



XML3D and Xflow

An Overview and Demos

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Motivation

- 3D graphics is becoming a commodity
  - **High-Performance Graphics** – even for mobile
  - **3D-Stereo and 3D-Input** – even for consumers
  - **Fast Internet Connections** – even on wireless
- 3D graphics is still a broadcast medium
  - Almost exclusively focused on games (and CAD)
  - Specialized content for specialized engines (and v.v.)
- 3D graphics must be sharable across the Web
  - Must work for non-experts – its a means, not a goal
  - Make it available to millions of Web developers

► **Need to adapt 3D graphics for Web**

Motivation

- Compare to Video Technology
  - Technology had been since the mid 1990ies
    - RealVideo, MPEG, MMX, …
  - But nothing happened for almost a decade
- The Web changed the (Video) World
  - YouTube (2005)
    - Allowed *anyone* to *easily* add video to the *their* Web page
  - Everyone can create, share, experience video
    - Today: 2 billion views per day
    - Revenue of $1.1 Billion (target for 2011)

► **Can we repeat something similar for 3D?**

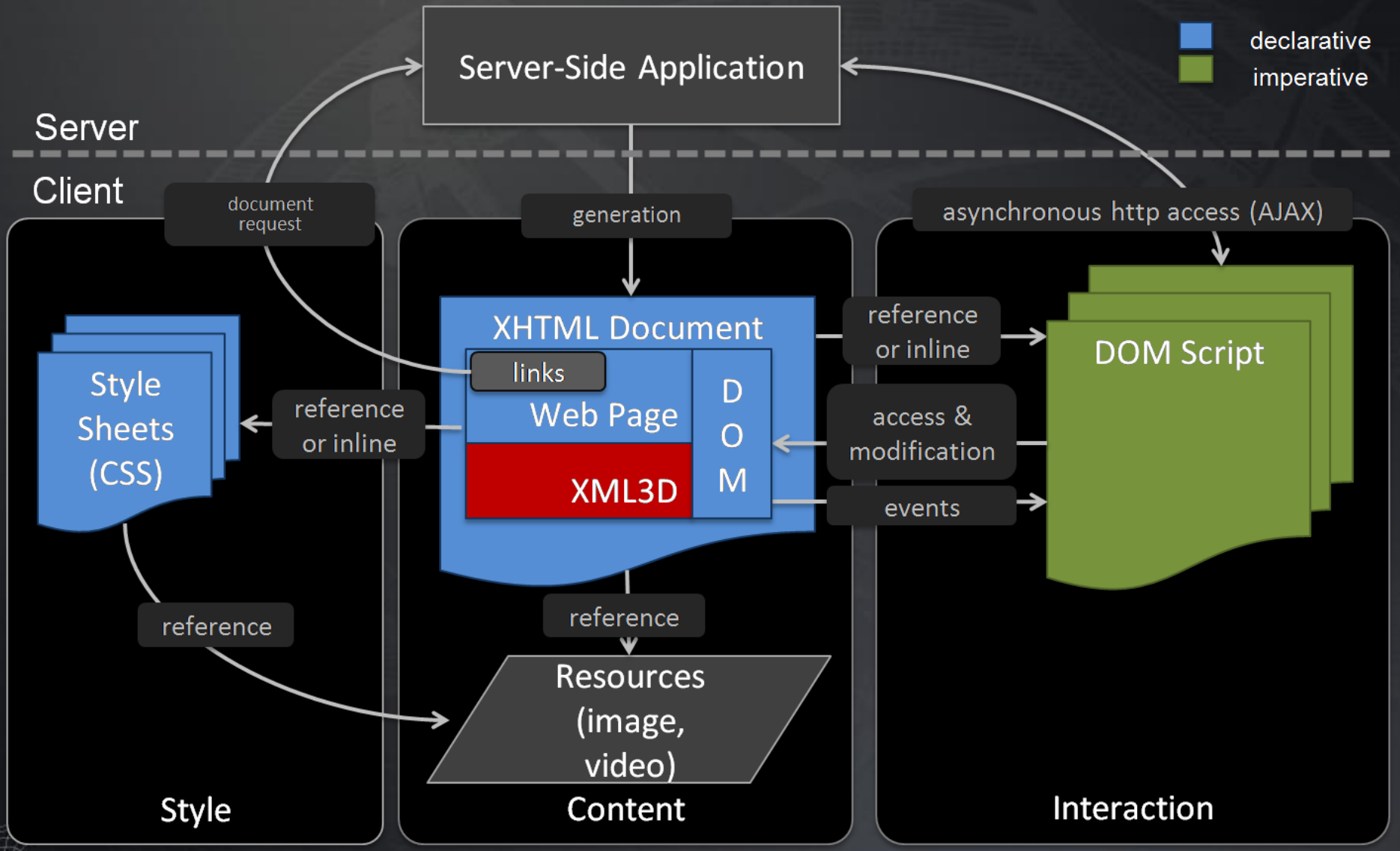
Proposal: Declarative 3D On The Web

- Make it easy to add 3D to Web pages
  - Fully integrate 3D content into HTML5 *documents*
    - Interactive 3D graphics as first class DOM objects
  - Reuse existing Web technology wherever possible
    - Avoid barrier to entry – make Web developers feel at home
    - Do not add new concepts, unless absolutely necessary
- Jump start 3D on the Web
  - Freely provide necessary technology
    - Specification of HTML extensions & standardization
    - Native browser & JS implementations, server side, …
  - Tutorials, examples, hosting, …
  - Joint initiative with research and industry

XML3D in Projects

- EU Future Internet PPP (Architecture Board)
  - Generic Enabler with Disney Research, BBC, Technicolor, Sintef, …
- EU Verve & EU SocialSensor
  - INRIA, Trinity College, several hospitals, …
- EU EIT
  - Most top EU companies & research parters
- BMBF German Spitzencluster (with X3DOM)
  - SAP, Software AG, Fraunhofer, …
- BMBF Ecouss
  - Cray, HLRS Stuttgart, RTT, Beiersdorf, …
- Industry: Caigos & Interactive Software
  - 3D-GIS Extension, IAA Presentation
- Public: Cultural Heritage
  - Museum of Saarlouis, 3D-Kiosk
- Intel Visual Computing Institute & ISTC-VC & Intel
  - Main Project Partner, Links to Stanford, Links to Business Units

Structure of Content: 2D Web



(Re-)use of Web technologies

- HTML / SVG
  - <img>, <video>, <canvas>, <iframe>
    - To define (interactive) textures.
  - <script> for programmable parts
    - Shader, vertex processing …
  - <defs> to define objects reused later
    - As in SVG
  - Event attributes: onmouseover, onclick …
    - Works the same in 3D

(Re-)use of Web technologies

- DOM
  - Event and scripting mechanisms
  - Run time environment
- CSS
  - Separate e.g. geometry from the apperance
  - CSS3 Proposals
    - 3D Transforms, Animations
- Others
  - EXI for external binary data
  - Device API
  - SMIL, XBL

