“The Web, From Whence, & Whither"

Cornerstone Lecture

Renaissance Weekend

Napa Valley

October 19, 2012

Dr. Larry Smarr

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Jacobs School of Engineering, UCSD

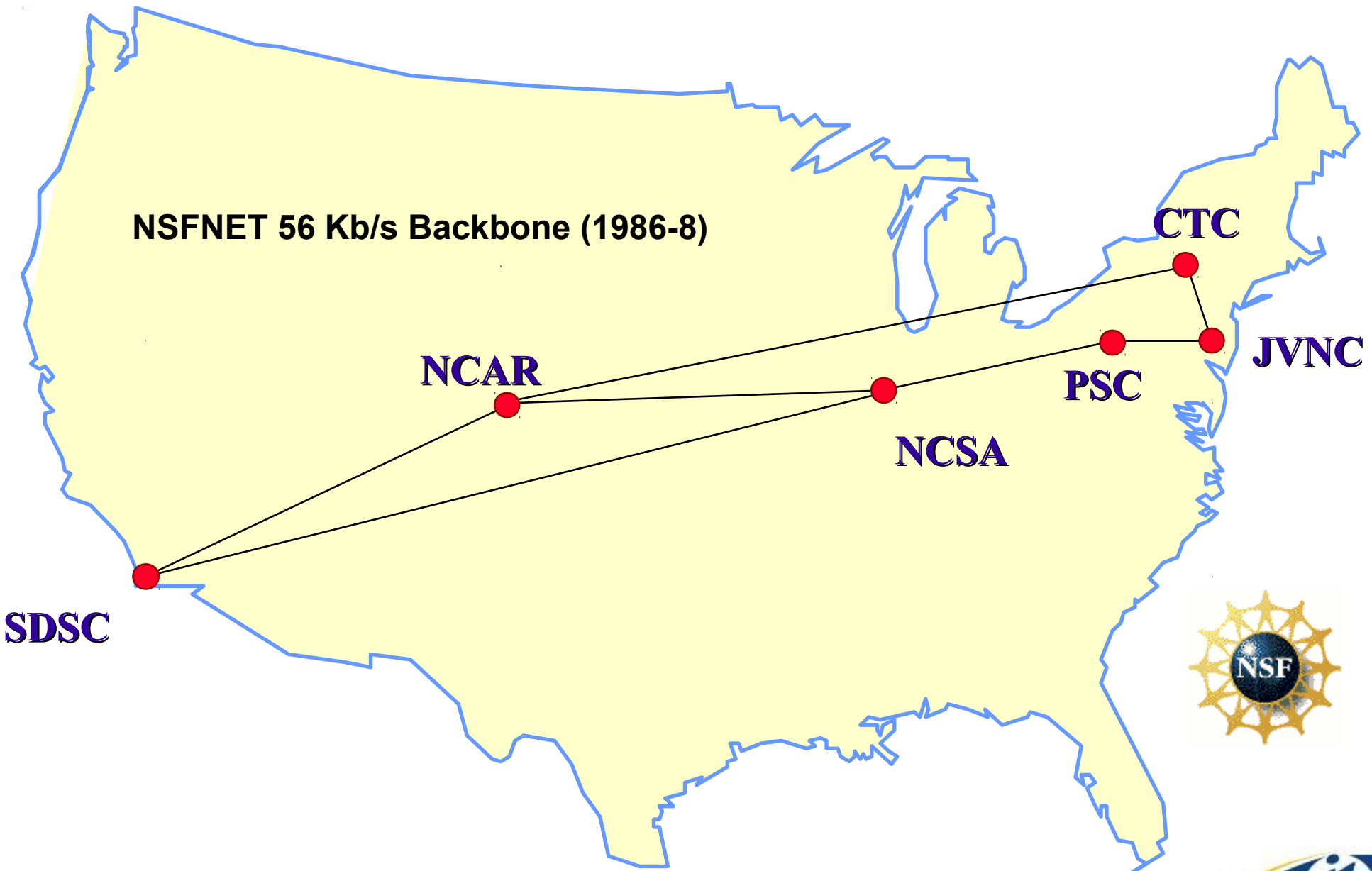
Birth of the Internet in Early 1970s Led to Forty Years of Exponential Growth



Vint Cerf, Robert Kahn, Len Kleinrock, Larry Roberts

http://www.uclabruin.com/30anniv.htm

The First NSFnet Backbone:
The National Shared Bandwidth = a Dial-Up Modem!



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



NCSA's Blue Waters Petascale Supercomputer (2012)
Is Over 1 Million Times Faster than Cray Y-MP (1990)!
Enormous Growth in Parallelism
Processors: Y-MP 4, Blue Waters ~400,000

www.ncsa.uiuc.edu/BlueWaters/system.html

NCSA Mosaic, a Module in *NCSA Collage* Desktop Collaboration Software, Led to the Modern Web World



