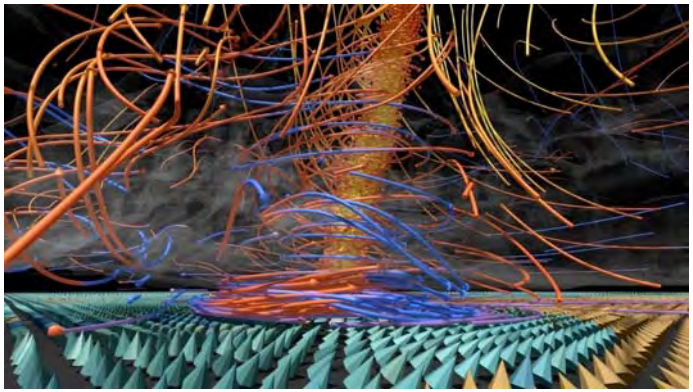
# Supercomputers and Supernetworks are Transforming Research




**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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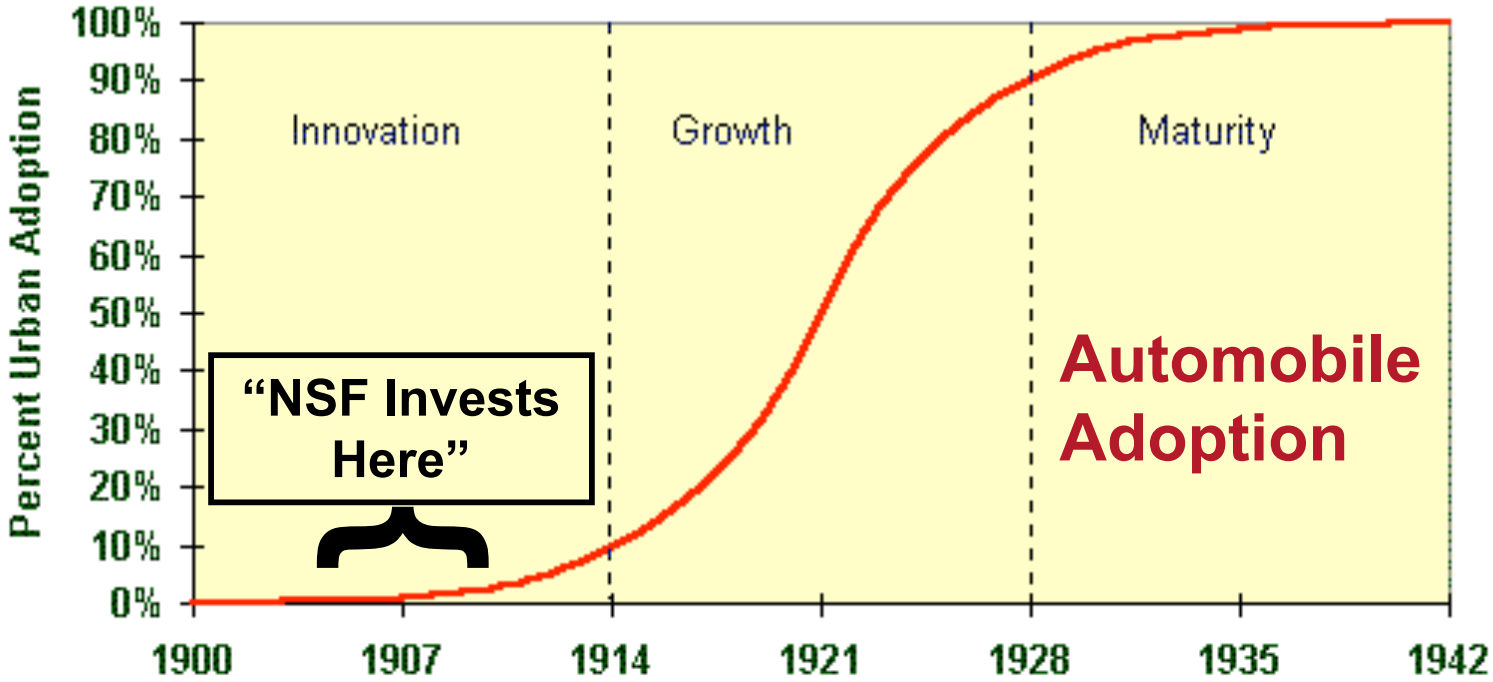
# From Elite Science to the Mass Market

