Surfing the Exponential for Forty Years

Invited Speaker
San Diego Science Festival
Patrick Henry High School
San Diego, CA
March 30, 2009

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

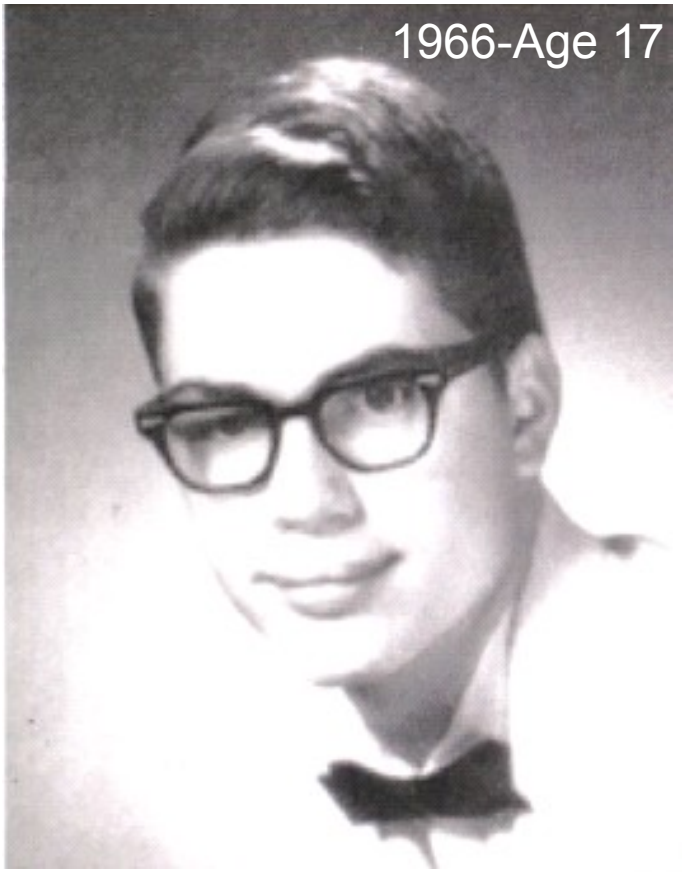
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From Early Engineering Experiences to Graduating from High School



I Studied Astronomy on My Own
from First Grade Through High School

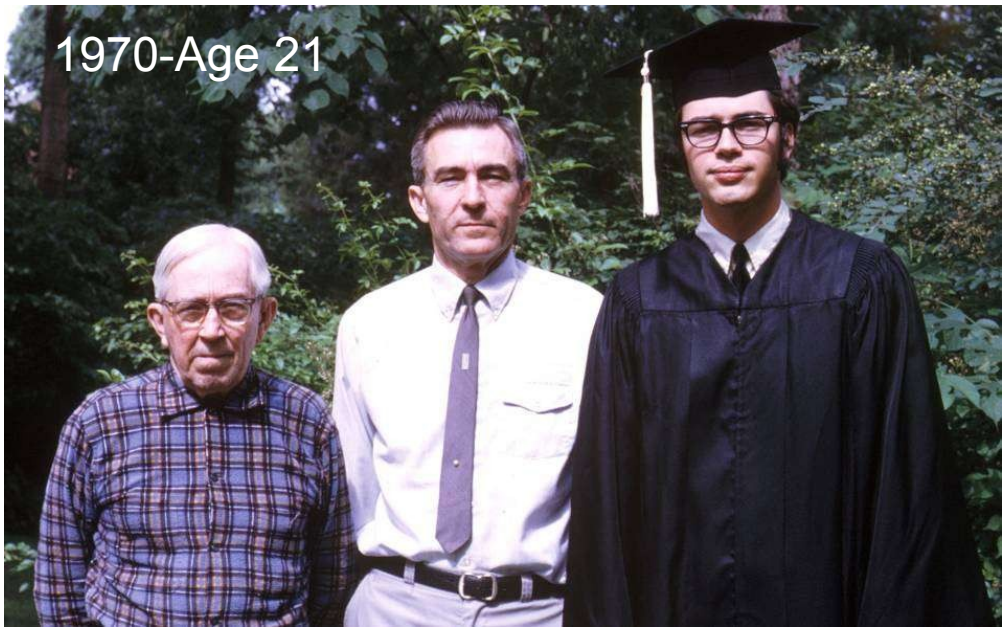


I Took My First Course
in Computer Programming in 1966

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Graduating from College to My First PhD Student



Grandfather Father Me

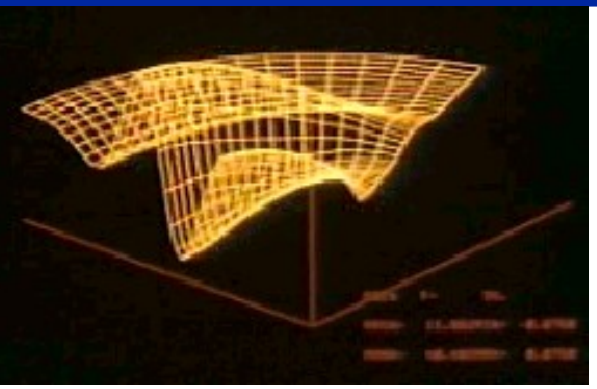
I Majored in Math and Physics as an Undergrad



I Applied Supercomputers to Einstein's Theory of General Relativity as a Graduate Student

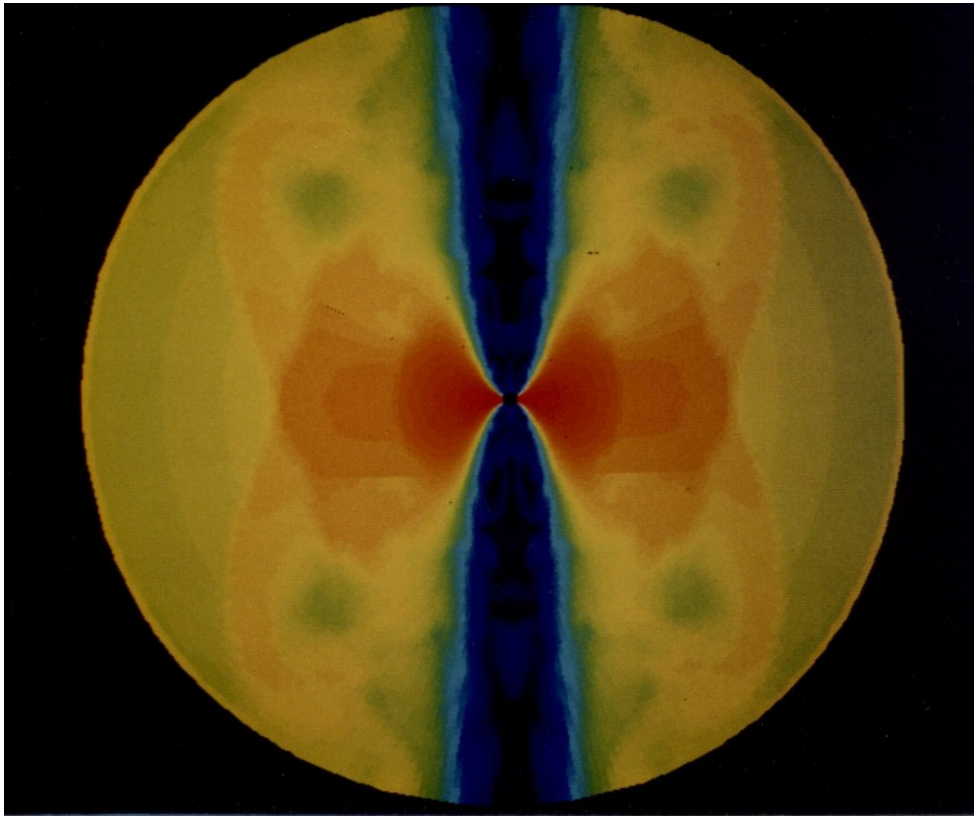
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I Then Used Supercomputers to Simulate Energetic Astrophysical Systems with my Co-Workers



Colliding Black Holes
Emit Gravitational Radiation

1973-1983



Gas Accretion Onto a Black Hole
Creates “Exhaust Channels”



Cosmic Jets
Emerge from
Galactic Centers

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I Explored the Andromeda Galaxy's Stellar Bulge Using Radio, Optical, and X-Ray Telescopes