Licensing

SPYGLASS

100 Commercial Licensees

NCSA Programmers





1993

NCSA Collage

1992



NCSA HTTPd

Open Source



Mac OS X Server

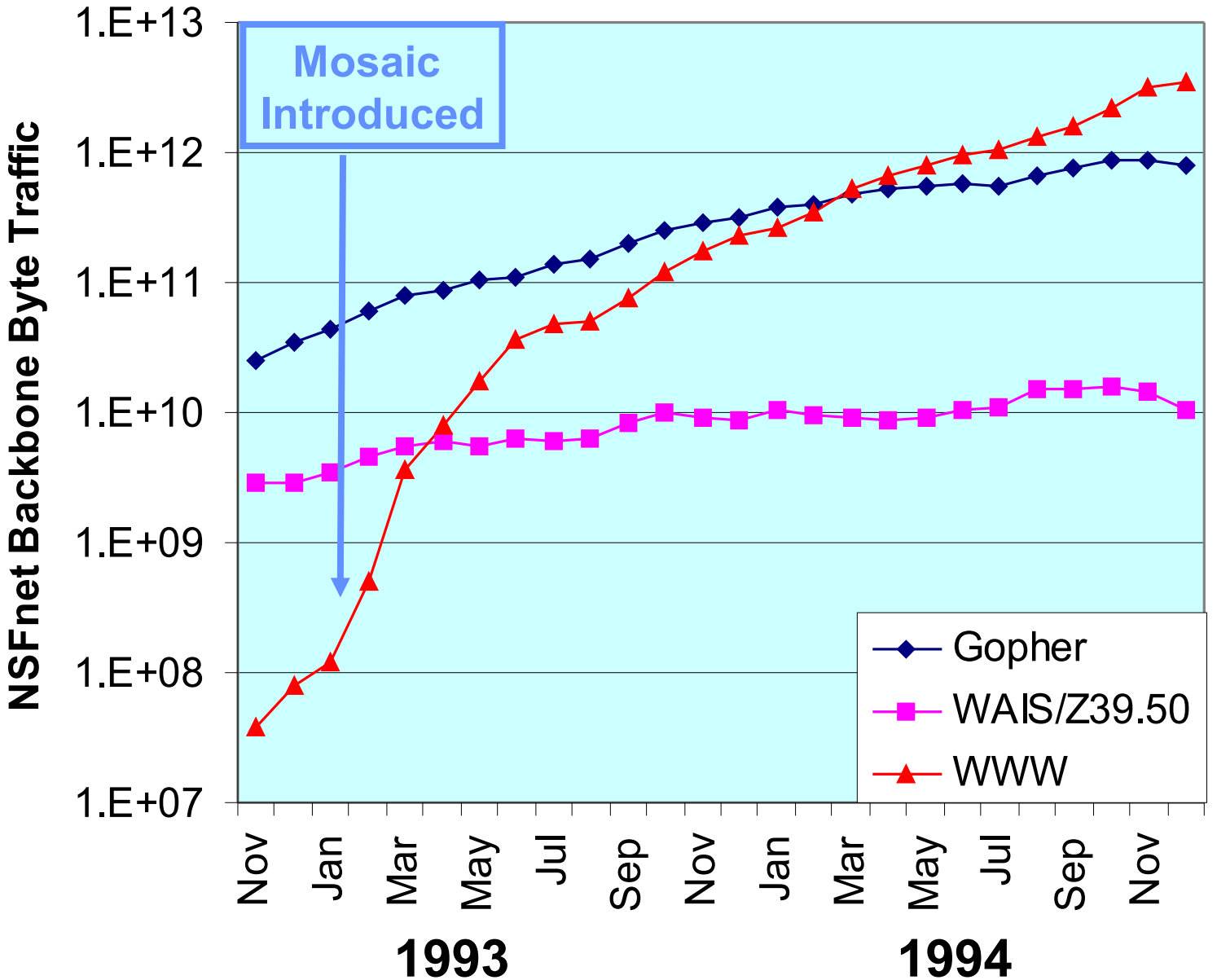


IBM WebSphere Software



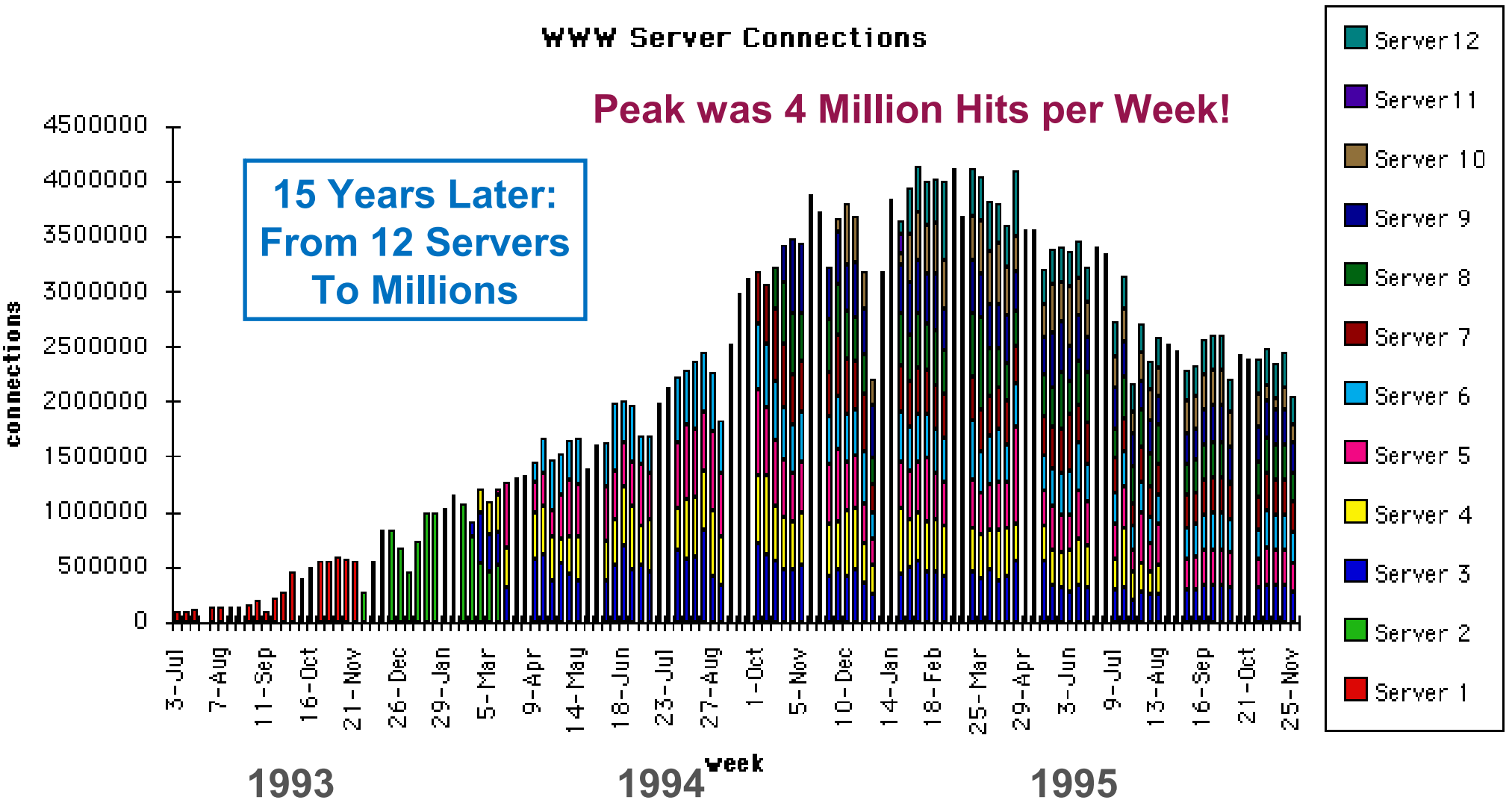
Source: Larry Smarr

NCSA Mosaic
Set Off the Exponential Growth in Web Browsing



Source: Data from Merit; Graph by Larry Smarr

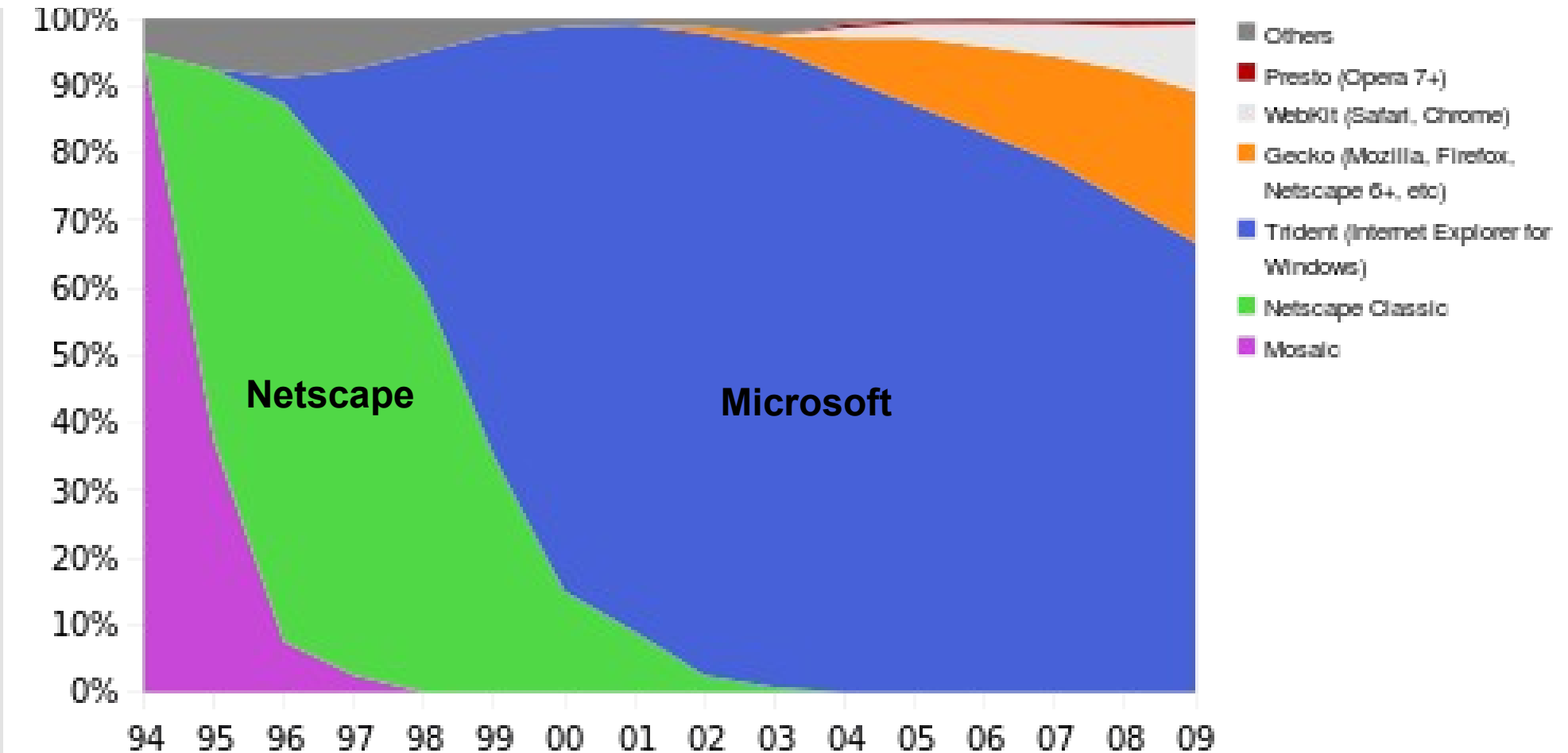
NCSA Web Server Traffic Increase Led to NCSA Creating the First Parallel Web Server