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




Source: Harry Dent, The Great Boom Ahead

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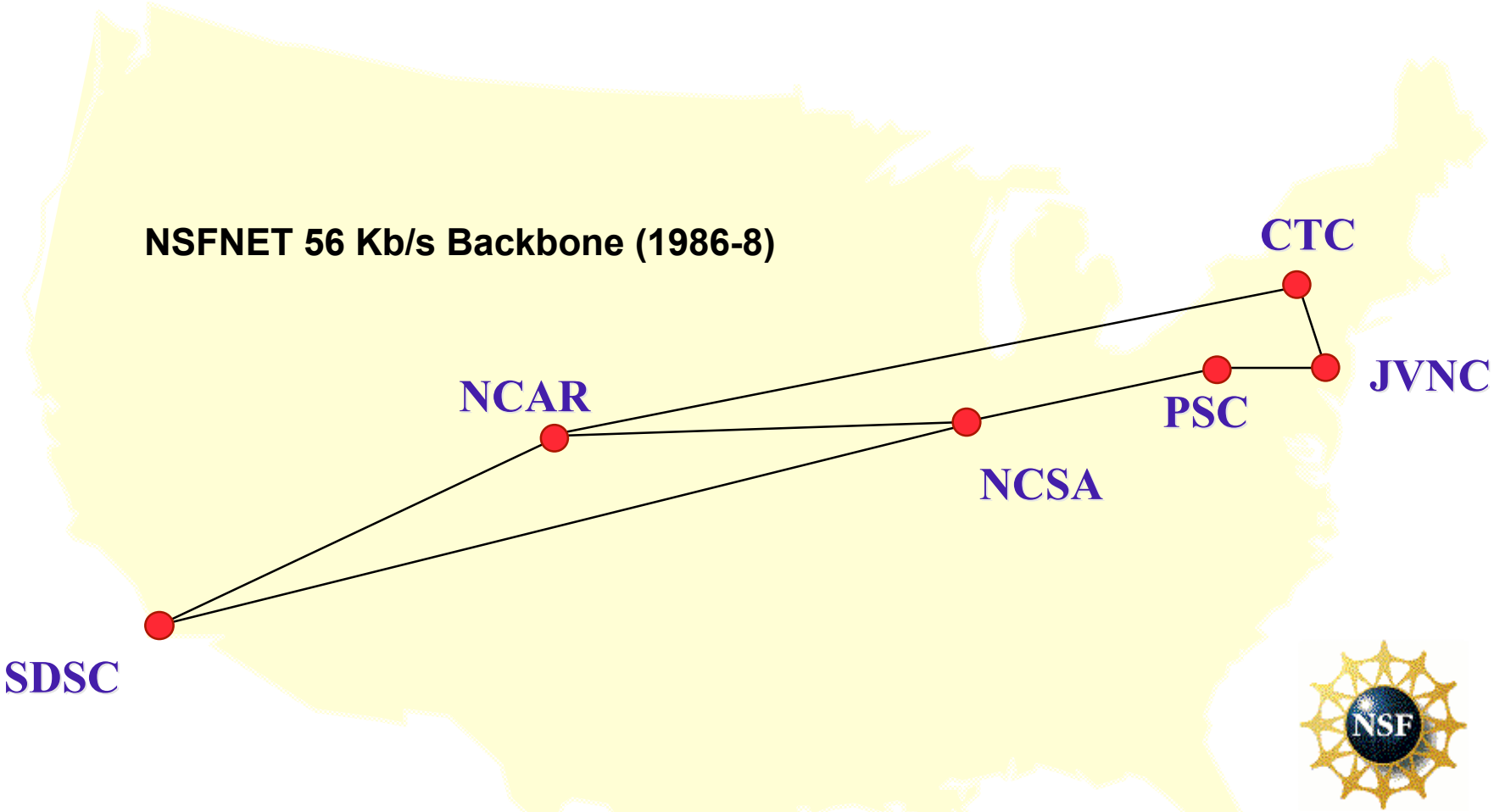
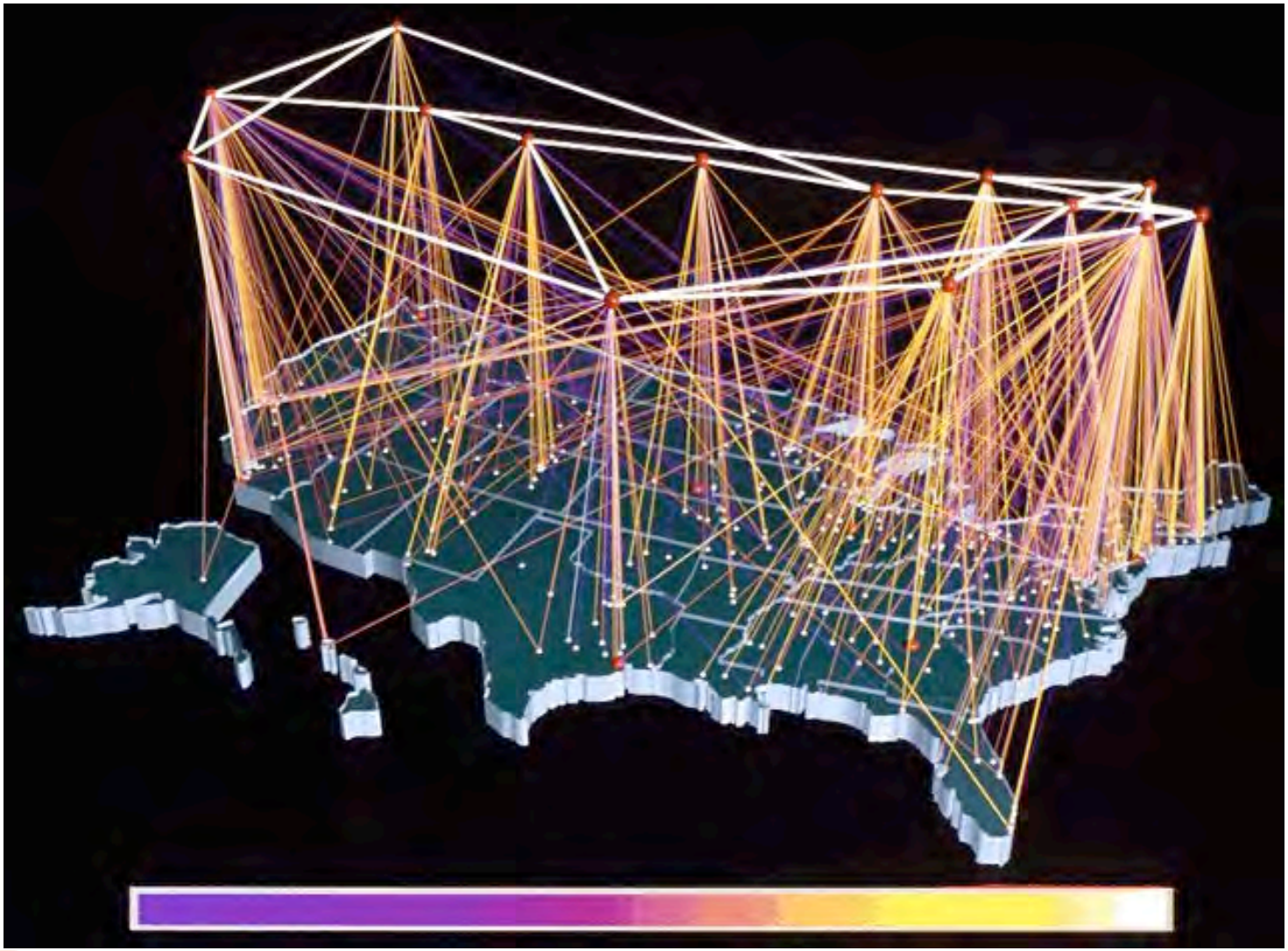
# Launching the Nation's Information Infrastructure: NSFnet Supernetwork and the Six NSF Supercomputers