XML3D Elements

- <xml3d>
  - Canvas for XML3D content
  - Embed into (X)HTML
- <defs>
  - Definition of resources
- <group>
  - Structuring and transformation hierarchy
- <transform>
  - Alternative transformation syntax, can be referenced via CSS

```
<body>
<h1>XHTML Document</h1>
<xml3d style="width: 640px; height: 480px"
       xmlns="http://www.xml3d.org/2009/xml3d">
      <!-- ... -->
</xml3d>
</body>
```

```
<xml3d ... >
<defs>
      <transform id="xfm1" translation="3 0 1" />
      <transform id="xfm2" scale="2 2 2" />
</defs>

<group style="transform: url(#xfm1)" >
      <group cass="scaleMe" >
            <mesh ... />
      </group>
      <group style="transform: scale3d(3,1,3)"
            <mesh ... />
      </group>
</group>
</xml3d>
```

XML3D Generic Data

- <data>
  - Collections of typed & named arrays (float int, …)
  - Maps well to HW
    - GPU buffers
    - Arguments to shaders
  - Allows external references
    - E.g. in binary EXI format
  - Supports easy reuse
  - Used also for XFlow

```
<xml3d ... >
<defs>
    <data id="data01">
        <int name="index" >
            0 1 2 0 1 3 1 3 4 ... </int>
        <float3 name="position" >
            0.12 3.1 2.69 ... </float3>
        <float3 name="normal" >
            1 0 0 ...</float3>
    </data>
    <data id="heatData">
        <data src="#data01"/>
        <float name="temperature" >
            32.4 19.2 -42 ...</float>
    </data>
</defs>
<!-- ... -->
</xml3d>
```

XML3D Elements

- <mesh>
  - Format for triangles, triangleStrips etc.
  - Generic mesh attributes
  - Easy to map to hardware buffers
  - Meshes that reference same data source are geometry instances

```
<xml3d ... >
<mesh type="triangles">
      <data id="myData">
            <int name="index" >
                  0 1 2 0 1 3 1 3 4 ... </int>
            <float3 name="position" >
                  0.12 3.1 2.69 ... </float3>
            <float3 name="normal" >
                  1 0 0 ...</float3>
      </data>
</mesh>
<group …>
      <mesh type="triangles" src="#myData"/>
</group>
<!-- ... -->
</xml3d>
```

XML3D Elements

- <shader>
  - Material description
  - Like paint/stroke in SVG
    - But: Arbitrary parameters
  - Use CSS to assign material to geometry
    - References shader script
    - Predefined common shaders (via URN)
  - Portable material descriptions (AnySL)

```
<xml3d ... >
<defs>
      <script id="tex_script"
            type="text/anysl:RSL">
            <!-- ... -->
      </script>

      <shader id=”shader1” script=”#tex_script” >
            <data id=“shaderData”>
                  <texture name=”diffuseTexture”>
                        <img src=”metal.png”/>
                  </texture>
            </data>
      </shader>

      <shader id=“phong”
            script=“urn:xml3d:shader:phong”>
            <data src=“#shaderData”/>
      </shader>
</defs>

<group style=”shader: url(#shader1)”
      <mesh > <!-- ... -> </mesh>
</group>
</xml3d>
```

XML3D Elements

- <view>
  - Specify a 3D viewpoint
  - May be the destination of a link
- <light>
  - Specify lights
  - References light shader
  - Fixed function and programmable

```
<xml3d ... >
        <!-- ... -->
        <group class="animatedView" >
                <view ... />
        </group>
        <light intensity="0.5"/>
</xml3d>
```

Interaction

- DOM Scripting
  - Well known to Web developers
  - Arbitrary scene graph modifications
  - Animations via triggering redraws
- DOM Events
  - Data via attributes
  - 3D specific data

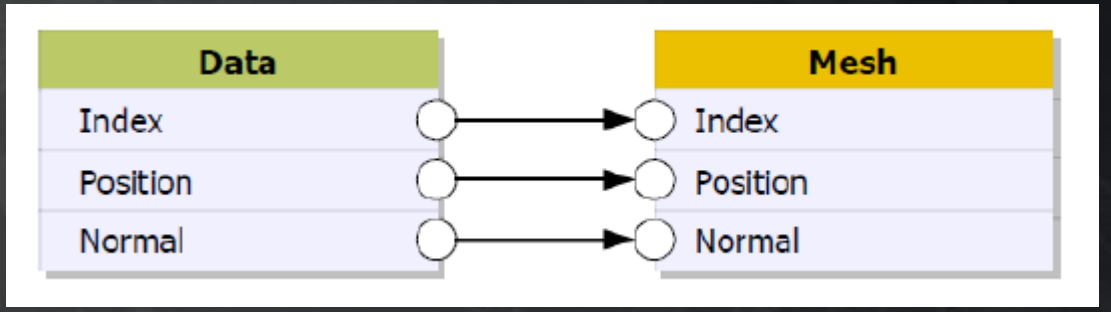
```
<xml3d ... >
<defs>
    <transform id="xfm1" translation="0 0 0" />
</defs>

<group style="transform: url(#transform1)" >
    <mesh type="triangles"
        onclick="alert('Interaction!')">
     ...
    </mesh>
</group>

</xml3d>

<script type="text/javascript" >
    function moveMesh(){
        var xfm = document.getElementById('xfm1');
        xfm.translation.x += 0.1;
    }
    setInterval("moveMesh()", 50);
</script>
```

XML3D

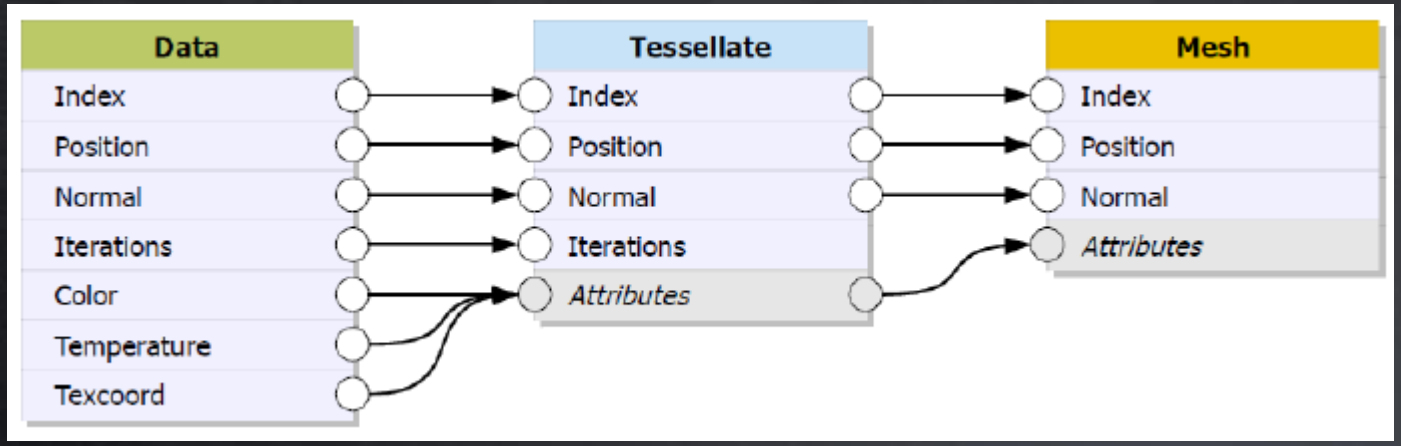
- Interactive 3D graphics
  - Few new elements
  - DOM is scene graph and run time
- Portable Format
  - Portable geometry and material descriptions
- Full support for programmable GPUs
  - Programmable shading (materials, animation, …)
  - HW-oriented data formats
- But what about Animations & Dynamics?
  - Vertex shaders, image (pre/post-)processing

