

Network-based Visualization and Visual Collaboration

iLight 2004 Workshop

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Indiana University*



UITS Advanced Visualization Lab



- Unit of University Information Technology Services at Indiana University
 - Part of Research & Academic Computing division
- Labs in Bloomington and Indianapolis
 - 3 staff members at IUB
 - 4 staff members at IUPUI
 - Operate as single cross-campus unit
- Actively expanding to select regional campuses



AVL Mission

... to provide...

consulting • development • hardware & software resources

...in the areas of...

visualization • virtual reality • high-end graphics • visual collaboration

... to support the...

research • education • creative activities

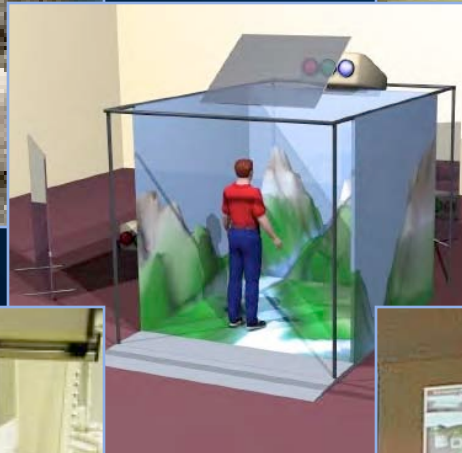
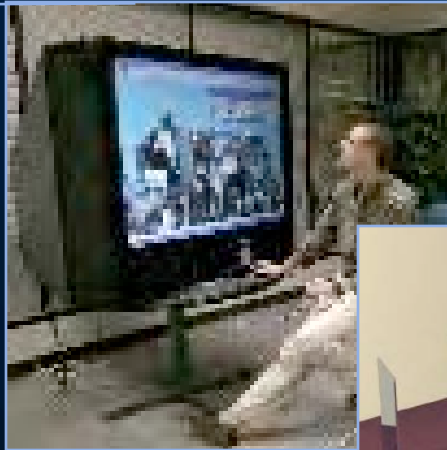
...missions of IU across...

all departments • all campuses



AVL Resources

John-e-Box
Portable
Stereo Display



Tiled
Displays
&
Clusters

CAVE
Immersive VR

Haptics &
Multi-modal
Interaction

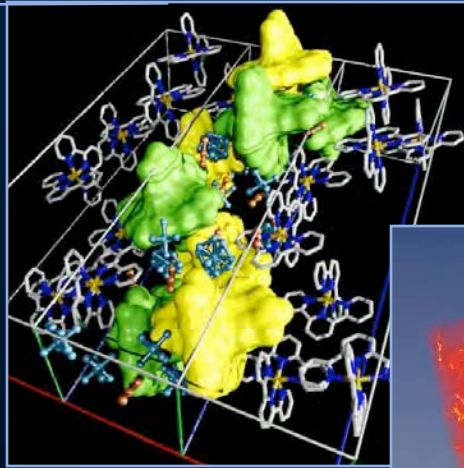


Tele-
Collaboration

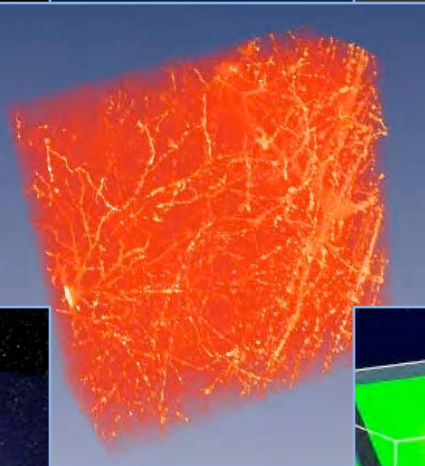
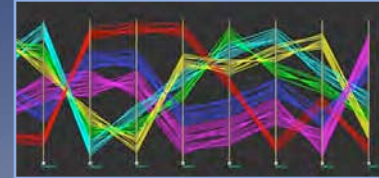
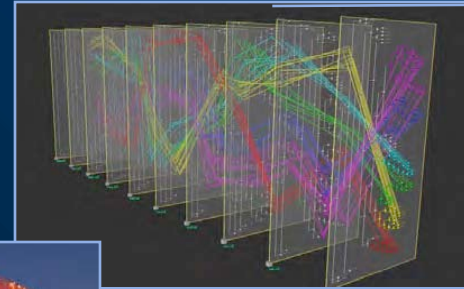


