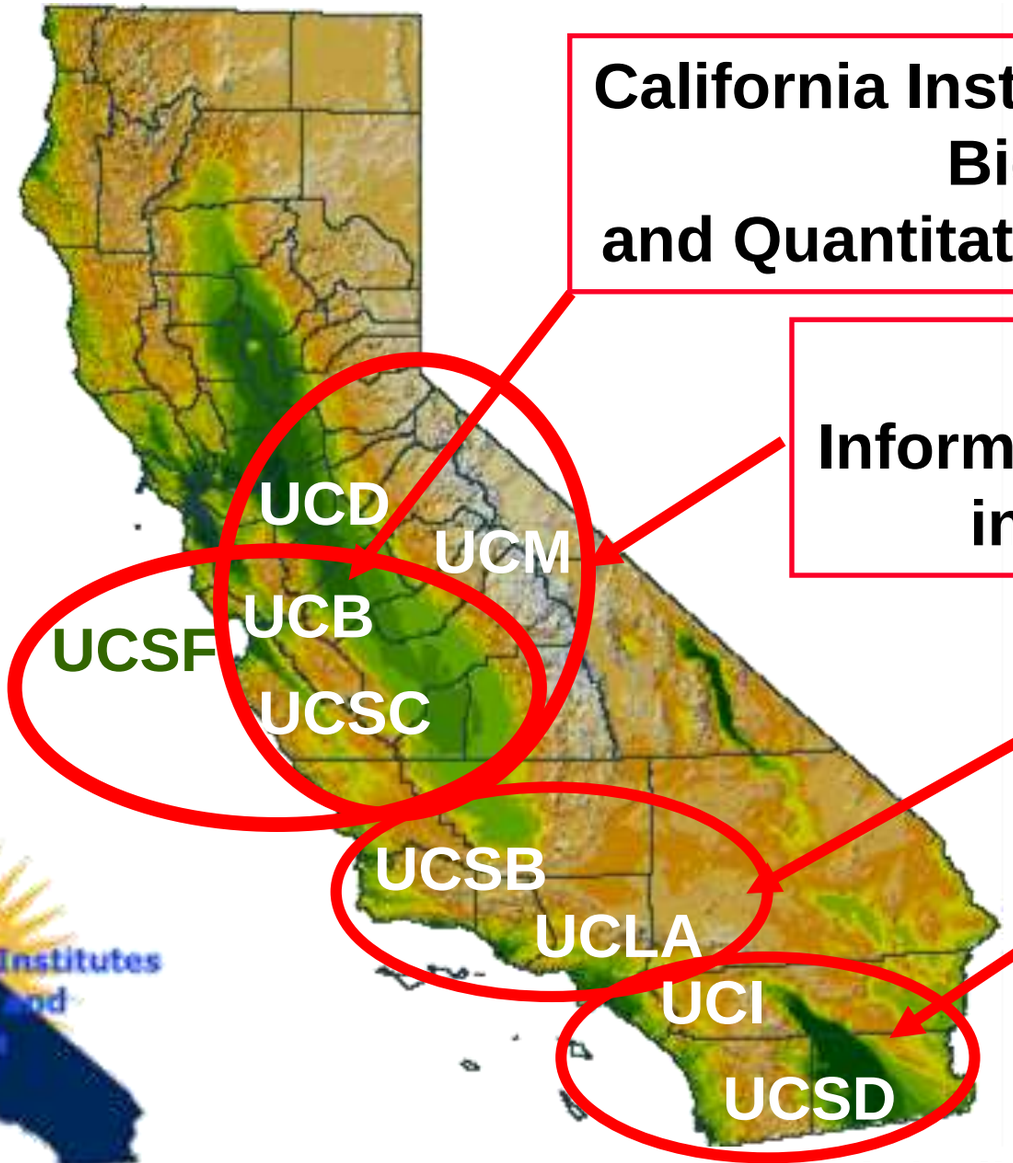
“The Creation of Calit2”

Guest Lecture
Gordon Engineering Leadership Center
UC San Diego
January 25, 2017

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
http://lsmarr.calit2.net

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

www.ucop.edu/california-institutes

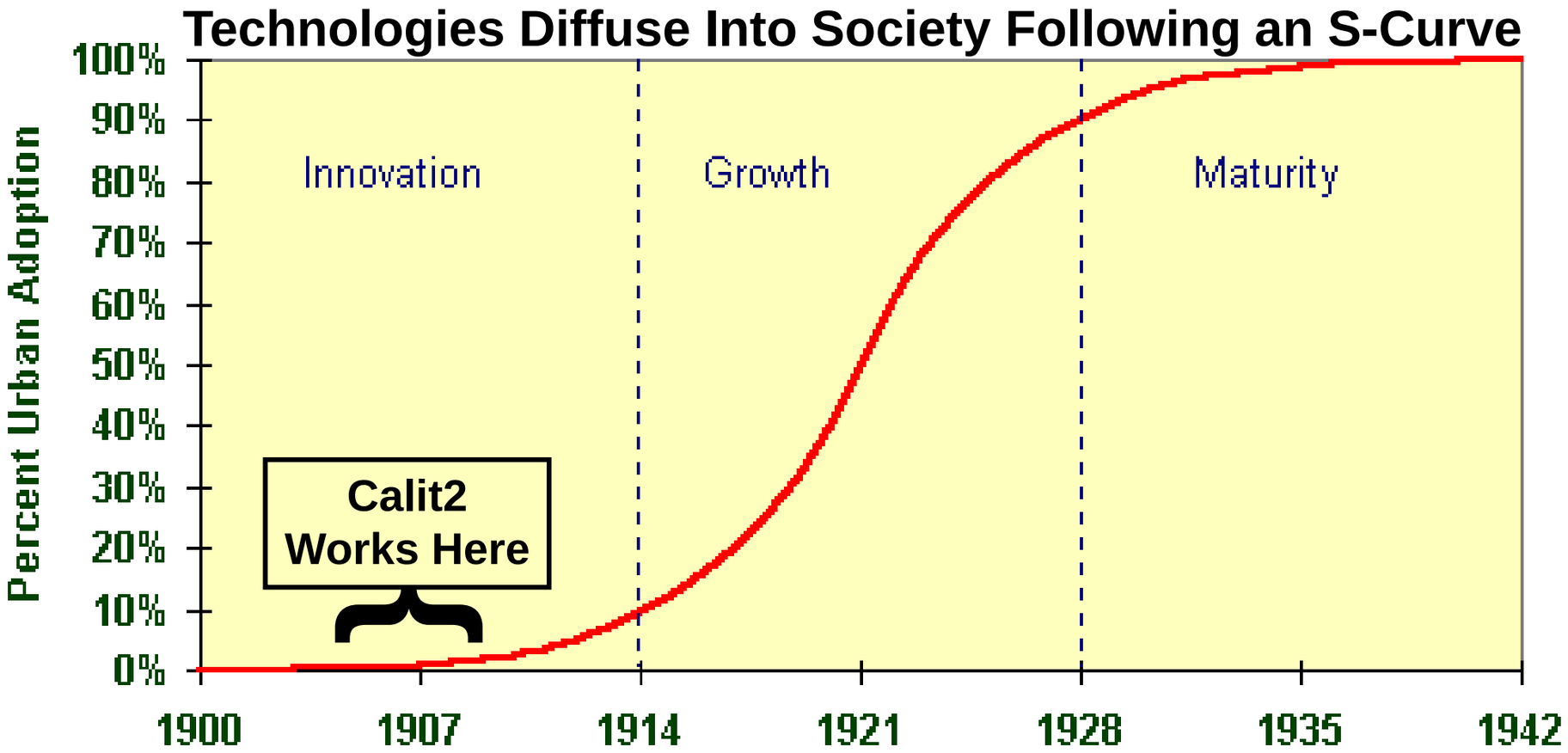
Calit2's Initial Mission Statement

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.

Calit2 “Lives in the Future” By Building Systems of Emerging Disruptive Technologies

Co-Evolution of Personal Automobile and Highway/Petroleum Infrastructure



Source: Harry Dent, The Great Boom Ahead

Complex Problems Require a New Research and Education Framework

220 UCSD & UCI Faculty Working in Multidisciplinary Teams With Students, Industry, and the Community

Calit2 Slide 2001



The State Provides $100 M For New Buildings and Equipment

www.calit2.net

A Broad Partnership Response from the Private Sector

Calit2 Slide 2001

Akamai
Boeing
Broadcom
AMCC
CAIMIS
Compaq
Conexant
Copper Mountain
Emulex
Enterprise Partners VC
Entropia
Ericsson
Global Photon
IBM
IdeaEdge Ventures
Intersil
Irvine Sensors
Leap Wireless
Litton Industries
MedExpert
Merck
Microsoft

Computers
Communications
Software
Sensors
Biomedical
Startups
Venture Firms

Large Partners
>$10M Over 4 Years

Mission Ventures
NCR
Newport Corporation
Orincon
Panoram Technologies
Printronix
QUALCOMM
Quantum
R.W. Johnson Pharmaceutical RI
SAIC
SciFrame
Seagate Storage
Silicon Wave
Sony
STMicroelectronics
Sun Microsystems
TeraBurst Networks
Texas Instruments
UCSD Healthcare
The Unwired Fund
WebEx

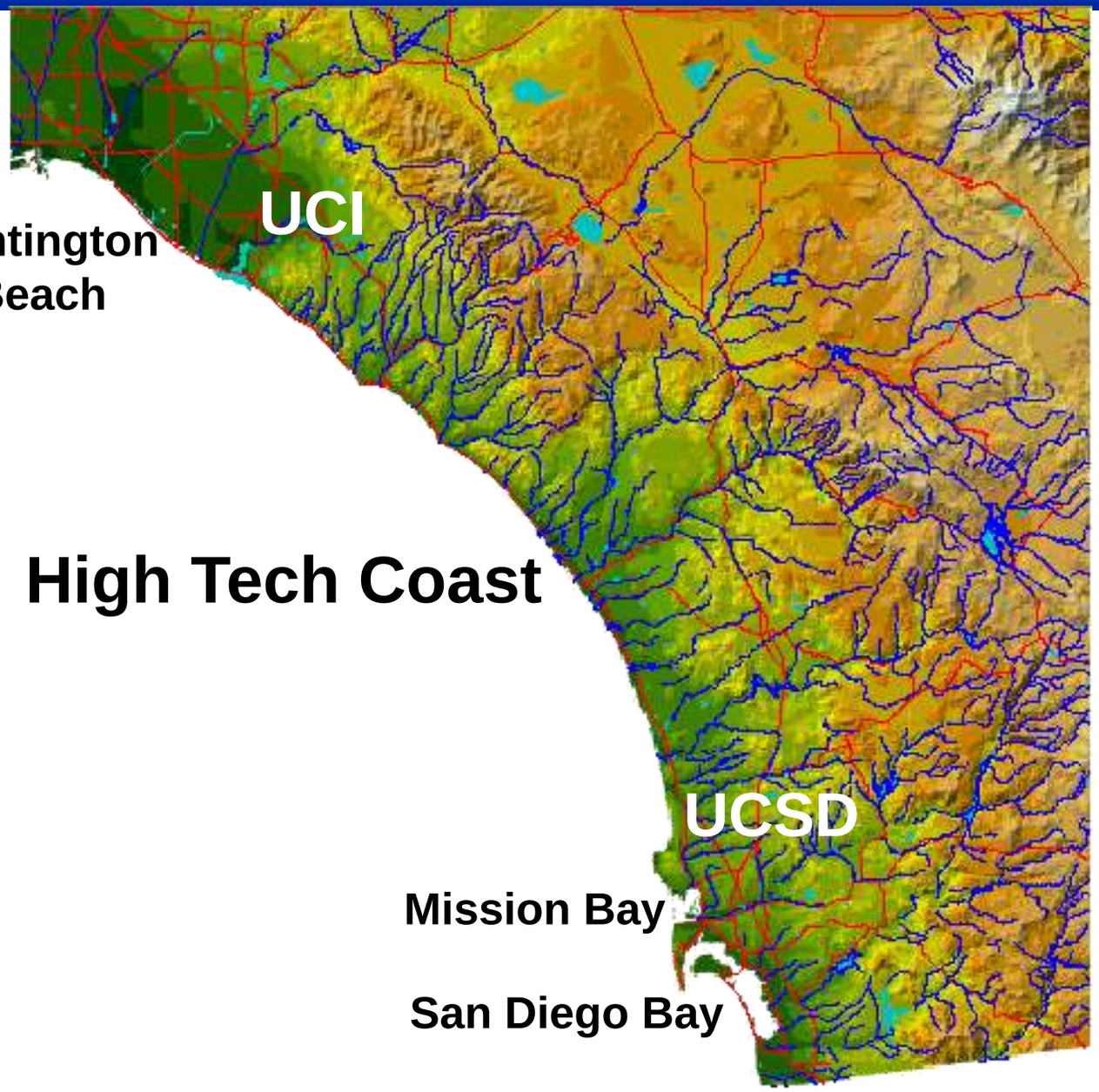
$140 M Match From Industry

Elements of the Cal -(IT)^2 Industrial Partnerships

- Endowed Chairs for Professors
- Start-Up Support for Young Faculty
- Graduate Student Fellowships
- Research and Academic Professionals
- Sponsored Research Programs
- Equipment Donations for Cal-(IT)^2 and Campus
- Named Laboratories in new Institute Buildings
- Pro Bono Services and Software

Calit2 Slide 2001

Can Use of These Technologies Help Us Avoid the Downsides of Prolonged Growth?



