

Advanced Biomedical Collaboration

Access Grid Retreat 2003 - ANL
April 16

Jonathan C. Silverstein, MD, MS, FACS
Fred Dech, MFA

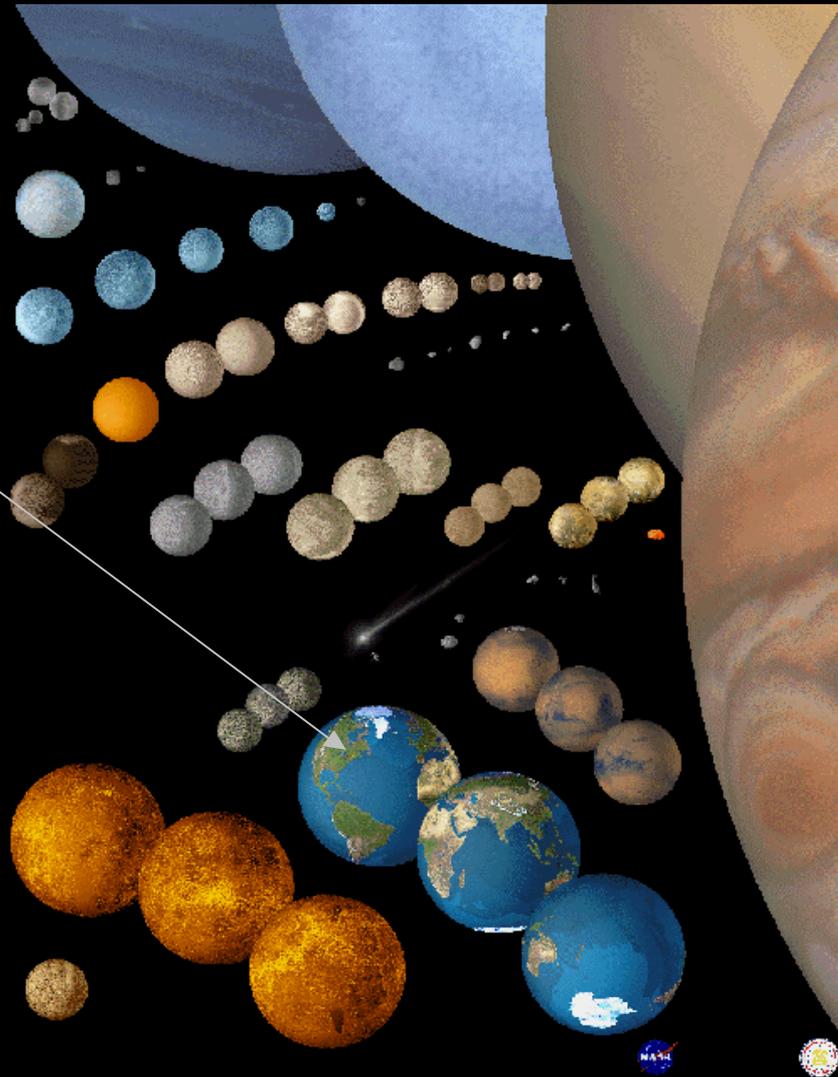


Contributing Collaborators

- Walter Panko, PhD
- Tom DeFanti, PhD
- Mary Rasmussen
- Ray Evenhouse
- Sean Prokasy
- Greg Blew
- Russell K. Pearl, MD
- Fred Dech, MFA
- Zhuming Ai, PhD
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- Phil Kouchoukos, MD, MS
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- Theodore Mason, MD
- Edward L. Applebaum, MD
- N.J. Espat, MD
- W. Scott Helton, MD
- Marcia Edison, PhD
- Michael Papka
- Rick Stevens
- Keith Thulborne, MD, PhD
- Jason Rubenstein, MD
- Ankur Chhadia, MD
- Peter Jurek
- Richard Morimoto, PhD



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From USGS



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UC Hospitals, Center for Clinical Information

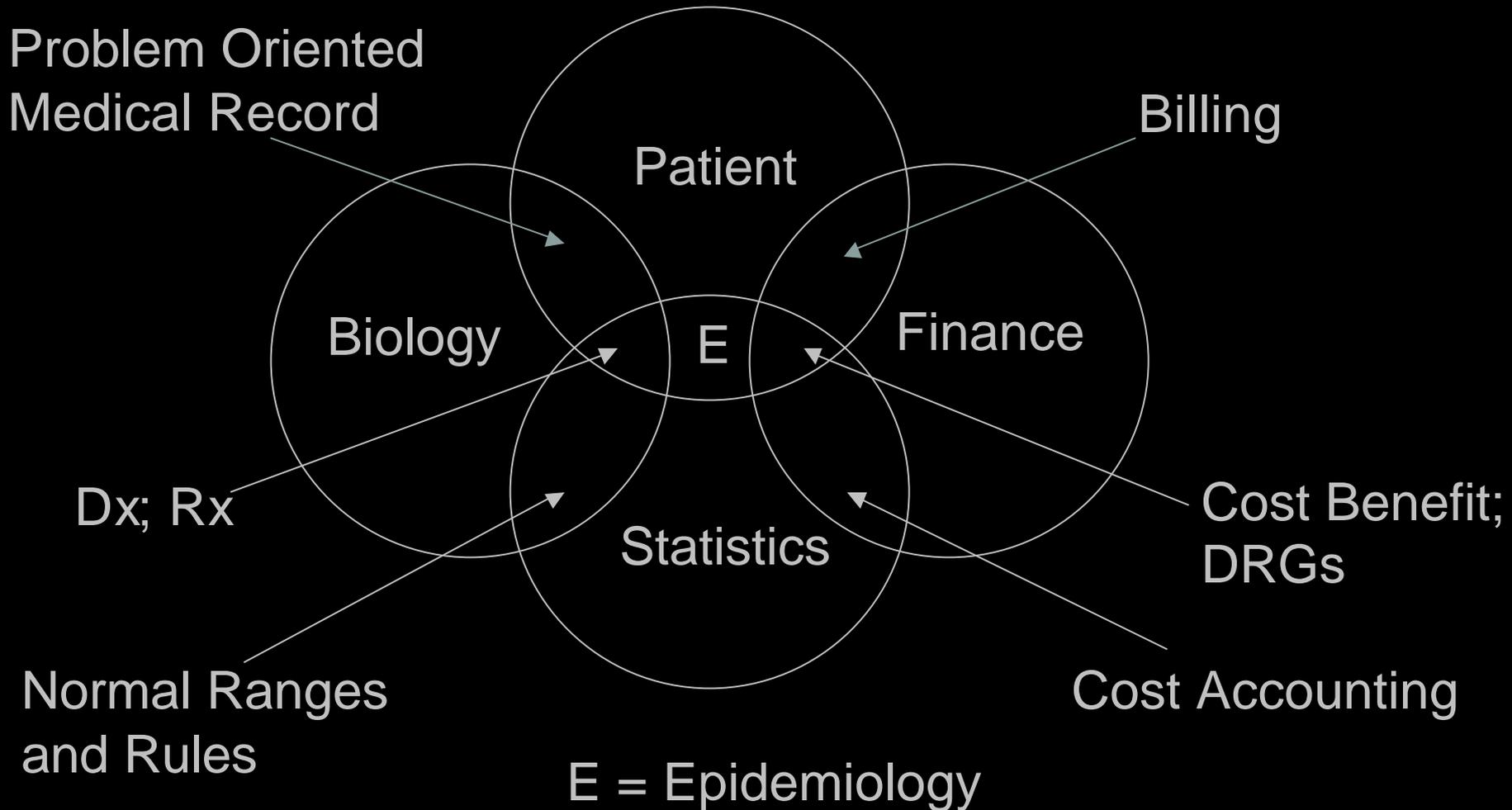
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Informatics

- National Library of Medicine 2001 - from T15 RFA
 - “Informatics concerns the acquisition, representation, storage, retrieval and use of information.
 - Information technology has become an almost ubiquitous element of informatics and informatics research because of the extraordinary power of computers and telecommunication to facilitate information management.”



Biomedical Informatics



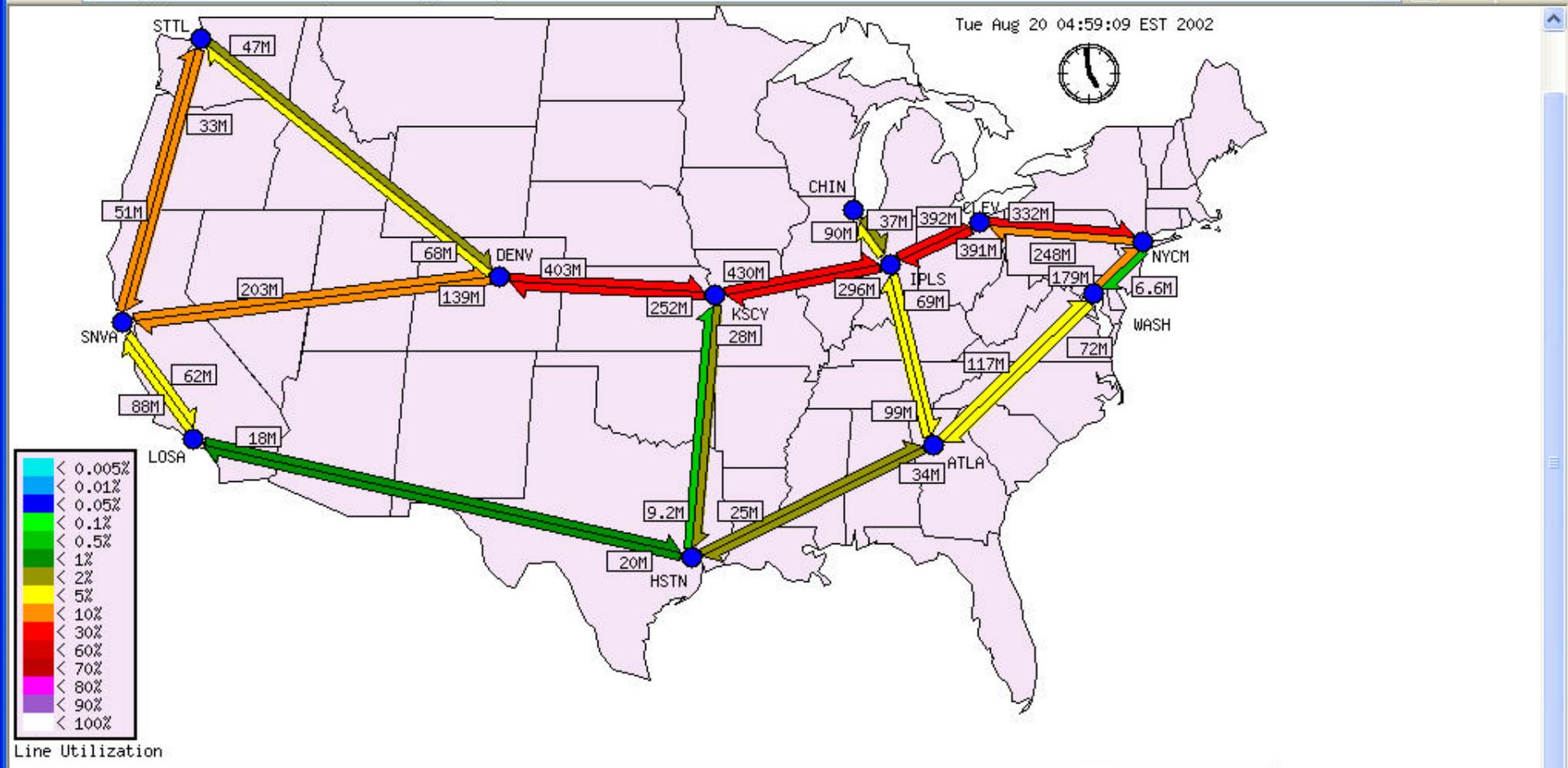
Based on: Thomas L. Lincoln and Ralph A. Korpman. *Science*;17 October 1980



Why is it so difficult?

