XML Schema for *OpenMath*

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Motivation

Develop an XML DTD which uses *OpenMath* for representing mathematical services and enforce that the XML documents use *OpenMath*: write an XML schema.

XML Activity

The Document Type Definition can be viewed as a mechanism for constraining the *use* of markup.

The XML Schema Working Group is addressing means for defining the

◇ structure,

◇ content and

◇ semantics

of XML documents mainly intended for automated processing of XML Documents.

XML Activity

The Working Group considered several submitted proposals:

- XML-Data, Jan 1998
- DCD, Aug 1998
- SOX, Sep 1998
- DDML, Jan 1999

XML Activity

A requirements document was published in early 1999, and the specification

- Part 0: Primer
- Part 1: Structures
- Part 2: Datatypes

is a Proposed Recommendation as of March 2001.

A draft formal description of XML Schema published in March 2001.

XML Schema for *OpenMath*: OMI

DTD

```
<!ELEMENT OMI (#PCDATA) >
```

Schema

```
<xsd:element name="OMI" type="xsd:integer">
```

XML Schema for *OpenMath*: OMV

DTD

```
<!ELEMENT OMV EMPTY>
<!ATTLIST OMV name CDATA #REQUIRED >
```

Schema

```
<xsd:element name="OMV">
 <xsd:complexType>
  <xsd:attribute name="name" type="xsd:string" use="required"/>
 </xsd:complexType>
</xsd:element>
```

XML Schema for *OpenMath*: OMS

DTD

```
<!ELEMENT OMS EMPTY>
<!ATTLIST OMS name CDATA #REQUIRED cd CDATA #REQUIRED >
```

XML Schema for *OpenMath*: OMS

Schema

```
<xsd:element name="OMS">
 <xsd:complexType>
  <xsd:attribute name="name" type="omstring" use="required"/>
  <xsd:attribute name="cd" type="xsd:string" use="required"/>
 </xsd:complexType>
</xsd:element>

<xsd:simpleType name="omstring" base="xsd:string">
  <xsd:pattern value="[A-Za-z][A-Za-z0-9_]*">
</xsd:simpleType>
```

XML Schema for *OpenMath*: OMOBJ

DTD

```
<!ENTITY % omel "OMS | OMV | OMI | OMB | OMS | OMF | OMA |
                 OMBIND | OME | OMATTR ">

<!ELEMENT OMOBJ (%omel;) >
```

XML Schema for *OpenMath*: OMOBJ

Schema

```
<xsd:element name="OMOBJ" type="OMOBJType"/>

 <xsd:complexType name="OMOBJType">
  <xsd:choice>
   <xsd:element ref="OMS"/>    <xsd:element ref="OMV"/>
   <xsd:element ref="OMI"/>    <xsd:element ref="OMB"/>
   <xsd:element ref="OMSTR"/>  <xsd:element ref="OMF"/>
   <xsd:element ref="OMA"/>    <xsd:element ref="OMBIND"/>
   <xsd:element ref="OME"/>    <xsd:element ref="OMATTR"/>
  </xsd:choice>
 </xsd:complexType>
```

XML Schema for *OpenMath*

```
<?xml version="1.0" encoding="UTF-8"?>

<xsd:schema  xmlns:xsd="http://www.w3.org/2001/XMLSchema"
             xmlns="http://www.openmath.org/OpenMath"
             targetNamespace="http://www.openmath.org/OpenMath"/>
```

Using an XML Schema for *OpenMath*

```
<?xml version="1.0" encoding="UTF-8"?>

<xsd:schema  xmlns:xsd="http://www.w3.org/2001/XMLSchema"
             xmlns:om="http://http://www.openmath.org/">
             xmlns="http://www.mathematics.org/MathService"
             targetNamespace="http://www.mathematics.org/MathService",

.....
```

Using an XML Schema for *OpenMath*

Other potential uses of an *OpenMath* schema include

enhancing with *OpenMath*

schema definitions from scientific, economic, publishing areas.

Future

- design and test *OpenMath* schema
- check CDs vs schema approach
- experiment with *OpenMath* schema inclusion