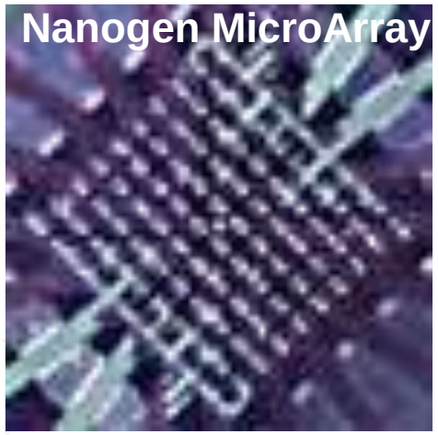
Calit2 Slide 2001

- Add Wireless Sensor Array
- Build GIS Data
- Focus on:
  - Pollution
  - Water Cycle
  - Earthquakes
  - Bridges
  - Traffic
  - Policy
- Work with the Community to Adapt to Growth

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

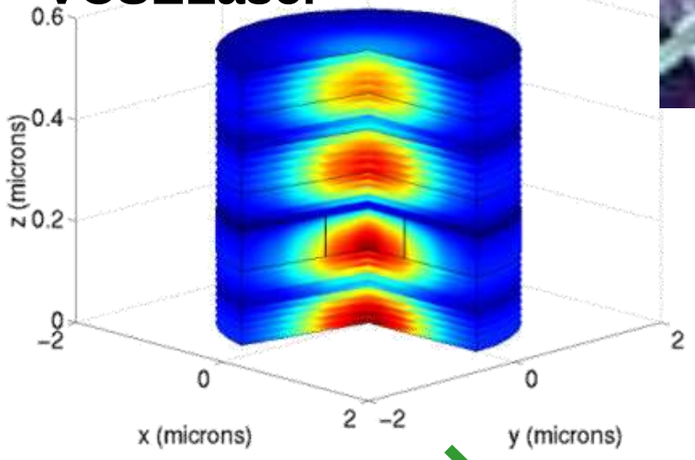
Calit2 Slide 2001

500x Magnification

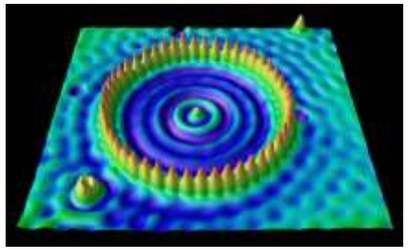


2 mm

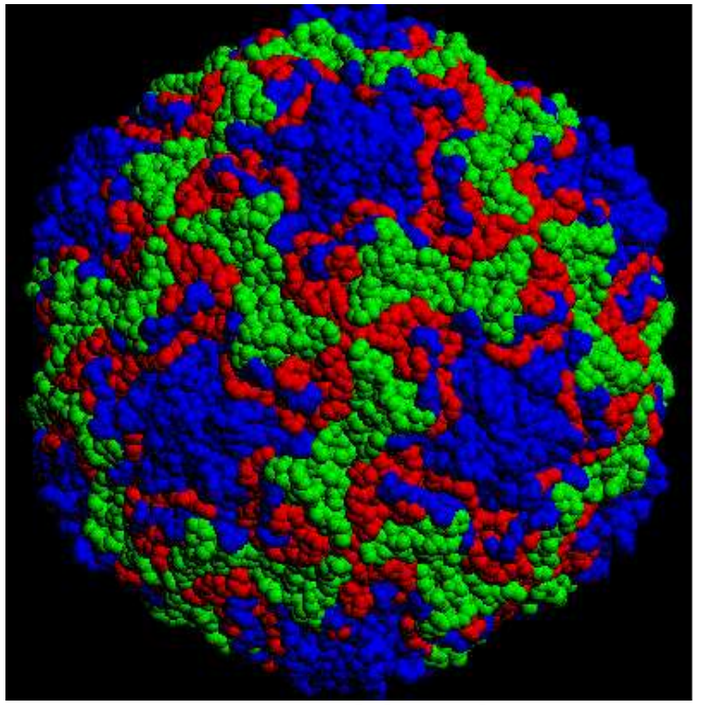
VCSELaser



400x Magnification



IBM Quantum Corral
Iron Atoms on Copper

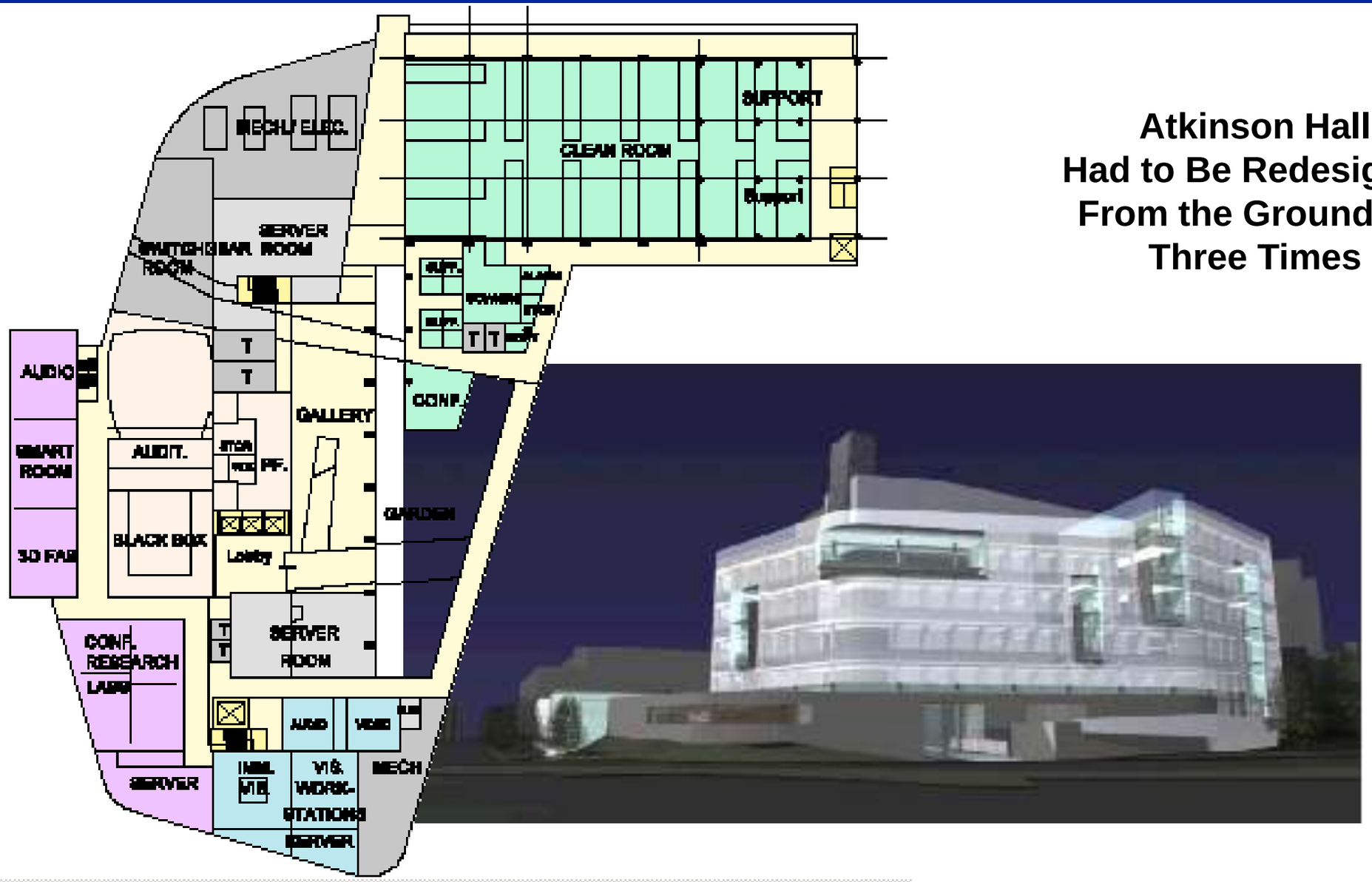


Human Rhinovirus

5 nanometers

From MEMS to Nanotech

The Cal-(IT)^2 Building in 2004 Will Form the Capstone of the Engineering Quad



Atkinson Hall
Had to Be Redesigned
From the Ground Up
Three Times

Calit2 Slide 2001

Calit2 Phase I: 2001-2005
~8,000 GSF, ~25 People, and No Facilities



Room 416 Engineering Tower
Calit2@UCI Division



Triple Wide Trailer
Calit2@UCSD Division

From Incubation to Full Scale Operations
2005-2006

Two New Calit2 Buildings Provide New Laboratories for “Living in the Future”

2005

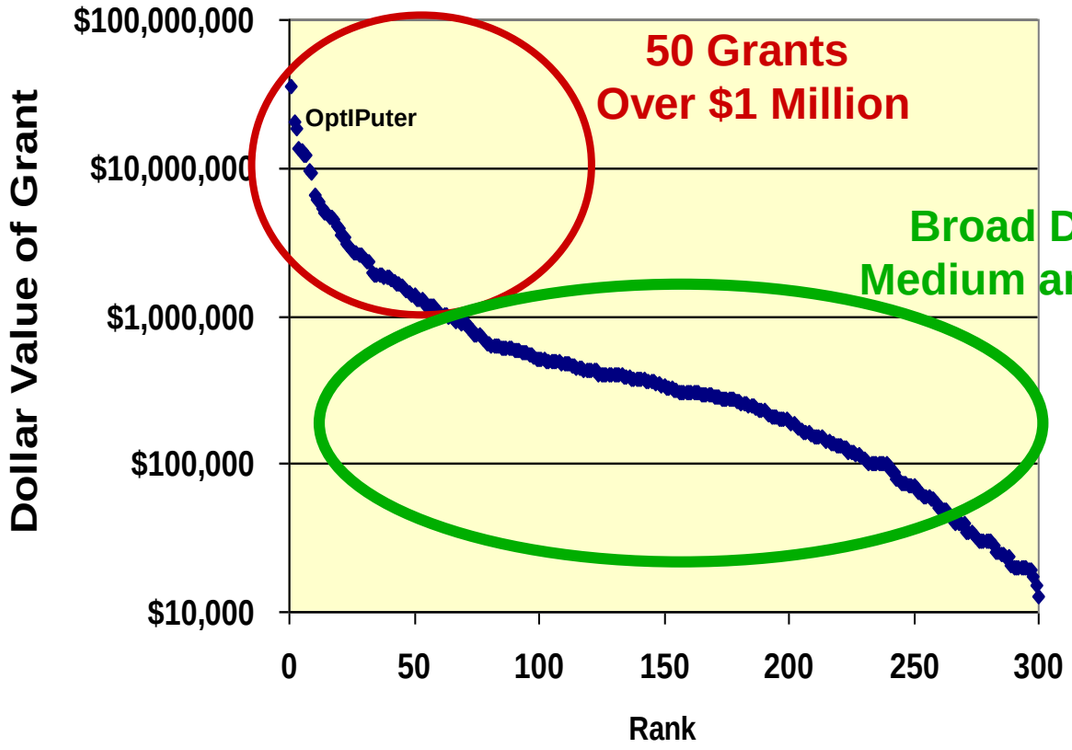


- “Convergence” Laboratory Facilities
  - Nanotech, BioMEMS, Chips, Radio, Photonics
  - Virtual Reality, Digital Cinema, HDTV, Gaming
- Over 1000 Researchers in Two Buildings
  - Linked via Dedicated Optical Networks

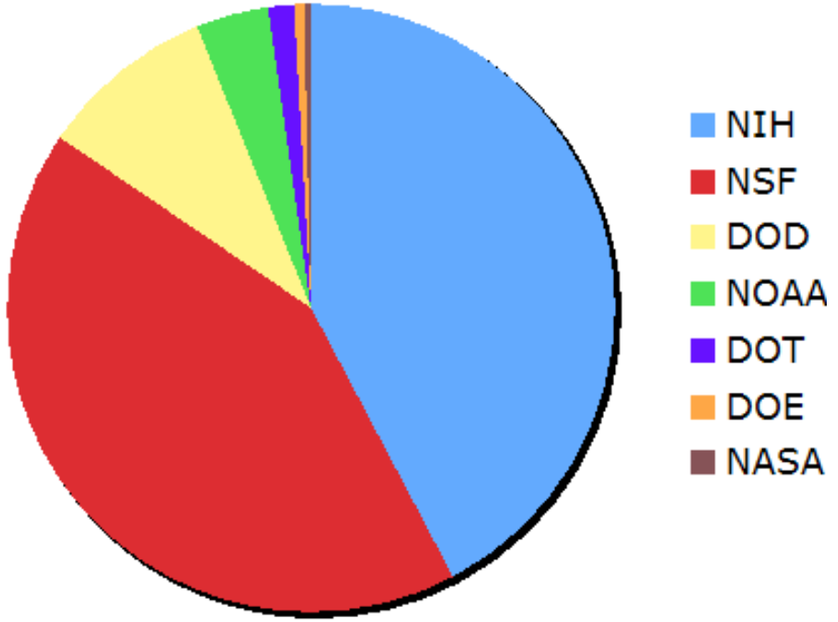


$100M From State for New Facilities

Federal Agencies Have Funded $350 Million to Over 300 Calit2 Affiliated Grants



Creating a Rich Ecology of Basic Research



Federal Agency Source of Funds

Calit2 Review Report p.4,21

The Challenge of Managing an Ecology of Federal Grants



Calit2 Review Report: Appendix A

Calit2 Industry Partners:
Driving Public-Private Innovation Throughout The U.S.



