SAGE: the Scalable Adaptive Graphics Environment Middleware for Visualization Streaming and Collaboration in Scalable Display Environments

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2008 Ultrascale Visualization Workshop, SC 2008

Motivation

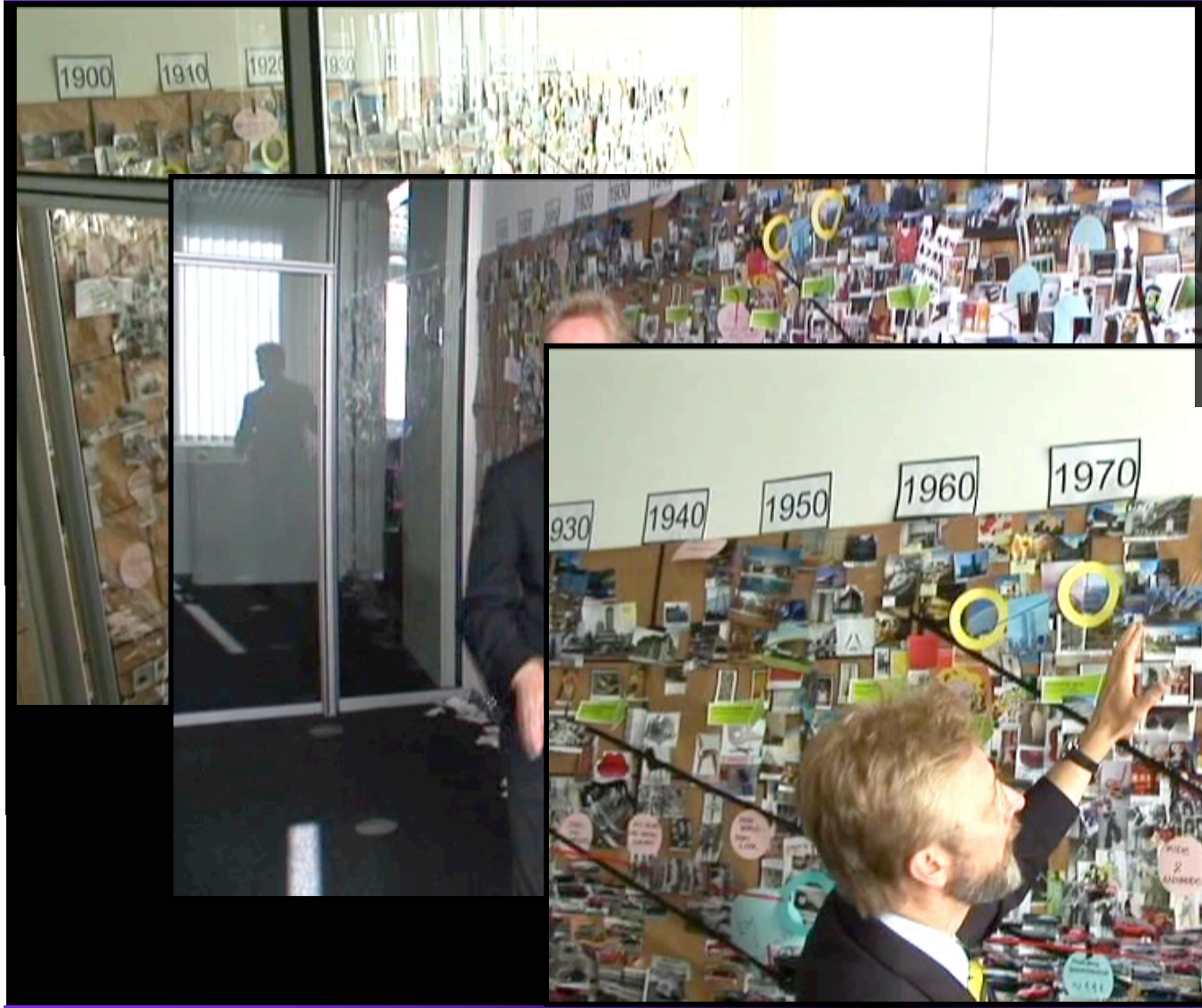
- Problems today are of much larger scale and complexity than ever before.
- These and other problems can only be solved through interdisciplinary collaborations- e.g. Global Climate Change.
- There is a need to teach students, not just scientists how to collaborate with people from other disciplines.