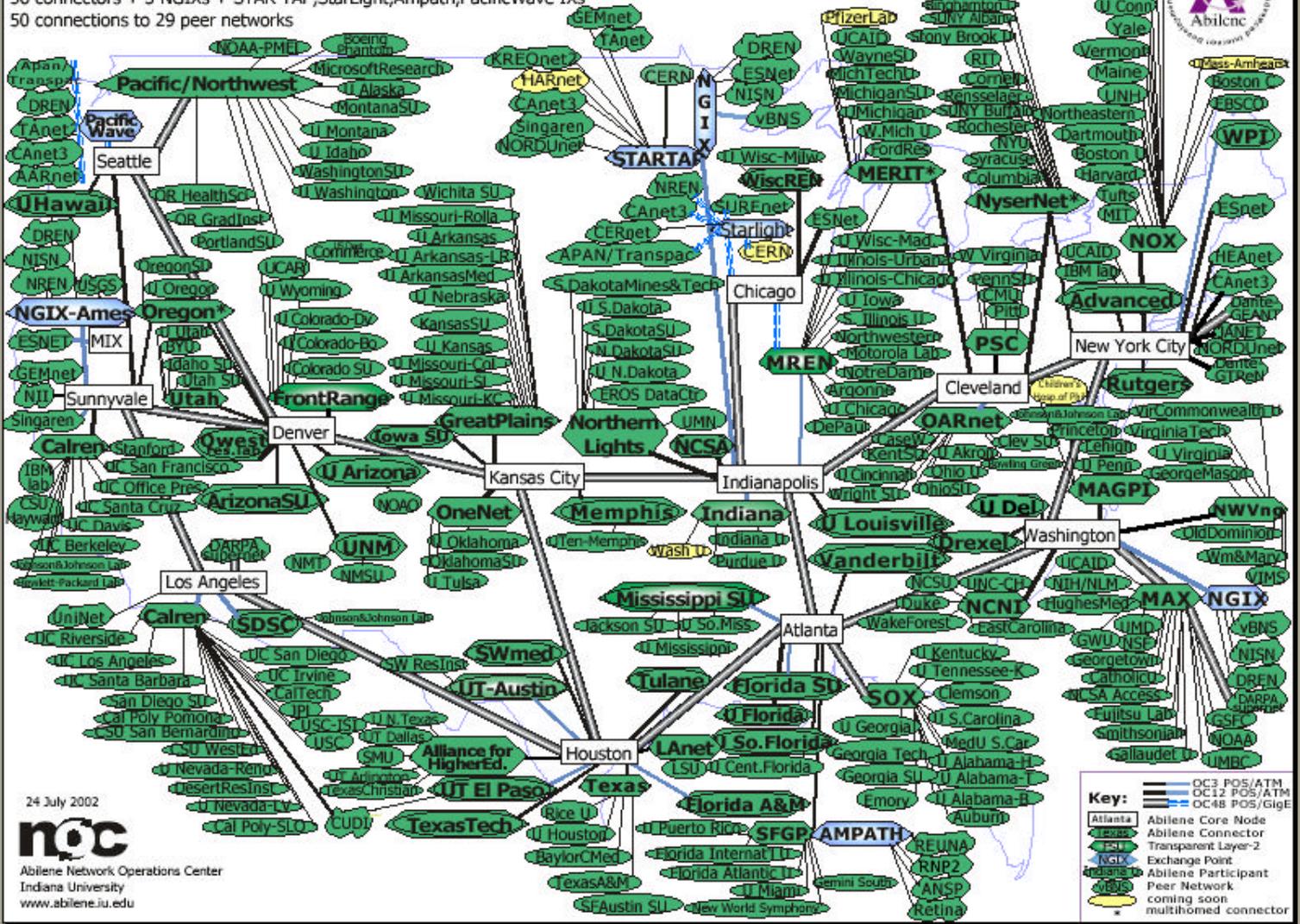
- The Fundamental Challenge – *The real world*
- Context – *MS (multiple sclerosis, mitral stenosis, morphine sulphate, microsoft?)*
- Canonical vs. Instantiated Case – *general vs. specific*
- Variation – *art and science*
- Linguistics as example of boundaries - *coding*
- Open Sets – *if...then, clearly defined scope*
- Combinatorial Complexity - *markup notations, neural nets, Bayesian inference, and fuzzy logics*
- Interoperability – *assemblage (the play of the imagination given a prepared mind and novel juxtaposition of information)*





completed connections:
228 participants
56 connectors + 3 NGIXs + STAR TAP, StarLight, Ampath, PacificWave IXs
50 connections to 29 peer networks

The Abilene Network



24 July 2002

 Abilene Network Operations Center
 Indiana University
 www.abilene.iu.edu

Key:

- OC3 POS/ATM
- OC12 POS/ATM
- OC48 POS/GigE
- Abilene Core Node
- Abilene Connector
- Transparent Layer-2
- Exchange Point
- Abilene Participant
- Peer Network
- coming soon
- multihomed connector

Bookmarks
Thumbnails

Advanced Biomedical (Tele)-Collaboration

Synchronous participation among biomedical professionals in complex environments (at distributed locations)

Key area of focus for us: Convergence of visualization and networking technologies in biomedicine





Access Grid Logo courtesy of Argonne National Laboratory



Chicago Biomedical Consortium

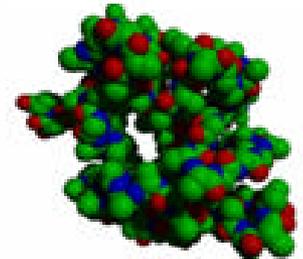
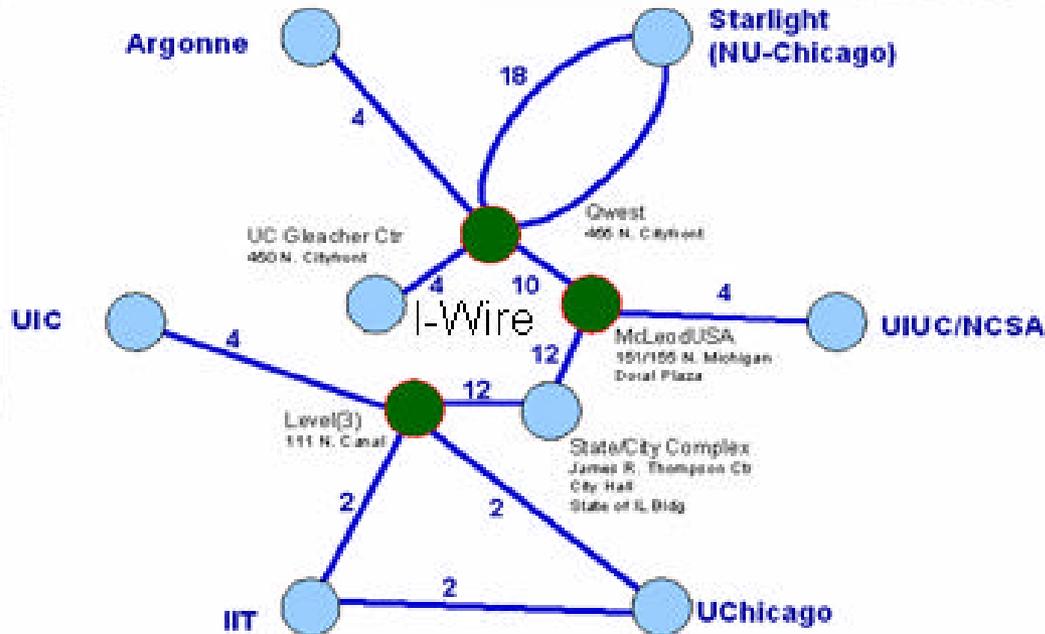
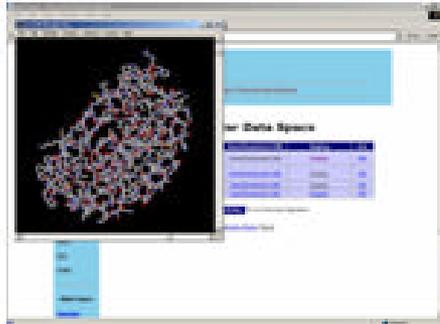
The mission of the Chicago Biomedical Consortium is to stimulate and sustain research at the frontiers of biomedicine through ongoing collaboration and exchange among scientists in the Chicago area. Established by scientists at Northwestern University, the University of Chicago, and the University of Illinois at Chicago, and endorsed by the three universities, it will:

- enable collaborative and interdisciplinary research that is beyond the range of an individual investigator or a single institution,*
- stimulate research and training programs that bridge institutional boundaries,*
- recruit and retain a strong cadre of biomedical leaders and researchers in Chicago,*
- promote the development of the biomedical industry in Chicago through partnerships with corporations, joint mentorship of researchers, and commercialization of discoveries,*
- execute a plan capable of improving the health of citizens of Chicago and beyond.*

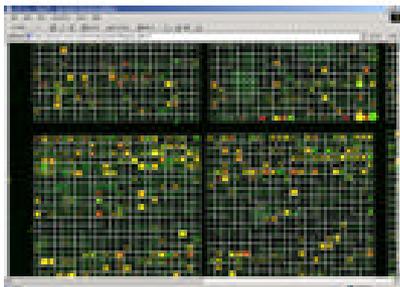


Proteomics/Bioinformatics Demonstration Project

ACCESS GRID



PROTEIN DATA BANK



This conceptual diagram symbolizes our goals of tightly collaborative scientific advancement and education across our institutions, which will be achieved by weaving together our substantial existing enterprises, enhancing them in strategic focus areas, and leveraging them with other national resources.



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Tele-Collaboration in Surgery: the future is clear

Surgical Education
Pre-Treatment planning
Surgical Rehearsal
Virtual Reality in the O.R.



