X3D Graphics for Web Authors

Chapter 1

Technical Overview

When we mean to build, we first survey the plot, then draw the model.

William Shakespeare, Henry IV

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Chapter Overview

X3D Significance

- VRML historical background
- Web3D Consortium, X3D Specifications, standards

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- Browsers and scene graph
- Profiles + components, field and node data types
- XML encoding, ClassicVRML, Compressed binary

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Chapter Overview

Overview: Technical Introduction

This chapter provides a broad overview of how X3D graphics is designed and implemented

- Goal is to provide quick coverage of many features

For newcomers to X3D, a quick read is sufficient

- Getting started building models in Chapters 2 and 3 is more important that understanding every point
- Can review again later to reinforce concepts

Details found in Chapter 1, *X3D for Web Authors*

- This chapter is available free online

X3D Significance

What is Extensible 3D (X3D)?

X3D is a royalty-free open-standard file format

- Communicate animated 3D scenes using XML
- Run-time architecture for consistent user interaction
- ISO-ratified standard for storage, retrieval and playback of real-time graphics content
- Enables real-time communication of 3D data across applications: archival publishing format for Web
- Rich set of componentized features for engineering and scientific visualization, CAD and architecture, medical visualization, training and simulation, multimedia, entertainment, education, and more

Historical background: VRML

Virtual Reality Modeling Language (VRML) began in 1994, seeking to create 3D markup for Web

- Numerous candidates considered by an open community of interested practitioners
- SGI's OpenInventor won the initial competition
- VRML 1.0 developed over the next year
- VRML 2.0 restructured some nodes, added features

VRML advanced to International Standard 14772 by ISO in 1997

- Accomplished by individuals and companies cooperating together openly

Web3D Consortium

Web3D Consortium founded in 1998 to protect, support and advance the VRML specification

- http://www.web3D.org

Continued efforts on new technology by multiple working groups led its successor, X3D

- http://www.web3D.org/x3d

Non-profit organization of many stakeholders ensures that X3D remains royalty free, relevant

- Partnership of industry, agency, academic and professional members

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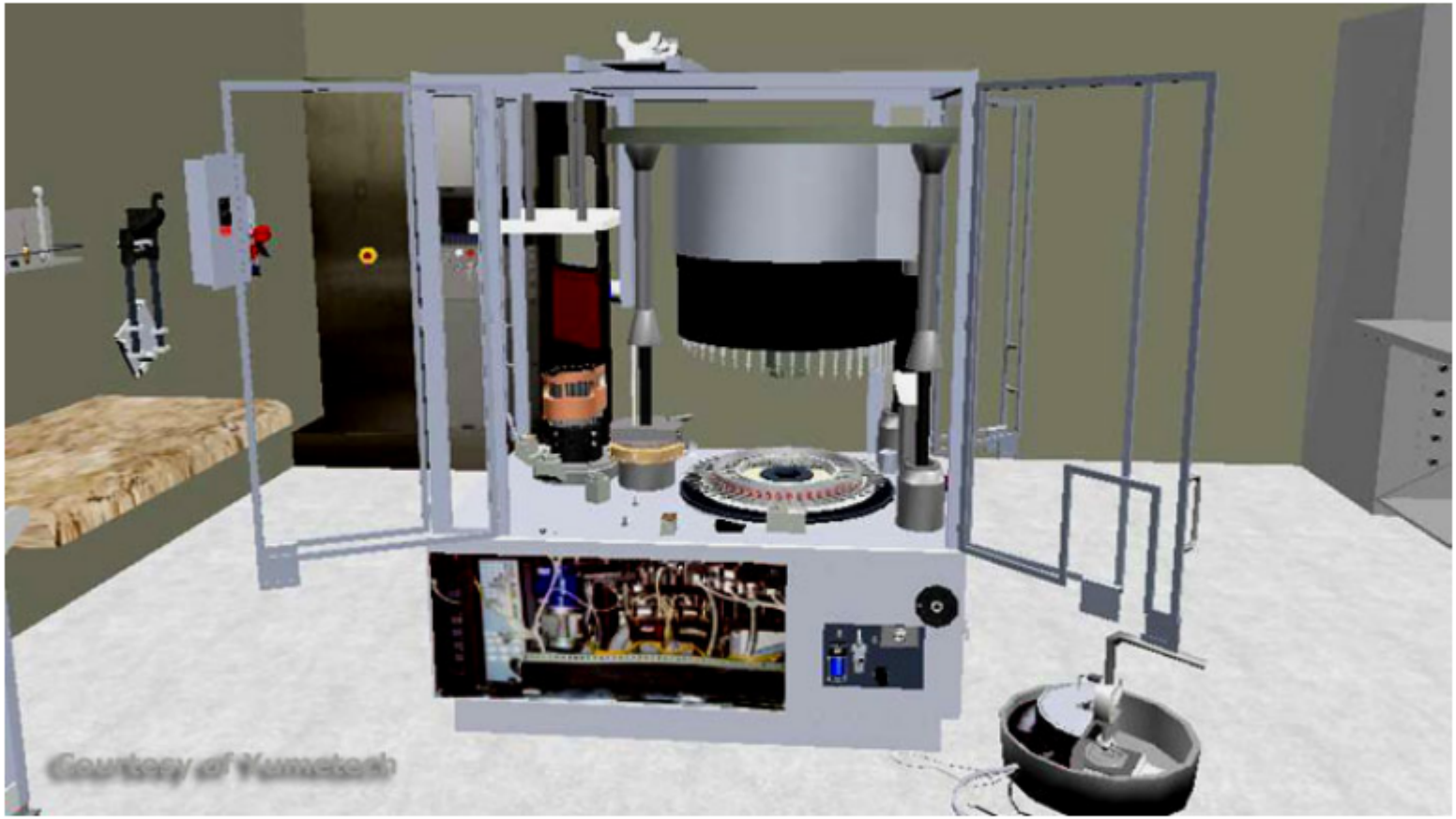

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The New Paradigms of Scientific Visualization

Jun 10, 2010 The COLLAVIZ project team has organized a workshop on 16 June, 2010 from 9:00 AM to 1:00 PM at the TER@TEC 2010 conference to discuss New Paradigms of Scientific Visualization. Web3D consortium's Dr. Johannes Behr, Fraunhofer, Germany will present the X3D interchange format as one of the Scientific Visualization Norms and Standards.
As a real decision-making support tool, scientific visualization faces new paradigms. With scientific tools multiplication and their respective evolutions, questions regarding 3D exchange formats norms have risen and must be addressed. X3D, Collada or VRML are examples (among many others) of formats offering different perspectives to different users.The COLLAVIZ project is developing a remote collaborative visualization framework, aiming at giving access to visualization through a simple Internet connection. It already integrates applications such as Ensight or Paraview, allowing the exploitation of the results in a collaborative mode in fields relative to fluids dynamics, biochemistry or geophysics, etc.

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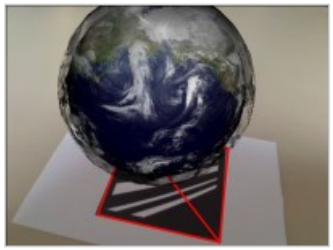
AR in a box – An X3D solution



May 31, 2010 The Web3D Consortium will be presenting at the ARE2010 Augmented Reality Event, taking place June 2-3, 2010 - Santa Clara Convention Center, CA.
The Web3D consortium will have a special interest group meeting in Room 204 on June 2 from 1:30 PM to 3:30 PM with AR application developers and industry leaders interested in using open standards. Come see our AR heroes

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Virtual Santiago de Compostela in X3D Octaga Player

The hearth of the important Spanish 9th century medieval pilgrimage route, Santiago de Compostela, is now available to the general public in 3D using the X3D Octaga Player. The Spanish multimedia company Dualmultimedia in Barcelona has done extraordinary work in modeling and recreating the ancient cultural and religious center. Dualmultimedia has a web distribution license from Octaga, enabling all visitors to use a full version of Octaga Player for interactive 3D viewing.

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X3D a write once, render anywhere, anytime 3D graphics format.

Dec 28, 2009 X3D a write once, render anywhere, anytime 3D graphics format for HTML 5.

As W3C is working on adding support for 3D in HTML 5, the Web3D Consortium's X3D-HTML5 Working Group is working closely with W3C presenting their thoughts and ideas on how to integrate X3D and HTML. The goal here is to have a DOM-integrated cross-platform open-standards 3D graphics in every browser. X3D is an abstracted graphics format; as long as the underlying OS and hardware supports some form of pixel display, X3D can be rendered on it. Whether your device uses one of the Direct-X graphical libraries, one of the continually evolving series of OpenGL versions, or some as-yet unwritten low-level graphics layer, X3D will be able to render on it, and if that device contains user i/o capabilities, X3D will be able to use that capability, too.

For more details on now X3D and HTML5 will fit with other 3D technologies please read the recent 3d-test interview with Web3D's X3D-HTML5 Working Group chair John Stewart at: http://www.3d-test.com/interviews/x3d_2.htm.

Demonstration with event passing to/from the HTML DOM using the X3DOM are available at: http://www.x3dom.org/?page_id=9. X3DOM is an experimental open source runtime, implemented in JavaScript and WebGL, which allows to inline X3D content in (X)HTML pages. It performs the current HTML5 specification for declarative 3D content and allows including X3D elements as part of any HTML5 DOM tree.

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Interactive Avatars with X3D

BS Contact a 3D real-time renderer from Bitmanagement enables online users to interact with an avatar acquired using a Web camera and X3D technology for real-time animation. Instead of rendering batch-jobs for a long time (e.g. days in some film productions with mainframe computers) the animation is rendered and presented with more than 30 frames per second on standard client computer of the user. The geometry and textures of the avatar – the 3D mesh – can be exported from standard graphic tools like 3ds max or blender to X3D.

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3D content for a lifetime: The 14th Web3D Symposium celebrates milestone of innovation & durability

May 20, 2009 The fourteenth annual International Web3D Symposium, to be held at Fraunhofer IGD in Darmstadt, Germany from June 15-17, 2009, will celebrate a decade of innovation and interoperability through the Extensible 3D (X3D) Standard.

The Symposium will showcase Web3D Consortium's standard X3D, the only open, royalty-free and ISO-certified technology available today for interactive 3D graphics on the World Wide Web. Use of X3D systems has increased steadily throughout the world, delivering durable applications in industry, science, medicine, culture, entertainment and education. Indeed, worlds and scenarios authored over ten years ago still run today and are faster than ever.

X3D systems have a proven track record of protecting content and have the process in place to support projects that require their content lifetime to exceed 50 years. Because X3D is a direct evolution of Virtual Reality Modeling Language (VRML), there are models over a decade old that run in the newest X3D players. It is not necessary to excavate the original 3D players to run that content. The business value - the virtual world content - survived, and the investment was protected. The open nature of the Web3D languages protects the content and the rights of the business.

Come see these innovative X3D systems and learn how to protect your 3D content investment for a lifetime. To register for the 2009 Web3D Symposium please visit: http://www.web3d2009.org/registration. X3D systems will also be demonstrated at SIGGRAPH 2009 in New Orleans, USA. Join the Web3D Consortium and become a part of this evolving standard.To join, visit us at: http://www.web3d.org/membership/join.

X3D_for_a_Lifetime_Press_Release.pdf

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CAVE Immersive experience with up to 75 % reduced cost and online testing

Many big companies today are using Cave Systems, which offering many advantages for instance in CAD development, design and simulation of logistical processes. Whereas the technology has been already established, most of smaller companies do not benefit from advantages due to high costs of cave.

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Player and Tool support for X3D components

Feb 10, 2009 The Extensible 3D (X3D) Graphics standard has many capabilities. X3D components are modular collections of nodes that make it easier for software to gradually implement the full range of X3D capabilities. Authors can also indicate what components are needed in an X3D scene in order to ensure that proper support is provided at run time.
The Player table records support for the official X3D components by each of the various X3D Players.
The Tool table records support for the official X3D components by each of the various X3D authoring tools and X3D conversion tools.

These tables are maintained by the X3D Working Group and member companies in the Web3D Consortium.
The X3D Resources page also provides lots of additional information about X3D.

Please Contact Web3D Consortium if you want to learn more or report an update.

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X3D-Earth Working Group Meeting - Call for Participation

Feb 07, 2009 Web3D Consortium members are cordially invited to participate in our next X3D Earth Working Group meeting, to be held at the Monterey Bay Aquarium Research Institute in Moss Landing, California on Thursday and Friday, March 5th and 6th 2009. Attendance is open to Web3D Consortium Members, and invited guests,

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Coperion 3D - A Virtual Factory on the Tabletop

The Coperion Group is planning and producing plants and systems for the plastics industry. The presentation at Coperion's booth at K Fair in Dusseldorf consisted of Fraunhofer IGD's multi-touch table and an impressive 8-meter wide high definition projection mirroring the table's image. With this application Coperion demonstrated their core-competencies to the markets and complex processes in a plant for bulk material handling via Virtual Reality. InstantPlayer and InstantCluster were used to render the interactive real time 3D visualisation.

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3D virtual spaces and direct manipulation in the classroom

Jan 05, 2009 The Edusim project is bringing 3D virtual learning environments into the classroom by leveraging Open source Cobalt and the classroom interactive whiteboard for direct manipulation of 3D virtual learning worlds. Edusim is a slimmed down verion of the core Open Cobalt Metaverse Project. Cobalt - Edusim is a 3D multi-user virtual world platform and authoring toolkit intended for your classroom interactive whiteboard (but equally powerful on the students laptop or desktop computers !). Cobalt - Edusim has been tested and works on the Smartboard, Activeboard, Interwriter, Polyvision, Mimio, eBeam, and even the Wiimote Whiteboard. Edusim is extendable allowing multiple classrooms to connect their interactive whiteboards for collaborative learning session.

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H3DAPI version 2.0 released

Dec 10, 2008 SenseGraphics is proud to announce the availability of SenseGraphics H3DAPI version 2.0. SenseGraphics H3DAPI is used for the development of simulator- and other multi-modal applications using force-feedback devices from SensAble, ForceDimension, Moog and Novint. Since its introduction to the public in 2005, the H3DAPI has been used by companies, universities and research institutes to create or add the simulation of touch to their applications. Built on the industry standards OpenGL and X3D, H3DAPI enables rapid application development using X3D and Python alone. More major projects have been developed by extending H3DAPI capabilities with C++. The improved H3DAPI 2.0 now builds on the haptics engine HAPI which grants users more freedom and control in haptics rendering. Users can choose from more haptics renderers, including SensAbleâ s OpenHaptics, Chai3D, and H3D point and sphere-based renderers.

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Web3D Consortium In Singapore

Web3D Consortium is announcing its first SIGGRAPH Asia 2008 participation (Dec 10-13) in Singapore.
Web3D Consortium will extend the horizons of innovation and excellence in 3D graphics to the Asian community. This year the consortium celebrates its 10th anniversary with a bigger presence in the 3D graphics industry. Visit them in the Machinima Booth #D12 and see the progress of this evolving standard and X3D/VRML innovations. While in Singapore Web Consortium will also be presenting at VRCAI 2008, National University of Singapore, Nanyang Technological University and Machinima Symposium.
Come visit us in Singapore and find out how you can use X3D for your real-time 3D graphics needs! A week full of events showcasing X3D technology.
VRCAI - Dec 8-9
NUS and NTU - Dec 9
SIGGRAPH Asia conference - Dec 10-13 - Booth #D12
SIGGRAPGH Asia Web3D Tech Talk = Dec 11, 4:00 to 6:00 PM
SIGGRAPH Asia Tutorial "X3D for Authors" - Dec 13 - 1:00 to 4:00 PM
Machinima Symposium - Dec 13 - 10:00 AM to 12:00 Noon

More information available at: Web3D in Singapore.

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Is a 3D web more than just empty promises?

Oct 16, 2008 VRML veterans like, Web3D Consortium member Tony Parisi last month marked the tenth anniversary of the language's first commercial implementation. And after a decade of waiting for a computer graphics Godot, they're used to encountering scepticism when they herald the imminent emergence of Web 3D.

Bodies littering the Web 3D landscape include that of Microsoft's Chromeffects effort (shelved in 1998), Adobe's Atmosphere title (killed in November), and Intel and Macromedia's joint venture to popularise Shockwave 3D on the Web (which dissolved along with other Intel Web 3D alliances).

In 10 years of turmoil and tried patience, both VRML and Parisi have changed. VRML, after achieving ISO standardisation, in recent years has been reborn, under the auspices of the Web3D Consortium, as an XML-based ISO standard called X3D. Parisi has kept the Web 3D religion with a San Francisco start-up called Media Machines now (Vivaty), whose clients include the US Navy and Joe Firmage's ManyOne portal.

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Reality To Go: 3-D Virtual Reality On Mobile Devices

Oct 13, 2008 If mere texting, talking, e-mailing and snapping pictures on mobile devices aren't enough to satisfy your data cravings, now there's the prospect of accessing and displaying 3-D virtual reality simulations and animations on them. New information architecture from researchers in Offenburg, Germany puts 3-D visualizations in the palm of your hand to make this possible.

By devising a novel information and communication architecture with optics technology, researchers created a new approach based on outsourcing to servers all

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Bitmanagement visualizes automatically constructed 3D cities on the web with BS Contact GEO

A quality leap hand in hand with a substantial cost reduction can be realized today in the 3D city model domain. Textured 3D models of complete cities at a resolution of 4 inch (10 cm) per pixel can be constructed automatically within days and visualized with the highly performing BS Contact GeoVRML/X3D viewer interactively on the web. 3D city models can be used integrated in many applications ranging from online search engines to embedded automotive navigation- and entertainment systems.

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Octaga announces new version of X3D/VRML viewer

Aug 15, 2008 Octaga, provider of visually stunning realization software and services to over 1 million users, announce the launch of a new version of their X3D/VRML viewer, Octaga Player 2.3 (beta). This new and improved version of the software is promoted at SIGGRAPH in connection with the Web3D Consortium, where the attendees will be among the first to experience the new Octaga Player. Octaga has provided leading edge 3D realization software since 2001, and since its inception Octaga software has gained over 1 million users in industries utilizing X3D/VRML & CAD data, including the AEC, MCAD and Oil & Gas markets.

Octaga Player 2.3 (beta) supersedes and includes all the functionality of Octaga Professional. However, and remarkably, Octaga player is still a free 3D viewer. Designed to comply with industry standards, Octaga Player offers a multiplatform solution with unrivaled functionality for X3D/VRML users. Octaga Player 2.3 boasts a new engine, a new and improved GUI and redesigned navigation for a smoother user experience. In addition it includes many new 'GO PRO' features, such as video rendering, the = ability to create and export viewpoints and walkthroughs. Octaga Player 2.3 will also serve as the free CAD viewer for models from Octaga's flagship product, Octaga Enterprise.

Octaga Player can be seamlessly integrated in web pages, as well as in PDF and Microsoft Office documents. You can find more information here.

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Web3D TECH TALK at SIGGRAPH

Aug 13, 2008 Take a break from the show floor and come to our TECH TALK, today (Aug 13) at 3:30 pm in HALL G Room 1, followed by a X3D raffle drawing and reception.

See our X3D innovators show off their latest real-world 3D applications and content, and find out how you can use X3D for your 3D graphic needs. Collect your own DVD with X3D Resources and start creating X3D Content NOW!

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METAIO brings Web3D innovative technology to E-commerce using Bitmanagement's BS Contact

Augmented reality and interactive Web3D innovative technology brings a whole new dimension to E-commerce, superimposing products directly on to a photo of the shopper's personal environment, on the right scale, appropriate to context and interactively.
As Internet shopping becomes increasingly popular, the number of products, services, product variants and suppliers are growing too. This makes it more and more confusing for shoppers and harder for sellers to stand out from the crowd. But it is possible using Web3D technology.
This is where augmented reality and interactive Web3D comes in. This innovative technology brings a whole new dimension to E-commerce, superimposing products directly on to a photo of the shopper's personal environment, on the right scale, appropriate to context and interactively. Let's say you want to buy new furniture. With augmented reality you can see how it looks in your home alongside your existing decor and try out different combinations of colours and variants before you make a purchase. This product is developed by Metaio based on BS Contact of Bitmanagement

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Interoperability and Open 3D Standards for Earth visualization: "The X3D-Earth Project"

May 02, 2008 On May 12th, the Laboratory of Integrated Systems (LSI) of the Polytechnic School of the University of São Paulo (EPUSP), Brazil will host an Interoperability Forum in Open-Source 3D Technologies and will present an overview of X3D-Earth. This 3D Interoperability forum is an international event focusing on topics of strategic and technological importance. The event congregates national and international guests and partner entities, featuring keynote speaker Don Brutzman from the Naval Postgraduate School in Monterey, California.

The main goal is to present the current State of Art in Open Source for 3D Interoperability for discussion in international groups of standardization like the Web3D Consortium an Open source 3D standards for interoperability. The intention is to promote interest in the use, development and research of open source using the X3D open format. The objective of the X3D-Earth working group is to define a set of standards and norms for an international system of 3D globes for visualization.

The X3D-Earth project intends to create an infrastructure of open and extensible standards to visualize in three dimension objects from the real world, adding information constructs in a geospatially referenced context. The possibility of integration of the archives of models using commercial and public domain tools will guarantee that the 3D content remain accessible, usable and valid for many years.

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Open Standards for Real-Time 3D Communication

March 2008

Featured Case Study
ALIVE, University of Southern Queensland - The Phoenix Challenge

ALIVE created "The Phoenix Challenge" using Flux Studio, Maya and Rawkee and implemented Ajax3D to keep track of the player's score and to interact with their database of objects. The player's objective is to make their way around the campus picking up objects which affect their STRENGTH, SMARTS and STRESS. There is a time limit to complete each level. X3D provided the ability to create a browser based game which students can find by following a URL and after installing the Flux Player, do not require other software on their system and can view other X3D scenes the ALIVE team create. The game can be played by visiting http://www.alivex3d.org/challenge Viewers can access this password protected game with the username: guest and the password: guest

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Media Grid to Take Education Across the Virtual World--and the XO

Feb 02, 2008 Media Grid recently announced its plans to roll out a cross-platform, immersive world for education for academics, students, and trainers everywhere because 3D environments need to provide a 3D educational perspective. After experimenting with VRML, the Unreal Engine, and other tools since 2001, the organization realized that it needed to begin looking beyond simply one platform. It formed the Immersive Education Initiative and looked for options. They looked at all the platforms that were available and arrived at the first three systems. Second Life, which is open source on the viewer; Sun Microsystems' Wonderland; and Croquet, an open-source educational environment created by Duke University. The thrust of the initiative was to get a product out as quickly as possible that is adaptable for ongoing upgrades. That involves establishing not only a user interface that's consistent across the three platforms, but a way to recognize assets for teaching tools, host them, and make them available for use in any environment. The Education Grid will be populated by file formats that can be read by existing forms and will have educational grid assets for Second Life and X3D for Wonderland and for Croquet. Read more

Category: | Permalink

New update to X3D-Edit

Feb 02, 2008 The National Postgraduate School (NPS) team has produced another update to X3D-Edit, a new authoring tool for simple error-free editing, authoring and validation of X3D scenes. The latest weekly build includes collaboration chat with file sharing, the complete set of X3D specifications, a new X3D Example Archives download panel, and an updated Xj3D viewer. Free download is available at X3D-Edit
In addition to being available as a cross-platform standalone application, X3D-Edit is now listed in the Netbeans Plugin Portal.
Public or private evaluation comments are welcome.