AVL – Support for Research

Chemistry

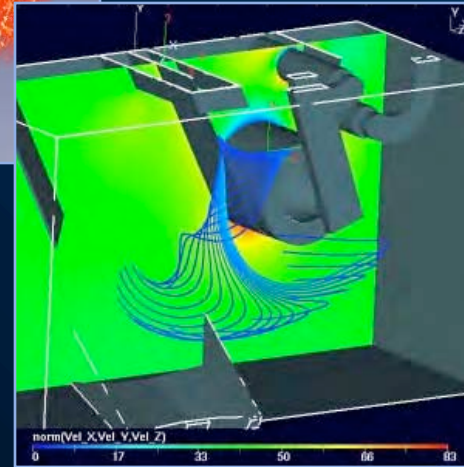


Bio-informatics



Astronomy

Medical Imaging

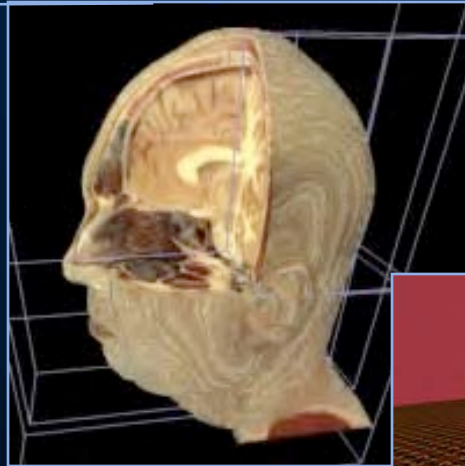


Engineering

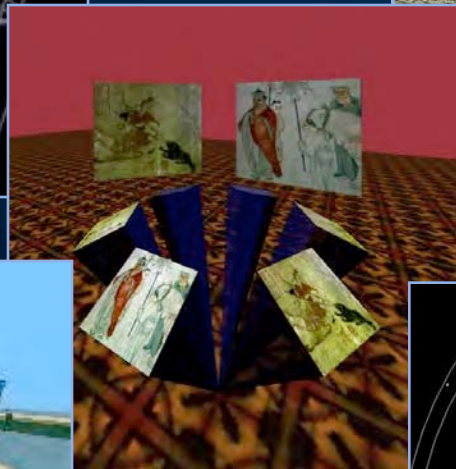
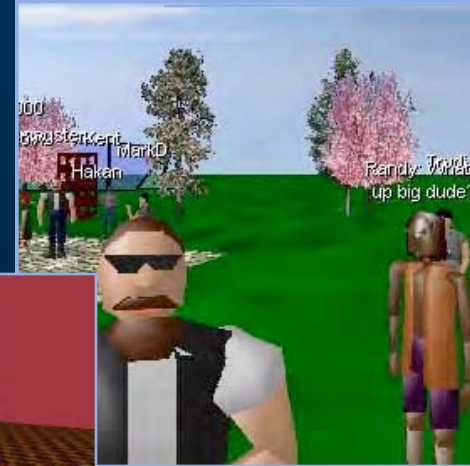


AVL – Support for Education

Anatomy



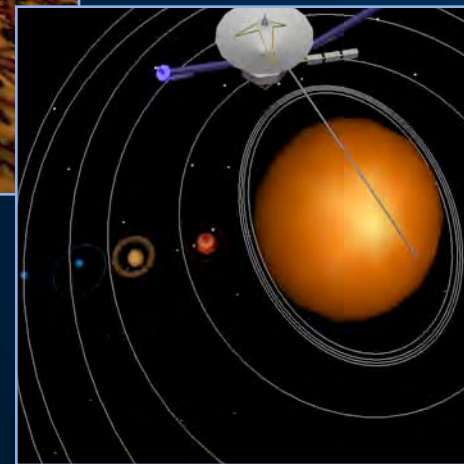
Collaborative Environments



Educational Outreach



Information Science

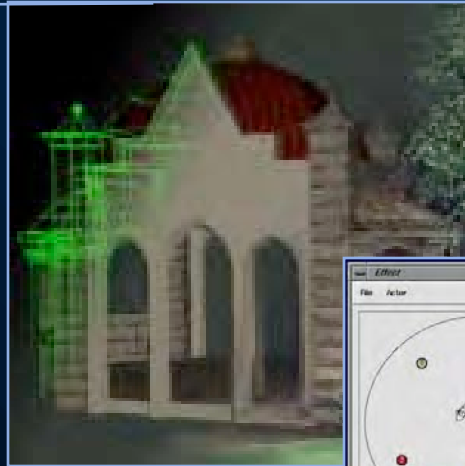


Science Education



AVL – Support for Creative Activities

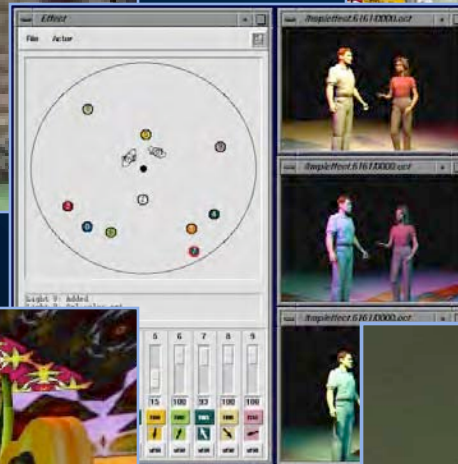
Interior Design & Architecture



Marketing Simulations



Theatre Lighting



Fine Arts



New Media



Presentation Objectives

- To describe the range of methods for interactive, networked visualization and collaboration
- To explain some specific, ongoing projects and investigations at AVL, IU, and elsewhere
- To discuss our vision for an ideal visualization infrastructure