Challenges of Surgical Education

- Rapid expansion of knowledge
- Limited availability of biological materials
- Limited availability of expert educators
- Increasingly specialized procedures
- Application of teleconferencing, telepresence, and virtual reality



Tele-Immersive Virtual Reality

- Two or more ImmersaDesk™ systems
 - stereo vision
 - viewer centered perspective
 - large angles of view
 - interactivity
- Networked collaboration (using CAVERNsoft)
 - converse, see each other, and point in 3D!

Electronic Visualization Lab, University of Illinois at Chicago



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Three-Dimensional Anatomy

- Highly complex
- Critical to understanding common problems
- Surgeon's conceptual visualization difficult to achieve with 2D illustrations or photos
- Cadaver dissection even difficult
- Few local experts in any region



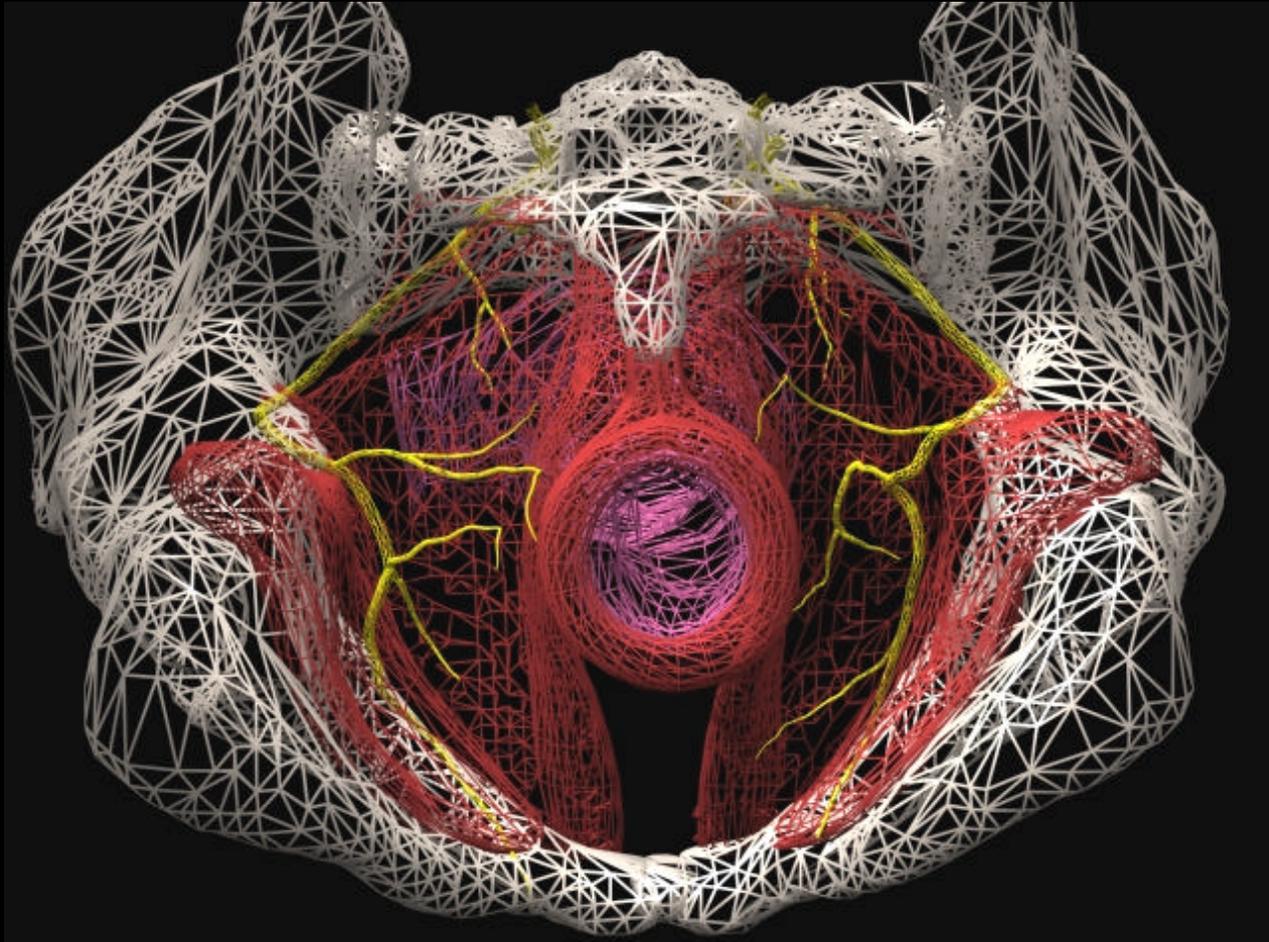
Biomedical Tele-Immersion Methods

- Slice sections digitized
- 3-D Structures segmented
 - by hand or by automatic methods
- 3-Dimensional surface geometry files generated
 - by offline processing or by automatic methods
- Manipulated in Networked ImmersaDesks

These projects have been funded in part with Federal funds from the National Library of Medicine, National Institutes of Health, under Contract No. N01-LM-9-3543 and Grant R01-LM-06756-01.



Virtual Pelvic Floor



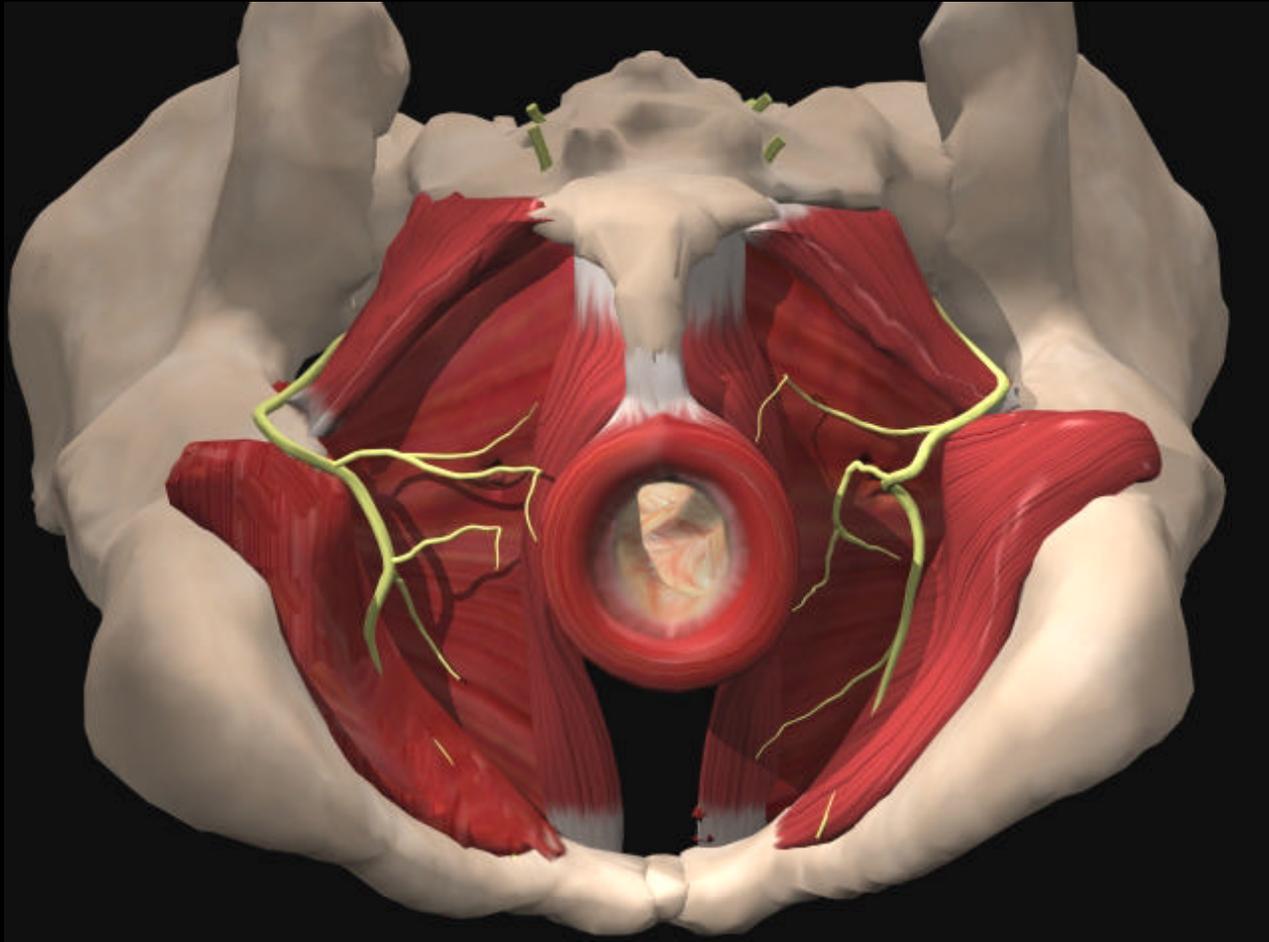
University of Illinois at Chicago, VRMedLab
Division of Colon and Rectal Surgery, Cook County Hospital