Category: | Permalink

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Virtual Worlds Today: A reality distortion field in the making?

We would like to thank all visitors to the Web3D booth at Siggraph!

Is Siggraph now Hollywood's version of E3?

Web3D Executive Director's Summer and Siggraph 2007 Update

Some tips for getting around on Web3D.org and getting your questions on X3D answered

View all blog entries

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The game can be played by visiting http://www.alivex3d.org/challenge
Viewers can access this password protected game with the username: guest and the password: guest

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Fraunhofer IGD releases Beta4 of the InstantReality System

Jan 21, 2008 Included in this release are the following new and/or improved features along with minor and major bugfixes.

- One of the first (alpha/ beta) implementations of the X3D Med/ VolumeRendering Component specification.
- The GPU based ray-caster allows to visualize volume-data very efficiently.
- Faster and more robust automatic optimization of static subtrees.
- Improved support for StaticGroup and Inlines of static data
- Improved cluster synchronization mechanisms. It is now much easier to setup a stereo wall or even a CAVE
- Improved cluster performance, especially if local and remote windows are used.
- Multi-touch extensions for all PointingSensor-nodes
- Geometry Shader extensions for the shader node-sets. Only available on graphics wahardre with Shader Model 4.0 (e.g. NVidia 8x).

The new labs section of the web-page http://www.instantreality.org/labs provides documentation, tutorials and neat tools to convert classic/xml data.

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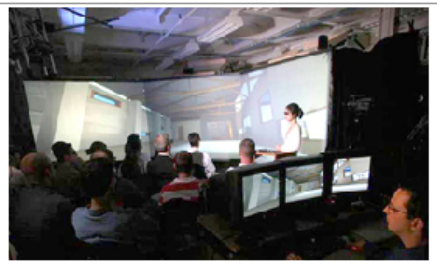
January 2008



Featured Case Study

Penn State to visualize cave with VRML/X3D based software

Penn State has developed cave applications, targeting to facilitate the effective use of virtual reality (VR) techniques in design, construction and other disciplines. The aim was to develop immersive environments, where users can study all kinds of designs for different ranges with special visualization techniques.Penn State opted for VRML/X3D- based standard software, BSContact Stereo from Bitmanagement. More PR

The core technology of the cave applications is the 3D visualization software. BS contact Stereo software, completely meets the requirements of a high quality stereoscopic rendering, which is essential to create a fully immersive environment. BS Contact Stereo is also an interactive, real time and internet ready software, which above all showing the stereo effect without special eyeglasses.

These are visualization systems with two, three or more ceiling high projection walls, which obtain a realistic three-dimensional impression. The stereoscopic effect is generated by two projectors in each wall. Each single wall is synchronized with all others, whereby the position of the watching person is covered by a tracking system, so that the watchers point of view is adapted to his or her respective location and accordingly to his or her moves. By the immersive perception - the stereoscopic 3D view - product can be analyzed virtually, but with visible depth effect.

Read more

Latest Web3D News

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Bitmanagement Announces the Release of VRML/X3D Viewer BS Contact 7.1.

Dec 22, 2007 Bitmanagement announces the release of VRML/X3D viewer BS Contact 7.1., and BS Collaborate Multi-User Server.

The BS Collaborate server is based on Web3D's proposal for the Networking component (networkSensor). These nodes allow VRML/X3D scenes to connect to arbitrary servers or directly link between two VRML/X3D players. With these nodes one can manipulate virtual objects collaboratively in real time.

Highlights of this new release:
* BS Contact, with it's new BS Collaborate Server, now supports virtual worlds in which multi-user avatar functionality can be utilized.
* BS Contact is now "multi-lingual", it supports not only the standard web3D formats X3D and VRML but also COLLADA.
* BS Contact is now interfaced to the high-speed Ageia PhysX engine as well as ODE, to aid in the visualisation of realistic simulations.
* BS Contact now enables the use of Flash in 3D applications with transparency.
* BS Contact with it's new automated installation mechanism is noticeably easier to load and start.

Many of these new features open the door for more applications and allows users to capitalize on the current trend towards interactive virtual worlds. You can download a test version at: http://www.bitmanagement.com/download/playerdownload.en.html

http://www.bitmanagement.com/documents/Pressemappe/BS_Contact_7.1_E.pdf
http://www.bitmanagement.com

Category: Applications | Permalink

SIGGRAPH 2007 - Web3D's "Tech Talk" Podcast Now Available

Dec 19, 2007 SIGGRAPH 2007 - Web3D's "Tech Talk" Podcast

Featured Case Study

Fraunhofer demonstrates largest Stereo-Display to run full X3D Content

The Fraunhofer IGD provides a new cluster application deployment solution which allows X3D content to run on computer clusters without changes. An application developer can now build a high level interactive 3D application utilizing the full immersive profile of the ISO standard X3D including PointingSensors and Scripting.

Read more

September 2007

Latest X3D News

Submit News

New Version of River of Life Is Available

Sep 12, 2007 A new version of River of Life has been posted at this link . Please feel free to test this new version.

There are usually some problems with a fresh release (caps in titles, etc.). If you load the world and find these, please post them to Len Bullard's blog at the link above. This world is encoded in VRML97. It will be converted to X3D once this version works.

Note that the world was built by hand using the BitManagement BSContact browser. It has not been tested on other VRML browsers lately. If you do, let Len Bullard know how that it goes. The worlds have been through Chisel and are error free to the best of his knowledge. There are still warnings and non-conformance messages given the tight restrictions of Chisel, but other wise it runs.

One favor: please don't pilfer the sound files. Those are samples under fair use and this is a not-for-profit world. All of the artists are listed in the credits.

Category: Applications | Permalink

The compressed binary encoding was approved by ISO/IEC!

Aug 06, 2007 Good news! It is now official, The compressed binary encoding was approved to be an IS.

X3D Specifications

X3D graphics is defined by a set of specifications

These "specs" are developed by working-group volunteers as part of the Web3D Consortium

- Nonprofit organization with business, nonprofit, academic and professional members
- http://www.web3D.org
- Efforts include editing, implementing and evaluating

Specification results reviewed and approved by International Organization of Standardization (ISO), online at http://www.iso.ch

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Why is a 3D standard important? 1

There are many types of 3D graphics engines and plugins available. Best known:

- Computer graphics games
- Animated movies

Well-kept secret: these are rarely interoperable

- Example: no 2 experts can run the other's demo

"Silly" question: hey, let's mix 2 games together!

- ... why should adding models together be so hard?
- Proprietary software actively prevents such mergers
- Interoperability over Web can change all that

Why is a 3D standard important? 2

Web standards let different companies do what they do well, then interoperate together

- Today there are many small islands of functionality
- Tomorrow might bring a much bigger playing field for 3D graphics to work with

A shared Web is good for everyone

- Business, public, government, universities
- Best practices emerge
- More information, more connectivity, more progress
- "A rising tide lifts all boats"

Interoperability - what's the difference?

Multiple paths, but often confused as equal

Standard: proven process for content interoperability, scalability, compatibility, licensing, growth, success

Specification: Algorithm descriptions, necessary detail

- But: might hide royalty problems, such as GIF imagery debacle in 1990s

Open source software: pile of (maybe repeatable) code

- But: usage licensing is not same as source-code licensing

Market share dominance: biggest competitor wins?

- Companies (or at least investors) hope to "own" 3D
- But: many defunct companies, dead-end technologies
- Everyone ends up with much smaller market than the Web

Equivalent X3D encodings, APIs

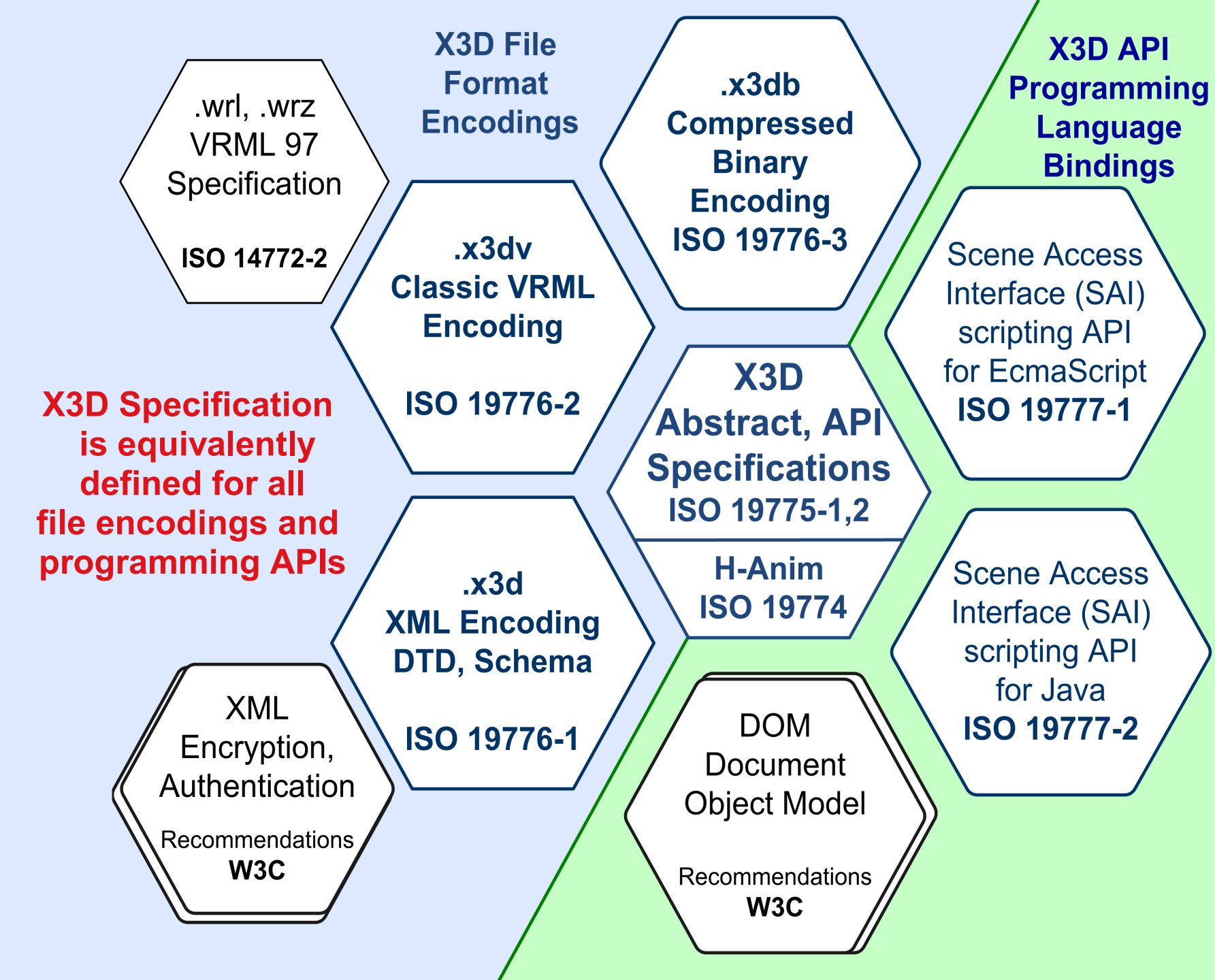
X3D has multiple file-format encodings

- .x3d is XML based
- .x3dv is ClassicVRML syntax
- .x3db is Compressed Binary Encoding with both geometric and information compression

X3D has multiple application program interfaces (APIs) with similar structure

- Javascript (formally known as EcmaScript)
- Java (optionally supported)

All these forms have equivalent functionality


X3D File Format Encodings
X3D API Programming Language Bindings
.wrl, .wrz VRML 97 Specification
ISO 14772-2
.x3db Compressed Binary Encoding ISO 19776-3
.x3dv Classic VRML Encoding
ISO 19776-2
Scene Access Interface (SAI) scripting API for EcmaScript
ISO 19777-1
X3D Specification is equivalently defined for all file encodings and programming APIs
X3D Abstract, API Specifications
ISO 19775-1,2
H-Anim
ISO 19774
.x3d XML Encoding DTD, Schema
ISO 19776-1
Scene Access Interface (SAI) scripting API for Java
ISO 19777-2
XML Encryption, Authentication
Recommendations
W3C
DOM Document Object Model
Recommendations
W3C

Reading the X3D specification

The X3D Specification is highly detailed, primarily written for 3D graphics experts.

Requirements must be described as strictly and precisely as possible so that X3D browsers can be implemented consistently. This precision means that X3D content is more likely to render and animate correctly.

Nevertheless the X3D specification is a great learning resource for additional graphics details. It is also the authoritative reference for questions.

Specification availability

The X3D specifications are online at

- http://www.web3d.org/x3d/specifications
- also embedded in the X3D-Edit help system

The X3D specifications are published by the Web3D Consortium and International Organization of Standardization (ISO)

- Web3D versions are published in HTML for free online
- ISO publishes .pdf versions and requires purchase

Feedback on X3D specifications is always welcome

- http://www.web3d.org/x3d/specifications/spec_feedback

Community rules

Thanks to an open process, IPR-protection rules and steady innovation by Web3D members, new X3D features continue to evolve and grow into great capabilities

Lots of working groups have formed, worked, faded, regrouped and succeeded

Web3D members and public mailing lists still keep these successes building, year after year

ISO and X3D

Implementation, evaluation and then formal review by the International Organization of Standardization (ISO) have made X3D an approved standard for real-world use, both on and off the Web.

Experts from 12-15 nations review our specs.

Immediate adoption by other governing bodies helps to increase deployment.

Nevertheless all changes and additions originate within Web3D working groups.

W3C

Further collaboration by Web3D Consortium with the World Wide Web Consortium (W3C) has made X3D a "first-class citizen" on the Web, providing excellent (and growing) interoperability with other XML standards.

More work (especially more volunteers) needed, some excellent individual opportunities here.

W3C WORLD WIDE WEB consortium

Leading the Web to Its Full Potential...

Activities | Technical Reports | Site Index | New Visitors | About W3C | Join W3C | Contact W3C

The World Wide Web Consortium (W3C) develops interoperable technologies (specifications, guidelines, software, and tools) to lead the Web to its full potential. W3C is a forum for information, commerce, communication, and collective understanding. On this page, you'll find W3C news, links to W3C technologies and ways to get involved. New visitors can find help in *Finding Your Way at W3C*. We encourage organizations to learn more about W3C and about W3C Membership.

XML10

To celebrate ten years of XML, W3C invites you to send a greeting and tell us about an XML-related blog or article. Many thanks to the FLWOR Foundation for their generous sponsorship of XML10.

W3C Supporters

Help W3C by making a donation through the W3C Supporters Program.

Employment

Current job opportunities at W3C: Training and Mobile Web Specialist. Current W3C Fellows Program openings are Business and Technology Communications Specialist; Software Engineer.

W3C A to Z

- Accessibility
- Amaya
- CC/PP
- Compound Document Formats (CDF)
- CSS
- CSS Validator
- Databinding
- DOM
- Efficient XML Interchange
- eGovernment

News

W3C Takes Steps to Make Video "First-Class" Web Citizen

2008-08-15: Web-based video is exploding, for advertising, enterprise collaboration, entertainment, product reviews, and other applications. As prices drop for consumer electronics, amateur and professionals alike are creating increasingly high quality videos. Social networks are sprouting up around Web-delivered media. W3C today launched a new Video in the Web Activity to make video a "first-class citizen" of the Web. The initial scope of work, determined as a result of a successful W3C Workshop on Video will be conducted by three groups:

- Media Annotations, which will provide an ontology designed to facilitate cross-community data integration of information related to media objects in the Web, such as video, audio and images.
- Media Fragments, which will address temporary and spatial links (i.e., into a particular moment of a multimedia track, or location in two visual dimensions) using Uniform Resource Identifiers (URIs).
- Timed Text, which will work on a standard for online captioning.

W3C continues to investigate the important topics of audio and video codecs on the Web. Learn more about the new Video in the Web Activity.

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Testimonials

Web3D Consortium

web3D CONSORTIUM
Open Standards for Real-Time 3D Communication

The Web3D Consortium, like W3C, supports open standardization. Web3D's open standards for real-time 3D communication include X3D, a powerful and extensible XML-based ISO standard for 3D visual effects, behavioral modeling, interaction and interoperability. Web3D membership includes companies, institutions, working groups and individuals. (Member testimonials)

Members

- Member Home Page
- Member Submissions
- Current Members
- Meetings
- Fellows (New Openings)

Intellectual property rights (IPR)

Web3D and W3C have similar policies

- Any known patented technology must be declared by members prior to consideration in safe haven of working groups
- Any patented technology contributions must be licensed on a royalty-free (RF) basis for inclusion in an openly used Web standard http://www.web3d.org/membership

Caveat: any legal problem can be solved, but only in advance!

Must innoculate against patent problems

Open source: at least one

One of two independent implementations

- Required for Web3D approval, standardization

Open for any use, without license fees

- Free = freedom to innovate, free to fix!
- Not necessarily free cost
- More like "free puppy", not "free beer"

Common shared example implementations

- Can provide a self-sustaining business model for continued activity, improvement
- Can clear up logjams when companies can't resolve interoperability issues due to proprietary code

Digital rights management

- X3D's XML and Compressed Binary encodings allow use of W3C's Security recommendations
  - XML Encryption
  - XML Digital Signature (for authentication)
  - Public key infrastructure
- More flexible DRM is now feasible
  - More uses than Hollywood-commercial exist
  - Sun's DReaM project, Open Media Commons http://www.openmediacommons.org

IPR summary

IPR = Intellectual Property Rights

Open standards & open source: part of success

Complements legacy approaches, traditional "hierarchical stovepipes," provides stability

Win-win approach for government, industry

- Both wins are needed for program success

Standards organizations, IPR agreements provide a stable playing field for long term

Welcome to another active playing field!

X3D Technical Overview

Web browsers, X3D plugins 1

X3D browsers parse (read) X3D scene models and render (draw) them

- Also provide simulation capabilities for animation and user interaction
- http://www.web3d.org/x3d/content/examples/X3dResources.html#Applications

Often implemented as plugins to web browsers:

- Internet Explorer http://www.microsoft.com
- Mozilla Firefox http://www.mozilla.com
- Opera http://www.opera.com
- Safari http://www.apple.com/safari

Web browsers, X3D plugins 2

There are many X3D plugins for Web browsers

- Contact http://www.bitmanagement.de
- FreeWRL/FreeX3D http://www.crc.ca/FreeWRL
- InstantReality http://instantreality.org
- Octaga http://www.octaga.com
- Xj3D http://www.xj3d.org
- Others available online

Most also operate as a standalone application

- Either commercial source code or open source
- Same X3D graphics content runs on each one

Example software architecture for X3D browser

3D graphics algorithms and implementations are intensely technical and performance-sensitive

X3D browsers are thus allowed to implement in any manner which they choose

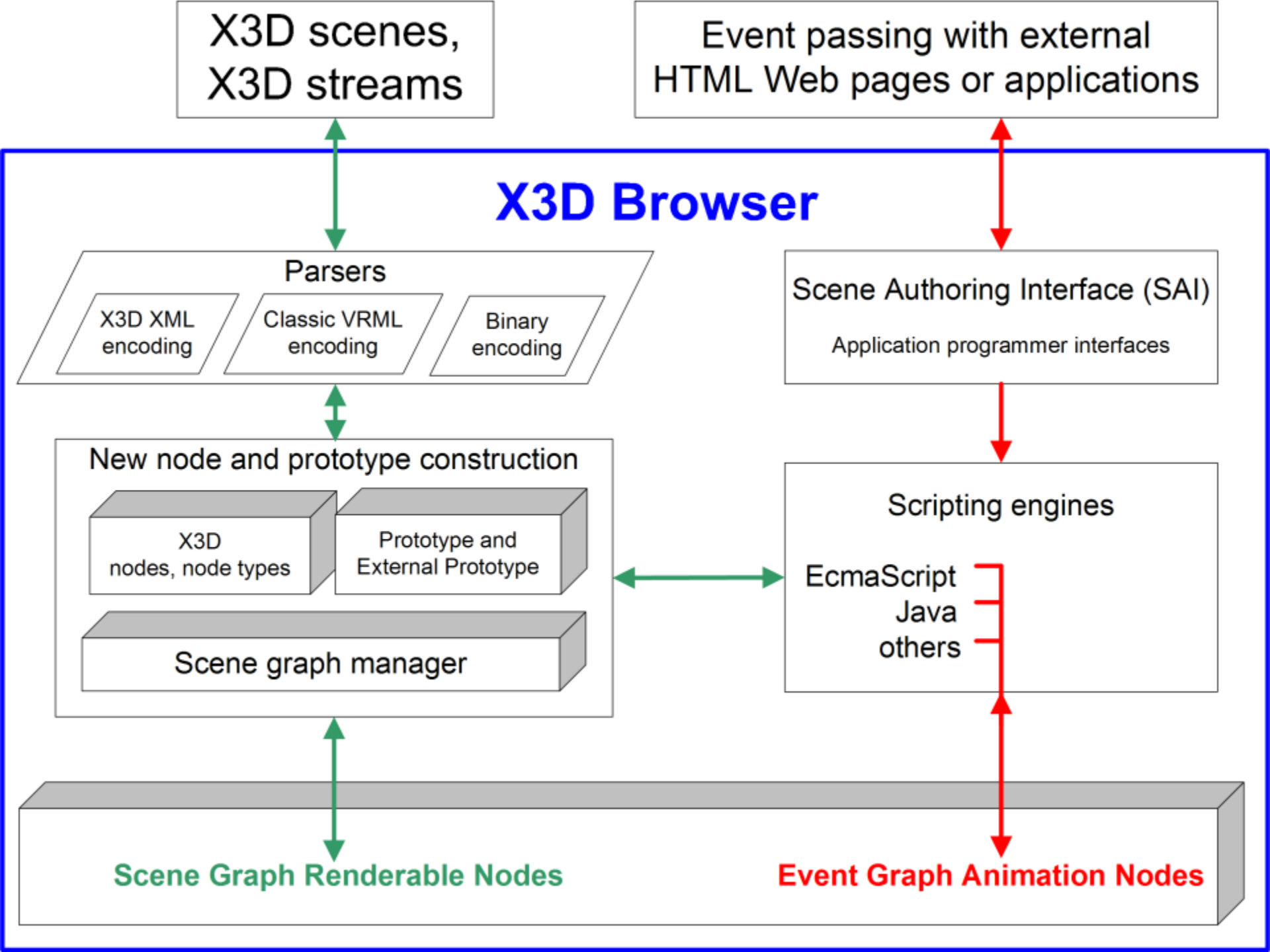
- As long as the author's X3D scene works properly

This is a healthy split of responsibilities

- Each gets to excel at what they are good at

Quality designs and shared "lessons learned" continue to build up nicely

- Next diagram shows example architecture


X3D scenes,
X3D streams
Event passing with external
HTML Web pages or applications
X3D Browser
Parsers
X3D XML
encoding
Classic VRML
encoding
Binary
encoding
Scene Authoring Interface (SAI)
Application programmer interfaces
New node and prototype construction
X3D
nodes, node types
Prototype and
External Prototype
Scene graph manager
Scripting engines
EcmaScript
Java
others
Scene Graph Renderable Nodes
Event Graph Animation Nodes

Scene graph concepts

Scene graphs are a model-centric approach to 3D that hierarchically defines geometry shape, appearance, position and orientation, etc. etc.