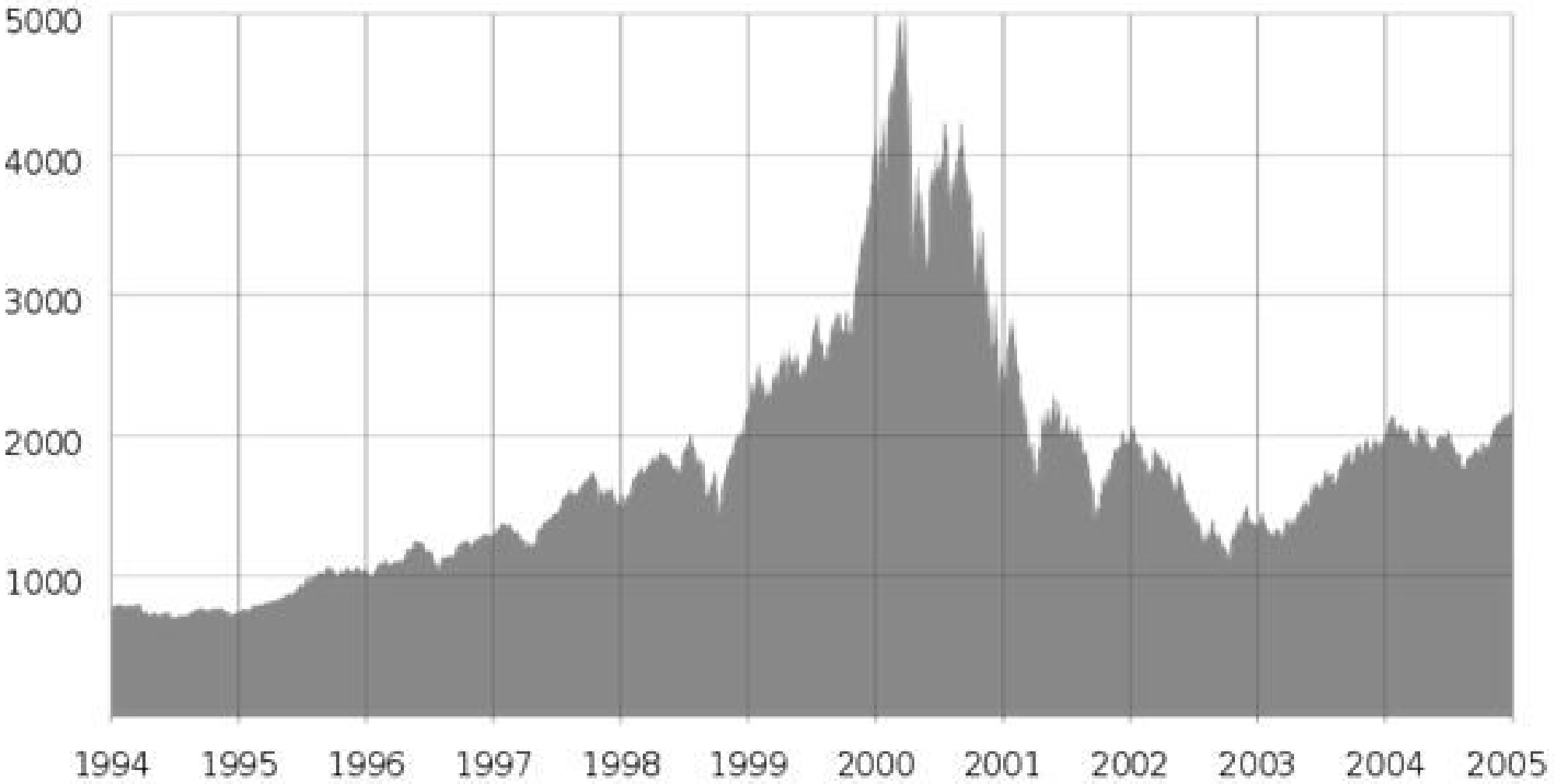
Data Source: Software Development Group, NCSA,
Graph: Larry Smarr