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Virtual Pelvic Floor



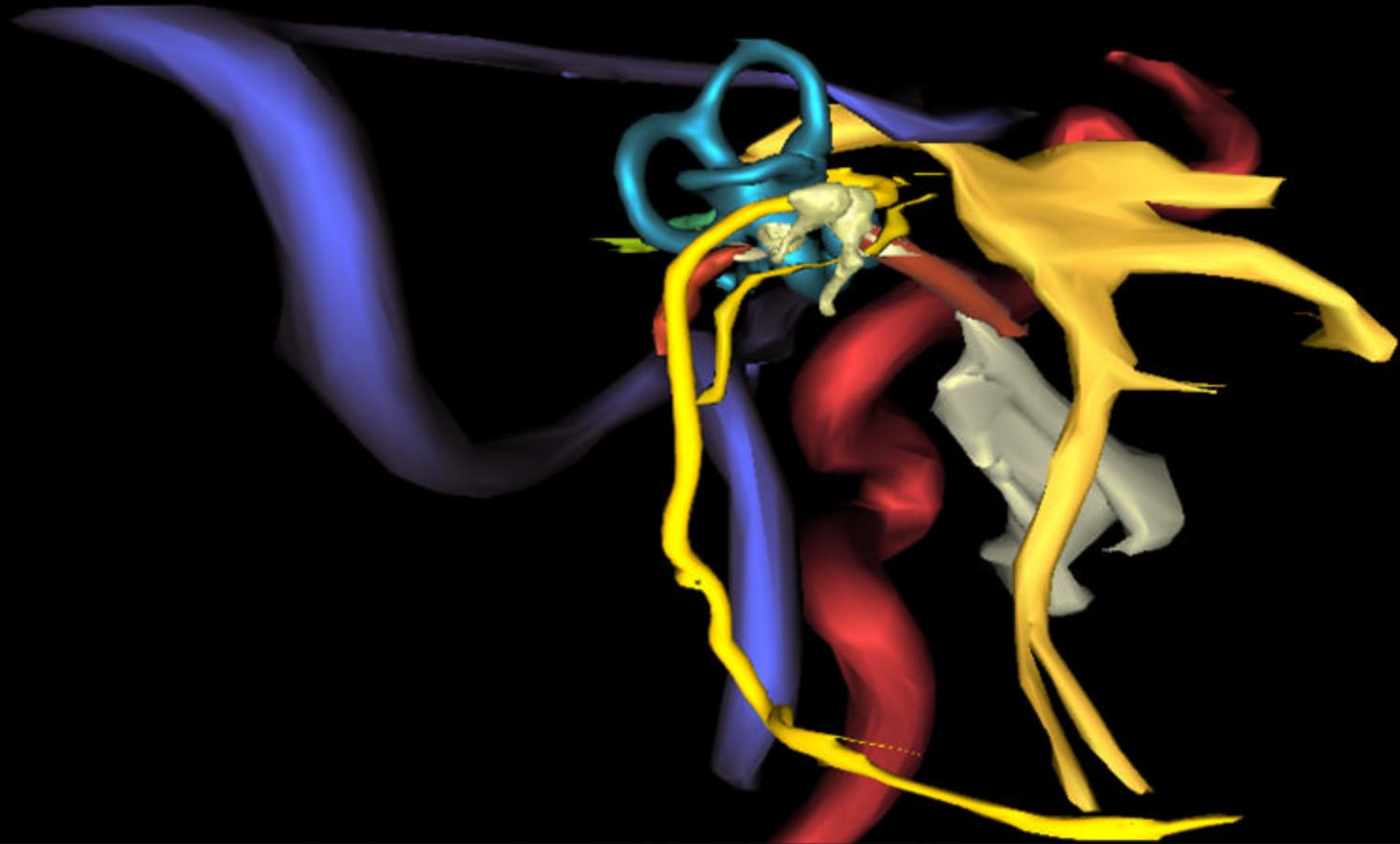
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Virtual Temporal Bone - VRML



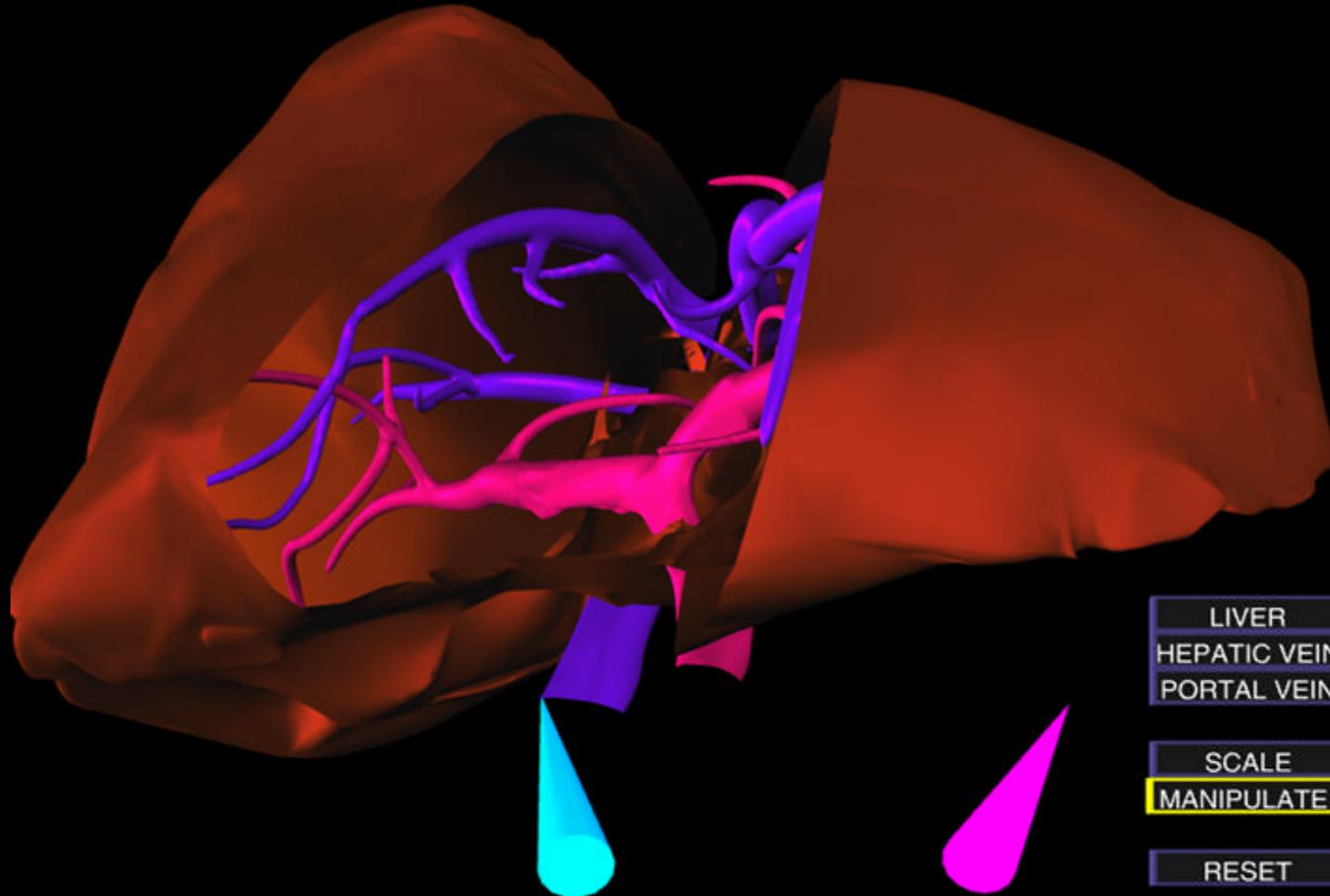
Results – Survey Data

1 = Strongly Disagree, 5= Strongly Agree

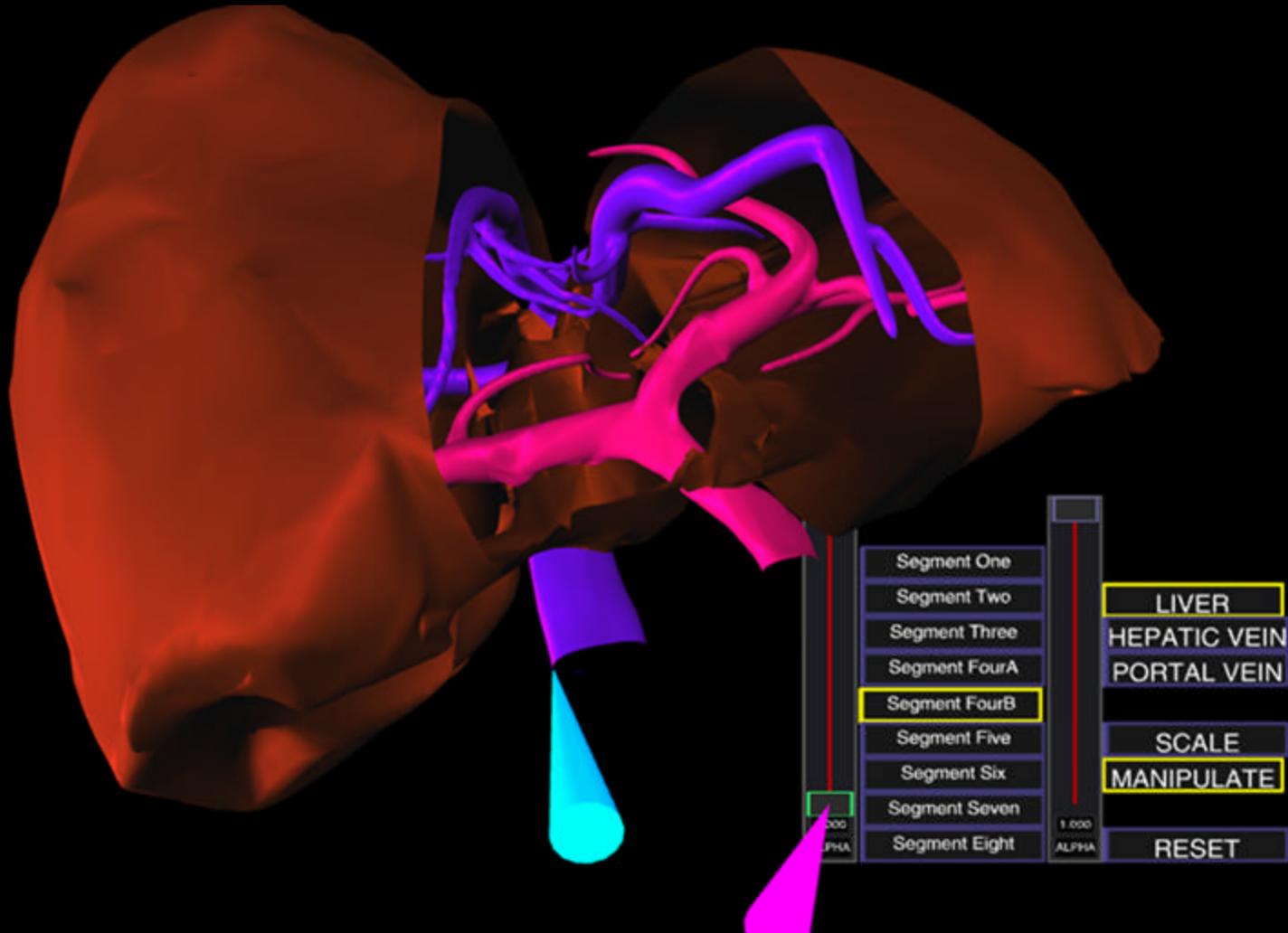
- I found the instructor easy to understand 4.12 ± 0.64
- I found the Tele-Immersive technology an enjoyable way to learn this material 4.33 ± 0.69
- The Tele-Immersive technology helped me to better master the subject material 4.33 ± 0.61
- I feel that I know more about the material from using this technology than I would have under traditional methods 4.06 ± 0.74
- The Tele-Immersive technology is an efficient way to learn the subject matter 4.00 ± 0.42
- I would like to take additional courses using this technology Yes = 31, No = 3