- Directed acyclic graph (DAG), meaning a tree with a root node and no loops
- Declarative listing of parameters of interest
- Similar to Computer Aided Design (CAD) models: define 3D geometry and appearance, but simply

Unlike most imperative programming approaches

- draw this triangle, that triangle, recompute, etc.

Scene graph terminology

Scene graph data file

- contains model description, may refer to data files

Scene graph viewer

- Reads and renders scene-graph models
- Implemented as application or web browser plugin

Scene graph editor

- Special text editor for scene graph development

Executable application

- Specific 3D model capable of running on a specific operating system

Scene graph rendering

The browser traverses the scene graph, updating any values within nodes and building an image

- New image then replaces previous screen image, process known as ***double buffering***
- Rapid repetitions are very important
- Frame rate faster than 7-10 Hz (cycles per second) provides appearance of smooth motion

Rendering is defined as this drawing process

Off-line rendering is performing such operations to image or movie files, rather than display

Performance optimizations

Scene graphs have performance optimizations sometimes not available in other Application Programming Interface (API) approaches

- Scene graph structure designed to take advantage of graphics hardware acceleration
- Can refer to (and reuse) subgraphs (X3D DEF, USE)
- "dirty bit" indicates whether a scene subgraph has been modified, avoiding needless recomputations
- Browser can rearrange or simplify geometry
- Scoping of lights to reduce computational impact
- Widely repeated interchange patterns

Scene-graph advantages relative to OpenGL, DirectX render layers

- OpenGL and DirectX APIs are thin software layers that expose underlying 3D graphics-acceleration hardware for real-time rendering
- Each is a state machine, optimized for drawing triangles textures etc., not designed to have memory for modeling high-level simulation objects, remembering user actions, etc.
- Scene graphs are a closer match to simulation models, easier to model and modify

Scene graphs and ray tracing

Ray tracing emulates physical properties of light interaction with material surfaces

- Ray vectors are propagated, computed, added
- Computational time can be intensive, usually best for high-fidelity rendering (rather than real-time)

Variety of different approaches, programs

- Persistence of Vision Raytracer (www.povray.org)
- Movies, e.g. Renderman (renderman.pixar.com)

Scene graph designed for real-time rendering

- But X3D Specification has no rendering prohibitions
- Okino Polytrans supports both (www.okino.com)

Many other scene graph architectures

OpenInventor (OI), predecessor of VRML

- http://oss.sgi.com/projects/inventor

Virtual Reality Modeling Language (VRML), direct predecessor of X3D

- http://www.web3d.org/x3d/specifications

Java3D quite similar to X3D scene graph

- https://java3d.dev.java.net

OpenSceneGraph (OSG)

- http://www.openscenegraph.org

OpenSG

- http://www.opensg.org

Behaviors

Behavior is defined as changing the value of a field contained by some node in scene graph

Animation nodes, user interaction nodes and network updates can produce updated values

ROUTE statements connect output of one node as an input to field in another node

Event is defined as the time-stamped value passed by a ROUTE, from one field to another

Thus the values held by nodes in scene graph can change as time advances

Behavior traversal of scene graph

Once frame is swapped to update screen image, need to update values in the scene

Event model consists of

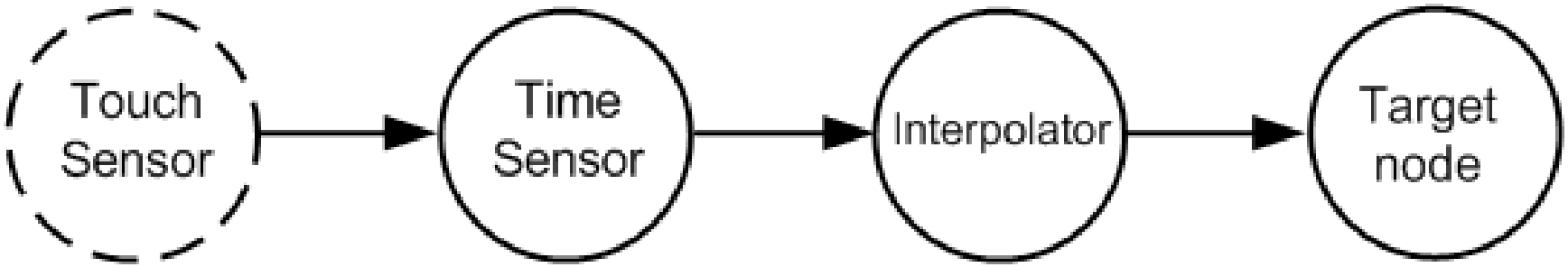
- Examining clock-driven and user-initiated events
- Updating scene-graph values
- Triggering and updating new events as appropriate
- Continue until all events handled, loops not allowed

Event updates modify the scene graph

- Changing rendering properties, or
- Generating further event outputs

Example behavior event chain

- User clicks button to start a timer clock
- Clock outputs new event at start of each frame,
- … which stimulates linear-interpolation function which produces another output value
- … which updates some target value in scene graph
- Repeat event traversal after each frame redraw



X3D file structure

X3D scene files have a common file structure

- File header (XML, ClassicVRML, Compressed Binary)
- X3D header statement
- Profile statement
- Component statements (optional)
- Meta statements (optional)
- X3D root node
- X3D scene graph child nodes

Need for subdivisions and subsets

3D graphics is a big and complicated subject

- Beginning authors just want simple scenes
- Experienced authors want to use everything

Similar needs for browser software builders

- Small rapid download for simple web graphics
- Full-capability software for every possible technique

Challenge: how to consistently support both?

- Object-oriented decomposition for consistency
- Key design criteria for bottom-up X3D extensibility
- X3D design answer: profiles + components

Profiles and components

Profiles are predefined collections of components

- Can augmented each by adding other components

Components are predefined collections of nodes

- Further defined by *level* of complexity
- Components match chapters in X3D specification

Authors define the expected complexity of scene by defining profile level in the X3D header

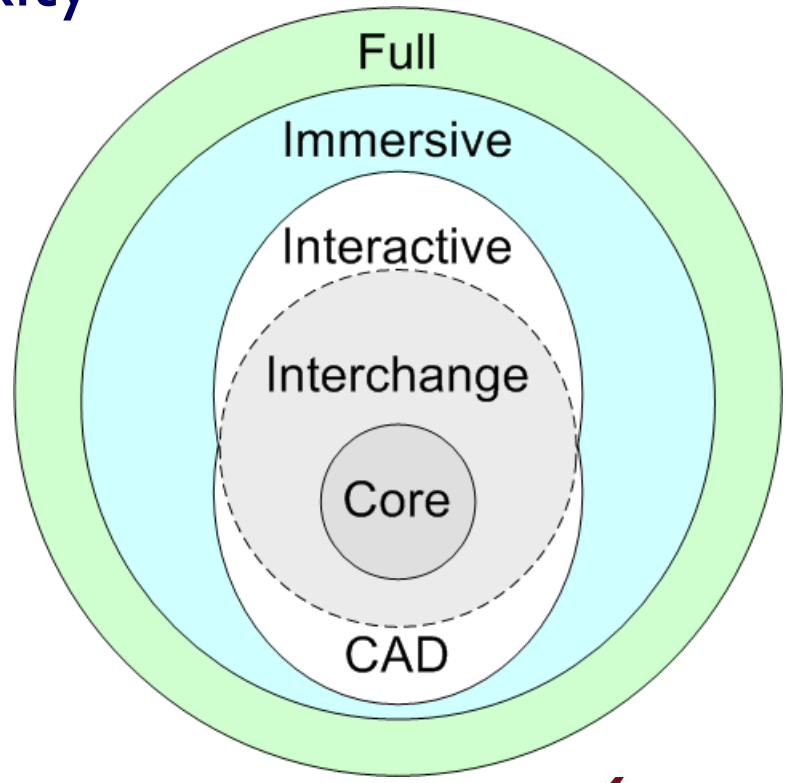
- Can also add optional components, if desired
- This tells the X3D browser what level of support is needed for run-time operation

Profiles cover common use cases

Profiles are a collection of components matching common levels of complexity

Profiles are X3D subsets

- Collection of X3D nodes for for author's palette
- *Interchange* suitable for simple geometry conversion
- *Interactive* adds simple user interactivity (clicking etc.)
- *Immersive* matches VRML97, plus a bit more
- *Full* profile includes all nodes



meta statements

meta statements provide information about the X3D scene

- Document metadata, not scene metadata

Information provided as name-value pairs

- Example:

```
<meta name='created' value='1 January 2008'/>
```

This approach is thus very general

- Wide variety of metadata can be represented
- Matches same approach used by HTML for regular hypertext web pages

profile, component and meta statements, XML (.x3d) encoding syntax

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE X3D PUBLIC "ISO//Web3D//DTD X3D 3.2//EN" "http://www.web3d.org/specifications/x3d-3.2.dtd">
<X3D version="3.2" profile="Immersive" xmlns:xsd="http://www.w3.org/2001/XMLSchema-instance"
                        xsd:noNamespaceSchemaLocation="http://www.web3d.org/specifications/x3d-3.2.xsd">
    <head>
        <component name='DIS' level='1'/>
        <component name='Geospatial' level='1'/>
        <component name='H-Anim' level='1'/>
        <component name='NURBS' level='4'/>
        <meta name='title' content='HeaderProfileComponentMetaExample.x3d'/>
    </head>
    <Scene>
        <!——Scene graph nodes are added here——>
    </Scene>
</X3D>
```

profile, component and meta statements, ClassicVRML (.x3dv) encoding syntax

```
#X3D V3.2 utf8
PROFILE Immersive
# No HEAD statement is provided in ClassicVRML Encoding
COMPONENT DIS:1
COMPONENT Geospatial:1
COMPONENT H-Anim:1
COMPONENT NURBS:4
META "filename" "HeaderProfileComponentMetaExample.x3d"
# Scene graph nodes are added here
```

newScene.x3d metadata prompts

<meta content='*enter FileNameWithNoAbbreviations.x3d here*' name='title'/>

<meta content='*enter description here, short-sentence summaries preferred*' name='description'/>

<meta content='*enter name of original author here*' name='creator'/>

<meta content='*if manually translating VRML-to-X3D, enter name of person translating here*' name='translator'/>

<meta content='*enter date of initial version here*' name='created'/>

<meta content='*enter date of translation here*' name='translated'/>

<meta content='*enter date of latest revision here*' name='modified'/>

<meta content='*enter version here, if any*' name='version'/>

<meta content='*enter reference citation or relative/online url here*' name='reference'/>

<meta content='*enter additional url/bibliographic reference information here*' name='reference'/>

<meta content='*enter reference resource here if required to support function, delivery, or coherence of content*' name='requires'/>

<meta content='*enter copyright information here* Example: Copyright (c) Web3D Consortium Inc. 2008' name='rights'/>

<meta content='*enter drawing filename/url here*' name='drawing'/>

<meta content='*enter image filename/url here*' name='image'/>

<meta content='*enter movie filename/url here*' name='MovingImage'/>

<meta content='*enter photo filename/url here*' name='photo'/>

<meta content='*enter subject keywords here*' name='subject'/>

<meta content='*enter permission statements or url here*' name='accessRights'/>

<meta content='*insert any known warnings, bugs or errors here*' name='warning'/>

<meta content='*enter online Uniform Resource Identifier (URI) or Uniform Resource Locator (URL) address for this file here*'
name='identifier'/>

<meta content='X3D-Edit, https://savage.nps.edu/X3D-Edit' name='generator'/>

<meta content='../../license.html' name='license'/>

(X3dToXhtml) - Mozilla Firefox

File Edit View History Bookmarks Tools GUtil! Help

http://www.web3d.org/x3d/content/examples/newScene.html

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE X3D PUBLIC "ISO//Web3D//DTD X3D 3.2//EN"  "http://www.web3d.org/specifications/x3d-3.2.dtd">

<X3D profile='Immersive' version='3.2' xmlns:xsd='http://www.w3.org/2001/XMLSchema-instance' xsd:noNamespaceSchemaLocation=' http://www.web3d.org/specifications/x3d-3.2.xsd '>
    <head>
        <meta name='title' content='*enter FileNameWithNoAbbreviations.x3d here*'/>
        <meta name='description' content='*enter description here, short-sentence summaries preferred*'/>
        <meta name='creator' content='*enter name of original author here*'/>
        <meta name='translator' content='*if manually translating VRML-to-X3D, enter name of person translating here*'/>
        <meta name='created' content='*enter date of initial version here*'/>
        <meta name='translated' content='*enter date of translation here*'/>
        <meta name='modified' content='*enter date of latest revision here*'/>
        <meta name='version' content='*enter version here, if any*'/>
        <meta name='reference' content='*enter reference citation or relative/online url here*'/>
        <meta name='reference' content='*enter additional url/bibliographic reference information here*'/>
        <meta name='requires' content='*enter reference resource here if required to support function, delivery, or coherence of content*'/>
        <meta name='rights' content='*enter copyright information here* Example: Copyright (c) Web3D Consortium Inc. 2008'/>
        <meta name='drawing' content='*enter drawing filename/url here*'/>
        <meta name='image' content='*enter image filename/url here*'/>
        <meta name='MovingImage' content='*enter movie filename/url here*'/>
        <meta name='photo' content='*enter photo filename/url here*'/>
        <meta name='subject' content='*enter subject keywords here*'/>
        <meta name='accessRights' content='*enter permission statements or url here*'/>
        <meta name='warning' content='*insert any known warnings, bugs or errors here*'/>
        <meta name='identifier' content='*enter online Uniform Resource Identifier (URI) or Uniform Resource Locator (URL) address for this file here*'/>
        <meta name='generator' content='X3D-Edit, https://savage.nps.edu/X3D-Edit'/>
        <meta name='license' content='../../license.html'/>
        <!-- Additional authoring resources for meta-tags:
        http://www.dublincore.org/documents/dcmi-terms
        http://www.dublincore.org/documents/dces
        http://www.w3.org/TR/html4/struct/global.html#h-7.4.4
        http://vancouver-webpages.com/META
        http://vancouver-webpages.com/META/about-mk-metas2.html
        Additional authoring resources for language codes:
        ftp://ftp.isi.edu/in-notes/bcp/bcp47.txt
        http://www.loc.gov/standards/iso639-2/langhome.html
        http://www.iana.org/numbers.html#L
        -->
    </head>
    <Scene>
        <!-- Scene graph nodes are added here -->
    </Scene>
</X3D>
```

Done 21.624s 66.118.165.56 205.155.65.236 0:1021 Now: Cloudy, 54° F Wed: 58° F Thu: 58° F

Field data types

X3D is a strongly typed language

- Each field in each node (i.e. each XML attribute) has a strictly defined data type
- Data types for boolean, integer, floating point, string

Types are either single or multiple-value

- Examples: SFFloat, SFVec2f, SFVec3f, SFOrientation

Also have arrays for all types

SF = Single Field, MF = Multiple Field (array)

Failure to match data types correctly is an error!

- During scene validation, loading, or at run time

Field data types, part 1

Field-type names	Description	Example values
SFBool	Single-field boolean value	true or false (X3D syntax), TRUE or FALSE (ClassicVRML syntax)
MFBool	Multiple-field boolean array	true false false true (X3D syntax), [TRUE FALSE FALSE TRUE] (ClassicVRML syntax)
SFColor	Single-field color value, red-green-blue	0 0.5 1.0
MFColor	Multiple-field color array, red-green-blue	1 0 0, 0 1 0, 0 0 1
SFColorRGBA	Single-field color value, red-green-blue alpha (opacity)	0 0.5 1.0 0.75
MFColorRGBA	Multiple-field color array, red-green-blue alpha (opacity)	1 0 0 0.25, 0 1 0 0.5, 0 0 1 0.75 (red green blue, varying opacity)
SFInt32	Single-field 32-bit integer value	0
MFInt32	Multiple-field 32-bit integer array	1 2 3 4 5
SFFloat	Single-field single-precision floating-point value	1.0
MFFloat	Multiple-field single-precision floating-point array	–1 2.0 3.14159

Field data types, part 2

Field-type names	Description	Example values
SFDouble	Single-field double-precision floating-point value	2.7128
MFDouble	Multiple-field double-precision array	–1 2.0 3.14159
SFImage	Single-field image value	Contains special pixel-encoding values, see Chapter 5 for details
MFImage	Multiple-field image value	Contains special pixel-encoding values, see Chapter 5 for details
SFNode	Single-field node	<Shape/> or Shape {space}
MFNode	Multiple-field node array of peers	<Shape/><Group/><Transform/>
SFRotation	Single-field rotation value using 3-tuple axis, radian angle form	0 1 0 1.57
MFRotation	Multiple-field rotation array	0 1 0 0, 0 1 0 1.57, 0 1 0 3.14
SFString	Single-field string value	"Hello world!"
MFString	Multiple-field string array	"EXAMINE" "FLY" "WALK" "ANY"
SFTime	Single-field time value	0
MFTime	Multiple-field time array	–1 0 1 567890

Field data types, part 3

Field-type names	Description	Example values
SFVec2f/SFVec2d	Single-field 2-float/2-double vector value	0 1.5
MFVec2f/MFVec2d	Multiple-field 2-float/2-double vector array	1 0, 2 2, 3 4, 5 5
SFVec3f/SFVec3d	Single-field vector value of 3-float/ 3-double values	0 1.5 2
MFVec3f/MFVec3d	Multiple-field vector array of 3-float/ 3-double values	10 20 30, 4.4 –5.5 6.6

ClassicVRML (.x3dv) encoding has some syntax differences compared to XML encoding (.x3d)

- TRUE and FALSE (rather than XML true and false)
- MF multiple-field array values are surrounded by square brackets, e.g. `[ 10 20 30, 4.4 -5.5 6.6 ]`
- No special XML escape characters such as `&`

accessType: input, output, initialize

accessType determines if field is data sender, receiver, or holder

- inputOnly: can only receive events
- outputOnly: can only send events
- initializeOnly: cannot send or receive, only initialized
- inputOutput: can send, receive and be initialized

Failure to match accessType correctly is an error!

- Detected during authoring-tool checks, or run time

accessType naming conventions

The accessType names were changed when VRML97 was upgraded to X3D

- Functionality remains essentially unchanged

X3D specification entries for each node use yet another shorthand, as shown here

VRML97 Name	X3D Name	X3D Specification abbreviation
eventIn	inputOnly	[in]
eventOut	outputOnly	[out]
field	initializeOnly	[ ]
exposedField	inputOutput	[in,out]

VRML, Virtual reality modeling language; X3D, Extensible 3D.

Use the X3D nomenclature in .x3d scenes

Abstract node types

X3D nodes also have strong typing

- Provides consistent field interfaces for similar nodes
- Object-oriented improvement over VRML97, which had several internal inconsistencies
- Better language design

Benefits include

- Allowed child-node content is consistent
- Simple-type field values have identical defaults
- Application programming interfaces more consistent
- Definitions are easier to remember and apply

XML file encoding

The Extensible Markup Language (XML) is a plain-text format used by many Web languages

- Including Hypertext Markup Language (HTML)

XML is used to define other data-oriented languages

- Thus XML is not a language by itself, rather it is a language about languages, a *metalanguage*

XML has many benefits and is well-suited for X3D

XML in 10 Points

http://www.w3.org/XML/1999/XML-in-10-points

- XML is for structuring data
- XML looks a bit like HTML
- XML is text, but isn't meant to be read
- XML is verbose by design
- XML is a family of technologies
- XML is new but not that new
- XML leads HTML to XHTML
- XML is modular
- XML is basis for RDF and the Semantic Web
- XML is license-free, platform-independent and well-supported

XML in 10 Points is a key reference for understanding the common underlying design principles underlying the great diversity of XML.

Only 4 pages long – essential reading.

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XML and X3D correspondence

Opening element	`<Shape>`
Singleton element, attribute="value"	`<Sphere radius="10.0" solid="true"/>`
Opening element	`<Appearance>`
Singleton element, attribute='value'	`<ImageTexture url='earth-topo.png'/>`
Closing element	`</Appearance>`
Closing element	`</Shape>`

Elements correspond to X3D nodes

Attributes correspond to X3D simple-type fields

Parent-child relationships define containerField

Validatable XML using X3D DTD, schema

XML validation

XML validation applies XML rules to an XML document to confirm whether it is correct

- *Well formed XML*: legal header, matching open/close tags, proper attribute-value pairs, etc.
- *DTD (DOCTYPE) validation*: adds checks on legal element and attribute names, proper parent-child relationships, simple checks on attribute values
- *XML Schema validation*: also includes stricter checks on data types of attribute values

XML validation finds problems before end users

- reducing garbage-in garbage-out (GIGO)

ClassicVRML file encoding

The ClassicVRML file syntax is a direct, backwards-compatible extension of VRML97

- VRML version 2.0 became X3D version 3.0, 3.1 etc.
- No changes in syntax rules
- Some additional new nodes and slight naming differences to match specification improvements
- VRML97 content still works and is easily supported

XML, ClassicVRML and Compressed Binary encodings are functionally equivalent

- Governed by same X3D abstract specification

Compressed binary encoding

Two types of compression for .x3db encoding

- XML-centric ISO Fast Infoset
- Geometry-centric for coplanar polygons, quantization of points, colors & normals, etc.

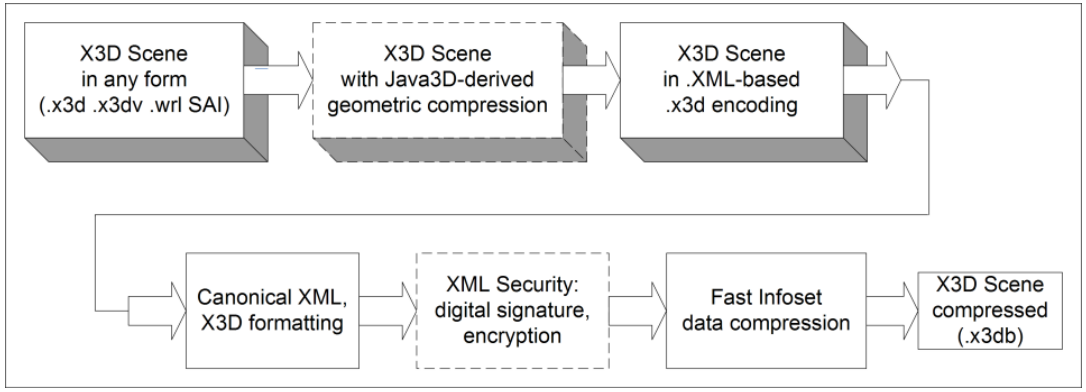
Java3D algorithms are default for geometry compression

- Royalty free for use with X3D
- Other uses – please contact Sun Microsystems

Alternate geometry compression is allowed

Implementations: Xj3D, Instant Reality, EDF

X3D compressed binary algorithm and XML Security



X3D compressed binary uses Canonical X3D form

- Strict formatting rules so that files with identical format can be shown to match

Canonical form enables use of XML Security

- XML Encryption
- XML Digital Signature (for author authentication)

Additional Resources

Public Mailing Lists

Consortium Members have access to all internal X3D Technical and Working Group mailing lists including X3D, UI, Med, CAD, Conformance, DIS-XML, and Shaders.

