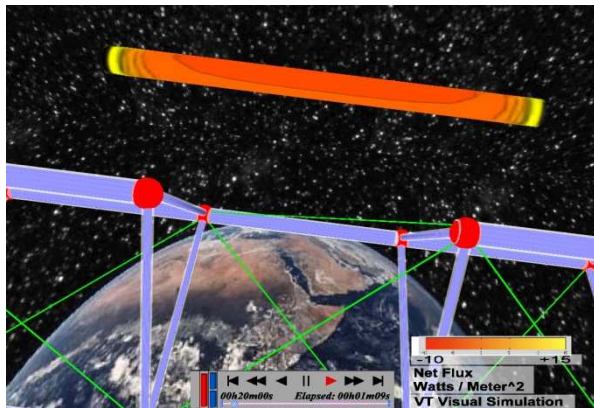
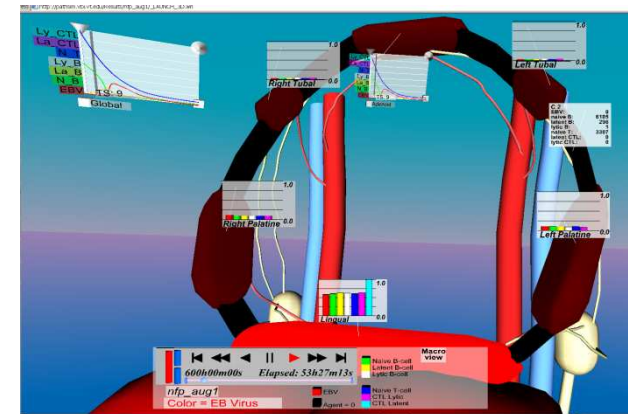


HPC Bootcamp 2010: Visual Computing

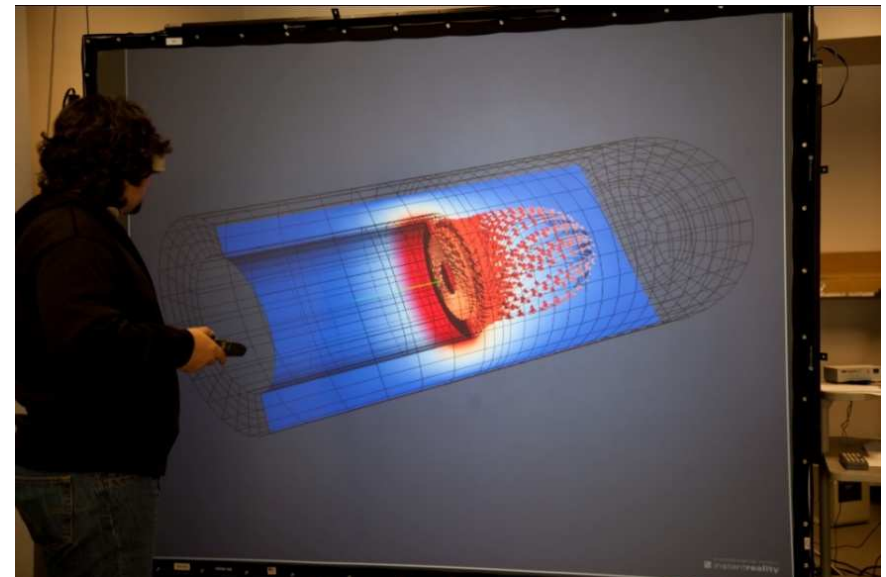


Nicholas F. Polys, Ph.D.
VT Advanced
Research Computing



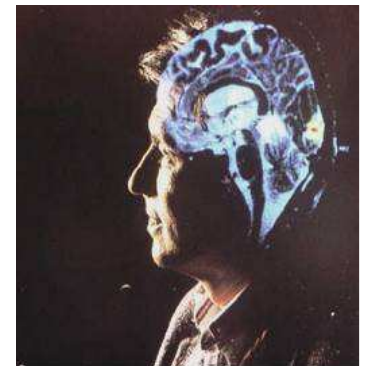
Thursday Outline

- “Visualization”
- Deep Media Tour
- VT Resources
 - *break*
- Principles of Perception
 - *lunch*
- Tools: Paraview
 - *break (*)*
- Tools: Visit +



Visualization

- A Core Competency for this century's scientist:
 - Drives hypothesis generation, analysis, *insight*
 - Enables communication, collaboration
- Understanding data requires exploration, search, comparison and pattern recognition
- Larger and more complex systems require tools with computational and cognitive scalability!



Human Vision

- Highest bandwidth sense
- Fast, parallel
- Pattern recognition
- Pre-attentive
- Extends memory and cognitive capacity
 - (Multiplication test)
- People think visually
- Brain = 8 lbs, vision = 3 lbs



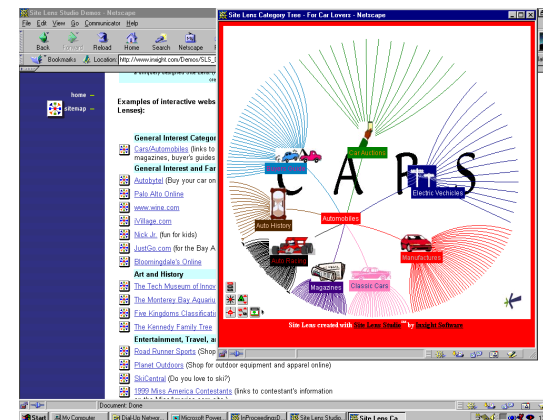
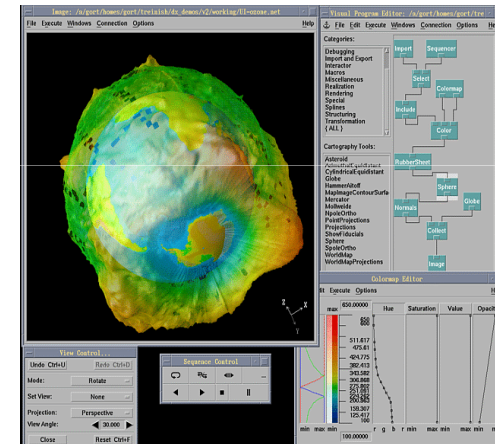
Impressive... Lets use it!

A Definition

- Generally:
 - The use of computer-supported, interactive, visual representations of data to amplify cognition