The 1990s Browser Wars

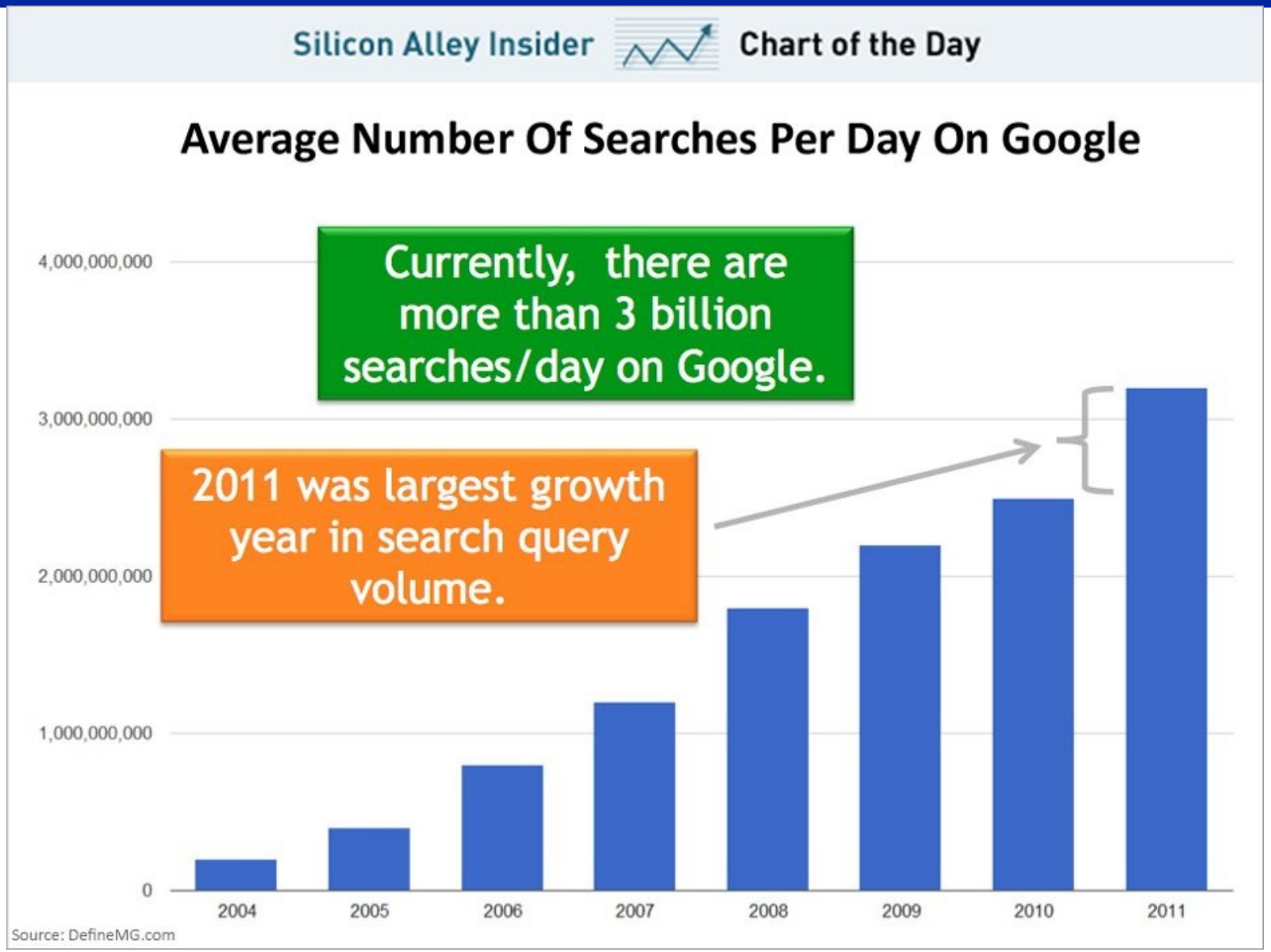
Chart showing history of web browser market share



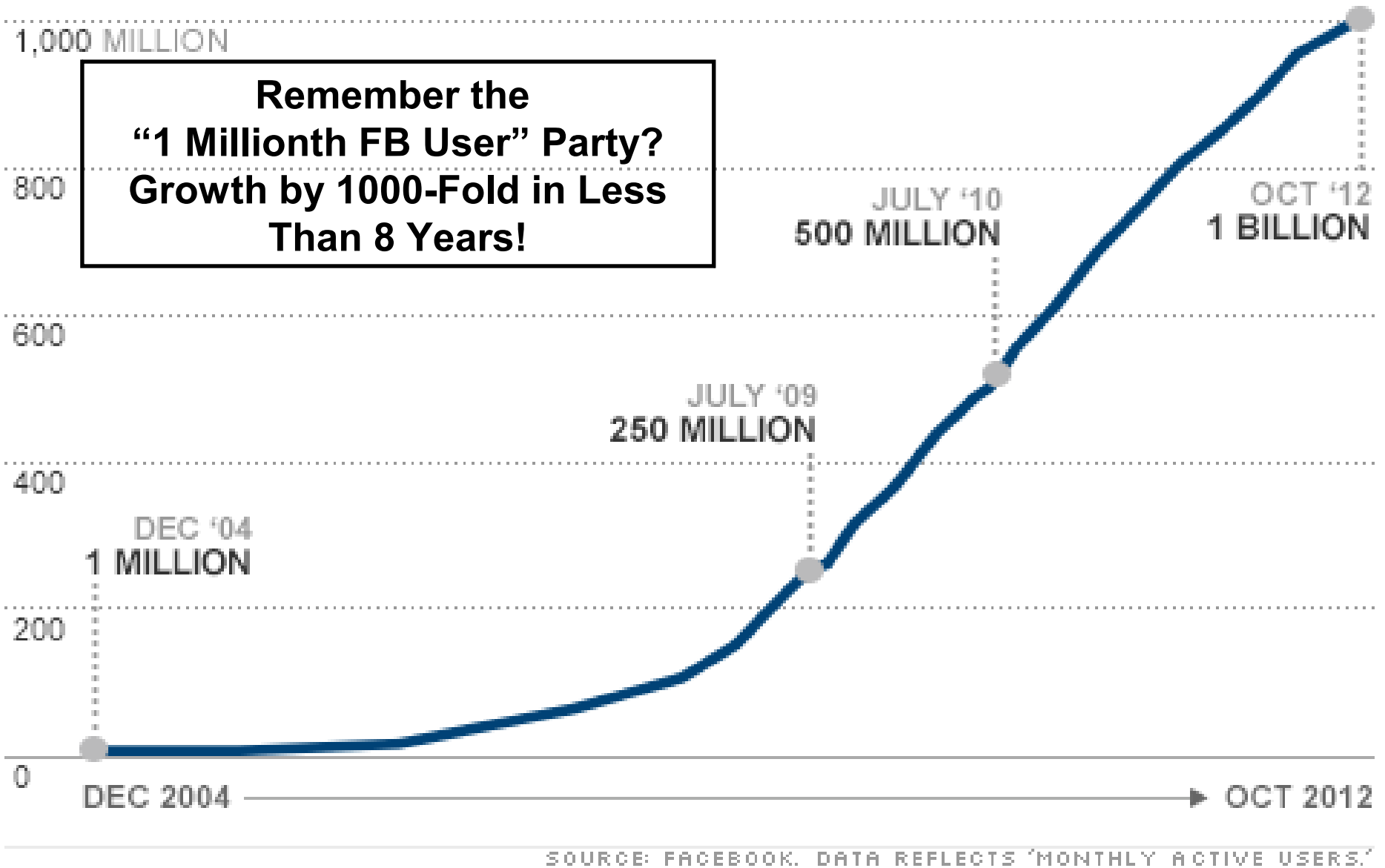
Then Came the Dot-Com Crash - Creative Destruction of Capitalism



Out of the Rubble
Google Brings Search to the Web



Over the Same Period
Facebook Leads the Rise of the Social Web



The Scale of the Web Today: "You Know What's Cool?-a Billion"