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

# 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

# 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

**NSF Blue Waters Petascale Supercomputer (2011)**
**Will be Over 1 Million Times Faster than Cray Y-MP!**
**Enormous Growth in Parallelism**
**Processors: Y-MP 4, Blue Waters 200,000**

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

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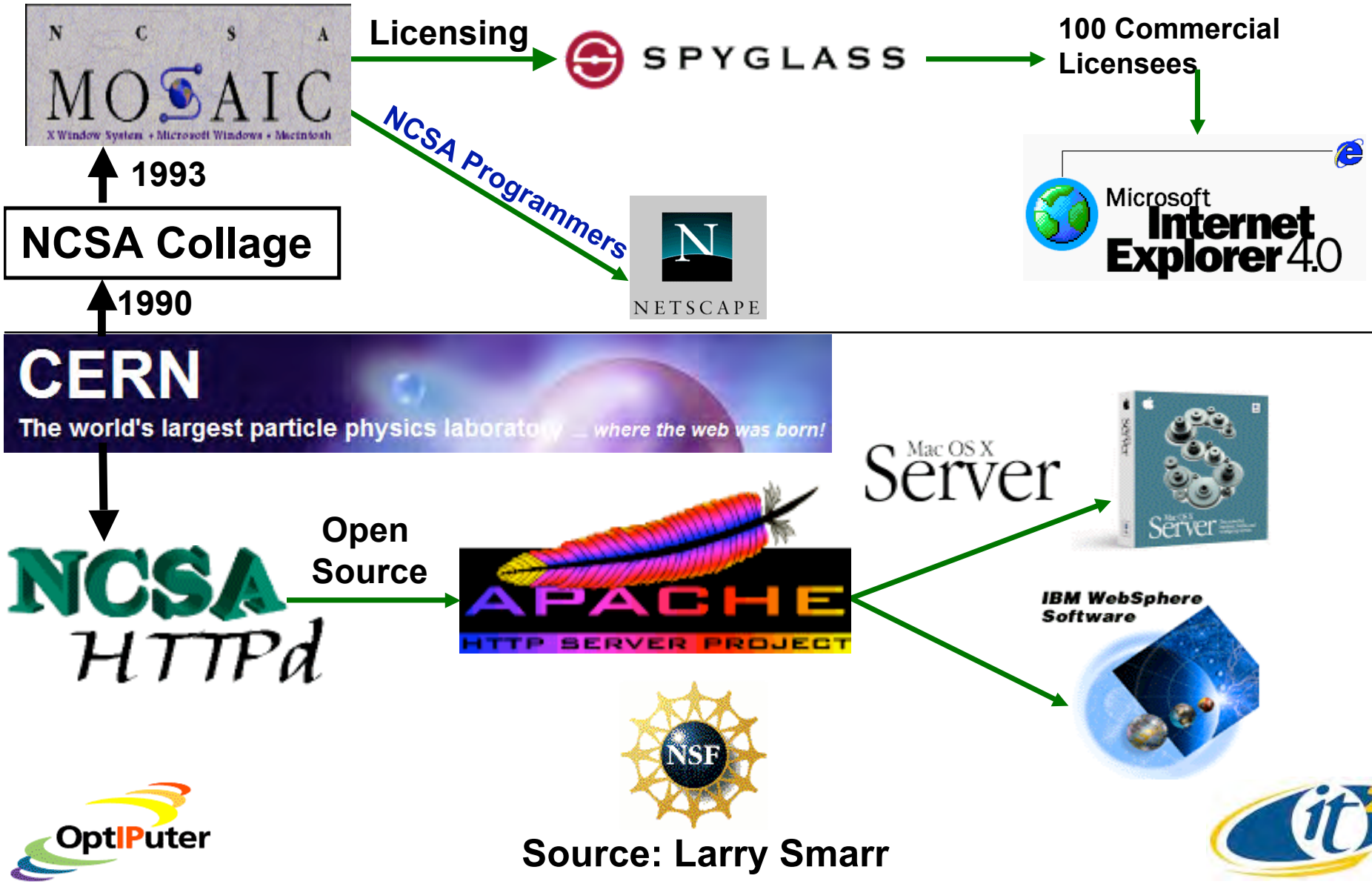
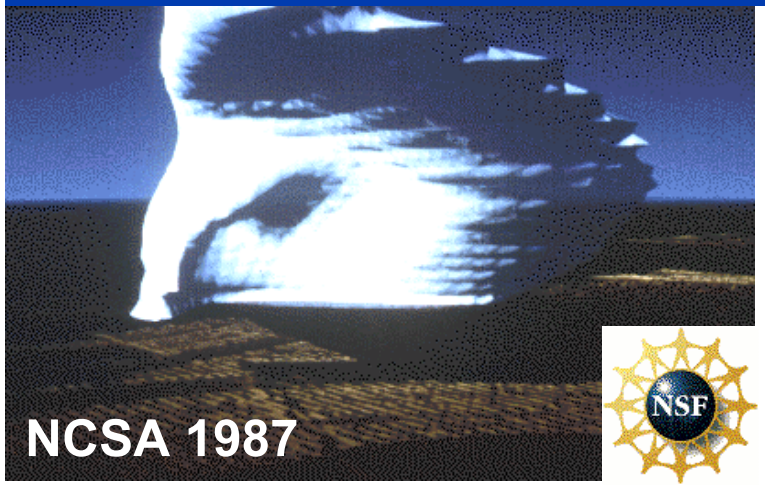
# An Unexpected Benefit of NSF Investments: *NCSA Mosaic* Led to the Modern Web World