Card, McKinlay and Schneiderman

- Scientific Visualization
- Information Visualization
- Virtual Environments



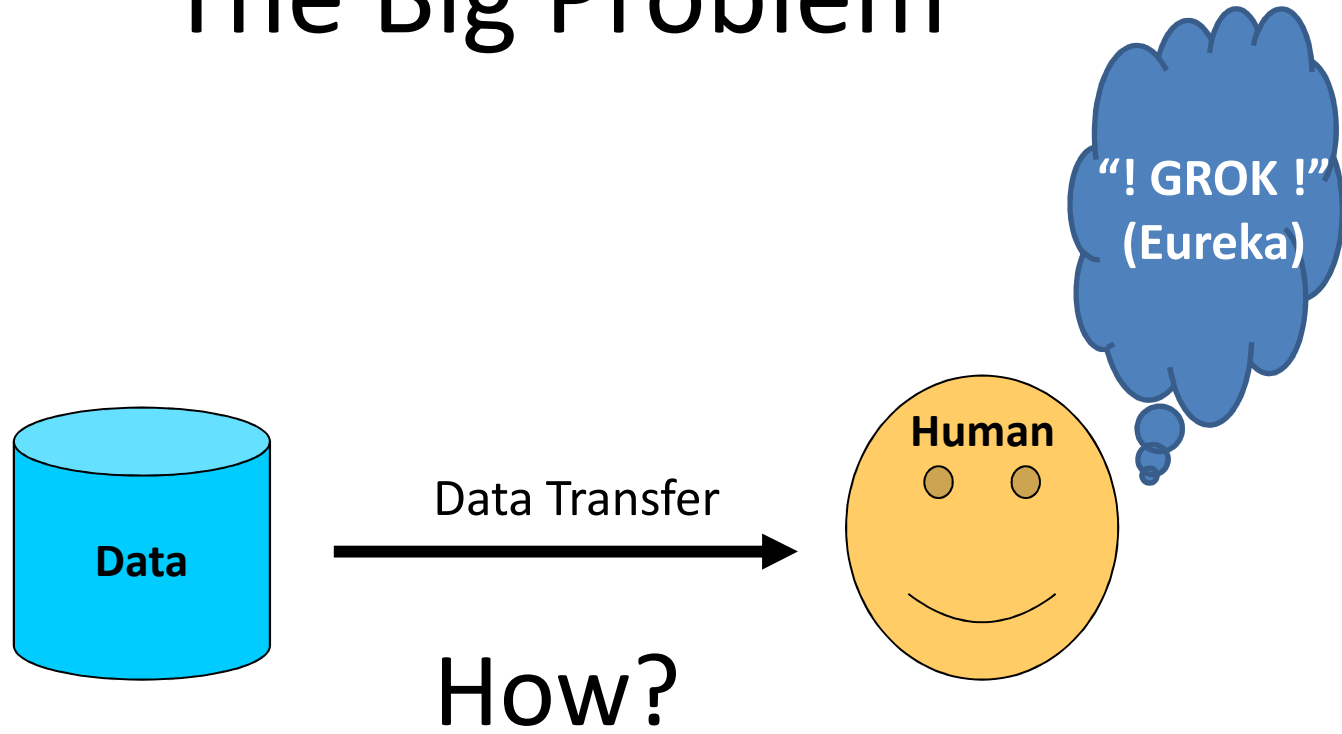
Visual Thinking

- Many of the great scientists were good at visual thinking:
 - Leonardo da Vinci
 - James Clerk Maxwell
 - Michael Faraday
 - Albert Einstein
- This was often at the expense of verbal skills
- Tom West : “In the Mind’s Eye”
 - See also http://www.krasnow.gmu.edu/twest/maxwell_visual.html



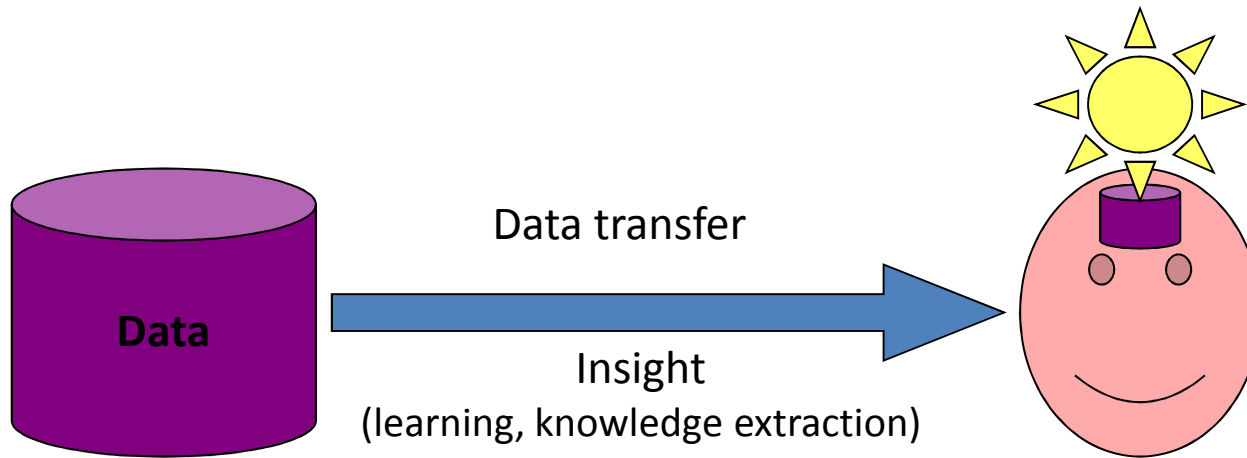
Maxwell's clay model now in
New Cavendish Laboratory, Cambridge
(picture by Tom West)