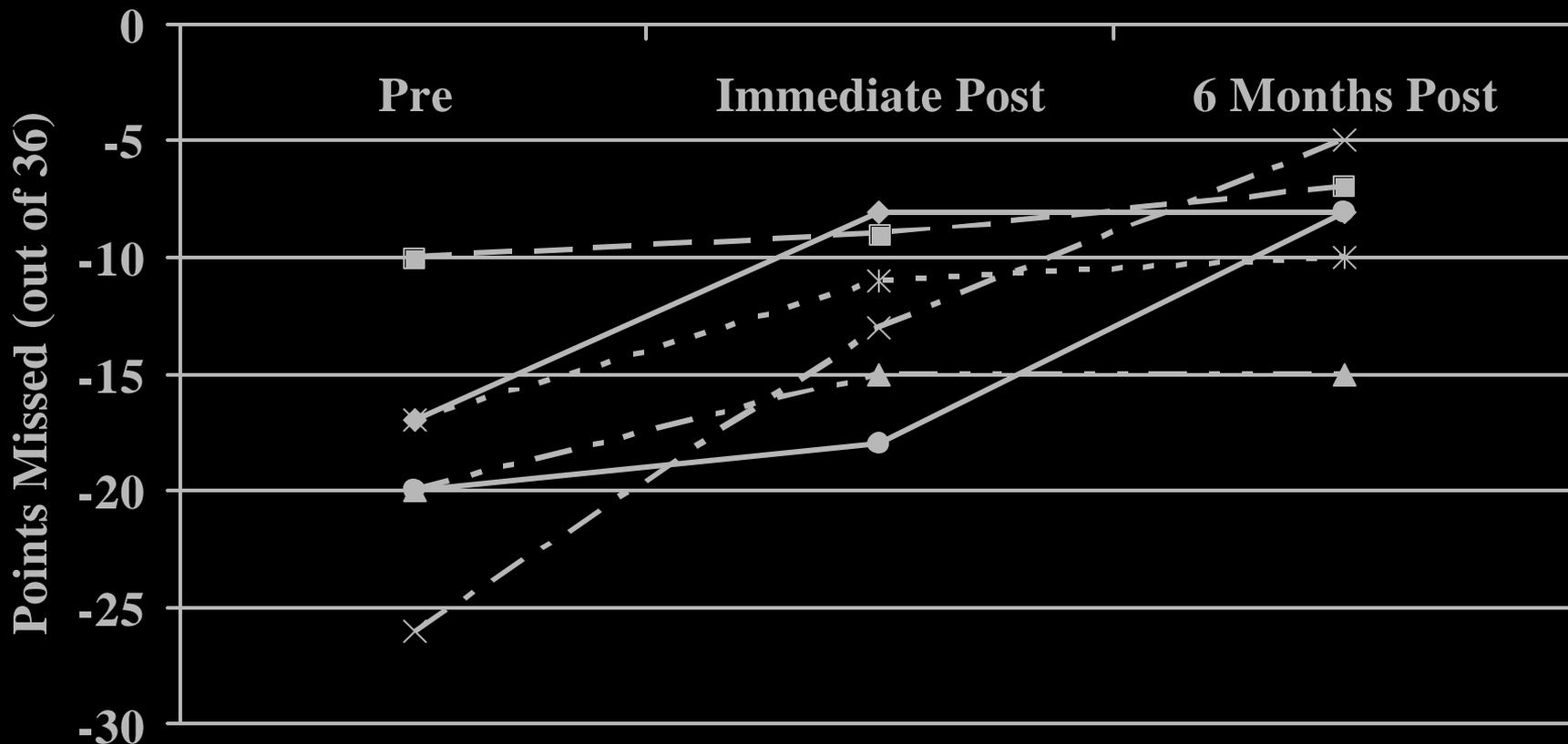
Immersive Hepatic Surgery Educational Environment (IHSEE)



Immersive Hepatic Surgery Educational Environment (IHSEE) - MOVIE



Liver Quiz Results



—◆— Resident 1 —■— Resident 2 —▲— Resident 3
 —×— Resident 4 —*— Resident 5 —●— Resident 6

Surgery. 2002 Aug;132(2):274-7



Rigorous Exploration of Medical Data in Collaborative Virtual Reality Applications

Distributed, collaborative, stereoscopic visualization and high precision manipulation of volumetric data

Collaborators:

