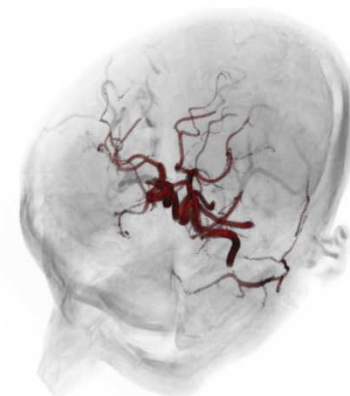
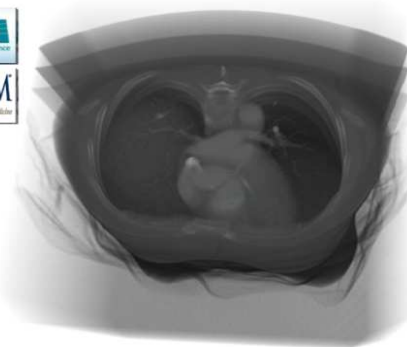


Medical and Volume Visualization with X3D



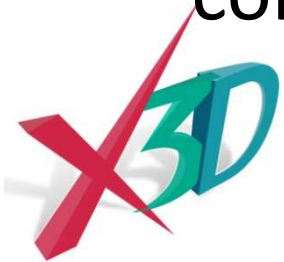
SIGGRAPH 2011 BOF

Nicholas F. Polys, Ph.D.
Virginia Tech,
Web3D Consortium



Overview

- International Standardization efforts to specify the basis for reproducible real-time, interactive volume visualization
- Launched by US ARMY TATRC
- Developed by Web3D Consortium
- Technology Scope
- New ISO draft released for public comment !



Open Standards

www.web3d.org



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



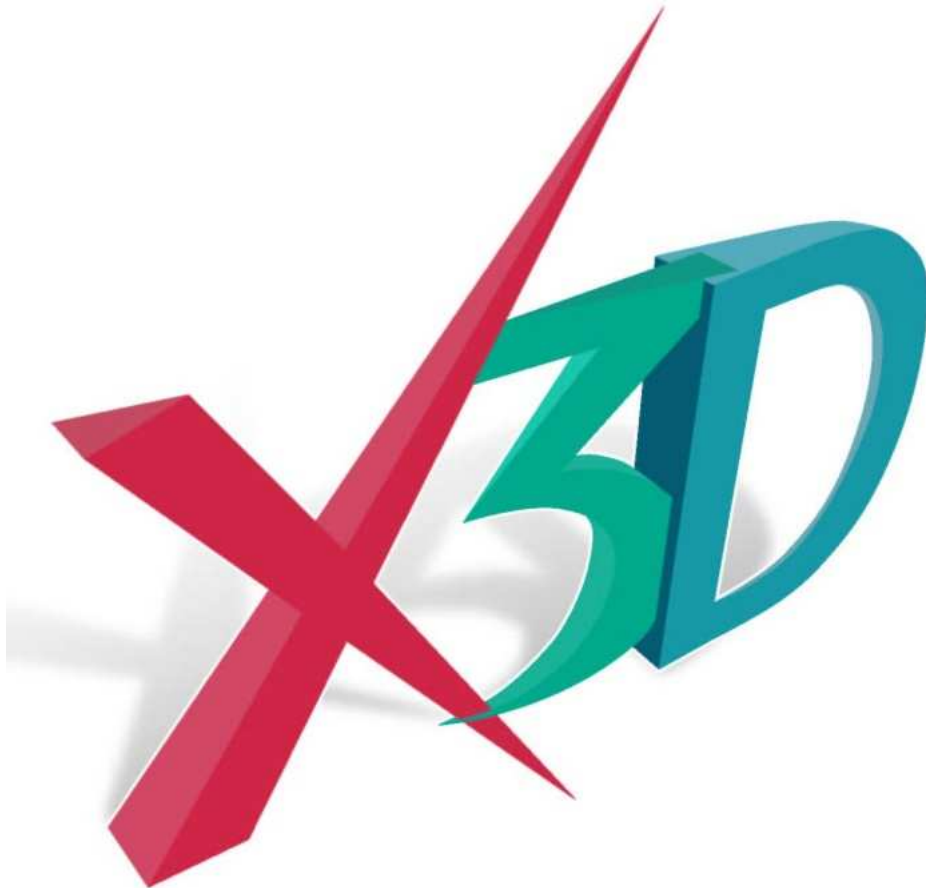
© 1999-2011, Web3D Consortium

A nonprofit organization that develops and maintains the X3D, VRML, and H-Anim standards – 3D file formats and runtime specifications for the delivery and integration of interactive 3D data over networks: open, royalty-free and ISO-ratified.