The Big Problem

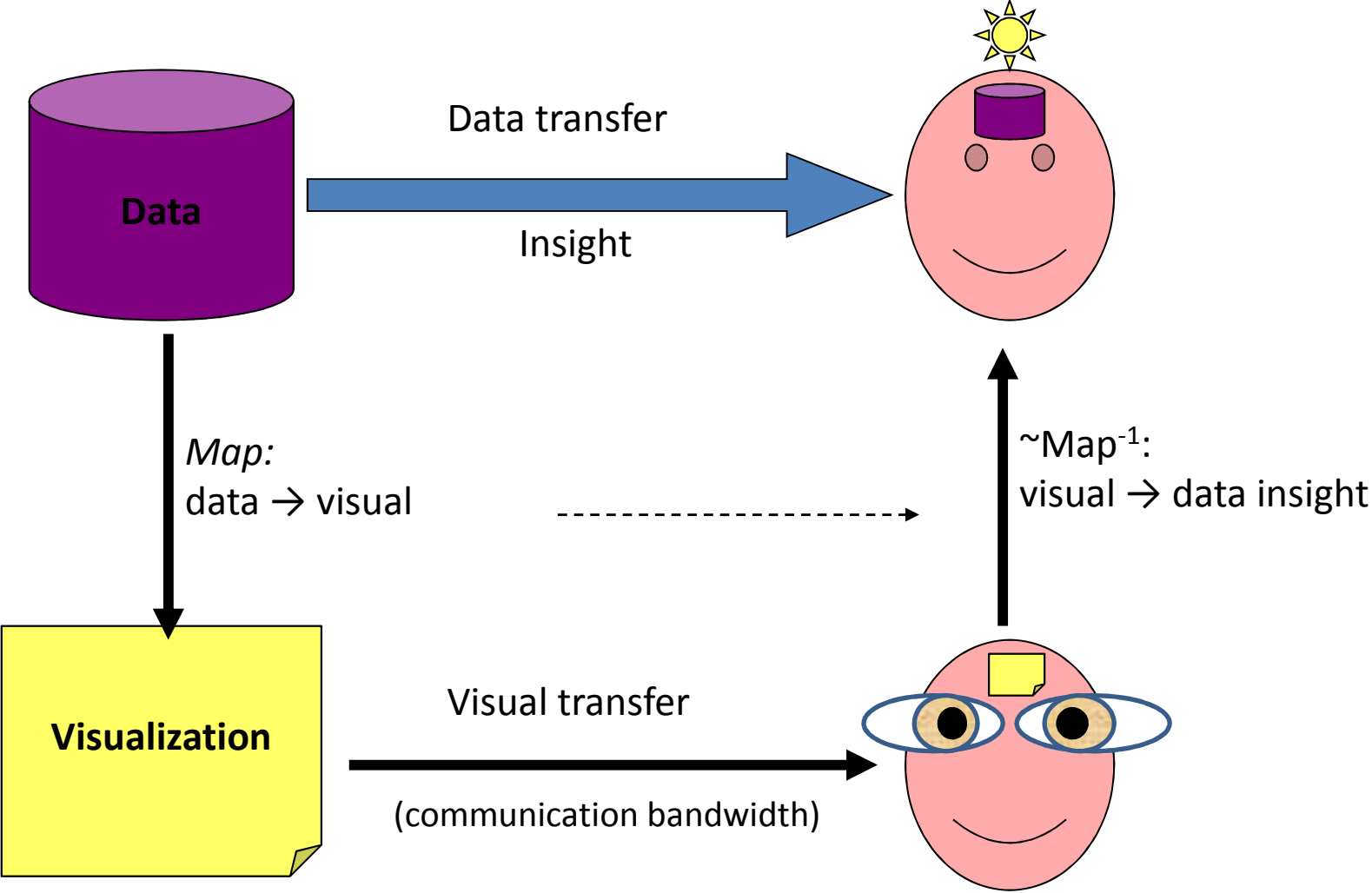


Vision
Aural
Smell
Haptics
Taste

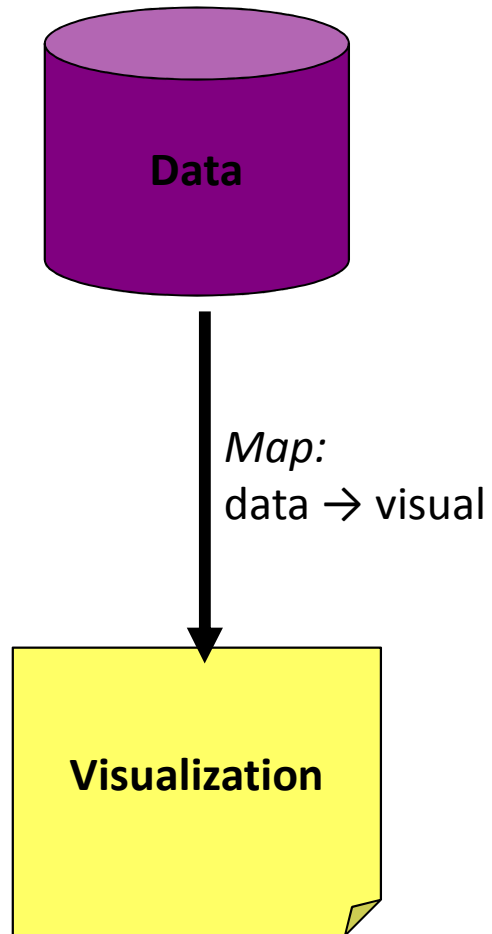
Goal



Method

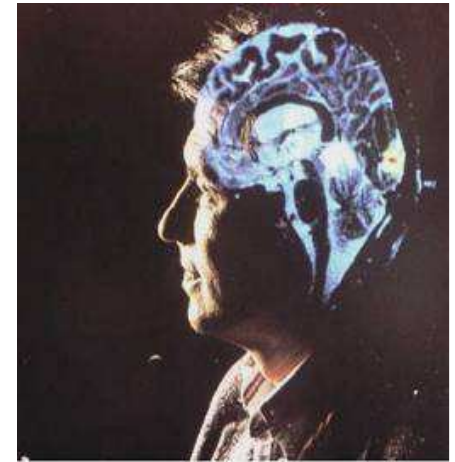


Visual Mappings



Visual Mappings must be:

- Computable (math)
$$\text{visual} = f(\text{data})$$
- Comprehensible (invertible)
$$\text{data} = f^{-1}(\text{visual})$$
- *Creative!*



Visualization Overview

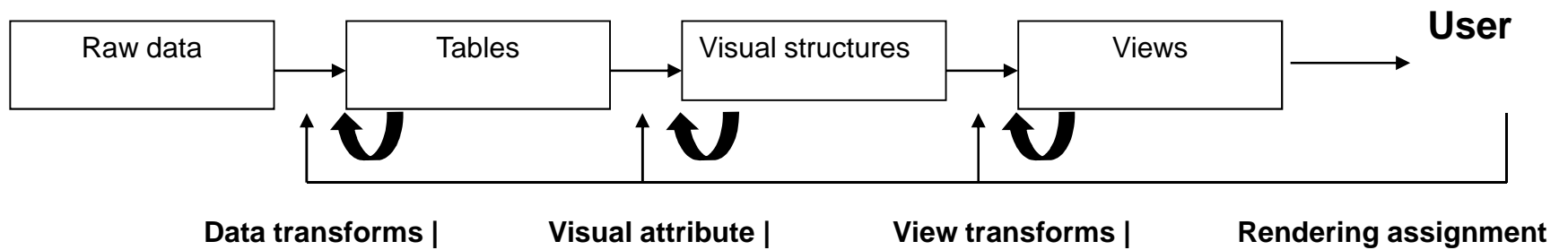
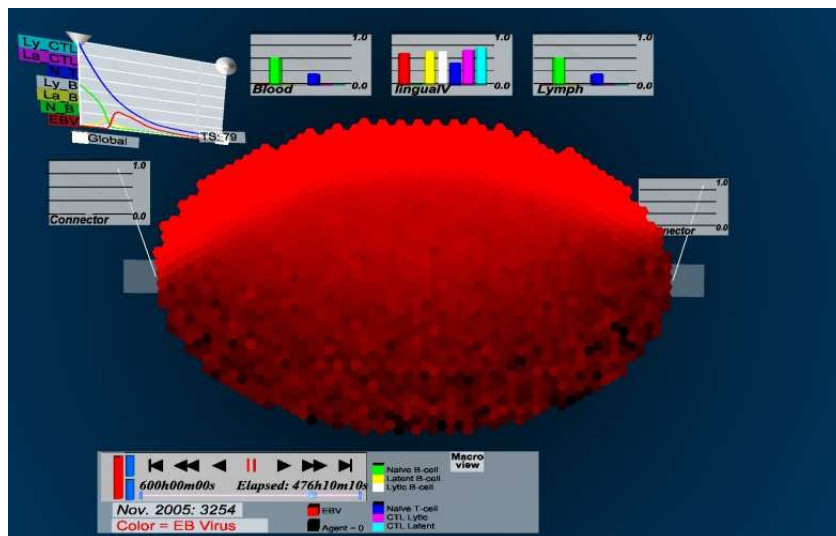
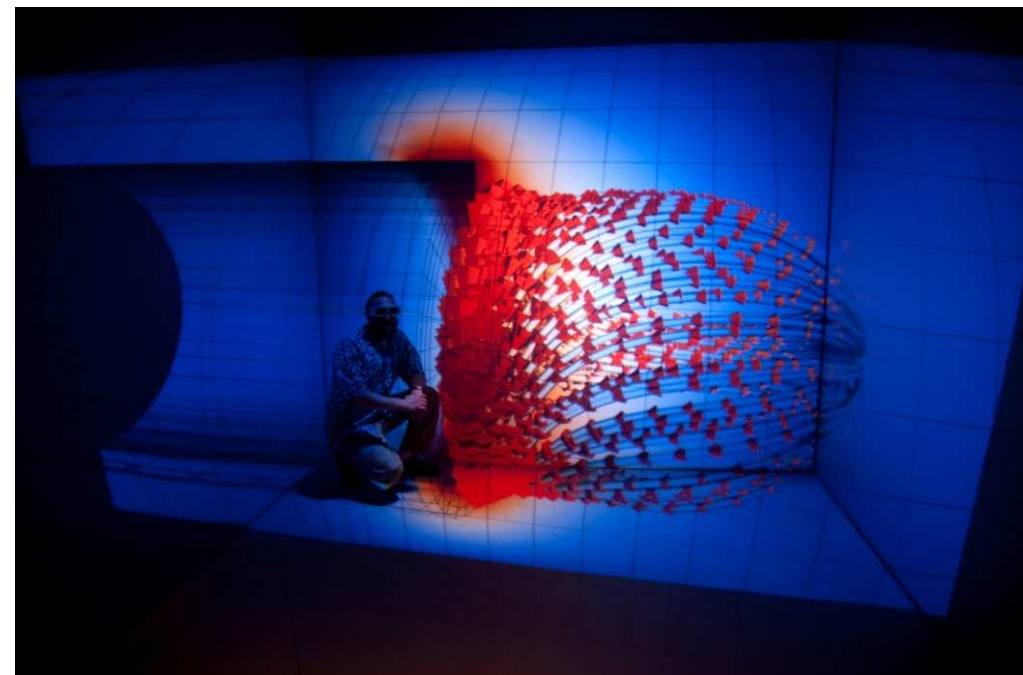
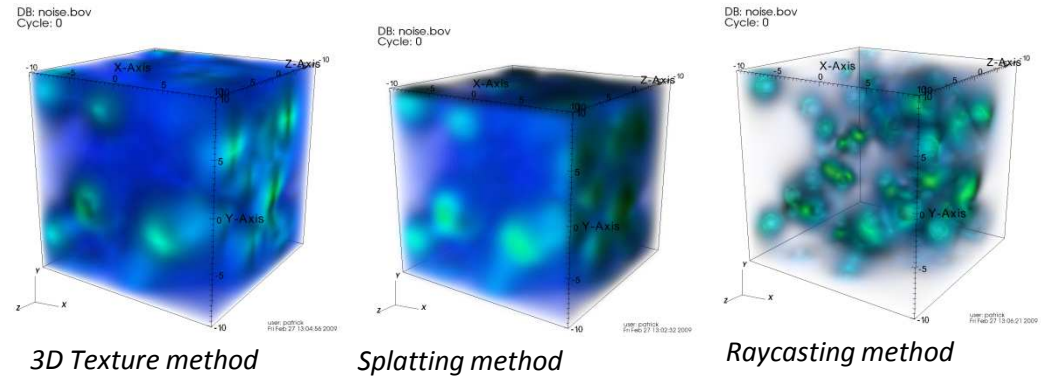


