# *SAGE*: Scalable Adaptive Graphics Environment

## High-Resolution Visualization over Optical Networks

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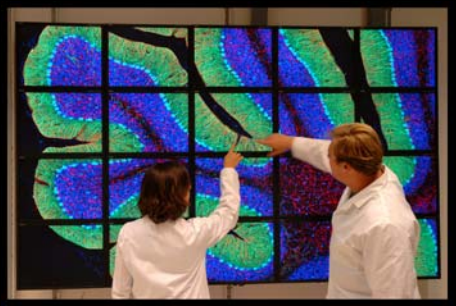
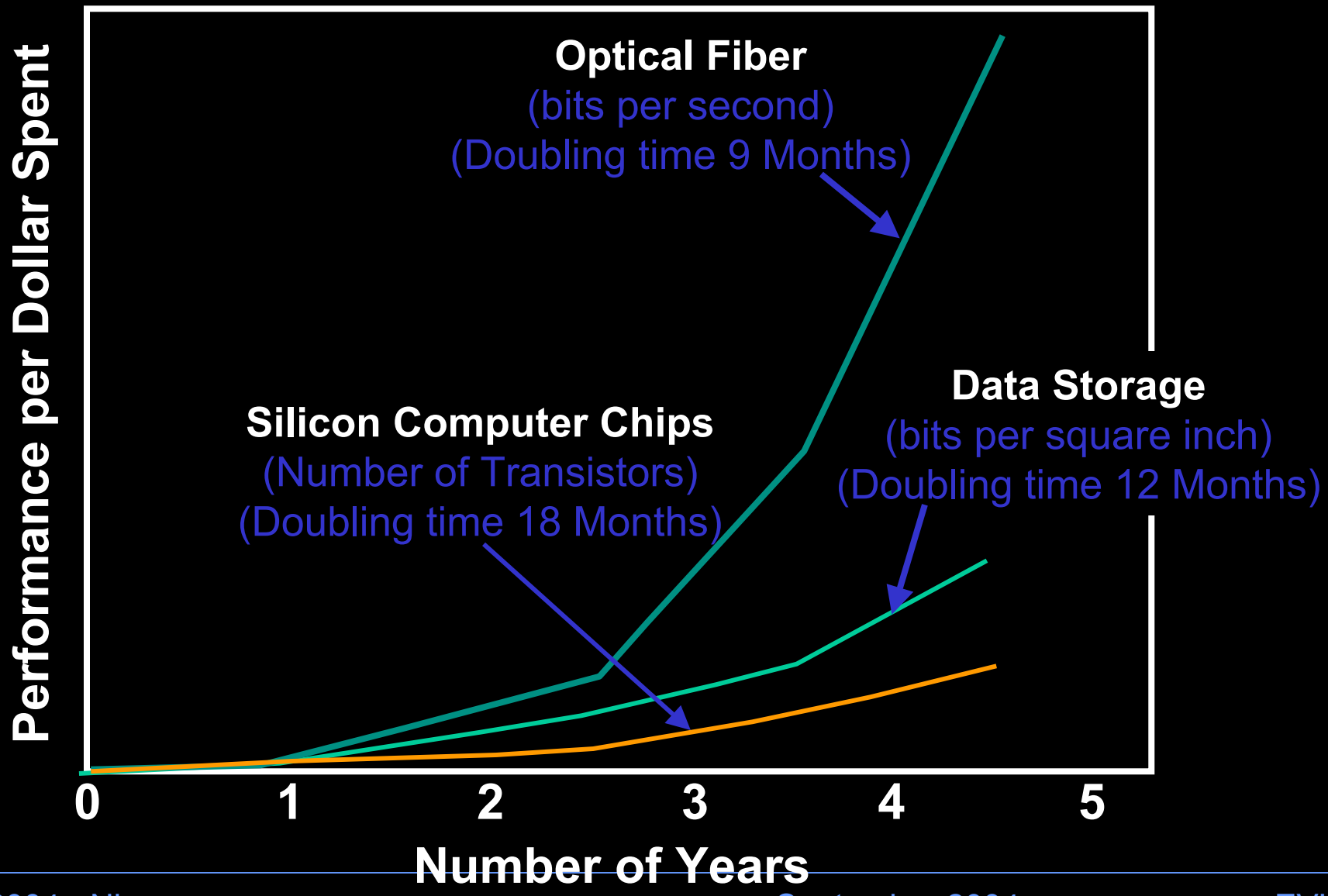
# Scientific Visualization

- US Geological Survey
  - 51TB of aerial photos
  - 133 cities of the US at 1/3 meter resolution
  - 365,000 * 365,000 pixels maps
- NCMIR (National Center for Microscopy and Imaging Research)
  - Rat Brain Map
  - Montage of 43,200 images
  - 4,000x4,000 pixels sensor (soon 8k x 8k)
- Core Lab (Geology/Oceanography)
  - 300 km of core samples, scanned at 1200dpi