Source: Larry Smarr

# From Scientific Visualization of Supercomputing Science to Movie Special Effects



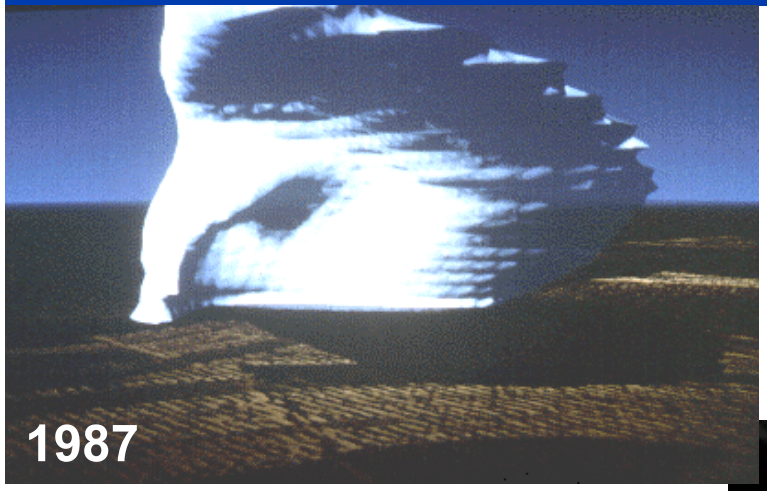



Computer Graphics
From NCSA to ILM

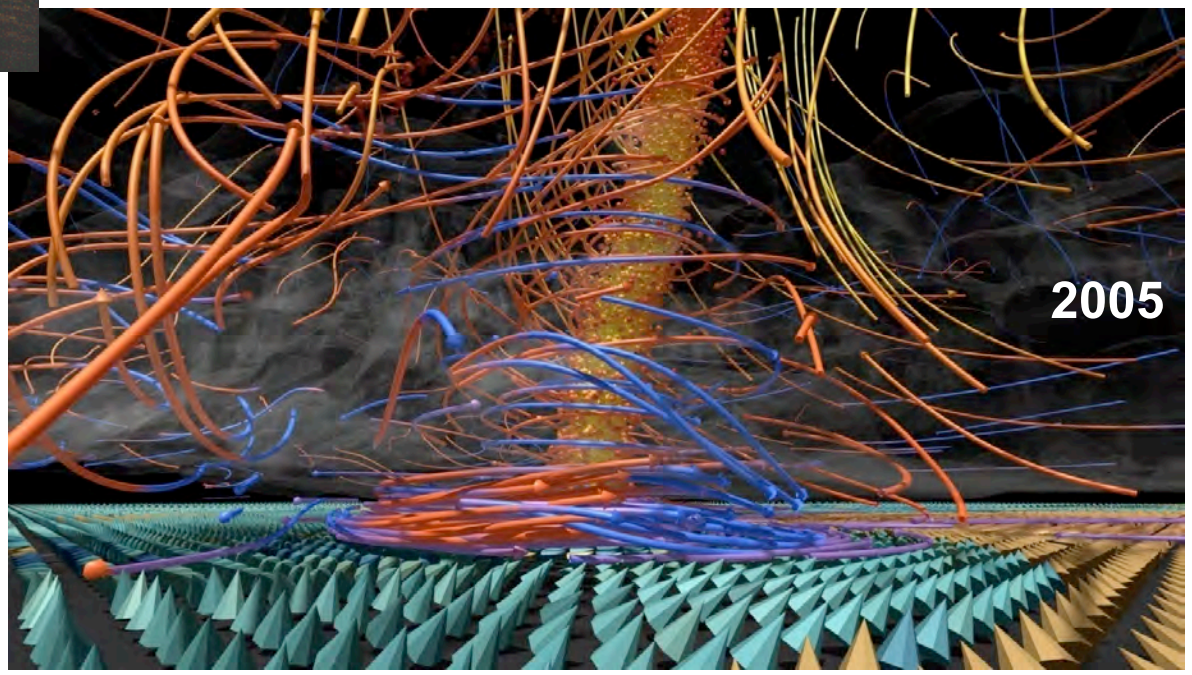



http://access.ncsa.uiuc.edu/
http://movies.warnerbros.com/twister
www.jurassicpark.com; www.jamescameron.org
www.cinemenium.com/perfectstorm/