http://ri.calit2.net/industry/ Jerry Sheehan, Calit2 Lead

Calit2 Works Closely with San Diego and Orange County Industrial Groups

SDSIC NETWORK San Diego Software Industry Council

CommNexus™ San Diego A Network of Communications Companies

OCTANe Fueling Innovation Development in Orange County

BIOCOM Accelerating Life Science Success

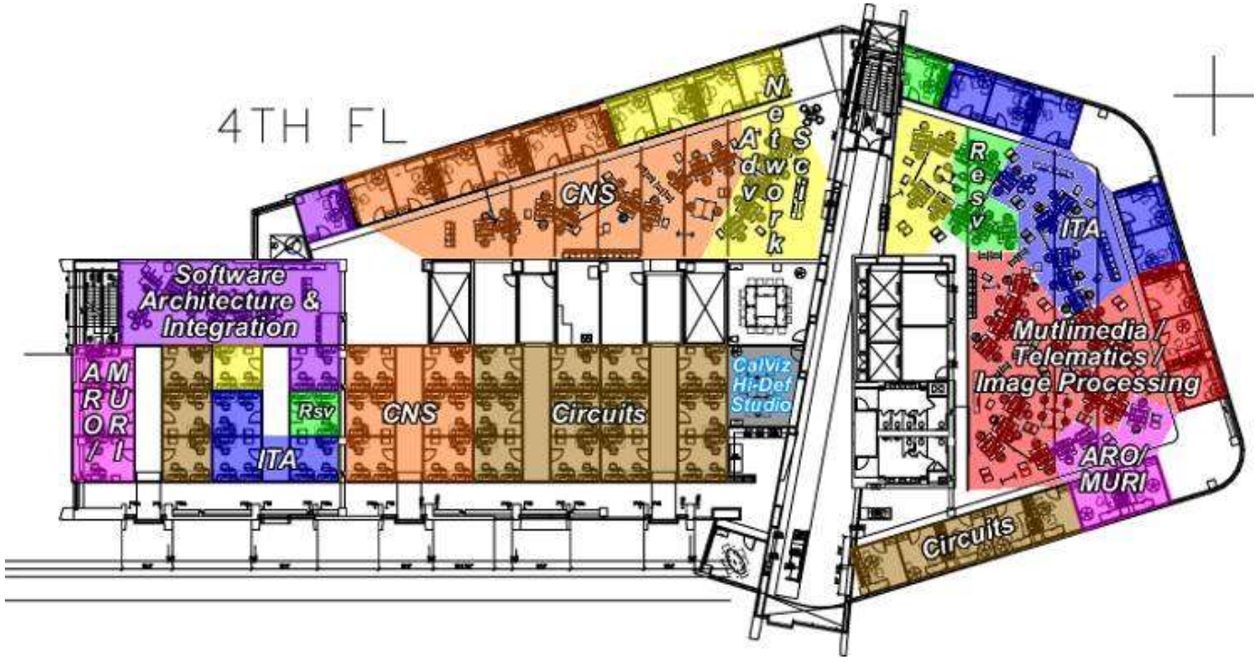
SAN DIEGO DEFCOMM A Defense and Space Technology Consortium

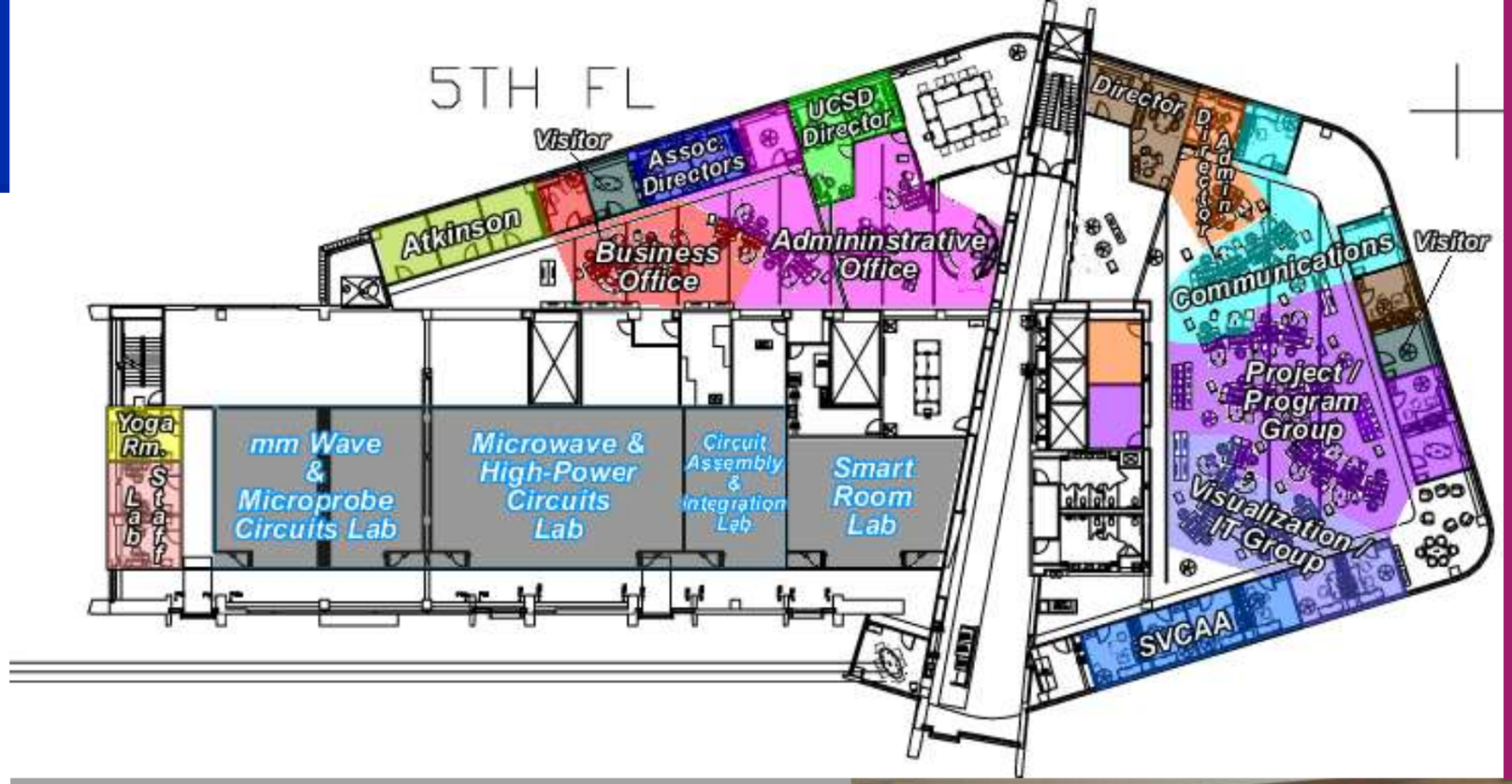
it²



- ✓ **Information Theory & Applications Center**
- ✓ **Center for Networked Systems**
- ✓ **Advanced Network Sciences**
- ✓ **Software Systems**

Projects and Centers





Laboratories

- ✓ Millimeter Wave
- ✓ Microwave/PA
- ✓ Circuits
- ✓ Photonics



Calit2 Materials and Devices Laboratory: "Nano3"–NanoScience, NanoEngineering, NanoMedicine

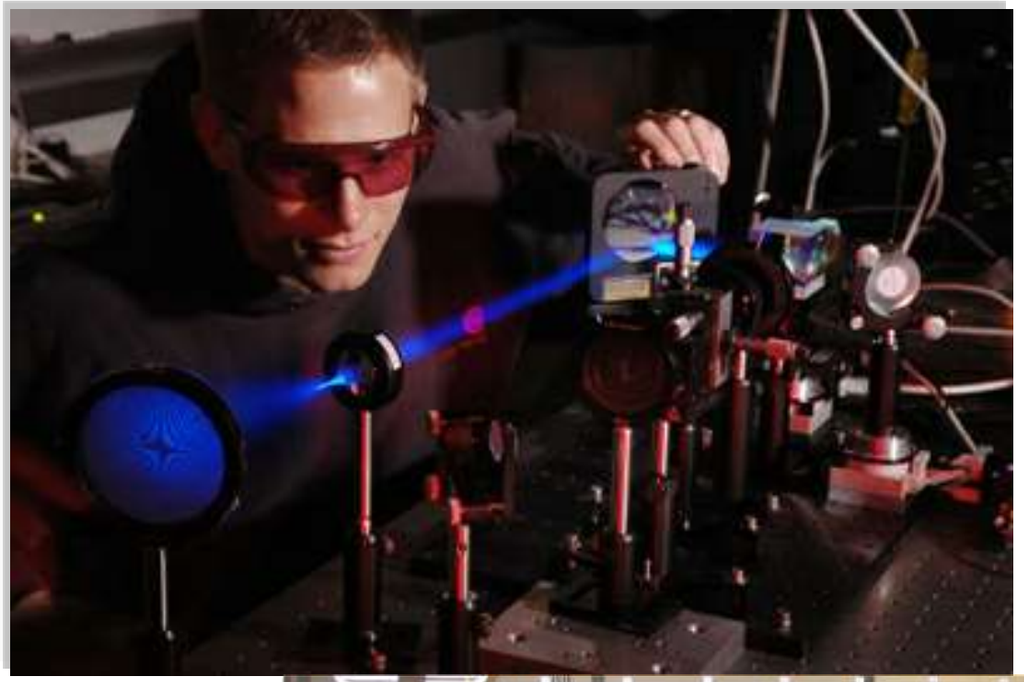
10,000 sq. feet State-of-the-Art Materials and Devices Laboratory