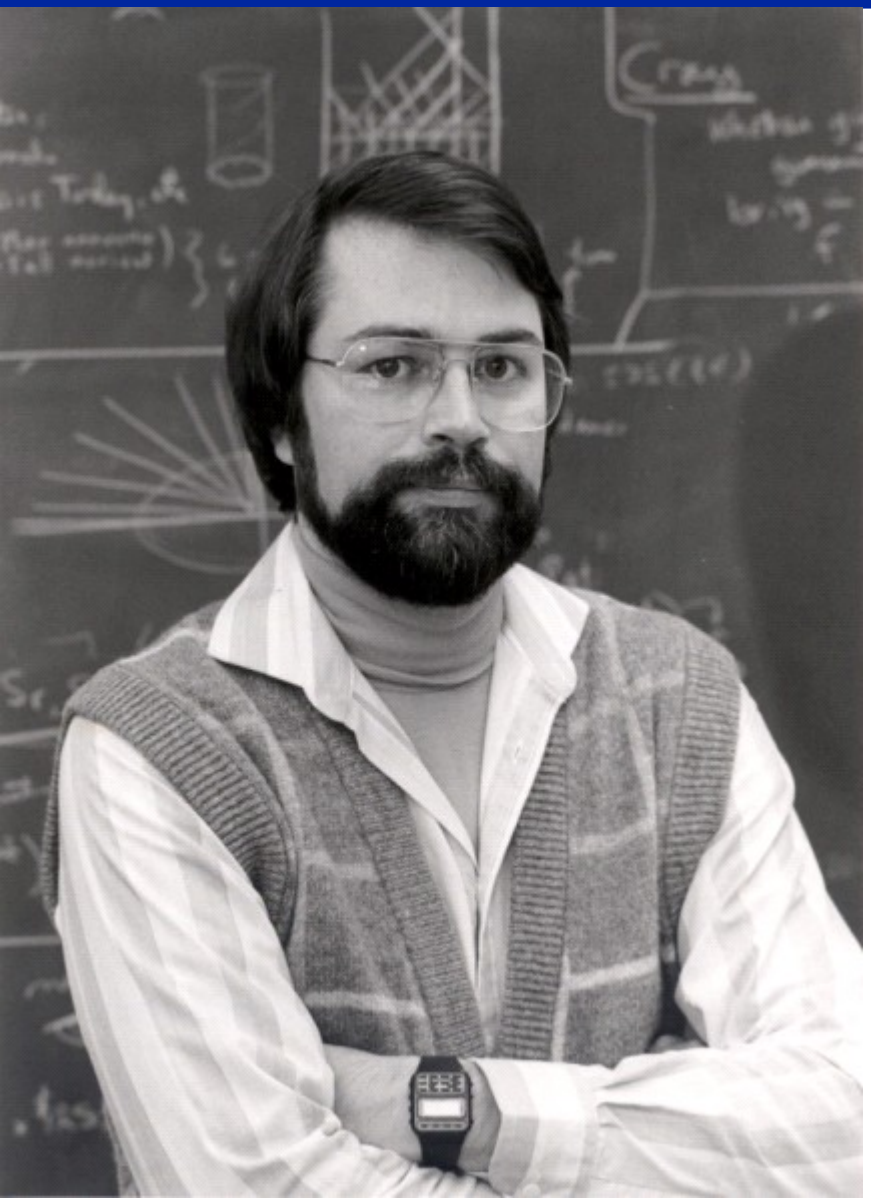




1978-1983

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From Dreams of a Supercomputer Center to Owning a Cray



1983-1985

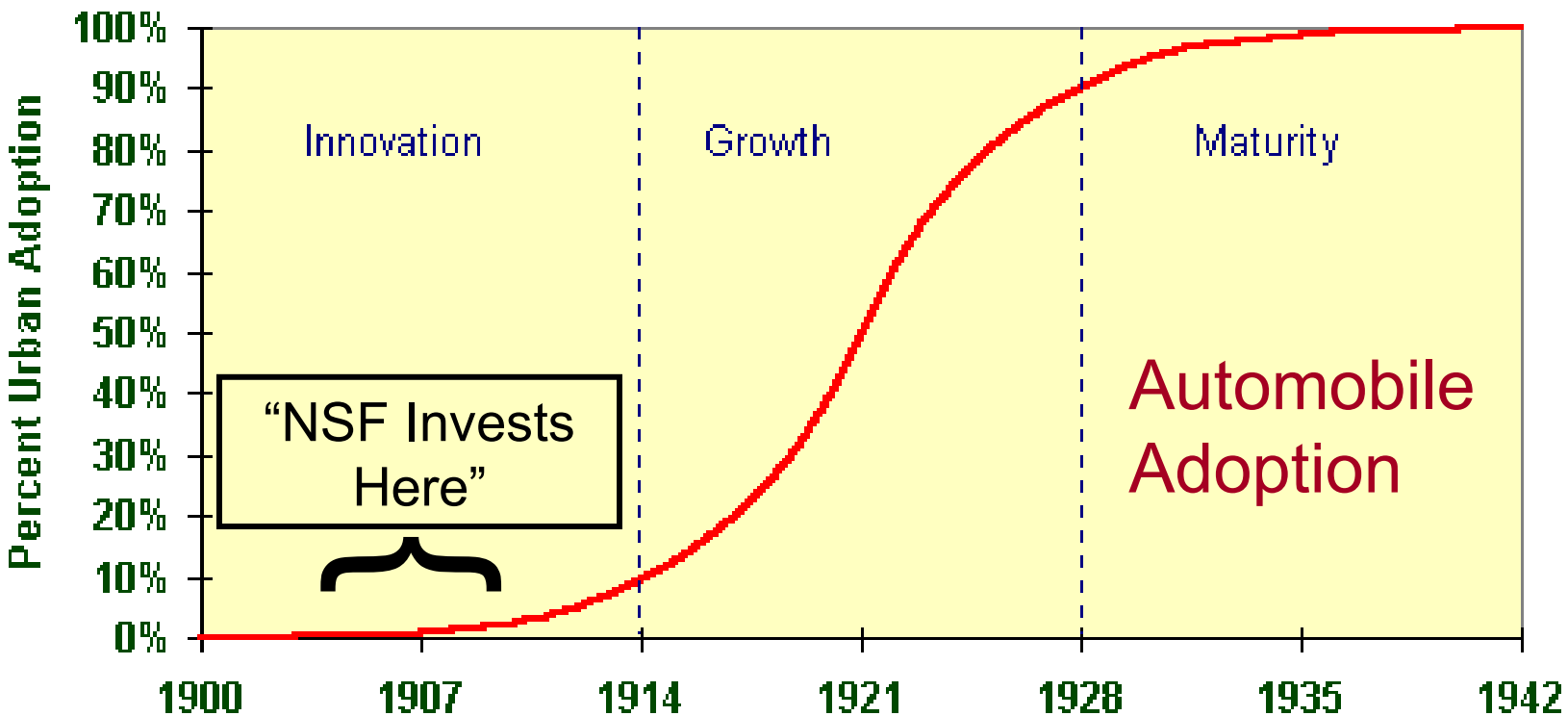


Remember to Get Married and
Have a Family…

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From Elite Science to the Mass Market