ISO Standards



*Open Standards for
Real-Time 3D Communication*

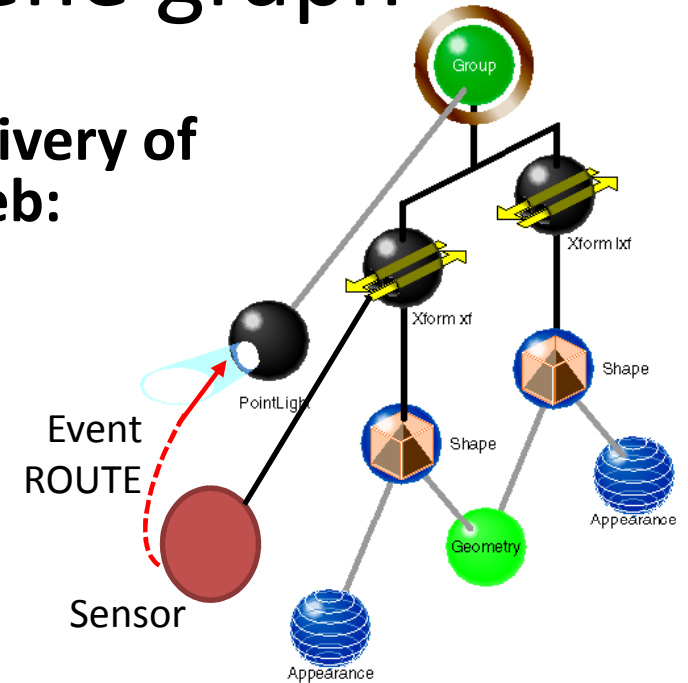




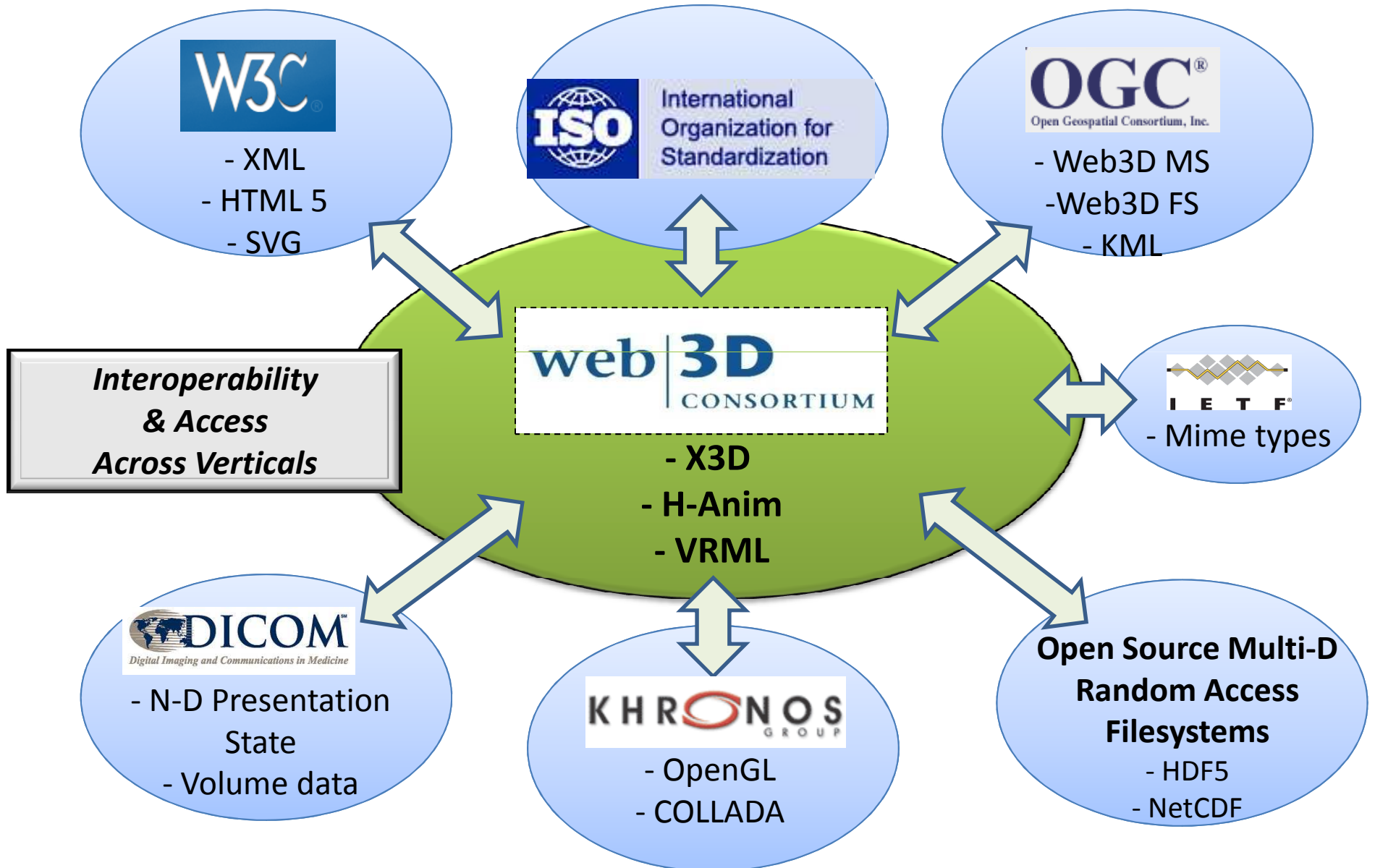
: the Standard Scene graph

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

- Meshes, lights, materials, textures, shaders
 - Integrated video, audio
 - Animation
 - Interaction
 - Scripts & Behaviors
-
- Multiple encodings (ISO = XML, VRML-Classic, Binary)
 - Multiple Application Programming Interfaces (ISO = ECMA, Java)
-
- X3D 3.3 includes examples for Volume rendering, CAD and Geospatial support!

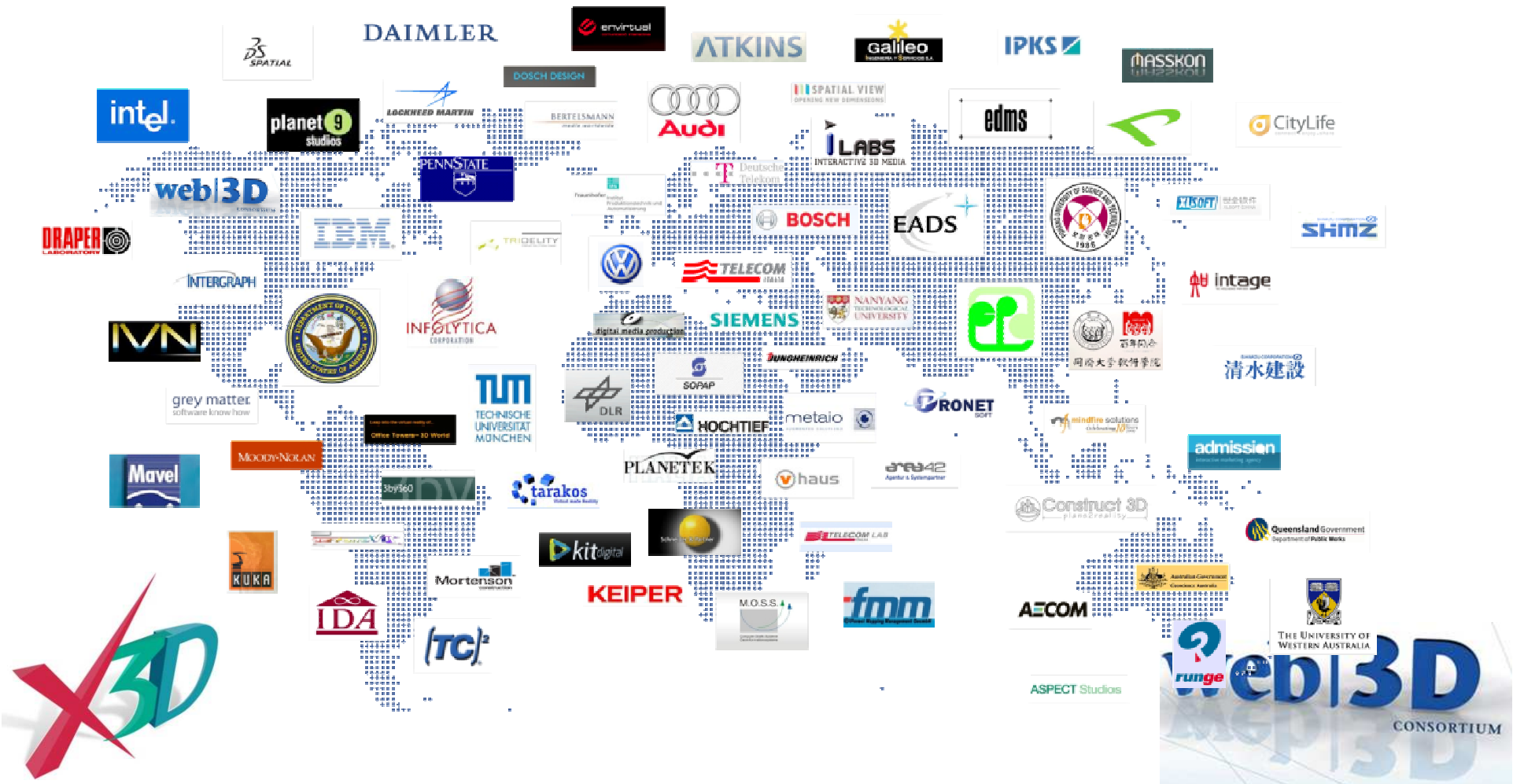
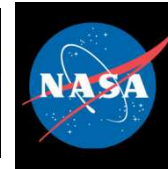


Web3D Collaboration & Convergence



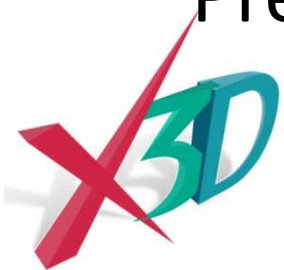


Adoption



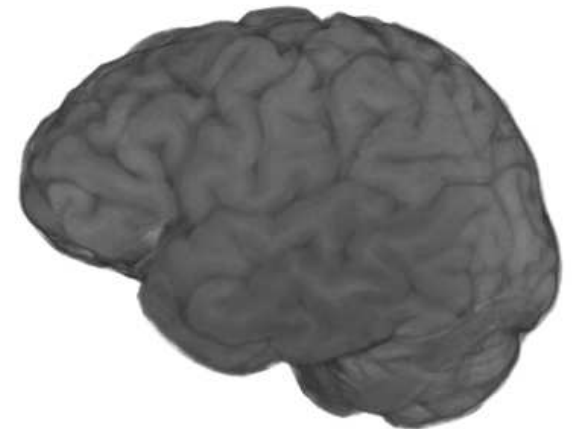
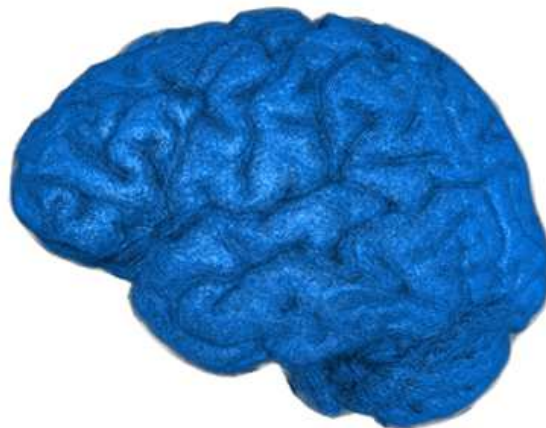
X3D Medical Working Group

