Considerations for potential new profile

Proposed X3D Graphics profile for mobile, HTML5 and augmented reality (AR) applications

Don Brutzman and Johannes Behr

Naval Postgraduate School and Fraunhofer IGD

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Background

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

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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.

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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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

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Motivation

Simple but effective

A lightweight profile is valuable for author creation of simple but dramatic content

This allows approach allows

- Production of small-footprint X3D players that can support such content well

- Easy export from other formats

- Simple vocabulary for new authors who are learning how to create content

However, defining too many profiles can become confusing and counterproductive

Existing profiles are pretty close

X3D Interchange Profile

- Simple geometry only
- Good match for display quality and efficiency

X3D Interactive Profile

- Superset of Interchange Profile
- Good match for animation
- User interaction includes Anchor links, TouchSensor which correlate to HTML5 and mobile interactions
- Drag sensors also provide complex 3D-specific manipulations via Cylinder/Plane/Sphere sensors

Other capabilities needed in new profile?

Scripting via JavaScript for more flexibility
- Can sometimes take advantage of built-in browser support, soon high performance
- Commonly understood by many Web authors

Simpler user-interaction model
- Match common interface conventions already in use

Improve X3D value to important new areas
- Mobile applications
- Lightweight HTML5 web pages, various devices
- Augmented reality (AR)

Extensibility safety net

"First law of engineering"

- If something isn't broken, don't fix it

Existing X3D system supports specialty needs

- Author requests lower-level profile and then adds components for whatever else is needed

- This content definition can match any footprint needed

- Nevertheless browser support might be heavier than needed, since not all players are built using a componentized architecture

Thus deliberate decision is OK either way

Summary of goals for combined profile

- Define profile for X3D content creation that is suitable for mobile applications
- Determine whether similar profile might also be suitable for simple HTML5 applications
- Also determine whether common ground can be found with augmented reality (AR) applications
- Checkpoint: evaluate whether Interchange profile plus components is already sufficient

X3D encodings,
profiles and components

Equivalent X3D encodings, APIs

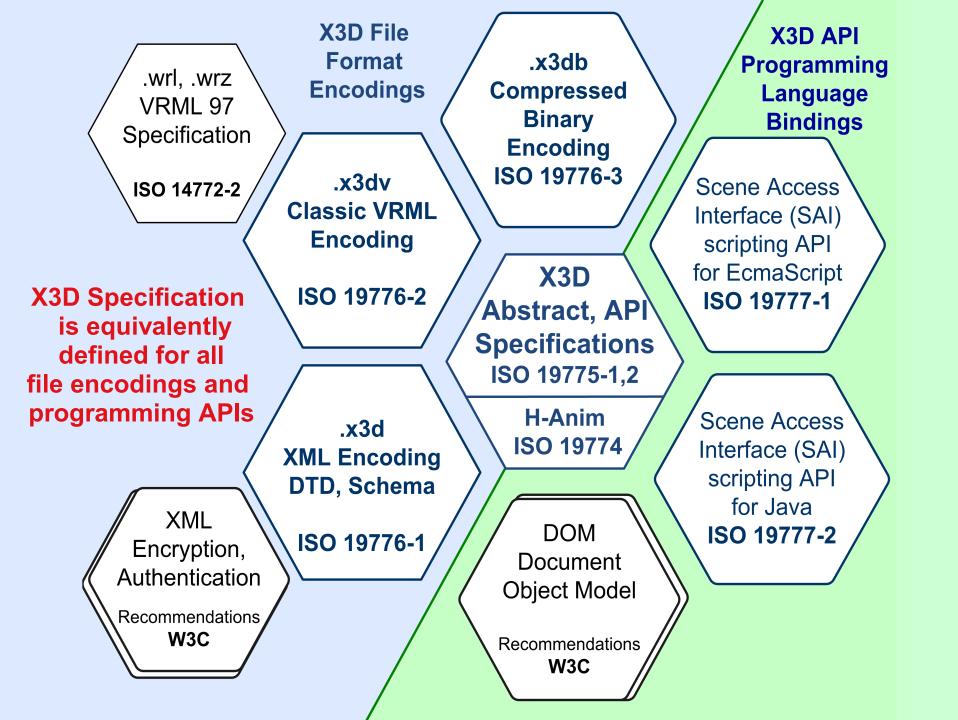X3D has multiple file-format encodings

- .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

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X3D

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

X3D Specification is equivalently defined for all file encodings and programming APIs