# Optical Networks as a Driver

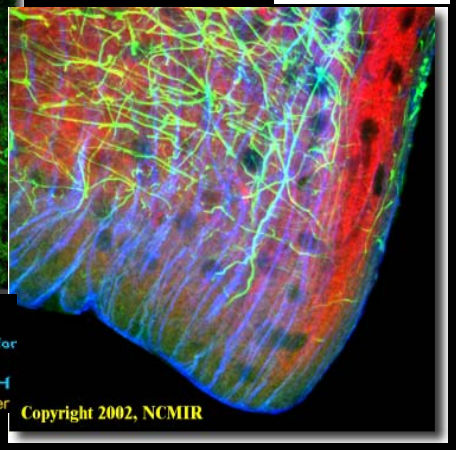



Scientific American, January 2001

# The OptIPuter Project –
## Removing Bandwidth as an Obstacle In Data Intensive Sciences

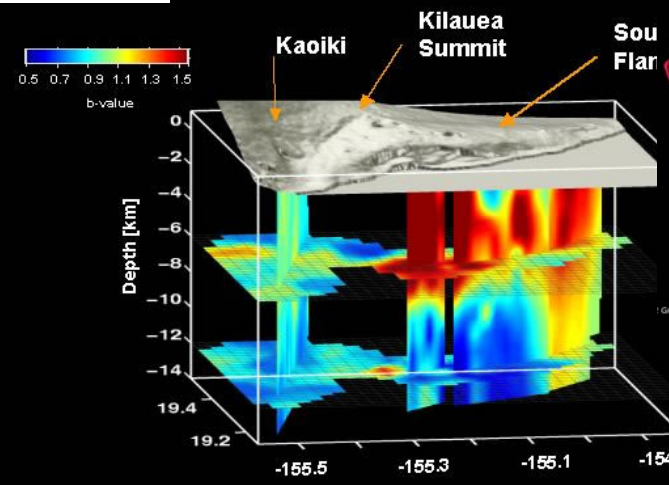
- NSF Large Information Technology Research Proposal
  - UCSD and UIC Lead Campuses—Larry Smarr PI
  - USC, UCI, SDSU, NW, TA&M Partnering Campuses
- Industrial Partners: IBM, Sun, Telcordia/SAIC, Chiaro, Calient
- $13.5 Million Over Five Years
- Optical IP Streams From Lab Clusters to Large Data Objects

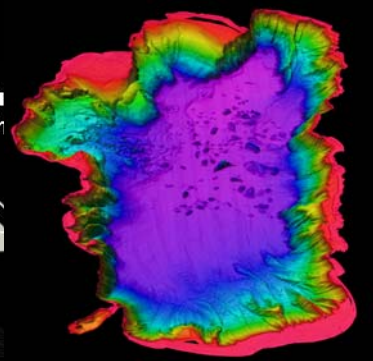
**NIH Biomedical Informatics Research Network**


NCMIR
NATIONAL CENTER for MICROSCOPY and IMAGING RESEARCH
at San Diego, an NIH supported resource center

**NSF EarthScope**

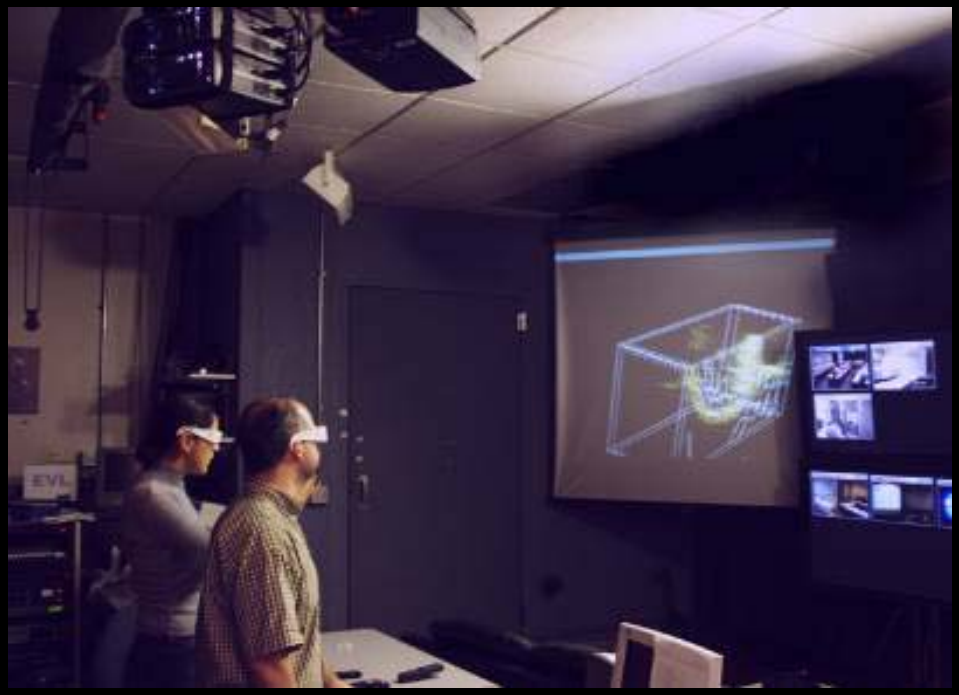


# EVL Displays

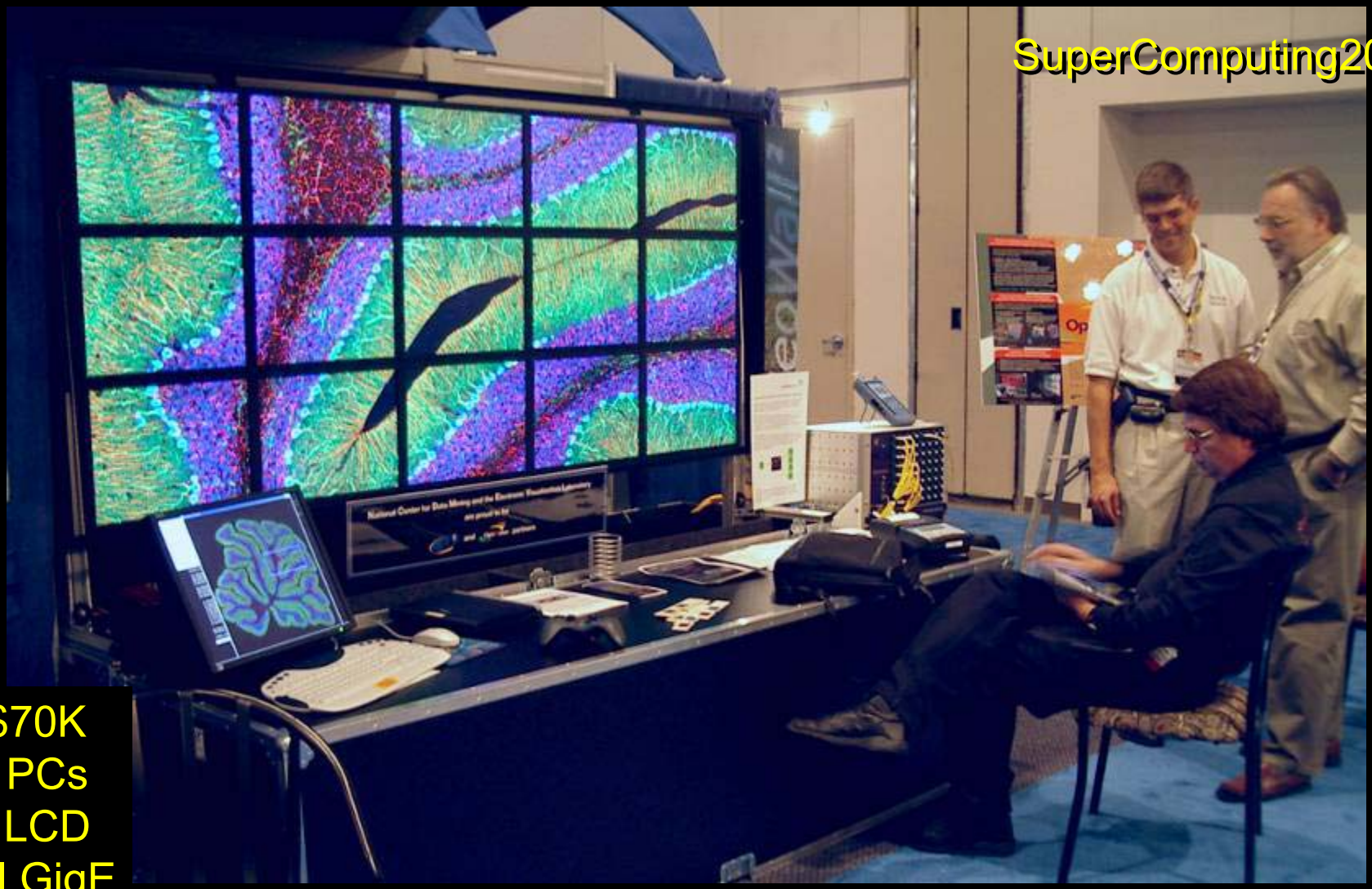
- ***GeoWall*** brought low-cost passive stereo visualization in the classroom
- ***GeoWall2*** is bringing moderate-cost ultra high-resolution to the scientist
- ***Personal GeoWall 2***
  - GeoWall + “Array of LCD panels”
  - Single machine
  - 3 graphics cards: 1 stereo, 2 driving 4 LCDs
  - 64bit computing (Opteron, Pentium EMT64)