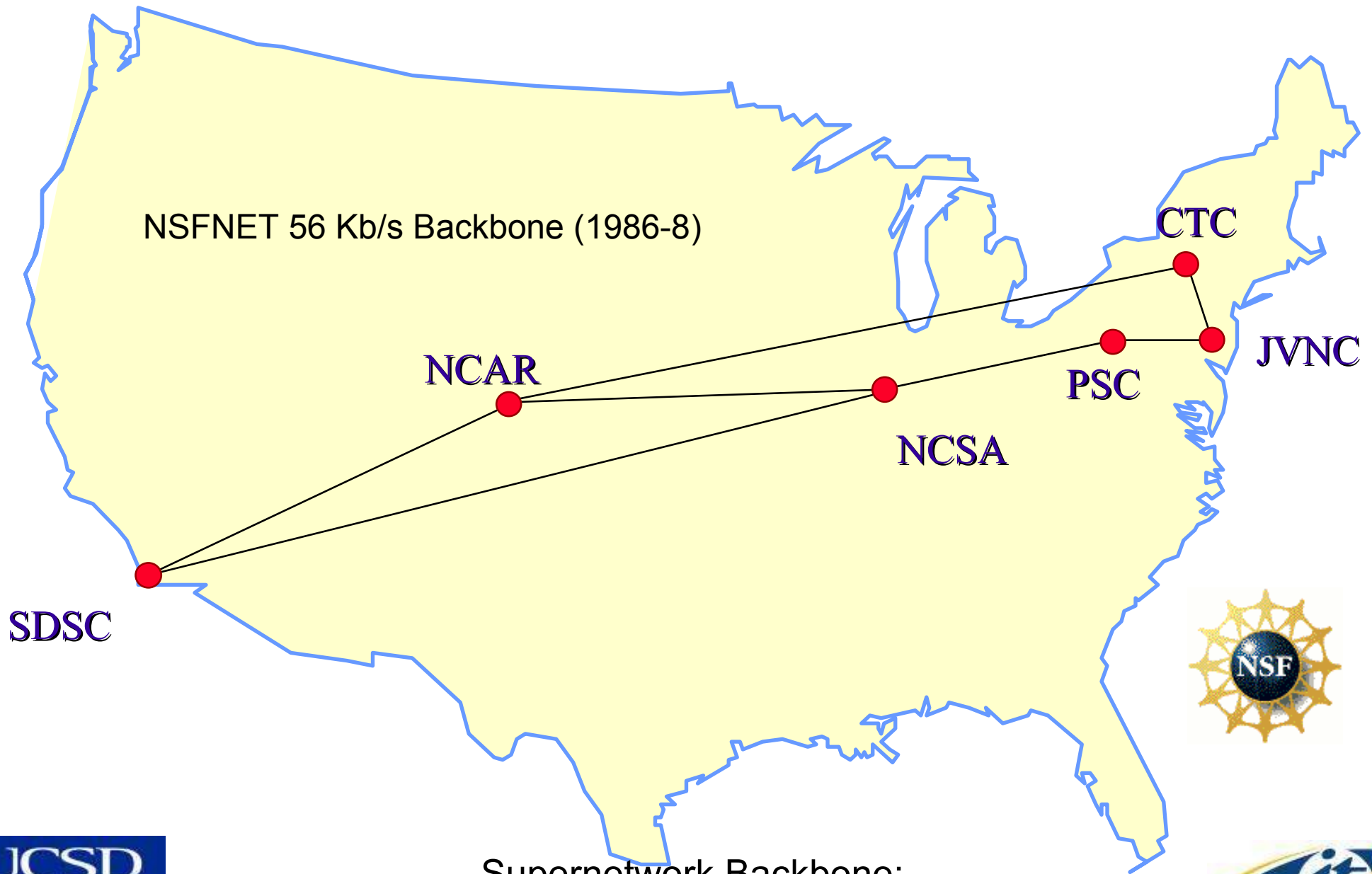
Technologies Diffuse Into Society Following an S-Curve



Source: Harry Dent, The Great Boom Ahead

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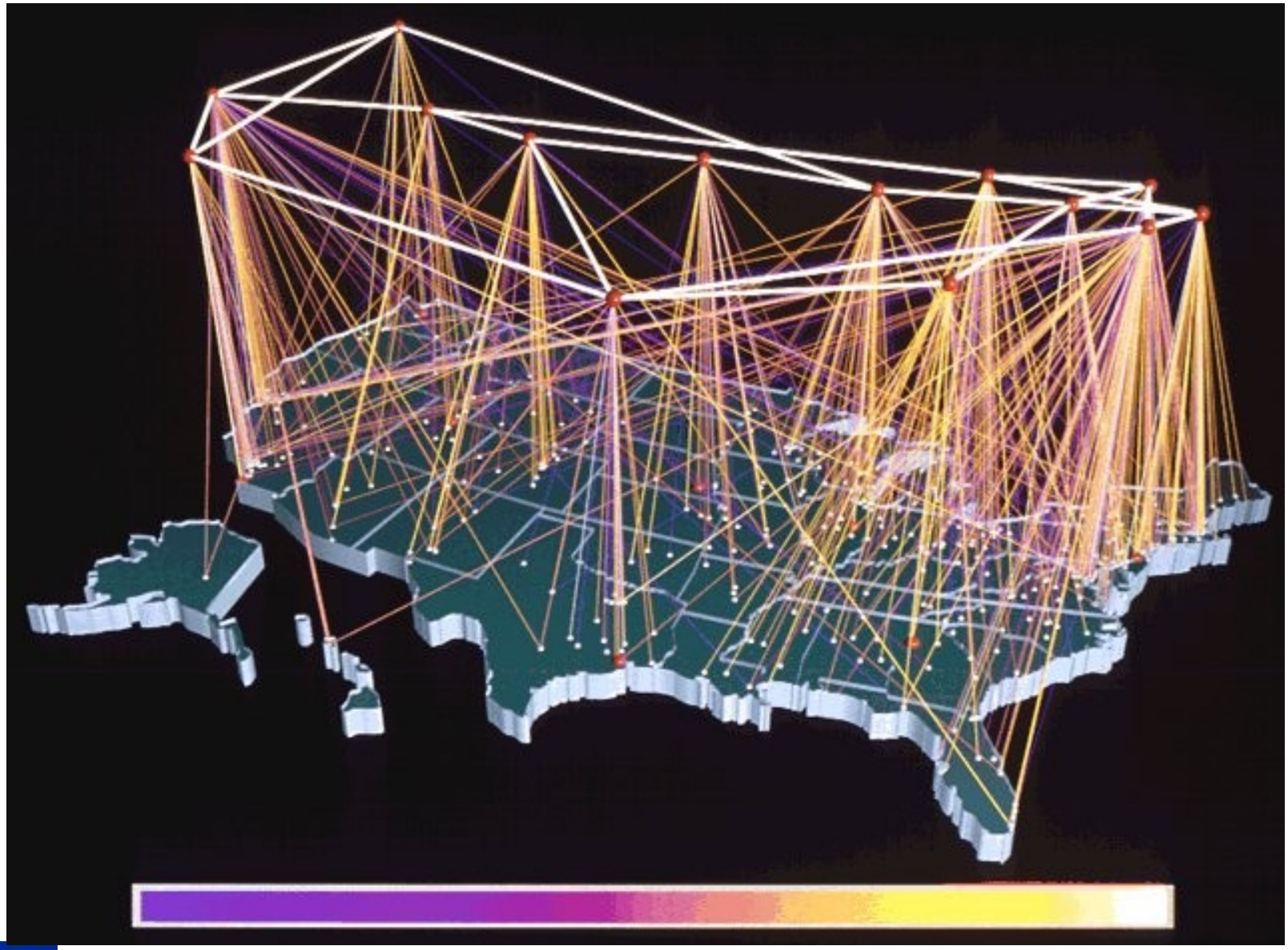
Launching the Nation's Information Infrastructure: NSFnet Supernetwork and the Six NSF Supercomputers



Supernetwork Backbone:
56kbps is 50 Times Faster than 1200 bps PC Modem!

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The NSFnet was Commercialized in 1995 Leading to Today's Internet



Visualization by NCSA's Donna Cox and Robert Patterson
Traffic on 45 Mbps Backbone December 1994

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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



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From Scientific Visualization of Supercomputing Science to Movie Special Effects







Computer Graphics
From NCSA to ILM







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

Public Service is an Important Part of the Life of a Scientist



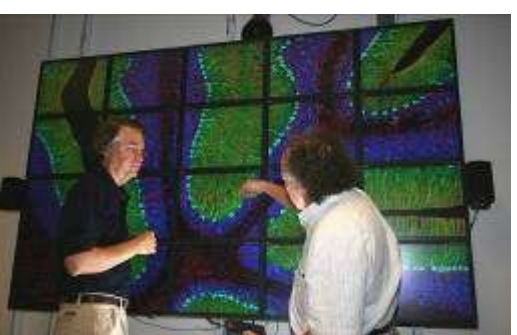
The President's Information Technology Advisory Committee Delivers its Report to Vice President Gore in the White House 1998

"Broadband" Depends on Your Application: Data-Intensive Science Needs Supernetworks









- **Mobile Broadband**
  - **0.1-0.5 Mbps**

100,000 Fold Range
All Here Today!