# Exponential Increases in Supercomputer Speed and Visualization Technology Drive Understanding and Applications



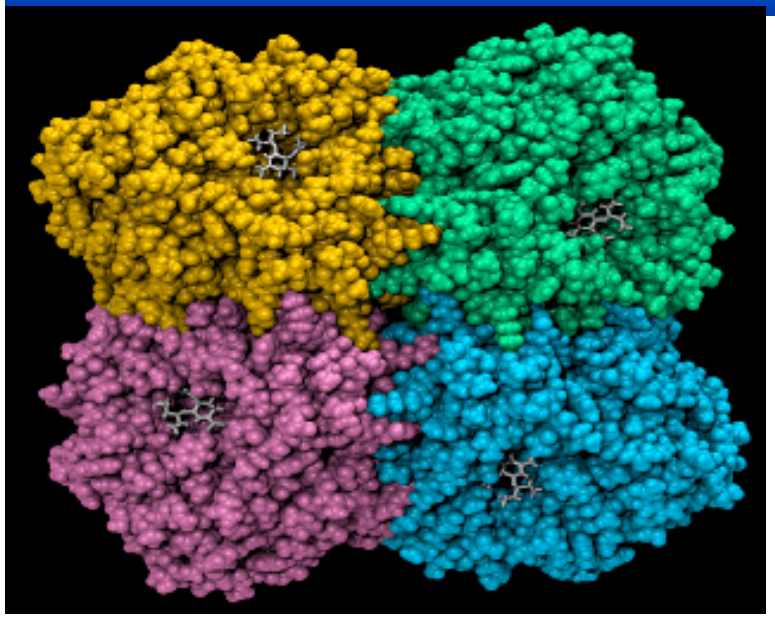

**Showed Thunderstorms Arise from Solving Physics Equations**



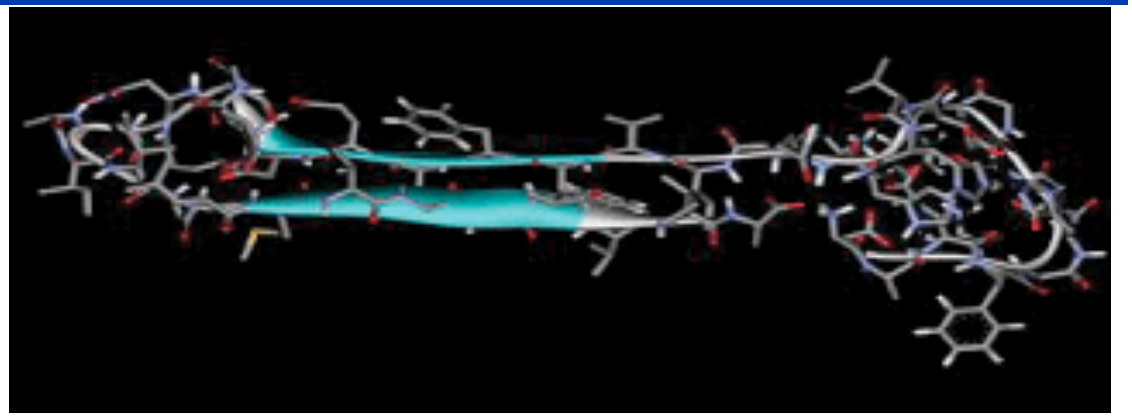

**Vastly Higher Resolution Uncovers Birth of Tornadoes**

Source: Donna Cox, Robert Patterson, Bob Wilhelmson, NCSA

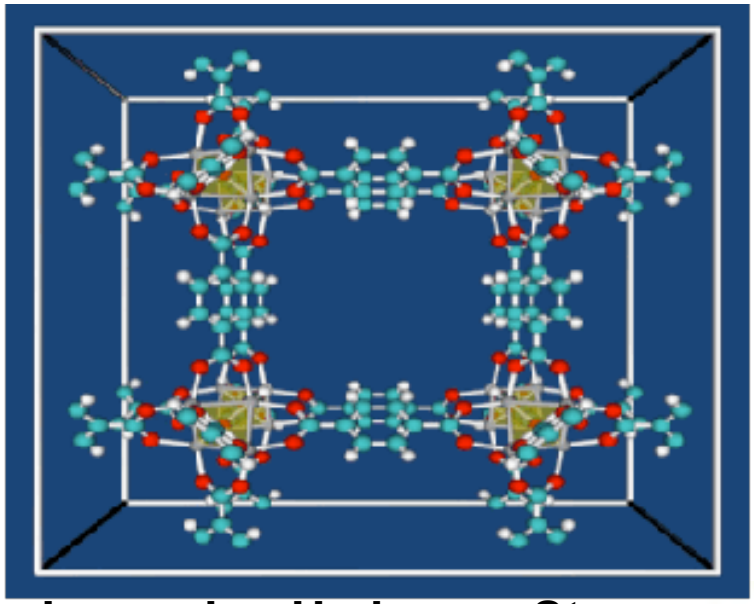
# Frontier Applications of High Performance Computing Enabled by NSF's TeraGrid



Designing Bird Flu Drugs

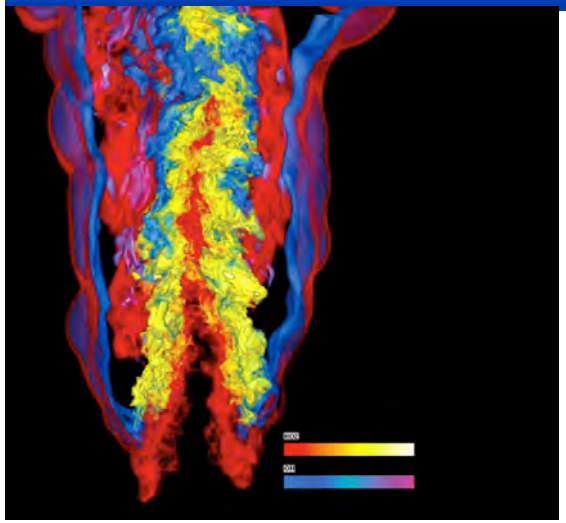


Investigating Alzheimer's Plaque Proteins

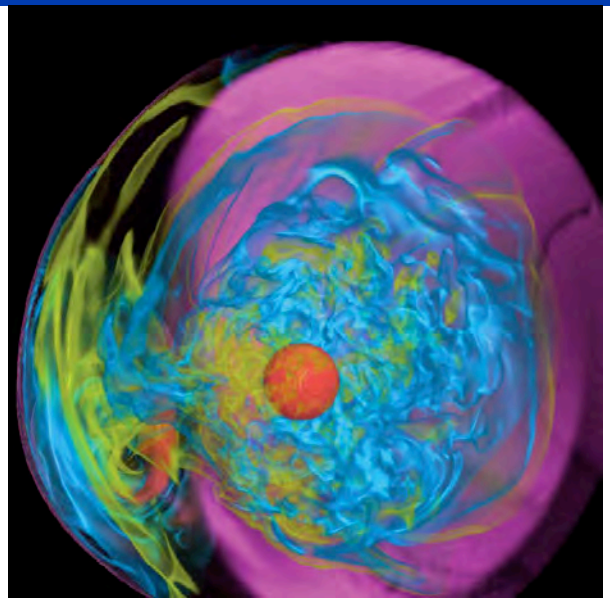



Improving Hydrogen Storage in Fuel Cells

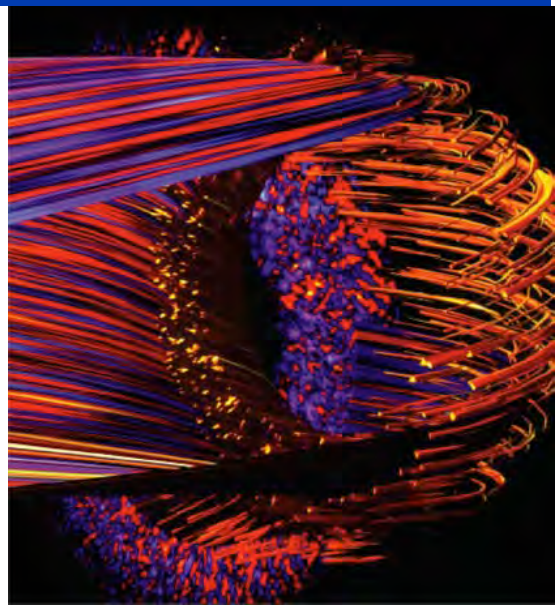
# Department of Energy Office of Science
# Leading Edge Applications of Petascale Computers