# GeoWall



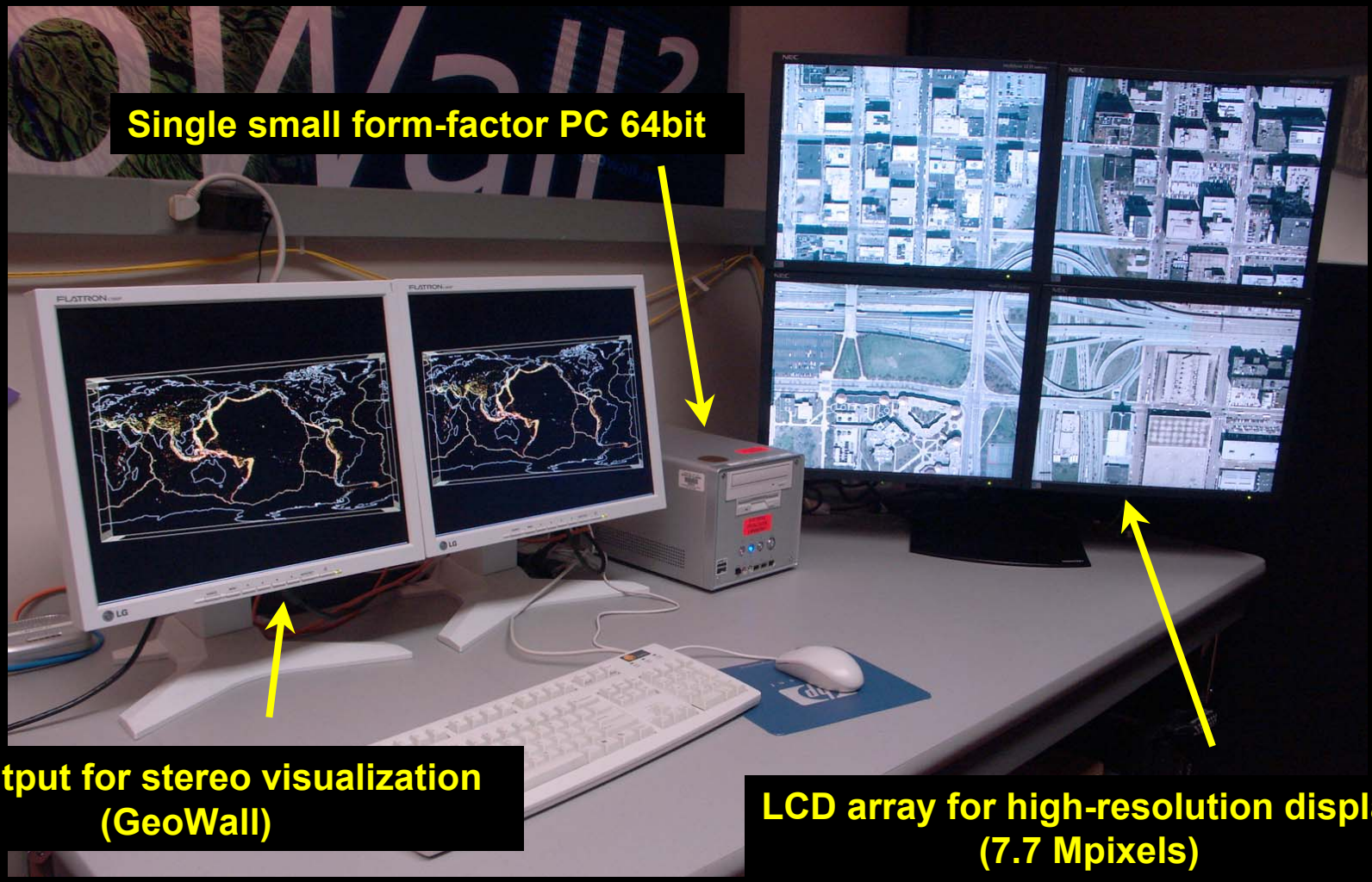
- GeoWall: Low cost 1 megapixel passive stereo display using commodity PCs for displaying 3D data. (Paul Morin, Jason Leigh, Peter van Keken)