XFlow: Data Processing for XML3D

- Data specification
  - Typically used to provide data for meshes and shaders (surface, lights, geometry, …)



- Simply allow processing elements in the chain
  - Shaders that take data and provides new data



XFlow: Different XFlow Elements

- XFlow Processing Elements
  - Map XML3D data elements to new data sets
- Predefined Fixed-Functions (URN)
  - Geometry shaders (OGL/DX/RT)
    - Morphing, Skeletal Animation, …
  - Post Processing, Tone Mapping, …
- Programmable Elements
  - But which language: Javascript (slow), Plugins (too awkward), CUDA/OpenCL (too HW specific)
  - AnySL: Portable representation & embedded compiler
    - Compiled to x86/SSE, PTX/CUDA, OpenCL, GLSL, …

Beyond Static Geometry

- Different Types of Animations
  - Hierarchical Rigid Motion – OK
  - Morphing – **NOT OK**
  - Skinning – **NOT OK**
  - Tesselation and many more – **NOT OK**
- Different Execution Environments
  - CPU (x86, SSE, AVX, …)
  - GPU (GLSL, OpenCL, CUDA/PTX, others)
  - Avoid having to go back to GPGPU
  - Should make best use of hardware
- Provide Portable Solution

Go for Generic Solutions

- Avoid specializes elements
  - Like <hanim>, <skinning>, <bone>, <morphing>, …
  - No blow up in new concepts
- Generic solution for data parallel processing
  - Like <data script="…" >
  - At least as powerful as GLSL/HLSL/…
  - But platform-independent
- XFlow: Approach for declarative data processing
  - Description of flow graph in HTML/XML3D
    - Composition of data field (easy to re-use and route)
    - Scripts for processing code (where necessary)

A Simple Mesh

```
<mesh type="triangles" >
   <int name="index" >0 1 2 1 2 3 ...</int>
   <float3 name="position" >1.0 2.0 -0.2 ...</float3>
   <float3 name="normal"   >0.0 1.0 0.0 ...</float3>
</mesh>
```

=

```
<mesh type="triangles" >
   <data>
      <int name="index" >0 1 2 1 2 3 ...</int>
      <float3 name="position" >1.0 2.0 -0.2 ...</float3>
      <float3 name="normal"   >0.0 1.0 0.0 ...</float3>
   </data>
</mesh>
```

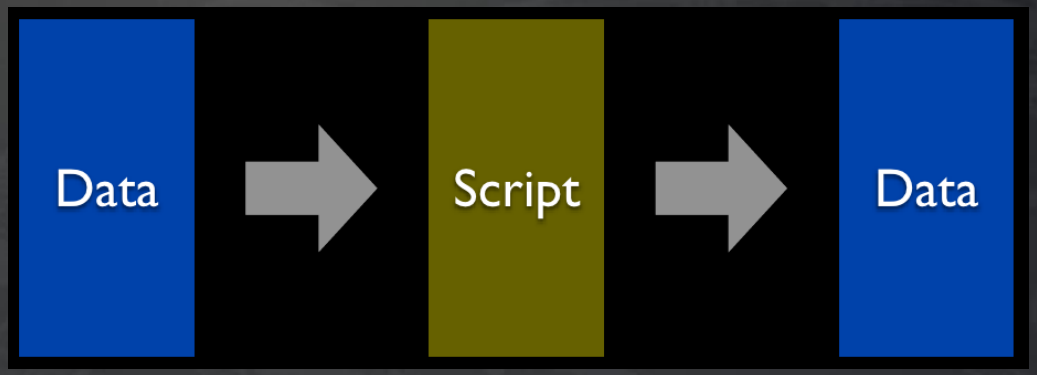
Instantiate with <data>

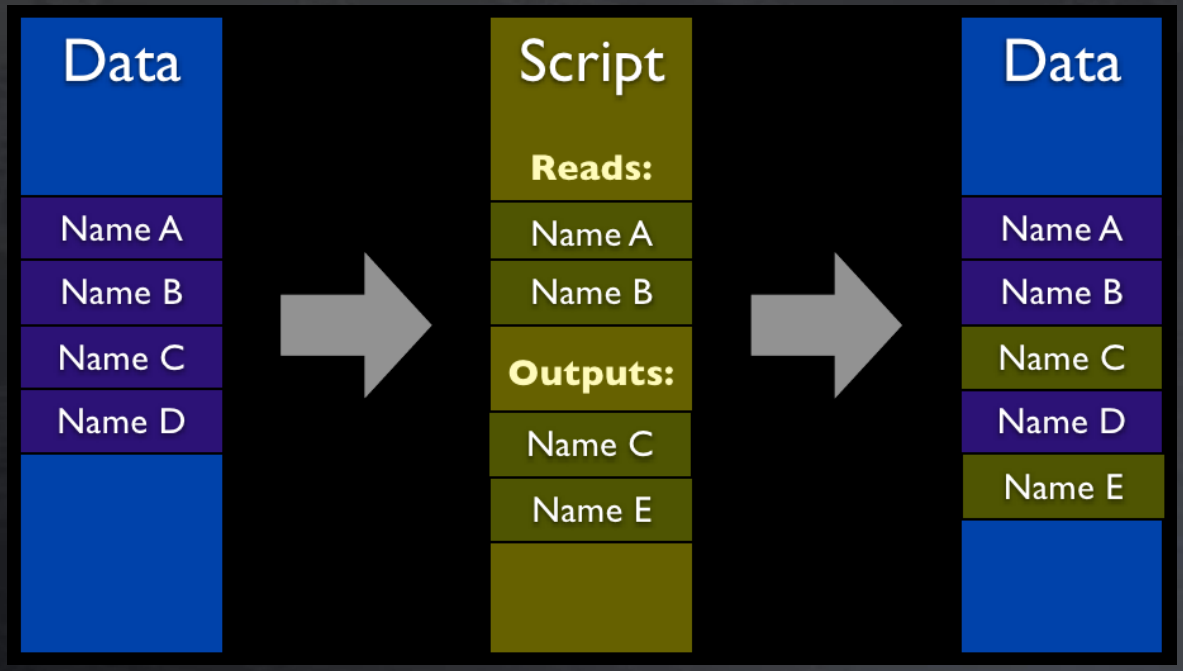
```
<defs>
   <data id=”meshData” >
      <int name=”index” >0 1 2 1 2 3 ...</int>
      <float3 name=”position” >1.0 2.0 -0.2 ...</float3>
      <float3 name=”normal”   >0.0 1.0 0.0 ...</float3>
   </data>
</defs>
...

<mesh type=”triangles” src=”#meshData” />
<group style=”transform: ... “ >
   <mesh type=”triangles” src=”#meshData” />
</group>
```