Depts. of Radiology, UIC and UC

Electronic Visualization Lab, UIC

Math & Computer Science Div., ANL

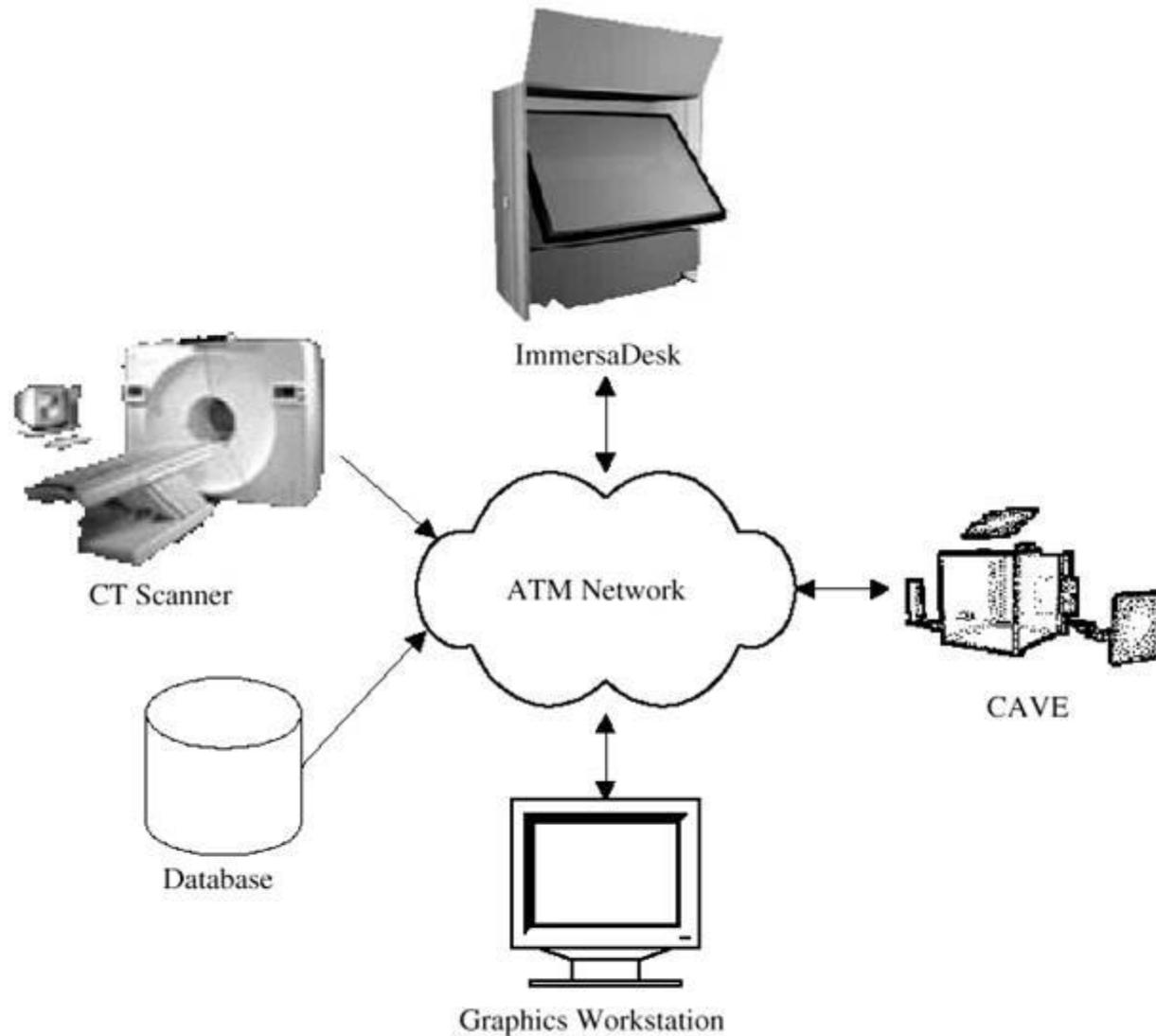


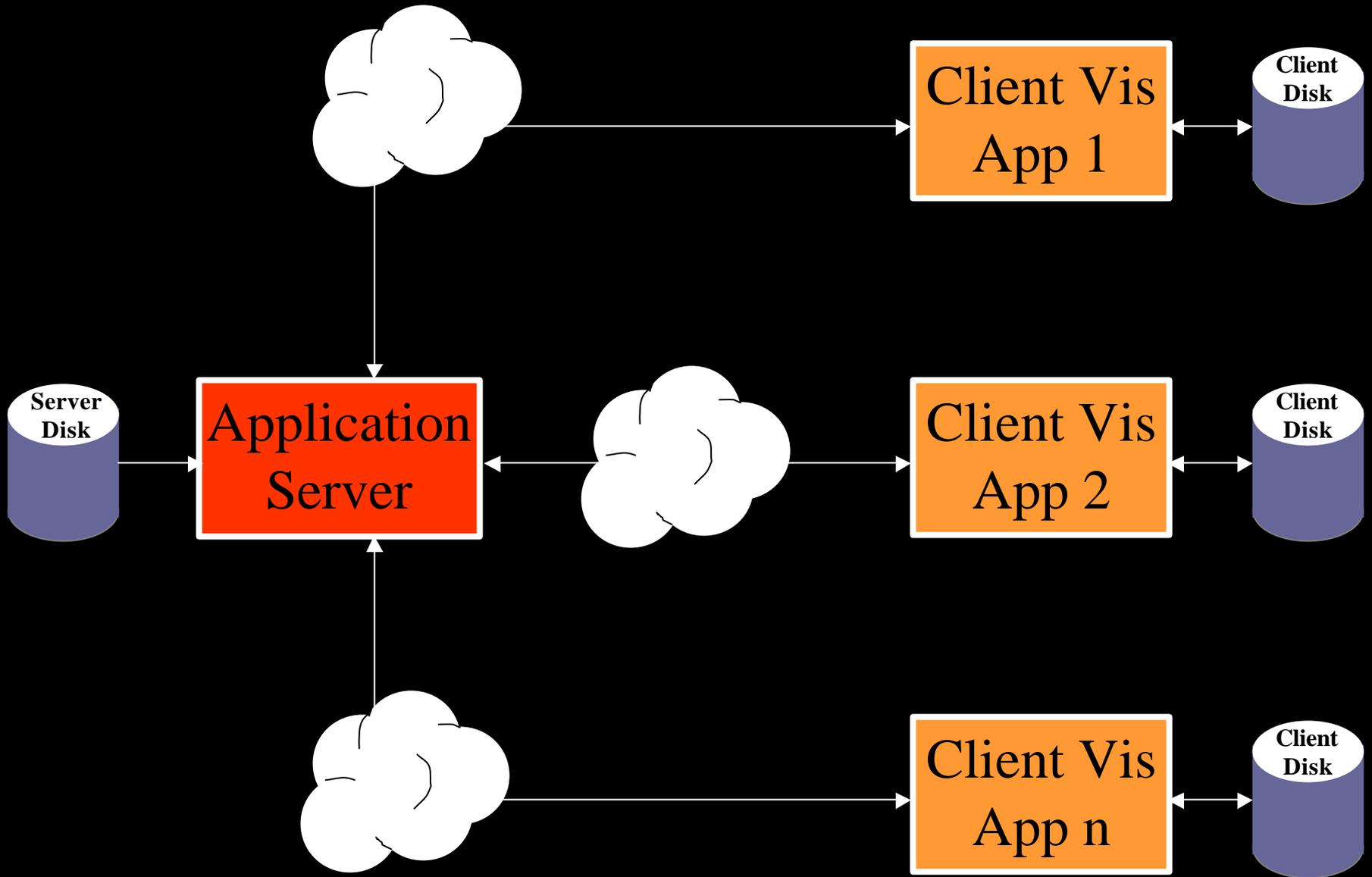
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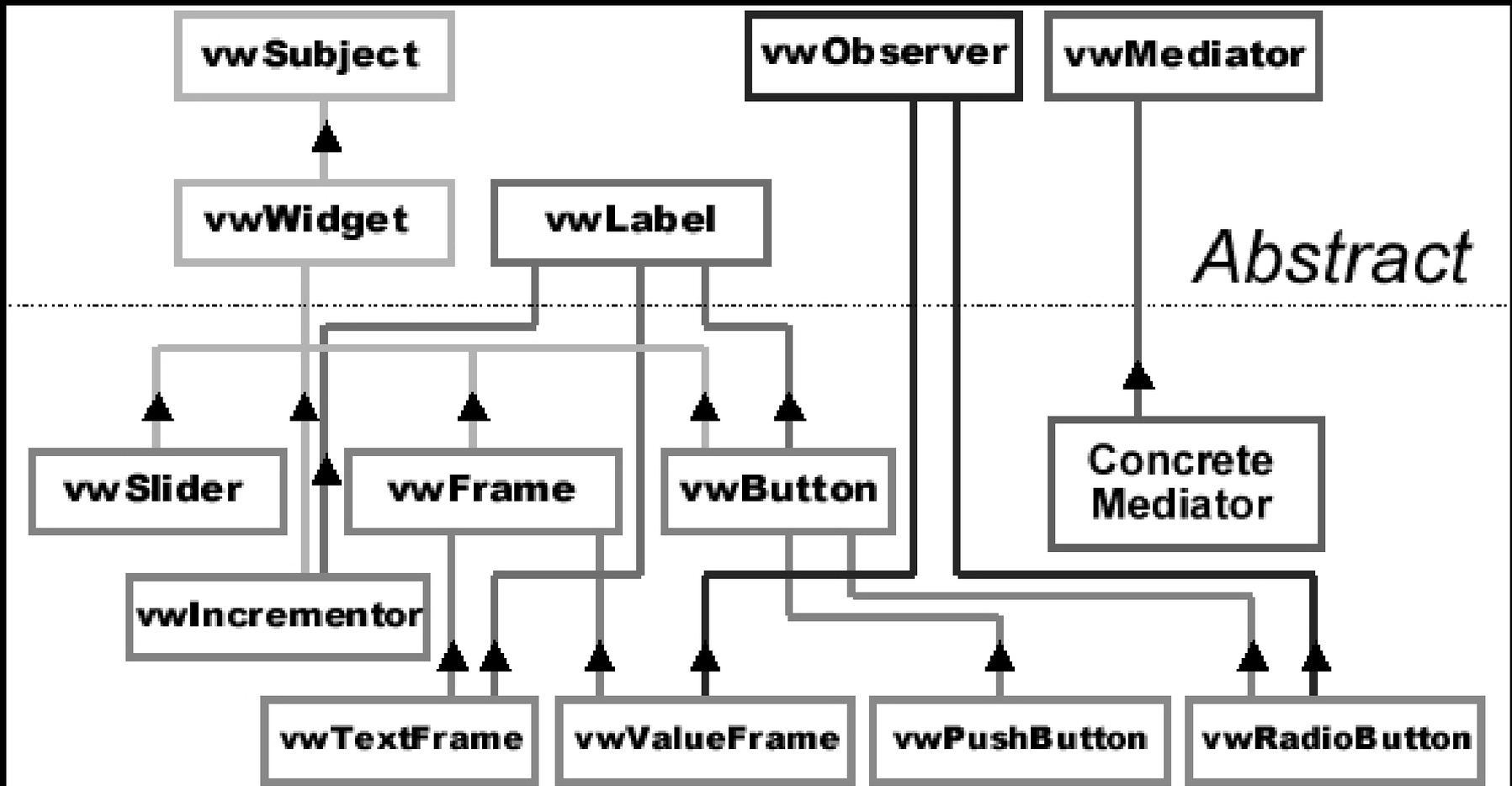


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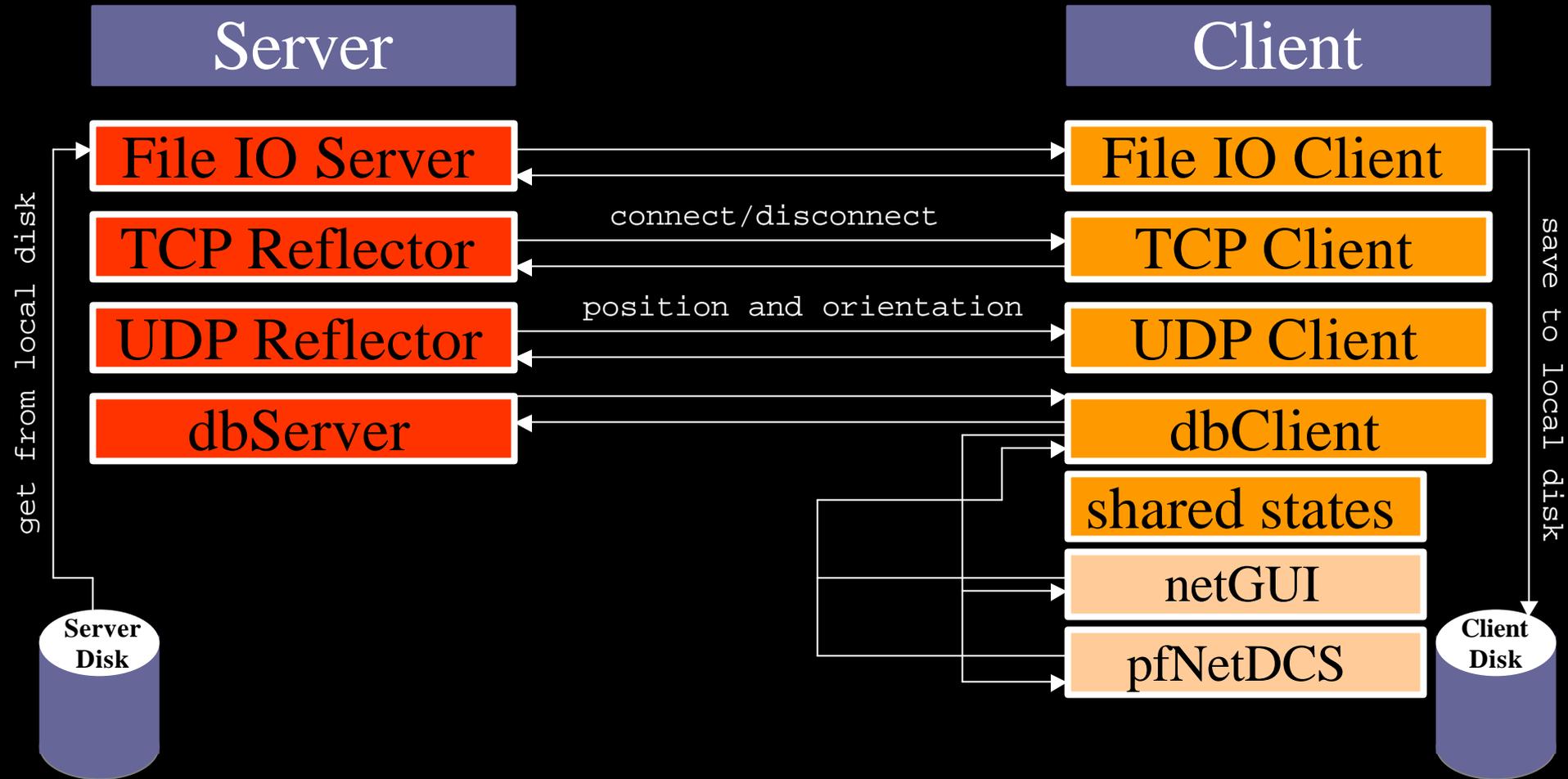
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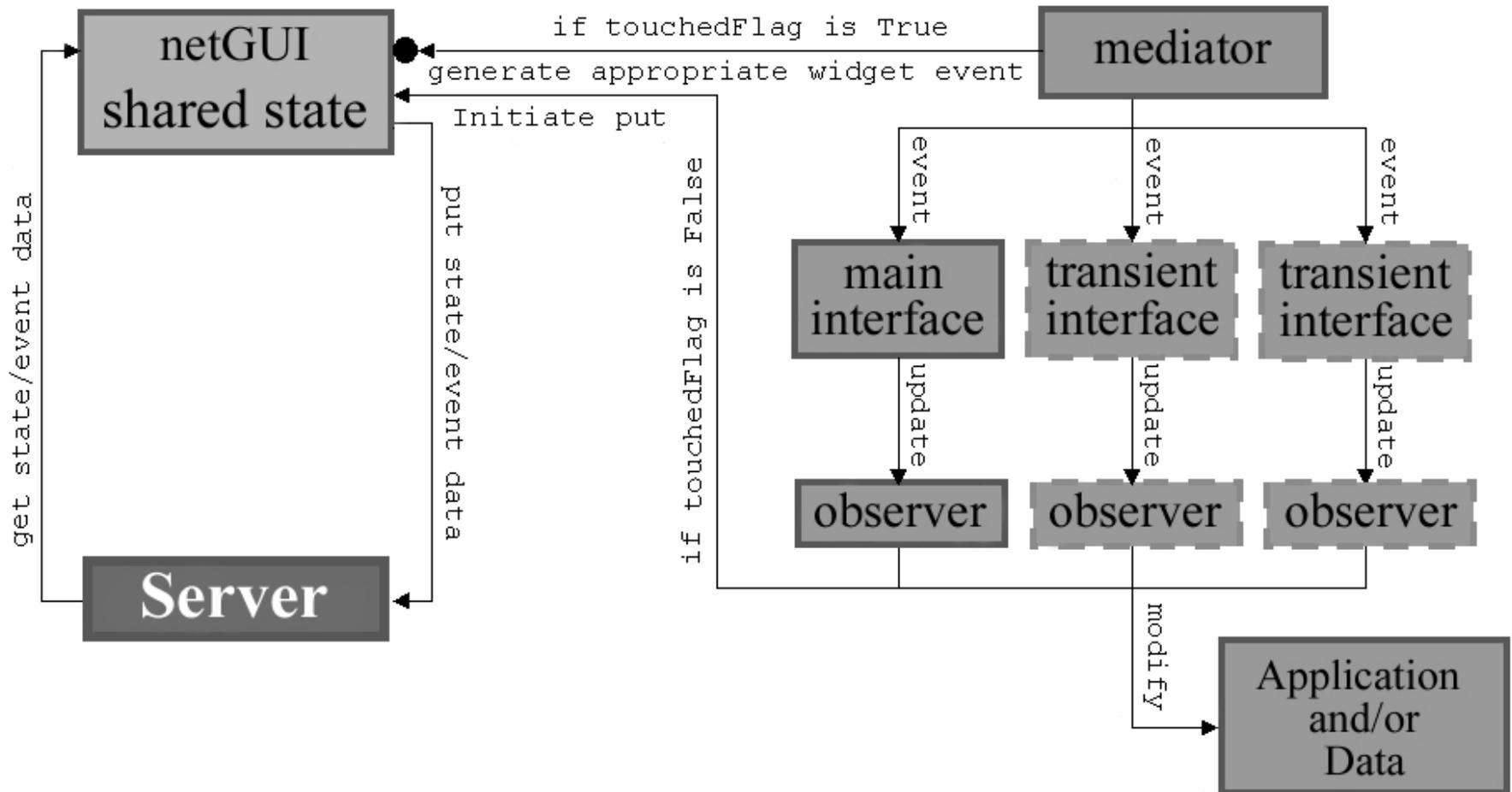