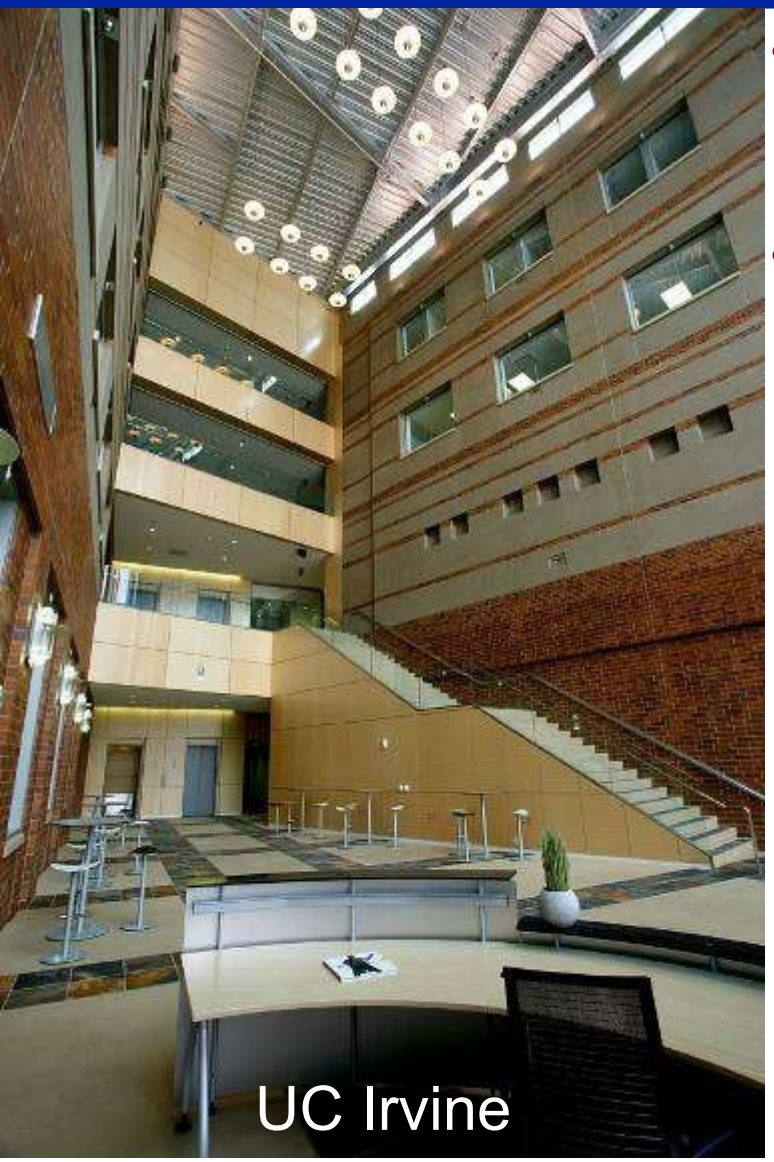
- **Home Broadband**
  - **1-5 Mbps**

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

- **University Dorm Room Broadband**
  - **10-100 Mbps**

- **Dedicated Supernetwork Broadband**
  - **1,000-10,000 Mbps**

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



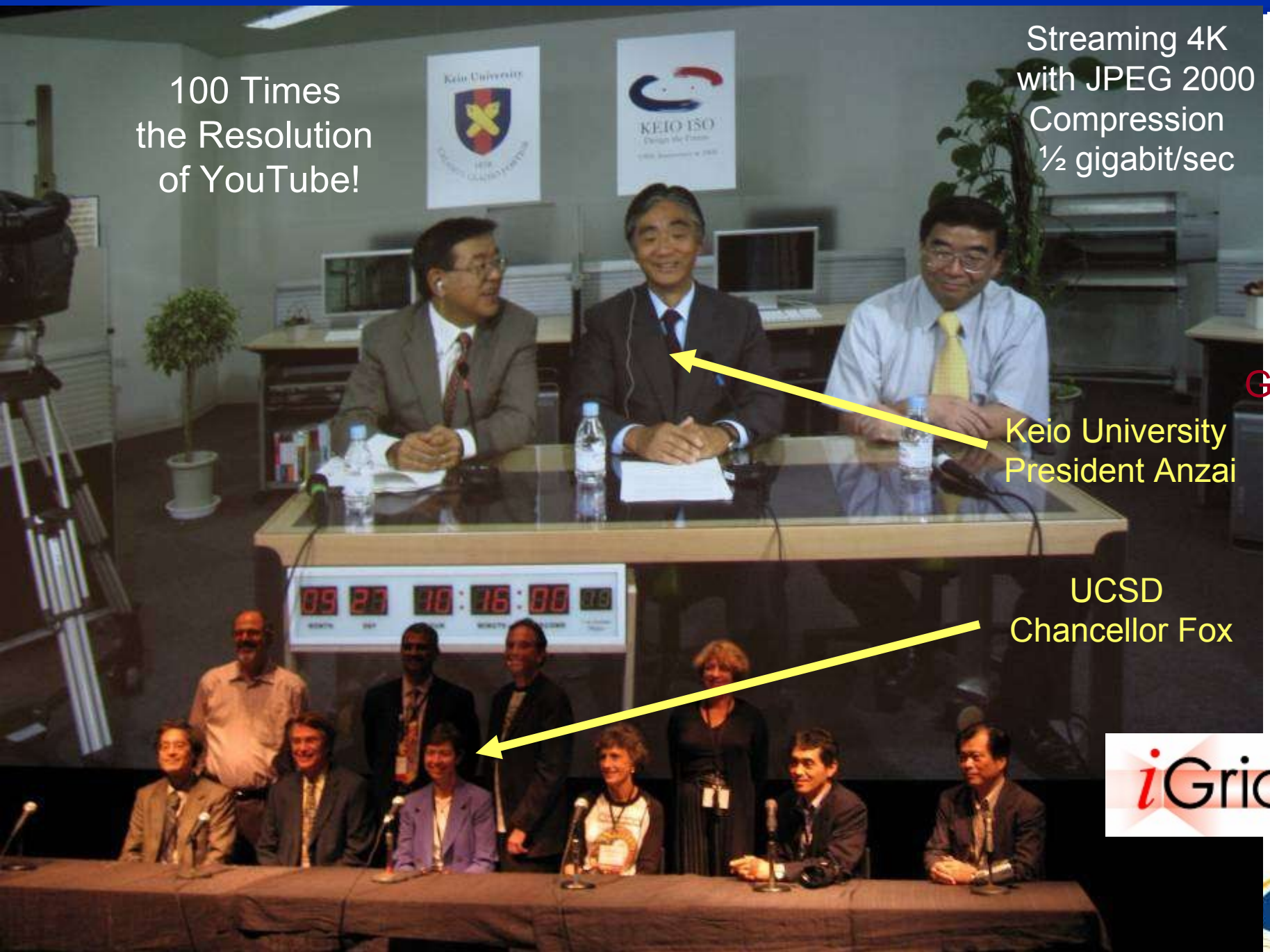
www.calit2.net

Preparing for a World in Which Distance is Eliminated…

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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

Remote Interactive High Definition Video of Deep Sea Hydrothermal Vents



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Source John Delaney & Deborah Kelley, UWash

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NSF's OptIPuter Project: Using Supernetworks to Meet the Needs of Data-Intensive Researchers