Partial Re-Use of Data

```
<defs>
   <data id="basicMeshData" >
      <int name="index" >0 1 2 1 2 3 ...</int>
      <float3 name="position" >1.0 2.0 -0.2 ...</float3>
      <float3 name="normal"   >0.0 1.0 0.0 ...</float3>
   </data>
</defs>
...
<mesh type="triangles">
   <data src="#basicMeshData" />
   <float3 name="color" >1.0 0.7 0.1 ...</float>
</mesh>
...
<mesh type="triangles">
   <data src="#basicMeshData" />
   <float3 name="color" >0.2 0.7 0.9 ...</float>
</mesh>
```

Data Scripts

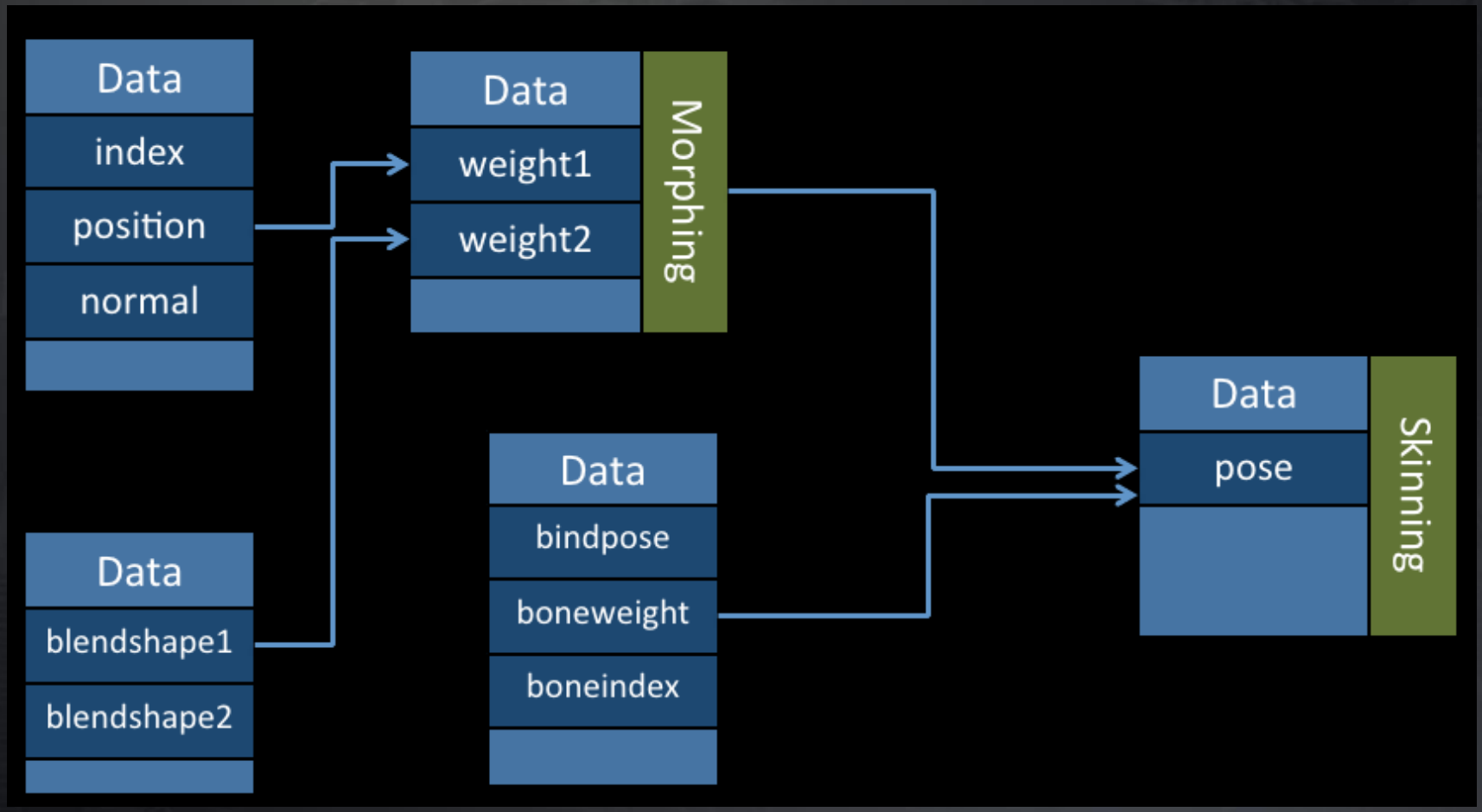




Script Attached to Data

```
<data id="meshData" script="morphing.xxx" >
   <int name="index" >0 1 2 1 2 3 ...</int>
   <float3 name="position" >1.0 2.0 -0.2 ...</float3>
   <float3 name="normal"   >0.0 1.0 0.0 ...</float3>
   <float3 name="blendshape1"   >1.5 2.3 -0.4 ...</float3>
   <float3 name="blendshape2"   >1.2 1.9 0.1 ...</float3>
   <float name="weight1"   >0.3</float3>
   <float name="weight2"   >0.5</float3>
</data>
```

More Complex Data Flow



Compactness of Data Flow Spec

```
<mesh type="triangles" >
   <data script="skinning.xxx" >
      <data script="morphing.xxx" >
        <data src="#meshData" />
        <data src="#blendData" />
        <float3 name="weight1" >0.8</float3>
        <float3 name="weight2" >0.2</float3>
      </data>
      <data src="#skinningData" />
      <float4x4 name="pose">...</float4x4>
   </data>
</mesh>
```