CAVERN G2 Networking Components



Interface

Event and State Propagation

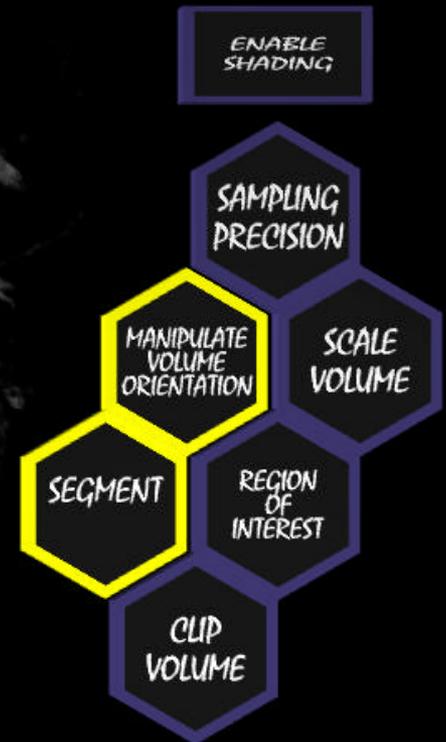


Collaborative Virtual Reality Features Implemented

- Persistent Server-Client Tele-Collaboration
 - Distributed application control, Synchronization, Audio and video channels sharing
- Model selection, Transparency of Elements
- Translate, Rotate, Scale
- Automatic DICOM import
- Segmentation
- Region of Interest
- Sampling Precision
- Arbitrary Clipping Plane



Visualization from Visible Human Dataset



Radiological Visualization MOVIES



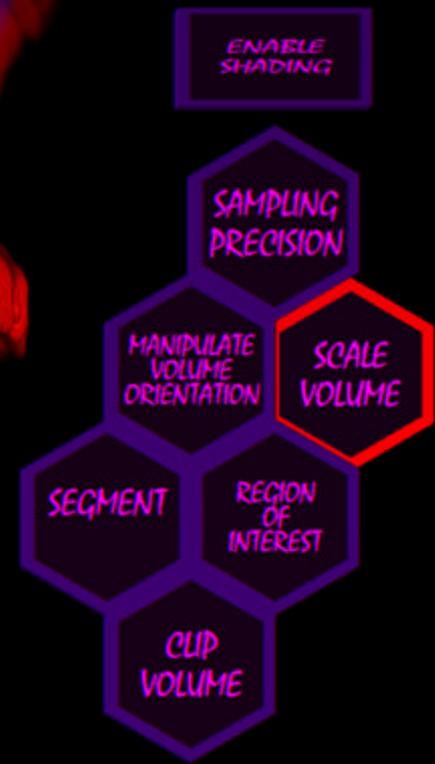
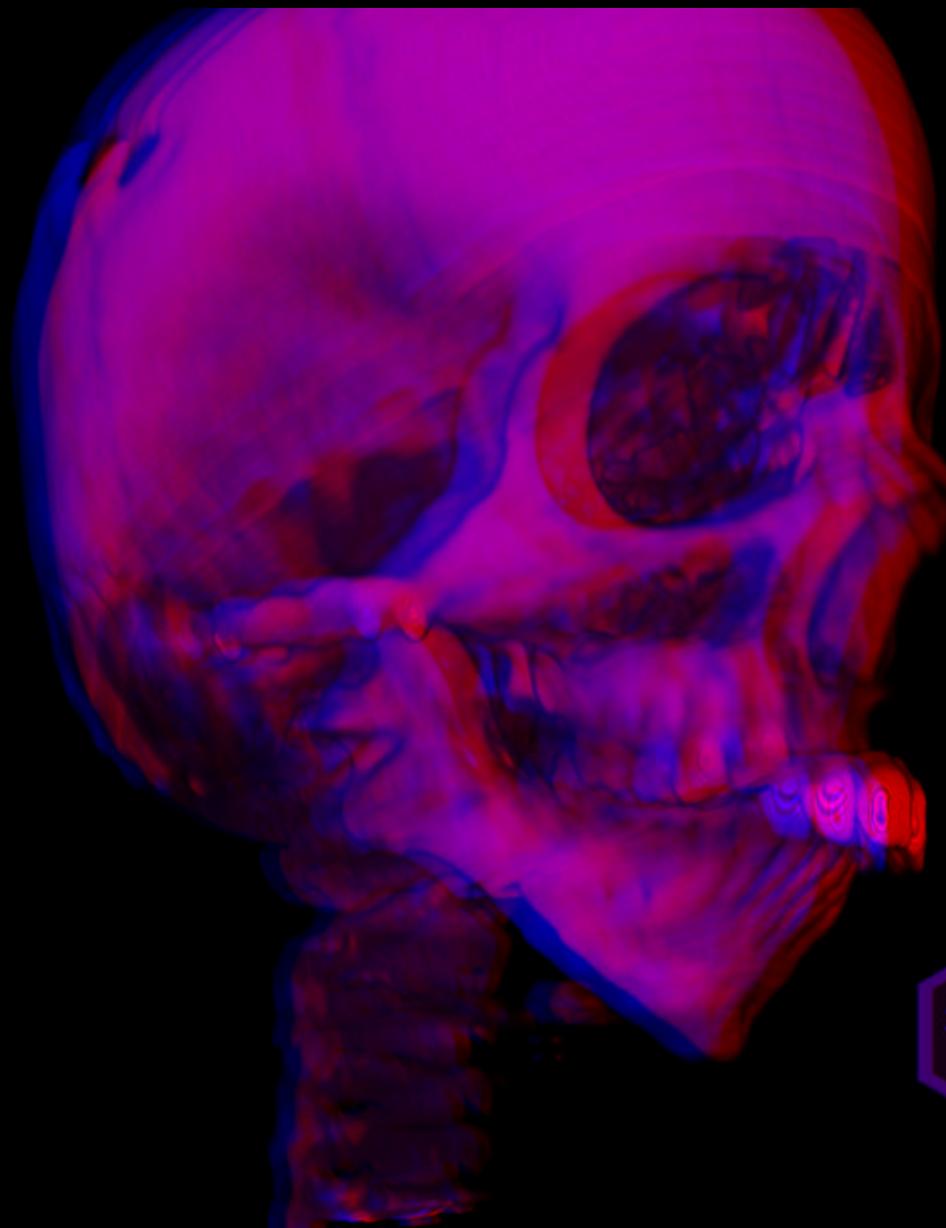
Control panel for visualization settings:

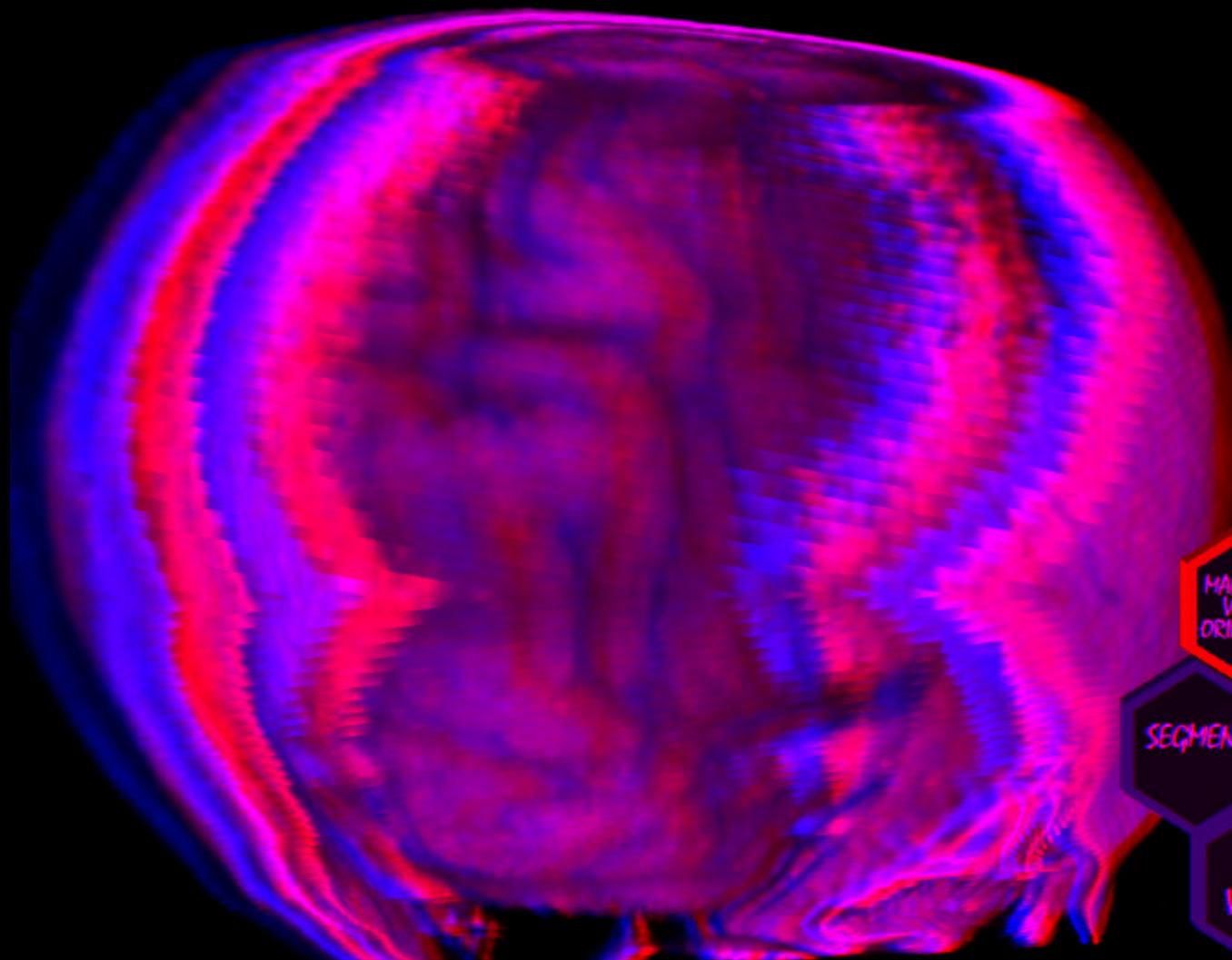
- MIP
- EXPONENTIAL
- SIN RAMP
- LINEAR RAMP
- SIN CURVE**
- LINEAR CURVE