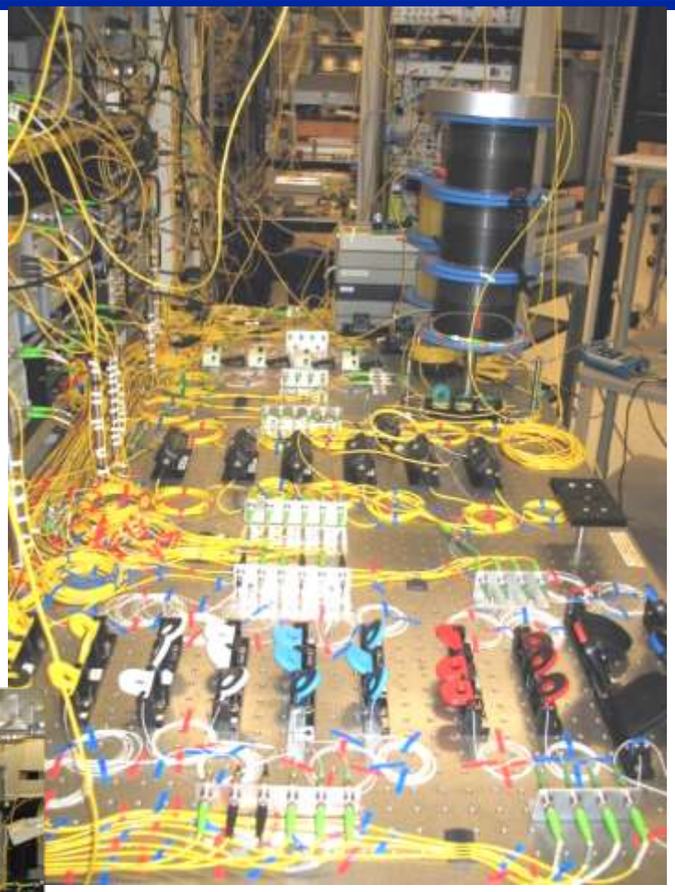


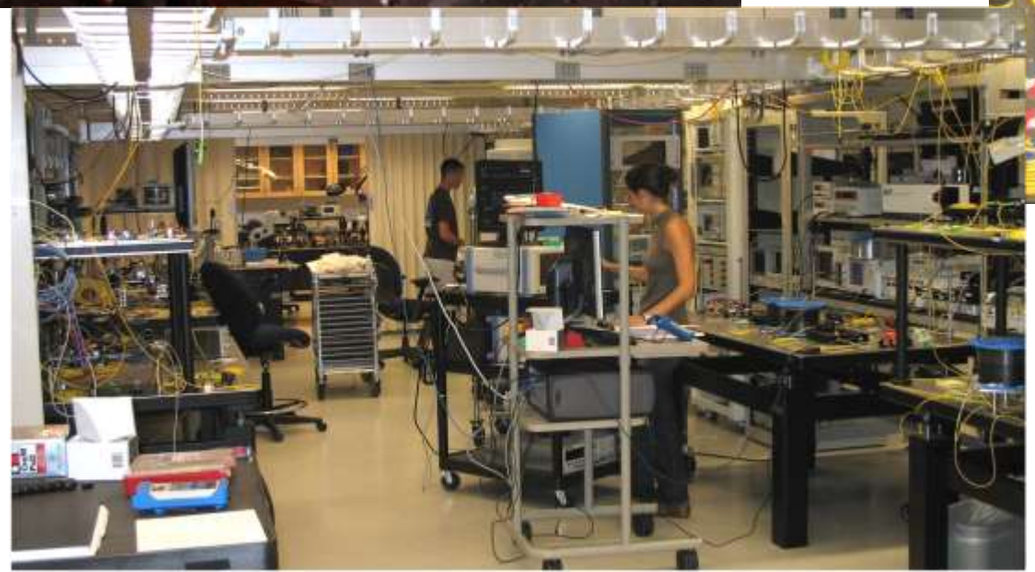
Similar Clean Rooms at UCI

Source: Bernd Fruhberger, Calit2

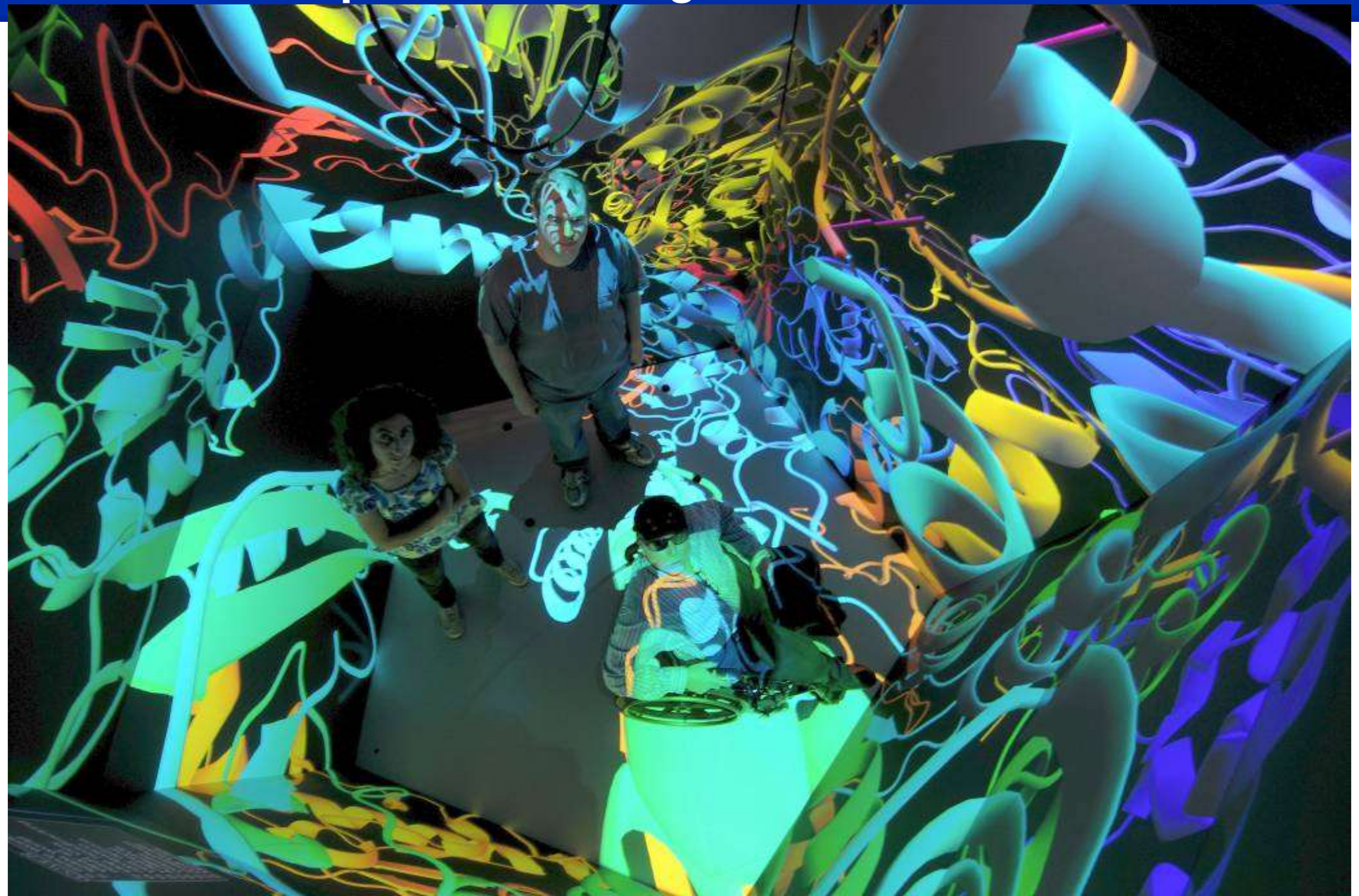
One of the Most Advanced Photonics Systems Labs in the World







Calit2 3D Immersive StarCAVE OptIPortal: Enables Exploration of High Resolution Simulations



Calit2 is Experimenting with Open Reconfigurable Work Spaces to Enhance Collaboration

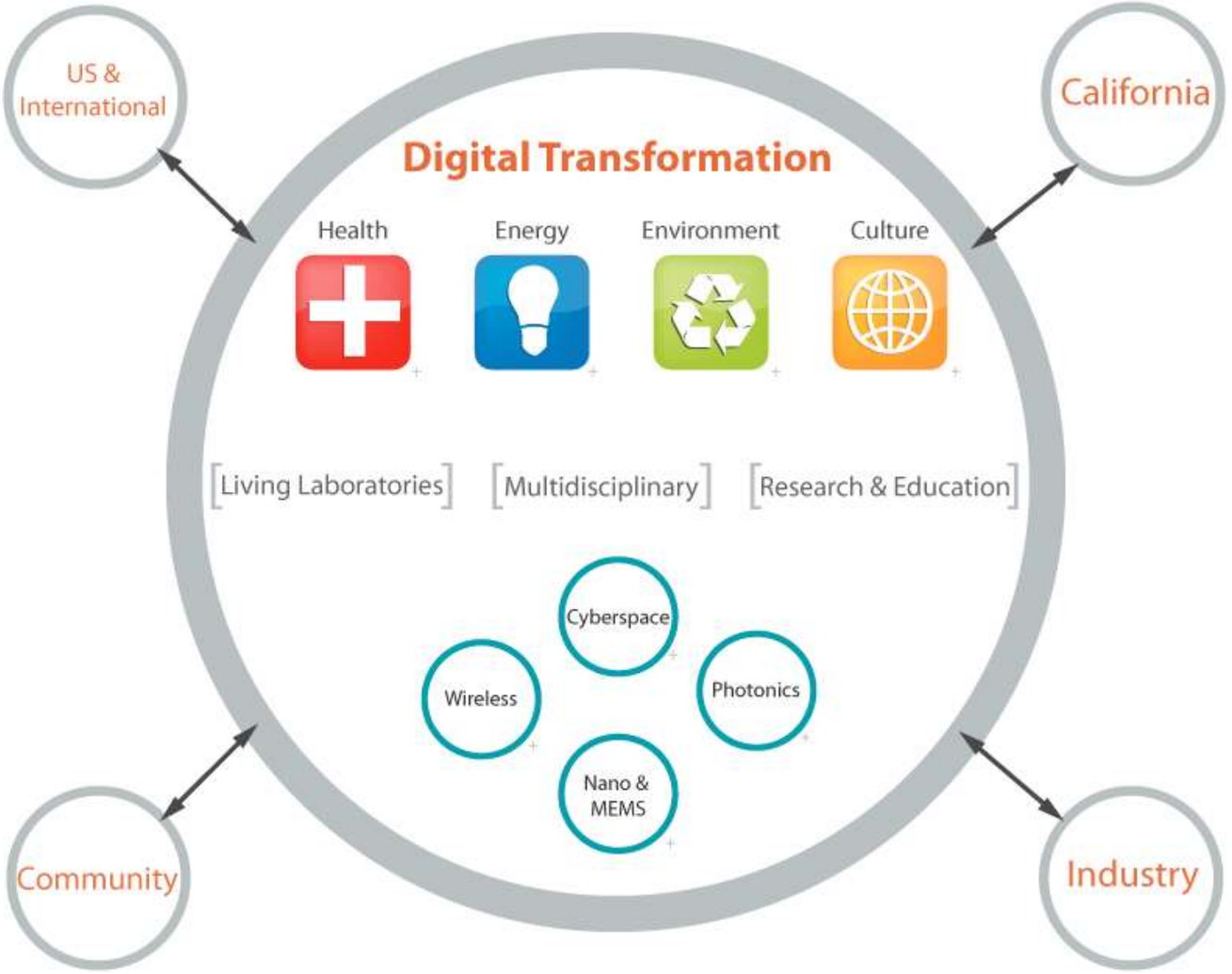




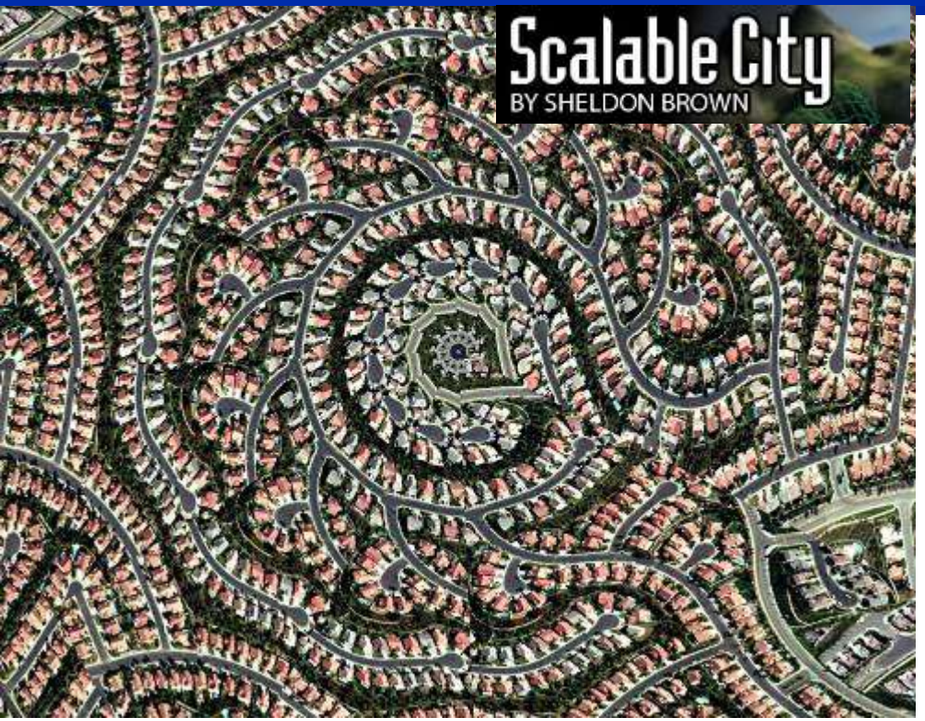


Re-Branding: Calit2 is a Framework for “Living in the Future” of the Digital Transformation of Society

2010



Calit2 Has Facilitated Deep Interactions With the Digital Arts on Both Campuses



The New York Times

Business Day

Technology

WORLD | U.S. | N.Y. / REGION | BUSINESS | TECHNOLOGY | SCIENCE | HEALTH | SPORTS | OPINIO

Researchers Look to Create a Synthesis of Art and Science for the 21st Century

By JOHN MARKOFF
Published: November 5, 2005

SPECFLIC 1.0 – A Speculative Distributed Social Cinema by Adrienne Jenik



Bill Tomlinson, Lynn Carpenter UCI "EcoRaft"