- A Working Group chartered to catalyze reproducible medical visualizations across platforms and over the network
- Develop Volume visualization standards that meet the industry's greatest common denominator
- Work with DICOM on the n-Dimensional Presentation State work item (WG11)



Web3D Medical Working Group Scope

- Consistent and interoperable presentation states for medical image data
 - Hospitals, Experts, Patients
 - Well-developed use cases
- Broad impact across the spectrum of care:
 - Training
 - Acute & Chronic Care
 - Prevention
 - Rehabilitation

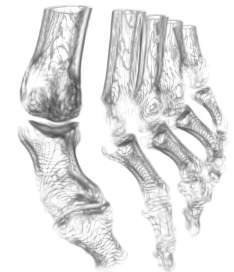
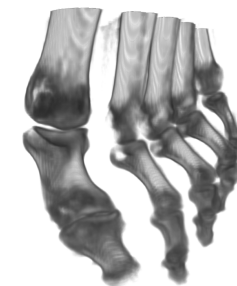
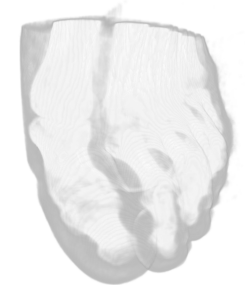
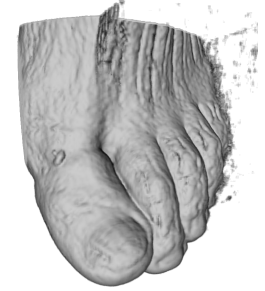


Use Cases

Accessibility outside the radiology suite:

- Surgical Planning
- Informed Consent
- Custom Prostheses
- Radiation Therapy
- Anatomy Education
- Surgical Training

...



N-D Requirements

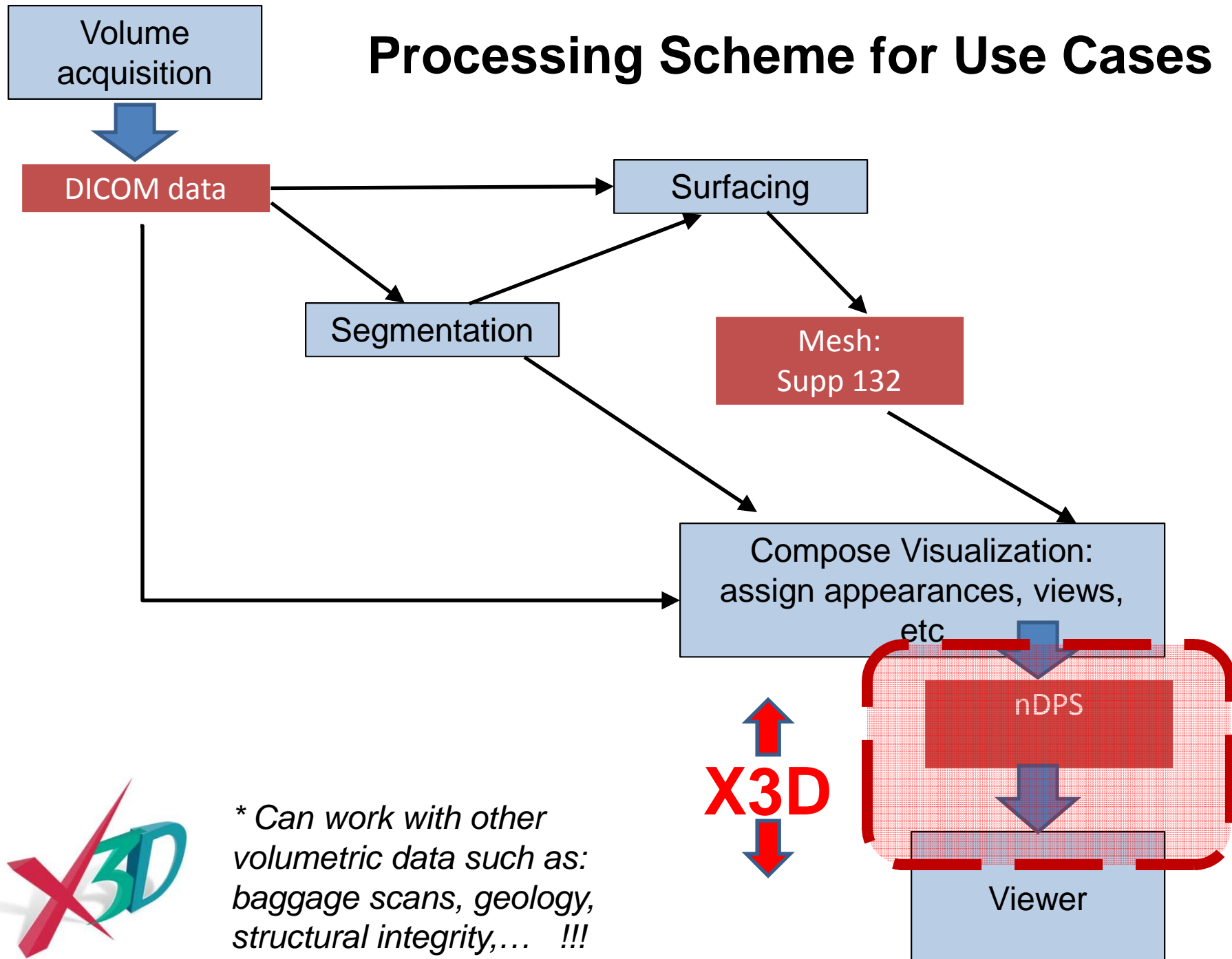
Reproducible rendering throughout the healthcare enterprise

An n-D Presentation must include:

- Structured and interactive virtual environment display (2D & 3D objects and time series) *
- Platform-independent, royalty-free technology to enable vendor innovation
- Can be rendered with or without stereoscopy
- Openly-published



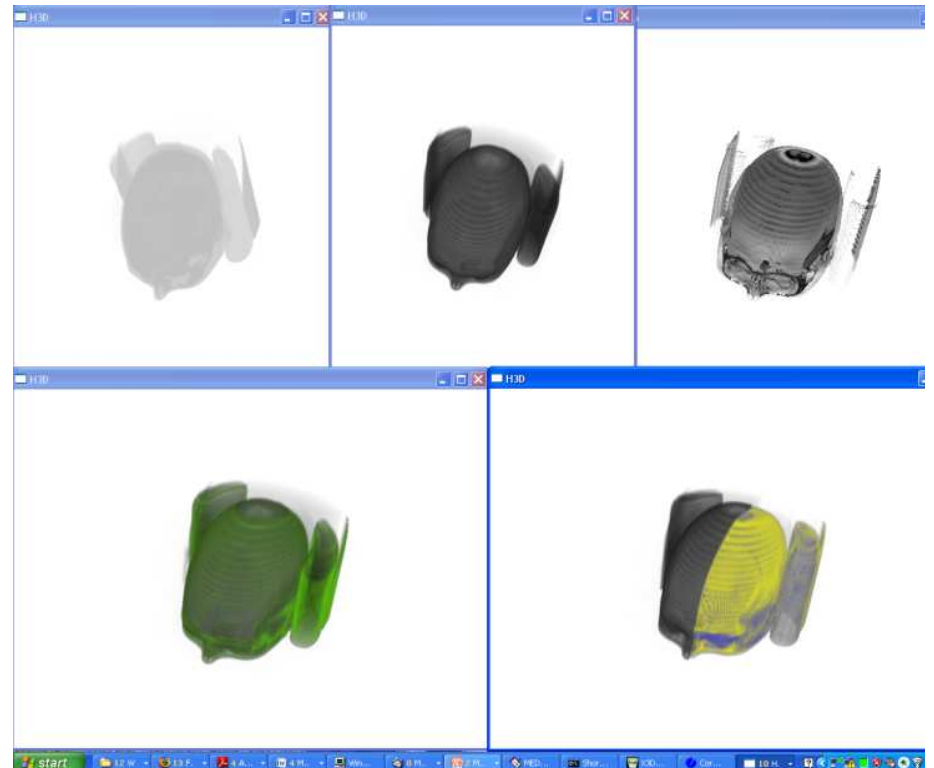
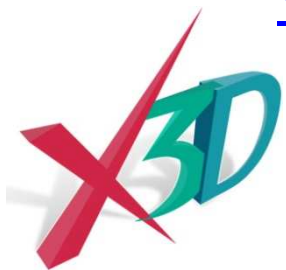
Processing Scheme for Use Cases