Non-members are invited to use the X3D user-to-user message boards and public emails lists listed below

X3D-Public Email list

The X3D mailing list is the place to to have focused discussions and feedback on X3D technical and development issues. It is appropriate for content creators, end-users and coders . This list is the primary vehicle non-members to communicate with and receive announcements from the Web3D Consortium board and X3D Specification team.

Online Sign Up - To subscribe or unsubscribe to the X3D-Public email list use the online interface.

Manual Sign Up - To manually subscribe to the list, send an email to majordomo@web3d.org. In the body of your message include the line *subscribe x3d-public*. You will receive back a confirming email when your subscription has been approved. To unsubscribe send an email to majordomo@web3d.org. In the body of your message include the line *unsubscribe x3d-public*.

X3D-Public List Archives - Browse through the archives of past X3D-Public list messages.

WWW-VRML Public Email list

The VRML mailing list is the place to discuss VRML97 (the predecesor to X3D) issues, philosophies and application. The comments on this list represent the views and knowledge of the comment authors only. They do not necessarily represent official views from the Consortium.

Online Sign Up - To subscribe or unsubscribe to the WWW-VRML email list use the online interface.

Manual Sign Up - To manually subscribe to the list, send an email to majordomo@web3d.org. In the body of your message include the line *subscribe www-vrml*. You will receive back a confirming email when your subscription has been approved. To unsubscribe send an email to majordomo@web3d.org. In the body of your message include the line *unsubscribe www-vrml*.

WWW-VRML List Archives - Browse through the archives of past WWW-VRML list messages.

Web3D-Announce Marketing and News Newsletter

Sign up for the newsletter.

Web3D liaison organizations

World Wide Web Consortium (W3C)

- Leading the Web to its Full Potential

International Organization of Standards (ISO)

- Review and ratification of X3D Graphics Standard

Open Geospatial Consortium (OGC)

- Leading the development of standards for geospatial and location-based services.
- http://www.opengeospatial.org

Web3D Symposium series in cooperation with SIGGRAPH, Eurographics

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Annual Conferences 2009

SIGGRAPH

- New Orleans Louisiana, 3-7 August 2009
- http://www.siggraph.org

Web3D Symposium

- Darmstadt Germany, 15-17 June 2009
- http://www.web3d.org/conferences/web3d2009

Eurographics

- Munich Germany, 30 March - 3 April 2009
- http://www.eg.org

SIGGRAPH Asia

- Yokohama Japan 16-19 December 2009
- http://www.siggraph.org/asia2009

Chapter Summary

Chapter Summary

This technical overview chapter is a mile wide and a few meters deep. Key points include

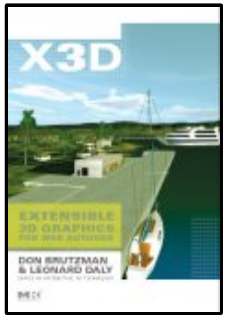
- VRML historical background
- Web3D Consortium
- Browsers, X3D Specifications, scene graph
- Profiles + components, field and node data types
- XML encoding, ClassicVRML, Compressed binary

New students of X3D can refer to details later. Get working on examples in the next chapters!

References

References 1

X3D: Extensible 3D Graphics for Web Authors
by Don Brutzman and Leonard Daly, Morgan Kaufmann Publishers, April 2007, 468 pages.



- Chapter 1, Technical Overview
- http://x3dGraphics.com
- http://x3dgraphics.com/examples/X3dForWebAuthors

X3D Resources

- http://www.web3d.org/x3d/content/examples/X3dResources.html

References 2

X3D-Edit Authoring Tool

- https://savage.nps.edu/X3D-Edit

X3D Scene Authoring Hints

- http://x3dgraphics.com/examples/X3dSceneAuthoringHints.html

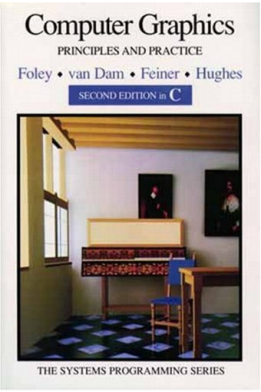
X3D Graphics Specification

- http://www.web3d.org/x3d/specifications
- Also available as help pages within X3D-Edit

References 3

Computer Graphics, Principles and Practice, by James D. Foley, Andries van Dam, Stephen K. Feiner and John F. Hughes, Addison-Wesley, second edition, 1997.

- http://portal.acm.org/citation.cfm?id=83821



Bert Bos et al., "XML in 10 Points," World Wide Web Consortium (W3C), created 1999, updated 2003.

- http://www.w3.org/XML/1999/XML-in-10-points

References 4

Leonard Daly and Don Brutzman, "X3D: Extensible 3D Graphics Standard," *Standards in a Nutshell* column, *IEEE Signal Processing Magazine*, vol. 24 no. 6, November 2007, pp. 130-133.

Wayne Carlson, *A Critical History of Computer Graphics and Animation,* course notes, Ohio State University.

- http://design.osu.edu/carlson/history/lessons.html
- http://design.osu.edu/carlson/history/ID797.html

Book testimonials 1

There will be no problem understanding these concise, clear, comprehensible background concepts for readers new to Extensible 3D (X3D). There are many notes and examples that compare X3D to Virtual Reality Modeling Language (VRML) features. Don Brutzman and Leonard Daly clearly and thoroughly illustrate each logical concept and feature of X3D with diagrams, tables, code snippets, screenshots of 3D objects/environments, and example scenes, while making use of the very latest specifications and implementations. Their approach contributes greatly to an easy and in-depth understanding of the X3D language. This book is the ultimate introductory guide to X3D!

—Dr. Vladimir Geroimenko, University of Plymouth, School of Computing Communications and Electronics, Plymouth, UK

Book testimonials 2

This book is required reading for anybody interested in Web3D. The authors are well known and respected in the X3D community as pioneers. Their writing style is concise and engaging, set at an appropriate level to encourage understanding, and uses the concepts being introduced. Their "Hints and warnings" sections provide added value above what is available from X3D specification documents. Hard to achieve in a reference manual!

—Professor Nigel W. John, School of Computer Science, University of Wales, Bangor; Chair of Web3D 2005 Symposium

Book testimonials 3

How many times have we heard "The ISO specification is hard to read, do you have something more approachable?" This book is the answer. It provides a detailed explanation of each node in the Immersive profile and gives many reusable examples. After reading this book you'll be well prepared to develop your own X3D content.

—Alan Hudson, President Web3D Consortium, Yumetech Inc.

This is a much-needed book about the X3D standard and X3D content development. The book follows the structure of the X3D standard specifications which helps readers understand and apply the X3D standard. It can also be used as a reference material in virtual reality and graphics-related courses.

—Professor Denis Gracanin, Virginia Polytechnic Institute & State University, Chair Web3D 2006 Symposium

Contact

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1.831.656.2149 voice

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CGEMS, SIGGRAPH, Eurographics

The Computer Graphics Educational Materials Source(CGEMS) site is designed for educators

- to provide a source of refereed high-quality content
- as a service to the Computer Graphics community
- freely available, directly prepared for classroom use
- http://cgems.inesc.pt

X3D for Web Authors recognized by CGEMS! ☺

- Book materials: X3D-Edit tool, examples, slidesets
- Received jury award for Best Submission 2008

CGEMS supported by SIGGRAPH, Eurographics

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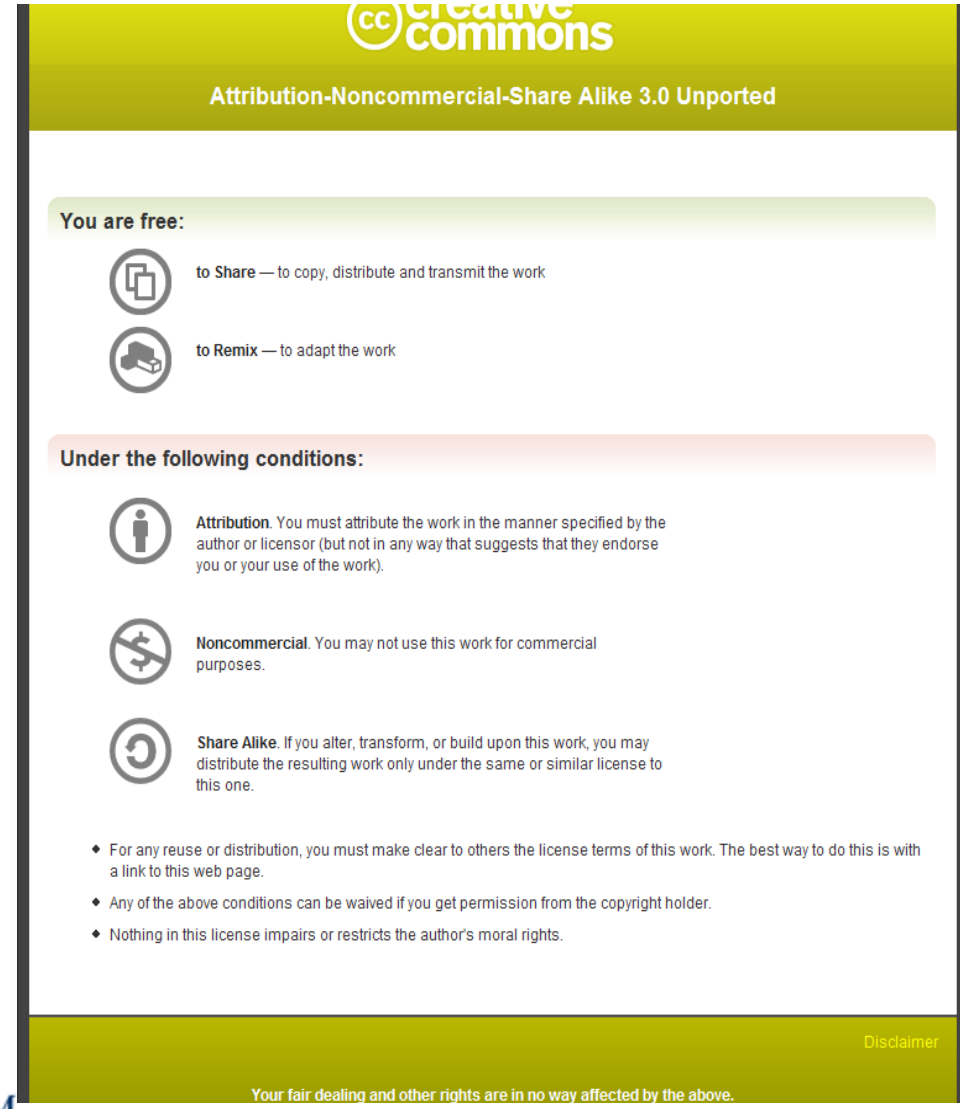

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X3D

Open-source license
for X3D-Edit software and X3D example scenes

http://www.web3d.org/x3d/content/examples/license.html

X3D Graphics for Web Authors

Chapter 1

Technical Overview

When we mean to build, we first survey the plot, then draw the model.

William Shakespeare, Henry IV

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Chapter Overview

4

Overview: Technical Introduction

This chapter provides a broad overview of how X3D graphics is designed and implemented

- Goal is to provide quick coverage of many features

For newcomers to X3D, a quick read is sufficient

- Getting started building models in Chapters 2 and 3 is more important that understanding every point
- Can review again later to reinforce concepts

Details found in Chapter 1, *X3D for Web Authors*

- This chapter is available free online

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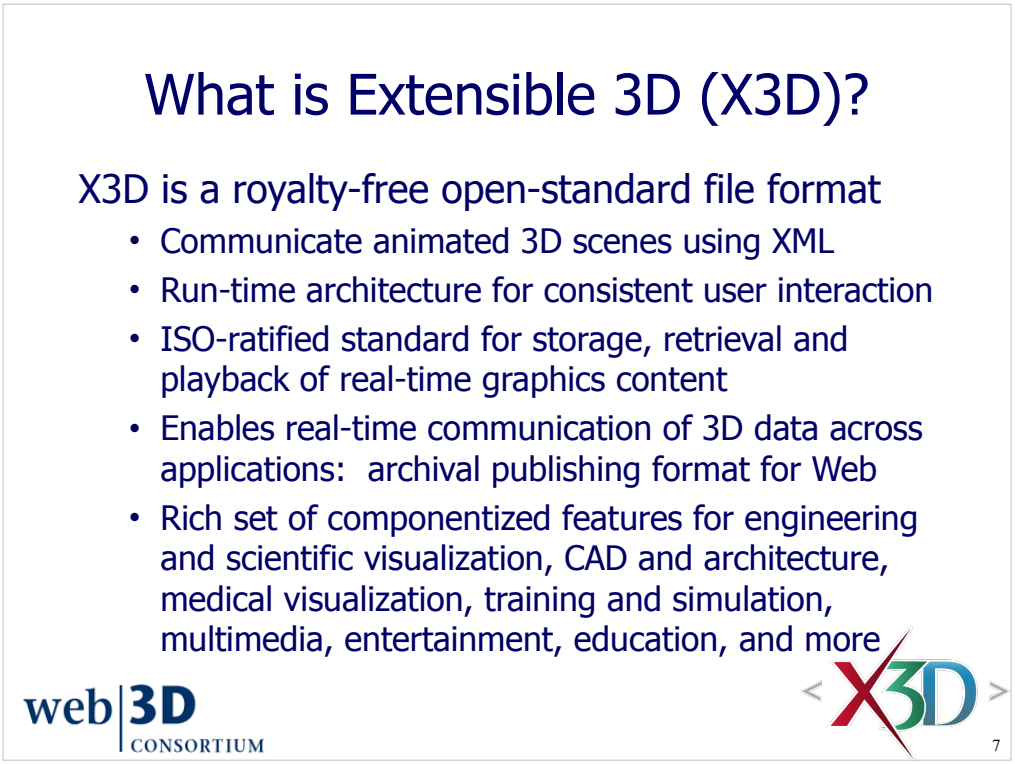
5

http://x3dgraphics.com/examples/X3dForWebAuthors/Chapter01-TechnicalOverview/Chapter01-Technical_Overview.pdf

back to Table of Contents

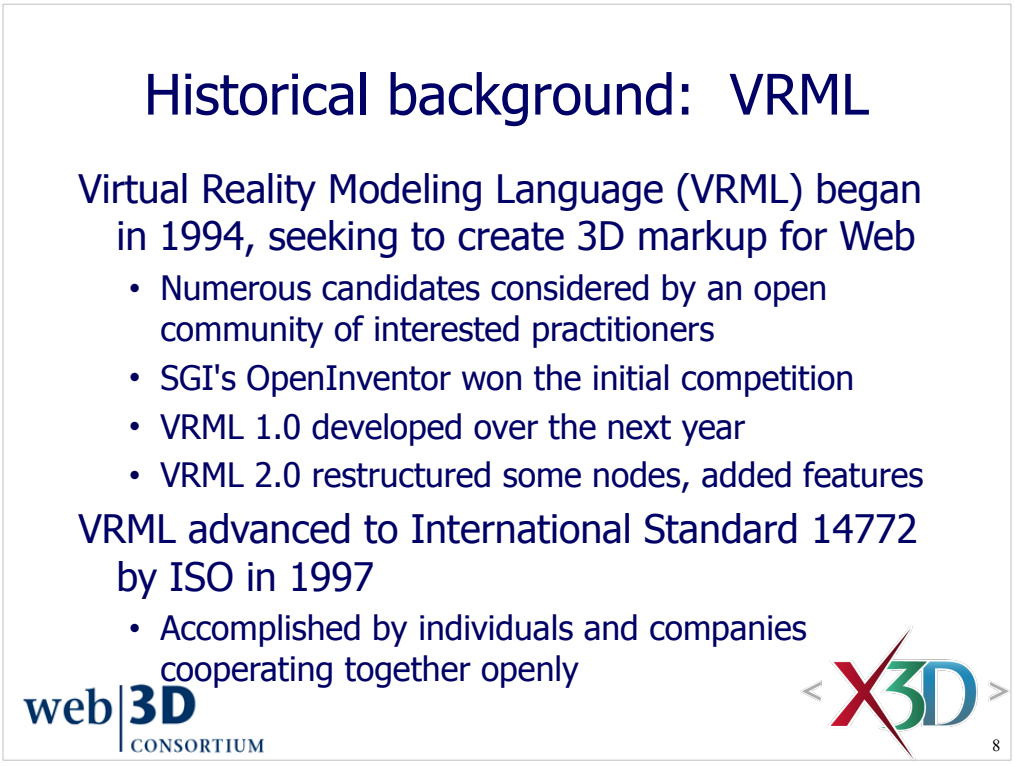
X3D Significance

6



Lots more can be said here. Indeed numerous books have been written about VRML.

- http://x3dgraphics.com/examples/X3dResources.html#Books



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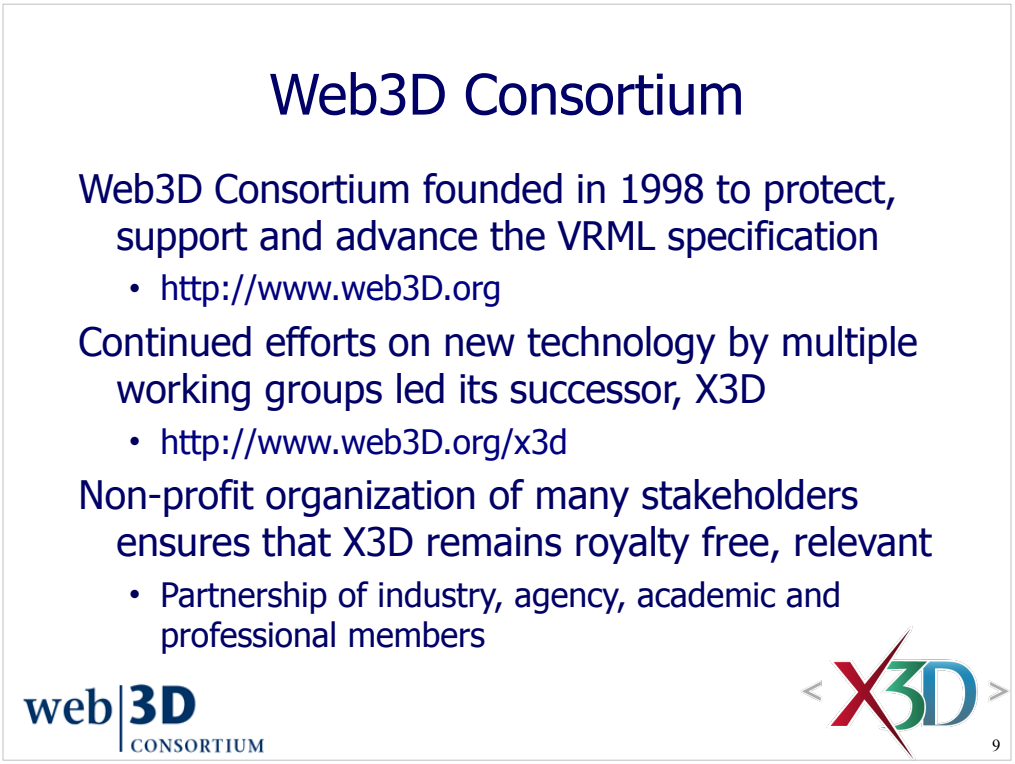
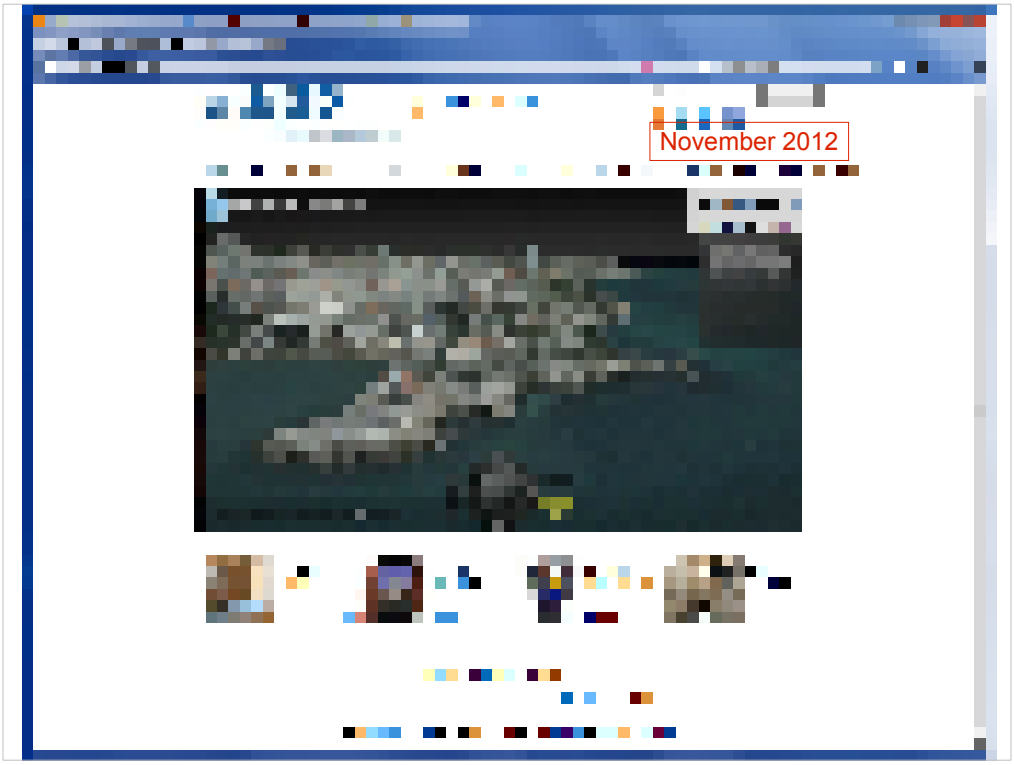
- http://x3dgraphics.com/examples/X3dResources.html#Books



Perhaps the key test of 'openness' for any self-proclaimed 'open' organization: exactly who is allowed to join? Many industry associations only allow preselected (usually paying) companies to participate.

The Web3D Consortium includes industry, government-agency, college/university and individual professional memberships. This makes it one of the most open organizations around.