Virtual Jazz-Coupling UCI with UCSD



Egypt’s Luxor in the StarCAVE

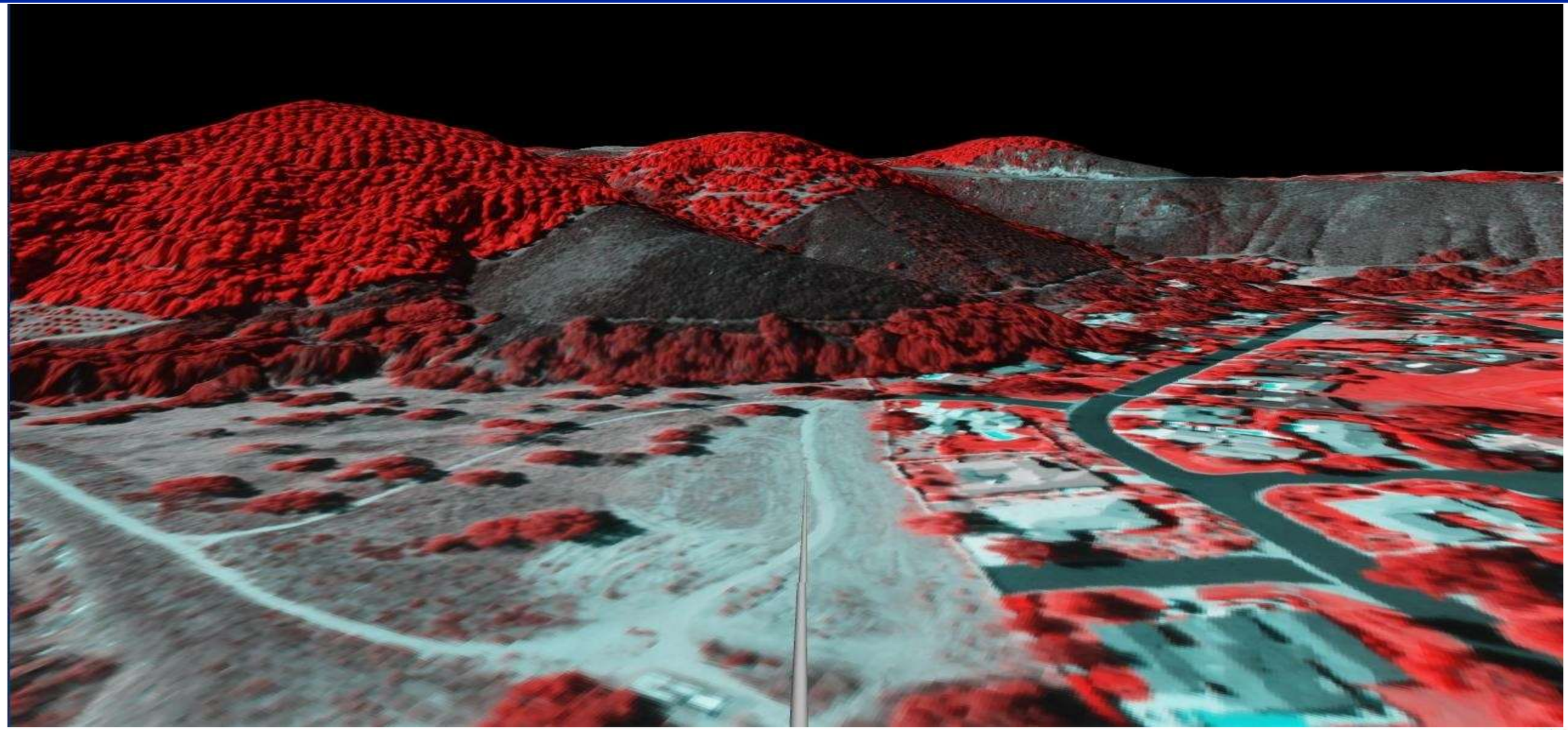


Cultural Analytics-1 Million Manga Pages



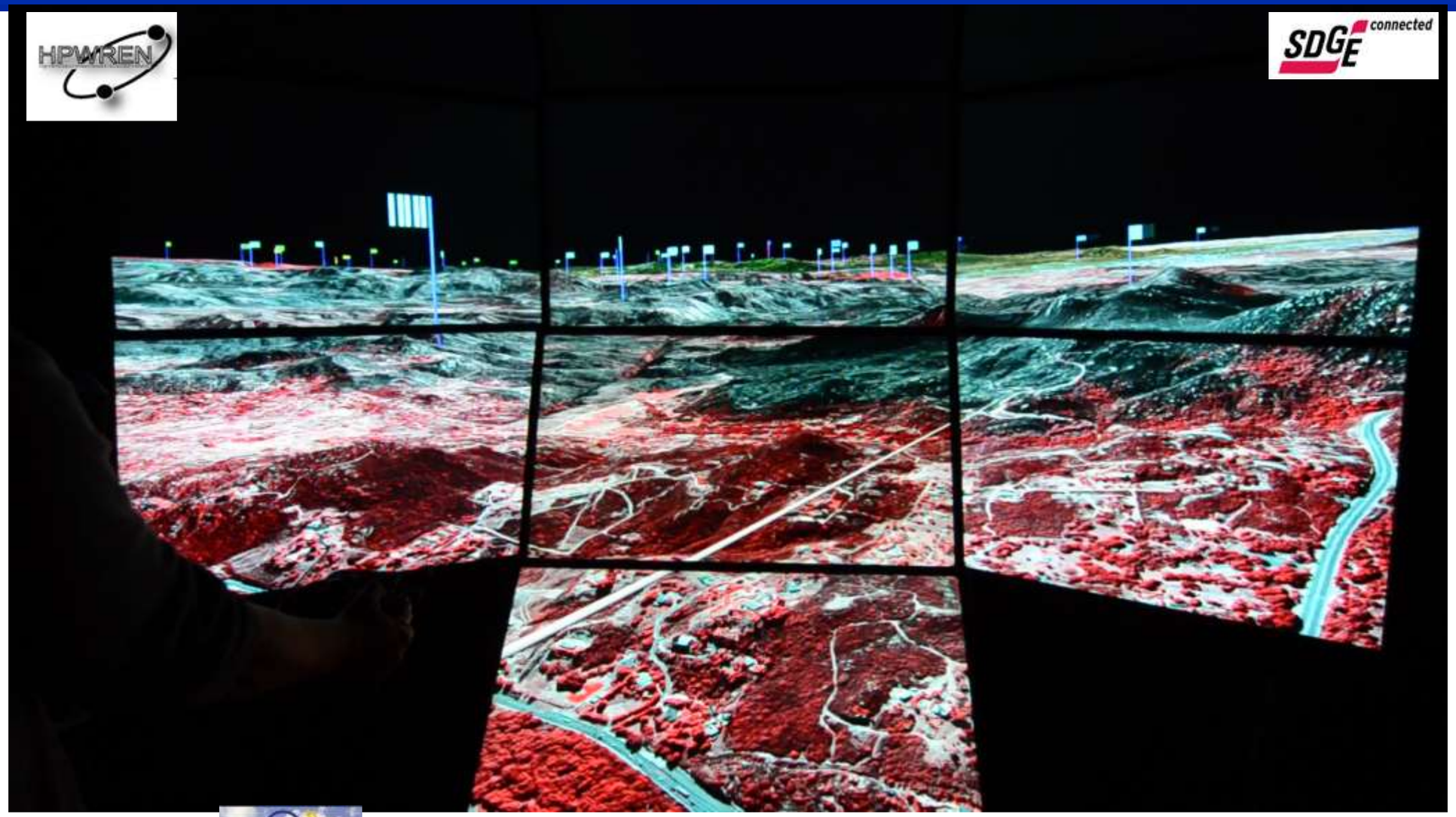
UCI Psychiatry Profs at Work

Creating a Digital “Mirror World”: Interactive Virtual Reality of San Diego County



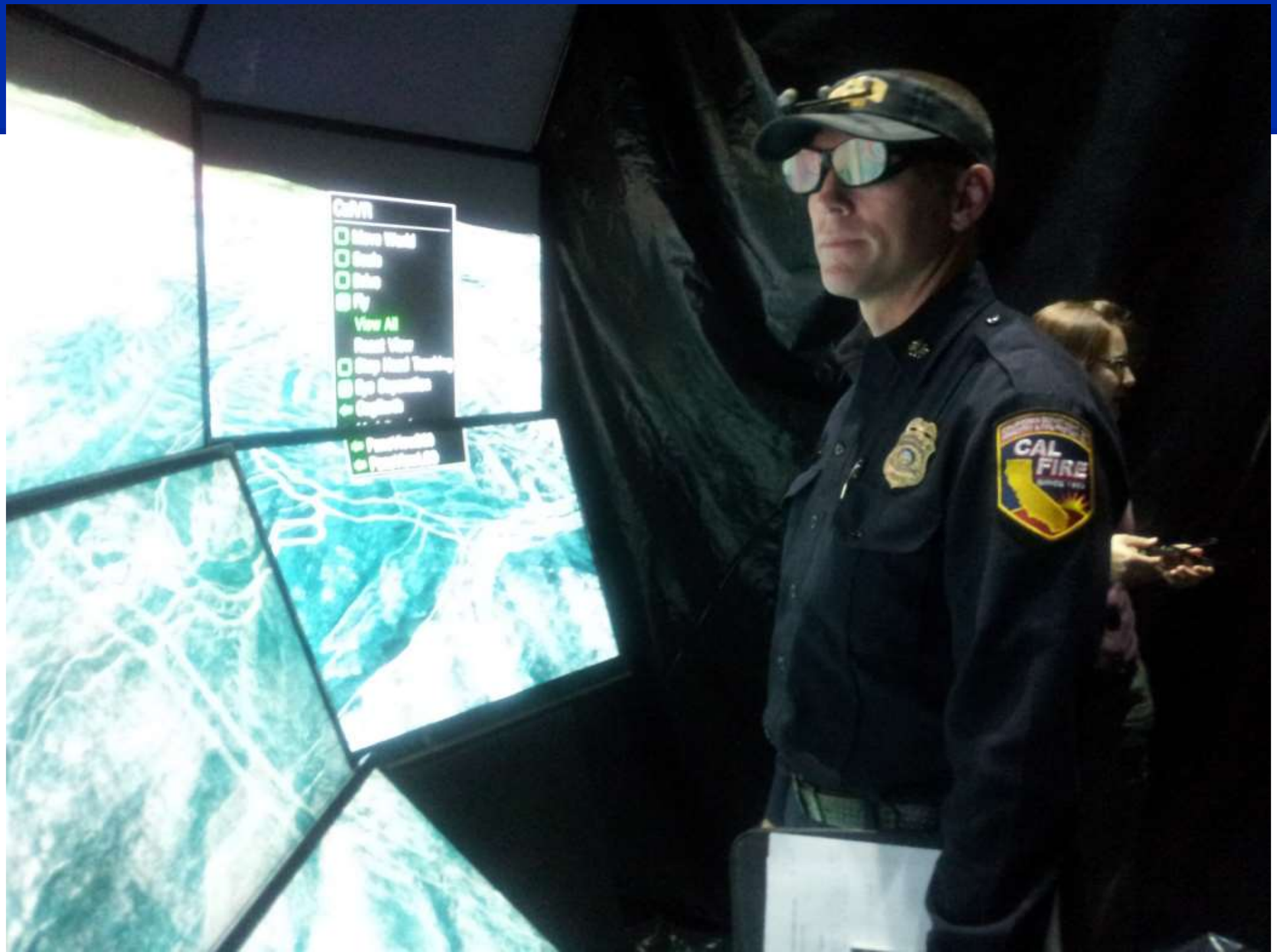
0.5 meter image resolution.
2meter resolution elevation

All Meteorological Stations Are Represented in Realtime: Wind Direction, Velocity, and Temperature





Source: Jessica Block, Calit2


CAL FIRE

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









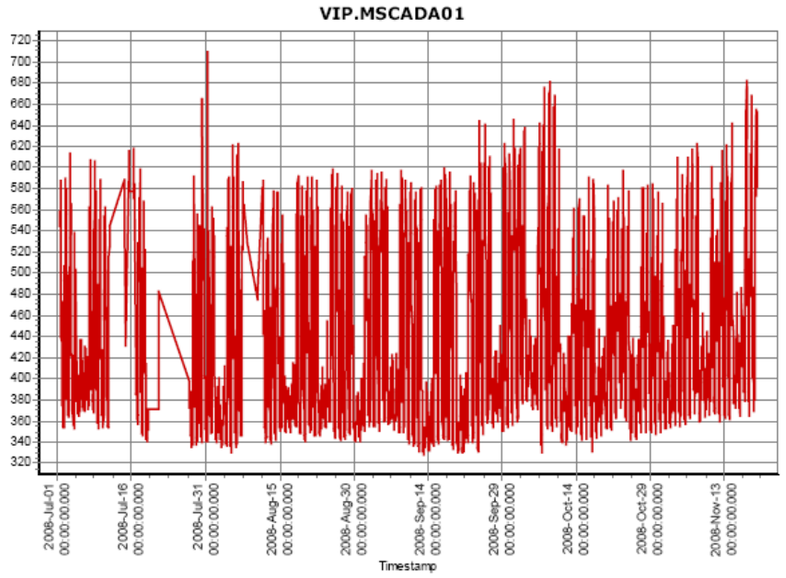


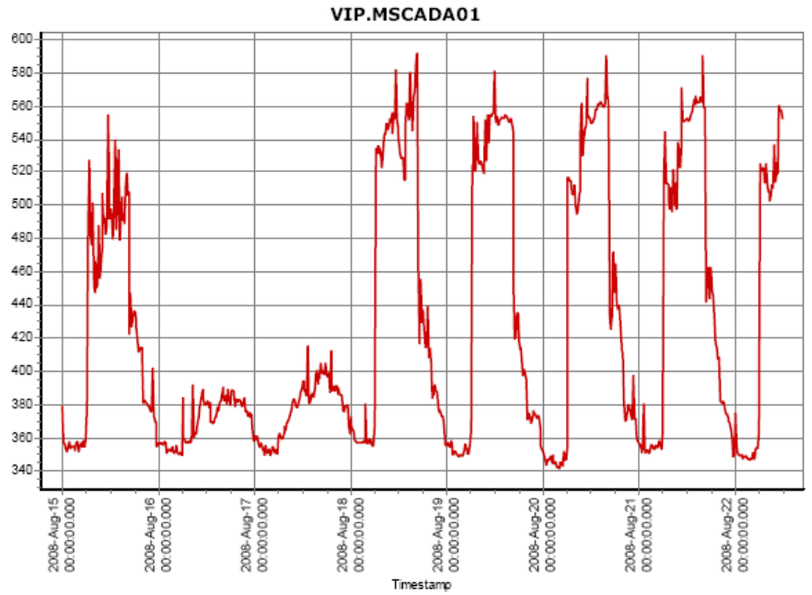


Power Management in Mixed Use Buildings: The UCSD CSE Building is Energy Instrumented

- **500 Occupants, 750 Computers**
- **Detailed Instrumentation to Measure Macro and Micro-Scale Power Use**
  - **39 Sensor Pods, 156 Radios, 70 Circuits**
  - **Subsystems: Air Conditioning & Lighting**