Flames

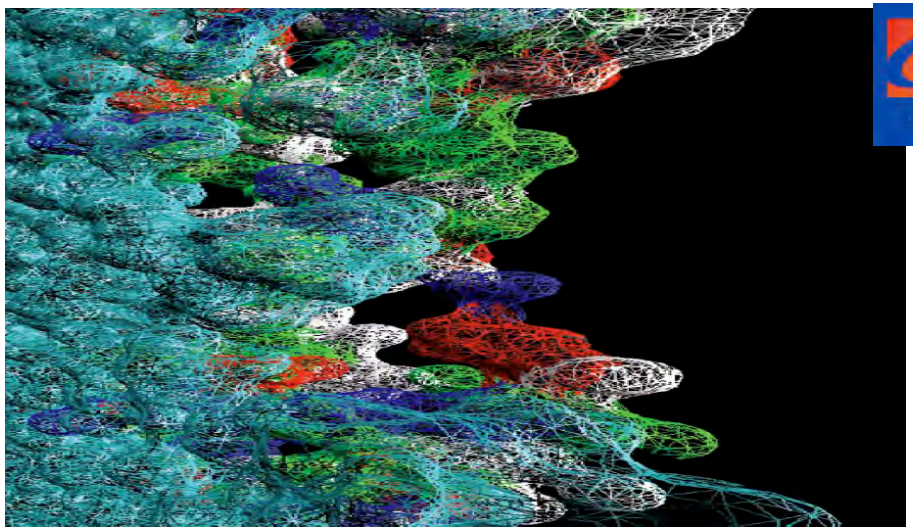


Supernova

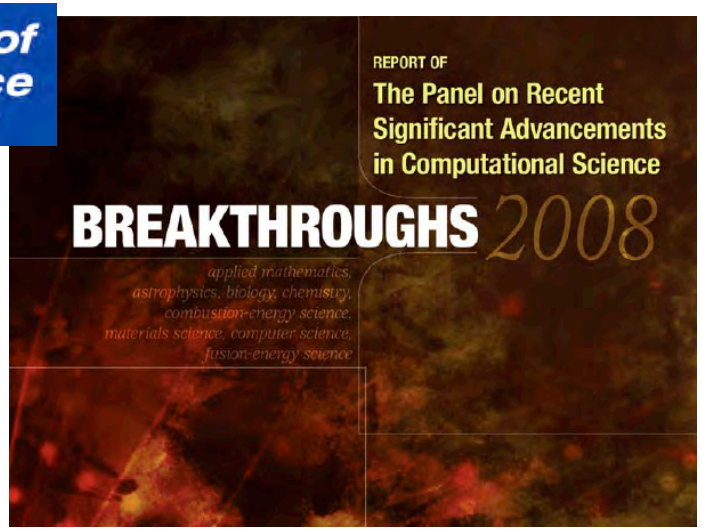


Fusion

Parkinson's



Office of Science
U.S. DEPARTMENT OF ENERGY



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

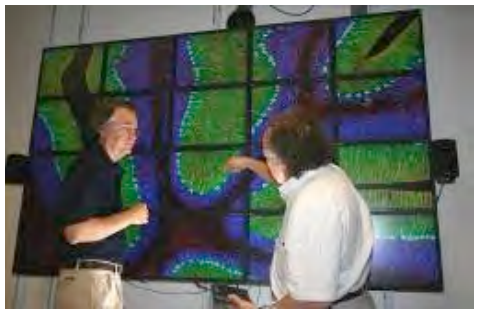
- **Mobile Broadband**
  - **0.1-0.5 Mbps**