# GeoWall-2

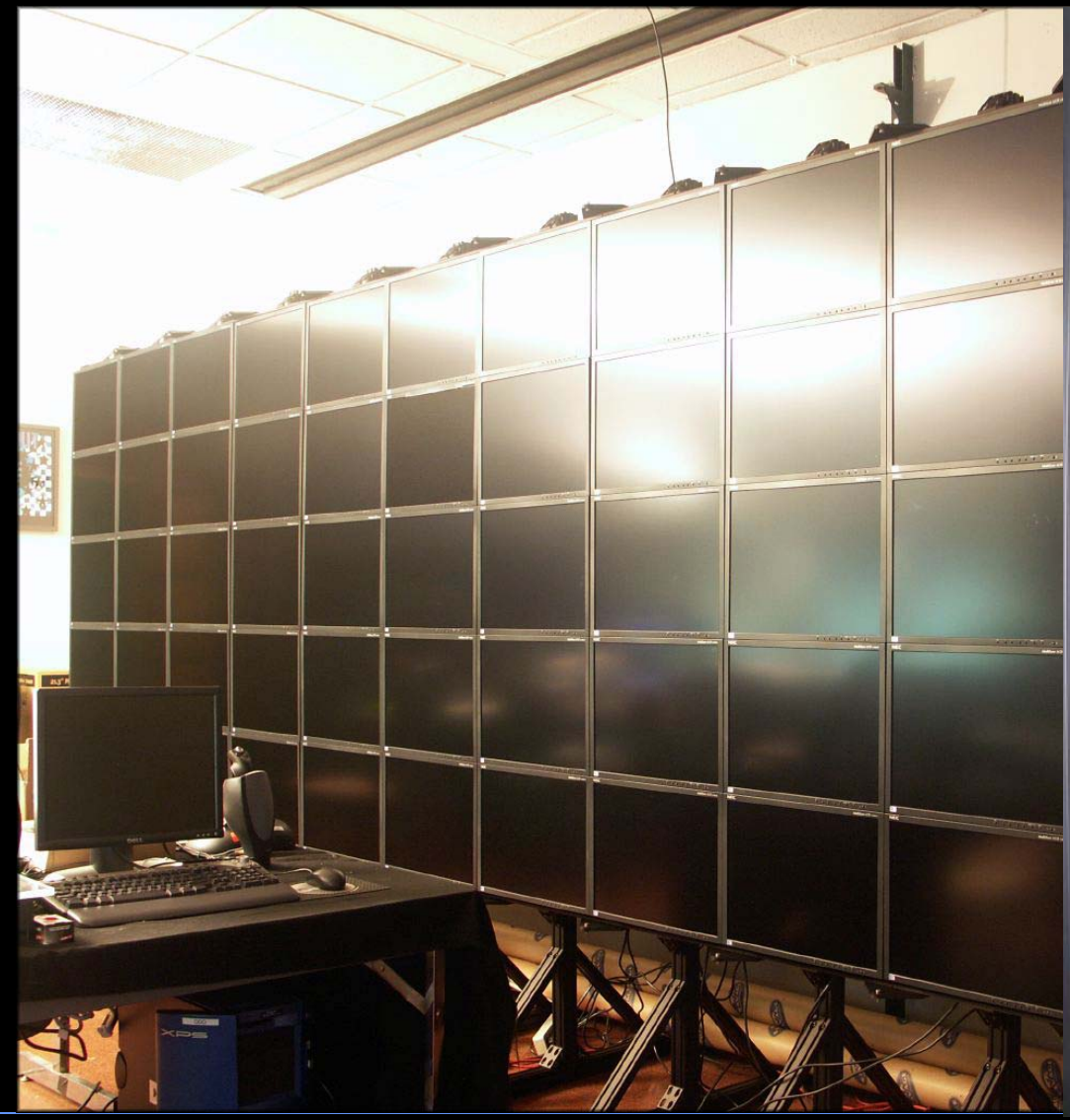



~ $70K
10 PCs
15 LCD
Dual GigE

# Personal GeoWall-2



# LambdaVision: 100Mpixels



# LambdaVision: 100Mpixels


**Total: 105.6 Mpixels**

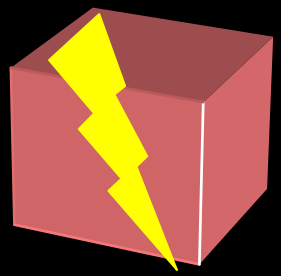
**Less than 0.1% of Chicago Map**

# LambdaVision: 100Mpixels

- 100Mpixels display: 11x5 21.3” LCD tiles
- 30 dual Opteron nodes
- 2 LCDs per graphics card
- 10Gigabit/s interfaces
- MRI Recently recommended for funding by NSF

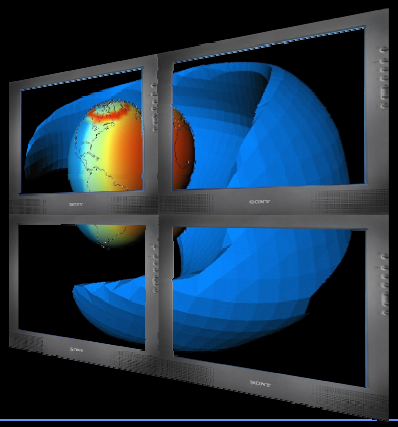
# TeraVision: How To Share Visualizations