Source: Rajesh Gupta, CSE, Calit2

Launch of ZEVnet Fleet of Wireless Cars--
First Calit2 Testbed for Intelligent Transportation

TOY



April 18,
Irvine,
www.zevn

Toyota Delivers Plug-in Prius to UC Irvine and UC Berkeley as Part of Clean Mobility Partnership





TORRANCE, Calif., Nov. 9, 2007 -- Toyota Motor Sales, U.S.A.,

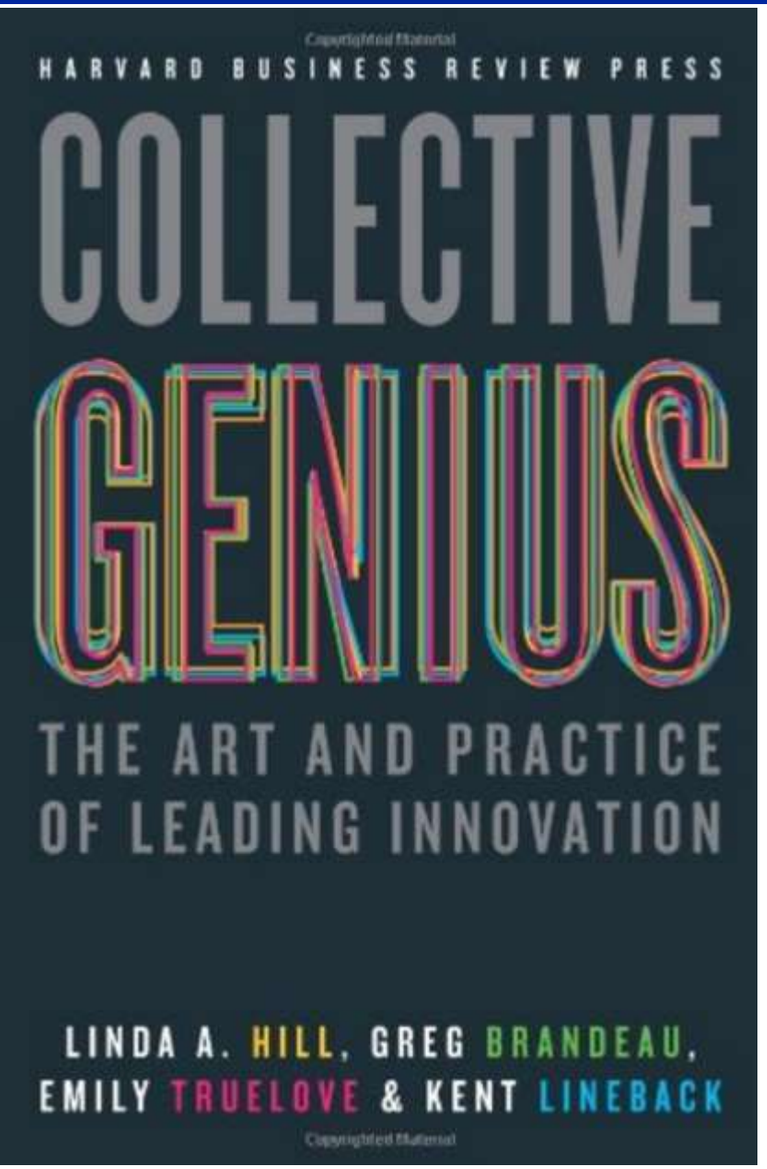




Natio
Universit

TUDIES

Independent Analysis of Calit2:
Harvard Business School's Case Study on Calit2



HARVARD | BUSINESS | SCHOOL

9-411-105

JUNE 8, 2011

LINDA A. HILL

ALISON BERKLEY WAGONFELD

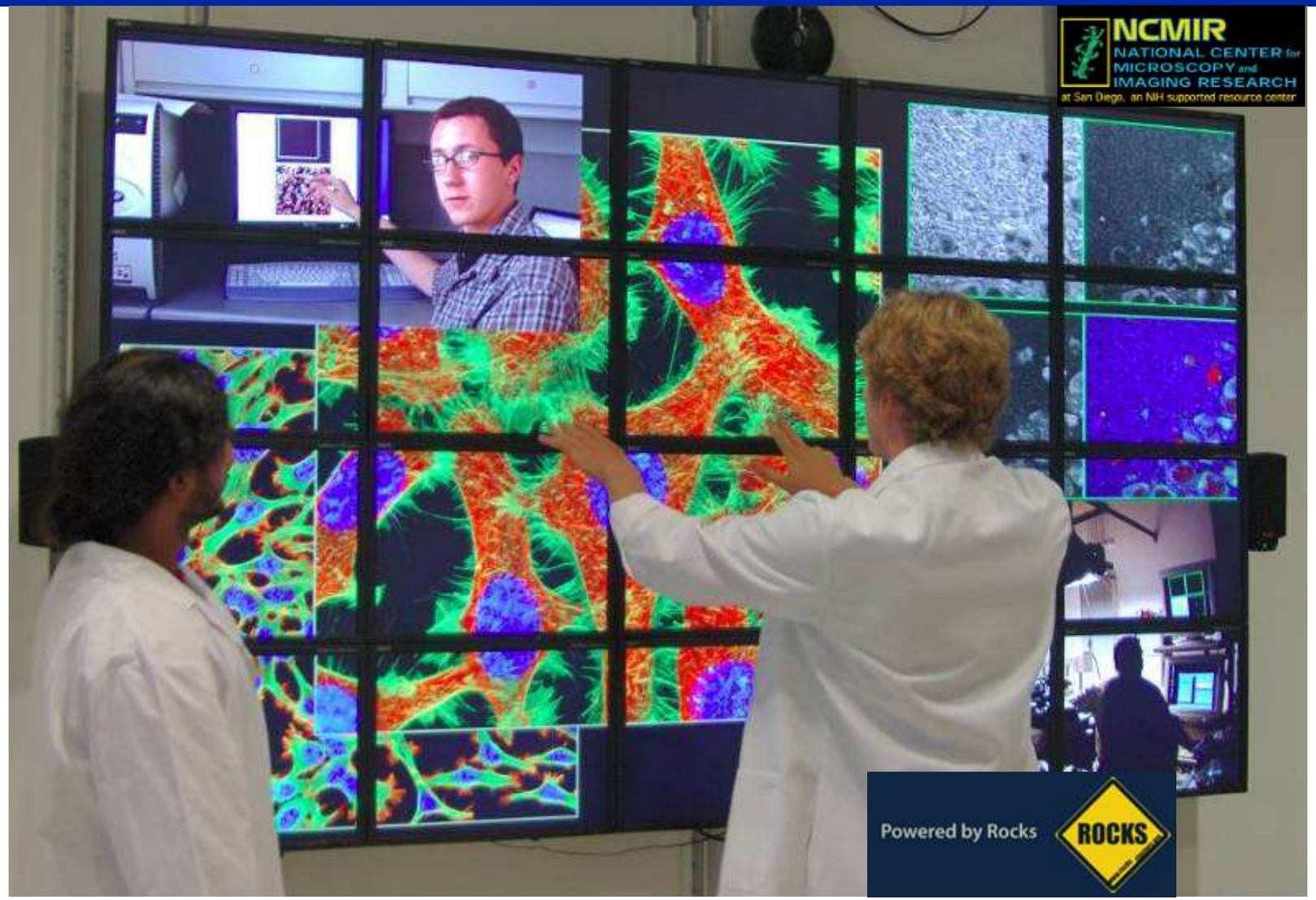
Calit2: A UC San Diego, UC Irvine Partnership

June 10, 2014

NSF's OptIPuter Project: Demonstrating How SuperNetworks Can Meet the Needs of Data-Intensive Researchers

LS Slide 2005

OptIPortal– Termination Device for the OptIPuter Global Backplane



2003-2009
$13,500,000

In August 2003, Jason Leigh and his students used RBUDP to blast data from NCSA to SDSC over the TeraGrid DTFnet, achieving18Gbps file transfer out of the available 20Gbps

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

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!

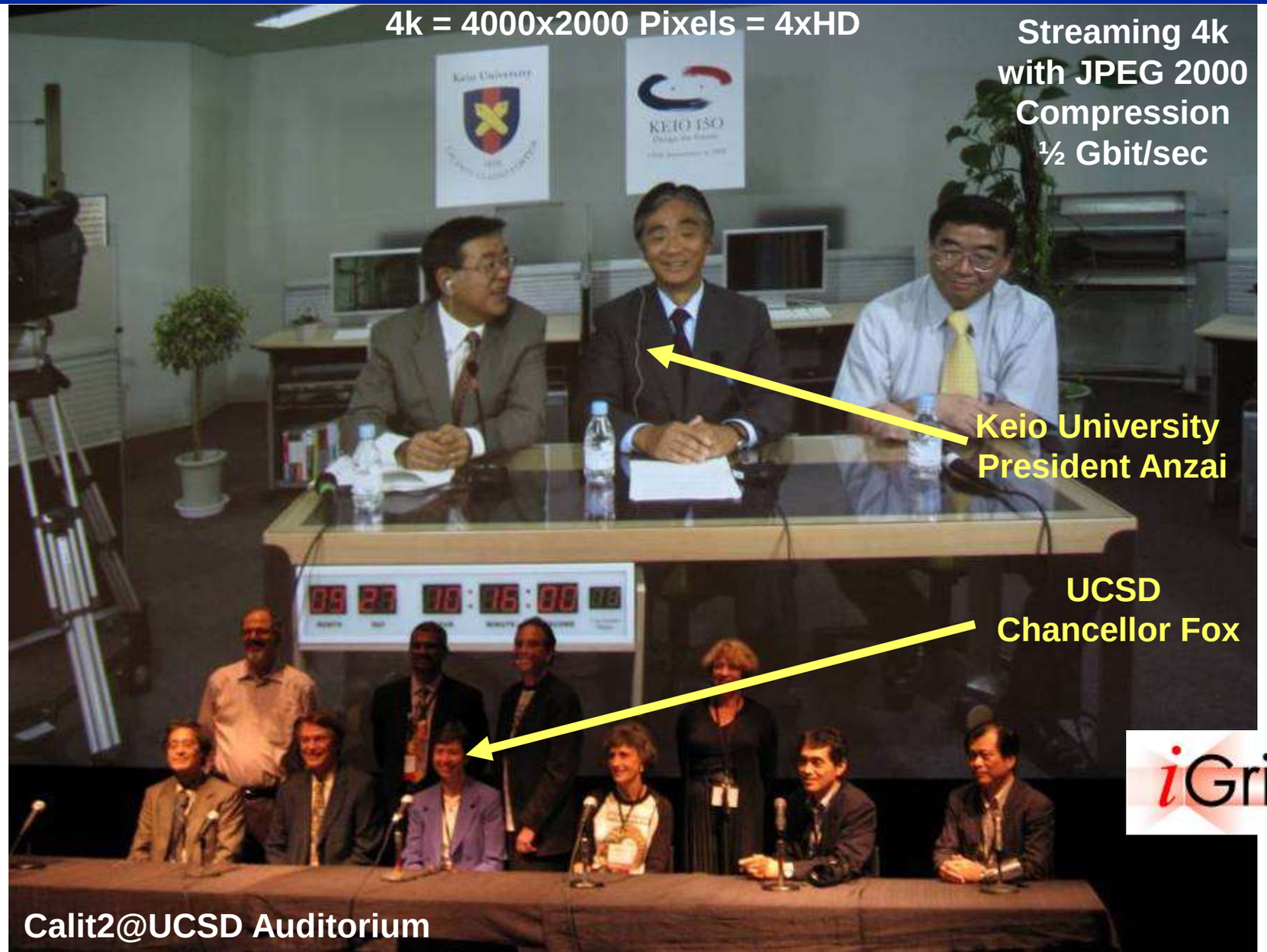


"I can see every hair on your head!"—Prof. Aoyama

Source: U Washington Research Channel

Calit2 First Event-First Trans-Pacific Telepresence Meeting Using Digital Cinema 4k Streams