Ultimate Goal: To help stimulate your thinking on how you can apply networked visualization and visual collaboration techniques to benefit your work

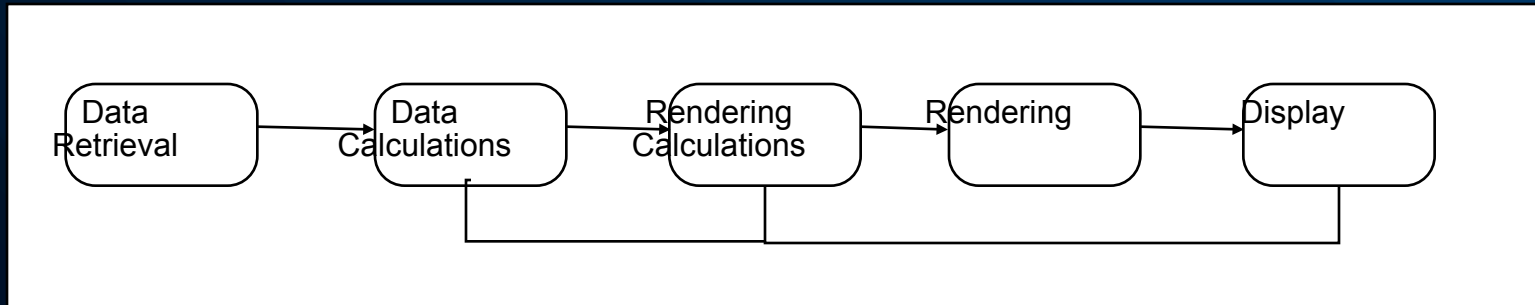


Challenges of Networked Visualization & Visual Collaboration

- diversity of users and applications
- diversity of advanced displays
- developing a compelling remote visualization resource
- interfacing with other high-performance services: computing, storage, networking
- demands for “interactivity”
- location of user - last mile problem