Real World Examples of Managing Scale and Complexity (not just in science)

Will Self, English novelist known for crafting complex narratives with weaving story lines

www.will-self.com/writing-room

Examples of Managing Scale and Complexity



BMW's Wall of Inspiration

Depicts trends in context of Time, Fashion and Architecture

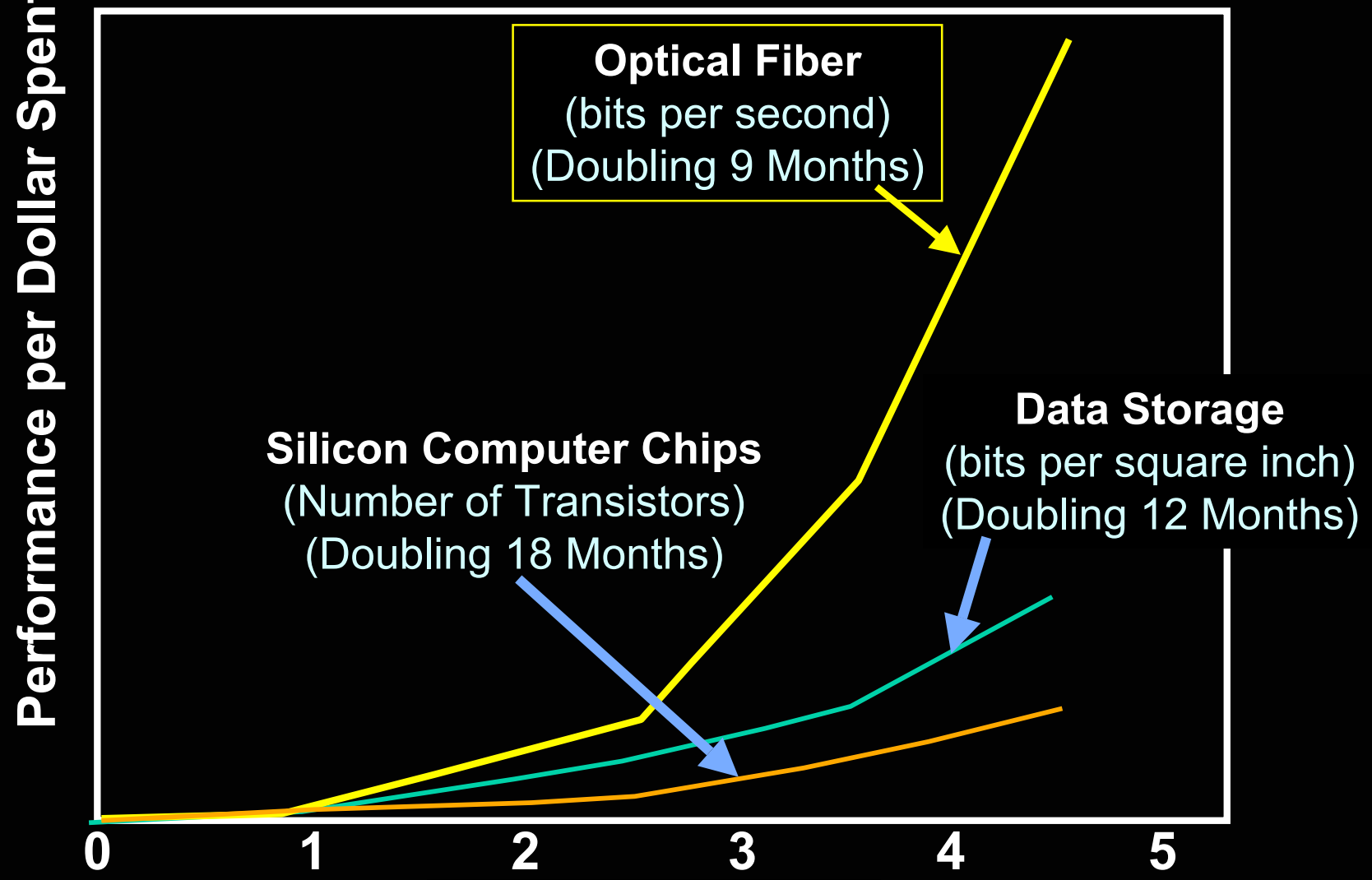
Real World Examples of Managing Scale and Complexity