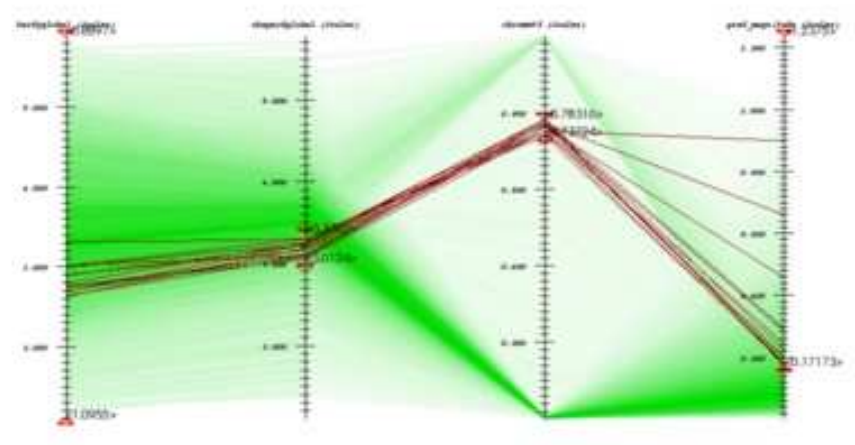
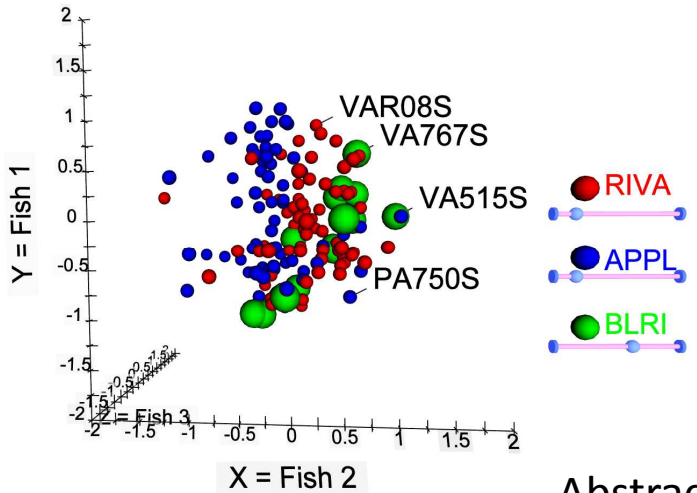
Figure 2.1: Processing in a typical visualization pipeline (from Card et al, 1999)

Visual Encoding Examples

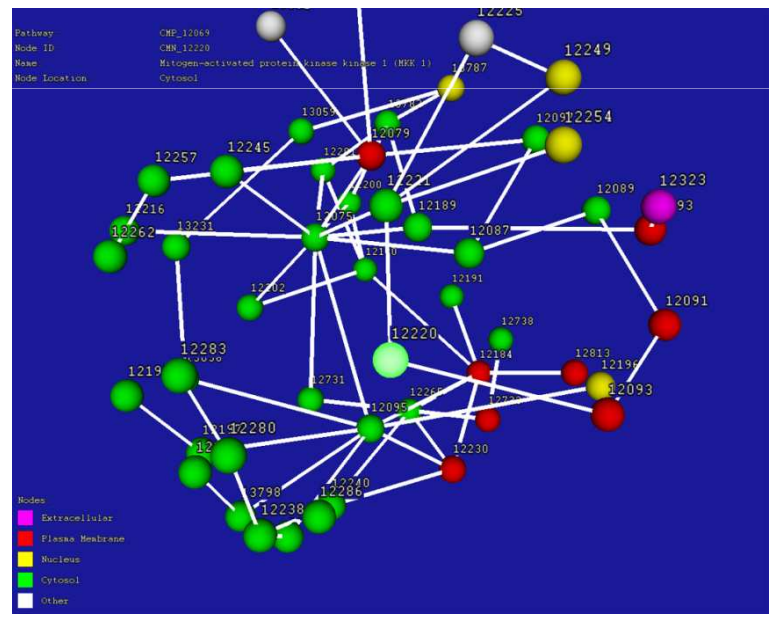
Sci Vis

- Spatial substrate
- Visual 'marks'
 - Visual properties
 - Time-varying

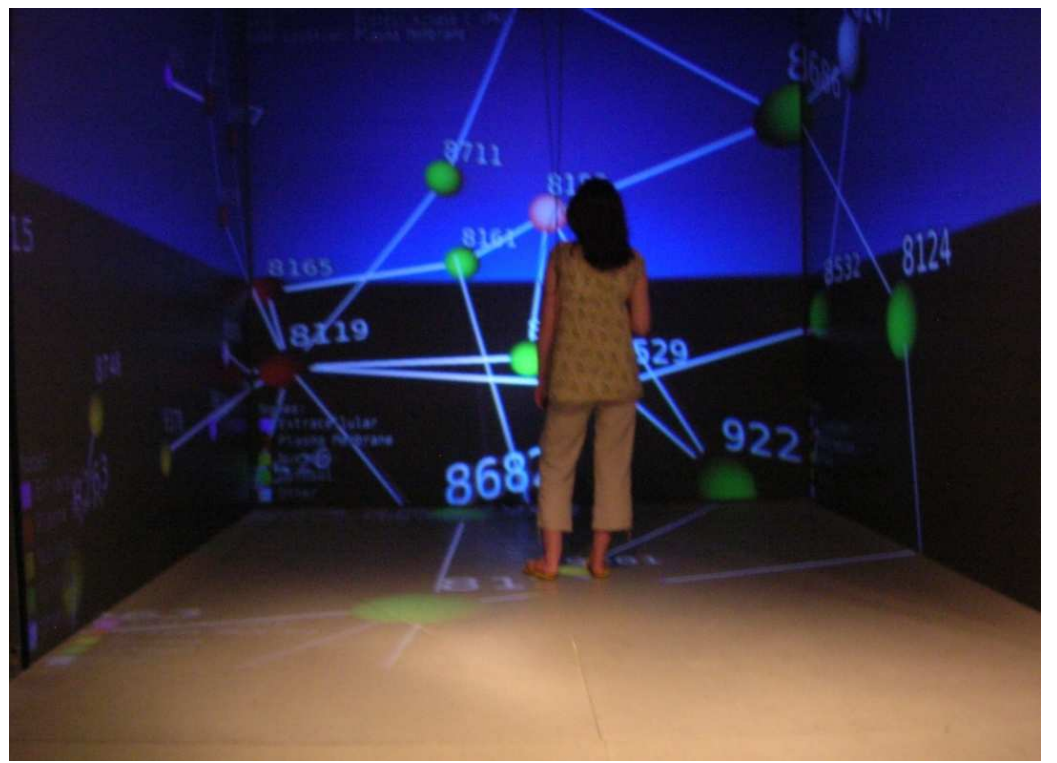




Abstract Data

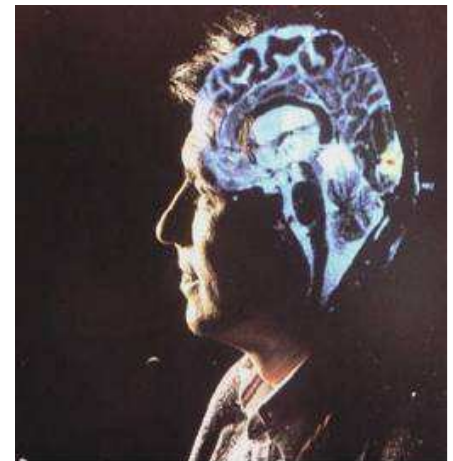


Network Data



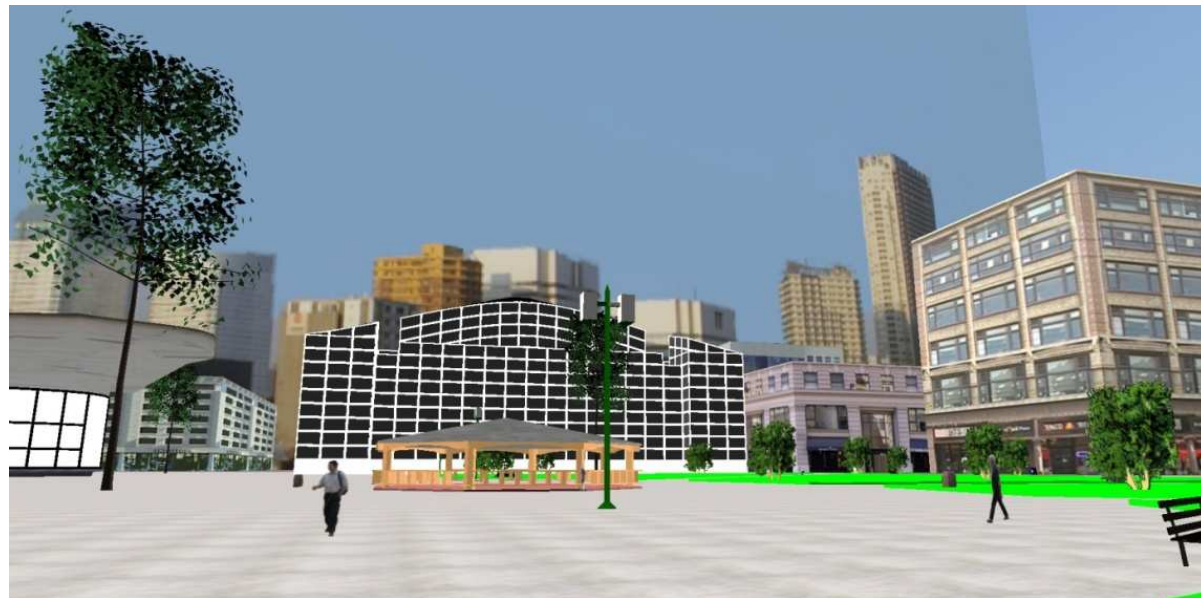
Visualization

- An instrument / tool to
 - look at your data and see things otherwise hidden...
 - Amplify Cognition
- 3 key stages:
 - Transforming data
 - Encoding data
 - Delivering / Rendering