Scene Access Interface (SAI) scripting API for EcmaScript **ISO 19777-1**

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**

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

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

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

```xml
<?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

Shared profile considerations:

mobile, HTML5, and Augmented Reality (AR)

Common authoring footprint?

X3D implementer experience has been good

- Mobile, HTML5 and some AR applications demonstrated to date suggest that a common functionality might be achievable

If further implementation and evaluation of use cases confirms that, then a dedicated mobile profile is likely worthwhile

- rather than Interchange profile plus various components

Common platform targets

Multiple X3D mobile applications in recent years have consistently confirmed player implementability using Interactive profile

HTML5 design goals include suitability for Mobile Web applications

Augmented reality (AR) applications are typically useful only when deployed and situated within a real-world environment

- Thus a natural candidate for mobile devices

Consolidation useful

- Simplifies implementation requirements for X3D players targeting these devices

- Simplifies authoring requirements through availability of a common palette

- Enables broader application base for X3D scenes written using this new profile

X3D nodes in potential profile

HTML5 working group

X3D and HTML5 wiki is publicly available

- http://www.web3d.org/x3d/wiki/index.php/X3D_and_HTML5

Large body of work completed already

- X3D and HTML5 Summary slideset (.pdf)
- HTML5 Recommendation Additions for Integrating X3D Graphics

Especially important: X3DOM ("X-Freedom") project at http://x3dom.org
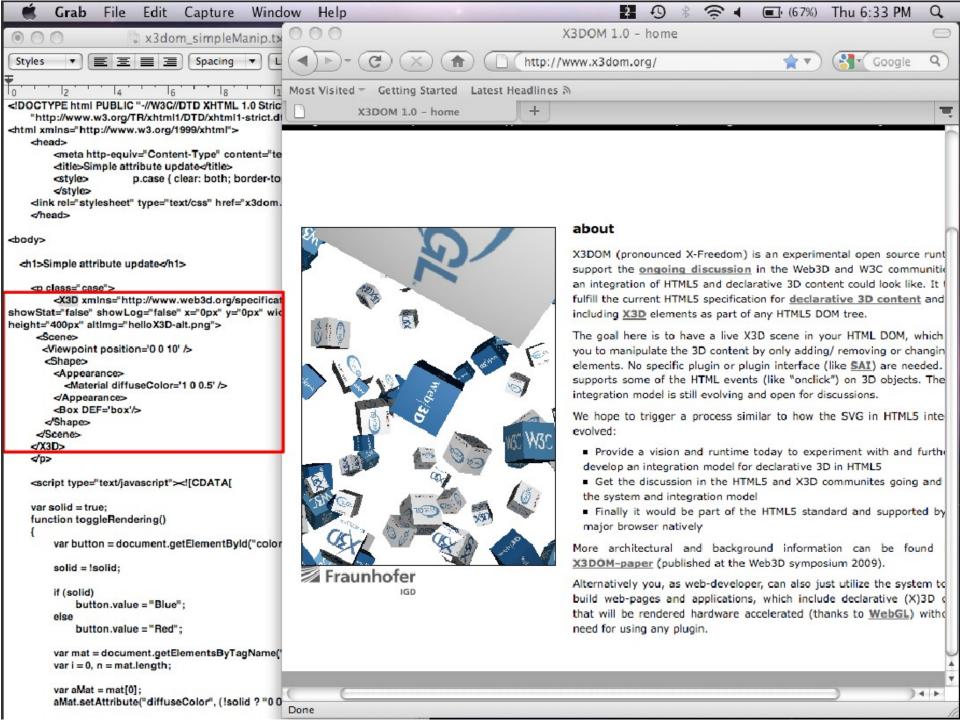
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X3DOM.org implementation

- Open Source
- Javascript / WebGL based
- Needs Firefox/WebKit nightly builds
- Runs without any plugin
- Can be easily modified while evolving
- Needs XHTML encoded data
- One line script per XHTML

Also runs on Apple Safari and Google Chrome
current developmental browsers supporting WebGL

x3dom_simpleManip.tx

Styles ▼ | ≡ ≡ ≡ ≡ | Spacing ▼ | L