The Visualization Pipeline

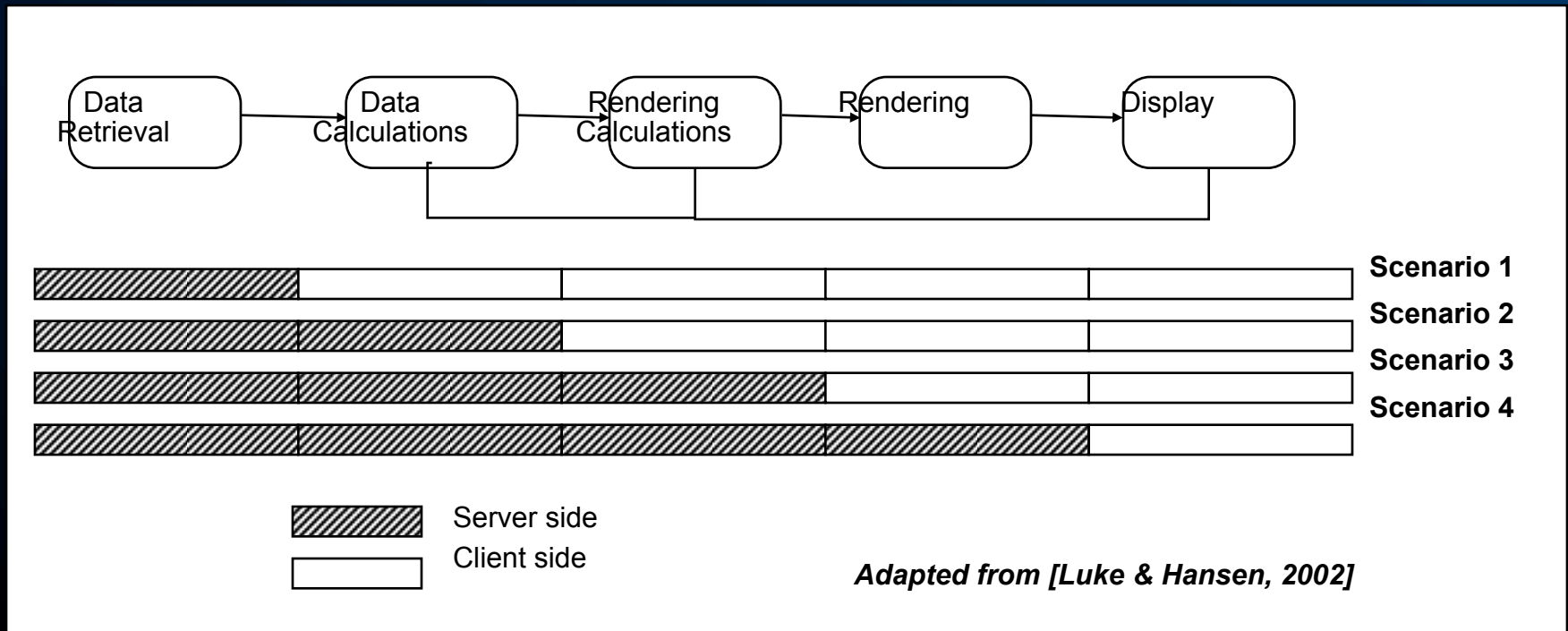


1. Data access / retrieval
2. Data calculations (filtering and conversion)
3. Rendering calculations (data mapping)
4. Rendering
5. Display



Network-based Visualization

- 4 logical places to divide the work between server and client



Network-based Visualization Scenarios

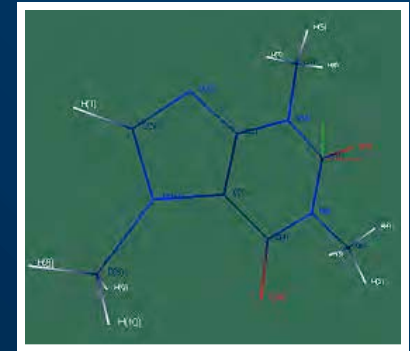
- Scenario 1/2 - Data transfer
 - requires significant local storage, computation & rendering
- Scenario 2/3 - Graphics command transfer
 - computation & rendering load shared between systems
- Scenario 4 - Image transfer (includes video streaming)
 - storage, computation, and rendering load remain on server; good for lightweight clients
- *Must consider data complexity, visual quality, display requirements, and bandwidth availability to determine best method for any given application*



Network-based Visualization - Example

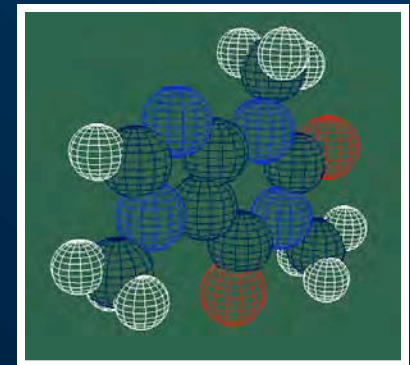
- Data Transfer

- atom 1 (type, location), atom 2, ...



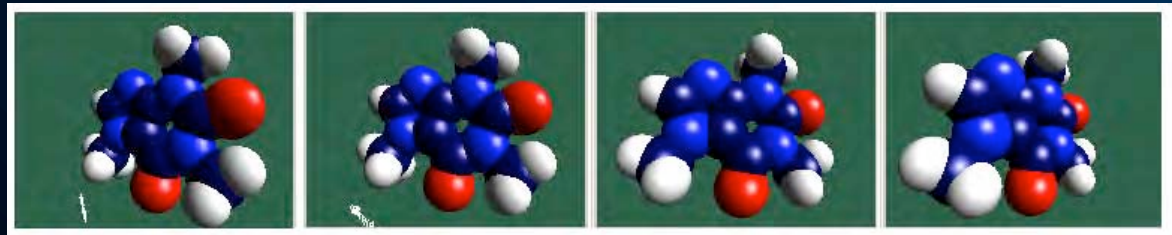
- Graphics Commands Transfer

- color(red), sphere(radius 0.57), ...



- Image Transfer

- image 1, image 2, image 3, ...



Interactivity Requirements

- What is “interactive”? - It depends on the task:

30 FPS (frames per second)	for simulation & training
10 FPS	for manipulation
1-3 FPS	for passive observing
30-60 seconds per frame	for complex data analysis (within the span of human attention)
5-30 minutes	for complex image or simple movie preview
2 hours – 1 day	for complex movie preview or batch rendering



Display Requirements

High Resolution	Tiled display wall IBM T221 display	Tiled stereo wall CAVE
Standard Resolution	Desktop displays Web, PDAs	John-e-Box Desktop stereo
	Monoscopic	Stereoscopic



Bandwidth Requirements (for Image Transfer)