Deep Media Tour

- Web3D & ISO Technology
- Web3D & ISO Applications
- Emerging Paradigms

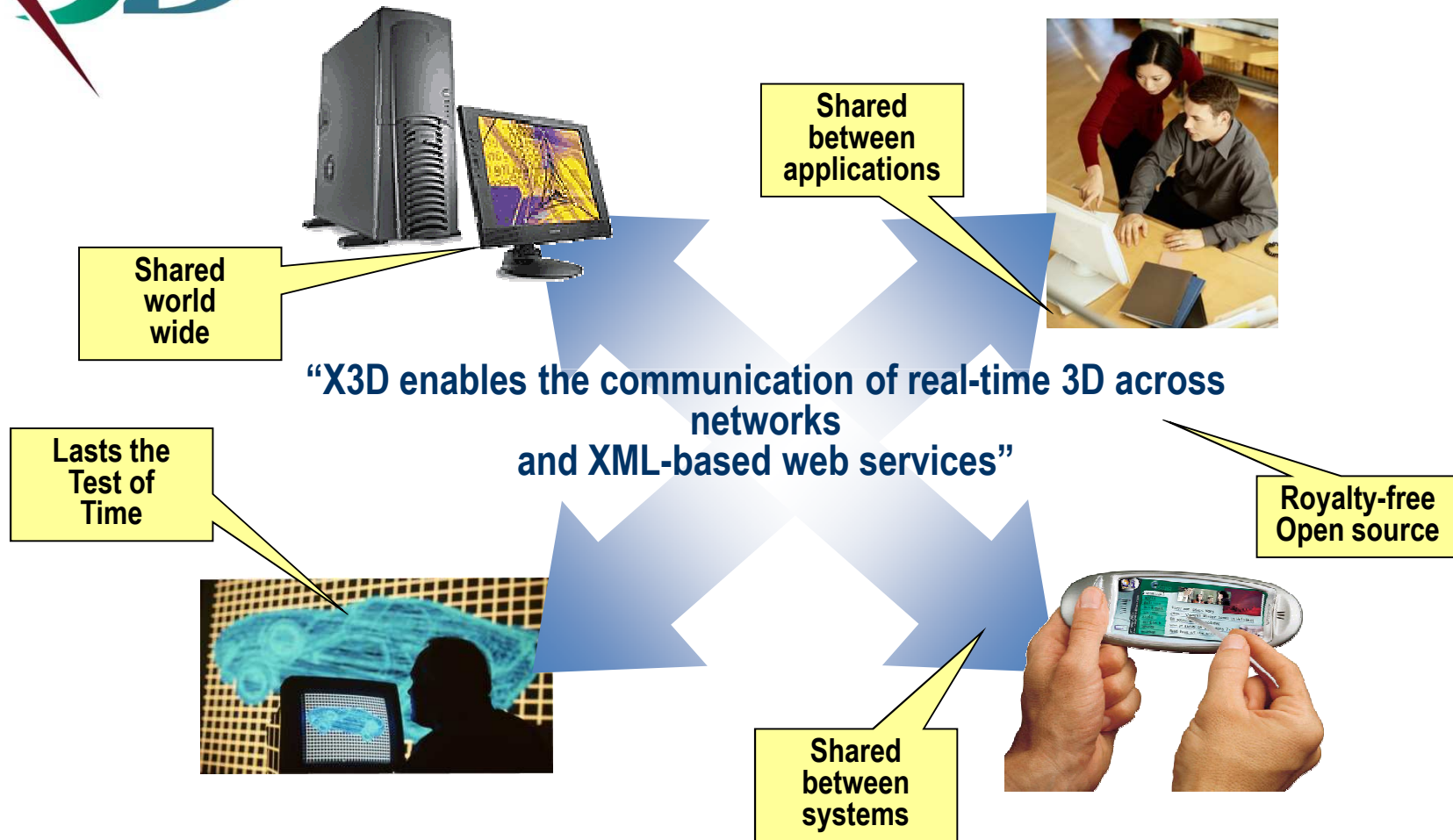


Once upon a time





The ISO Standard for 3D on the Web



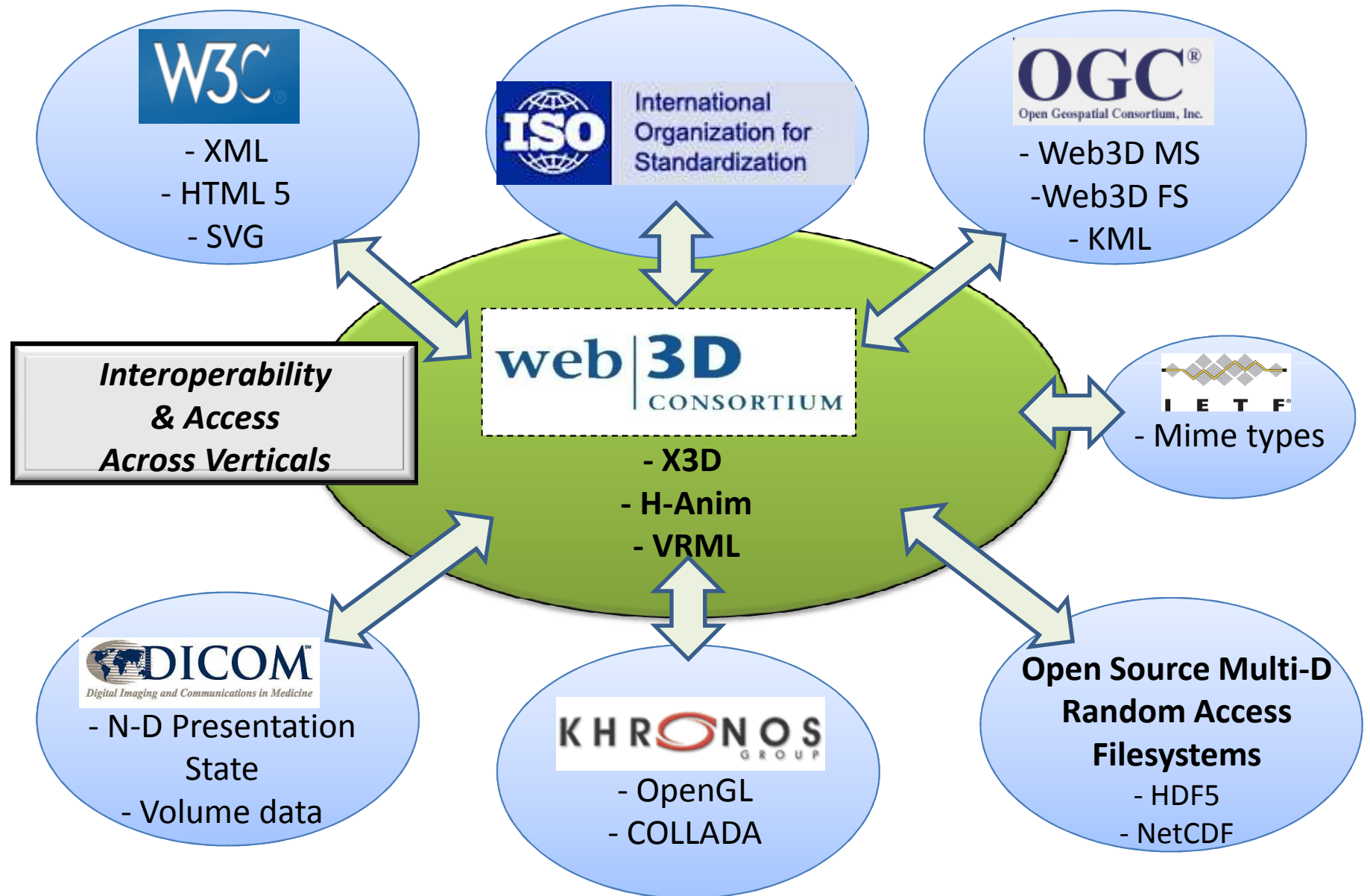
Open Standards

www.web3d.org

- Portability
- Durability
- IP independence
- International recognition and support