September 2005



CineGrid

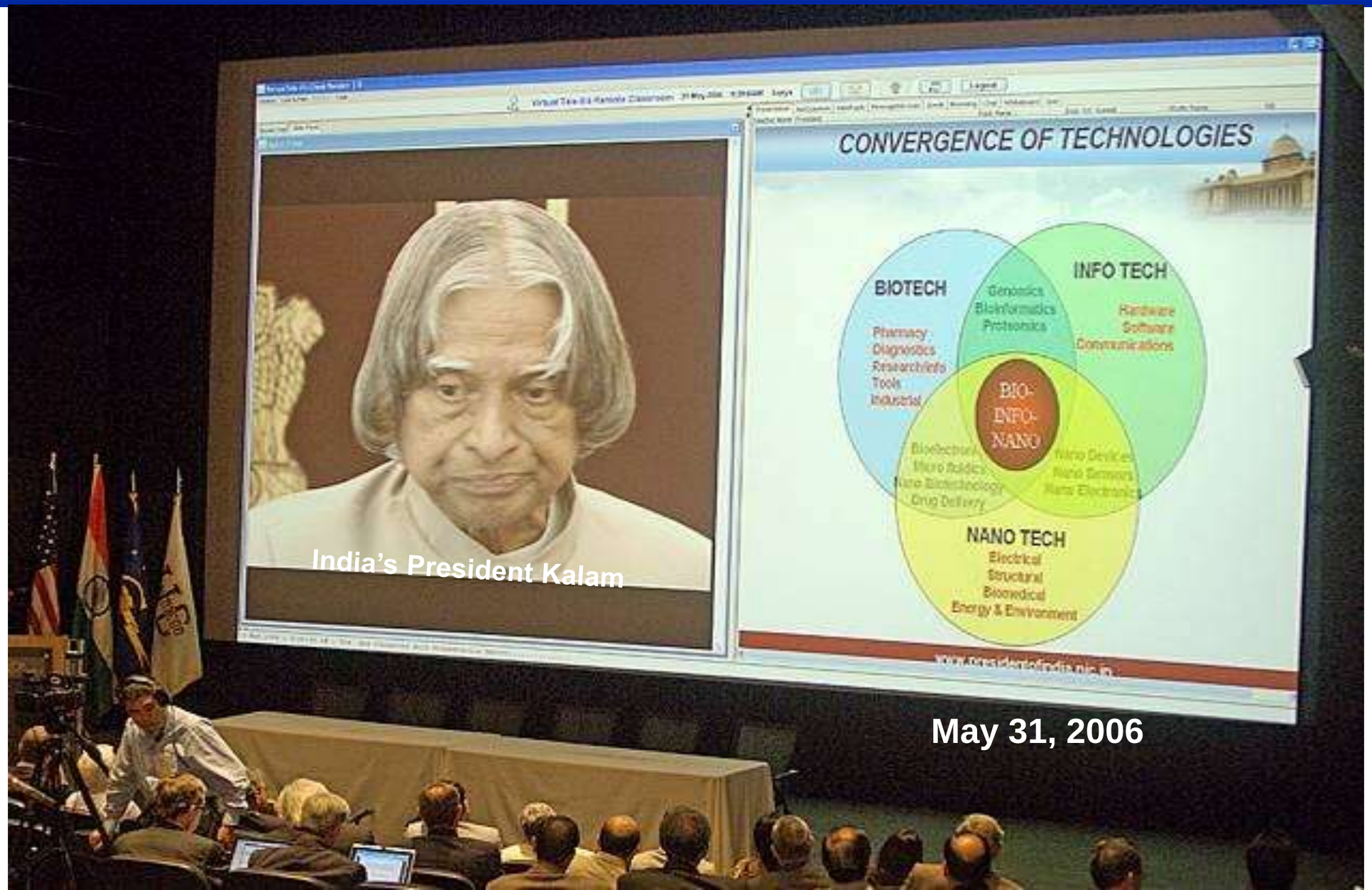
Lays Technical Basis for Global Digital Cinema

Sony
NTT
SGI

iGrid 2005

it²

Building a Global Collaboratorium: India's President Kalam Gives Lecture to Calit2



Launch of the 100 Megapixel OzIPortal Over Qvidium Compressed HD on 1 Gbps CENIC/PW/AARNet Fiber



ROCKS

January 15, 2008

OptIPuter

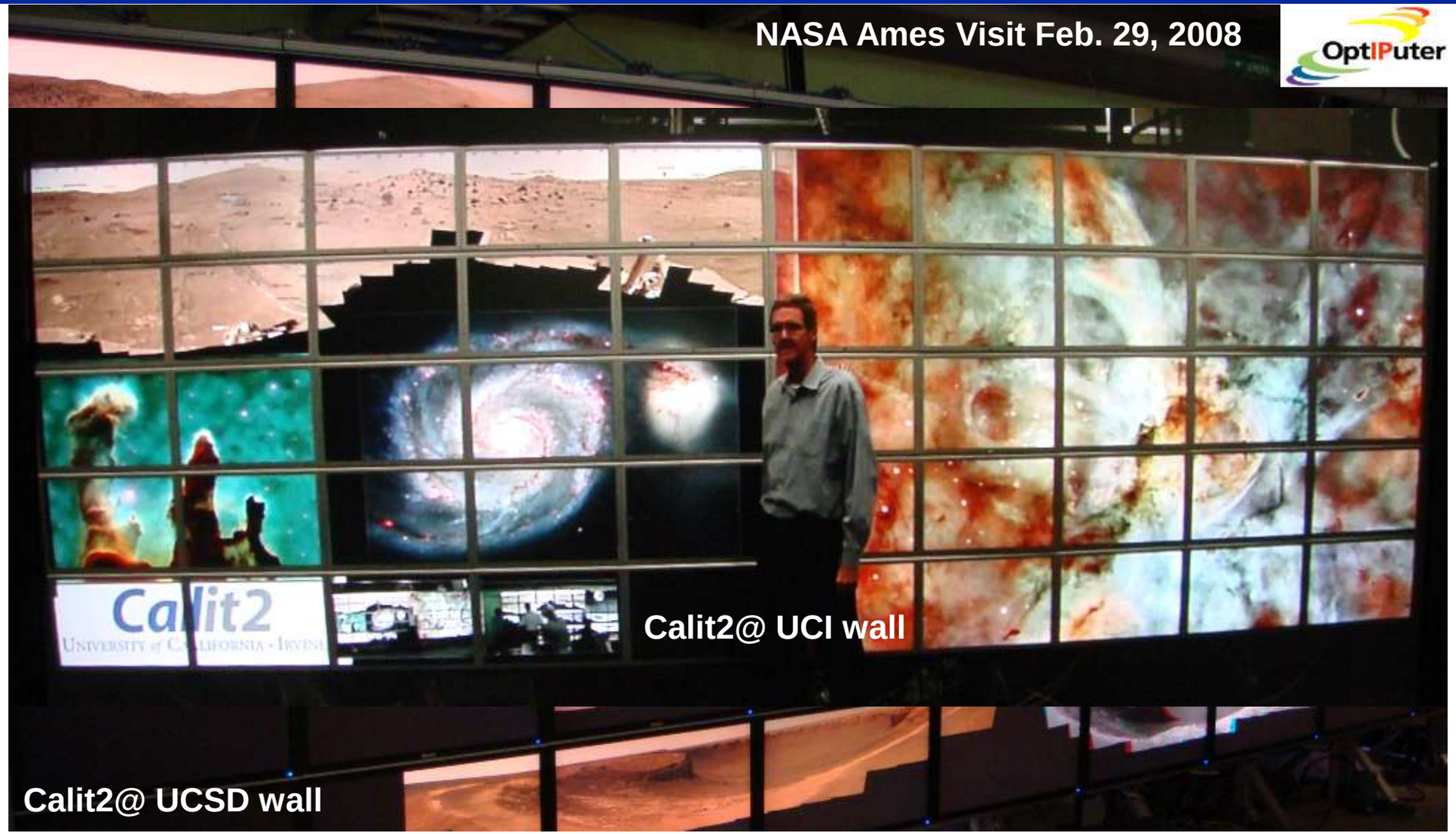
www.calit2.net/newsroom/release.php?id=1219

Victoria Premier and Australian Deputy Prime Minister Asking Questions



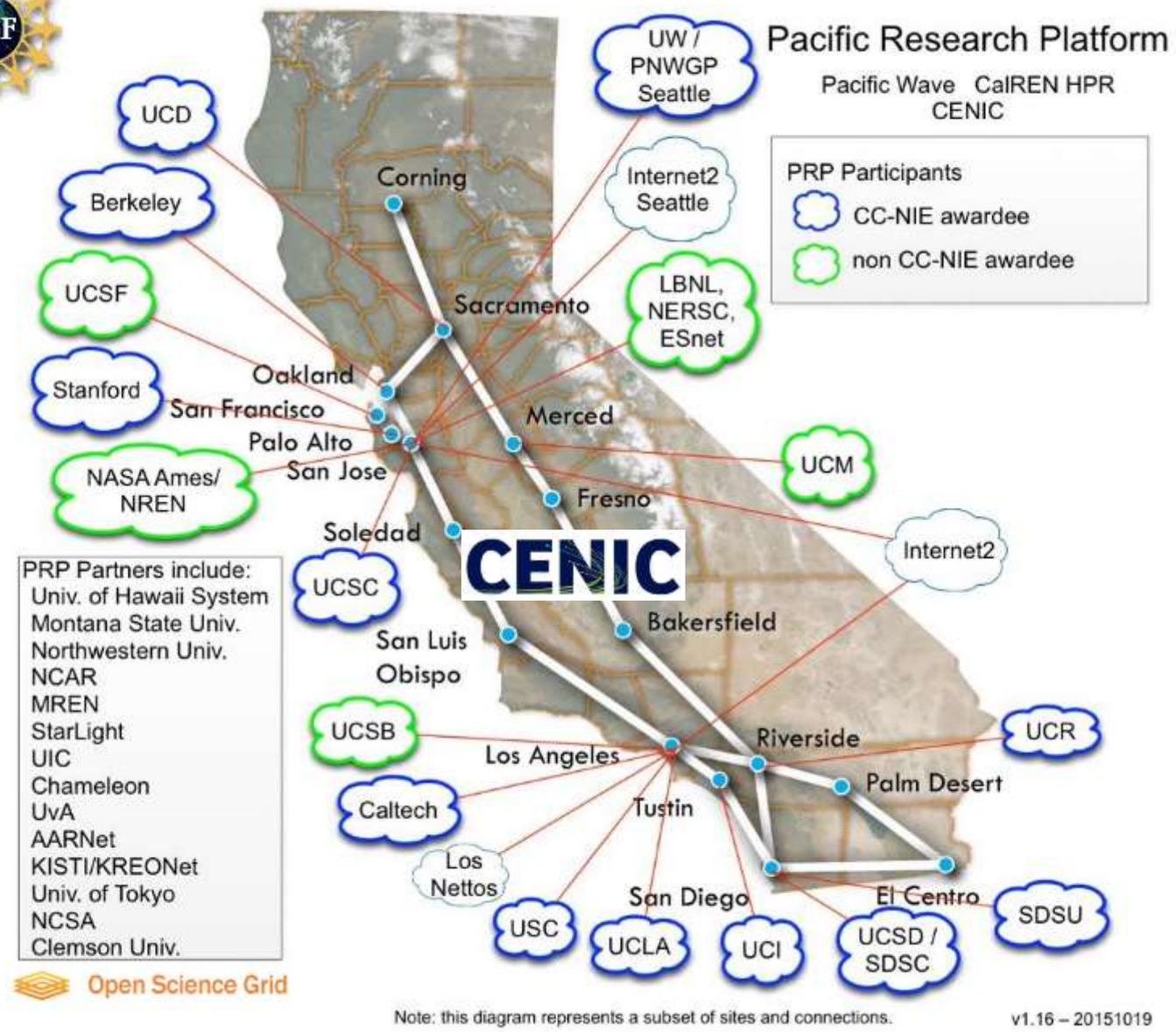
www.calit2.net/newsroom/release.php?id=1219

The Calit2 200 Megapixel OptIPortals at UCSD and UCI Are Now a Gbit/s HD Collaboratory



NASA Ames is Completing a 245 Mpixel Hyperwall as Project Columbia Interface

Next Step: The Pacific Research Platform Creates a Regional End-to-End Science-Driven "Big Data Superhighway" System



NSF CC*DNI Grant
$5M 10/2015-10/2020

PI: Larry Smarr, UC San Diego Calit2
Co-Pis:

- **Camille Crittenden, UC Berkeley CITRIS,**
- **Tom DeFanti, UC San Diego Calit2,**
- **Philip Papadopoulos, UCSD SDSC,**
- **Frank Wuerthwein, UCSD Physics and SDSC**