- **John-e-Box**

- 1024x768 pixels x 24bits x 2 (stereo) x 10 FPS = 188 Mbps

- **IBM T221 (9.2 megapixel display)**

- 3840x2400 pixels x 24bits x 3 FPS = 664 Mbps

- **6-Tile SXGA Display Wall**

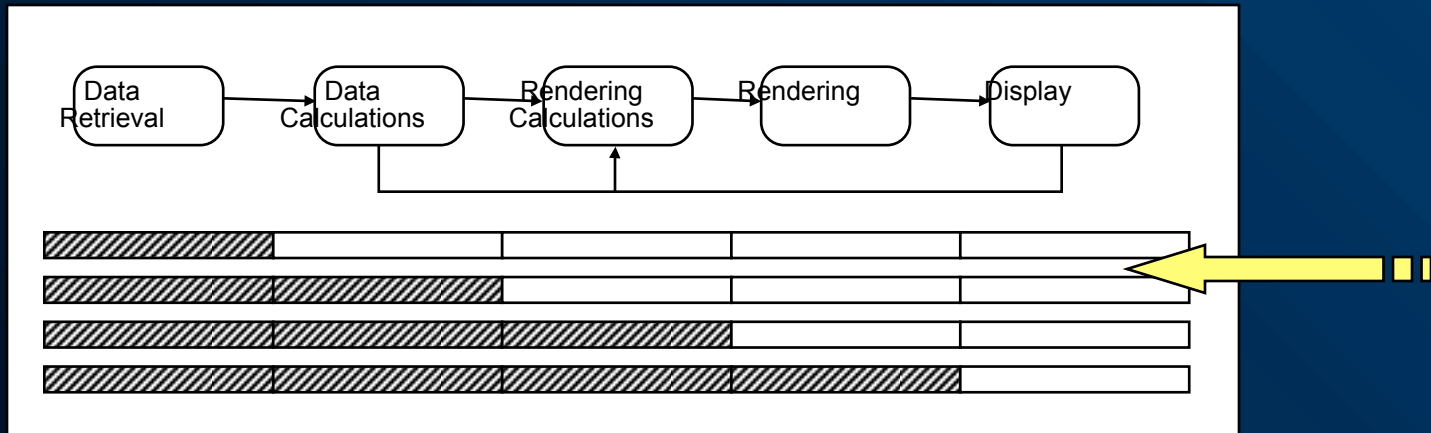
- 1280x1024 x 24bits x 6 tiles x 10 FPS = 1.88 Gbps

- **CAVE**

- 1280x1024 x 24bits x 4 walls x 2 (stereo) x 30 FPS = 7.55 Gbps



Data Transfer – Techniques

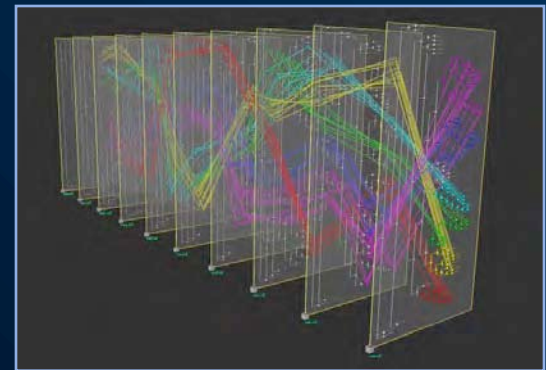
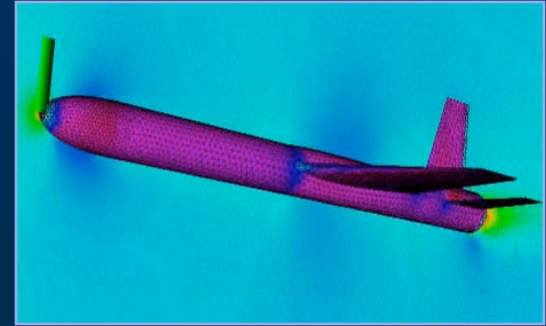


- Good: download and visualize
- Better: network-based querying/ data mining
- Better Still: querying and visualization over real-time data streams