VGA / DVI capture



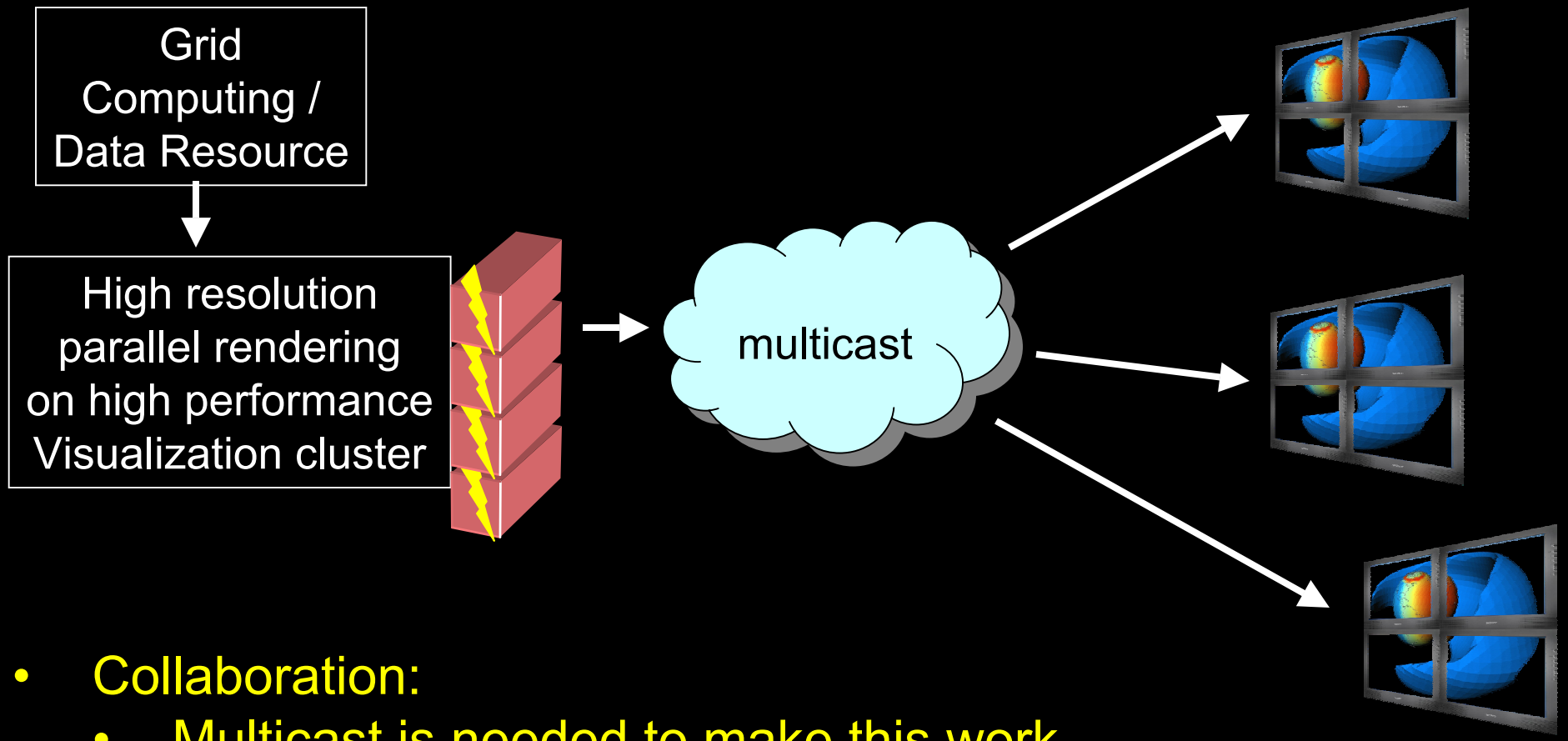
GigE

Remote Display



- Like a Powerpoint projector with a Gigabit NIC built into it.
- Capture raw image 1024x768 30fps 500Mbps uncompressed stream
- 64bit card captures at 1600x1200

# Gang TeraVision Boxes to Stream a Tiled Display




- Collaboration:
  - Multicast is needed to make this work.
  - Multicasting gigabit streams