More About Data Scripts

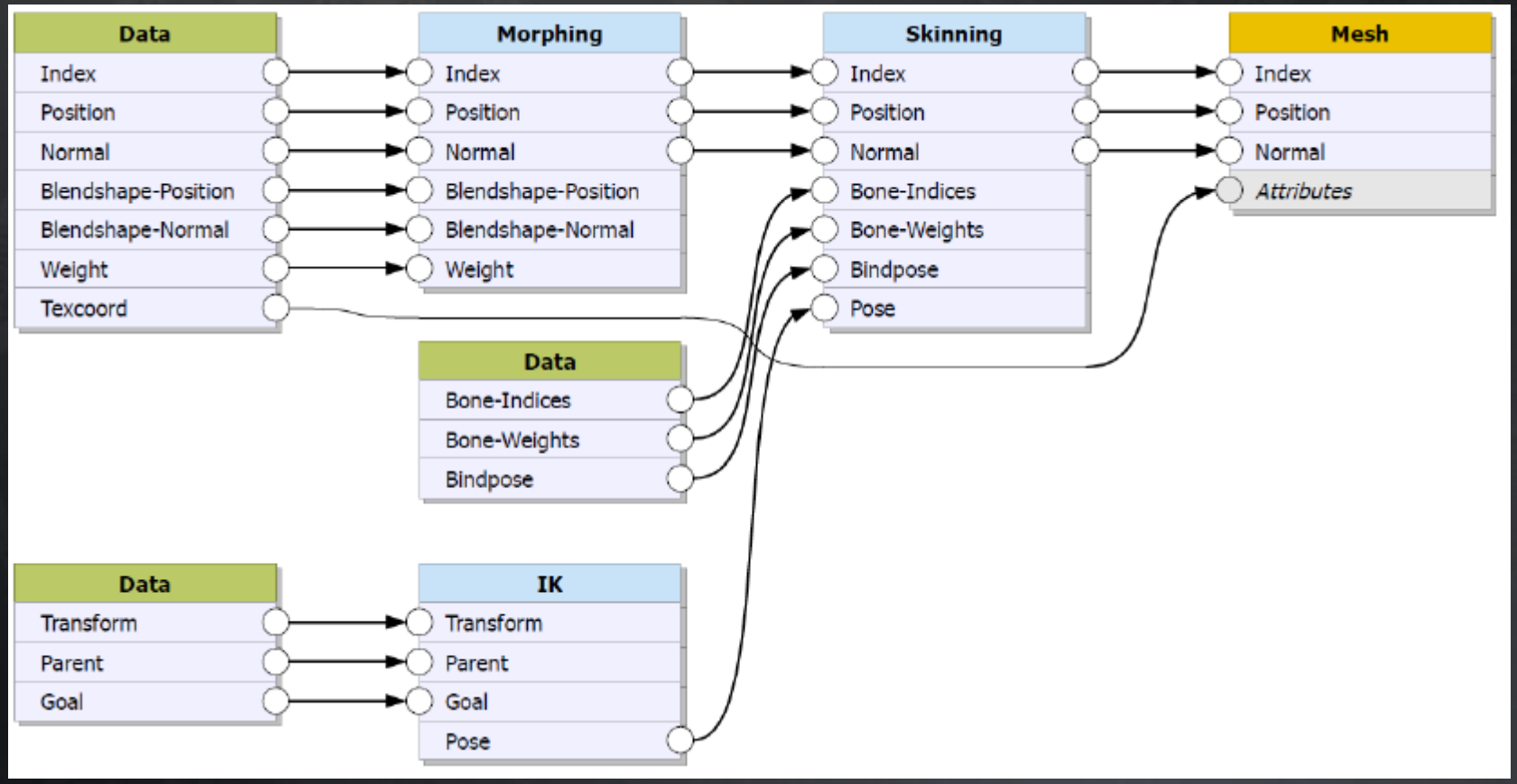
- Platform independent description
  - Use AnySL
  - Safe exposure of parallel computing via OpenCL / CUDA
- Script execution not bound to specific hardware
  - Can be executed on GPU or CPU depending on context and renderer

External Data

- Natural extension to XFlow concept
  - <data src=”external.xxx” />
    - Any format that can be converted to data representation
    - May include Xflow script for decompression, etc.

Example: Character Animation

- All shaders are cross-platform, cross-renderer
  - HW accelerated (CUDA, OpenCL, DXCompute)