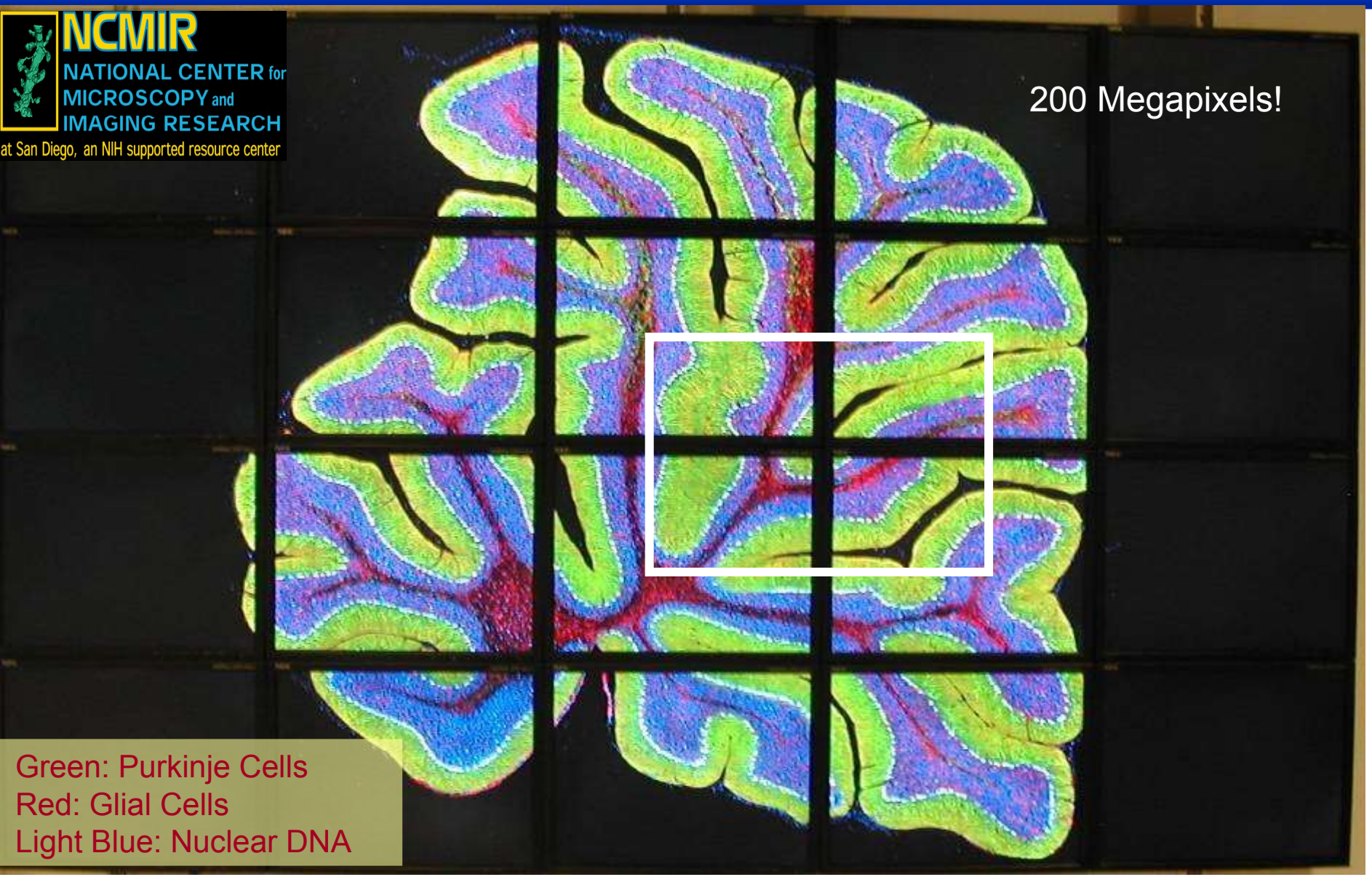


OptIPortal–Termination Device for the OptIPuter Global Backplane

Powered by Rocks

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

OptIPuter Scalable Displays Are Used for Multi-Scale Biomedical Imaging



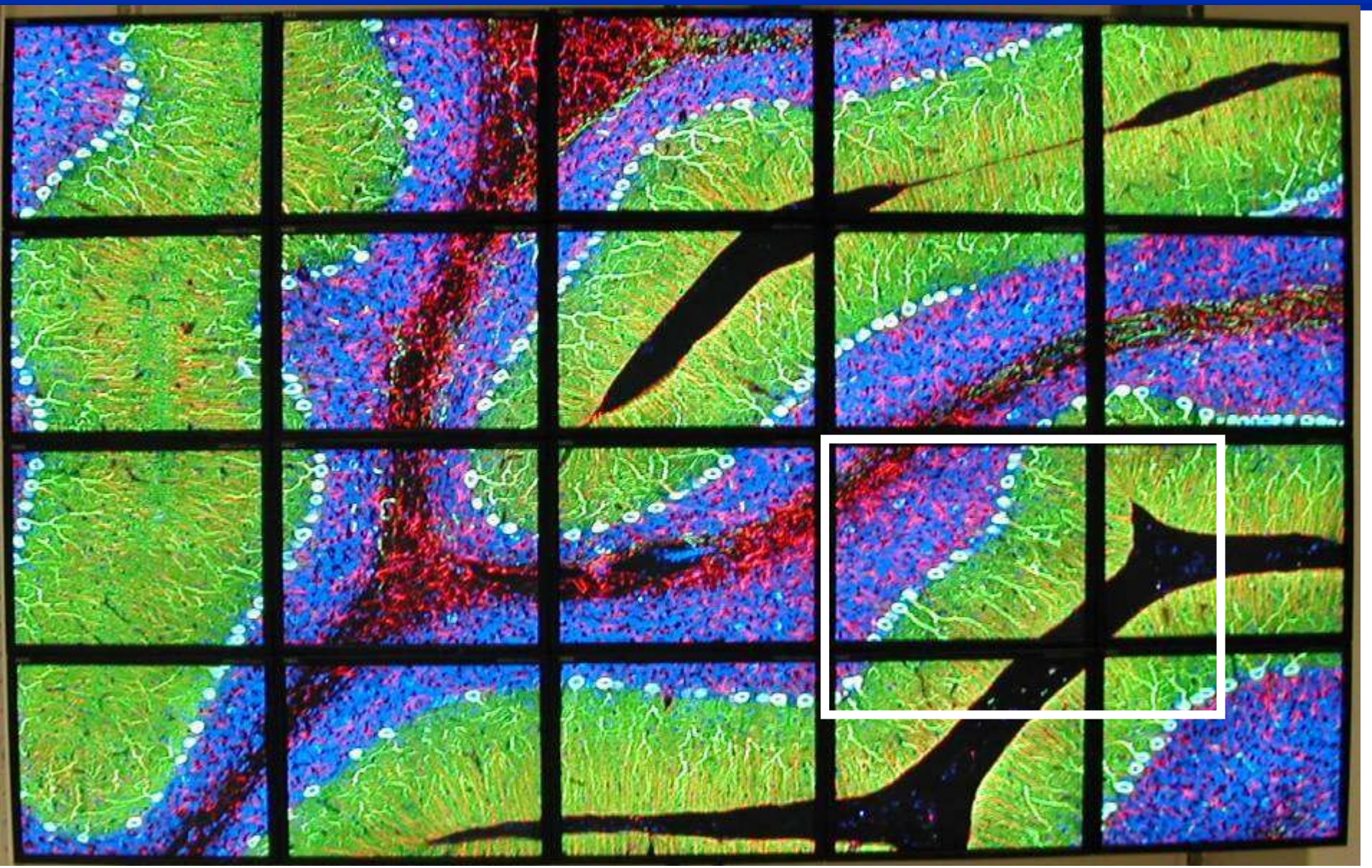
Source: Mark Ellisman, David Lee, Jason Leigh

Two-Photon Laser Confocal Microscope Montage of 40x36=1440 Images in 3 Channels of a Mid-Sagittal Section of Rat Cerebellum Acquired Over an 8-hour Period

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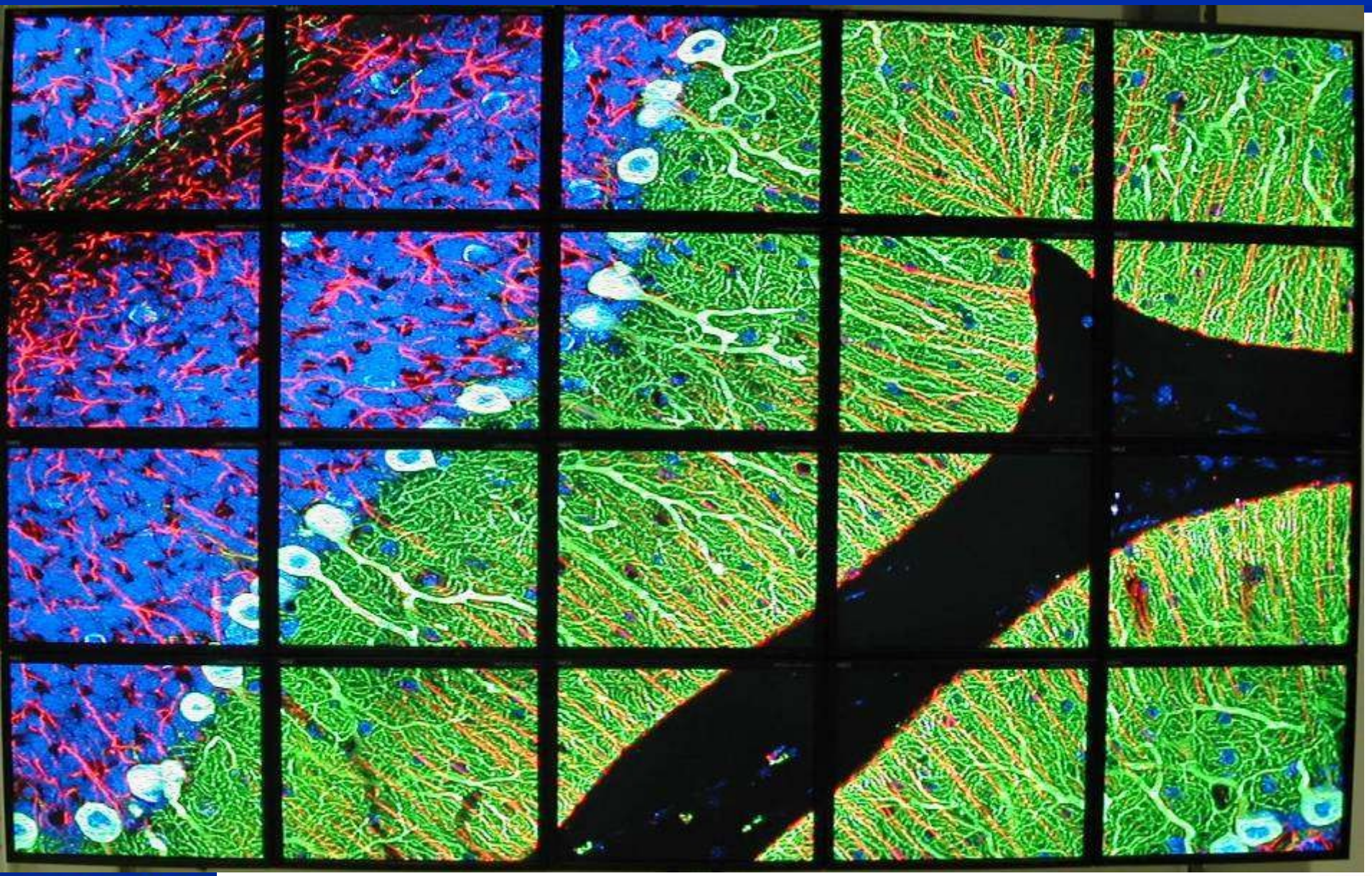
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Scalable Displays Allow Both Global Content and Fine Detail