**100,000 Fold Range**
**All Here Today!**

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

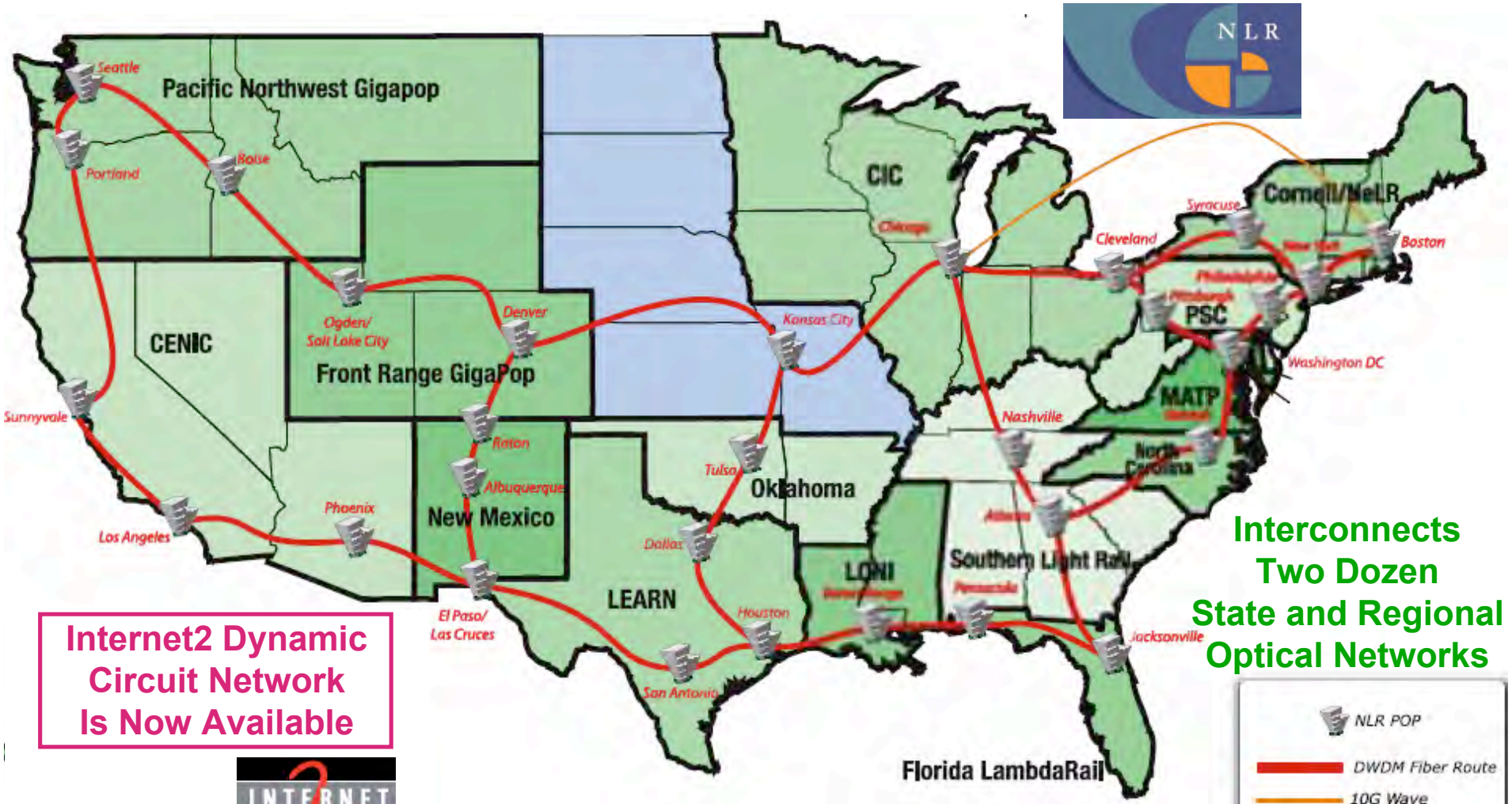
**"The future is already here,**
**it's just not evenly distributed"**
**William Gibson, Author of Neuromancer**

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



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

# Dedicated 10,000Mbps Supernetworks Tie Together State and Regional Fiber Infrastructure



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

**OptIPortal–Termination Device for the OptIPuter Global Backplane**

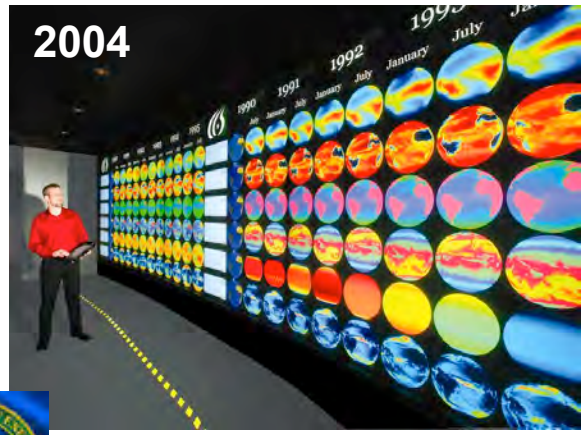
Powered by Rocks

**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**

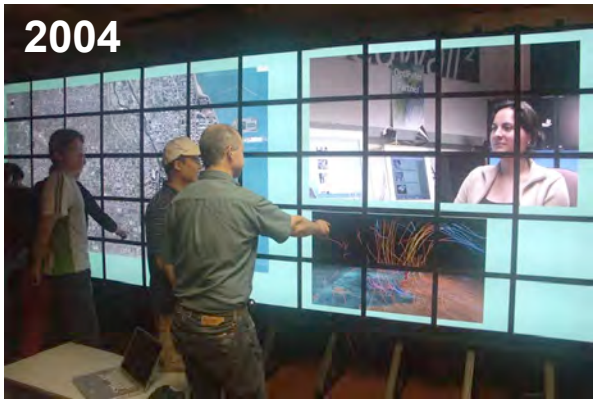
# Challenge—How to Bring Scalable Visualization Capability to the Data-Intensive End User?