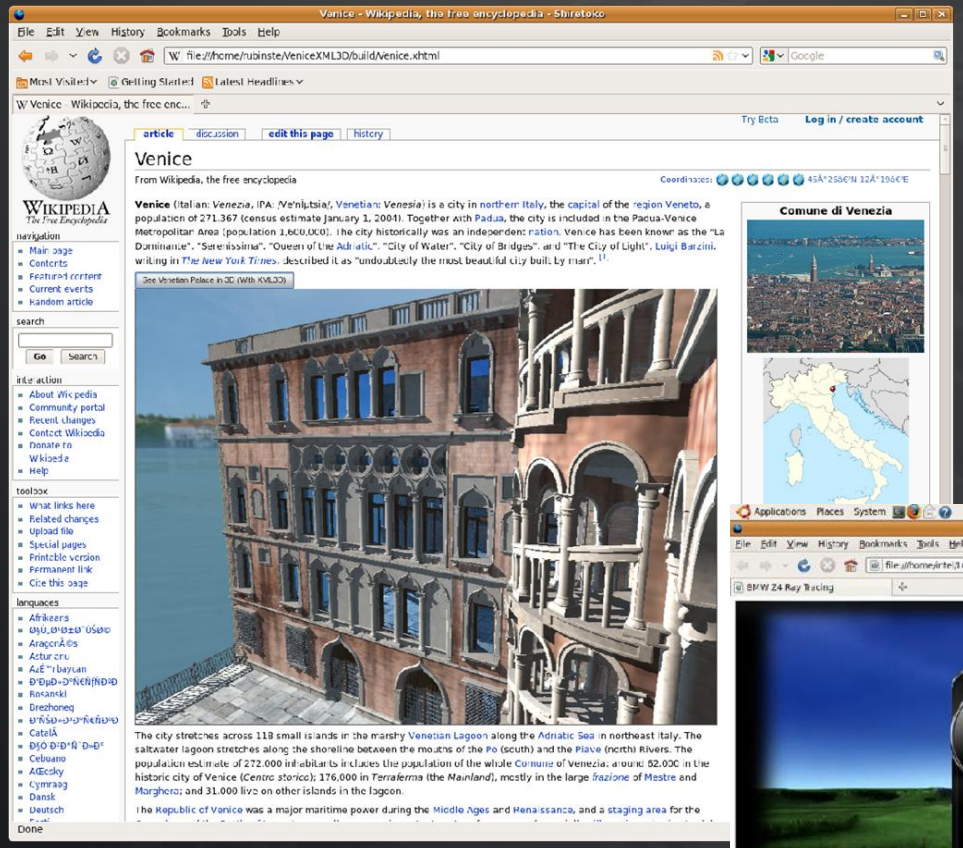
XML3D Implementations

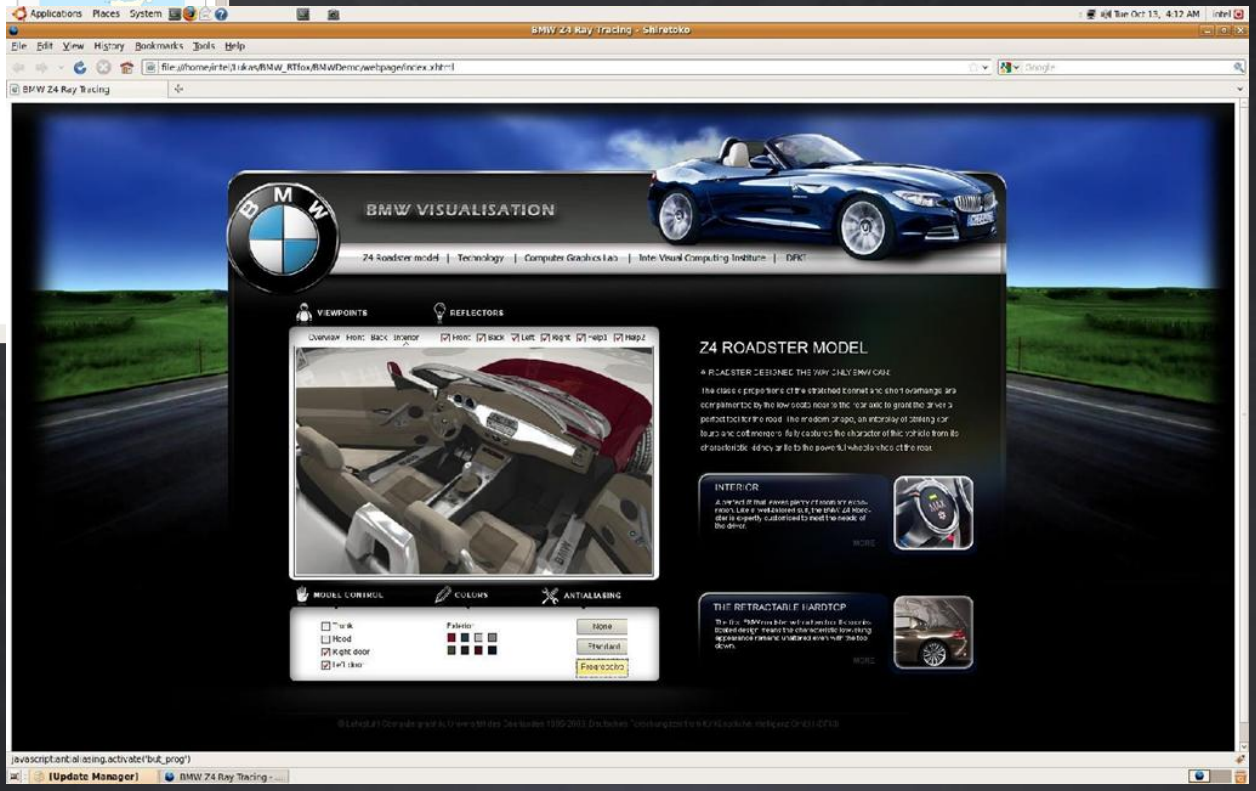
- Native implementations
  - Mozilla Firefox & Google Chromium
  - Renderer:
    - Realtime Ray Tracing & native OpenGL 4.X
- WebGL/JS-based renderer
  - Limitation due to OpenGL ES, CSS, JS
- Standardization at W3C
  - Creation of Incubator/Community group
- Freely available (alpha version):
  http://www.xml3d.org

XML3D Content Pipeline

- Exporters
  - Cinema 4D
  - Blender
- Converters
  - COLLADA
  - X3D / VRML
- Application integration
  - Caigos, BallView, 3D-Kiosk, …
- More to come…