Further information on membership and joining available online at http://www.web3d.org/membership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Open Earth Globe Format


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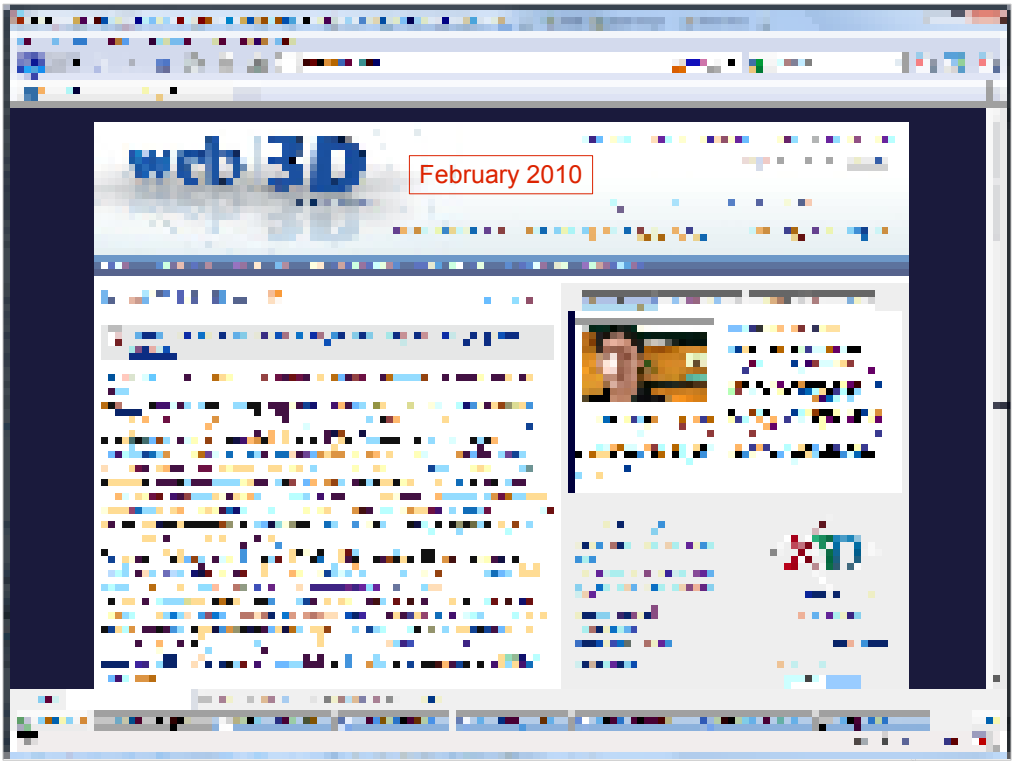
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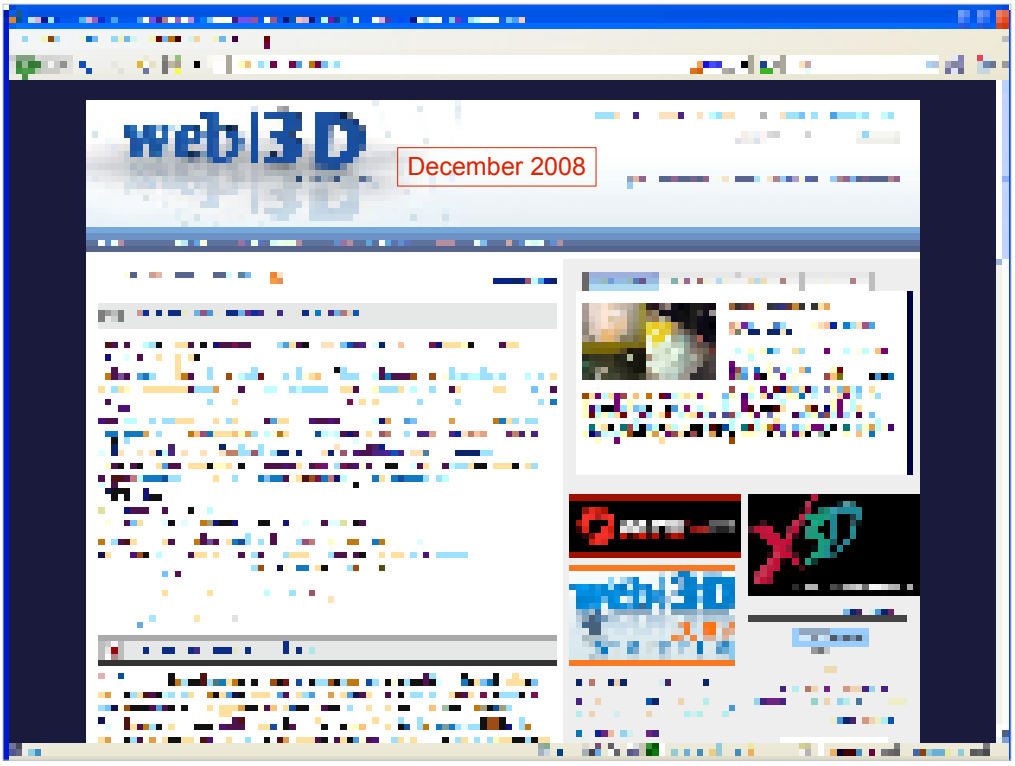
http://www.web3d.org February 2009

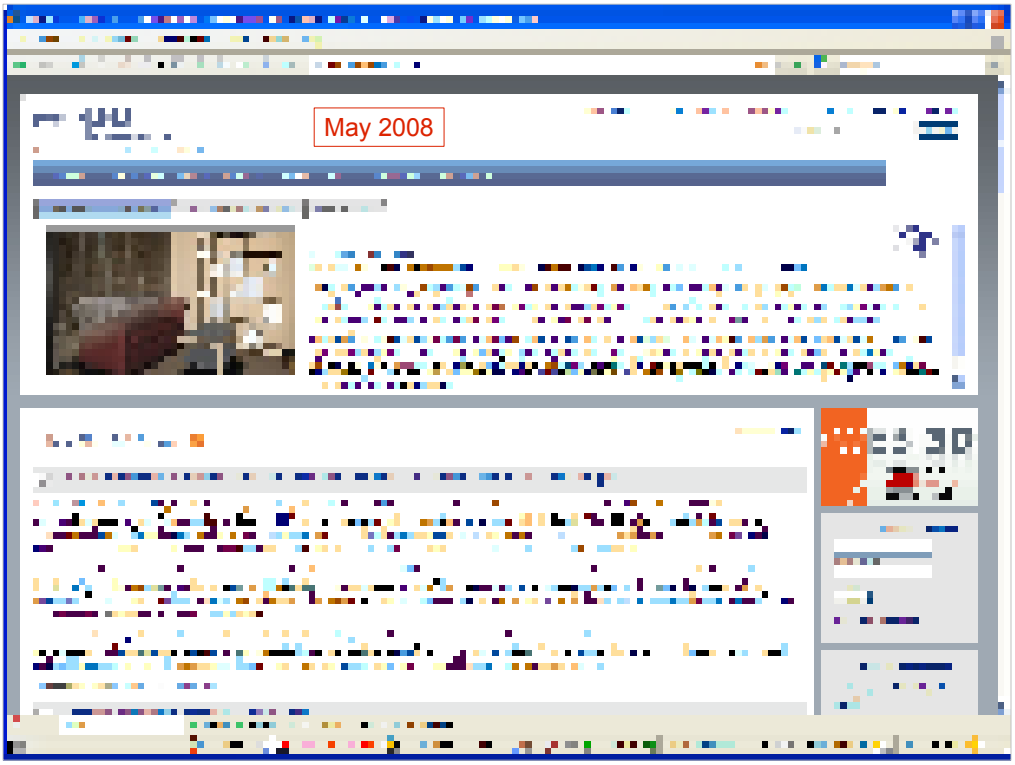
http://www.web3d.org January 2009



http://www.web3d.org December 2008

http://www.web3d.org January 2008

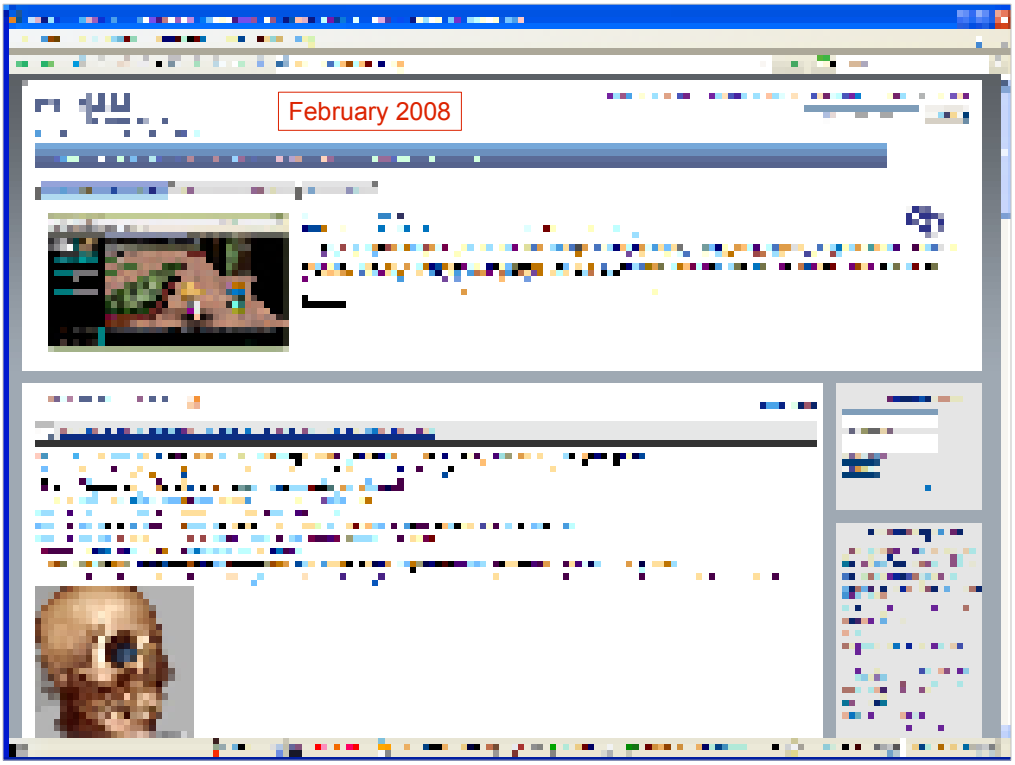
http://www.web3d.org August 2008



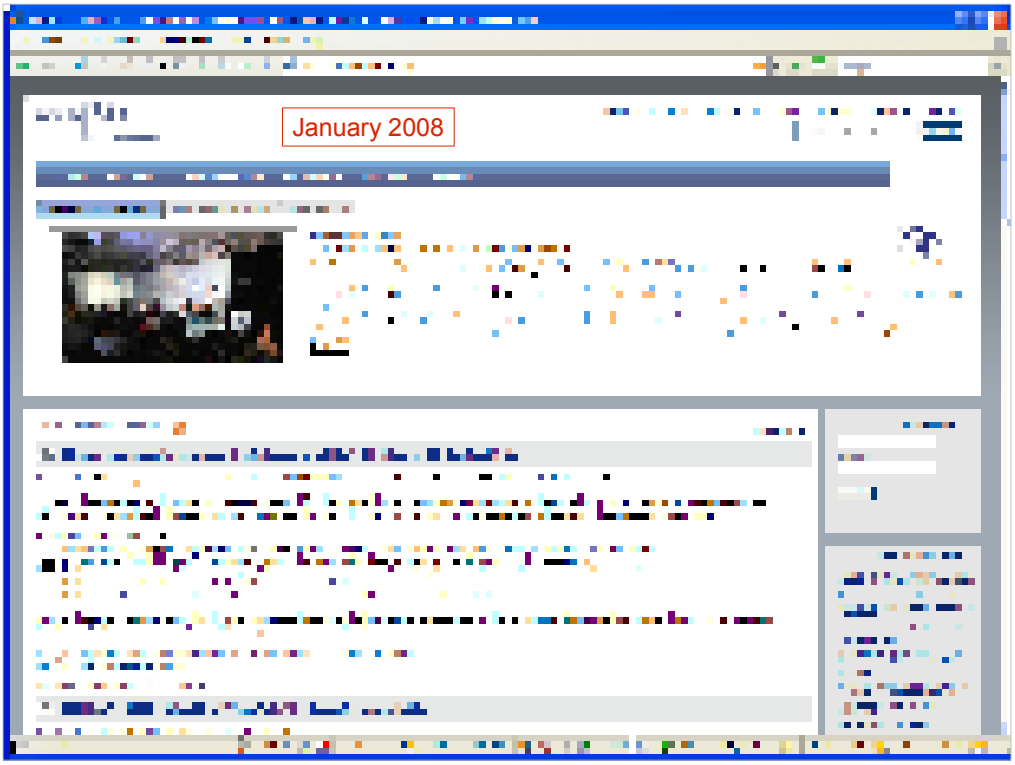
http://www.web3d.org May 2008

http://www.lsi.usp.br/forumx3d

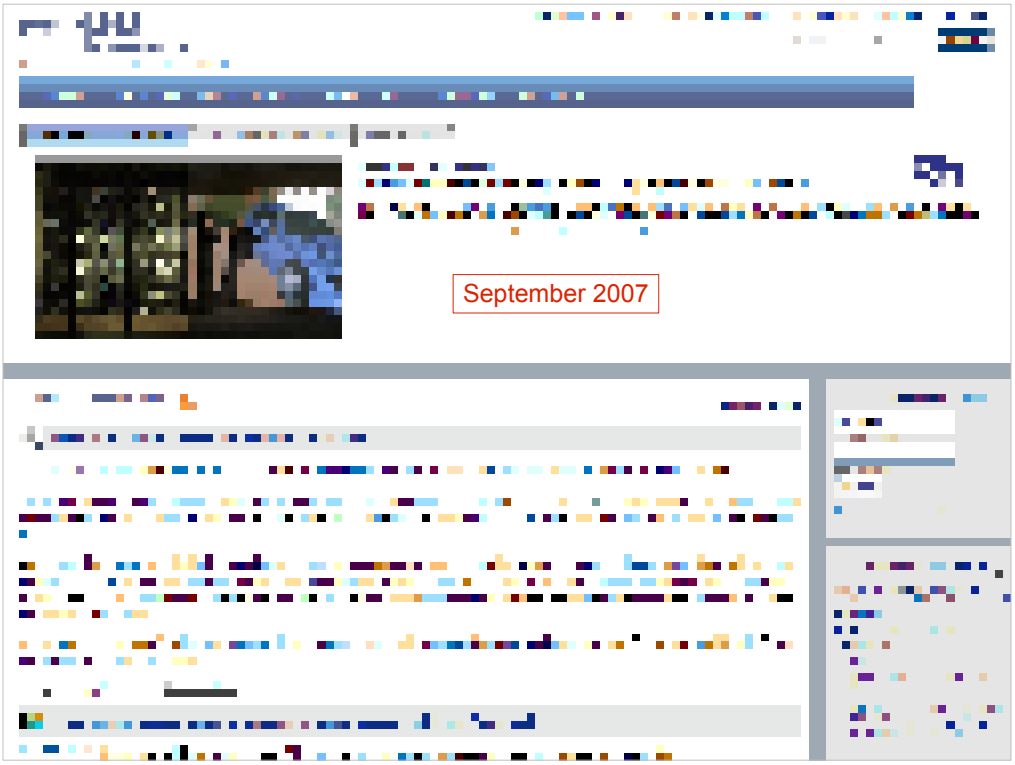
http://www.web3d.org February 2008



http://www.web3d.org January 2008



http://www.web3d.org December 2007



http://www.web3d.org September 2007

X3D Specifications

X3D graphics is defined by a set of specifications

These "specs" are developed by working-group volunteers as part of the Web3D Consortium

- Nonprofit organization with business, nonprofit, academic and professional members
- http://www.web3D.org
- Efforts include editing, implementing and evaluating

Specification results reviewed and approved by International Organization of Standardization (ISO), online at http://www.iso.ch

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Typically 10-15 member nations review and vote on the X3D Specification

Why is a 3D standard important? 1

There are many types of 3D graphics engines and plugins available. Best known:

- Computer graphics games
- Animated movies

Well-kept secret: these are rarely interoperable

- Example: no 2 experts can run the other's demo

"Silly" question: hey, let's mix 2 games together!

- ... why should adding models together be so hard?
- Proprietary software actively prevents such mergers
- Interoperability over Web can change all that

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Why is a 3D standard important? 2

Web standards let different companies do what they do well, then interoperate together

- Today there are many small islands of functionality
- Tomorrow might bring a much bigger playing field for 3D graphics to work with

A shared Web is good for everyone

- Business, public, government, universities
- Best practices emerge
- More information, more connectivity, more progress
- "A rising tide lifts all boats"

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Interoperability - what's the difference?

Multiple paths, but often confused as equal

Standard: proven process for content interoperability, scalability, compatibility, licensing, growth, success

Specification: Algorithm descriptions, necessary detail

- But: might hide royalty problems, such as GIF imagery debacle in 1990s

Open source software: pile of (maybe repeatable) code

- But: usage licensing is not same as source-code licensing

Market share dominance: biggest competitor wins?

- Companies (or at least investors) hope to "own" 3D
- But: many defunct companies, dead-end technologies
- Everyone ends up with much smaller market than the Web

It is important to use these terms precisely. They are often used interchangeably, which commonly leads to confusion about the significance of open source and open standards.

Equivalent X3D encodings, APIs

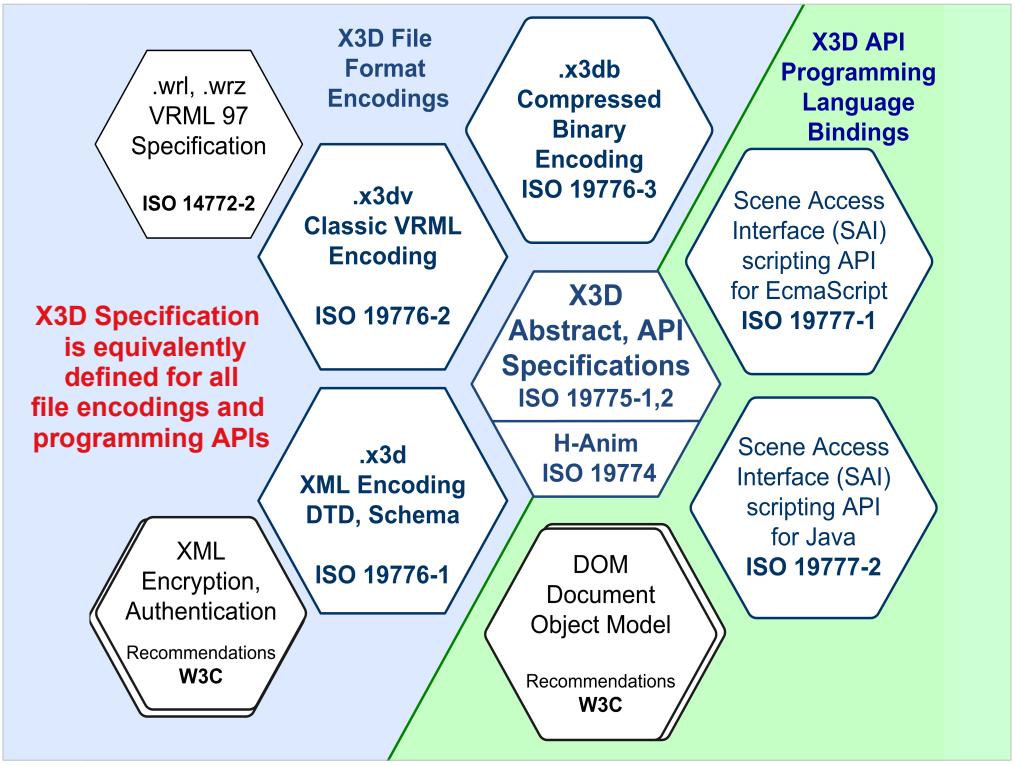
X3D has multiple file-format encodings

- .x3d is XML based
- .x3dv is ClassicVRML syntax
- .x3db is Compressed Binary Encoding with both geometric and information compression

X3D has multiple application program interfaces (APIs) with similar structure

- Javascript (formally known as EcmaScript)
- Java (optionally supported)

All these forms have equivalent functionality



This is also known as the “honeycomb” diagram for the X3D specification.

Encodings define file formats.

Each Scene Access Interface (SAI) binding is a specific Application Programming Interface (API) to simplify and regularize the consistent creation and use of programming-language objects specifically designed for X3D.

ECMAScript is the formal-specification name for JavaScript.

ECMA was originally named the European Computer Manufacturers Association and is now ECMA International - European association for standardizing information and communication systems. http://www.ecma-international.org

Reading the X3D specification

The X3D Specification is highly detailed, primarily written for 3D graphics experts.

Requirements must be described as strictly and precisely as possible so that X3D browsers can be implemented consistently. This precision means that X3D content is more likely to render and animate correctly.

Nevertheless the X3D specification is a great learning resource for additional graphics details. It is also the authoritative reference for questions.

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The Web3D Consortium was the first organization to request (and receive) permission to place final versions of approved ISO specifications online for free retrieval using HTML. Purchase of hard-copy bound and electronic versions from ISO remains available.

Community rules

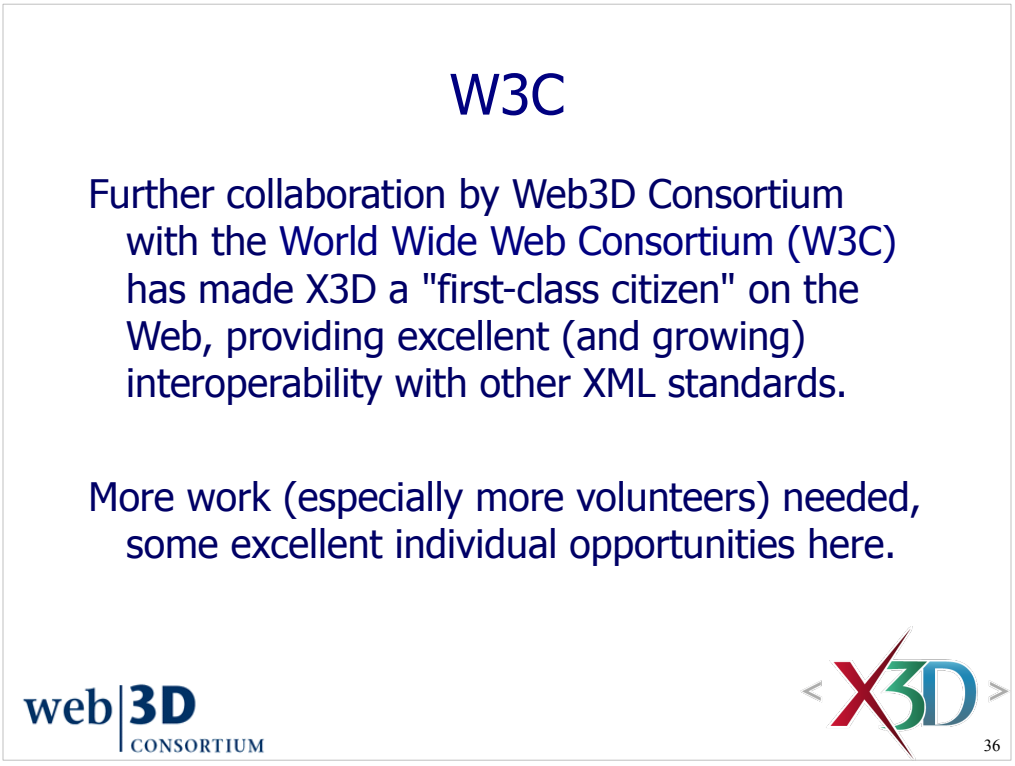
Thanks to an open process, IPR-protection rules and steady innovation by Web3D members, new X3D features continue to evolve and grow into great capabilities

Lots of working groups have formed, worked, faded, regrouped and succeeded

Web3D members and public mailing lists still keep these successes building, year after year

ISO and X3D

- Implementation, evaluation and then formal review by the International Organization of Standardization (ISO) have made X3D an approved standard for real-world use, both on and off the Web.
- Experts from 12-15 nations review our specs.
  - Immediate adoption by other governing bodies helps to increase deployment.
  - Nevertheless all changes and additions originate within Web3D working groups.