** Can work with other volumetric data such as: baggage scans, geology, structural integrity,... !!!*

X3D Volume Rendering

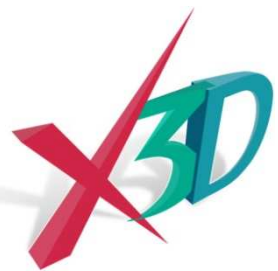
- Necessary and Sufficient node set for industry's greatest common denominator:
 - **Volume Component:** render styles
 - **X3D version 3.3**
- Two independent implementations:
 - www.h3d.org
 - www.instantreality.org



X3D Volume Rendering

- Composable Render Styles covering the state of the art
 - Formalizes parameters and transfer functions for 3D rendering & blending
- Assign different RenderStyles to different segments
- Clipping Planes are already specified in

X3D 3.2 Rendering Component



X3D Volume Rendering Component

X3D 3.3 -> ISO SC24

July 2011

ISO/IEC 19775-1.2:2008/Medical WDS Am1:201x

<X3D>
Extensible 3D (X3D)
Part 1: Architecture and base components
41 Volume rendering component

41.1 Introduction

41.1.1 Name
The name of this component is "VolumeRendering". This name shall be used when referring to this component in the COMPONENT statement (see 2.2.5.4 Component statement).

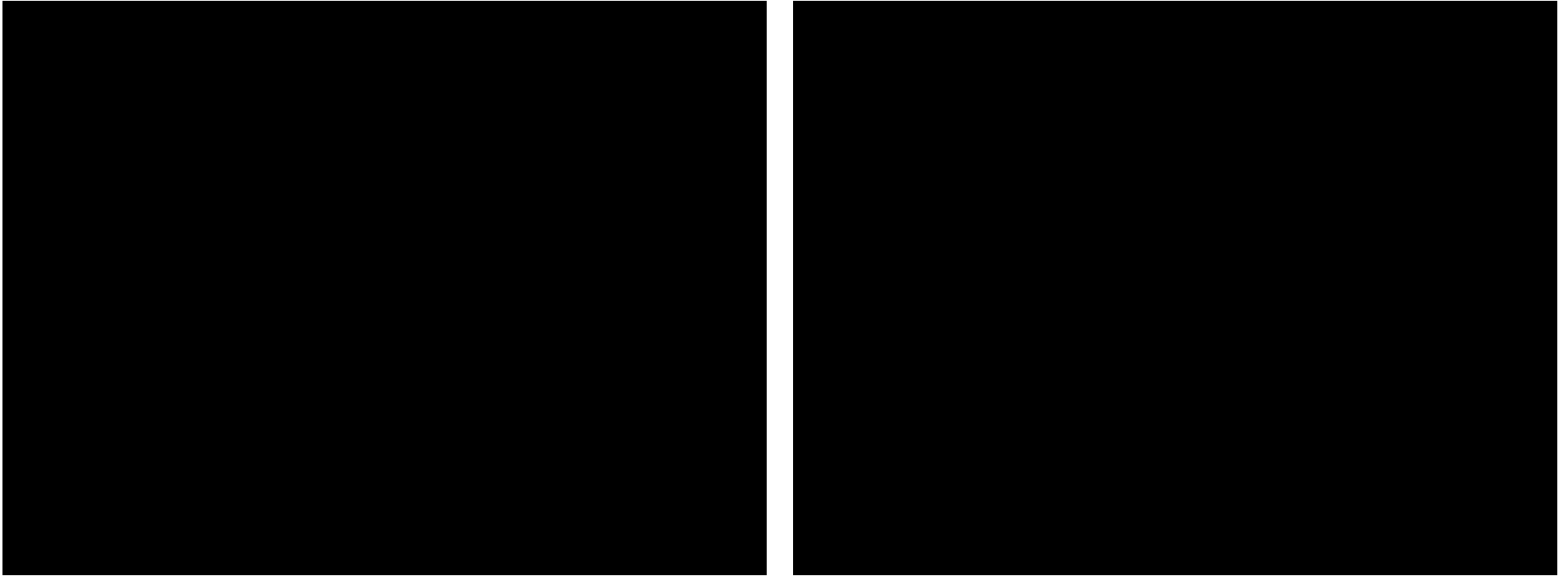
41.1.2 Overview
This component provides the ability to specify and render volumetric data sets. Table 41.1 provides links to the major topics in this clause.

Table 41.1 – Topics

- 41.1 Introduction
 - 41.1.1 Name
 - 41.1.2 Overview
- 41.2 Concepts
 - 41.2.1 Overview
 - 41.2.2 Representing volumetric data
 - 41.2.2.1 Registration and scaling
 - 41.2.2.2 Data representation
 - 41.2.2.2.1 3D texture definition
 - 41.2.2.2.2 Vector and normal representation
 - 41.2.2.2.3 Data optimization
 - 41.2.2.3 Segmentation information
 - 41.2.2.4 Tensor representation
 - 41.2.2.5 Visual representation
 - 41.2.3 Interaction with other nodes and components
 - 41.2.3.1 Overview
 - 41.2.3.2 Lighting
 - 41.2.3.3 Geometry
 - 41.2.4 Conformance
 - 41.2.4.1 Dimensionality
 - 41.2.4.2 Hardware requirements

- [41.3 Abstract types](#)
- [41.3.1 X3DComposableVolumeRenderStyleNode](#)
- [41.3.2 X3DVolumeDataNode](#)
- [41.3.3 X3DVolumeRenderStyleNode](#)
- [41.4 Node reference](#)
- [41.4.1 BlendedVolumeStyle](#)
- [41.4.2 BoundaryEnhancementVolumeStyle](#)
- [41.4.3 CartoonVolumeStyle](#)
- [41.4.4 ComposedVolumeStyle](#)
- [41.4.5 EdgeEnhancementVolumeStyle](#)
- [41.4.6 IsoSurfaceVolumeData](#)
- [41.4.7 OpacityMapVolumeStyle](#)
- [41.4.8 ProjectionVolumeStyle](#)
- [41.4.9 SegmentedVolumeData](#)
- [41.4.10 ShadedVolumeStyle](#)
- [41.4.11 SilhouetteEnhancementVolumeStyle](#)
- [41.4.12 ToneMappedVolumeStyle](#)
- [41.4.13 VolumeData](#)