Source:
John Hess, CENIC

Reverse Engineering of the Brain is Becoming a Reality

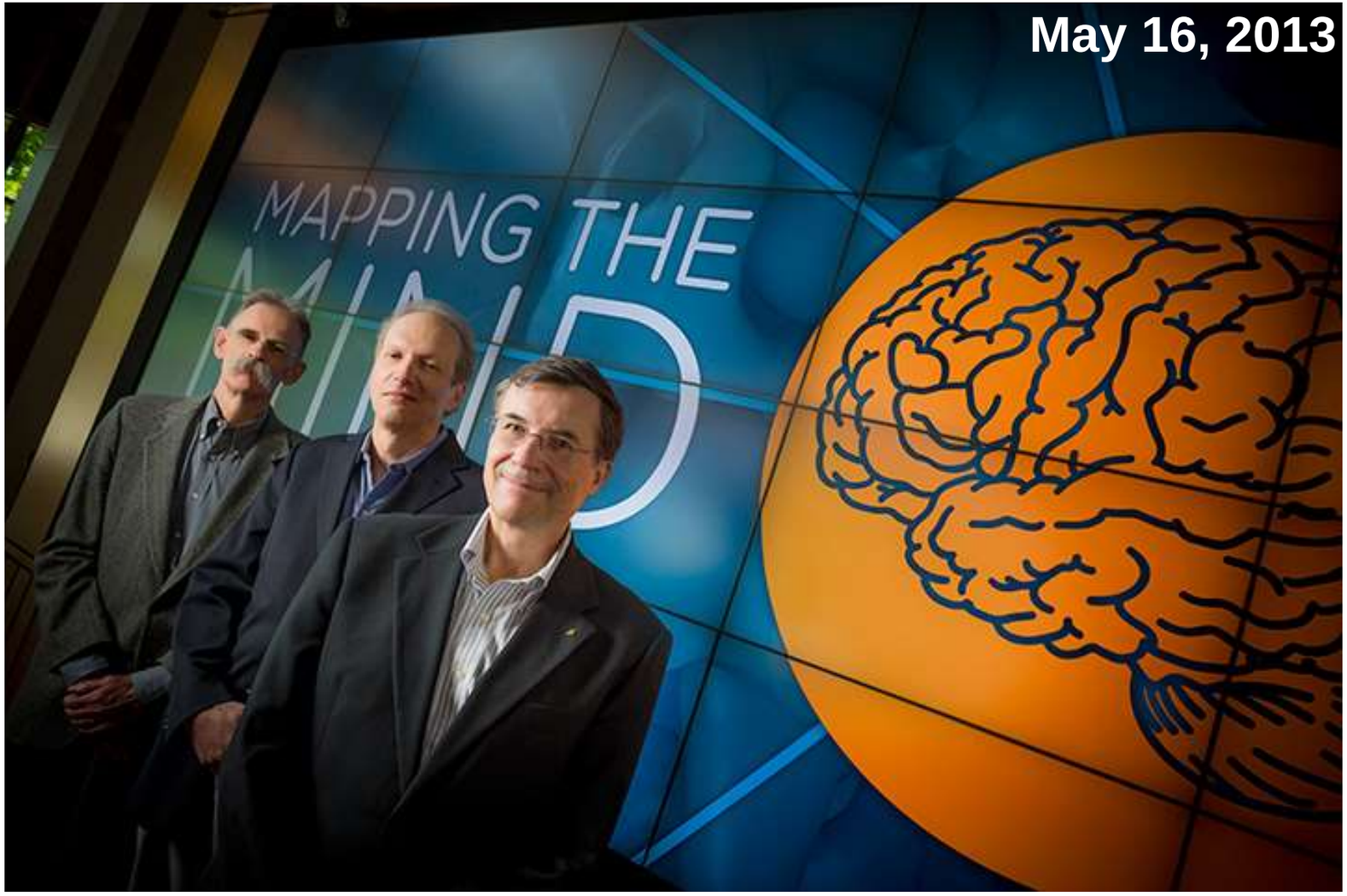


www.whitehouse.gov/infographics/brain-initiative

UC San Diego Creates Center for Brain Activity Mapping

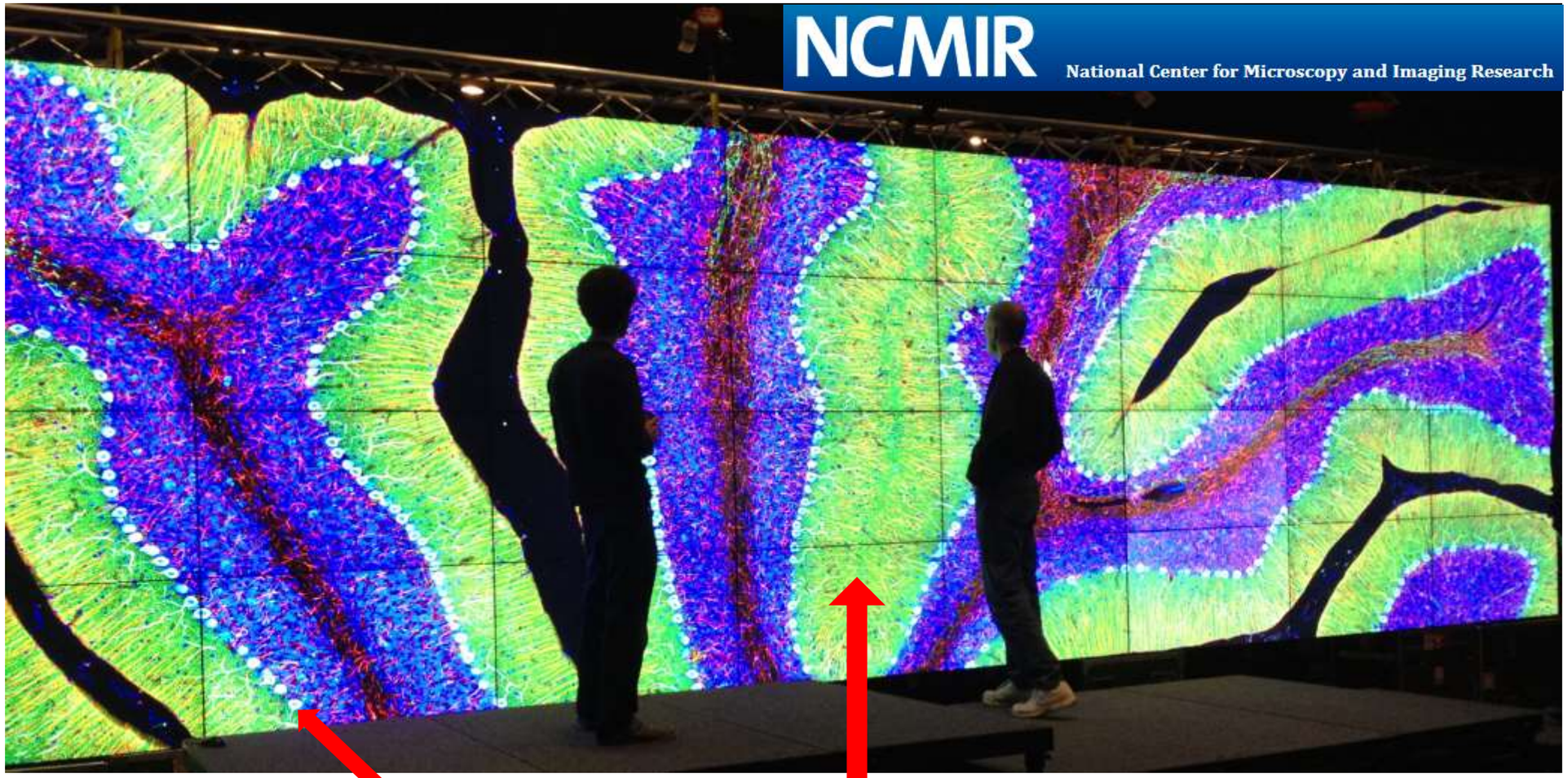
http://ucsdnews.ucsd.edu/feature/uc_san_diego_creates_center_for_brain_activity_mapping

May 16, 2013



From left, Nick Spitzer, Ralph Greenspan, and Terry Sejnowski.
Photos by Erik Jepsen/UC San Diego Publications

Reverse Engineering of the Brain:
Large Scale Microscopy of Mammal Brains Reveals Complex Connectivity



Neuron Cell Bodies

Neuronal Dendritic Overlap Region



Source: Rat Cerebellum Image, Mark Ellisman, UCSD

The Rise of Brain-Inspired Computers:
Left & Right Brain Computing: Arithmetic vs. Pattern Recognition



Adapted from D-Wave

Calit2's Qualcomm Institute Has Established a Pattern Recognition Lab For Machine Learning on non-von Neumann Processors



UCSD ECE Professor Ken Kreutz-Delgado Brings the IBM TrueNorth Chip to Start Calit2's Qualcomm Institute Pattern Recognition Laboratory September 16, 2015

Source: Dr. Dharmendra Modha
Founding Director, IBM Cognitive Computing Group

New Brain-Inspired Non-von Neumann Processors Are Emerging: KnuEdge Has Provided Processor to Calit2's PRL

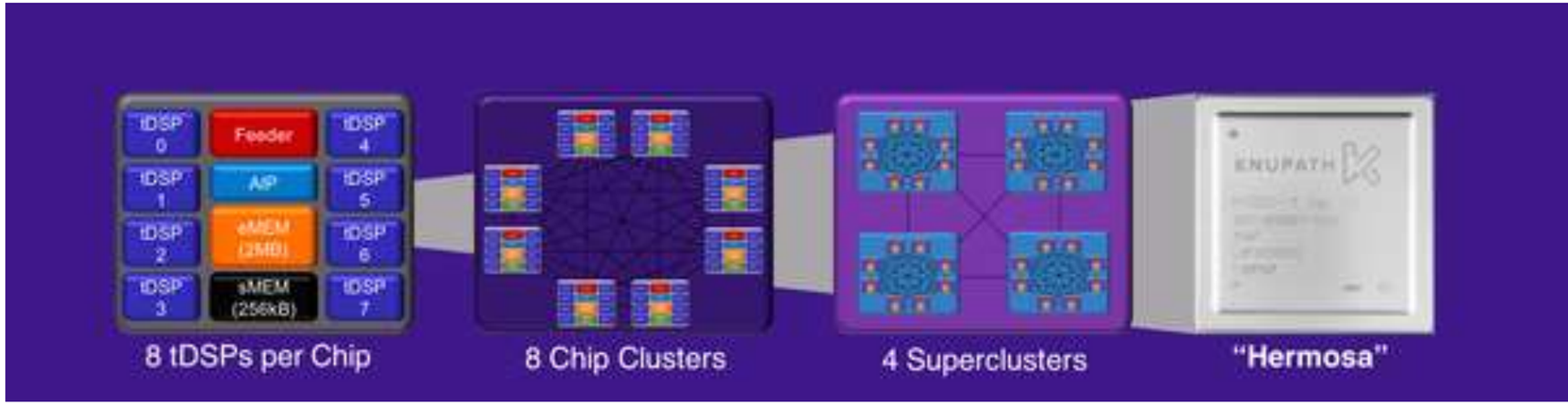
Former NASA Chief Develops Brain-Like Chips

Dan Goldin's startup, KnuEdge, has been working in secret for 10 years on a new kind of computing that mimics the human brain

THE WALL STREET JOURNAL. **June 6, 2016**

"KnuEdge and Calit2 have worked together since the early days of the KnuEdge LambdaFabric processor, when key personnel and technology from UC San Diego provided the genesis for the first processor design."

www.calit2.net/newsroom/release.php?id=2726



www.tomshardware.com/news/knuedge-announces-knuverse-and-knupath,31981.html

KNUEDGE

www.calit2.net/newsroom/release.php?id=2704

Artificial Intelligence (AI) is Advancing at a Amazing Pace: Deep Learning Algorithms Working on Massive Datasets

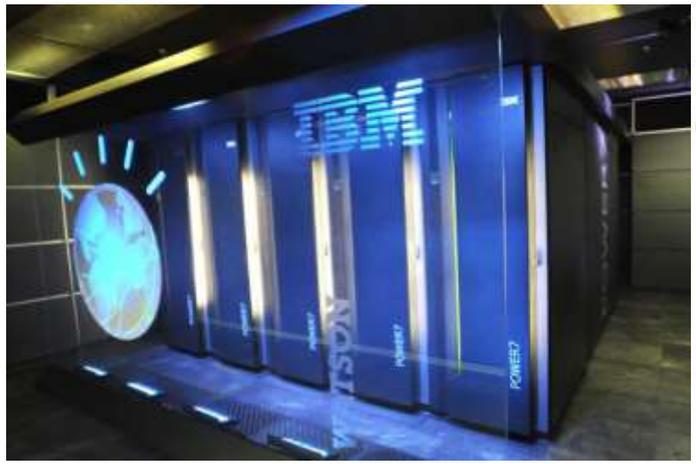


Training on 30M Moves, Then Playing Against Itself



Less Than 2 Years!

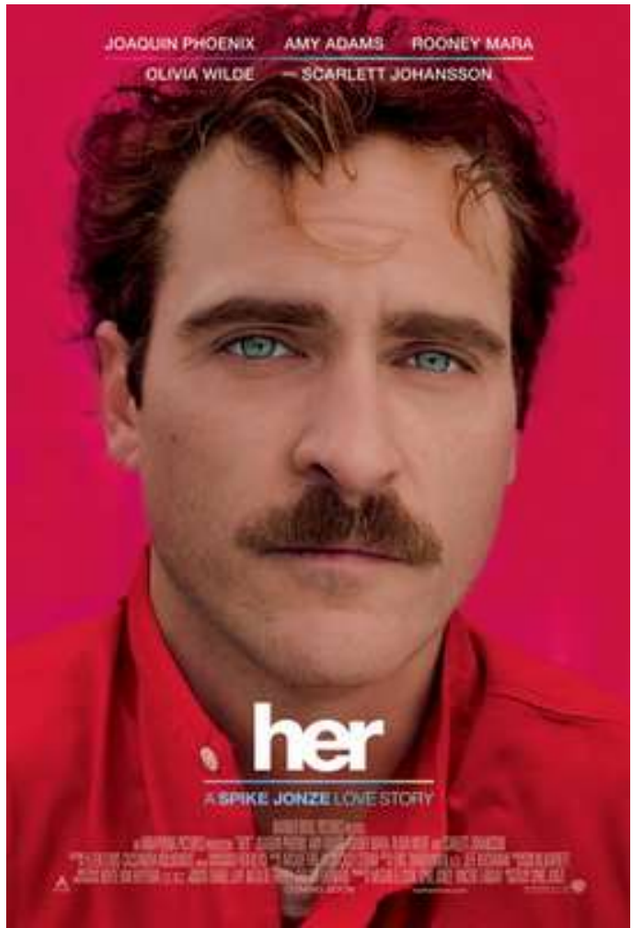
Deep Learning Will Provide Artificial Intelligence Personalized Assistants



IBM's Watson supercomputer gets its own $1 billion business

IBN Live **January 10, 2014**

Where AI Coaching is Now



Where AI Coaching is Going