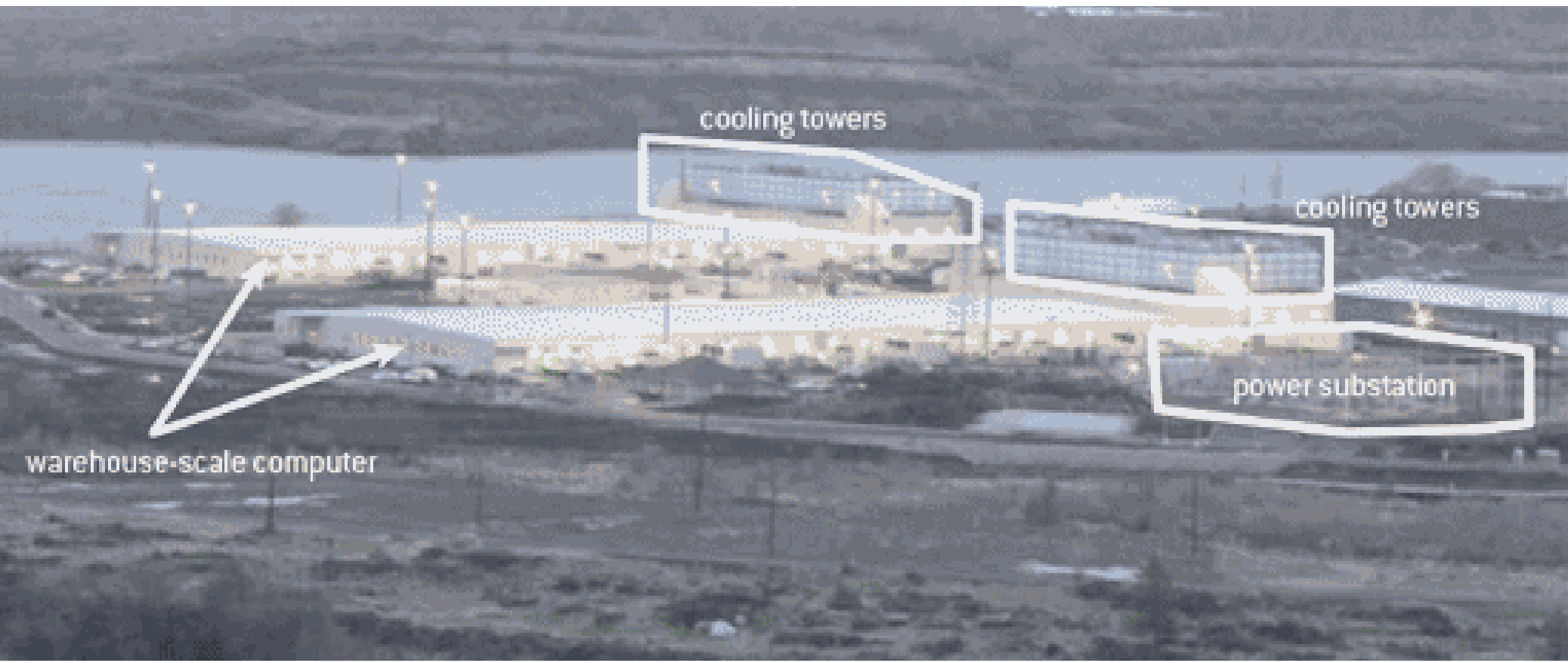
- **Facebook**
  - One Billion Active Users
- **YouTube**
  - 4 Billion Hours of Video Watched Each Month
- **Google**
  - Over One Billion Searches Every Day
- **Apple**
  - 15 Billion Apps Downloaded Per Year
- **Smartphones**
  - 1 Billion Active Users

The Unrelenting Computing Exponential

The Computing Power to Make a Single Google Search Is More Than Was Used In Space & On Earth For the 11 Year, 17 Flight Apollo Program!

http://insidesearch.blogspot.com/2012/08/the-power-of-apollo-missions-in-single.html

Warehouse-Scale Data Centers-
The Planetary Computer That Powers the Internet and Web



Source: A Guided Tour through Data-center Networking
Dennis Abts, Bob Felderman, Google

Inside Google's First Container Data Center



Each Google Container is a Data Center

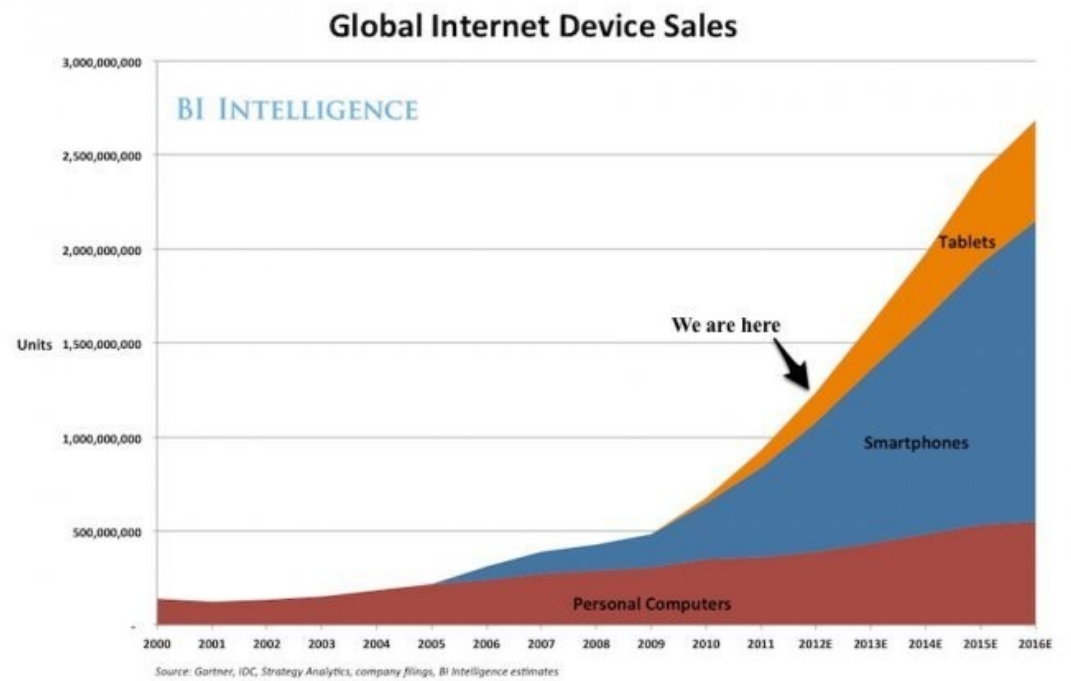
www.youtube.com/watch?v=zRwPSFpLX8I&feature=player_embedded

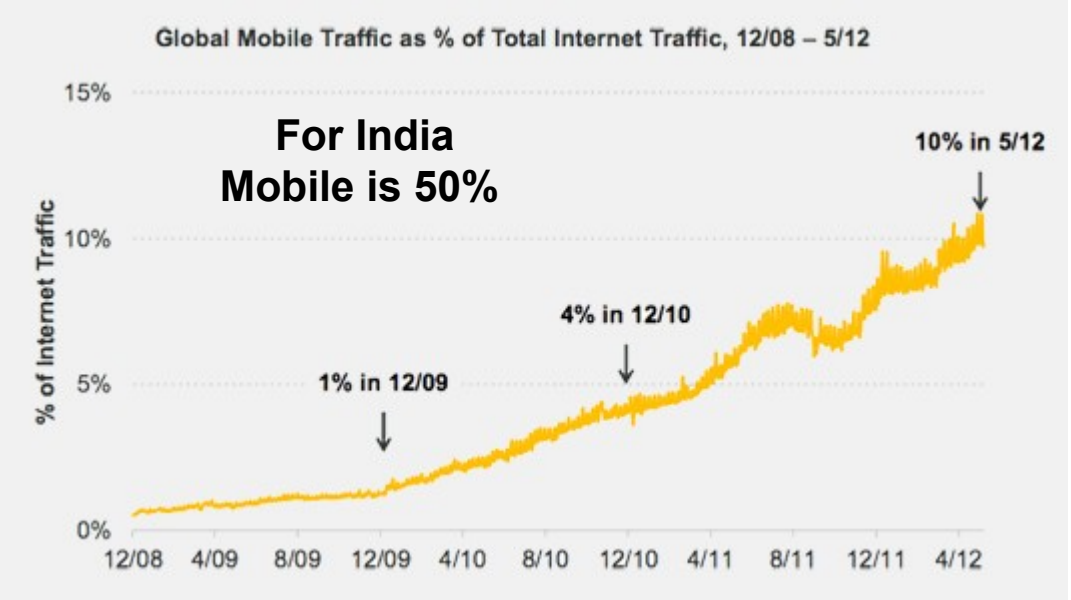
Densely Packed Computers on an Aisle of Microsoft's Chicago Data Center