Web3D contributed to the W3C Video on the Web Workshop.

- http://www.w3.org/2008/WebVideo

- Brutzman, Don and Mathias Kolsch, “Video Requirements for Web-based Virtual Environments using Extensible 3D (X3D) Graphics,” *W3C Video on the Web Workshop*, San Jose California and Brussels Belgium, 12-13 December 2007. Available at http://www.w3.org/2007/08/video/positions/Web3D.pdf

Web3D contributed to the W3C XML Binary Compression (XBC) Workshop and continues to participate in the subsequent Efficient XML Interchange (EXI) Working Group.

- http://www.w3.org/XML/EXI

- Brutzman, Don, McGregor, Don and Hudson, Alan, "XML Binary Serialization using Cross-Format Schema Protocol (XFSP) and XML Compression Considerations for Extensible 3D (X3D) Graphics," *W3C Workshop on Binary Interchange of XML Information Item Sets*, Santa Clara, California, USA, 24-26 September 2003. Available at
  http://www.w3.org/2003/08/binary-interchange-workshop

Web3D participated in the Video on the Web workshop.

Intellectual property rights (IPR)

Web3D and W3C have similar policies

- Any known patented technology must be declared by members prior to consideration in safe haven of working groups
- Any patented technology contributions must be licensed on a royalty-free (RF) basis for inclusion in an openly used Web standard http://www.web3d.org/membership

Caveat: any legal problem can be solved, but only in advance!

Must innoculate against patent problems

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Open source: at least one

One of two independent implementations

- Required for Web3D approval, standardization

Open for any use, without license fees

- Free = freedom to innovate, free to fix!
- Not necessarily free cost
- More like "free puppy", not "free beer"

Common shared example implementations

- Can provide a self-sustaining business model for continued activity, improvement
- Can clear up logjams when companies can't resolve interoperability issues due to proprietary code

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Digital rights management

- X3D's XML and Compressed Binary encodings allow use of W3C's Security recommendations
  - XML Encryption
  - XML Digital Signature (for authentication)
  - Public key infrastructure
- More flexible DRM is now feasible
  - More uses than Hollywood-commercial exist
  - Sun's DReaM project, Open Media Commons http://www.openmediacommons.org

IPR summary

IPR = Intellectual Property Rights

Open standards & open source: part of success

Complements legacy approaches, traditional "hierarchical stovepipes," provides stability

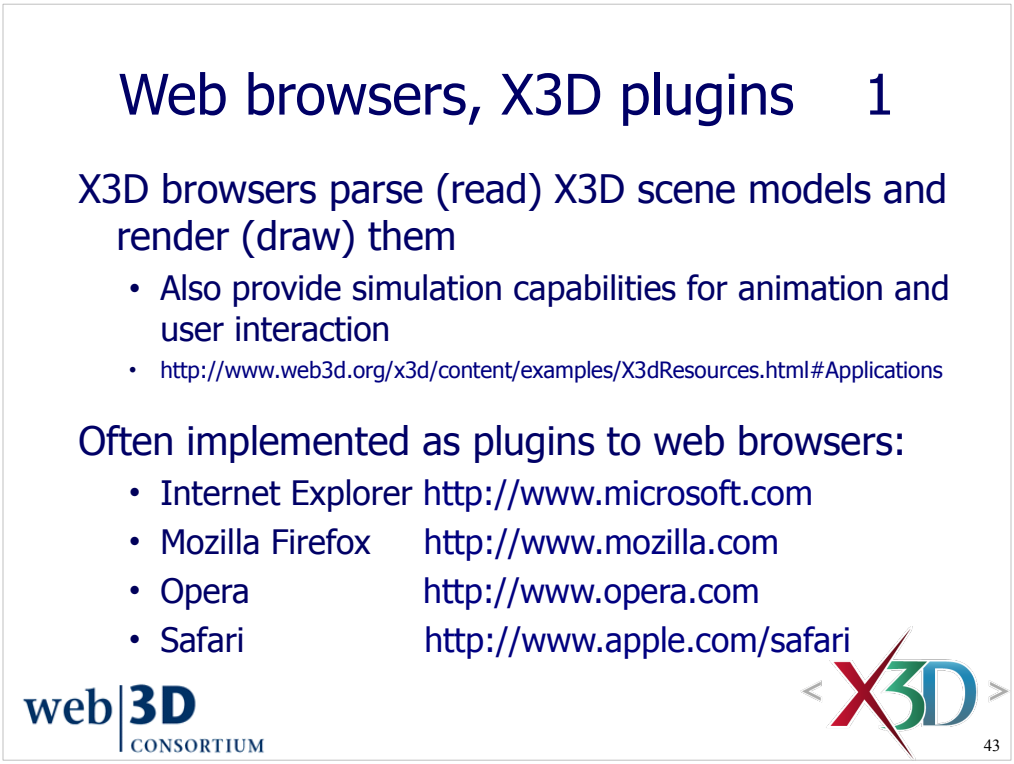
Win-win approach for government, industry

- Both wins are needed for program success

Standards organizations, IPR agreements provide a stable playing field for long term

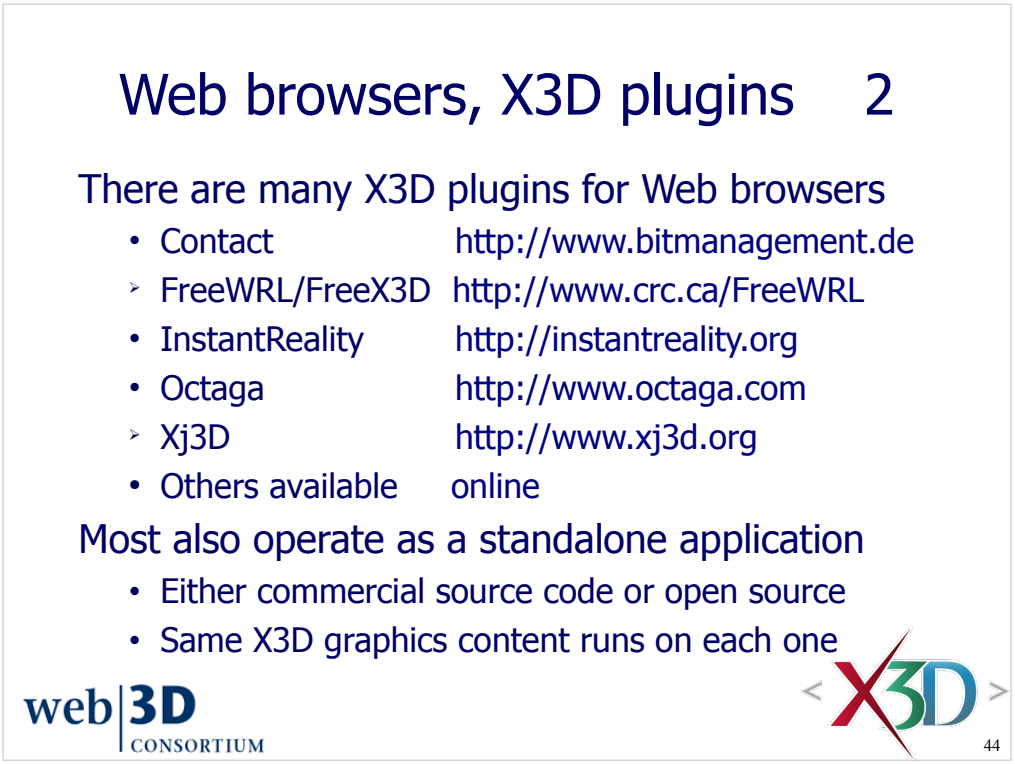
Welcome to another active playing field!

X3D Technical Overview



It is a good idea to install an X3D plugin in your web browser. Available via

http://www.web3d.org/x3d/content/examples/help.html#Applications



- Right-arrow bullets indicate open-source codebases

List of X3D browser plugins and standalone applications maintained at
http://www.web3d.org/x3d/content/examples/help.html#Applications

Player support for X3D components is kept up-to-date for each browser at
http://www.web3d.org/x3d/wiki/index.php/Player_support_for_X3D_components

X3D-Edit authoring tool supports downloading, installing and launching X3D software via your local web browser plugin or to locally installed X3D applications

Example software architecture for X3D browser

- 3D graphics algorithms and implementations are intensely technical and performance-sensitive
- X3D browsers are thus allowed to implement in any manner which they choose
  - As long as the author's X3D scene works properly
- This is a healthy split of responsibilities
  - Each gets to excel at what they are good at
- Quality designs and shared "lessons learned" continue to build up nicely
  - Next diagram shows example architecture

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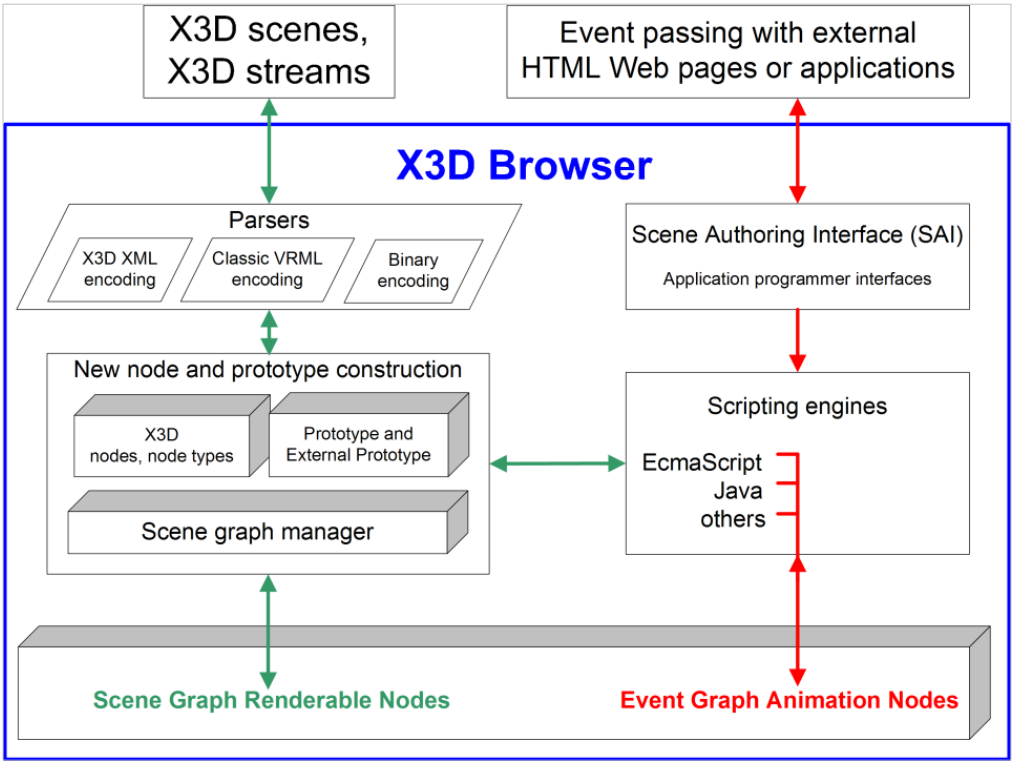

X3D browser implementers can use any approach they choose. This architecture diagram is generic to illustrate common approaches.

Part of the magic for X3D scene authors is that they don't have to care about underlying hard-core technical details “under the hood” of each browser. Rather, scenes are designed to capture shapes, appearance and behaviors from a content-authoring perspective that emphasizes modeling results.

Scene graph concepts

Scene graphs are a model-centric approach to 3D that hierarchically defines geometry shape, appearance, position and orientation, etc. etc.

- Directed acyclic graph (DAG), meaning a tree with a root node and no loops
- Declarative listing of parameters of interest
- Similar to Computer Aided Design (CAD) models: define 3D geometry and appearance, but simply

Unlike most imperative programming approaches

- draw this triangle, that triangle, recompute, etc.

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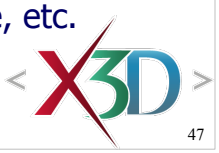

Scene graph terminology

Scene graph data file

- contains model description, may refer to data files

Scene graph viewer

- Reads and renders scene-graph models
- Implemented as application or web browser plugin

Scene graph editor

- Special text editor for scene graph development

Executable application

- Specific 3D model capable of running on a specific operating system

Scene graph rendering

The browser traverses the scene graph, updating any values within nodes and building an image

- New image then replaces previous screen image, process known as ***double buffering***
- Rapid repetitions are very important
- Frame rate faster than 7-10 Hz (cycles per second) provides appearance of smooth motion

Rendering is defined as this drawing process

Off-line rendering is performing such operations to image or movie files, rather than display

Performance optimizations

Scene graphs have performance optimizations sometimes not available in other Application Programming Interface (API) approaches

- Scene graph structure designed to take advantage of graphics hardware acceleration
- Can refer to (and reuse) subgraphs (X3D DEF, USE)
- "dirty bit" indicates whether a scene subgraph has been modified, avoiding needless recomputations
- Browser can rearrange or simplify geometry
- Scoping of lights to reduce computational impact
- Widely repeated interchange patterns

Scene-graph advantages relative to OpenGL, DirectX render layers

- OpenGL and DirectX APIs are thin software layers that expose underlying 3D graphics-acceleration hardware for real-time rendering
- Each is a state machine, optimized for drawing triangles textures etc., not designed to have memory for modeling high-level simulation objects, remembering user actions, etc.
- Scene graphs are a closer match to simulation models, easier to model and modify

Scene graphs and ray tracing

Ray tracing emulates physical properties of light interaction with material surfaces

- Ray vectors are propagated, computed, added
- Computational time can be intensive, usually best for high-fidelity rendering (rather than real-time)

Variety of different approaches, programs

- Persistence of Vision Raytracer (www.povray.org)
- Movies, e.g. Renderman (renderman.pixar.com)

Scene graph designed for real-time rendering

- But X3D Specification has no rendering prohibitions
- Okino Polytrans supports both (www.okino.com)

Many other scene graph architectures

OpenInventor (OI), predecessor of VRML

- http://oss.sgi.com/projects/inventor

Virtual Reality Modeling Language (VRML), direct predecessor of X3D

- http://www.web3d.org/x3d/specifications

Java3D quite similar to X3D scene graph

- https://java3d.dev.java.net

OpenSceneGraph (OSG)

- http://www.openscenegraph.org

OpenSG

- http://www.opensg.org

OpenInventor reference on Wikipedia: http://en.wikipedia.org/wiki/Open_Inventor

VRML97 is still an approved ISO specification. Furthermore the X3D ClassicVRML encoding is a direct extension of VRML 97, moving from version 2.0 to 3.0.

The Java3D scene graph has been described as over 90% similar to VRML and X3D. There are many good books and resources.

From the website: “The OpenSceneGraph is an open source high performance 3D graphics toolkit, used by application developers in fields such as visual simulation, games, virtual reality, scientific visualization and modeling.”

Behaviors

Behavior is defined as changing the value of a field contained by some node in scene graph

Animation nodes, user interaction nodes and network updates can produce updated values

ROUTE statements connect output of one node as an input to field in another node

Event is defined as the time-stamped value passed by a ROUTE, from one field to another

Thus the values held by nodes in scene graph can change as time advances

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Behavior traversal of scene graph

Once frame is swapped to update screen image, need to update values in the scene

Event model consists of

- Examining clock-driven and user-initiated events
- Updating scene-graph values
- Triggering and updating new events as appropriate
- Continue until all events handled, loops not allowed

Event updates modify the scene graph

- Changing rendering properties, or
- Generating further event outputs

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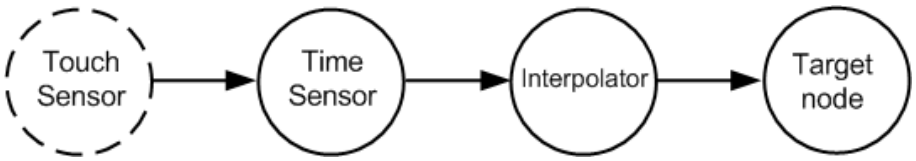
Example behavior event chain

- User clicks button to start a timer clock
- Clock outputs new event at start of each frame,
- ... which stimulates linear-interpolation function which produces another output value
- ... which updates some target value in scene graph
- Repeat event traversal after each frame redraw



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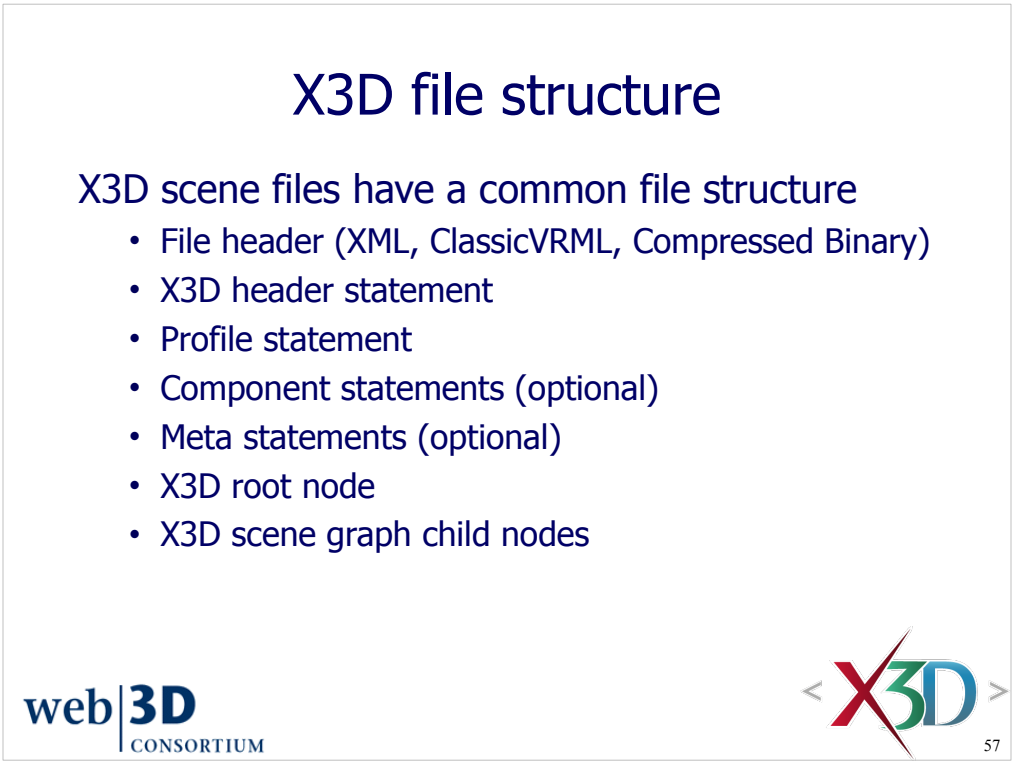
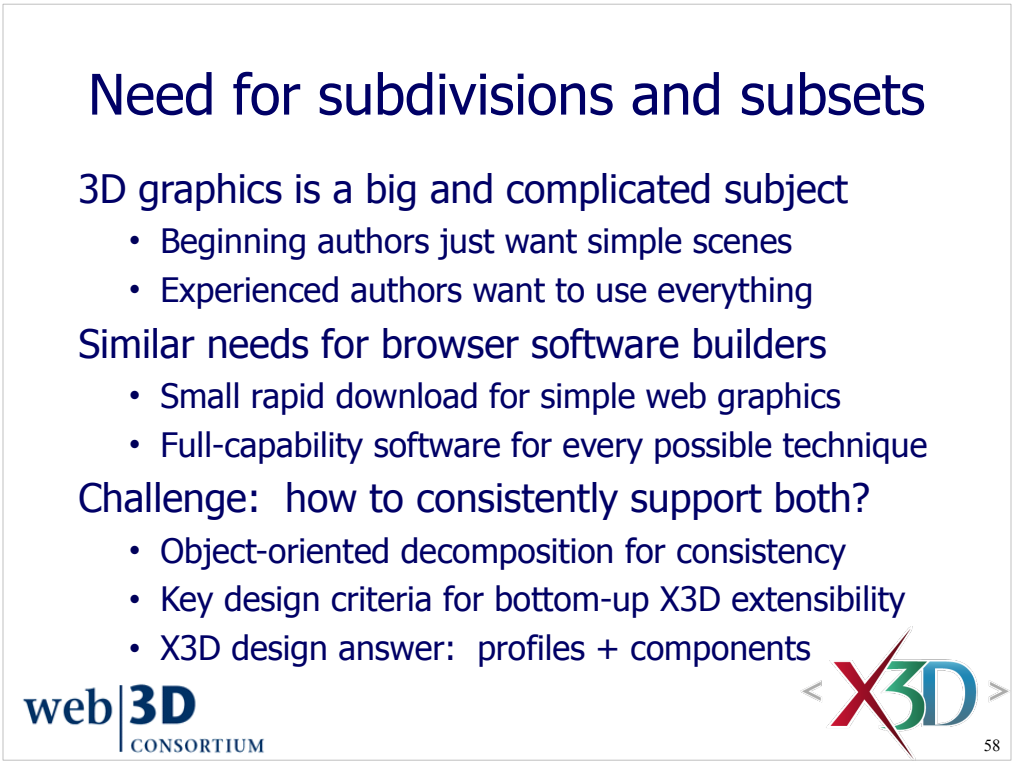
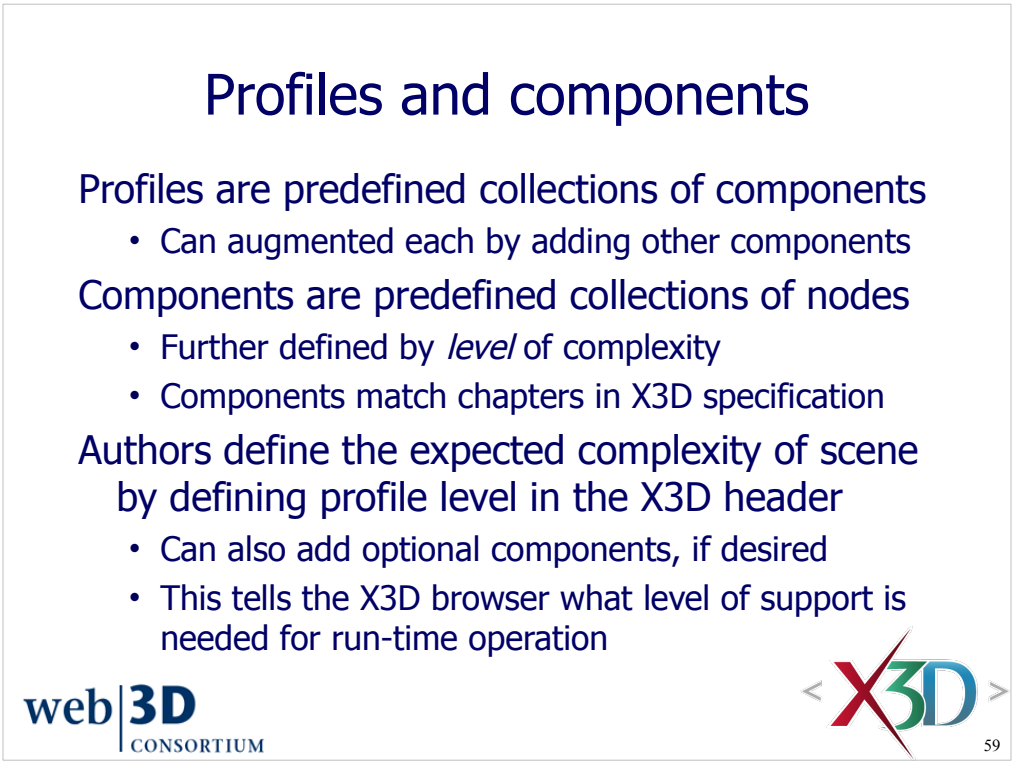


The X3D scene root node is implicit in ClassicVRML encoding and not listed per se.