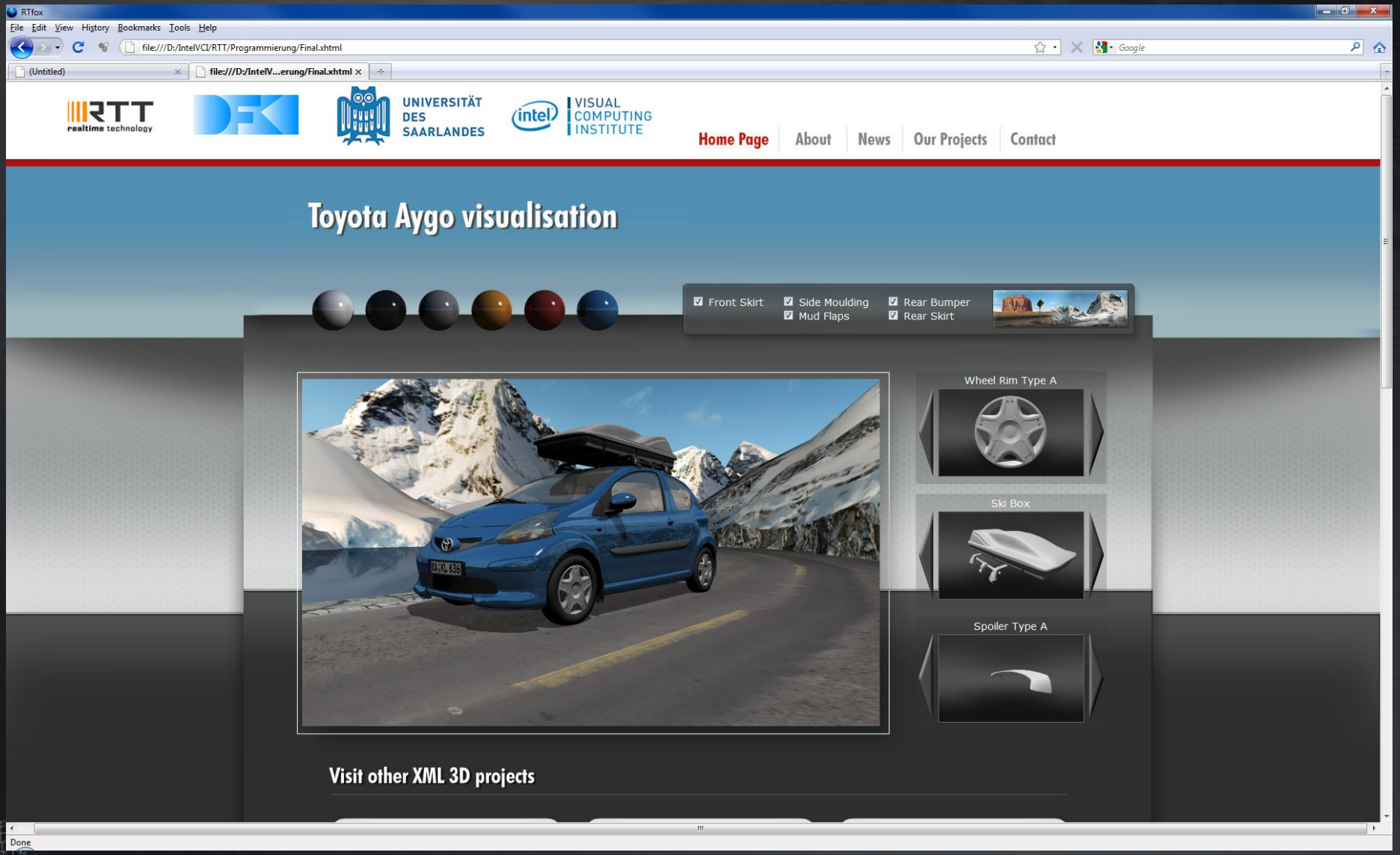
Firefox with XML3D



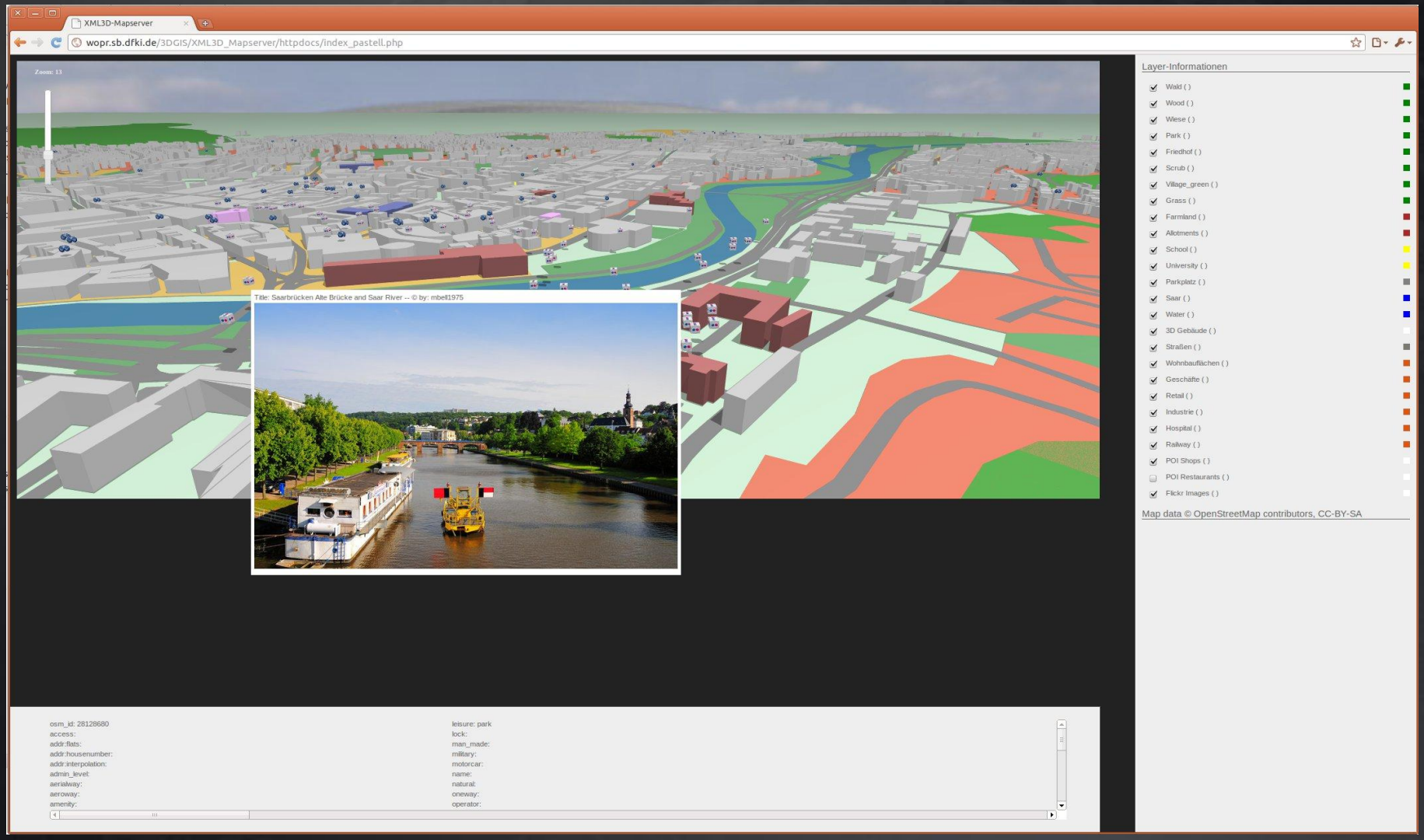


AGENTS and SIMULATED REALITY

XML3D: 3D on the Web



More XML3D Examples



Interactive Web-GIS in 3D from OpenStreetMap & GIS data

In cooperation with Caigos (SME), Dell

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More XML3D Examples

More XML3D Examples

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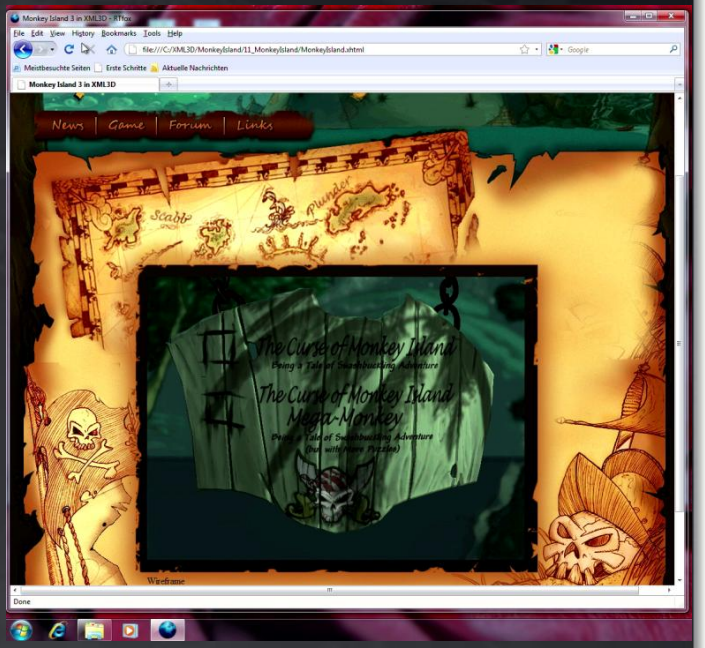
More XML3D Examples