www.informationweek.com/news/infrastructure/remote_access/220300620

The Internet is Increasingly Mobile





The Mobile Internet Experience Will Overlay Physical Reality



Google Project Glass

Wikitude 3D Augmented Reality Browser



Four Trends of the Future Web

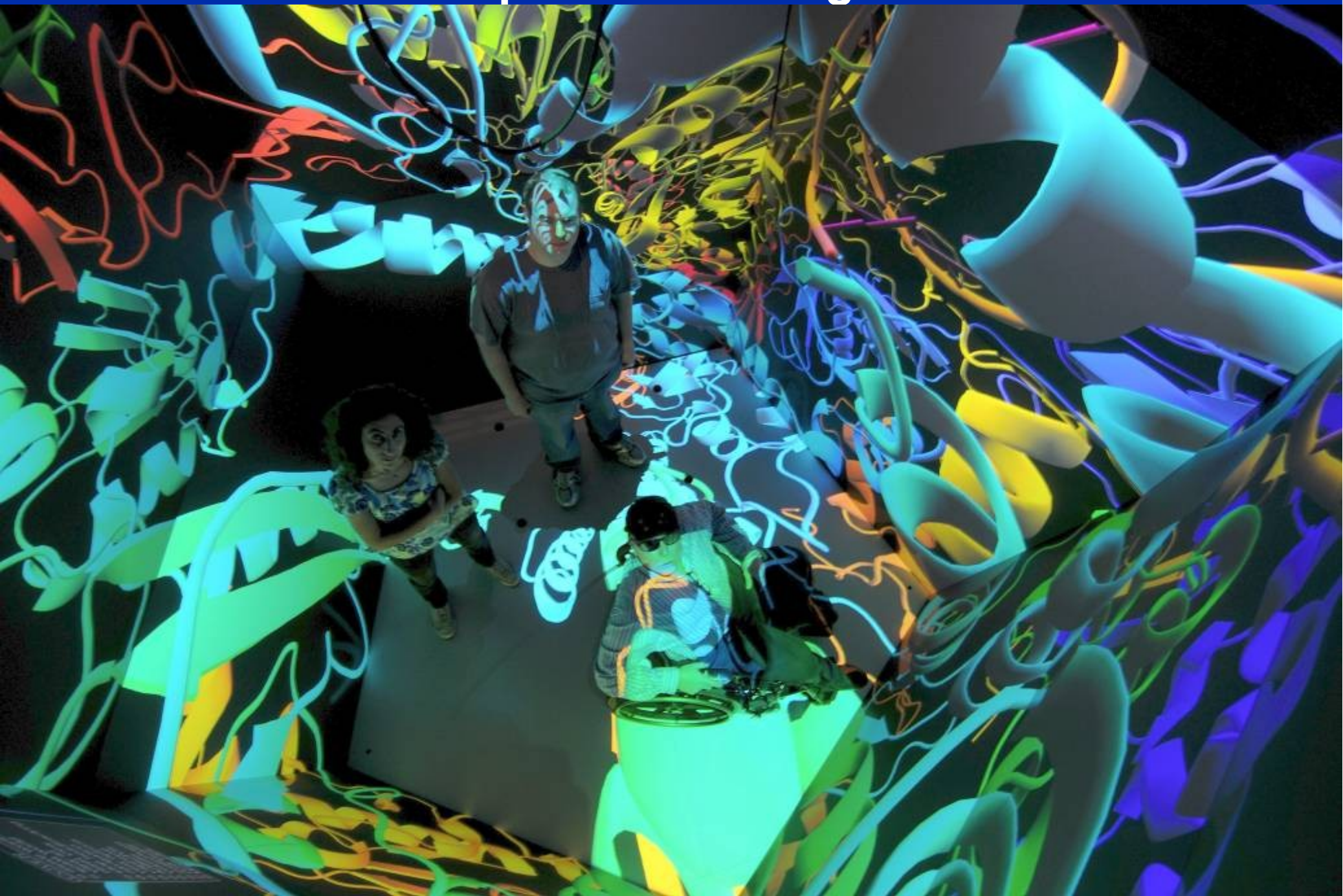
- Virtual Rooms
- Being There
- Telepresence
- Know Thyself

Towards Digital Wallpaper

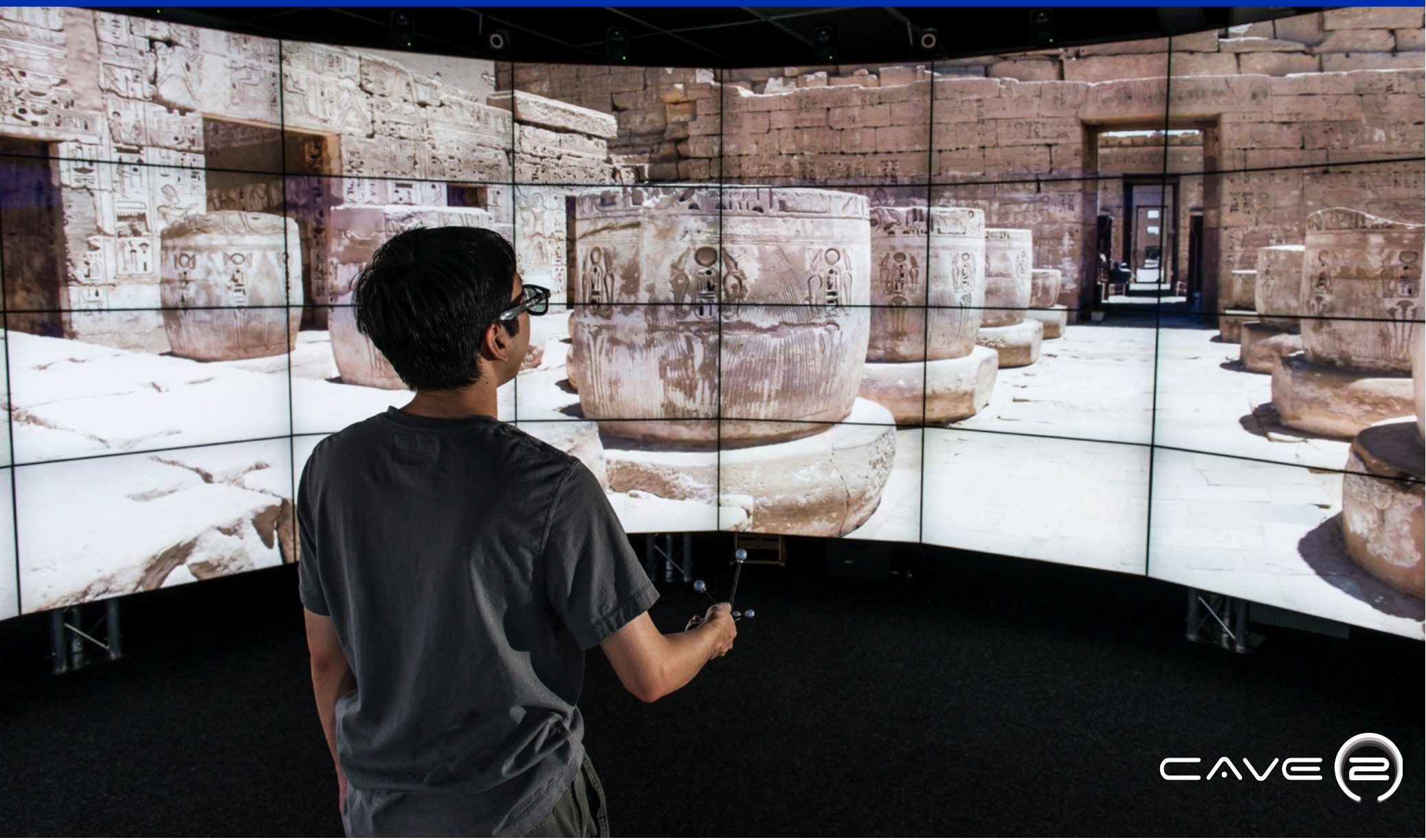


Hubble Space Telescope Collage of 48 Frames (30,000x 14,000 pixels) on Calit2's Vroom