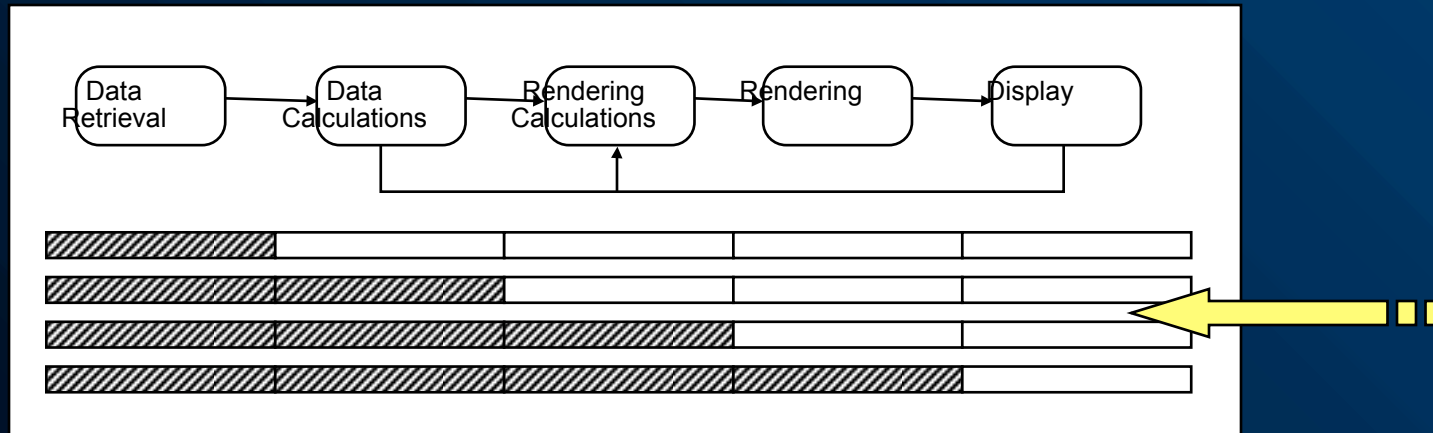


Data Transfer – Examples

- **Good: FEA visualization w/VTK**
 - data download to workstation
- **Better: Pedigree Tree Vis**
 - data queries to Access server
- **Better Still: Phylogenetic Vis**
 - Real-time data from running computation



Graphics Command Transfer – Techniques



- Good: remote graphics display (e.g., Xwindows)
- Better: geometry optimization methods
- Better still: application-transparent streaming and optimization



Graphics Command Transfer – Examples

- **Good:** remote OpenGL via GLX
 - works with most applications
- **Better:** Marching Cubes optimizations
 - Minimize number of vertices transferred (Lakshmipathy, et. al.)
- **Better still:** Chromium tiled rendering
 - Application-transparent sorting, caching, and state optimizations

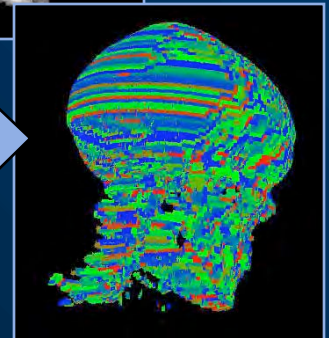
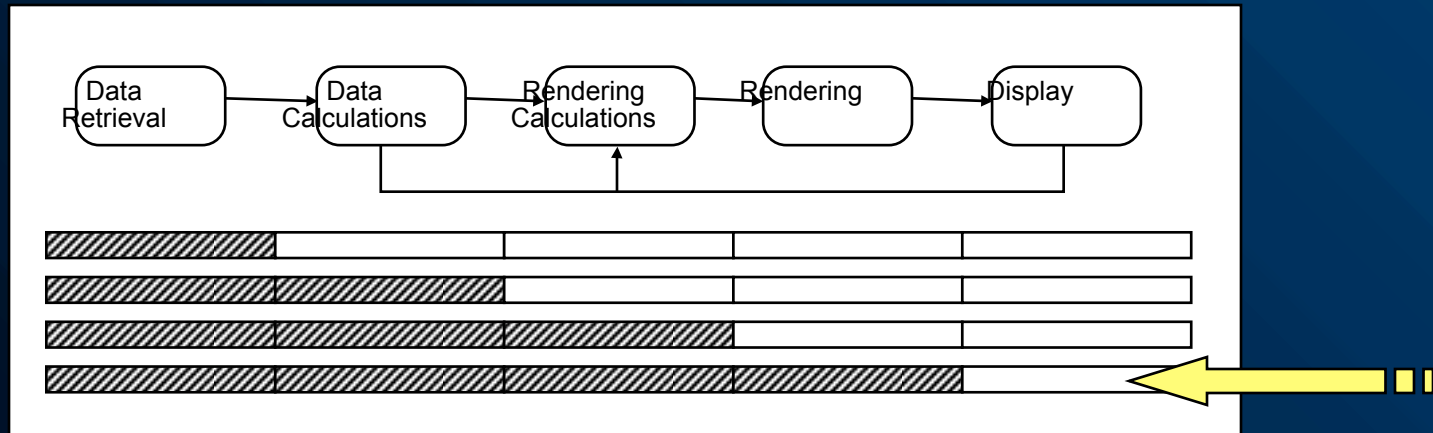