More XML3D Examples

XML3D for Cultural Heritage

More XML3D Examples



Curse of Monkey Island

3D version of pupolar 2D game

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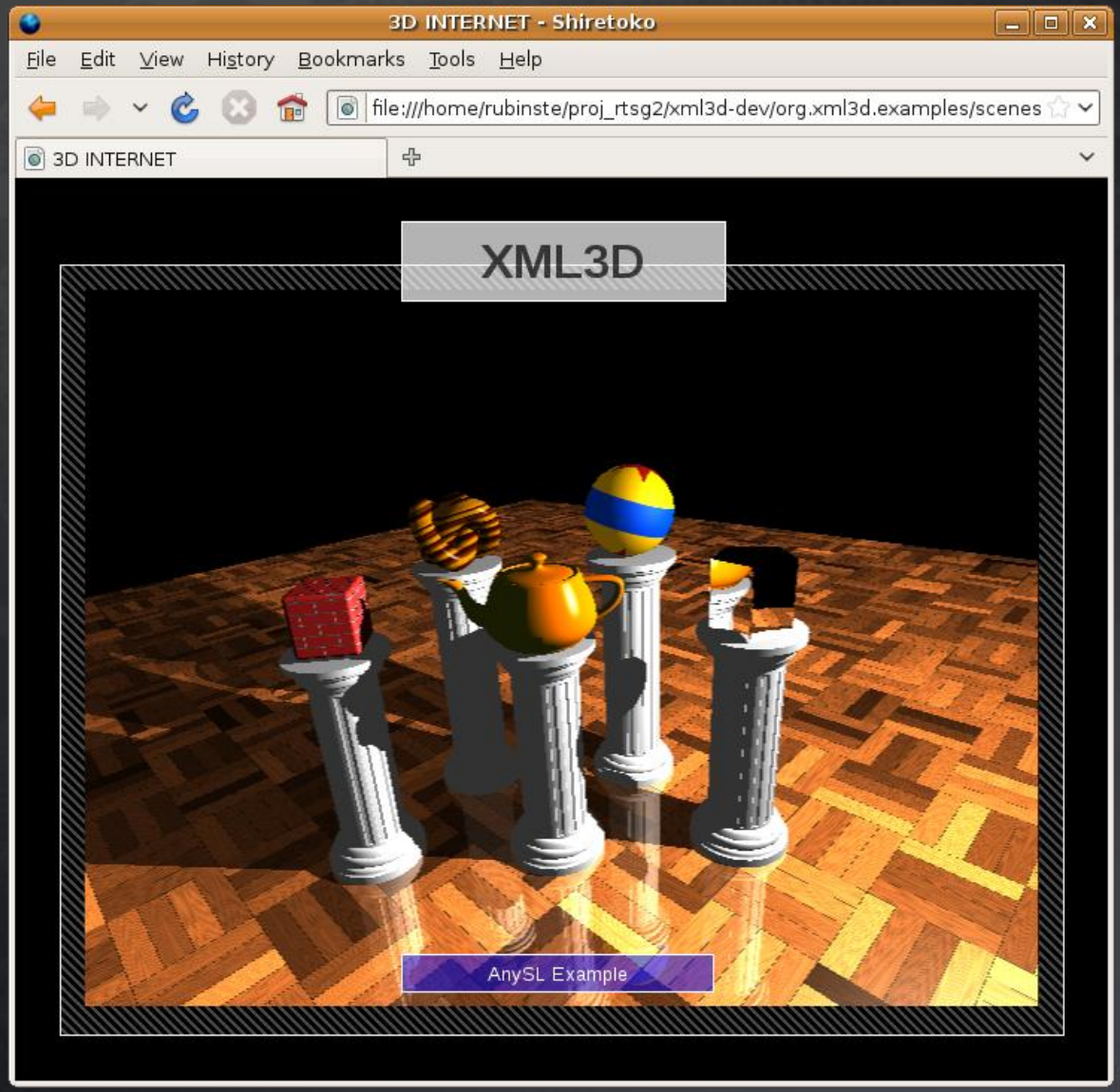
More XML3D Examples

AnySL: Interactive RenderMan in Your Web Browser



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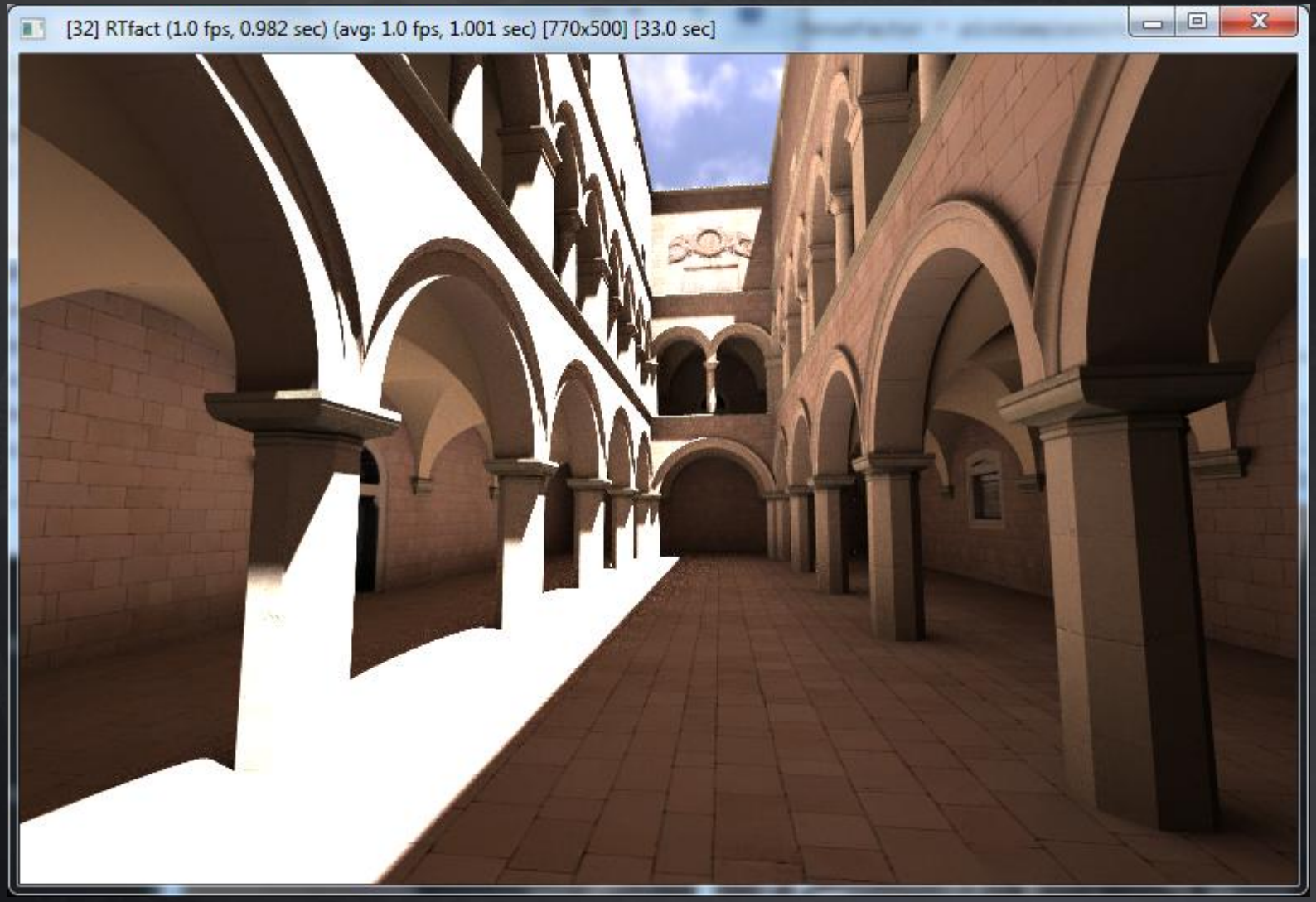
Interactive Global Illumination



Interactive Global Illumination

Summary

- Declarative 3D on the Web with XML3D
  - 3D will be a hot topic – particularly on the Web
  - W3C should play major role for *declarative 3D*
  - Upcoming W3C Incubator Group
  - Three fully working prototypes using XML3D
    - Native Mozilla Firefox
    - Native Google Chromium
    - Portable WebGL/Javascript implementation
- Ready to start on your projects today!