```
<!DOCTYPE html PUBLIC "-//W3C//DTD XHTML 1.0 Stric
    "http://www.w3.org/TR/xhtml1/DTD/xhtml1-strict.d
<html xmlns="http://www.w3.org/1999/xhtml">
    <head>
        <meta http-equiv="Content-Type" content="te
        <title>Simple attribute update</title>
        <style>        p.case { clear: both; border-to
        </style>
    <link rel="stylesheet" type="text/css" href="x3dom.
    </head>

<body>

    <h1>Simple attribute update</h1>

    <p class="case">
        <X3D xmlns="http://www.web3d.org/specificat
showStat="false" showLog="false" x="0px" y="0px" wid
height="400px" altImg="helloX3D-alt.png">
        <Scene>
        <Viewpoint position='0 0 10' />
        <Shape>
            <Appearance>
                <Material diffuseColor='1 0 0.5' />
            </Appearance>
            <Box DEF='box'/>
        </Shape>
        </Scene>
    </X3D>
    </p>

    <script type="text/javascript"><![CDATA[

    var solid = true;
    function toggleRendering()
    {
        var button = document.getElementById("color

        solid = !solid;

        if (solid)
            button.value = "Blue";
        else
            button.value = "Red";

        var mat = document.getElementsByTagName("
        var i = 0, n = mat.length;

