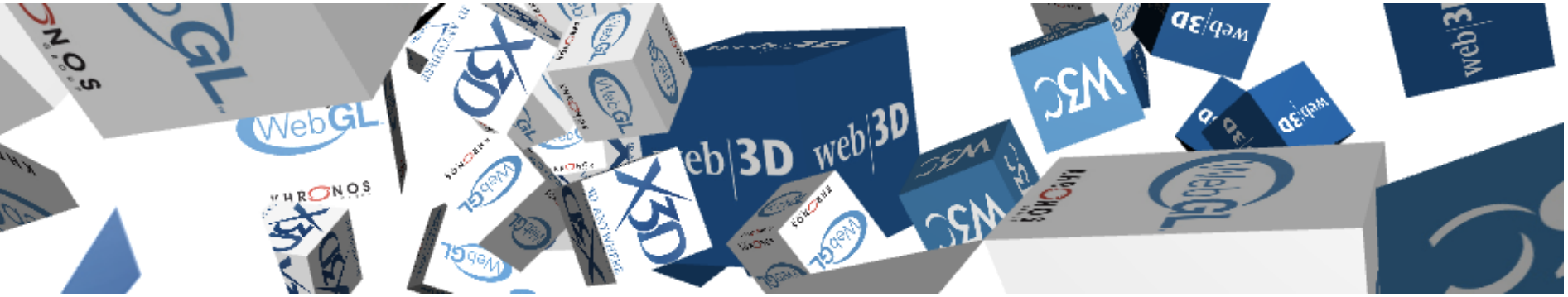
X3DOM

Fast content delivery for declarative 3D



WebGL BOF, Siggraph 2011

Johannes Behr

W3C: Chair of „Declarative 3D“ Community Group

johannes.behr@igd.fraunhofer.de

Fraunhofer IGD

W3C web3D

W3C “Declarative 3D” CG

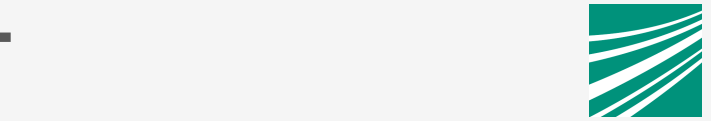
Fraunhofer IGD, DFKI and Web3D Consortium

	2D (HTML5 spec)	**3D** (No W3C spec yet)
Declarative Scenegraph Part of HTML-document DOM Integration CSS/ Events	SVG	
Imperative Procedural API Drawing context Flexible	 <canvas>	

Runs on

Declarative (X)3D in HTML

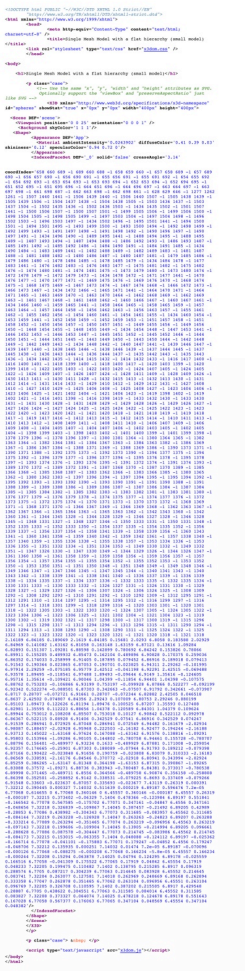
Embed a live scenegraph in the DOM



```
<!DOCTYPE html >
<html >
    <body>
        <h1>Hello X3DOM World</h1>
            <x3d xmlns='…' profile='HTML' >
                <scene>
                    <shape>
                        <box></box>
                    </shape>
                </scene>
            </x3d>
    </body>
</html>
```

Declarative (X)3D in HTML

Efficient processing of large content sets



- Real applications tend to be huge HTML-files
  - Unpleasant non-interactive user experience
  - Browser are not build to hold GByte of DOM attribute data (e.g. multiple data copies)
- Reference external sub-trees
  - X3D “Inline” node
  - black/white-box interface?
- Binary XML decompression
  - x3z: (ISO) Decoding on JS-Level
  - x3db: (ISO) Fast Infoset: No UA or JS-lib
  - EXI: (W3C) Even worse

DOM holds structure and data

```
<!DOCTYPE html>
<html>
  <head>
    <link rel='stylesheet' type='text/css' href='http://www.x3dom.org/x3dom/release/x3dom.css'></link>
    <script type='text/javascript' src='http://www.x3dom.org/x3dom/release/x3dom.js'></script>
  </head>
  <body>
    <x3d id='3dstuff' width='400px' height='400px'>
      <scene DEF='scene'>
        <shape>
          <appearance>
            <material diffuseColor='#FF0000'></material>
          </appearance>
          <indexedTriangleSet solid='false' index='0 1 2 1 3 2 1 4 3 5 4 1 0 5 1 0 6 5 6 7 5 5 7 4 7 8 4 7 9 8 7 6 9 6 10 9 10 11
9 10 2 11 10 0 2 6 0 10 11 2 3 8 11 3 4 8 3 11 8 9'>
            <coordinate point='0.447214 0 -0.894427 0.447214 0.850651 -0.276393 1 0 -0 0.447214 0.525731 0.723607 -0.447214
0.850651 0.276393 -0.447214 0.525731 -0.723607 -0.447214 -0.525731 -0.723607 -1 0 0 -0.447214 0 0.894427 -0.447214 -0.850651
0.276393 0.447214 -0.850651 -0.276393 0.447214 -0.525731 0.723607'></coordinate>
            <normal vector='0.447214 0 -0.894427 0.447214 0.850651 -0.276393 1 0 -0 0.447214 0.525731 0.723607 -0.447214 0.850651
0.276393 -0.447214 0.525731 -0.723607 -0.447214 -0.525731 -0.723607 -1 0 0 -0.447214 0 0.894427 -0.447214 -0.850651 0.276393
0.447214 -0.850651 -0.276393 0.447214 -0.525731 0.723607'></normal>
          </indexedTriangleSet>
        </shape>
      </scene>
    </x3d>
  </body>
</html>
```