# TeraVision on Tiled Display

# High-resolution 2D Montages: *JuxtaView*

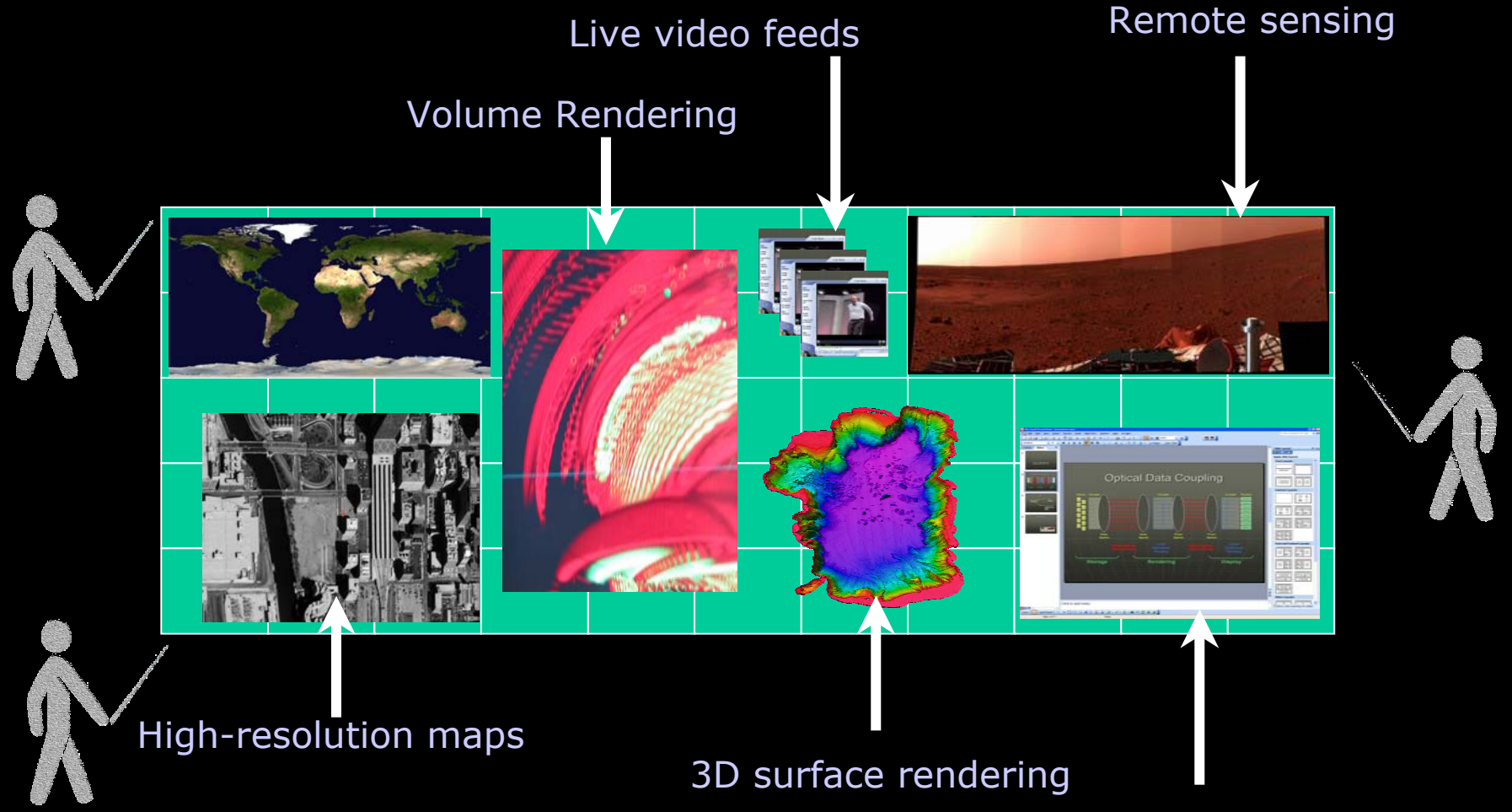
# Large Volume Rendering: *Vol-a-tile*

# SAGE: Scalable Adaptive Graphics Environment

- Imagine
  - Display everywhere
  - Unlimited Bandwidth
- Decoupling rendering and display
- Visualization
  - Scalable in term of data size
  - Scalable in term of resolution

# Working in display-rich environments

**Information must be able to flexibly move around the wall**



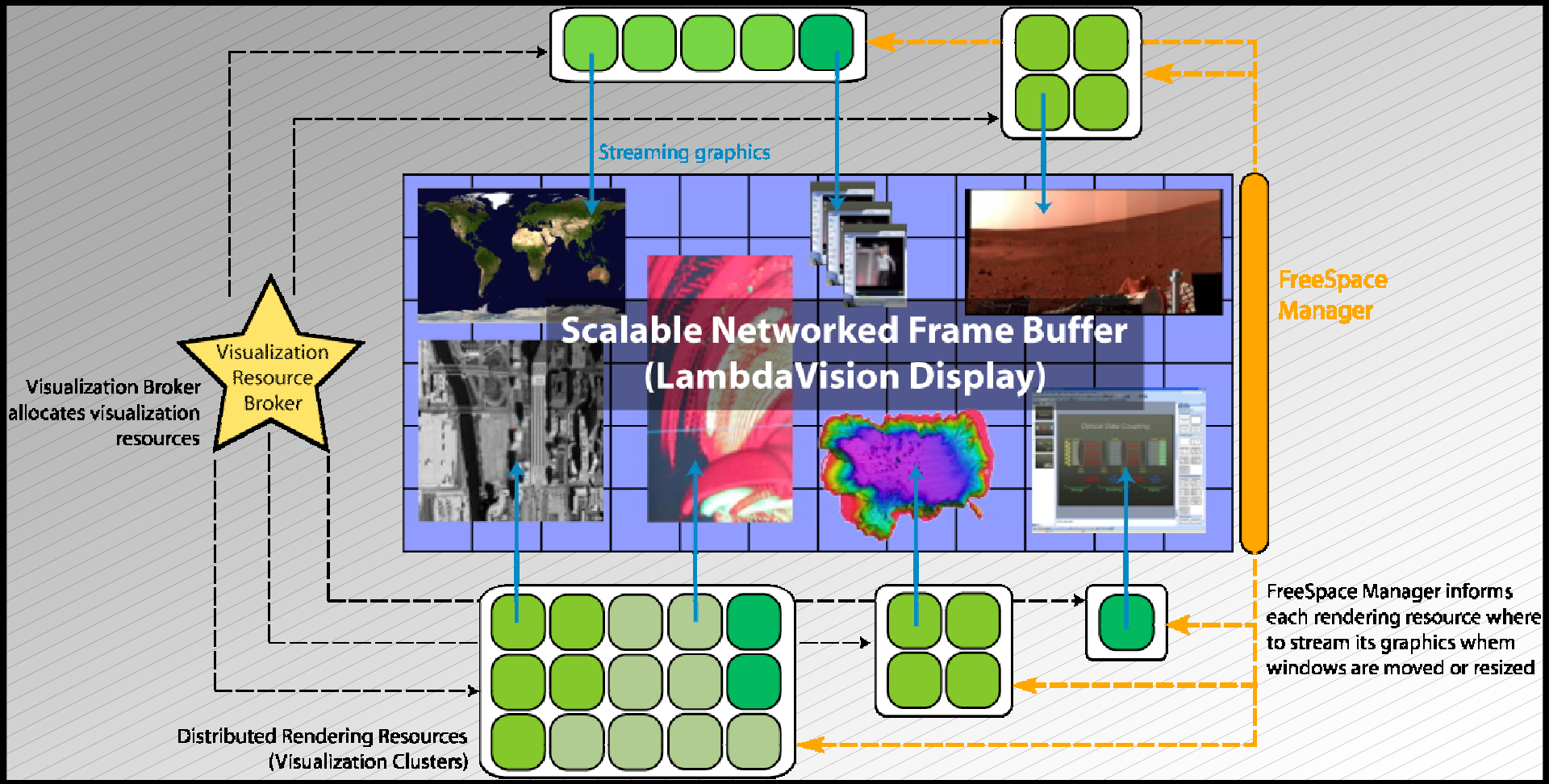
# Adaptive Rendering

- Adapt to the display client
  - Laptop, high-resolution monitor, tiled display
- Networked rendering
  - Leveraging existing infrastructures
- Adapt to output resolution
  - “resize” and “move” events
  - Pixel up-scaling or down-sampling
  - Increase rendering resolution