Antarctic Drilling Program
Documenting features is done by hand, on paper

Managing Scale and Complexity in Teams

"War" Rooms / Project Rooms

Technological Trends:
Performance per Dollar between Optical Fiber, Silicon and Data Storage

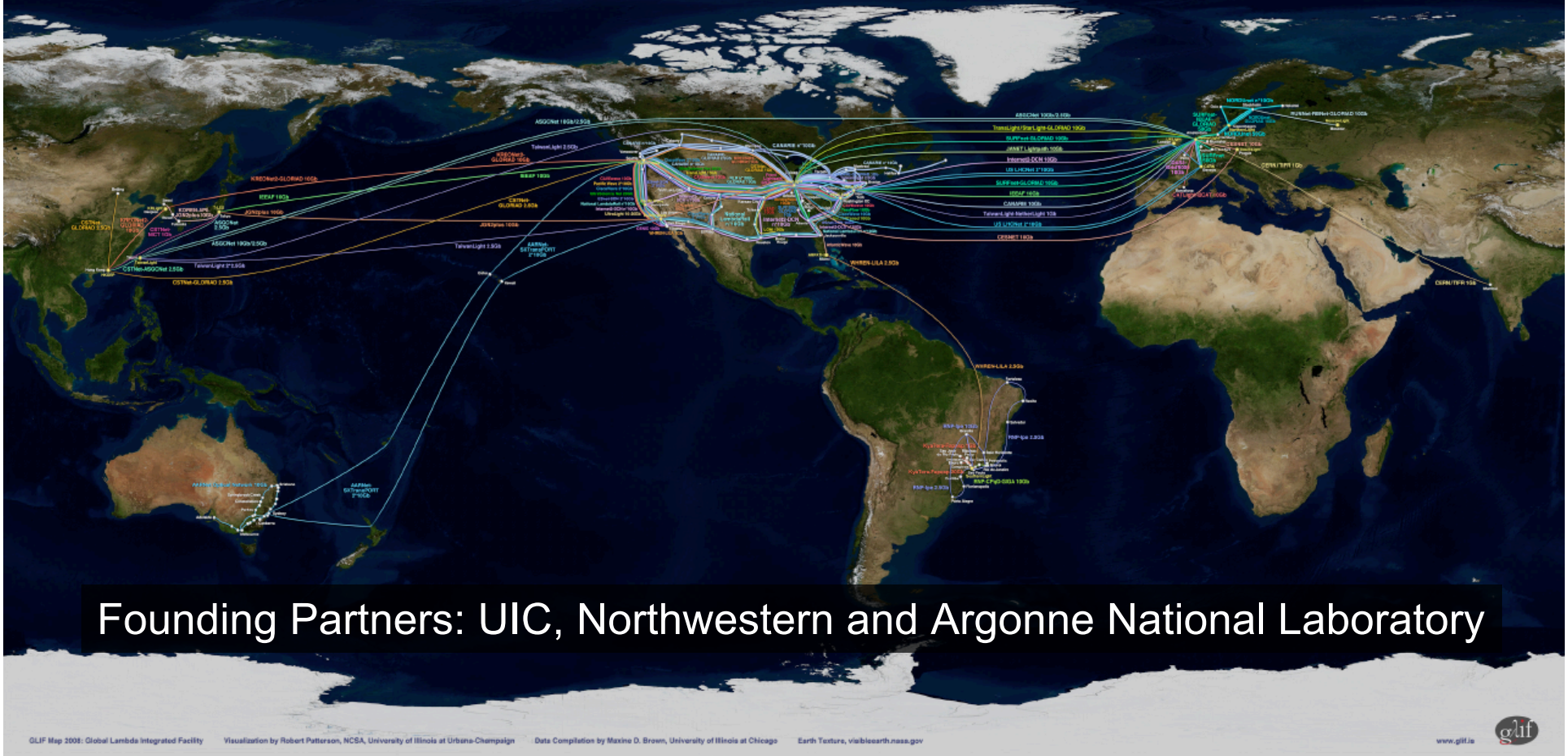


Scientific American, January 2001

International Network Infrastructure

Global Lambda Integrated Facility

Persistent Optical Networking Infrastructure for
Rapid Distribution of Large Scale Instrumentation Data



Technological Trends: High Resolution Displays are Becoming the Lenses to Cyber-Instruments

Chairman of Sharp

"In ten years' time entire walls could be screens"

Forbes, June 4, 2007

http://www.time.com/time/photogallery/0,29307,1622338_1363003,00.html

OptIPuter

- The OptIPuter is a NSF Information Technology Research project to examine a new model of computing whereby ultra high speed networks form the backplane of a, planetary scale computer.
- The projects partners include UCSD, UIC, NU, SDSU, TAMU, UCI, UIUC/NCSA, USC/ISI; affiliate partners are USGS EROS Data Center, NASA, UvA, SARA (Netherlands), KISTI (Korea), AIST (Japan)
- Optiputer research focuses on developing technology to enable the real time collaboration and visualization of very large data-sets in the service of science- in particular earth sciences and the biosciences
- Realization is: It is more cost-effective for scientists to buy bandwidth to connect to shared Cyber-Infrastructure than to redundantly clone more cyber-infrastructure.

OptIPortal:
Leveraging High Speed Networks & High Resolution Displays Connected to Cyber-Infrastructure to Create Cyber-Mashups