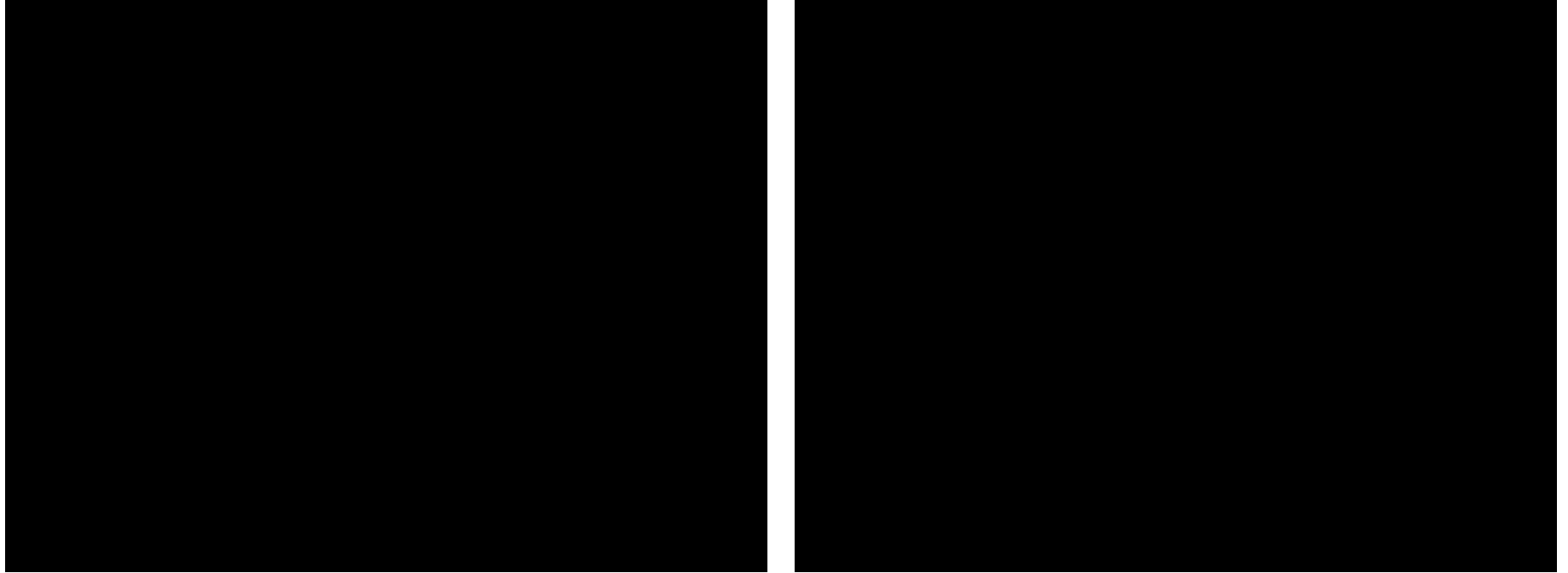
X3D Volume Videos



VolumeRenderStyle : OpacityMap



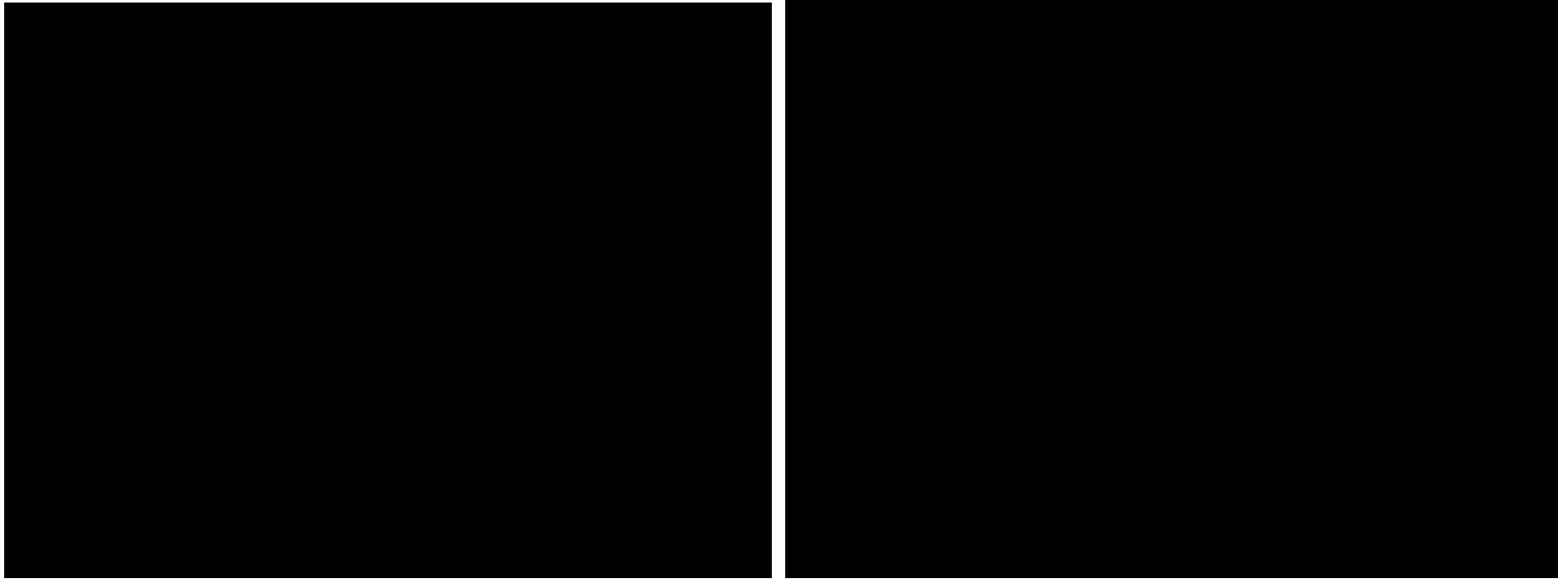
X3D Volume Videos



VolumeRenderStyles : Edge enhanced, Shaded



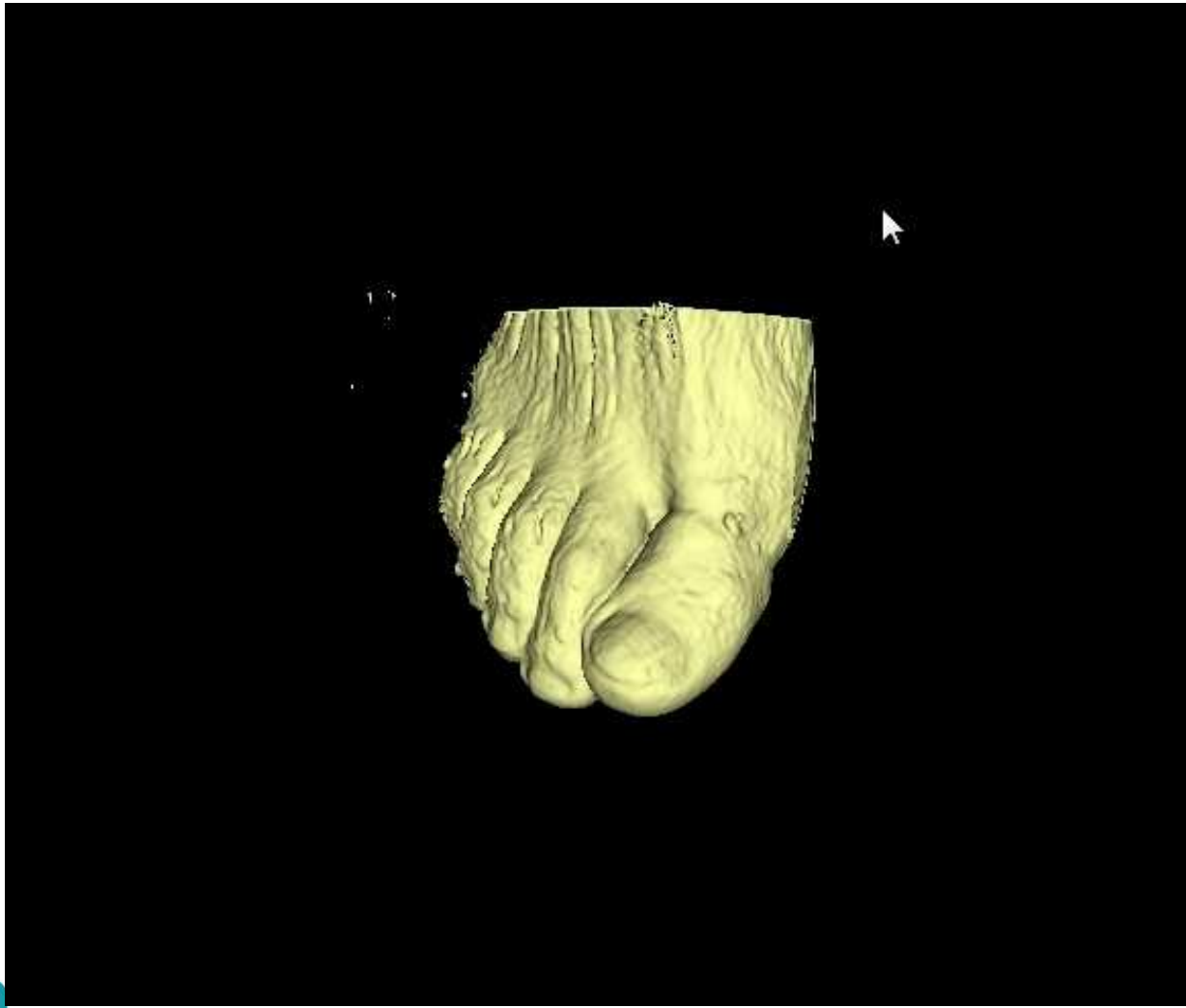
X3D Volume Videos



VolumeRenderStyles : Cartoon, Composed



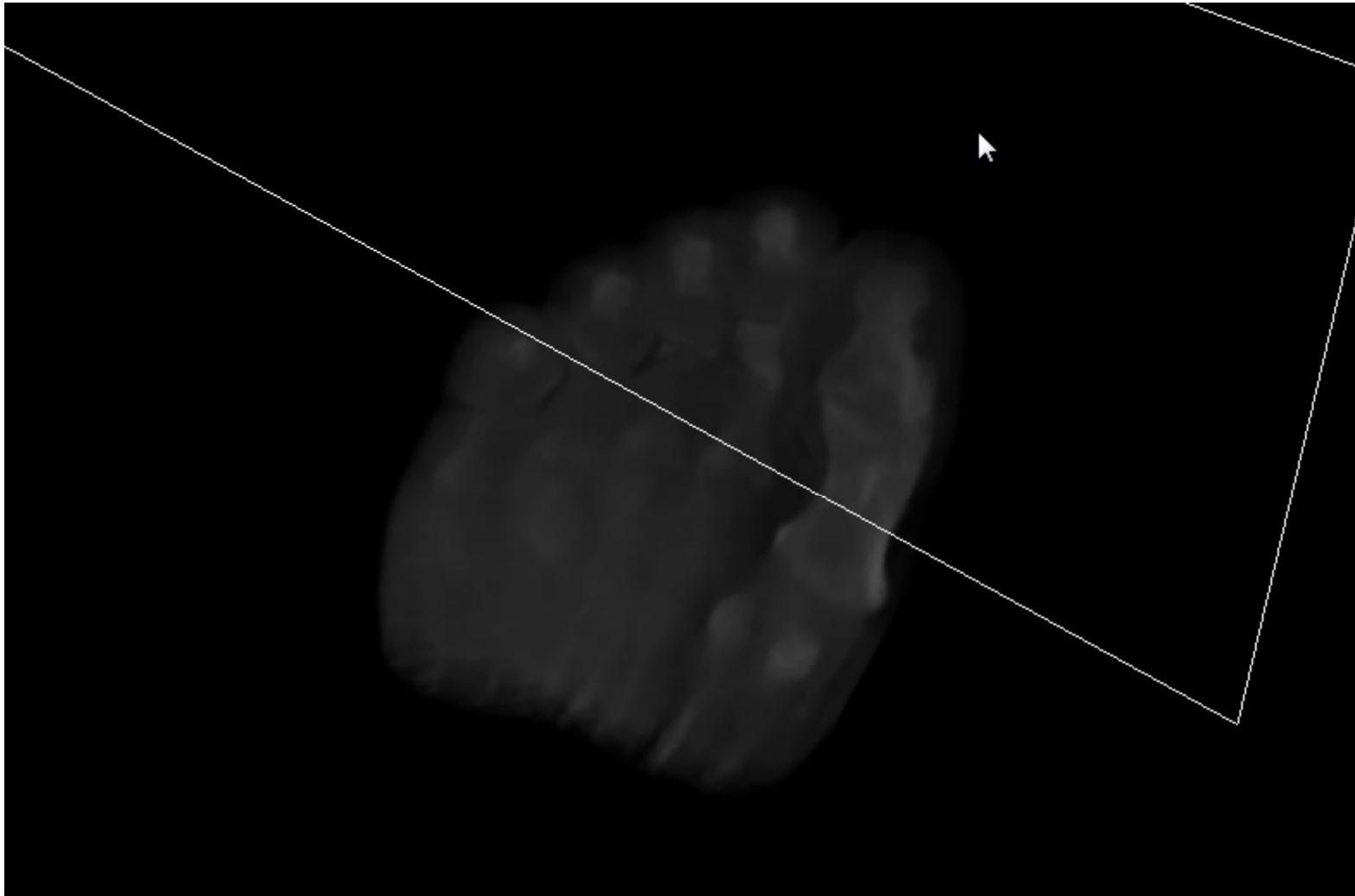
X3D Volume Videos



VolumeRenderStyle : IsoSurface



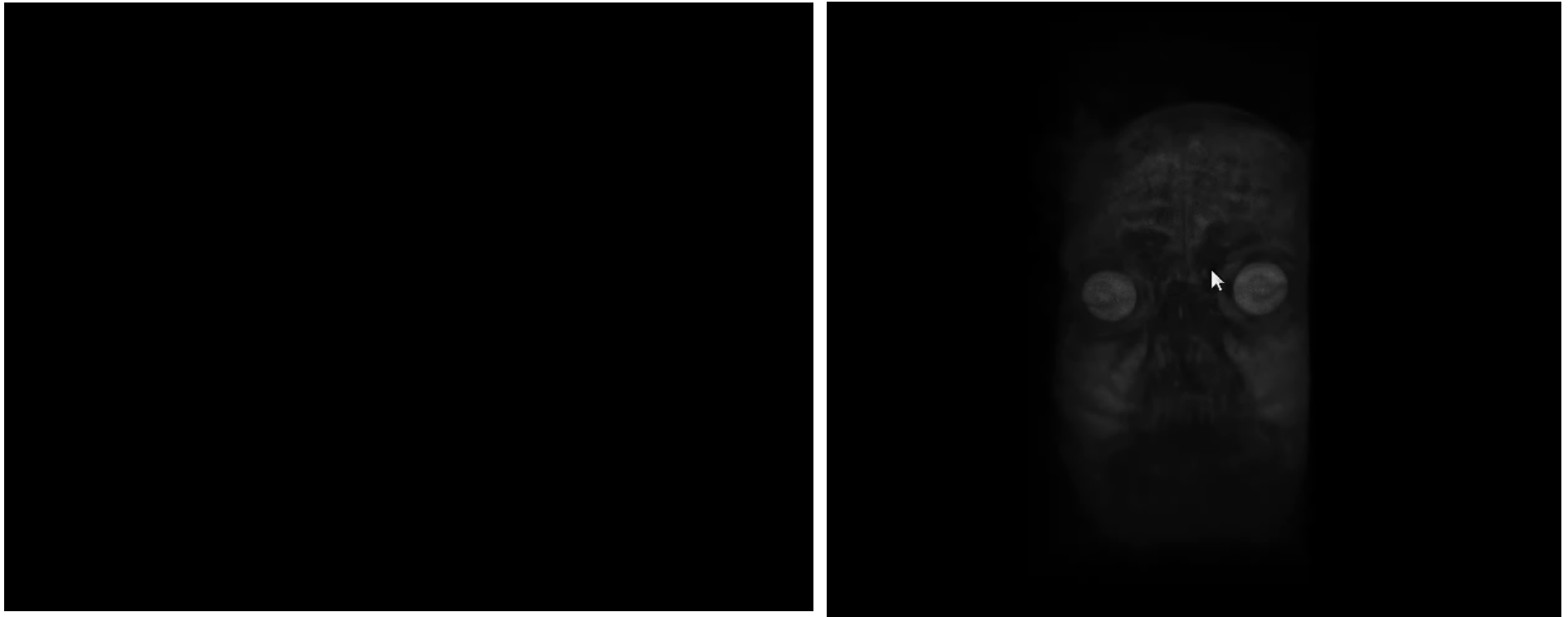
X3D Volume Videos



- ClippingPlane



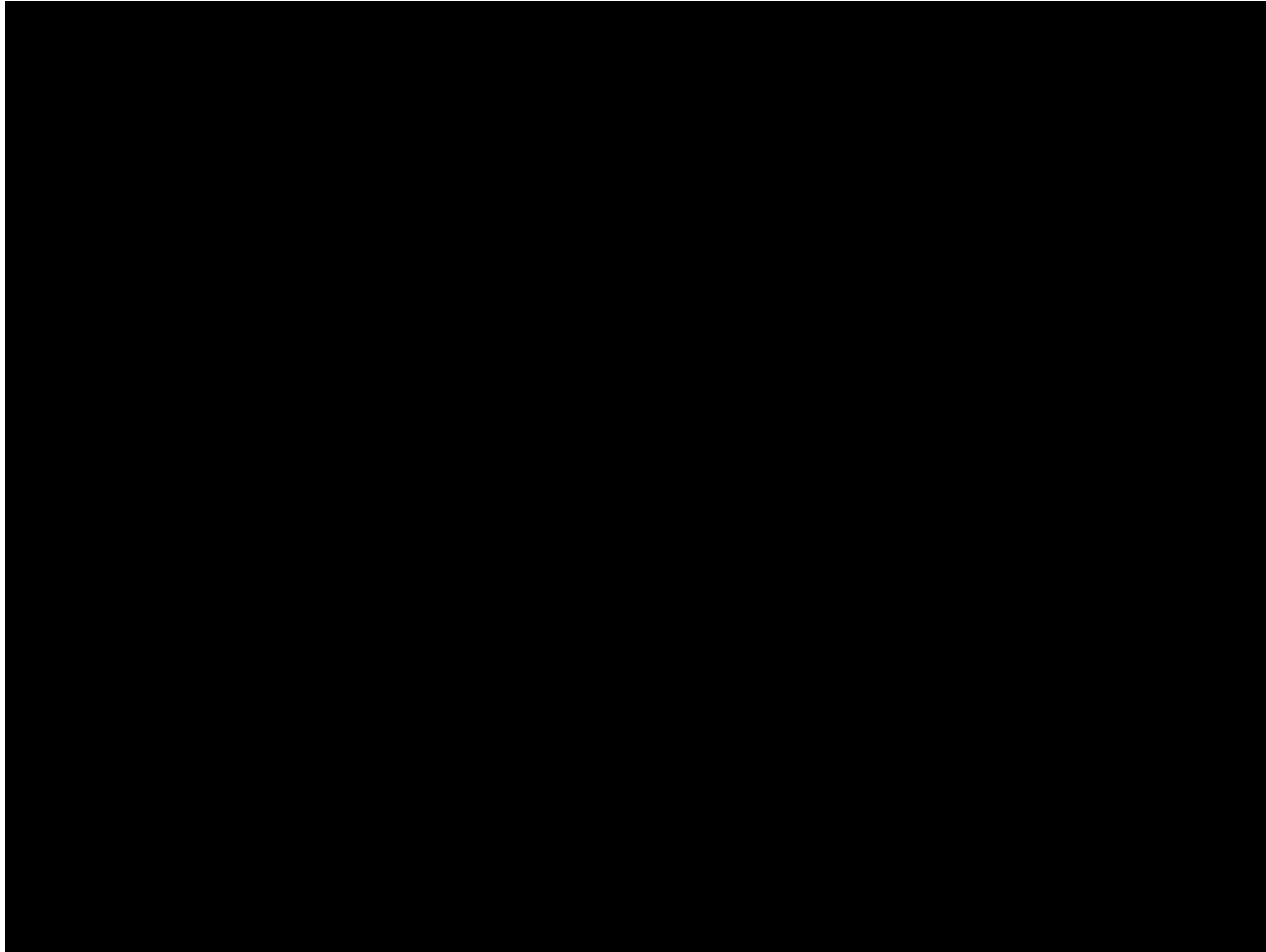
X3D Volume Videos