These points are some of the original design challenges that faced X3D architects when evolving from the successes and lessons learned of VRML97.

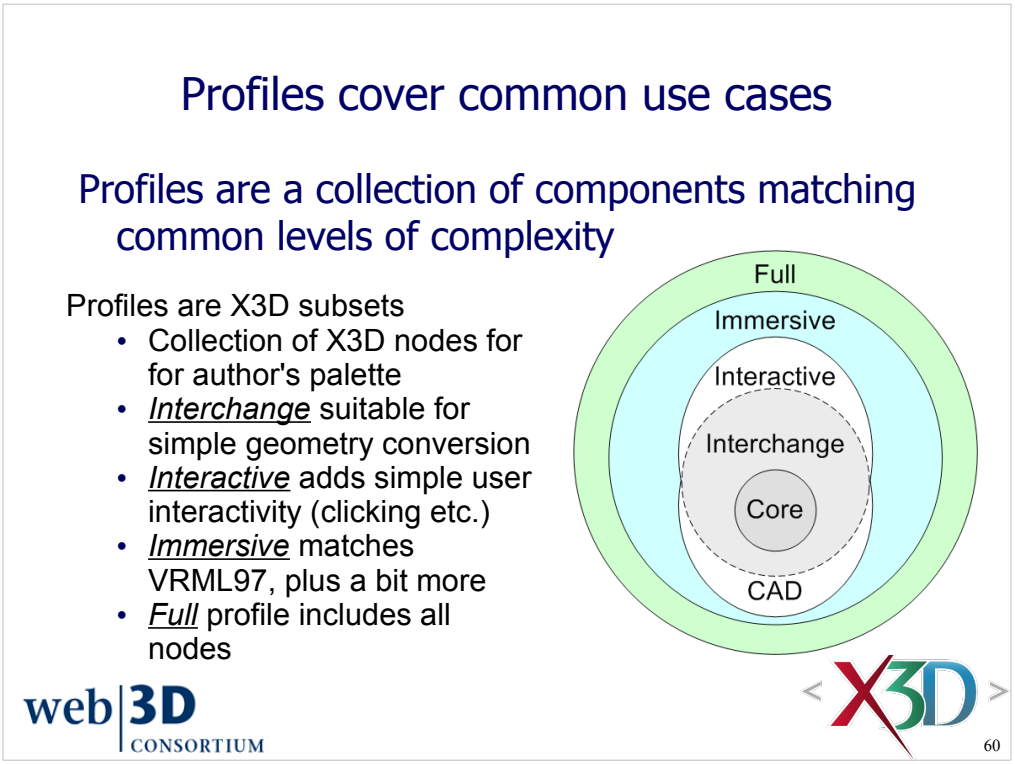


Someday X3D browser software applications might themselves begin to componentize, enabling a light-weight initial download followed by run-time addition of further components as needed.

Each specification chapter includes a table at the end that lists the nodes and fields which are included for each component level.

This might sound a bit complicated, but is actually a helpful thing architecturally. Authors can simply choose the best profile, rarely needing to worry about the components or levels that make them up. Authoring tools can simplify the process of identifying the minimum profile. X3D schematron validation, X3dToClassicVrml.xslt and X3dToVrml97.xslt each offer such diagnostics.

Further customization within a scene is always possible using `component` statements to identify the correct level of functional support beyond the identified profile.



This is known as the “onion” diagram for X3D profiles and components.

Usually authors don't have to worry about any of this. Immersive Profile is common for most cases. Tools warn if insufficient profile/component levels are specified.

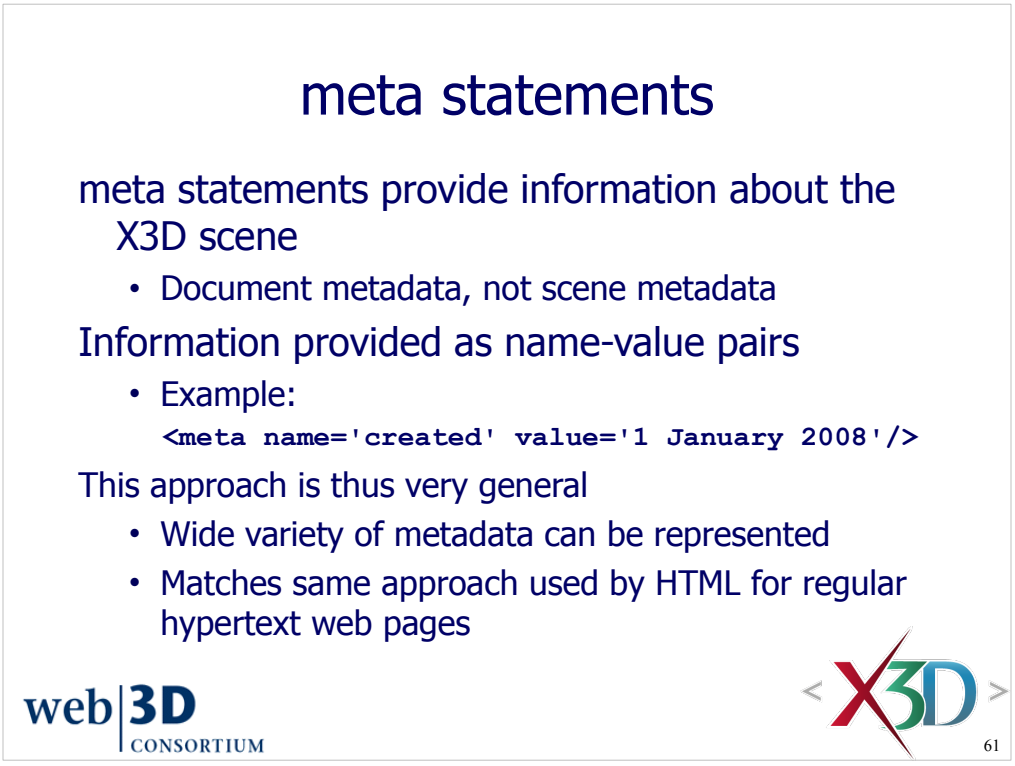
Profile and component support levels are listed in detail in X3D Specification Annexes which list corresponding support levels, nodes, numbers of polygons, etc. etc.

- A Core profile
- B Interchange profile
- C Interactive profile
- D MPEG-4 interactive profile
- E Immersive profile
- F Full profile

Of particular interest is the corresponding table which shows which version of X3D is required for each node.

- L Version content

For convenience, authors can also use the Component index, Profile index and Node Index which list the support levels required for each node.



newScene.x3d includes a number of prompts for authors to fill in the proper metadata

http://www.web3d.org/x3d/content/examples/newScene.x3d

http://www.web3d.org/x3d/content/examples/newScene.html

A variety of metadata standards exist that specify the proper metadata terms to use. This allows consistent searchability among data files that follow the metadata norms.

<!-- Additional authoring resources for meta-tags:

http://www.dublincore.org/documents/dcmi-terms

http://www.dublincore.org/documents/dces

http://www.w3.org/TR/html4/struct/global.html#h-7.4.4

http://vancouver-webpages.com/META

http://vancouver-webpages.com/META/about-mk-metas2.html

Additional authoring resources for language codes:

ftp://ftp.isi.edu/in-notes/bcp/bcp47.txt

http://www.loc.gov/standards/iso639-2/langhome.html

http://www.iana.org/numbers.html#L

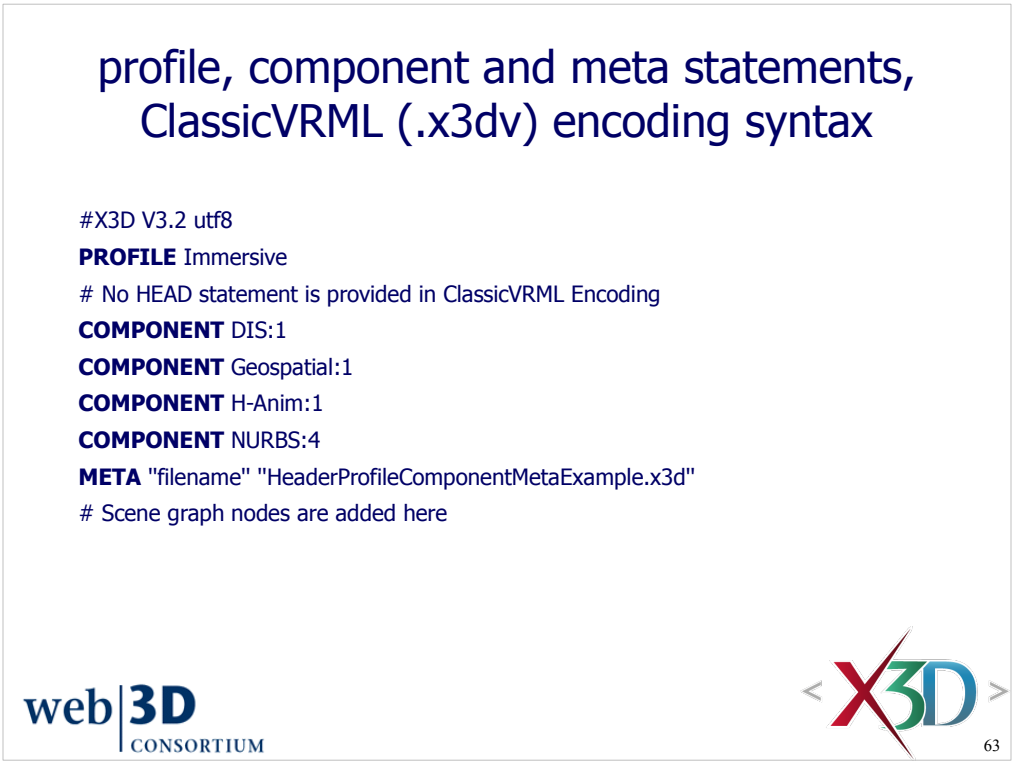
→

X3D-Edit provides this block as helpful info which you can delete from your scenes.

profile, component and meta statements, XML (.x3d) encoding syntax

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE X3D PUBLIC "ISO//Web3D//DTD X3D 3.2//EN" "http://www.web3d.org/specifications/x3d-3.2.dtd">
<X3D version="3.2" profile="Immersive" xmlns:xsd="http://www.w3.org/2001/XMLSchema-instance"
                    xsd:noNamespaceSchemaLocation="http://www.web3d.org/specifications/x3d-3.2.xsd">
    <head>
        <component name='DIS' level='1'/>
        <component name='Geospatial' level='1'/>
        <component name='H-Anim' level='1'/>
        <component name='NURBS' level='4'/>
        <meta name='title' content='HeaderProfileComponentMetaExample.x3d'/>
    </head>
    <Scene>
        <!——Scene graph nodes are added here——>
    </Scene>
</X3D>
```

Profile capabilities are identified first, then component capabilities are incrementally added.

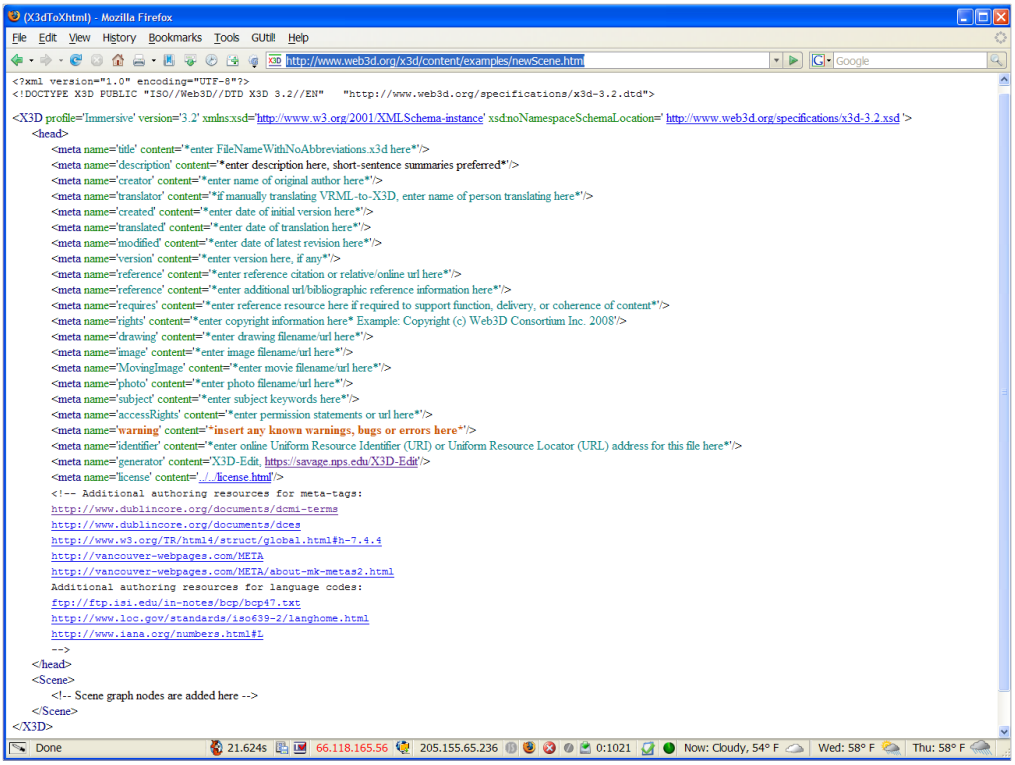


The book and slideset emphasize XML (.x3d) syntax over ClassicVRML (.x3dv) syntax but each may be used equivalently.

X3D-Edit is designed using the XML (.x3d) encoding, with ability to import/export ClassicVRML (.x3dv) and the Compressed Binary Encoding (.x3db). Native editing support for .x3dv (node coloration, popup menus, etc.) may be provided someday.

newScene.x3d metadata prompts