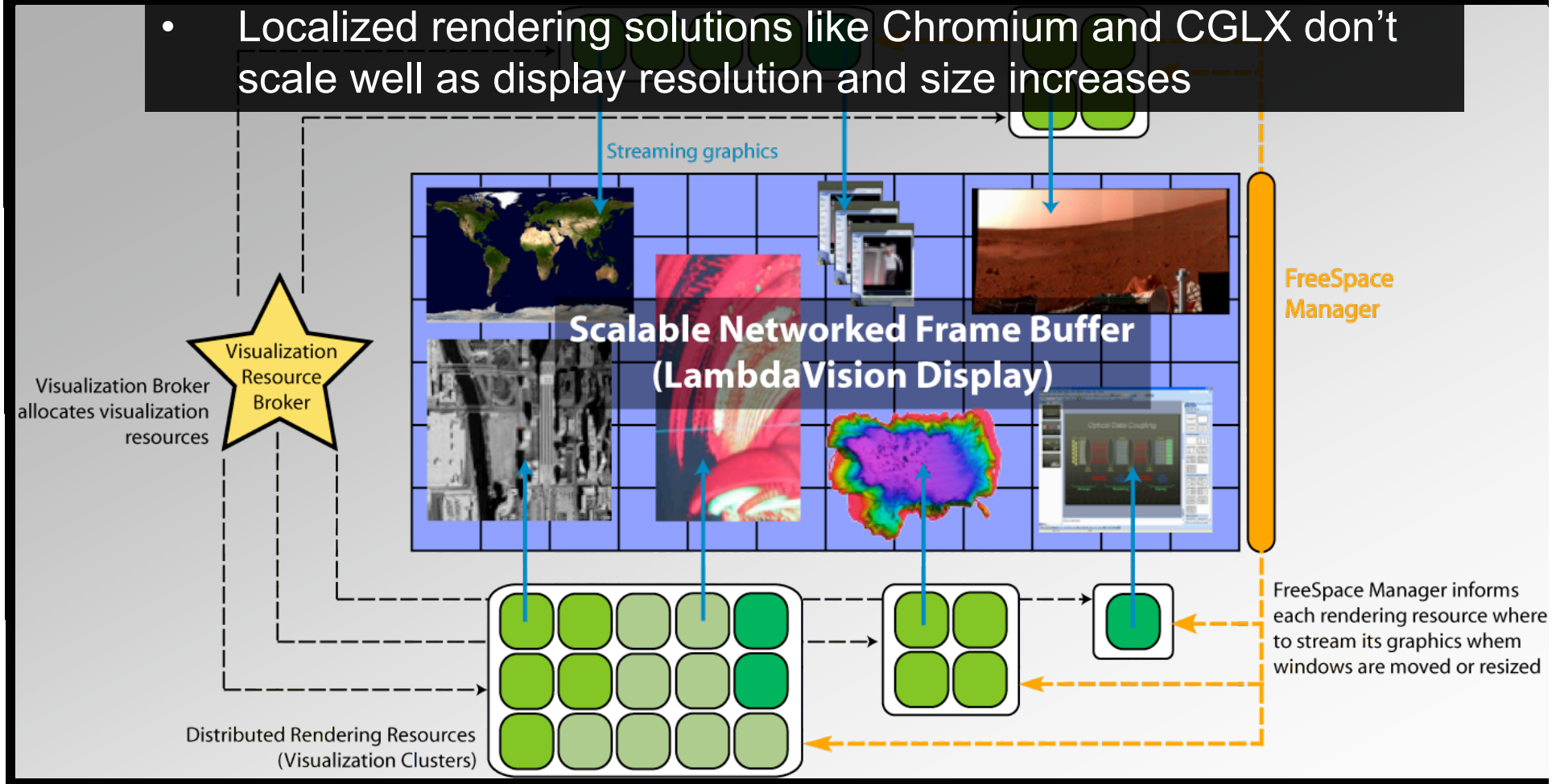
What can you do with large displays and high resolution that you can't do otherwise?

	Small Screen	Big Screen
Low Res	1 doc @ a time Pan & zoom	1 doc @ a time Pan & zoom
		New modalities of interaction (up close and far away)

- Summary:
  - Larger Displays facilitate group viewing
  - Higher Resolution facilitates the juxtaposition of more information
  - Large High Resolution facilitates group viewing and interaction of multiple high resolution visualizations
  - Large Scale High Resolution Display Spaces enable users to Externalize and Expand their Working Memory

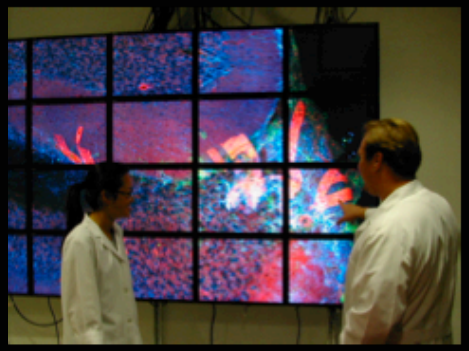
SAGE
Scalable Adaptive Graphics Environment

- Users want to juxtapose more than one visualization, not use up the entire wall for a single visualization.
- Localized rendering solutions like Chromium and CGLX don't scale well as display resolution and size increases