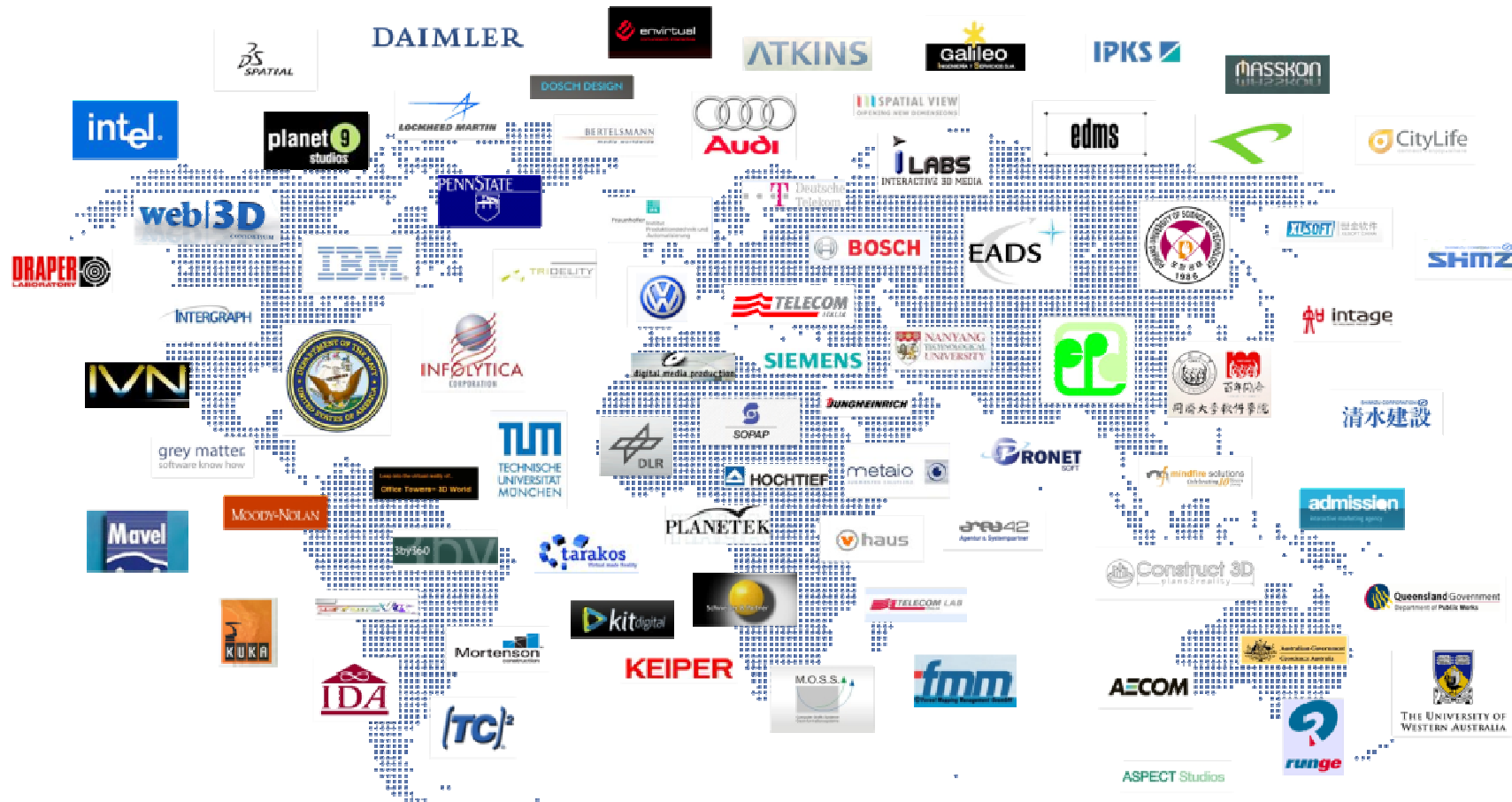
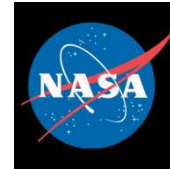


Web3D Collaboration & Convergence



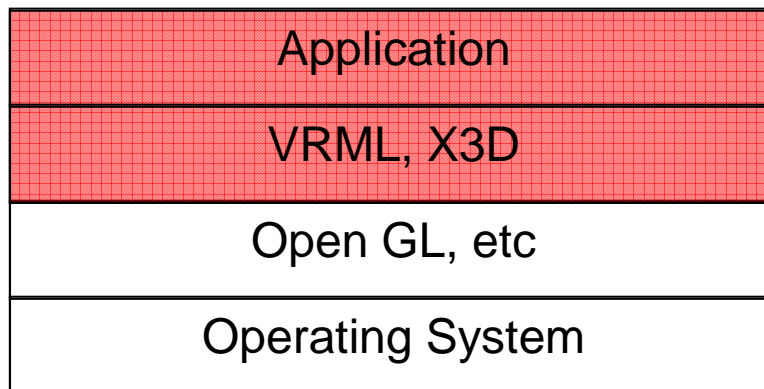


Adoption



Foundations

- ISO standard, openly published and royalty-free
- A layer above media and rendering libraries
- Multiple implementations including open source codebases
- X3D Scene graph includes the *Transformation graph* and the *Behavior graph*



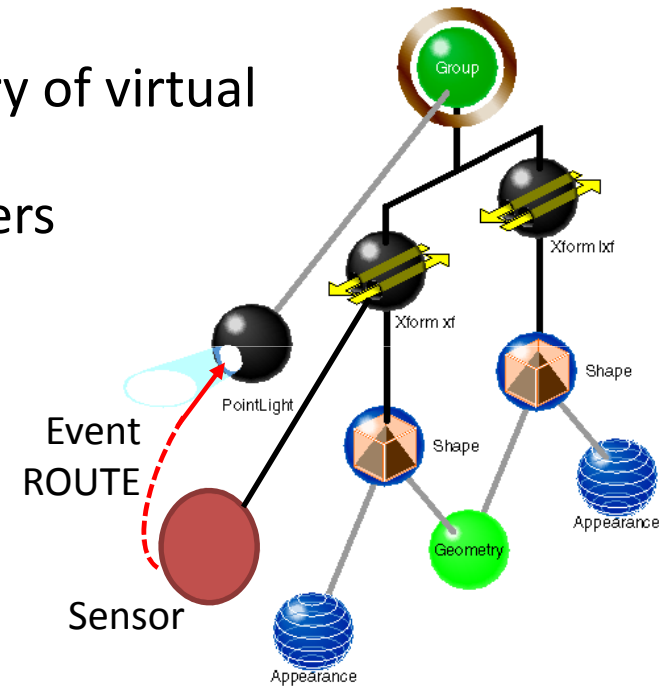


Standard Scope

Scene graph for real-time interactive delivery of virtual environments over the web:

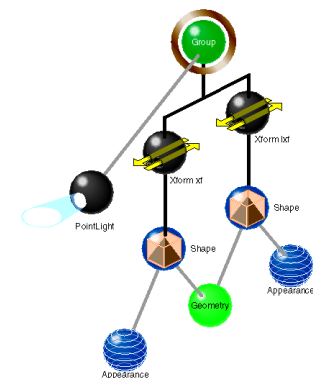
- Meshes, lights, materials, textures, shaders
- Integrated video, audio
- Animation
- Interaction
- Behaviors
- Scripts
- Application Programming Interfaces

- 3.3 examples for Medical Imaging, CAD and Geospatial support!