NCSA 4 MPixel
NSF Alliance PowerWall

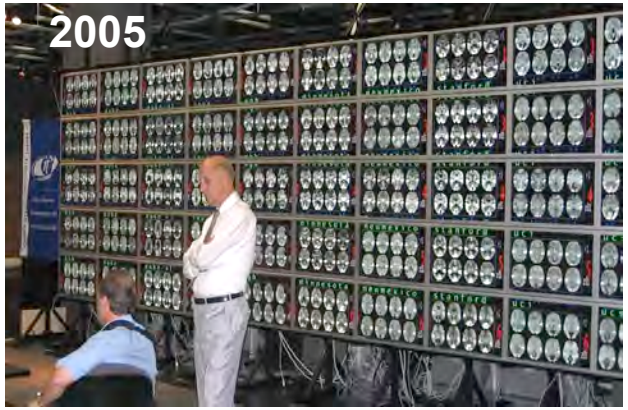

LLNL 20 Mpixel Wall




ORNL 35Mpixel EVEREST




EVL 100 Mpixel LambdaVision
NSF MRI




Calit2@UCI 200 Mpixel HiPerWall
NSF MRI


TACC 307 Mpixel Stallion
NSF TeraGrid

OptIPuter

NSF

**A Decade of NSF and DoE Investment--
Two Orders of Magnitude Growth!**

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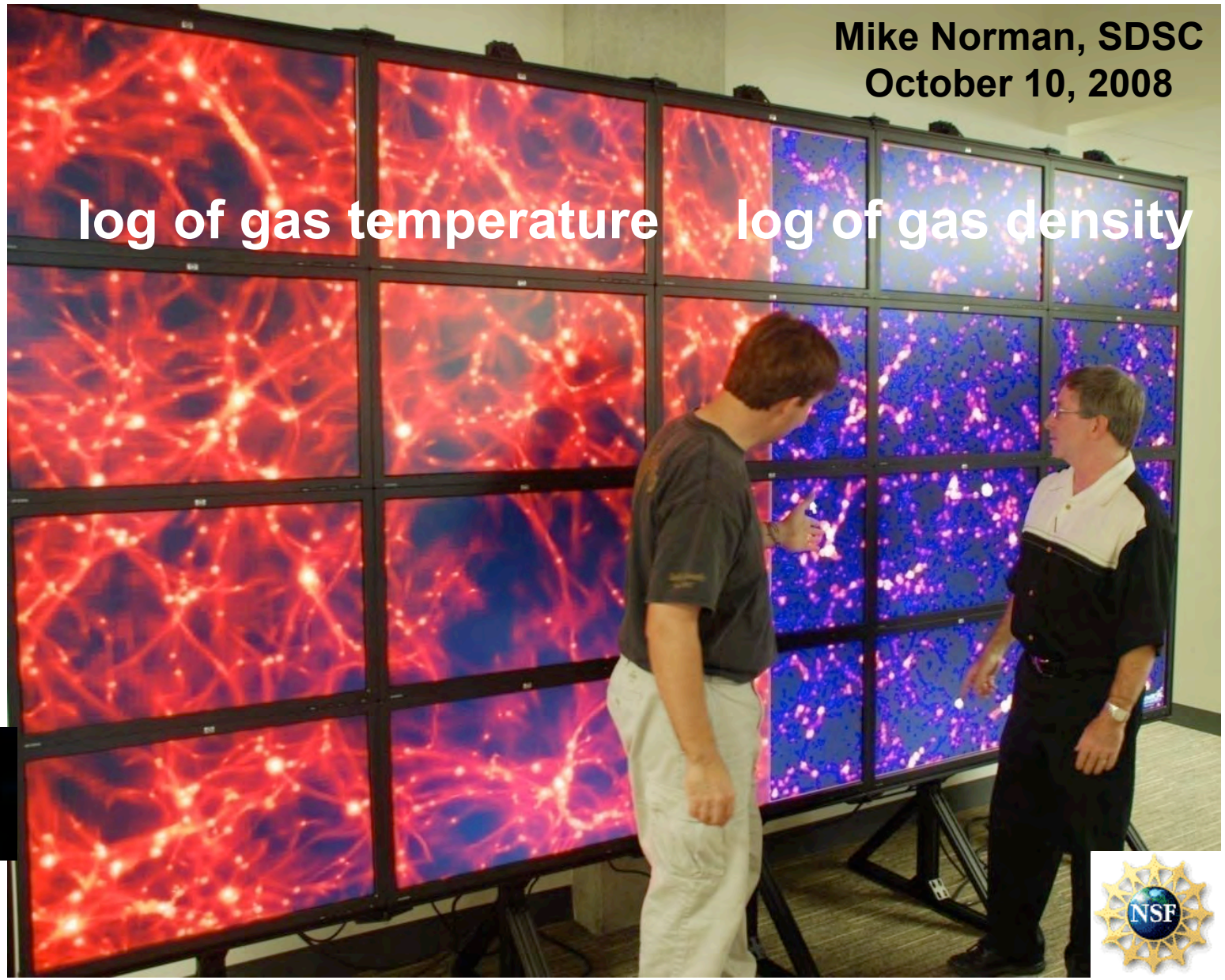
# OptIPortals: Scaling up the Personal Computer For Supernetwork Connected Data-Intensive Users

SDSC
SAN DIEGO SUPERCOMPUTER CENTER

Two 64K Images From a Cosmological Simulation of Galaxy Cluster Formation




ROCKS

CGLX

OptIPuter

NSF

# The Data-Intensive Research "OptIPlatform" Backplane for Cyberinfrastructure: A 10Gbps Lightpath Cloud

End User OptIPortal

Instruments

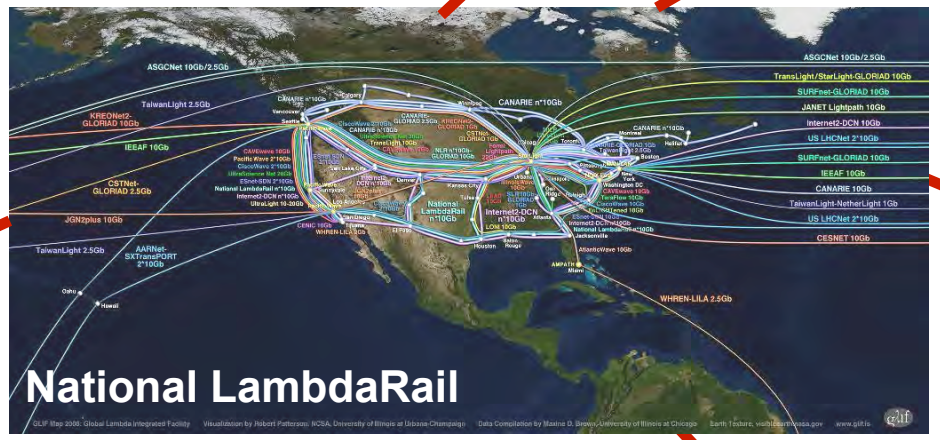

HD/4k Telepresence

HD/4k Video Cams

HPC

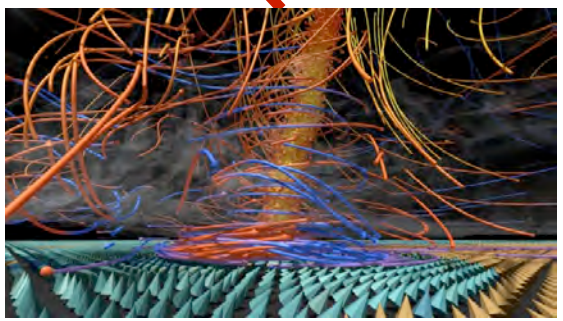
Campus Optical Switch

10G Lightpath




TeraGrid

Data Repositories & Clusters



HD/4k Video Images

NSF

OptIPuter

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