        var aMat = mat[0];
        aMat.setAttribute("diffuseColor", (!solid ? "0 0
```

X3DOM 1.0 – home

🔵 http://www.x3dom.org/   ⭐▼ | 🔍 Google

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about

X3DOM (pronounced X-Freedom) is an experimental open source runt
support the **ongoing discussion** in the Web3D and W3C communitie
an integration of HTML5 and declarative 3D content could look like. It
fulfill the current HTML5 specification for **declarative 3D content** and
including **X3D** elements as part of any HTML5 DOM tree.

The goal here is to have a live X3D scene in your HTML DOM, which
you to manipulate the 3D content by only adding/ removing or changin
elements. No specific plugin or plugin interface (like **SAI**) are needed.
supports some of the HTML events (like "onclick") on 3D objects. The
integration model is still evolving and open for discussions.

We hope to trigger a process similar to how the SVG in HTML5 inte
evolved:

- Provide a vision and runtime today to experiment with and furthe
  develop an integration model for declarative 3D in HTML5
- Get the discussion in the HTML5 and X3D communites going and
  the system and integration model
- Finally it would be part of the HTML5 standard and supported by
  major browser natively

More architectural and background information can be found
X3DOM–paper (published at the Web3D symposium 2009).

Alternatively you, as web-developer, can also just utilize the system to
build web-pages and applications, which include declarative (X)3D
that will be rendered hardware accelerated (thanks to **WebGL**) witho
need for using any plugin.

Done

X3DOM proposed HTML5 profile

Superset of Interactive profile, not Interchange

- http://www.x3dom.org/?page_id=158
- Does not include any internal Script nodes or support for prototypes, developers are supposed to script and partition the content from the DOM/HTML side
- Includes Inline, Anchor (not TouchSensor)
- Leave out pointing sensors so that HTML5 interaction techniques remain consistent
- Considered suitable for mobile apps

Omitted from Interactive Profile

Interactive profile specification definitions (including Interchange profile for geometry) minus

- Pointing device sensor level 1   20.5 Cylinder/Plane/Sphere/TouchSensor

- Key device sensor   level 1   21.5 KeySensor node

- Environmental sensor   level 1   22.5 ProximitySensor node

Embedded scripting?

- X3DOM shows that external use of Javascript Document Object Model (DOM) scripting has sufficiently high performance for X3D scenes

- Can pass events between parent and child X3D scenes via IMPORT/EXPORT (which is already defined for Inline X3D nodes)

Need to consider whether scripting rationale also pertains to mobile and AR applications...

- may need embedded Script node as alternative

Additional nodes

- Chasers and dampers are included because they are lightweight to implement and also add significant animation capability

- Grouping component increased to Level 3 in order to add Switch node for animation

  and StaticGroup for small-memory devices

- Triangle geometry nodes already included because they are part of Interchange Profile

  - direct match for graphics hardware acceleration

Shaders?

Shader nodes are currently included

- Pro: allow building more interesting materials and shading

- Con: content becomes much less portable due to inconsistent language support on graphics cards and operating systems, unless the X3D author provides multiple blocks of shader code

Shaders thus might be excluded from profile, further deployment testing is needed

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Multitexture?

MultiTexture nodes are currently included

- Pro: commonly available on many new machines and not too hard to implement

- Pro: Provides a good fallback for high-quality rendering (bump maps, light maps)

- Con: usually requires special authoring tools to support, more converter support needed

- TBD: available on mobile hardware?

MultiTexture rendering is perhaps especially valuable if shaders are not available

TouchSensor needed?

- TouchSensor seems consistent with HTML semantics for mouse hovering, selection

- Provides native X3D technique for selection to trigger animation or further loading

- Not computationally complex, functionality similar to Anchor

- Examine whether to include TouchSensor to simplify X3D authoring and support scene interaction when no HTML browser provided

Other sensor nodes needed?

Some sort of AccelerometerSensor is likely needed for mobile and AR applications

- Recent work by Firefox shows ability to access disk accelerometers from browser

- No proposal for X3D AccelerometerSensor yet seen, seems worth further investigation

Similar rationale might be made for a new GpsSensor node to support AR applications

Recommendations

Recommendations

- Review ISO mobile workshop contributions
- Determine both existing and needed X3D capabilities for AR
- Evaluate implementation lessons learned from HTML5 and X3DOM efforts
- Meet at Web3D and SIGGRAPH conferences in Los Angeles July 23-27 to discuss further
- Implement, evaluate for possible inclusion in draft X3D v3.3 specification
- Decide on a good name! Mobile profile?

References

References   1

X3DOM

- http://www.x3dom.org
- http://www.x3dom.org/?page_id=158

X3D and HTML5

- Working group wiki page publicly available at
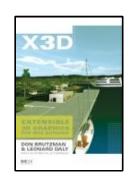- http://www.web3d.org/x3d/wiki/index.php/X3D_and_HTML5

X3D Graphics Specifications

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

References   2

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   3

X3D-Edit Authoring Tool

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

X3D Scene Authoring Hints

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

Contact

Don Brutzman

brutzman@nps.edu

http://web.nps.navy.mil/~brutzman

Code USW/Br, Naval Postgraduate School
Monterey California 93943-5000 USA
1.831.656.2149 voice
1.831.656.7599   fax

Contact

Johannes Behr

johannes.behr@igd.fraunhofer.de

www.igd.fraunhofer.de

Fraunhofer-Institut für Graphische
Datenverarbeitung IGD

Fraunhoferstr. 5 | 64283 Darmstadt | Germany

Tel +49 6151 155-510

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