```
<meta content='*enter FileNameWithNoAbbreviations.x3d here*' name='title'/>
<meta content='*enter description here, short-sentence summaries preferred*' name='description'/>
<meta content='*enter name of original author here*' name='creator'/>
<meta content='*if manually translating VRML-to-X3D, enter name of person translating here*' name='translator'/>
<meta content='*enter date of initial version here*' name='created'/>
<meta content='*enter date of translation here*' name='translated'/>
<meta content='*enter date of latest revision here*' name='modified'/>
<meta content='*enter version here, if any*' name='version'/>
<meta content='*enter reference citation or relative/online url here*' name='reference'/>
<meta content='*enter additional url/bibliographic reference information here*' name='reference'/>
<meta content='*enter reference resource here if required to support function, delivery, or coherence of content*' name='requires'/>
<meta content='*enter copyright information here* Example: Copyright (c) Web3D Consortium Inc. 2008' name='rights'/>
<meta content='*enter drawing filename/url here*' name='drawing'/>
<meta content='*enter image filename/url here*' name='image'/>
<meta content='*enter movie filename/url here*' name='MovingImage'/>
<meta content='*enter photo filename/url here*' name='photo'/>
<meta content='*enter subject keywords here*' name='subject'/>
<meta content='*enter permission statements or url here*' name='accessRights'/>
<meta content='*insert any known warnings, bugs or errors here*' name='warning'/>
<meta content='*enter online Uniform Resource Identifier (URI) or Uniform Resource Locator (URL) address for this file here*'
    name='identifier'/>
<meta content='X3D-Edit, https://savage.nps.edu/X3D-Edit' name='generator'/>
<meta content='../../license.html' name='license'/>
```



http://www.web3d.org/x3d/content/examples/newScene.html

Field data types

X3D is a strongly typed language

- Each field in each node (i.e. each XML attribute) has a strictly defined data type
- Data types for boolean, integer, floating point, string

Types are either single or multiple-value

- Examples: SFFloat, SFVec2f, SFVec3f, SFOrientation

Also have arrays for all types

SF = Single Field, MF = Multiple Field (array)

Failure to match data types correctly is an error!

- During scene validation, loading, or at run time

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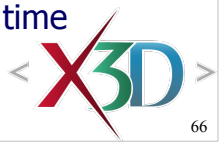

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Data types and accessType names are listed on the following slides, and later covered in detail in *X3D for Web Authors*, Chapter 7, Event Animation and Interpolation.

Types are either single or multiple-value. Examples: SFFloat (single-value), SFVec2f (2-tuple), SFVec3f (3-tuple), SFOrientation (4-tuple for axis-angle values).

Data type and accessType information is available for each node in the X3D Tooltips and X3D Specification.

When speaking about data types, you can substitute “array of” for the “MF” prefix. Example: “MFColor is an array of Color values.”

Field data types, part 1

Field-type names	Description	Example values
SFBool	Single-field boolean value	true or false (X3D syntax), TRUE or FALSE (ClassicVRML syntax)
MFBool	Multiple-field boolean array	true false false true (X3D syntax), [TRUE FALSE FALSE TRUE] (ClassicVRML syntax)
SFColor	Single-field color value, red-green-blue	0 0.5 1.0
MFColor	Multiple-field color array, red-green-blue	1 0 0, 0 1 0, 0 0 1
SFColorRGBA	Single-field color value, red-green-blue alpha (opacity)	0 0.5 1.0 0.75
MFColorRGBA	Multiple-field color array, red-green-blue alpha (opacity)	1 0 0 0.25, 0 1 0 0.5, 0 0 1 0.75 (red green blue, varying opacity)
SFInt32	Single-field 32-bit integer value	0
MFInt32	Multiple-field 32-bit integer array	1 2 3 4 5
SFFloat	Single-field single-precision floating-point value	1.0
MFFloat	Multiple-field single-precision floating-point array	–1 2.0 3.14159

X3D for Web Authors, Table 1.4, pp. 19-20.

X3D Field Type Reference online at

http://www.web3d.org/x3d/specifications/ISO-IEC-19775-1.2-X3D-AbstractSpecification/Part01/fieldsDef.html#FieldTypes

Field data types, part 2

Field-type names	Description	Example values
SFDouble	Single-field double-precision floating-point value	2.7128
MFDouble	Multiple-field double-precision array	–1 2.0 3.14159
SFImage	Single-field image value	Contains special pixel-encoding values, see Chapter 5 for details
MFImage	Multiple-field image value	Contains special pixel-encoding values, see Chapter 5 for details
SFNode	Single-field node	<Shape/> or Shape {space}
MFNode	Multiple-field node array of peers	<Shape/><Group/><Transform/>
SFRotation	Single-field rotation value using 3-tuple axis, radian angle form	0 1 0 1.57
MFRotation	Multiple-field rotation array	0 1 0 0, 0 1 0 1.57, 0 1 0 3.14
SFString	Single-field string value	"Hello world!"
MFString	Multiple-field string array	"EXAMINE" "FLY" "WALK" "ANY"
SFTime	Single-field time value	0
MFTime	Multiple-field time array	–1 0 1 567890

X3D for Web Authors, Table 1.4, pp. 19-20.

X3D Field Type Reference online at

http://www.web3d.org/x3d/specifications/ISO-IEC-19775-1.2-X3D-AbstractSpecification/Part01/fieldsDef.html#FieldTypes

Field data types, part 3

Field-type names	Description	Example values
SFVec2f/SFVec2d	Single-field 2-float/2-double vector value	0 1.5
MFVec2f/MFVec2d	Multiple-field 2-float/2-double vector array	1 0, 2 2, 3 4, 5 5
SFVec3f/SFVec3d	Single-field vector value of 3-float/ 3-double values	0 1.5 2
MFVec3f/MFVec3d	Multiple-field vector array of 3-float/ 3-double values	10 20 30, 4.4 –5.5 6.6

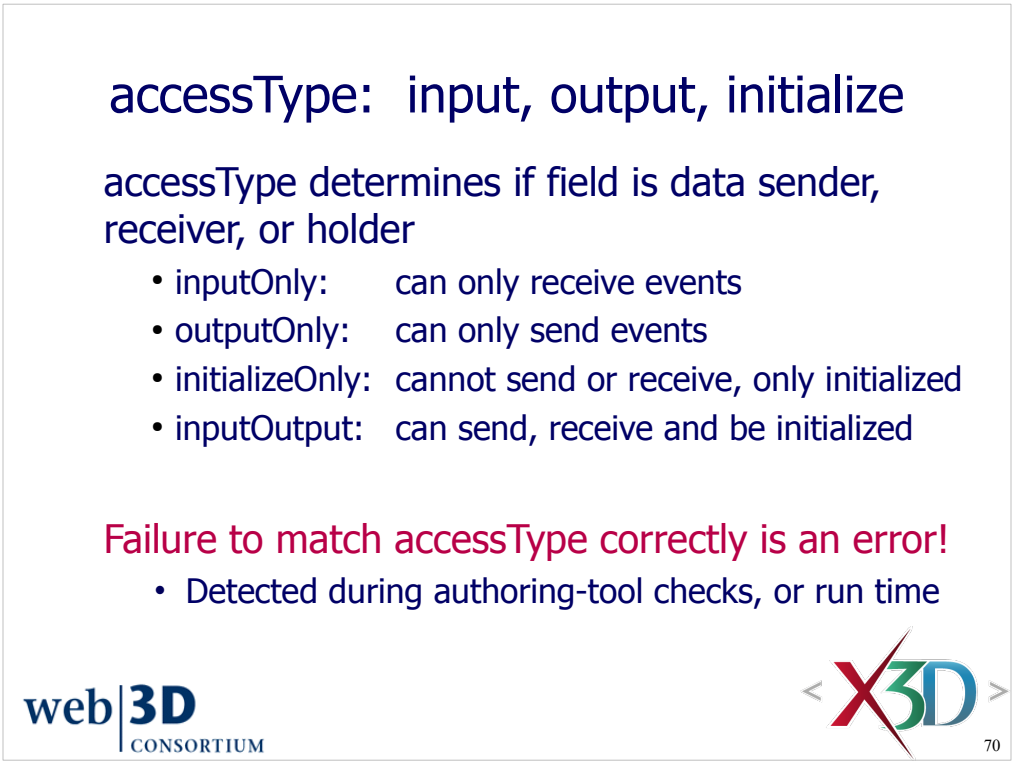
ClassicVRML (.x3dv) encoding has some syntax differences compared to XML encoding (.x3d)

- TRUE and FALSE (rather than XML true and false)
- MF multiple-field array values are surrounded by square brackets, e.g. `[ 10 20 30, 4.4 -5.5 6.6 ]`
- No special XML escape characters such as `&`

X3D for Web Authors, Table 1.4, pp. 19-20.

X3D Field Type Reference online at
http://www.web3d.org/x3d/specifications/ISO-IEC-19775-1.2-X3D-AbstractSpecification/Part01/fieldsDef.html#FieldTypes

TODO improved resolution figure



Data types and accessType are covered in *X3D for Web Authors*, Chapter 7, Event Animation and Interpolation.

Data type and accessType information is available for each node in the X3D Tooltips and X3D Specification.

accessType naming conventions

The accessType names were changed when VRML97 was upgraded to X3D

- Functionality remains essentially unchanged

X3D specification entries for each node use yet another shorthand, as shown here

VRML97 Name	X3D Name	X3D Specification abbreviation
eventIn	inputOnly	[in]
eventOut	outputOnly	[out]
field	initializeOnly	[ ]
exposedField	inputOutput	[in,out]

VRML, Virtual reality modeling language; X3D, Extensible 3D.

Use the X3D nomenclature in .x3d scenes

X3D for Web Authors, Table 1.6, p. 28.

Abstract node types

X3D nodes also have strong typing

- Provides consistent field interfaces for similar nodes
- Object-oriented improvement over VRML97, which had several internal inconsistencies
- Better language design

Benefits include

- Allowed child-node content is consistent
- Simple-type field values have identical defaults
- Application programming interfaces more consistent
- Definitions are easier to remember and apply

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XML file encoding

The Extensible Markup Language (XML) is a plain-text format used by many Web languages

- Including Hypertext Markup Language (HTML)

XML is used to define other data-oriented languages

- Thus XML is not a language by itself, rather it is a language about languages, a *metalanguage*

XML has many benefits and is well-suited for X3D

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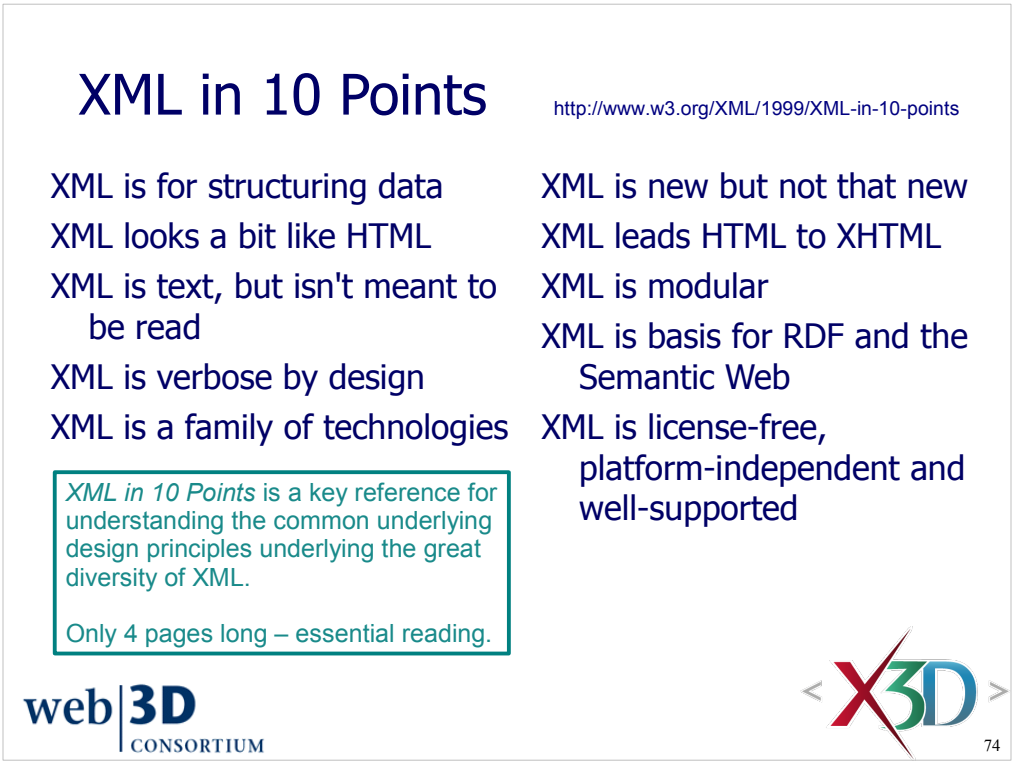
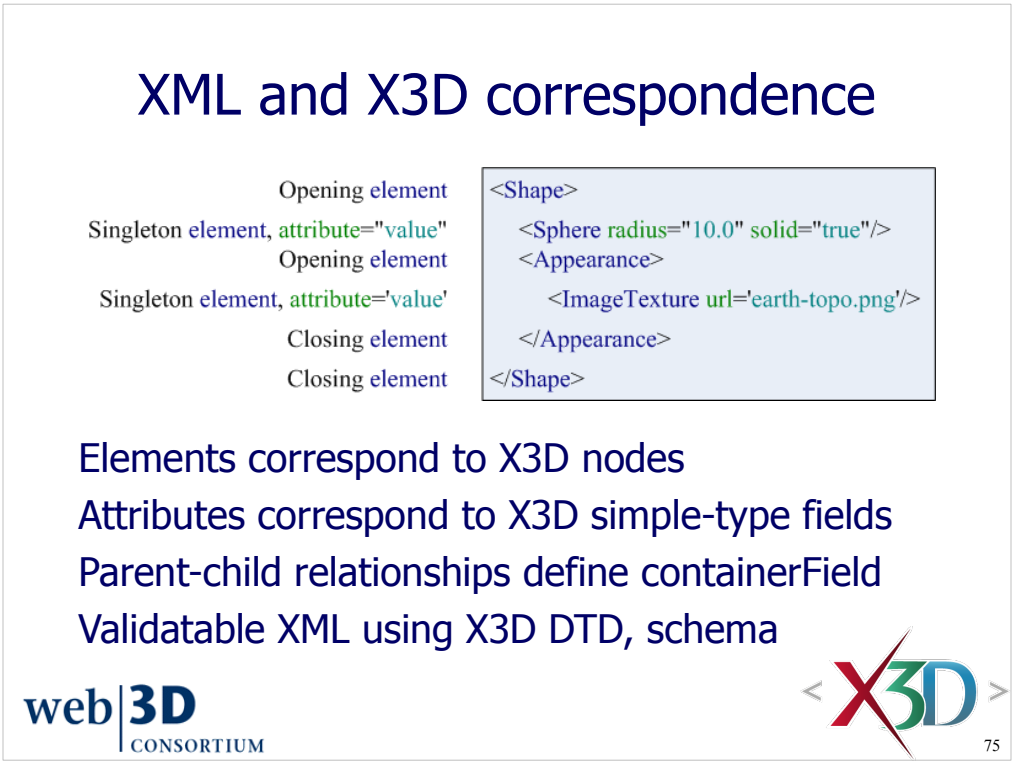


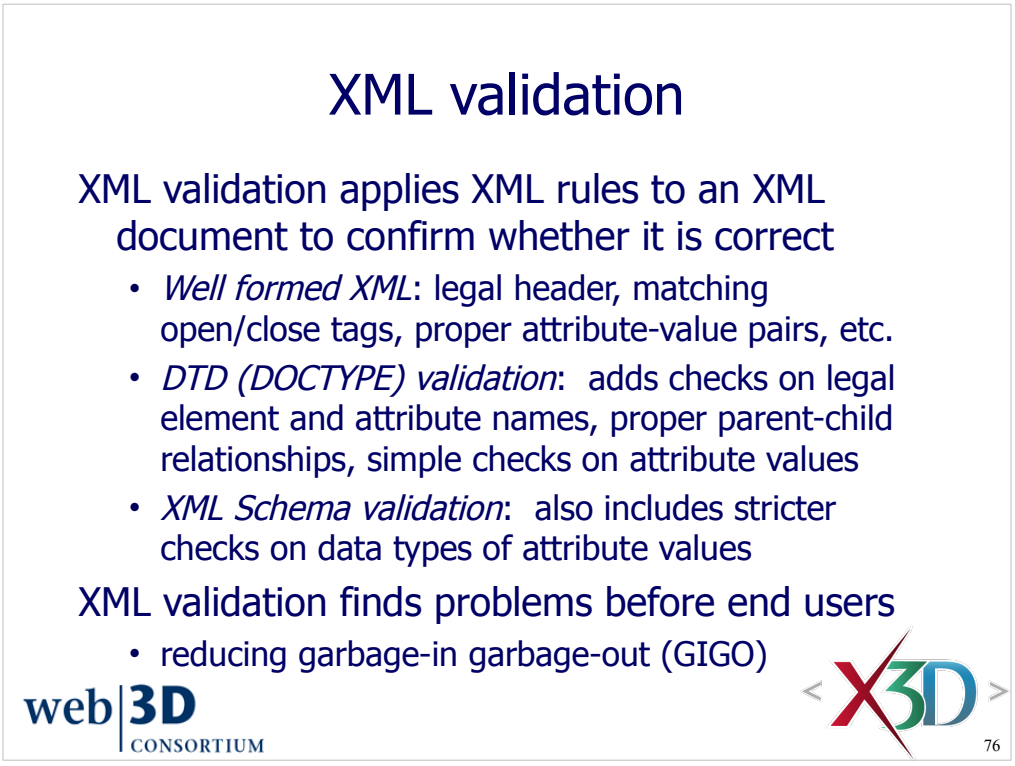
Bert Bos et al., "XML in 10 Points,: World Wide Web Consortium (W3C), created 1999, updated 2003. Available at http://www.w3.org/XML/1999/XML-in-10-points



XML documents have a tree structure that is a good match for the X3D scene graph.

Critical benefit: XML well-formed checks and validation detect numerous tricky errors.

- Draconian parse rule prevents an XML parser from continuing if errors are encountered. This is a good thing, because it forces the author to find and fix critical input problems, rather than having the application somehow trying to fix or recover from incorrect input.
- This approach thus prevents Garbage In Garbage Out (GIGO) syndrome.
- It is better to know that faults occur. The worst error is the unrecognized error.



There are DTD and XML Schema definitions for X3D versions 3.1, 3.2 and 3.3

Additional quality-control checks are possible using special XSLT stylesheets and various X3D browsers themselves.

ClassicVRML file encoding

The ClassicVRML file syntax is a direct, backwards-compatible extension of VRML97

- VRML version 2.0 became X3D version 3.0, 3.1 etc.
- No changes in syntax rules
- Some additional new nodes and slight naming differences to match specification improvements
- VRML97 content still works and is easily supported

XML, ClassicVRML and Compressed Binary encodings are functionally equivalent

- Governed by same X3D abstract specification

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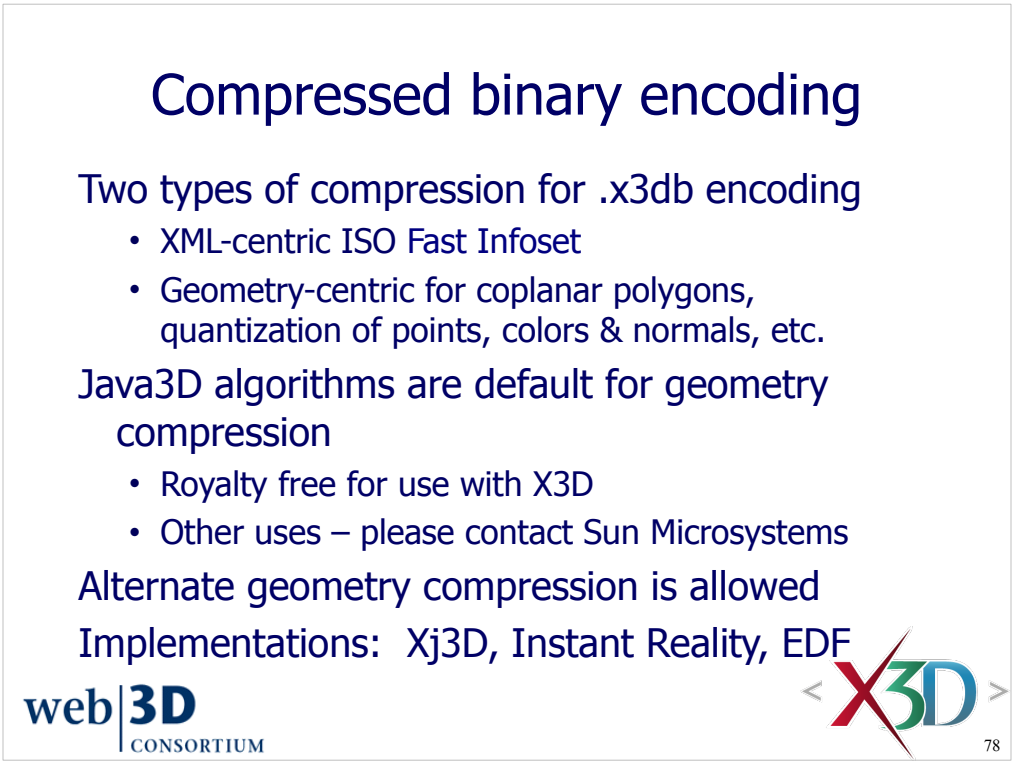
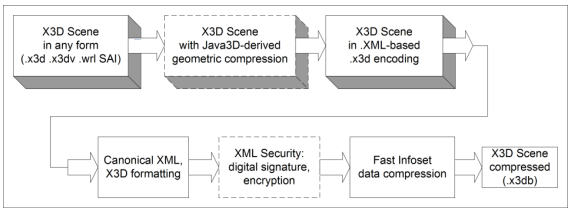


ISO Fast Infoset described at http://en.wikipedia.org/wiki/Fast_Infoset

X3D compressed binary algorithm and XML Security



X3D compressed binary uses Canonical X3D form

- Strict formatting rules so that files with identical format can be shown to match

Canonical form enables use of XML Security

- XML Encryption
- XML Digital Signature (for author authentication)

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X3D security examples, description an references:

- http://www.web3d.org/x3d/content/examples/Basic/Security/X3dSecurityReadMe.html
- http://www.web3d.org/x3d/content/examples/Basic/Security
- World Wide Web Consortium (W3C) Security http://www.w3.org/Security
- XML Encryption http://www.w3.org/TR/xmlenc-core
- XML Signature http://www.w3.org/TR/xmldsig-core
- X3D Canonicalization (C14N)

http://www.web3d.org/x3d/specifications/ISO-IEC-FCD-19776-3.2-X3DEncodings-CompressedBinary/Part03/concepts.html#X3DCanonicalForm

TODO add link to Jeff Williams' thesis

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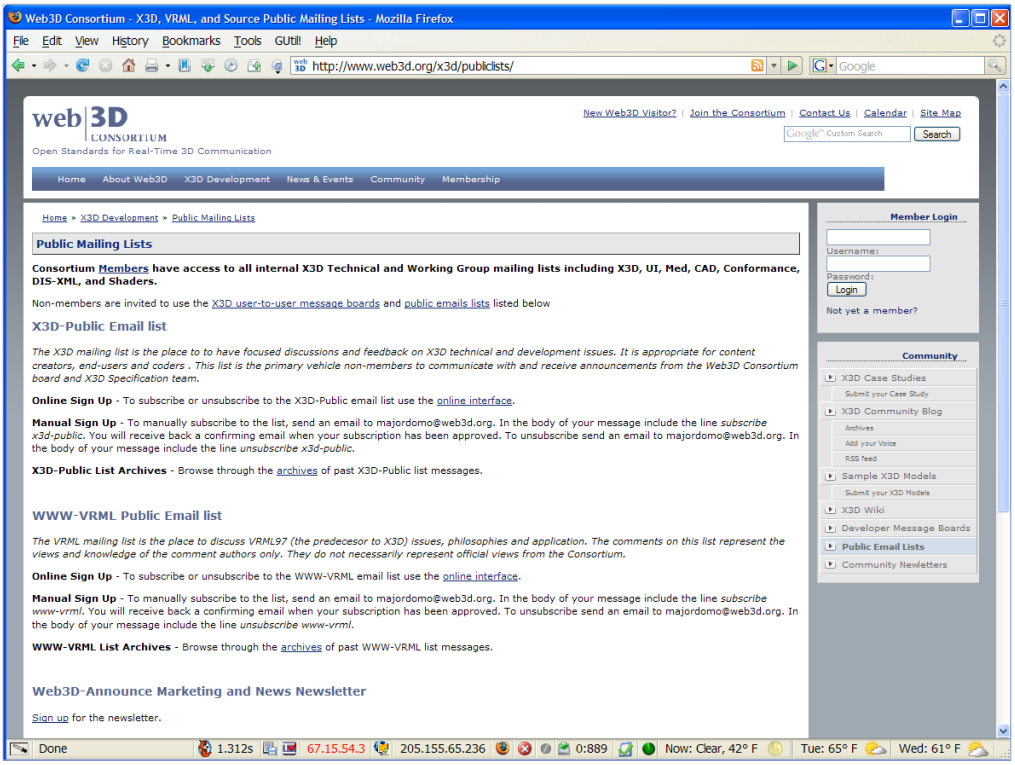
Additional Resources



There are two x3d mailing lists, plus more for other working groups

- x3d-public@web3d.org
- x3d@web3d.org private for Web3D members working on specification development

http://www.web3d.org/x3d/publiclists

W3C	http://www.w3.org
OGC	http://www.opengeospatial.org
ISO	http://iso.ch
SIGGRAPH	http://www.siggraph.org
Eurographics	http://eg.org
The Khronos Group	http://www.khronos.org

Annual Conferences 2009

SIGGRAPH

- New Orleans Louisiana, 3-7 August 2009
- http://www.siggraph.org

Web3D Symposium

- Darmstadt Germany, 15-17 June 2009
- http://www.web3d.org/conferences/web3d2009

Eurographics

- Munich Germany, 30 March - 3 April 2009
- http://www.eg.org

SIGGRAPH Asia

- Yokohama Japan 16-19 December 2009
- http://www.siggraph.org/asia2009

Web3D 2008 Tech Talk podcast

https://www.movesinstitute.org/video/web3d/SIGGRAPH2008/TechTalk2008

TODO 2009 link

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Chapter Summary

Chapter Summary

This technical overview chapter is a mile wide and a few meters deep. Key points include

- VRML historical background
- Web3D Consortium
- Browsers, X3D Specifications, scene graph
- Profiles + components, field and node data types
- XML encoding, ClassicVRML, Compressed binary

New students of X3D can refer to details later. Get working on examples in the next chapters!

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Students should have an X3D plugin installed in their Web browser by now, along with X3D-Edit or another editor.

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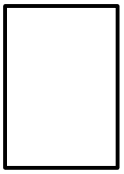
References

References 1

X3D: Extensible 3D Graphics for Web Authors by Don Brutzman and Leonard Daly, Morgan Kaufmann Publishers, April 2007, 468 pages.



- Chapter 1, Technical Overview
- http://x3dGraphics.com
- http://x3dgraphics.com/examples/X3dForWebAuthors

X3D Resources

- http://www.web3d.org/x3d/content/examples/X3dResources.html

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References 2

X3D-Edit Authoring Tool

- https://savage.nps.edu/X3D-Edit

X3D Scene Authoring Hints

- http://x3dgraphics.com/examples/X3dSceneAuthoringHints.html

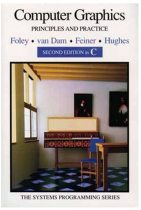
X3D Graphics Specification

- http://www.web3d.org/x3d/specifications
- Also available as help pages within X3D-Edit

References 3

Computer Graphics, Principles and Practice, by James D. Foley, Andries van Dam, Stephen K. Feiner and John F. Hughes, Addison-Wesley, second edition, 1997.

- http://portal.acm.org/citation.cfm?id=83821



Bert Bos et al., "XML in 10 Points," World Wide Web Consortium (W3C), created 1999, updated 2003.

- http://www.w3.org/XML/1999/XML-in-10-points

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<X3D>

References 4

Leonard Daly and Don Brutzman, "X3D: Extensible 3D Graphics Standard," *Standards in a Nutshell* column, *IEEE Signal Processing Magazine*, vol. 24 no. 6, November 2007, pp. 130-133.

Wayne Carlson, *A Critical History of Computer Graphics and Animation,* course notes, Ohio State University.

- http://design.osu.edu/carlson/history/lessons.html
- http://design.osu.edu/carlson/history/ID797.html

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Book testimonials 1

There will be no problem understanding these concise, clear, comprehensible background concepts for readers new to Extensible 3D (X3D). There are many notes and examples that compare X3D to Virtual Reality Modeling Language (VRML) features. Don Brutzman and Leonard Daly clearly and thoroughly illustrate each logical concept and feature of X3D with diagrams, tables, code snippets, screenshots of 3D objects/environments, and example scenes, while making use of the very latest specifications and implementations. Their approach contributes greatly to an easy and in-depth understanding of the X3D language. This book is the ultimate introductory guide to X3D!

—Dr. Vladimir Geroimenko, University of Plymouth, School of Computing Communications and Electronics, Plymouth, UK

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Book testimonials 2

This book is required reading for anybody interested in Web3D. The authors are well known and respected in the X3D community as pioneers. Their writing style is concise and engaging, set at an appropriate level to encourage understanding, and uses the concepts being introduced. Their "Hints and warnings" sections provide added value above what is available from X3D specification documents. Hard to achieve in a reference manual!

—Professor Nigel W. John, School of Computer Science, University of Wales, Bangor; Chair of Web3D 2005 Symposium

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Book testimonials 3

How many times have we heard "The ISO specification is hard to read, do you have something more approachable?" This book is the answer. It provides a detailed explanation of each node in the Immersive profile and gives many reusable examples. After reading this book you'll be well prepared to develop your own X3D content.

—Alan Hudson, President Web3D Consortium, Yumetech Inc.

This is a much-needed book about the X3D standard and X3D content development. The book follows the structure of the X3D standard specifications which helps readers understand and apply the X3D standard. It can also be used as a reference material in virtual reality and graphics-related courses.

—Professor Denis Gracanin, Virginia Polytechnic Institute & State University, Chair Web3D 2006 Symposium

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CGEMS, SIGGRAPH, Eurographics

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- to provide a source of refereed high-quality content
- as a service to the Computer Graphics community
- freely available, directly prepared for classroom use
- http://cgems.inesc.pt

X3D for Web Authors recognized by CGEMS! ☺

- Book materials: X3D-Edit tool, examples, slidesets
- Received jury award for Best Submission 2008

CGEMS supported by SIGGRAPH, Eurographics

From the CGEMS home page:

- http://cgems.inesc.pt

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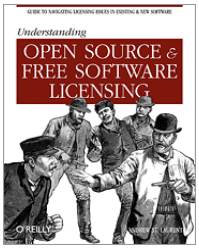
Good references on open source:



Andrew M. St. Laurent, *Understanding Open Source and Free Software Licensing*, O'Reilly Publishing, Sebastopol California, August 2004. http://oreilly.com/catalog/9780596005818/index.html

Herz, J. C., Mark Lucas, John Scott, *Open Technology Development: Roadmap Plan*, Deputy Under Secretary of Defense for Advanced Systems and Concepts, Washington DC, April 2006. http://handle.dtic.mil/100.2/ADA450769