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Allows for Interactive Zooming from Cerebellum to Individual Neurons



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Using Advanced Info Tech and Telecommunications to Accelerate Response to Wildfires

Early on October 23, 2007, Harris Fire San Diego



Calit2, SDSU, and NASA Goddard Used NASA Prioritization and OptIPuter Links to Cut Time to Receive Images from 24 to 3 Hours



NASA Earth Satellite Images
Wildfires October 2007
Calit2@San Diego

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Just in Time OptIPuter Collaboratory: Live Session with NASA Ames from Calit2



From Start to This Image in Less Than 2 Weeks!

View from NASA Ames Lunar Science Institute Mountain View, CA

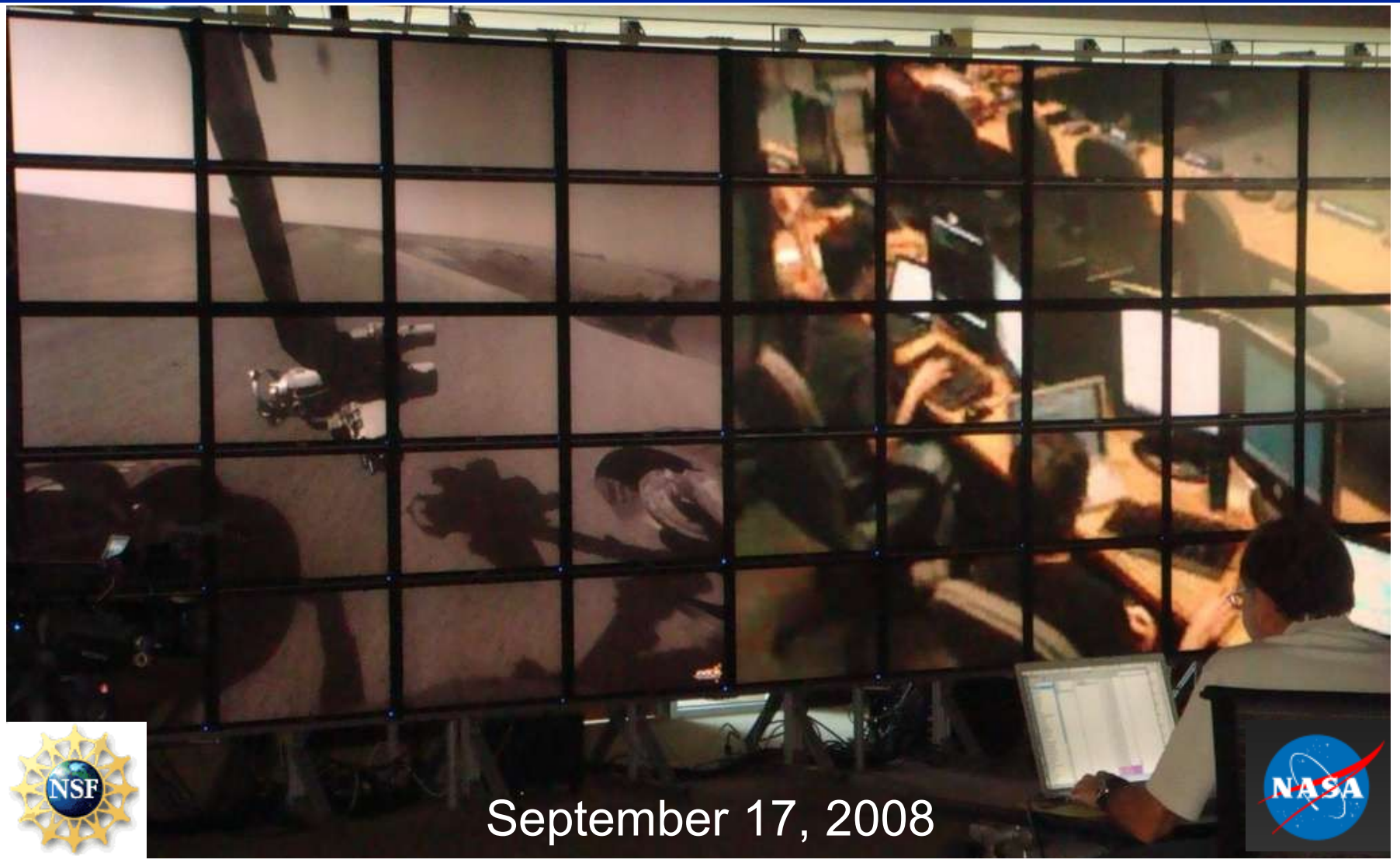
"Virtual Handshake"

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CGLX

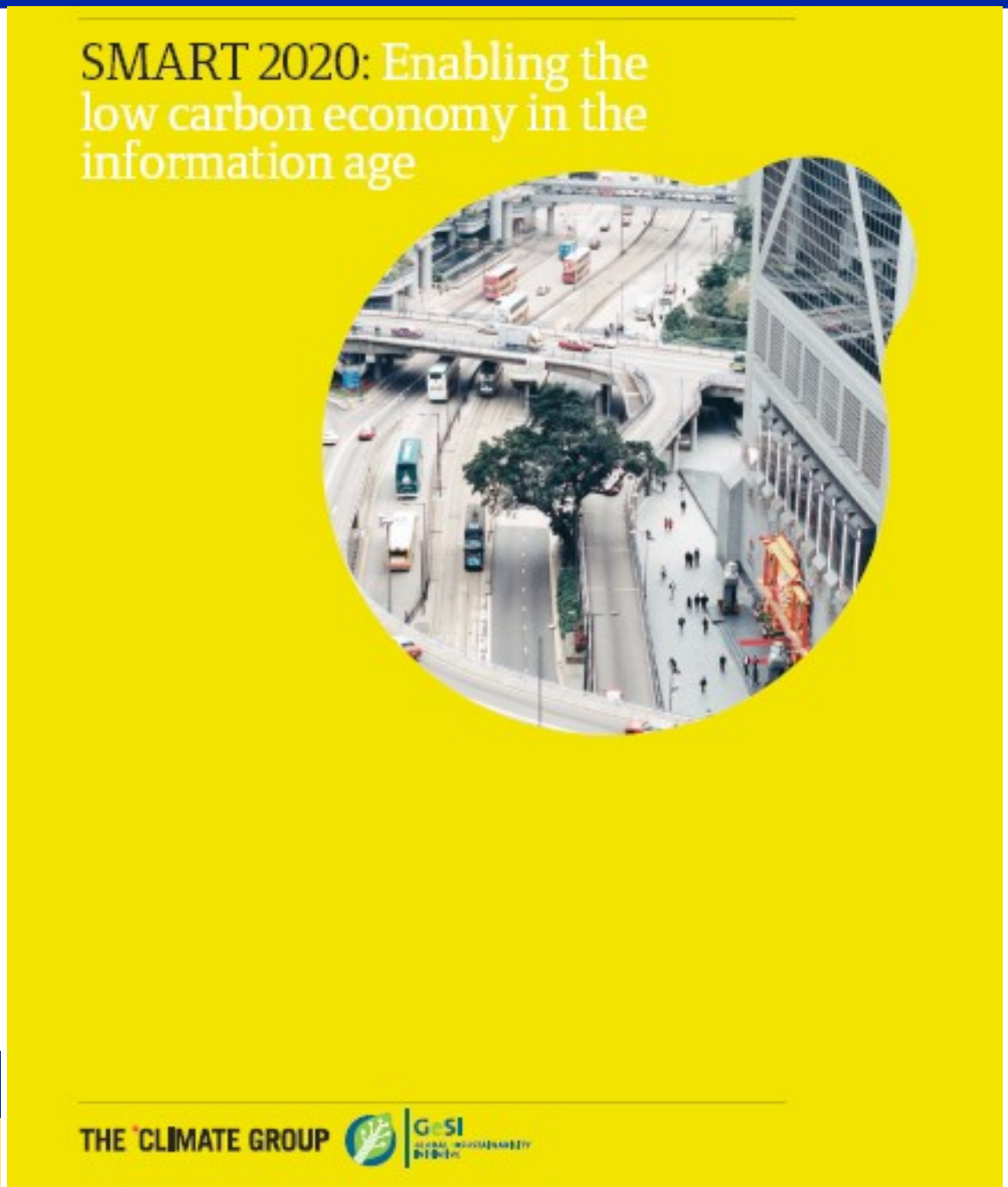
Source: Falko Kuester, Calit2; Michael Sims, NASA