Image Transfer – Techniques

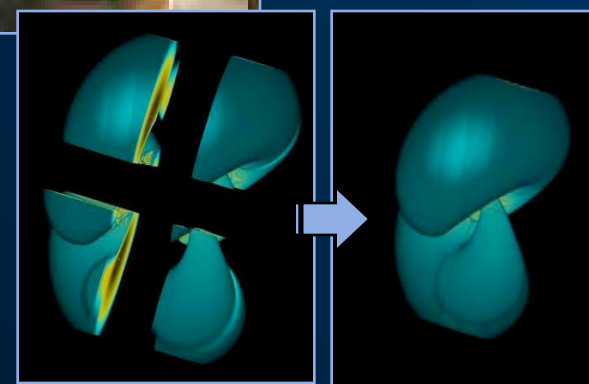
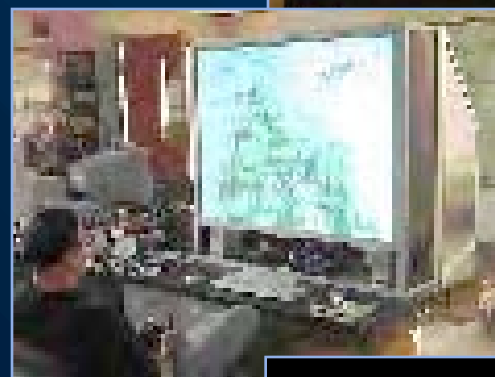


- Good: individual (monoscopic) images
- Better: stereo images
- Better still: composited or tiled images

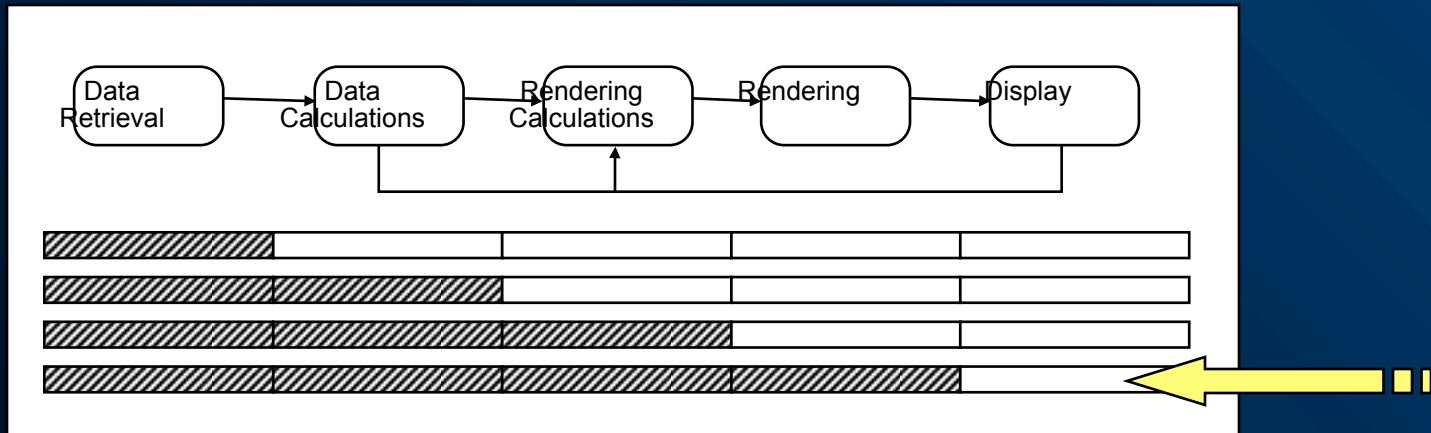


Image Transfer – Examples

- **Good: VNC w/ GIS applications**
 - point-to-point and multipoint collaboration
- **Better: VNC for stereo**
 - shared side-by-side stereo applications on John-e-Box
- **Better Still: Compositing with VTK or Chromium**
 - Parallel rendering provides scalability of data, rendering quality, and speed



Video Streaming – Techniques



- Good: point-to-point streaming
- Better: multicast streaming
- Better still: multiple, synchronized visualization streams



Video Streaming – Examples

- **Good: Polycom**
 - Point-to-point or 4-way MCU
- **Better: Multicast Streaming**
 - Access Grid
 - AVL “virtual distributed lab”
- **Better still: synchronized streams**
 - Chromium H262 SPU (Argonne)
 - TeraVision (EVL @ UIC)