Calit2 3D Immersive StarCAVE: Enables Exploration of Digital Worlds



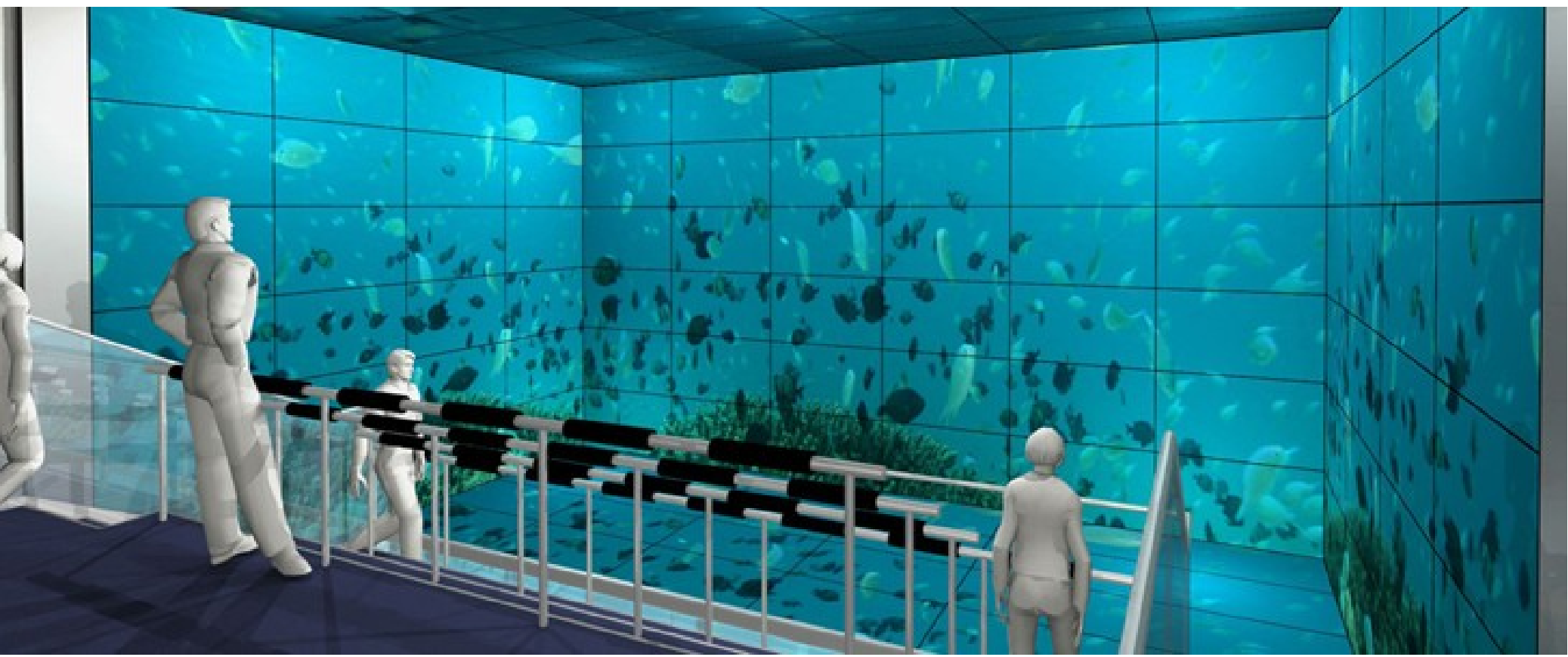
Cultural Heritage Visualization in Chicago's Electronic Visualization Lab's CAVE2



Displayed is a 3D panorama of Luxor in Egypt-
Images were Created at Calit2 by Tom DeFanti and Dan Sandin

The Beginning of Virtual Rooms

Sharp Corp's 156 60"LCDs for the 5D Miracle Tour at the Hui Ten Bosch Theme Park in Nagasaki Opened April 29, 2011



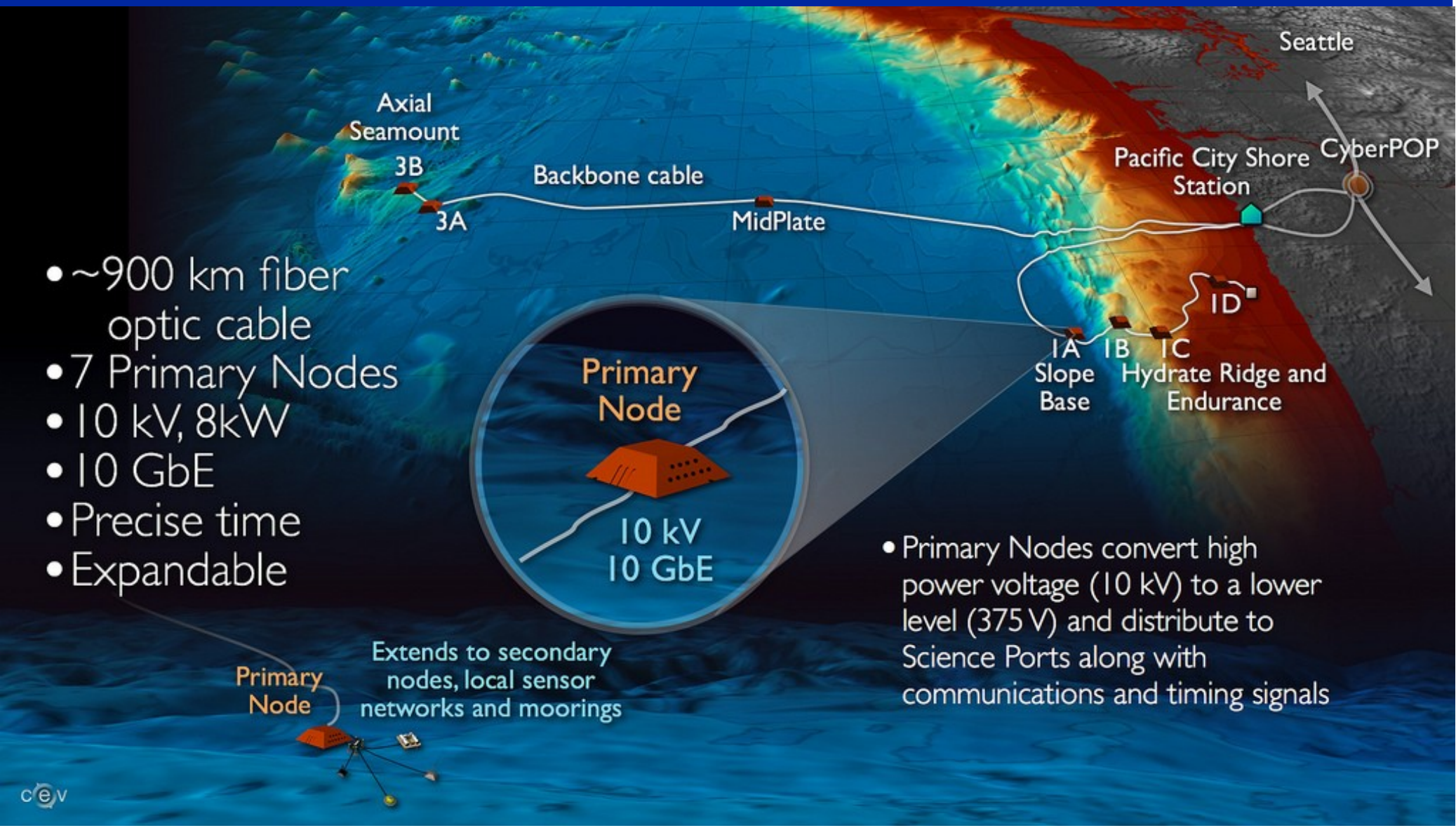
http://sharp-world.com/corporate/news/110426.html