Segmentations w/ separate
RenderStyles



Videos



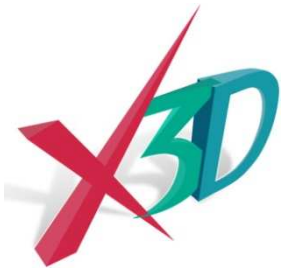
Two Volumes blended together



Example Volume Rendering Style

(Torso example , XML encoding)

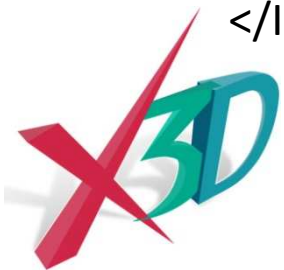
```
<Transform rotation='1 0 0 1.5785'>  
  <VolumeData DEF='volume' dimensions='2 2 2'>  
    <OpacityMapVolumeStyle/>  
    <Image3DTexture containerField='voxels' url='IM-0001-0001.dcm'/>  
  </VolumeData>  
</Transform>
```



Example Volume Rendering Style

(Foot example, XML encoding)

```
<ISOSurfaceVolumeData dimensions='1.28 1.28 1.28' surfaceValues='0.02 0.3'>  
  <ImageTexture3D DEF='vol' containerField='voxels' url='\"../data/foot.nrrd\"'>  
    <TextureProperties DEF='foot_TP' boundaryModeR='CLAMP_TO_EDGE'  
boundaryModeS='CLAMP_TO_EDGE' boundaryModeT='CLAMP_TO_EDGE'  
magnificationFilter='AVG_PIXEL' minificationFilter='AVG_PIXEL'/>  
  </ImageTexture3D>  
  <ShadedVolumeStyle lighting='true'>  
    <Material diffuseColor='0.843137 0.898039 0.607843' transparency='0.37'/>  
  </ShadedVolumeStyle>  
  <CartoonVolumeStyle/>  
</ISOSurfaceVolumeData>
```