The Scene graph

- De-constructing Reality to re-construct it in a computer ... and present it interactively
- Provides a layer of abstraction above multimedia formats and rendering libraries
- Efficient traversal for manipulation and drawing
- A data representation (Directed Acyclic Graph, DAG) which includes a
 - *Transformation graph* and a
 - *Behavior graph*





Standardized Scenegraph

- ***Extensible 3D (X3D):***
 - ISO spec suite describing 4D assets, behaviors and interactive scenarios (scene graph)
 - Extensible: Profiles aggregate Components
 - Multiple Encodings and APIs
- ***Efficiency: Binary encoding, compression***
- ***Fidelity: double precision floats***
- ***Portable: Hardware & Platform Independent***
- ***Interoperable: WWW, Semantic web, ...***
- ***Durable: archive-quality format***
- ***Proven: Network-aware, Enterprise-ready, Royalty-free***

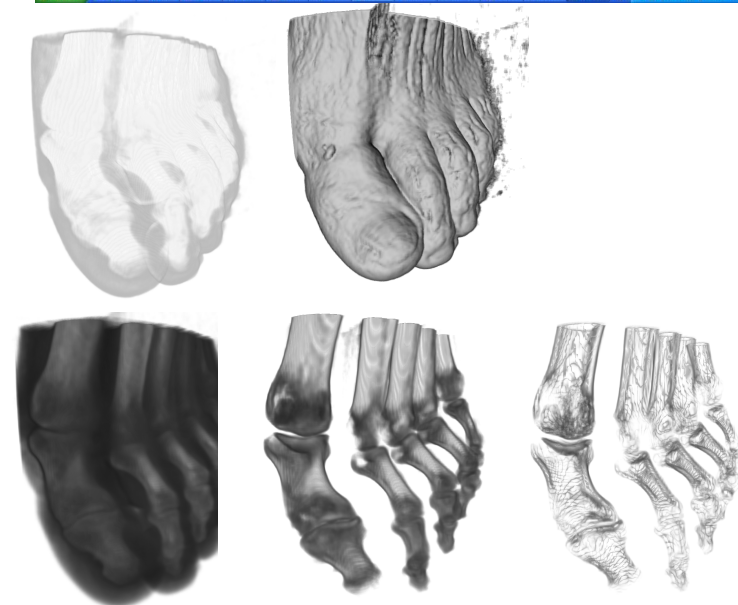
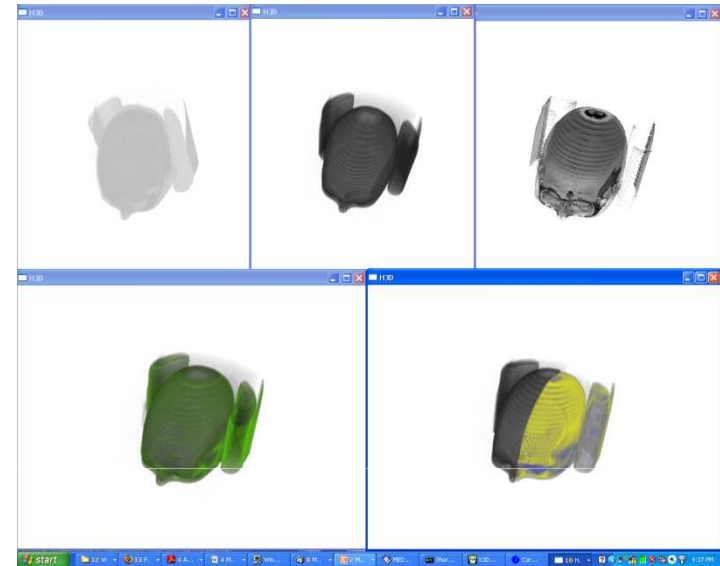
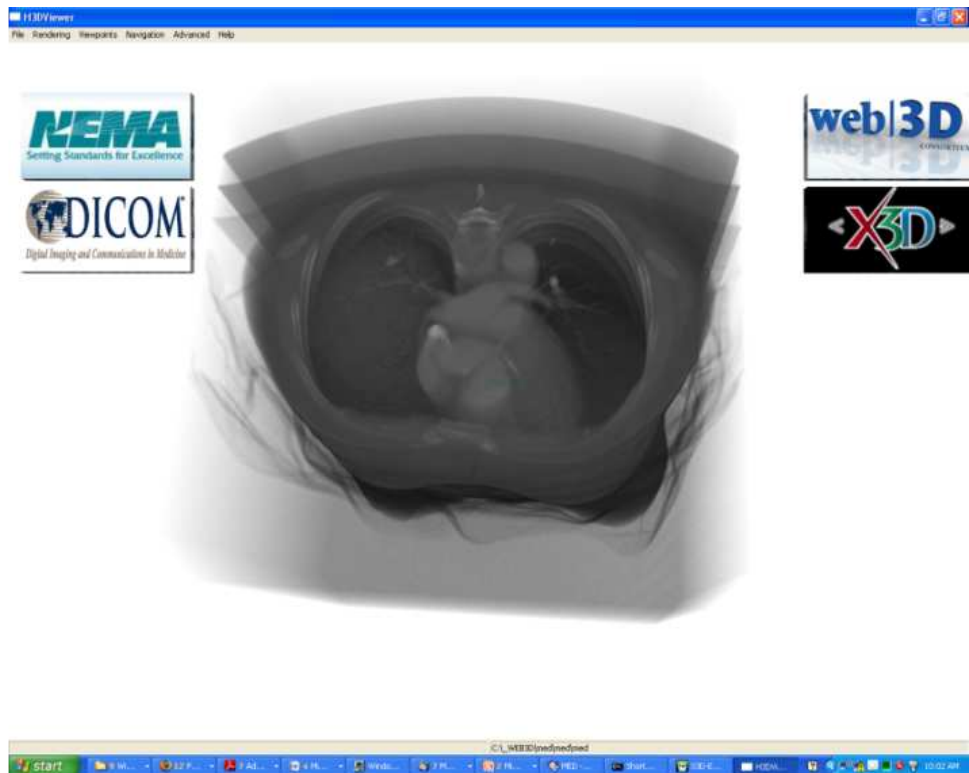
Source of Specs, Models, Links,
Bulleting boards, Blogs, Mailing lists, ...

<http://www.web3d.org>



SIGGRAPH 2010

- N-D Presentation States
- Volume Rendering Component



Perspectives on Web3D

Content publishing:

- Delivery by existing stand-alone app or plug-in
 - See:
http://legacy.caus.vt.edu/setareh/archresearch/Module_2/How_to_X3D.html

Application Development:

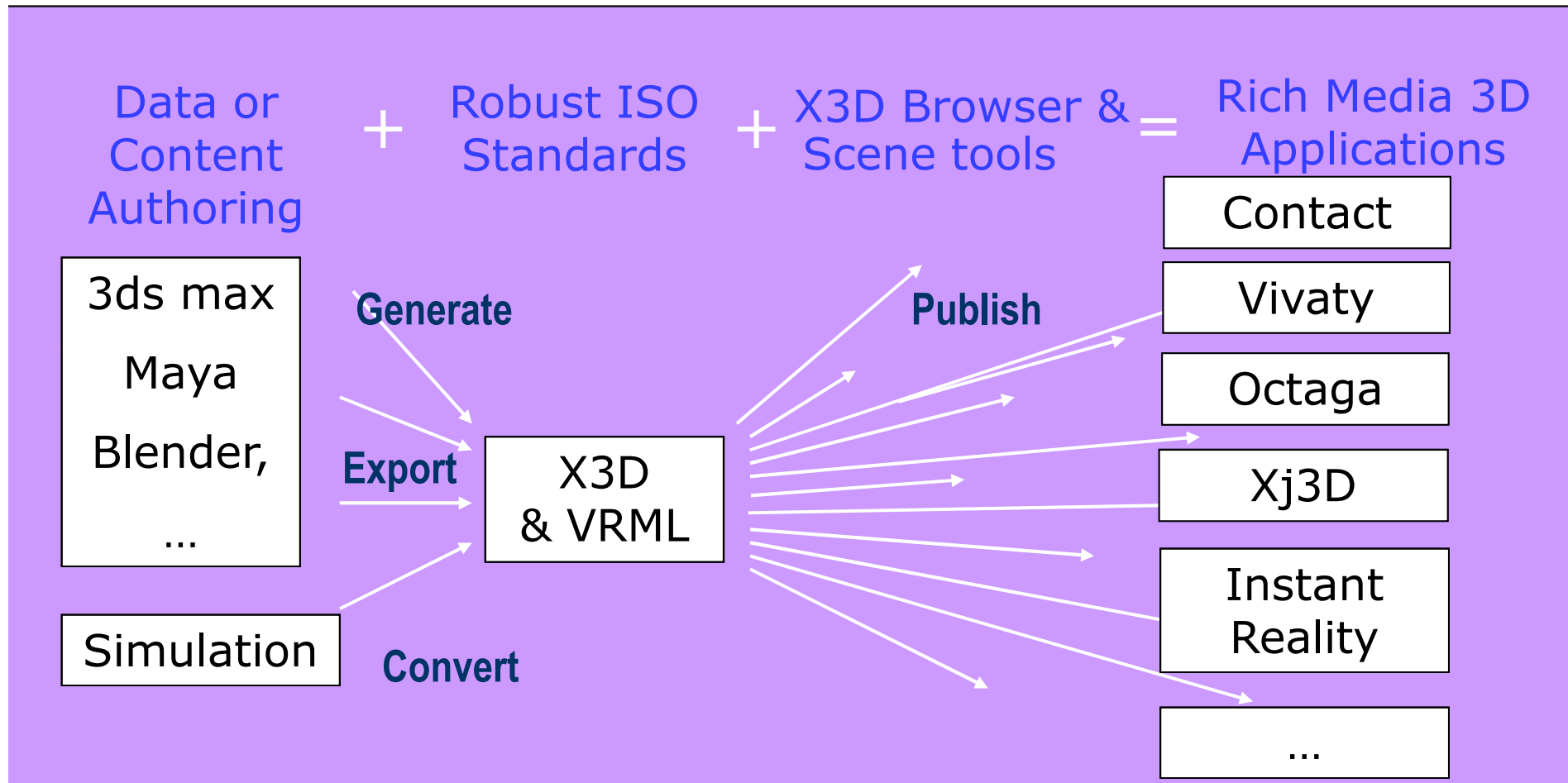
- Integrate a run-time engine into your application (numerous SDKs and codebases)