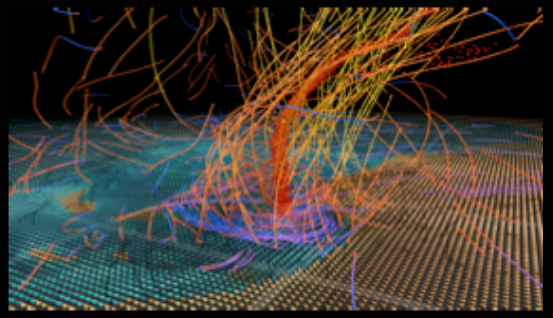
SAGE-enabled Visualization Tools

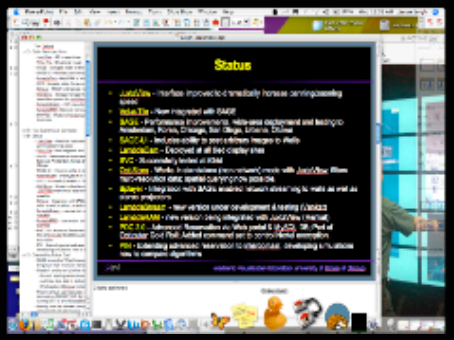
JuxtaView



VolaTile

BitPlayer





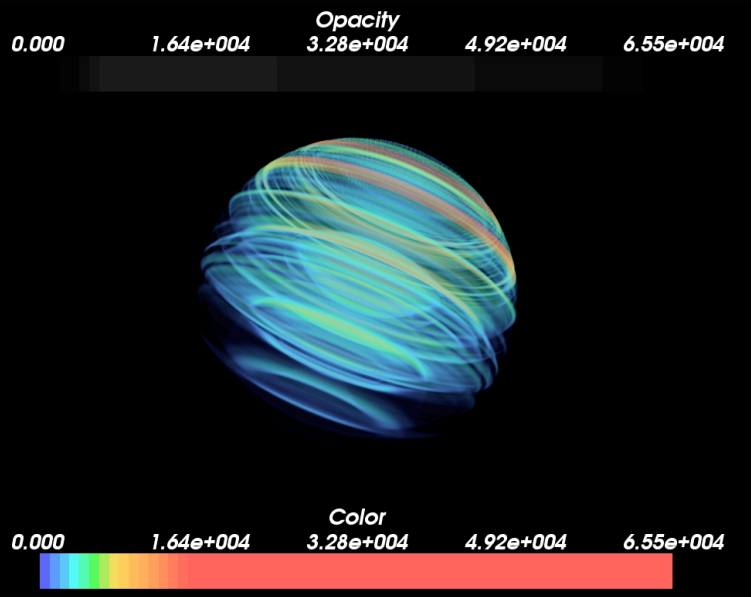
Desktop Sharing

HD Video

SAGE UI

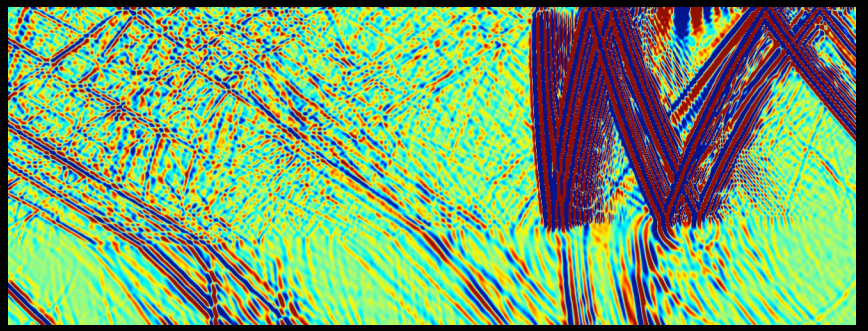
Simulation Output

- Images, animations, or videos produced at one site
- Load
  - Images: ‘imageviewer’ application
  - Movies: ‘mplayer’ plugin
  - Animation: `bitplayer’
- Stream
- Display



Example: SDSC/Geon

- Images at 8874x2000 pixels, 400 frames
- Movies of X and Z ground velocities from an earthquake simulation