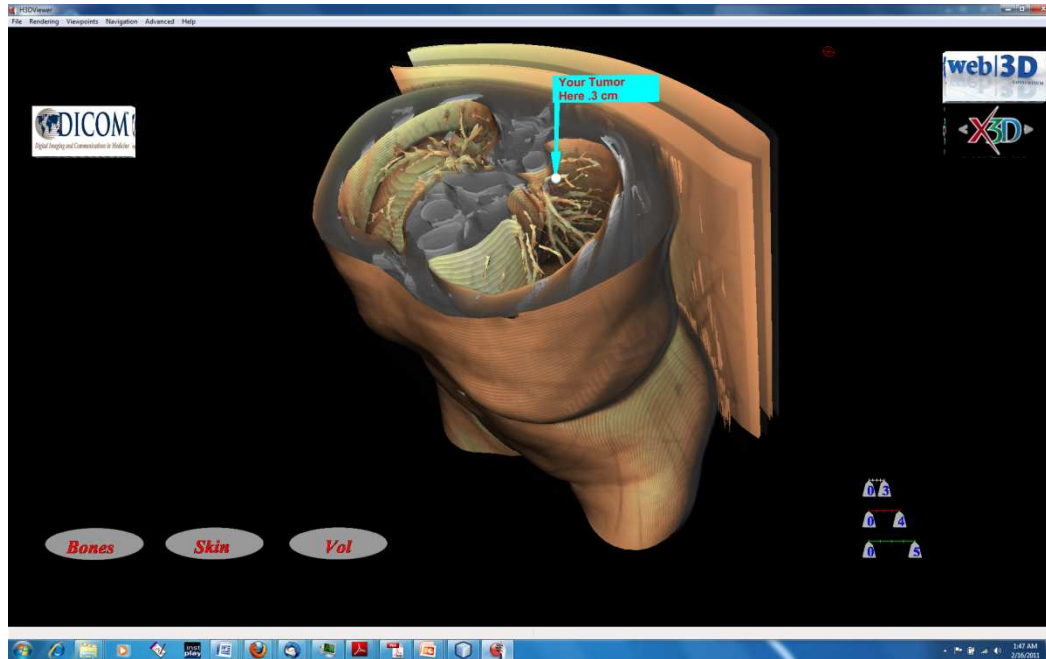


Applications & Requirements

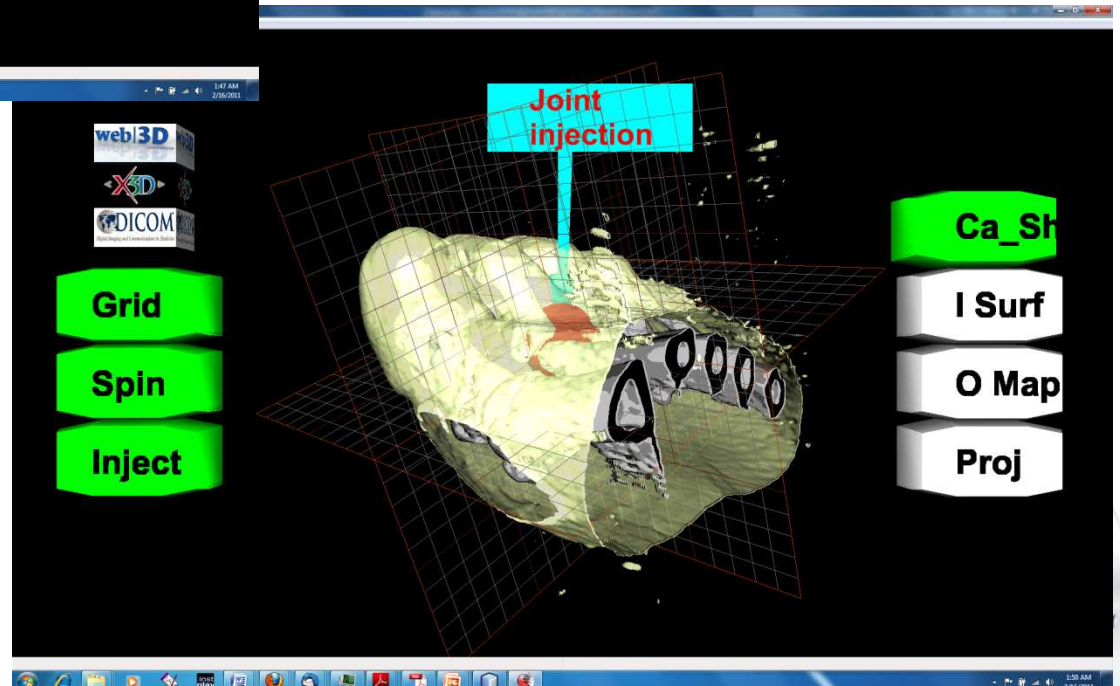
- Most use cases require that polygons and voxels are transformed, colored, lit and rendered together
- Grouping and Metadata (such as FMA, SNOMED) for scene graph nodes is core
- Animations of camera, scene objects
- Interactivity (navigation, picking, direct manipulation)



Example Applications



***Polygons and
Volumes living
together!***



 **VirginiaTech**
Invent the Future



demos

- Show minimal nodeset (footprint)



Specs & Feedback

X3D Working Group and Web3D Consortium membership ratified X3D 3.3 PDAM:

- Currently under ISO SC 24 international ballot
- Publicly available
- Comments open @ Web3D.org:
 - <http://web3d.org/x3d/specifications>
 - http://web3d.org/x3d/specifications/spec_feedback/



X3D and Related Specifications

- [X3D Specifications](#)
- [X3D Schema & DTD](#)
- [Humanoid Animation Draft Specification](#)
- [VRML97 International Standard](#)
- [Previous Versions](#)
- [Reporting Comments on the X3D Specification](#)

X3D International Standards

This Consortium has advanced X3D as an integrated 3D graphics and multimedia framework in the ISO process for Information technology — Computer graphics, image processing and environmental representation. The standards pass through a number of member only and then public review processes, until they reach full ISO approval as international standards. Previous versions of approved specifications may be found [here](#).

Summary of X3D specifications

ISO Name	Common Name	ISO Status	Date Last Updated	URL
ISO/IEC PDAM1 19775-1:2008	X3D Architecture and base components V3 (Change Document)	PDAM	July 2011	.html .zip
ISO/IEC 19775-1.2:2008	X3D Architecture and base components Edition 2	IS	July 2008	.html .zip
ISO/IEC 19775-2.2:2010	X3D Scene access interface Edition 2	IS	Jan 2011	.html .zip
ISO/IEC 19776-1.2:2009	X3D encodings: XML encoding Edition 2	IS	Oct 2009	.html .zip
ISO/IEC 19776-2.2:2008	X3D encodings: Classic VRML encoding Edition 2	IS	Oct 2008	.html .zip
ISO/IEC 19776-3:2007	X3D encodings: Compressed binary encoding Edition 1	IS	Sep 2007	.html .zip
ISO/IEC FDIS 19776-3.2:2011	X3D encodings: Compressed binary encoding Edition 2	FDIS	Jan 2011	.html .zip
ISO/IEC 19777-1:2006	X3D language bindings: ECMAScript	IS	May 2006	.html .zip
ISO/IEC 19777-2:2006	X3D language bindings: Java	IS	May 2006	.html .zip
ISO/IEC 19774:2006	Humanoid Animation	IS	June 2006	.html .zip
ISO/IEC 14772:1997	Virtual Reality Modeling Language (VRML97)	IS	Dec 2003	.html .zip
ISO/IEC 14772-1:1997/Amd. 1:2002	VRML97 Amendment 1	IS	Dec 2003	.html .zip

Specifications

- X3D, Encodings & Bindings
- X3D Schema & DTD
- H-Anim
- VRML97
- Spec Feedback Form

Tutorials, Presentations & Models

- X3D-Edit
- Sample Models

Developer Toolkits & Libraries

Open Source Projects

Xj3D

X3D Working Groups

CAD

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Google Custom Search

Open Standards for Real-Time 3D Communication

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Home » [X3D Developers](#) » [Spec Feedback](#)

X3D Specification Feedback Form

* Required Field
**You can specify either a Section or a URL or both

Submitter Information
Please provide us with your name and contact information so that we can contact you for further details or clarification as necessary.

*Name

*Your Contact E-mail:

*Specification on which you are commenting:
X3D Functional Specification Amendment (ISO/IEC 19775-1 PDAM 2011) ▾

**Section if appropriate
(e.g. 17.2.2.2 Lighting 'off')

**URL if appropriate (be sure to include http://)
(e.g. <http://www.web3d.org/x3d/specifications/ISO-IEC-19775-X3dAbstractSpecification/Part01/components/lighting.html>)

*Comment about the Specification
Please provide any detailed information to help us evaluate your bug report or comments.

X3D Development

- Specifications
 - X3D, Encodings & Bindings
 - X3D Schema & DTD
 - H-Anim
 - VRML97
 - Spec Feedback Form**
- Tutorials, Presentations & Models
 - X3D-Edit
 - Sample Models
- Developer Toolkits & Libraries
- Open Source Projects
- Xj3D
- X3D Working Groups
 - CAD
 - Medical
 - User Interface
 - X3D Earth
 - X3D Networking
 - X3D Conformance Program
 - X3D Shaders
 - GeoSpatial
 - DIS-XML
 - H-Anim
 - VizSim (XMSF)
 - Source
- X3D Conformance Testing



Medical X3D Next Steps I

Through wikis, listerves, and phone conferences, the Web3D Consortium members continue to refine and deliver, targeting:

- ISO FCD text for Volume Rendering Component finalized, ratified and submitted
- Compose X3D nodeset aligning to DICOM requirements
- Define Profile(s) for ISO X3D Medical



Medical X3D Next Steps II

- Medical Working Group continues innovating X3D representations including Haptic meshes (MMVR 2011 paper)
- Leverage X3D Binary Encoding + Security
- Extend WebGL as Volume rendering layer (e.g. X3DOM.org)



Join Us!

www.Web3D.org

X3D Medical Working Group

- **Web3D Consortium** *President*

– *Nicholas F. Polys, Ph.D.,*

Virginia Tech

npolys@vt.edu

- **Web3D Consortium** *Medical Working Group Chairs*

– *Michael Aratow M.D. FACEP,*

San Mateo Medical Center

– *Nigel John Ph.D.,*

Bangor University Wales

- **Sensegraphics.com**

Daniel Evestedt

www.h3dapi.org