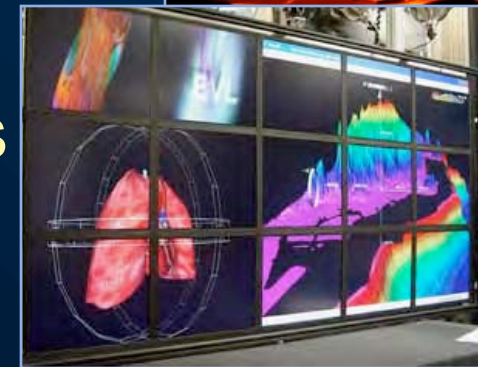


Image from EVL TeraVision web site

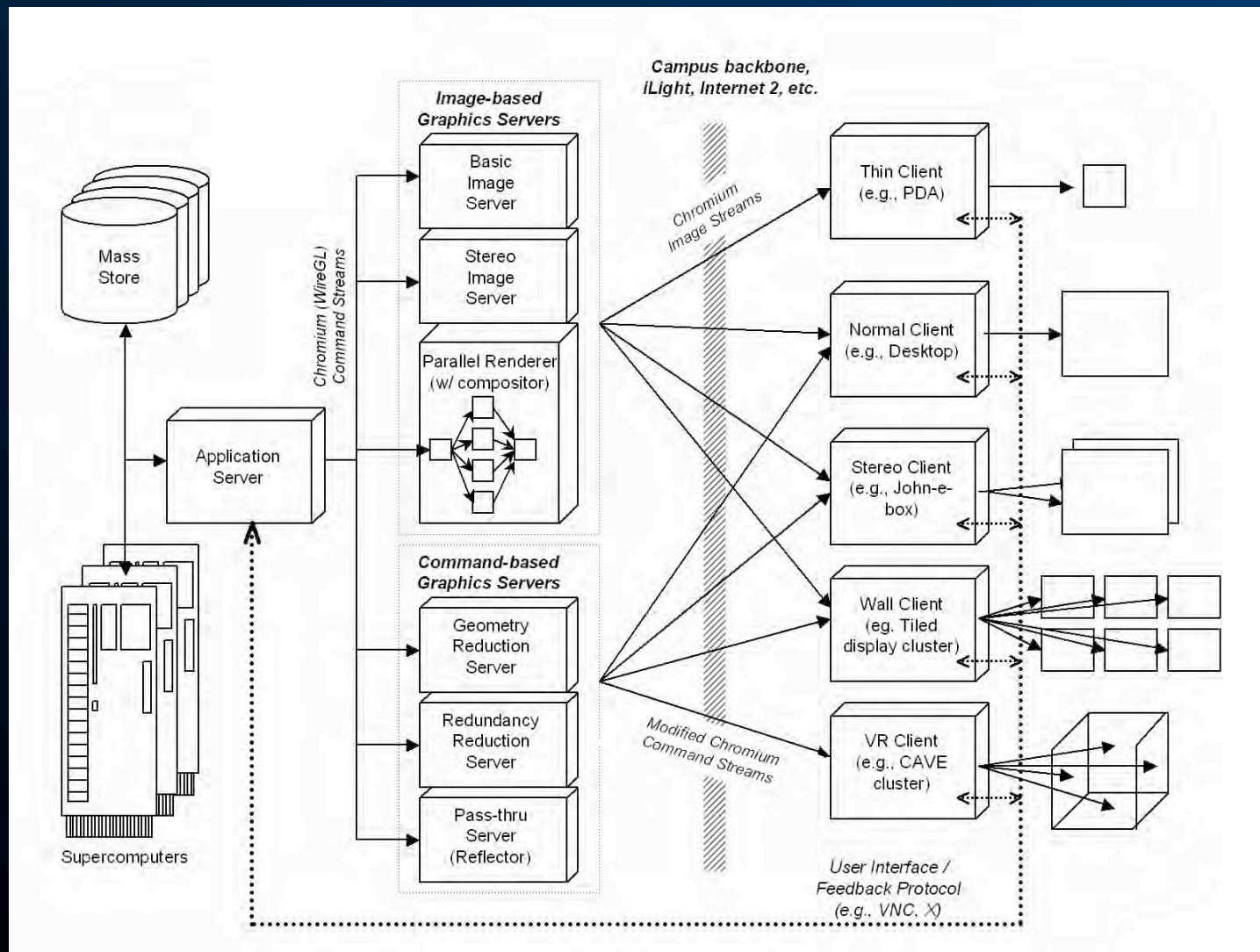


Desirable Traits of Networked Visualization

- *Scalable* – number of users, size of data, size/quality of visualization
- *Powerful* – provide a resource an order of magnitude better than desktop systems
- *Flexible* – one central visualization computing resource utilized in many different ways
- *Efficient* – makes best use of network and local compute resources
- *Simple* – for users and developers
- *Application-Transparent (Translucent)* – requires no (minimal) modifications to applications



Ideal Visualization Infrastructure



Conclusions

Network-based visualization and visual collaboration:

- Many techniques are currently possible
- Newer, better techniques are being developed
- The best technique depends on a number of factors
- Consult with the AVL at IU (or Envision Center at Purdue) if you have a visualization or visual collaboration problem or opportunity



More Information & Acknowledgements

For more information, please visit

<http://www.avl.iu.edu>

Acknowledgements:

- AVL staff & clients
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- Researchers at other institutions