Remote Control of Scientific Instruments: Live Session with JPL and Mars Rover from Calit2



Source: Falko Kuester, Calit2; Michael Sims, NASA

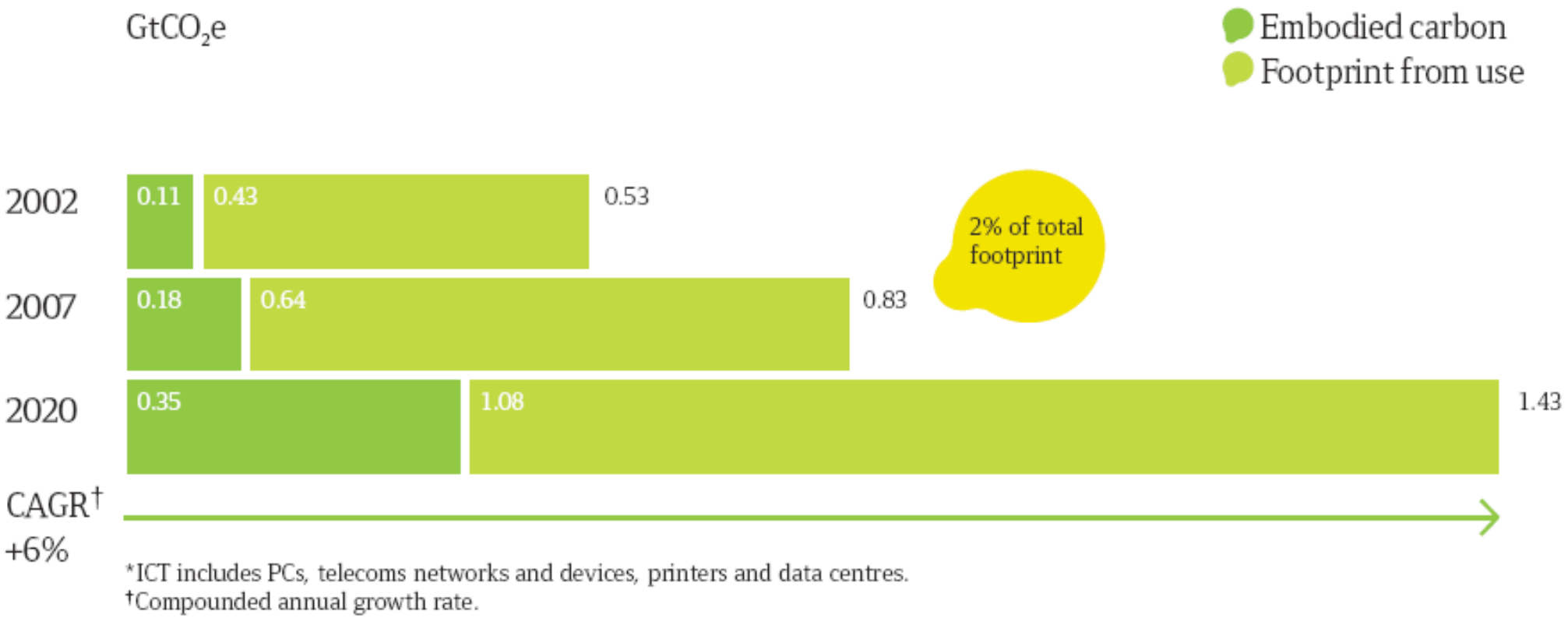
Looming Problem in Ever Greater Use of IT-- Running & Cooling Computers Adds to Global Warming



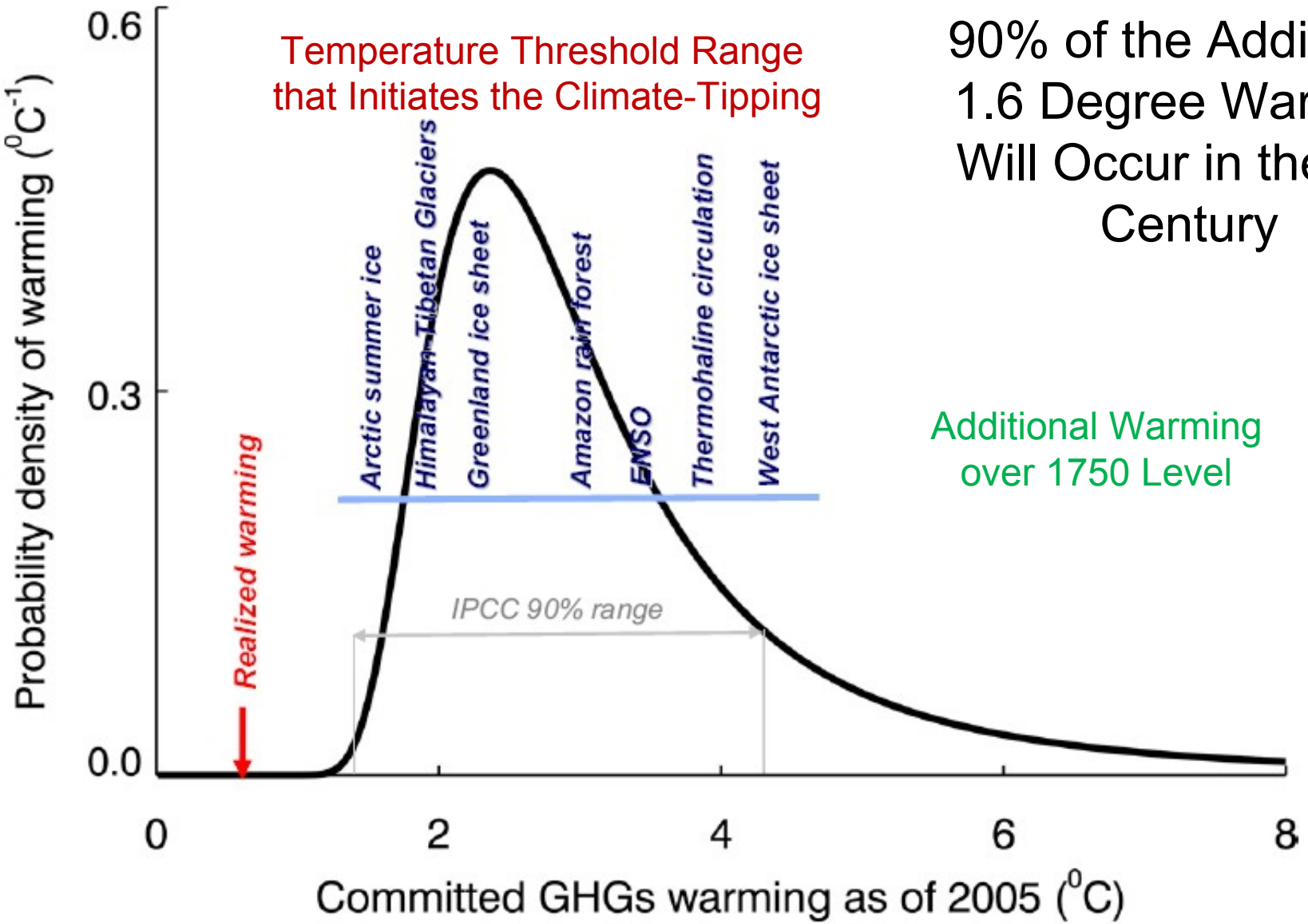
The Electricity Used by all the Gaming Boxes in the World Equals That Used by San Diego!

