Advanced Extension Mechanisms for X3D to Define, Implement and Integrate New First-Class Nodes, Components, and Profiles

Adopting and Augmenting X3D for Efficient 3D Content Production: Concepts and Tools
(Workshop at the Web3D 2003 Symposium)

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Outline

- Motivation and Vision
- Existing X3D Extension Mechanisms
  - Prototypes
  - Components & Profiles
- Advanced Extension Mechanisms
  - Architecture, Big Picture
  - Declaration of new Nodes and Components
  - Grammars and Usage
- Conclusion
Motivation and Vision

- X3D Modularization
  - Built-In Nodes
  - 24 Components
  - 5 Profiles

- X3D Extension Mechanisms
  - Spontaneous creation of new second-class nodes by prototype statements
  - Components and Profiles can be added by a formal registration process
Motivation and Vision

Advanced Extension Mechanisms

- Create first-class nodes on demand
- New nodes may be organized into proprietary unregistered components or profiles → meet specific application needs
- Define, implement and integrate new nodes, components and profiles on demand
- Without a registration process
- Based on XML Technologies
Extension: X3D Prototypes

<AnimateRotation key="0 1" value="1 0 0 -1.7, 1 0 0 0">

- ProtoDeclare: Definition of the new node type
- ExternProtoDeclare: Interface
- ProtoInstance: Usage of the new node type
  - Can not be instantiated like built-in nodes
Extension: Components & Profiles

- Creation of a new Part of the intended International Standard or by the Registration of
  - New components
  - New levels within components
  - New profiles

- Formal Procedures of the ISO International Registration Authority for Graphical Items

- Current X3D specification describe conceptual, but no syntactical aspects
Generic Extension Mechanism: Idea

- Java-like extension mechanisms
  - Standard Java distributions (e.g. J2SE, J2EE)
  - Huge set of open-source projects; Results as Java Archive (JAR)
  - Programs reach a mature state + useful → integration in the Java distribution

- Standardized set of nodes & components
  - Ad Hoc definition, implementation and integration of new first-class nodes, components, and profiles
Architecture

X3D Node Development
- XML Grammar
  - X3DNode
  - XML Schema
  - conform to
  - X3D Node Definitions
    - Node A
    - Node B
    - Node C
  - Node K
  - is generated from
  - Java-Classes
  - Node L
  - Node M
  - Java-Classes
  - Java-Classes
- XML-Instance
  - contains
- Implementation

X3D Component Development
- XML Grammar
  - X3DComponent
  - XML Schema
  - conform to
  - X3D Component Definitions
    - Component A
    - Component B
  - JAR-Archive A
  - refers to
- XML-Instance
  - contains

X3D Profile Development
- XML Grammar
  - X3DProfile
  - XML Schema
  - conform to
  - X3D Profile Definitions
    - Profile A
  - JAR-Archive B
  - refers to
## Basic Node Concept

<table>
<thead>
<tr>
<th>configurable</th>
<th>receives Events</th>
<th>generates Events</th>
<th>corresponds to X3D field access type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>false</td>
<td>false</td>
<td>false</td>
</tr>
<tr>
<td>2</td>
<td>false</td>
<td>false</td>
<td>true</td>
</tr>
<tr>
<td>3</td>
<td>false</td>
<td>true</td>
<td>false</td>
</tr>
<tr>
<td>4</td>
<td>false</td>
<td>true</td>
<td>true</td>
</tr>
<tr>
<td>5</td>
<td>true</td>
<td>false</td>
<td>false</td>
</tr>
<tr>
<td>6</td>
<td>true</td>
<td>false</td>
<td>true</td>
</tr>
<tr>
<td>7</td>
<td>true</td>
<td>true</td>
<td>false</td>
</tr>
<tr>
<td>8</td>
<td>true</td>
<td>true</td>
<td>true</td>
</tr>
</tbody>
</table>

- Improved field concept: name, type, possible default value, 3 change modes
X3D-Node Definitions

- Declaration of new X3D Nodes
  - XML Schema grammar \textit{X3DNode}

- Header: name, documentation
- Fields: none-node datatypes (Color, Rotation)
- ChildNodes: node datatypes (TimeBase)
- UsedNodes: node composition
X3D-Node Definitions

Instance of XML Schema X3DNode

```xml
<X3DNode>
  <Header name="SequentialStateMachine"/>
  <Interface nodeType="public" extends="BaseStateMachine">
    <Fields>
      <Field name="nextState" dataType="Time">
        <ChangeMode configurable="false" receivesEvents="true" generatesEvents="false"/>
      </Field>
    </Fields>
  </Interface>
</X3DNode>
```

```xml
<X3DNode>
  <Header name="TimeContainer"/>
  <Interface nodeType="abstract" extends="BaseTimeBase">
    <ChildNodes>
      <Field dataType="TimeBase" minOccurs="0" maxOccurs="unbounded">
        <ChangeMode configurable="true" receivesEvents="false" generatesEvents="true"/>
      </Field>
    </ChildNodes>
  </Interface>
</X3DNode>
```
X3D-Component Definitions

- Instance of XML Schema X3DComponent

```xml
<X3DComponent name="StateMachine">
  <Meta description="The nodes of this component allow the easy definition of state machines."/>
  <Level number="1" url="http://…/StateMachine1.jar">
    <X3DNode name="BaseStateMachine"/>
    <X3DNode name="SequentialStateMachine"/>
    <X3DNode name="StateMachine"/>
  </Level>
</X3DComponent>
```
Usage of new Nodes & Components

- Instance of an XML Schema X3DExtended

```xml
<head>
  <profile name="Interactive"/>
  <component name="Sound" level="1"/>
  <component name="StateMachine" level="1"
              url="http://…/StateMachine1.jar"/>
  <node name="AnimateTranslation"
        url="http://…/AnimateTranslation"/>
</head>

<Scene>
  <AnimateTranslation key="0 1" to="0 0 0, 0 0.05 0"/>
</Scene>
```
Extended X3D Grammar

X3D File

conform to

Extended X3D Grammar

Local Library

X3D Node Definitions

AnimateTranslation

uses

Implementation

X3D Component Definitions

StateMachine

uses

Implementation

XSLT-Stylesheet

Official standardized X3D Grammar

uses

uses

uses

uses
Conclusion

- Definition of new first-class nodes, components, and profiles with the help of a three level architecture on demand
- Huge set of proprietary X3D nodes and components to fulfill the industrial and scientific requirements
- Decentralized and liberal procedure based on XML technologies (XML Schema, XSLT) without any registration process
Thank you for your attention!