DOM holds structure and data

More than 95% are usually unstructured data

```
<!DOCTYPE html>
<html>
  <head>
    <link rel='stylesheet' type='text/css' href='http://www.x3dom.org/x3dom/release/x3dom.css'></link>
    <script type='text/javascript' src='http://www.x3dom.org/x3dom/release/x3dom.js'></script>
  </head>
  <body>
    <x3d id='3dstuff' width='400px' height='400px'>
      <scene DEF='scene'>
        <shape>
          <appearance>
            <material diffuseColor='#FF0000'></material>
          </appearance>
          <indexedTriangleSet solid='false' index='0 1 2 1 3 2 1 4 3 5 4 1 0 5 1 0 6 5 6 7 5 5 7 4 7 8 4 7 9 8 7 6 9 6 10 9 10 11
9 10 2 11 10 0 2 6 0 10 11 2 3 8 11 3 4 8 3 11 8 9'>
            <coordinate point='0.447214 0 -0.894427 0.447214 0.850651 -0.276393 1 0 -0 0.447214 0.525731 0.723607 -0.447214
0.850651 0.276393 -0.447214 0.525731 -0.723607 -0.447214 -0.525731 -0.723607 -1 0 0 -0.447214 0 0.894427 -0.447214 -0.850651
0.276393 0.447214 -0.850651 -0.276393 0.447214 -0.525731 0.723607'></coordinate>
            <normal vector='0.447214 0 -0.894427 0.447214 0.850651 -0.276393 1 0 -0 0.447214 0.525731 0.723607 -0.447214 0.850651
0.276393 -0.447214 0.525731 -0.723607 -0.447214 -0.525731 -0.723607 -1 0 0 -0.447214 0 0.894427 -0.447214 -0.850651 0.276393
0.447214 -0.850651 -0.276393 0.447214 -0.525731 0.723607'></normal>
          </indexedTriangleSet>
        </shape>
      </scene>
    </x3d>
  </body>
</html>
```

Separate structure and data

HTML element reference external binary data element

DOM / HTML Document

```
<!DOCTYPE html PUBLIC "-//W3C//DTD XHTML 1.0 Strict//EN"
        "http://www.w3.org/TR/xhtml1/DTD/xhtml1-strict.dtd">
<html xmlns="http://www.w3.org/1999/xhtml">
        <head>
                <meta http-equiv="Content-Type" content="text/html;
charset=utf-8" />
                <title>Single Mesh Model with a flat hierarchy (small model)
</title>
        <link rel="stylesheet" type="text/css" href="x3dom.css" />
        </head>

<body>

    <h1>Single Mesh Model with a flat hierarchy (small model)</h1>

        <p class="case">
            <!-- Use the same "x", "y", "width" and "height" attributes as SVG.
             Optionally support the "viewBox" and "preserveAspectRatio" just
like SVG -->
                <X3D xmlns="http://www.web3d.org/specifications/x3d-namespace"
id="spheres" showStat="true" x="0px" y="0px" width="400px" height="400px">

  <Scene DEF='scene'>
    <Viewpoint position='0 0 25' orientation="0 0 0 1" />
    <Background skyColor='1 1 1'/>
   <Shape>
          <Appearance DEF='App'>
            <Material ambientIntensity='0.0243902' diffuseColor='0.41 0.39 0.03'
shininess='0.12' specularColor='0.94 0.72 0'/>
          </Appearance>
          <IndexedFaceSet DEF='_0' solid='false' creaseAngle='3.14'

0.048382'/>
          </IndexedFaceSet>
        </Shape>
        </Scene>
        </X3D>
        </p>

        <p class="case">   </p>

        <script type="text/javascript" src="x3dom.js"></script>
</body>
</html>
```

Binary asset resources

Generic asset dictionary

- Directly loaded to TypedArrays
- Data assignment in JS
- Multiple arrays per file
- Multiple files per scene

Images and Videos

- Encodes int/float arrays (e.g. coordinate, normal, texCoords, generic-attributes) in RGBA-images
- Multiple images per array
- Multiple images per scene

<img>/<video> as generic binary container

Powerful abstraction for efficient data encoding for Web-apps

- Decompression for free (only lossless png is useful right now)
- Streaming updates for free: WebGL/X3DOM support <video>
- Quantization and encoding supports LOD & streaming of precision
- Flexible end efficient visualization
  - Single VBO: Extremely fast visualization with Vertex Textures Units, precession grows until vertex texture limit is reached
  - Multiple VBO: WebGL without Vertex Texture Unit / Flash 11
- Encoding is simple, fast and works with any mesh type
- Browser/Server well optimized to handle large number of images and parallel downloads of image => Great user experience
- User, Developer, Brower, Server and W3C love images and video: Content is HTML + image/video-resource data

Demo

http://x3dom.org/x3dom/example/x3dom_imageGeometry.html