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The Global ICT Carbon Footprint is Roughly the Same as the Aviation Industry Today



The Planet is Already Committed to a Dangerous Level of Warming



90% of the Additional 1.6 Degree Warming Will Occur in the 21st Century

Additional Warming over 1750 Level

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V. Ramanathan and Y. Feng, Scripps Institution of Oceanography, UCSD
September 23, 2008
www.pnas.orgcgidoi10.1073pnas.0803838105

Linking Australia and UCSD via the OptIPuter
Avoiding Travel While Enabling Collaboration



January 2008

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

Victoria Premier and Australian Deputy Prime Minister Asking Questions



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

it²

University of Melbourne Vice Chancellor Glyn Davis in Calit2 Replies to Question from Australia



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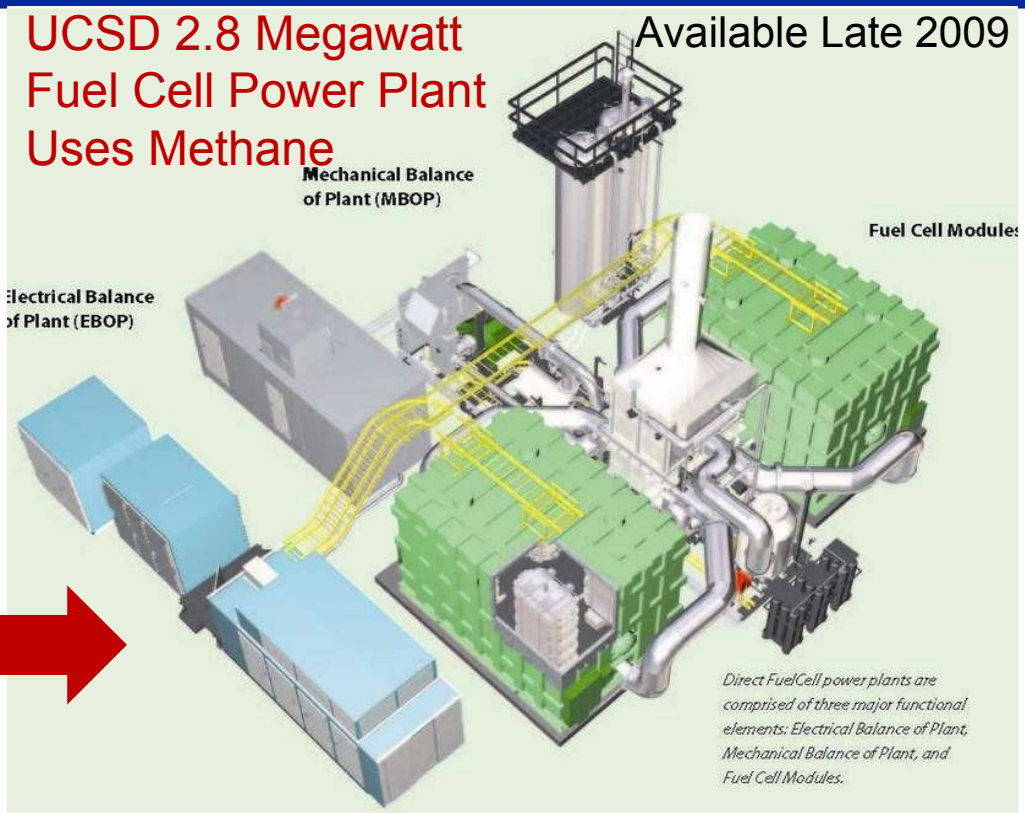
UCSD is Installing Zero Carbon Emission Solar and Fuel Cell DC Electricity Generators

San Diego's Point Loma Wastewater Treatment Plant Produces Waste Methane



UCSD 2.8 Megawatt Fuel Cell Power Plant Uses Methane

Available Late 2009





2 Megawatts of Solar Power Cells Being Installed

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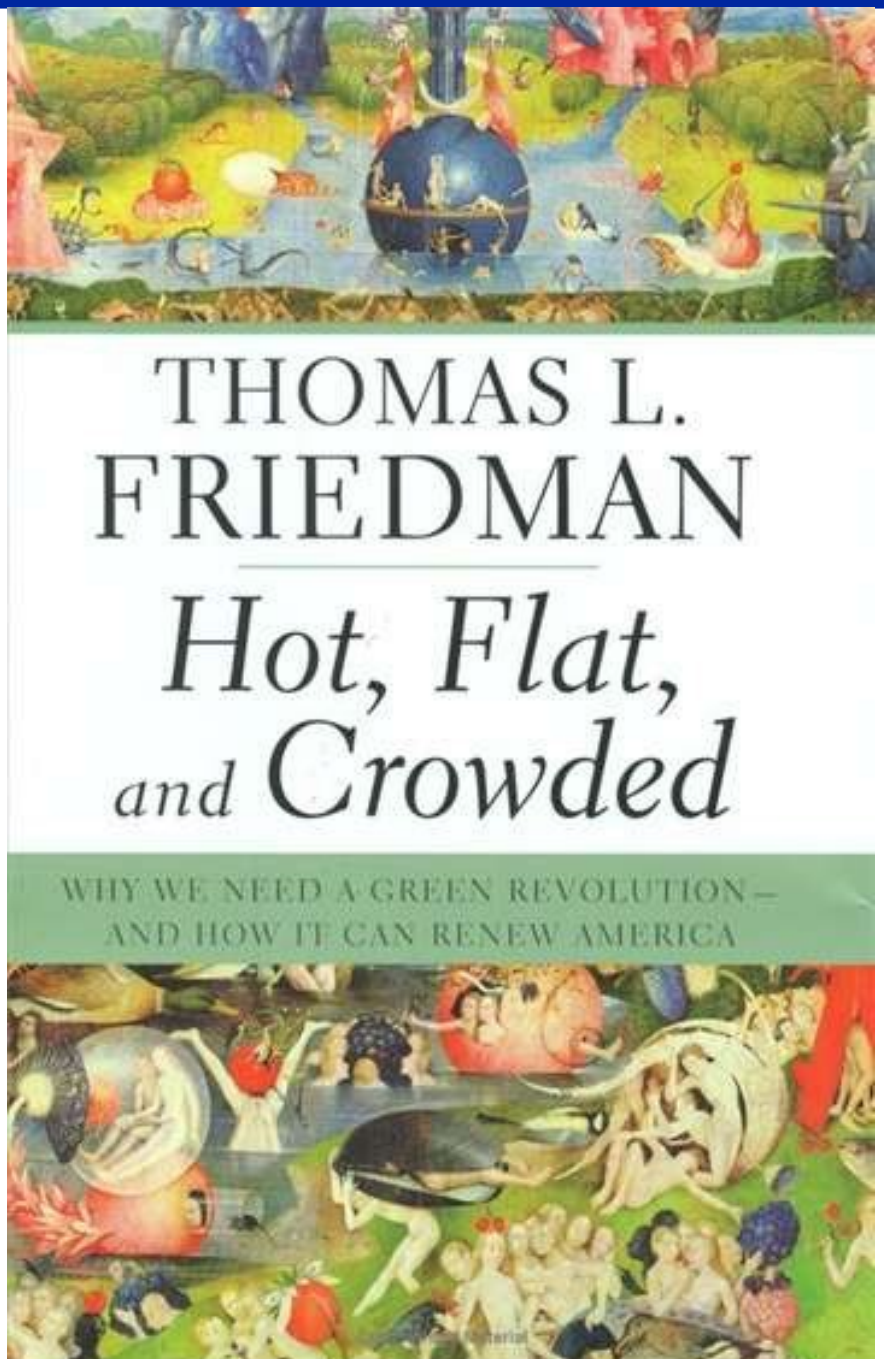
Calit2 GreenLight Project Enables Green IT Computer Science Research



- **Computer Architecture**
  - Rajesh Gupta/CSE
- **Software Architecture**
  - Amin Vahdat & Ingolf Kruger/ CSE
- **CineGrid Exchange**
  - Tom DeFanti/Calit2
- **Visualization**
  - Falko Kuster/Structural Engineering
- **Power and Thermal Management**
  - Tajana Rosing/CSE
- **Analyzing Power Consumption Data**
  - Jim Hollan/Cog Sci

http://greenlight.calit2.net

"It Will Be the Biggest Single Peacetime Project Humankind Will Have Ever Undertaken"



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UCSD is Becoming a "Living Laboratory of the Green Future"



GO GREEN TUBE BETA
Broadcast Planet Earth

UCSD
UCIrvine

www.gogreentube.com/watch.php?v=NDc4OTQ1

it²