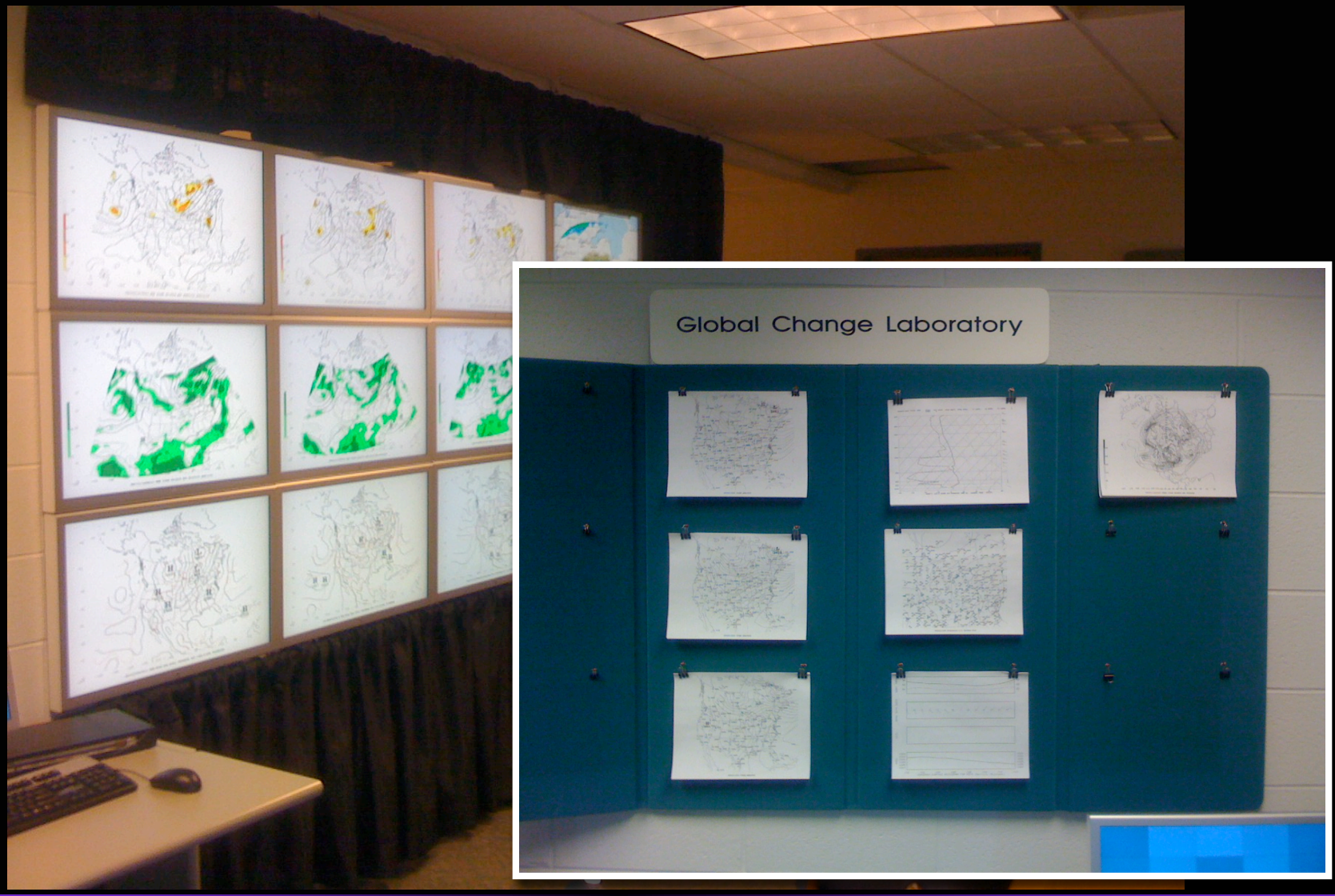
Streaming OpenGL

- OpenGL hardware rendering application
- Capture pixels
  - No application modification
  - Dynamic loading of a new OpenGL library
  - À la Chromium
- Stream
- Display