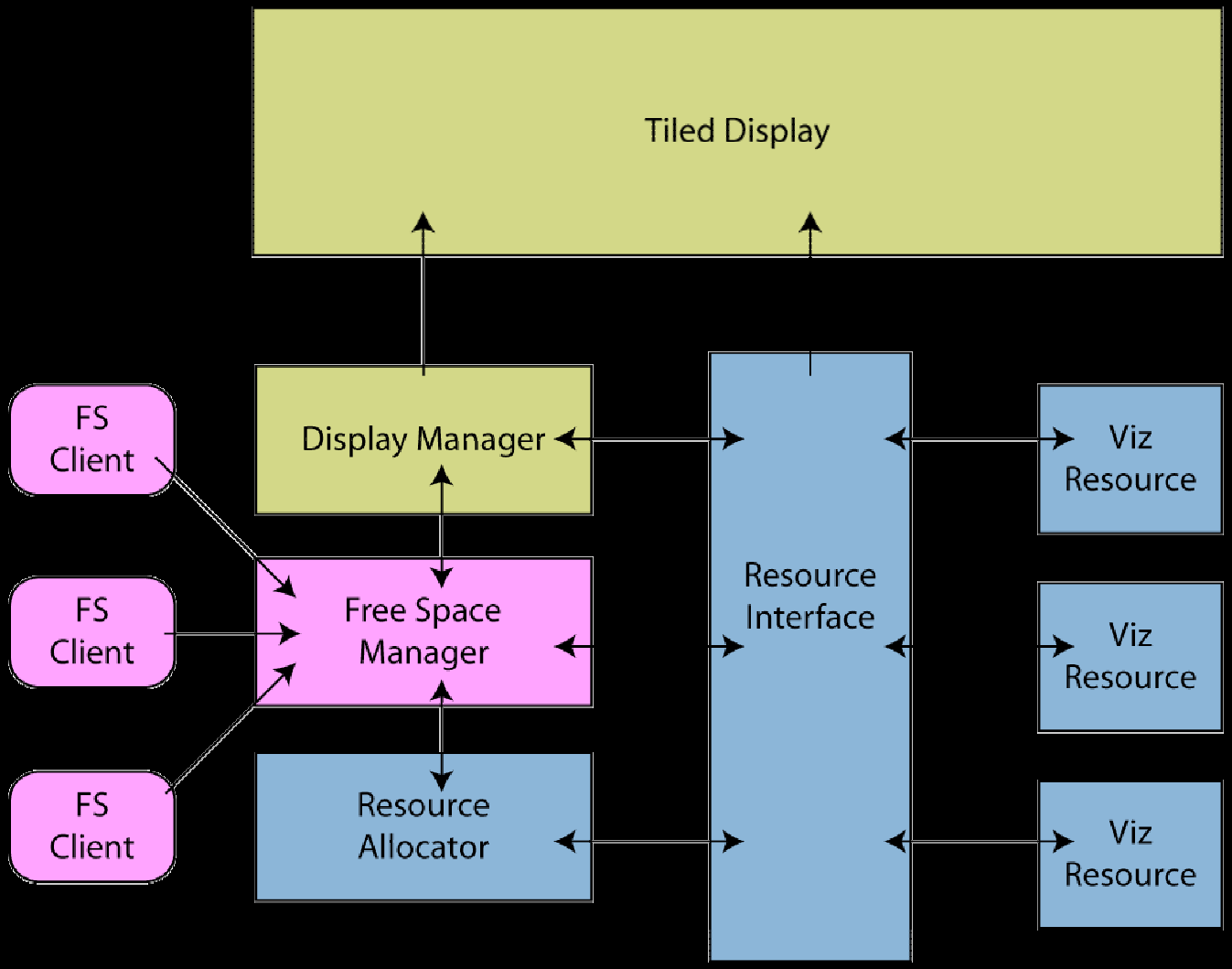
# Pixel Sources

- Visualization applications
  - Software rendering
  - Hardware rendering
- Legacy applications
  - Remote desktop protocols (RDP, ARD, VNC)s
  - TeraVision (hardware capture)
- Video streaming