Web Integration Historically

- A URL/URI resource a piece of 4D content
- Objects, Worlds and media are aggregated with Inlines and connected with Anchors
- Worlds can be dynamically built and served (e.g. Web 2.0)
- Worlds can also be included inside HTML pages with <Object> tag and runtimes connects (ecmascript/ajax, Java, ...)

Tool Independent Workflow



Explore!

Open up new worlds on the web!

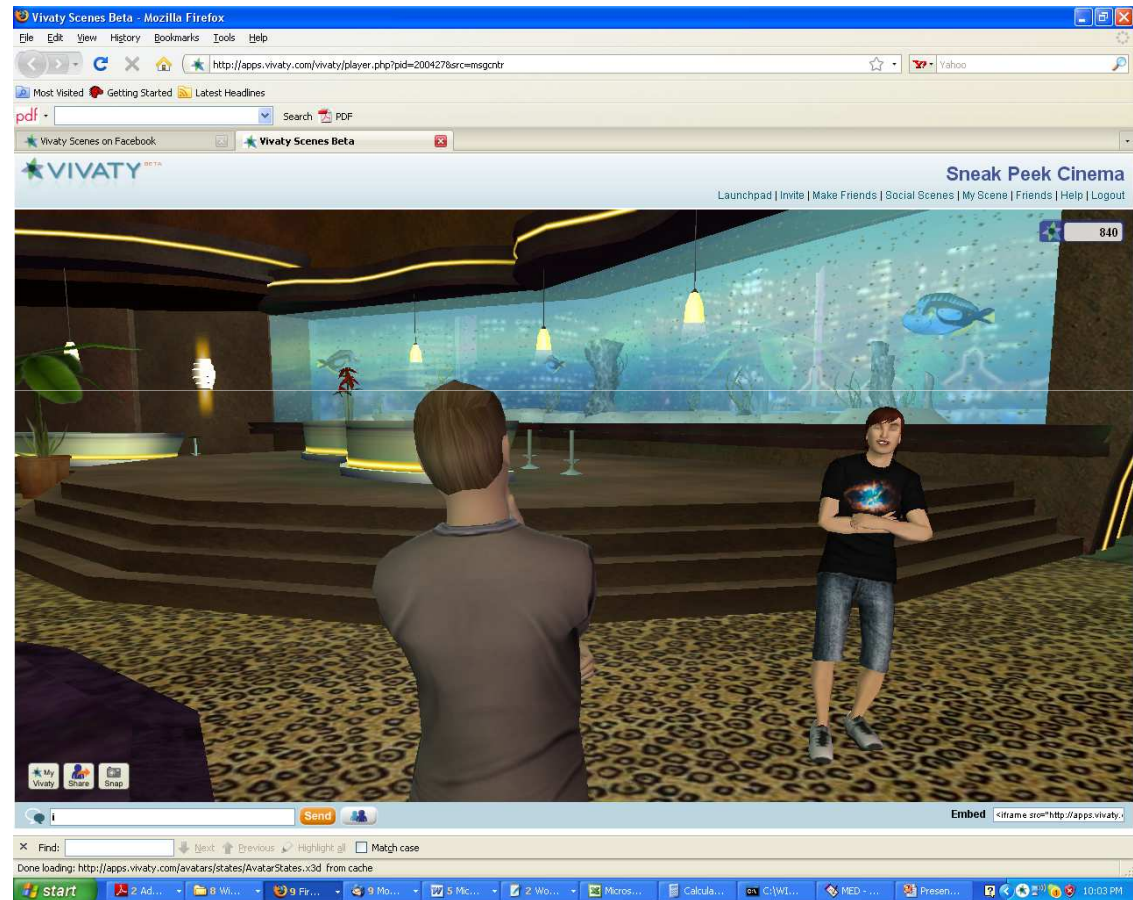
(examples w/ Instant Player)

One place to start now:

http://people.cs.vt.edu/~npolys/IT/2010_bootcamp

Emerging Paradigms

X3D



Online, Multi-User Collaborative Spaces

Web Browser Evolution

- Stand-Alone ->
- Plug-in ->
- Native Support via
 - WebGL (ES)
 - Optimize ECMA script
 - www.khronos.org
 - HTML 5

In dev builds of:

- Mozilla
- Chrome
- Safari
- Opera
- ...?



Delivery to Mobiles

Hardware and software profiles are a moving target, but:

- Also expect rendering on top of OpenGL ES
- Likely includes HTML 5 too
- X3D apps on iPhone, Android now (e.g.):
 - Raygun (www.planet9.com)
 - InstantPlayer port
 - ...



Remote Cluster Rendering

- Data is too BIG!
- Must analyze *in situ*
- A paradigm reflected in the National Labs, DOE, NSF
- Interactive and Batch sessions possible
- ... Athena ! , HokieSpeed !
- GPUs can also be used for general computation (e.g. CUDA, OpenCL)

Virginia Tech ARC Resources

Visual Computing

- Developing new website, currently at:
 - <http://Snoid.sv.vt.edu>
 - New Immersive Theater (VisCube) available in Visionarium Lab this month !
 - Athena Vis services rolling out this semester

Visual Computing Group

Provide staff to:

- Consult with researchers about applications of visualization technology
- Train faculty and students on how to use, develop, and demo visualization equipment
- Develop visualization solutions for domain experts / HPC users
- Develop additional grants and funding streams with domain experts to include visualization tools and HPC

Visual Computing Group

- Provide ‘World-Class’ visualization facilities for university researchers, faculty, and students
- Build cutting-edge software stack for domains, emphasizing content portability and ease-of-use
- Deploy visualization web services middleware to HPC systems
- Build and maintain online multi-user collaborative spaces
- Upgrade and proliferate display hardware for speed, resolution, and brightness

Facilities / Labs – VT ARC

- ***VT Visionarium*** (TORG 3050)
 - Immersive Theater (VisCube) w/ tracking
 - Stereo wall w/ tracking
 - Stereo TV (65")
 - MultiTouch Screen (52")
 - Video Conferencing
 - lab machines
- Other depts have stereo walls (architecture, art, civil engineering, geo)

Software Stack

Support for many data & disciplines:

- X3D/VRML
- CFD
- CAD
- Architecture
- Molecular Dynamics
- DIVERSE VR (Win, Mac, Linux)
- ... documentation available !

Faculty & Student Training

- FDI classes in Visualization Technology & production skills 6-session track run in spring, 2 x 2-session tracks in fall; summer Bootcamp/FDI
- VisCube & Vis Equipment training
 - Operation of, development for
 - Documentation online
 - Free, open to faculty, grad, undergrad
 - by appointment

BREAK