Being There - Remote Interactive High Definition Video of Deep Sea Hydrothermal Vents



Source John Delaney & Deborah Kelley, UWash

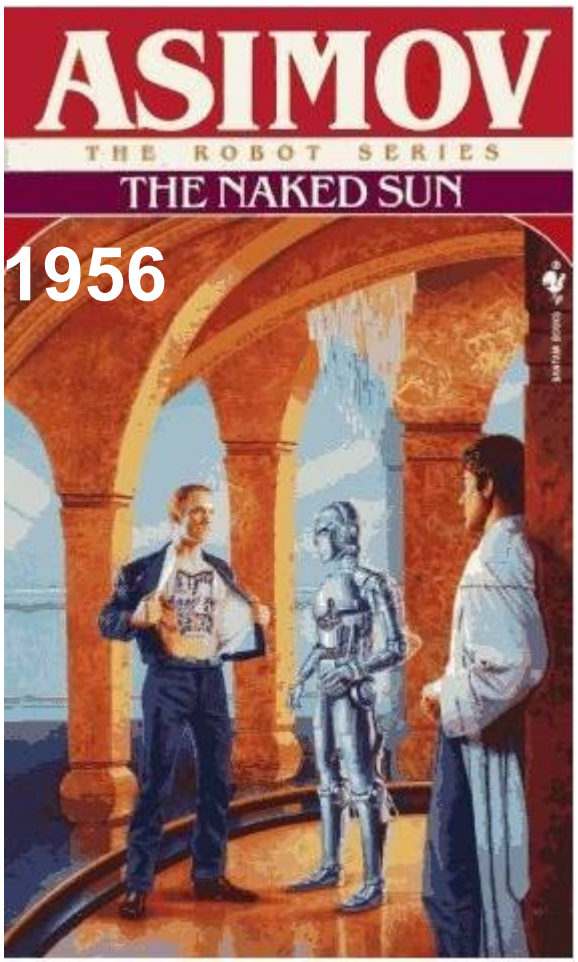
NSF's Ocean Observatory Initiative Has Funded Fiber Optic Sensornets on Seafloor Off Washington



OOI NSF Ocean Leadership OSU Oregon State RUTGERS UCSD UNIVERSITY of WASHINGTON it2


A Near Future
Fiber Optic Cable Observatory
Lights
Robotic Arm
Imaging Sonar
HD Stereo Cameras
Chemistry/Biology Lab
Fiber Optic Cable
Source John Delaney, UWash

Over Fifty Years Ago, Asimov Described a World of Remote Viewing

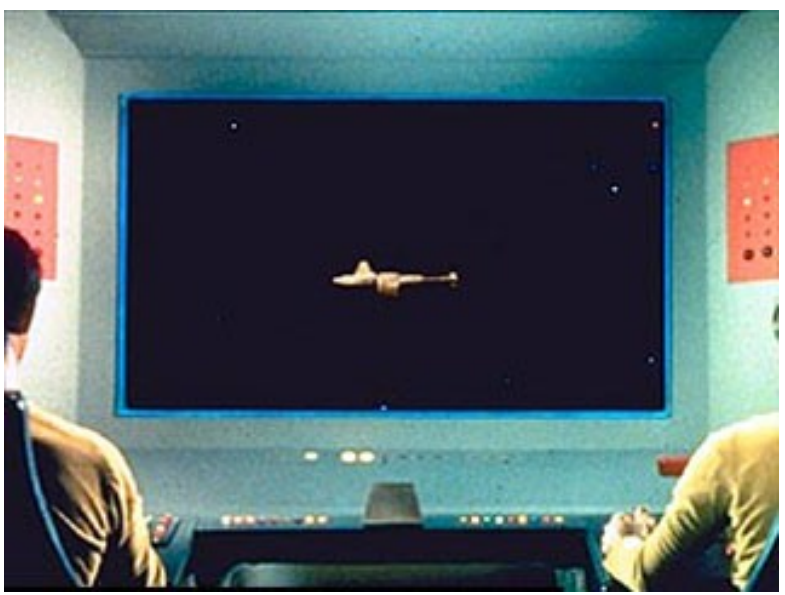


A policeman from Earth, where the population all lives underground in close quarters, is called in to investigate a murder on a distant world. This world is populated by very few humans, rarely if ever, coming into physical proximity of each other. Instead the people "View" each other with trimensional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

TV and Movies of 40 Years Ago Envisioned Telepresence Displays









Source: Star Trek 1966-68; Barbarella 1968

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

Creating Planetary-Scale Telepresence



Victoria Premier and Australian Deputy Prime Minister Discussing Issues with Australian-American Leadership Dialogue at Calit2

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

Dissolving Walls
Driven by Scientific Collaboration



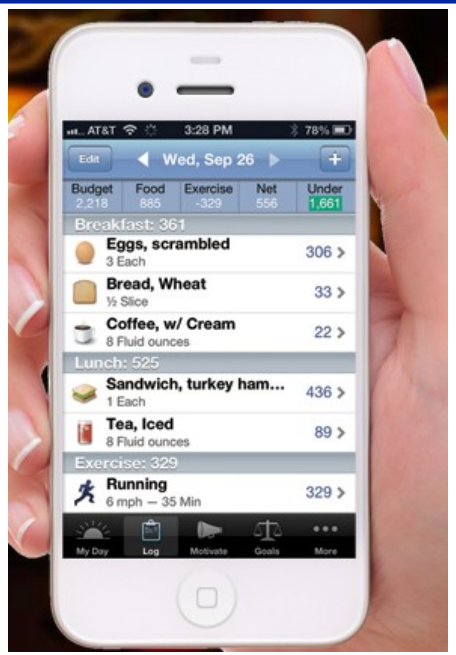
From Start to This Image in Less Than 2 Weeks!

View from NASA Ames Lunar Science Institute Mountain View, CA

NASA Interest in Supporting Virtual Institutes

Source: Falko Kuester, Calit2; Michael Sims, NASA

Consumer Smartphone Apps Enable Us to Read Out Our Bodies



Lose It- Calories Ingested



Body Media- Calories Burned



Withing/iPhone- Blood Pressure





EM Wave PC- Stress



Azumio-Heart Rate



Zeo-Sleep

A Vision for Healthcare in the Coming Decades

Using this data, the planetary computer will be able to build a computational model of your body and compare your sensor stream with millions of others. Besides providing early detection of internal changes that could lead to disease, cloud-powered voice-recognition wellness coaches could provide continual personalized support on lifestyle choices, potentially staving off disease and making health care affordable for everyone.

ESSAY
An Evolution Toward a Programmable Universe
By LARRY SMARR
Published: December 5, 2011

The New York Times

Science