# SAGE : to Manage Content on Tiled Displays



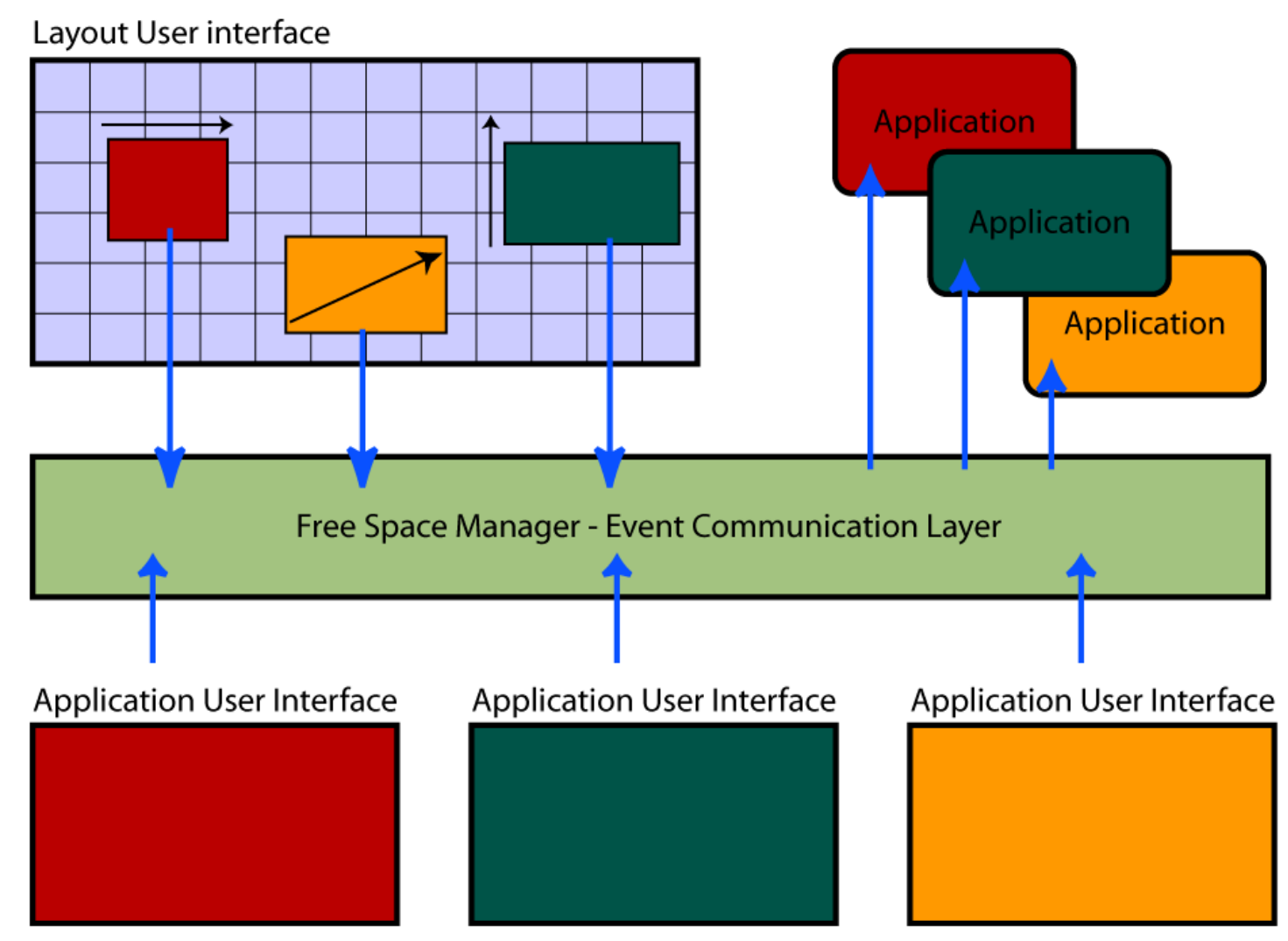
# SAGE Components



# SAGE Steps

- Capture the pixels
- Partitioning of the images
- Routing the pixels
- Layout on the display
- User interaction

# Application Model



# SAGE Primitives

- Now
  - Everything is pixel
  - RGB uncompressed
- Future
  - Color + depth
  - Compression
  - Screen updates (Digital Video Pack Link ?)
  - 3D primitives
    - Polygons, 2D and 3D textures, …

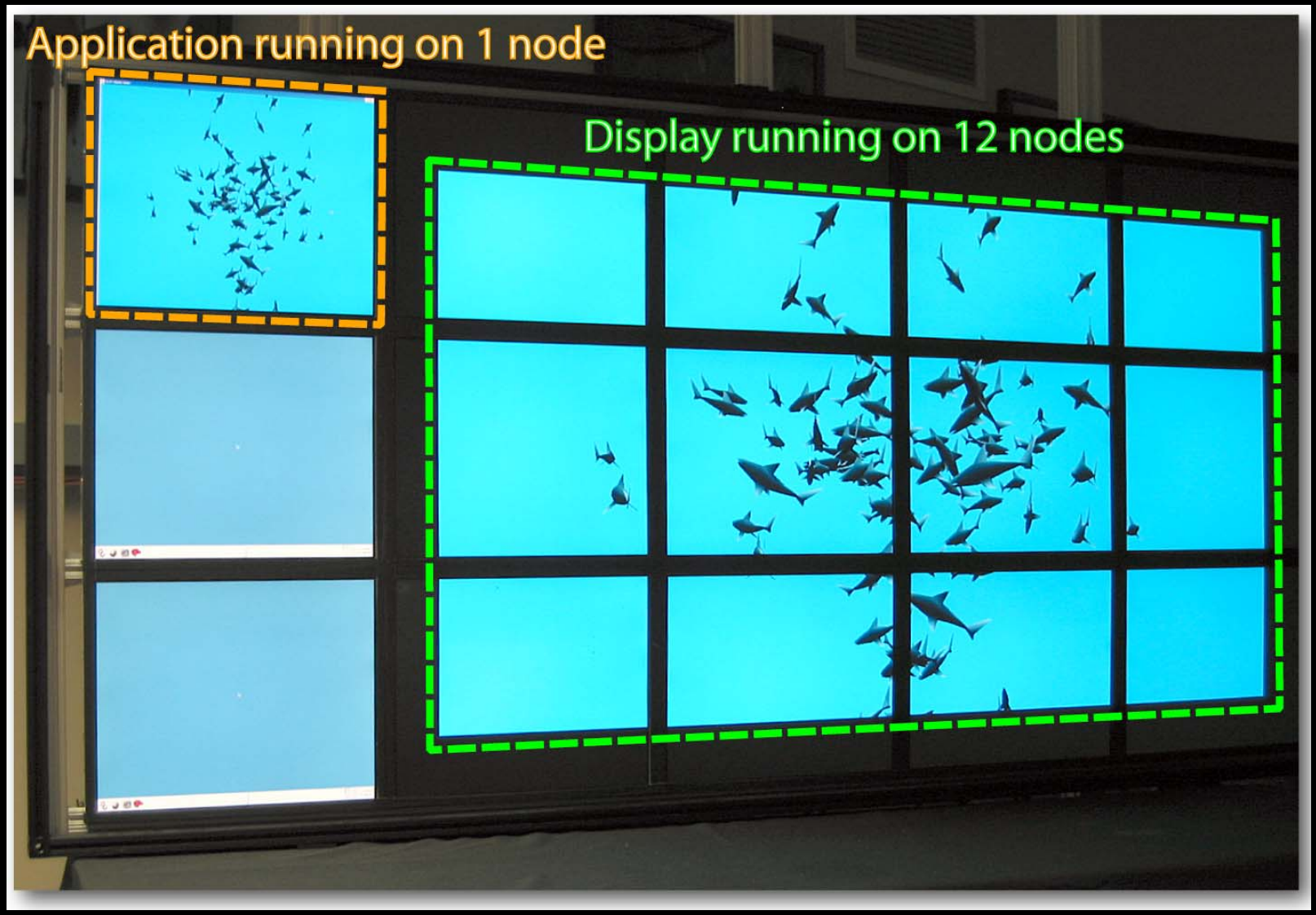
# Networking

- Large amount of bandwidth available through fibers
- Lambda: 1Gb, 10Gb, 40Gb, …
- Application controllable
  - Optical switch
  - Provision
  - Schedule
  - Dedicated
- But large latencies

# *LambdaStream*: Streaming Reliable Blast UDP

- Underlying protocol based on RBUDP
  - Aggressive protocol
  - UDP-based
  - Reliable
- Addition goals:
  - High throughput for ANY sized payloads
  - Lower jitter
  - Fast convergence to available network bandwidth
  - Able to coincide with more than one competing stream

# Current Implementation



# Summary

- Decoupling of rendering and display
- Adaptive to various displays
- Network-centric environment
- Research issues
  - Data management and retrieval
  - Human-computer interaction
  - Remote Collaboration
  - Adaptive rendering techniques

# Questions ?

**http://www.evl.uic.edu/cavern/sage**

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