Example: Paraview in SAGE

UIC Anatomy Class

U of Michigan
Atmospheric Sciences Department



Sharp Labs of America

Supporting Information-rich Distance Collaboration

- In time-critical situations, content needs to be distributed in real time to collaborating sites to facilitate joint analysis and decision making
- Require “multicasting” 10s of gigabits, not possible & affordable with current war room and telco equipment

- VisualCasting uses commodity clusters to provide a scalable way to broadcast real-time ultra-high-resolution content
- To scale up resolution or number of collaborators, you increase number of cluster nodes

VisualCasting Trial (Spring 2008)

KISTI

4x2 display
HD Camera
5G WAN

GIST

4x2 display
HD Camera
1G WAN

EVL

11x5 display
HD Camera
20G WAN

StarLight

2x Visualcasting
servers
20G WAN

U.
Michigan

6x4 display
HD Camera
10G WAN

SARA

5x3 display
HD Camera
10G WAN

33 OptIPortals Around the World

www.evl.uic.edu/cavern/optiplanet

Closing Remarks

- Large High Resolution Network-enabled environments are an economical way to leverage Cyber-Infrastructure.
- These environments facilitate group collaboration and juxtaposition of large quantities of detailed data to help mitigate problems of scale & complexity.
- We see these environments pervading not just meeting rooms but office spaces, and ultimately homes.
- Much research needs to be done in the following areas:
  - Creating end-user tools and techniques for authoring in these environments
    - creating Cyber-Mashups
  - Creating functionally complete interaction methods in the same way that today's desktop computer interfaces are functionally complete.
  - Enabling these environments to be persistent.

Closing Remarks

- For more info:
  - www.evl.uic.edu/cavern/sage
  - www.evl.uic.edu/cavern/optiplanet
  - www.optiputer.net
  - spiff@uic.edu

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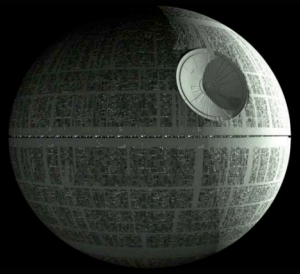
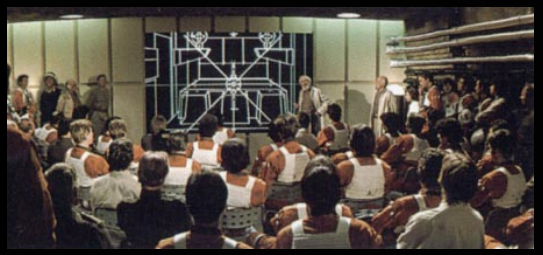
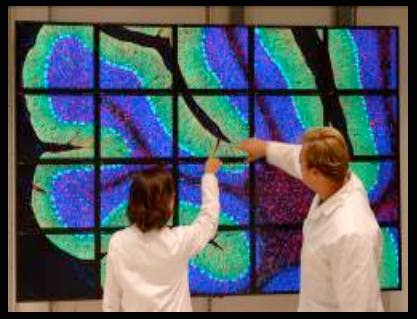
–NSF Awards CNS 0420477; OCI 0225642

Electronic Visualization Laboratory

- Established in 1973
- Directors: Jason Leigh, Tom DeFanti, Dan Sandin (emeritus)
- 10 full-time staff
- Interdisciplinary CS, Art, Biomedical, Communications Depts working in partnership with universities, research labs, non-profit orgs and industry.
- Currently 15 funded students
- Research in:
  - Advanced Display Instruments
  - Visualization and Simulation, Collaboration, Human-Computer Interaction
  - High-Speed Networking
  - International Network Infrastructure







Science Museum of Minnesota

ADLER PLANETARIUM

MUSEUM OF SCIENCE AND INDUSTRY

GM

Microsoft

NTT

SHARP