Slider controls:

- CENTER: -838
- WIDTH: 328
- MAGNIFY
- CENTER: 0
- WIDTH: 0
- MAGNIFY







ENABLE SHADING

SAMPLING PRECISION

MANIPULATE VOLUME ORIENTATION

SCALE VOLUME

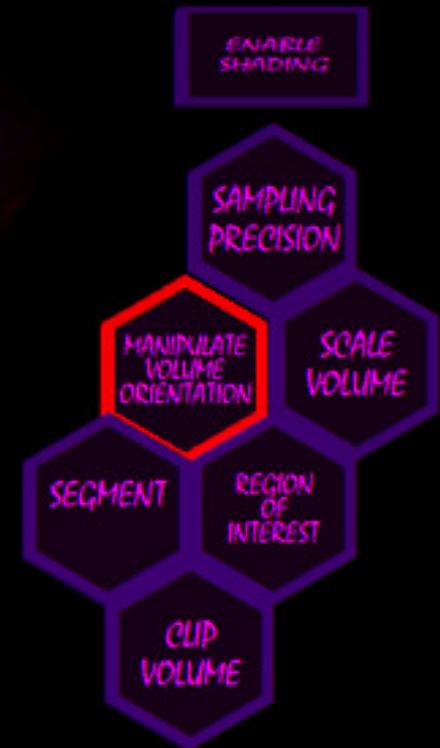
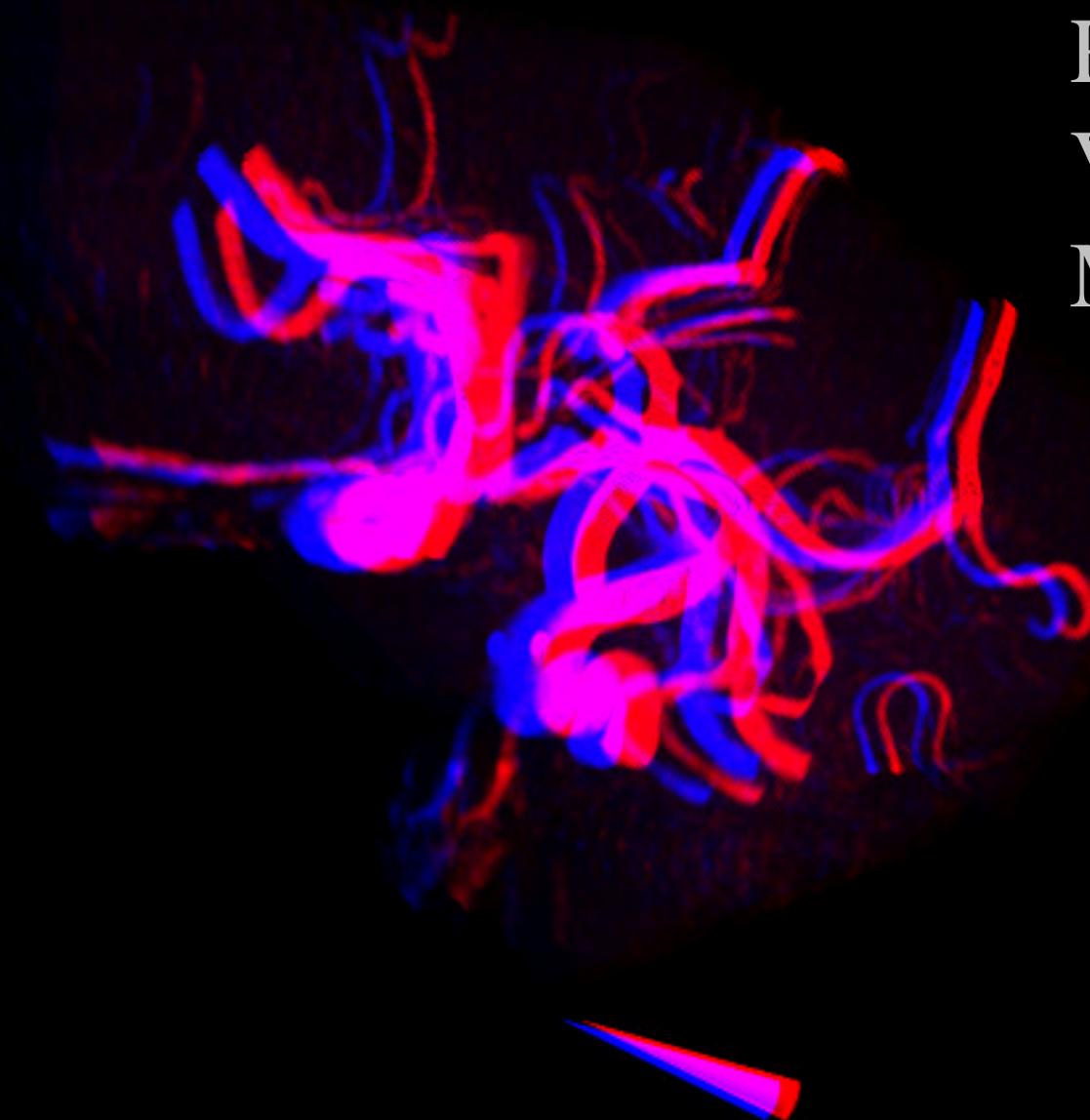
SEGMENT

REGION OF INTEREST

CLIP VOLUME



Stereo Radiological Visualization MOVIE





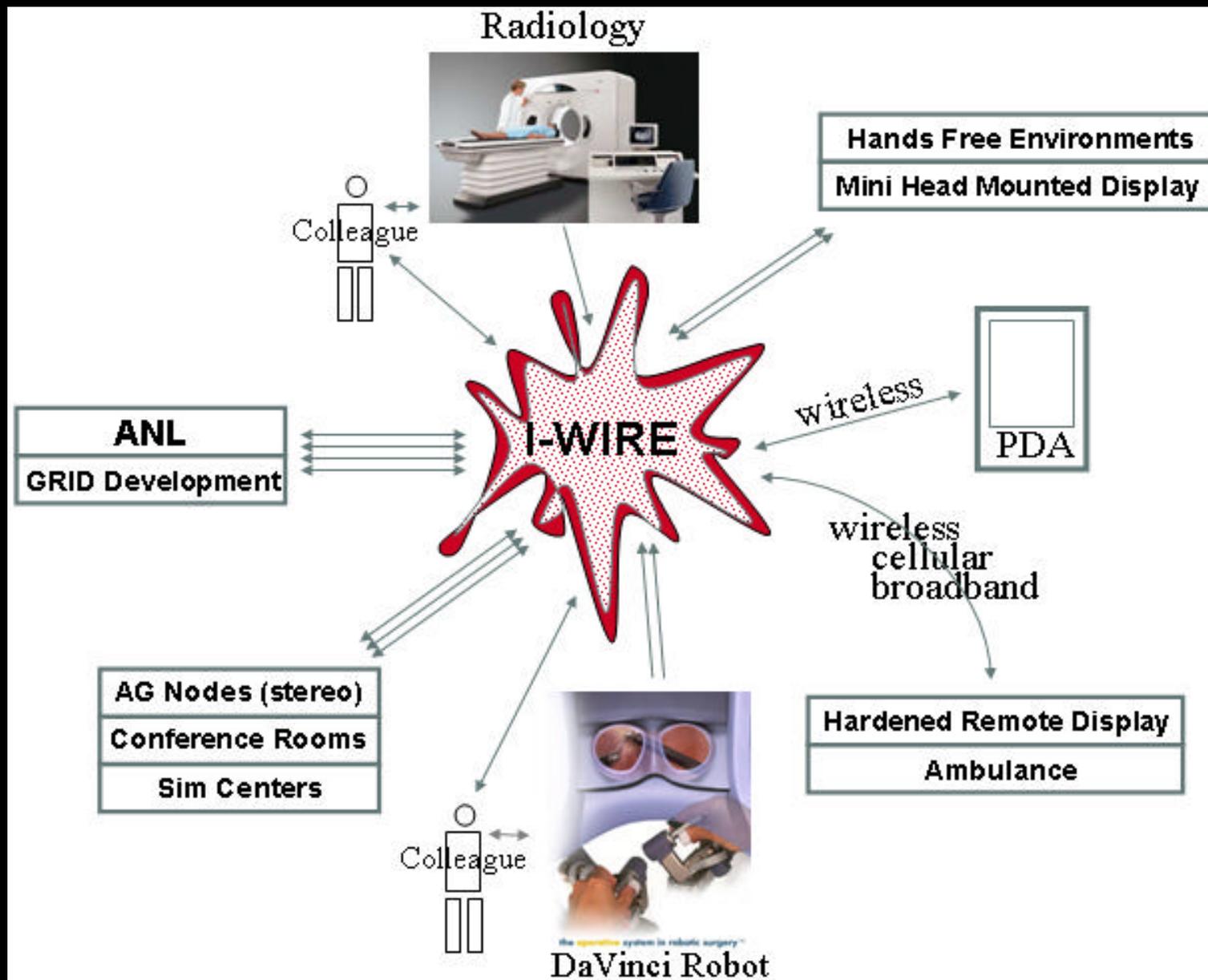
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Virtual Reality in the Operating Room

Challenges:

- New anatomy
- New technology
- Separated from Pt.
- Limited visualization
- Crowded O.R.

Solutions:

- Cognitive maps
- Telementoring
- Robotics
- Augmented Reality
- Wearable Display



Integrating Surgical Systems for Autonomy

The Operating Room (personnel) of the Future



Surgeon

Assistant

Scrub Nurse

Circulating nurse

Satava March, 2000



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Research Visions

VR in OR

- As telemedicine advances and the next generations of networking further protect data privacy and security, we will integrate biomedical collaboration technologies into numerous other activities where communications of complex three dimensional relationships are of the highest importance.
- We will enable the operating surgeon to take full advantage of heterogeneous data and collegial interaction in real time. We envision the surgeon's operating environment much like the fighter pilot's with a variety of instruments and people feeding critical data into the eyes and ears just in time and instruments responding to the slightest touch while improving on human precision. By combining the advents of immersive computer assisted surgery, Tele-Immersive volume rendering, wearable computing, Tele-presence, and novel approaches to complex networking we can make this vision a reality.