Automatically generated XML Schema for *OpenMath*

```
<?xml version="1.0" encoding="UTF-8"?>

<xsd:schema  xmlns:xsd="http://www.w3.org/2001/XMLSchema"
             xmlns="http://www.openmath.org/OpenMath"
             targetNamespace="http://www.openmath.org/OpenMath">


 <xsd:element name="OMS">
  <xsd:complexType>
   <xsd:attribute name="name" type="xsd:string" use="required"/>
   <xsd:attribute name="cd" type="xsd:string" use="required"/>
  </xsd:complexType>
 </xsd:element>

 <xsd:element name="OMV">
  <xsd:complexType>
   <xsd:attribute name="name" type="xsd:string" use="required"/>
  </xsd:complexType>
```

```
</xsd:element>

<xsd:element name="OMI">
 <xsd:complexType mixed="true">
 </xsd:complexType>
</xsd:element>

<xsd:element name="OMB">
 <xsd:complexType mixed="true">
 </xsd:complexType>
</xsd:element>

<xsd:element name="OMSTR">
 <xsd:complexType mixed="true">
 </xsd:complexType>
</xsd:element>

<xsd:element name="OMF">
 <xsd:complexType>
  <xsd:attribute name="dec" type="xsd:string" use="optional"/>
  <xsd:attribute name="hex" type="xsd:string" use="optional"/>
 </xsd:complexType>
</xsd:element>
```

```
<xsd:element name="OMA">
 <xsd:complexType>
  <xsd:choice maxOccurs="unbounded">
   <xsd:element ref="OMS"/>
   <xsd:element ref="OMV"/>
   <xsd:element ref="OMI"/>
   <xsd:element ref="OMB"/>
   <xsd:element ref="OMSTR"/>
   <xsd:element ref="OMF"/>
   <xsd:element ref="OMA"/>
   <xsd:element ref="OMBIND"/>
   <xsd:element ref="OME"/>
   <xsd:element ref="OMATTR"/>
  </xsd:choice>
 </xsd:complexType>
</xsd:element>

<xsd:element name="OMBIND">
 <xsd:complexType>
  <xsd:sequence>
   <xsd:choice>
    <xsd:element ref="OMS"/>
    <xsd:element ref="OMV"/>
    <xsd:element ref="OMI"/>
```

```
     <xsd:element ref="OMB"/>
     <xsd:element ref="OMSTR"/>
     <xsd:element ref="OMF"/>
     <xsd:element ref="OMA"/>
     <xsd:element ref="OMBIND"/>
     <xsd:element ref="OME"/>
     <xsd:element ref="OMATTR"/>
    </xsd:choice>
    <xsd:element ref="OMBVAR"/>
    <xsd:choice>
     <xsd:element ref="OMS"/>
     <xsd:element ref="OMV"/>
     <xsd:element ref="OMI"/>
     <xsd:element ref="OMB"/>
     <xsd:element ref="OMSTR"/>
     <xsd:element ref="OMF"/>
     <xsd:element ref="OMA"/>
     <xsd:element ref="OMBIND"/>
     <xsd:element ref="OME"/>
     <xsd:element ref="OMATTR"/>
    </xsd:choice>
   </xsd:sequence>
  </xsd:complexType>
 </xsd:element>
```

```
<xsd:element name="OMBVAR">
 <xsd:complexType>
  <xsd:choice maxOccurs="unbounded">
   <xsd:element ref="OMV"/>
   <xsd:element ref="OMATTR"/>
  </xsd:choice>
 </xsd:complexType>
</xsd:element>

<xsd:element name="OME">
 <xsd:complexType>
  <xsd:sequence>
   <xsd:element ref="OMS"/>
   <xsd:choice minOccurs="0" maxOccurs="unbounded">
    <xsd:element ref="OMS"/>
    <xsd:element ref="OMV"/>
    <xsd:element ref="OMI"/>
    <xsd:element ref="OMB"/>
    <xsd:element ref="OMSTR"/>
    <xsd:element ref="OMF"/>
    <xsd:element ref="OMA"/>
    <xsd:element ref="OMBIND"/>
    <xsd:element ref="OME"/>
```

```
    <xsd:element ref="OMATTR"/>
   </xsd:choice>
  </xsd:sequence>
 </xsd:complexType>
</xsd:element>

<xsd:element name="OMATTR">
 <xsd:complexType>
  <xsd:sequence>
   <xsd:element ref="OMATP"/>
   <xsd:choice>
    <xsd:element ref="OMS"/>
    <xsd:element ref="OMV"/>
    <xsd:element ref="OMI"/>
    <xsd:element ref="OMB"/>
    <xsd:element ref="OMSTR"/>
    <xsd:element ref="OMF"/>
    <xsd:element ref="OMA"/>
    <xsd:element ref="OMBIND"/>
    <xsd:element ref="OME"/>
    <xsd:element ref="OMATTR"/>
   </xsd:choice>
  </xsd:sequence>
 </xsd:complexType>
```

```
</xsd:element>

<xsd:element name="OMATP">
 <xsd:complexType>
  <xsd:sequence maxOccurs="unbounded">
   <xsd:element ref="OMS"/>
   <xsd:choice>
    <xsd:element ref="OMS"/>
    <xsd:element ref="OMV"/>
    <xsd:element ref="OMI"/>
    <xsd:element ref="OMB"/>
    <xsd:element ref="OMSTR"/>
    <xsd:element ref="OMF"/>
    <xsd:element ref="OMA"/>
    <xsd:element ref="OMBIND"/>
    <xsd:element ref="OME"/>
    <xsd:element ref="OMATTR"/>
   </xsd:choice>
  </xsd:sequence>
 </xsd:complexType>
</xsd:element>

<xsd:element name="OMOBJ" type="OMOBJType"/>
```

```
  <xsd:complexType name="OMOBJType">
   <xsd:choice>
    <xsd:element ref="OMS"/>
    <xsd:element ref="OMV"/>
    <xsd:element ref="OMI"/>
    <xsd:element ref="OMB"/>
    <xsd:element ref="OMSTR"/>
    <xsd:element ref="OMF"/>
    <xsd:element ref="OMA"/>
    <xsd:element ref="OMBIND"/>
    <xsd:element ref="OME"/>
    <xsd:element ref="OMATTR"/>
   </xsd:choice>
  </xsd:complexType>


</xsd:schema>
```

XML Schema for *OpenMath* in OMDOC

```
<?xml version="1.0"?>

<xsd:schema xmlns:xsd="http://www.w3.org/2001/XMLSchema"
        xmlns="http://www.openmath.org/OpenMath"
        targetNamespace="http://www.openmath.org/OpenMath">

 <xsd:annotation>
  <xsd:documentation>
      An XML Schema for OpenMath Objects in the OMDoc format
      Initial Version: Michael Kohlhase 2000-09-07
      URL: http://www.mathweb.org/omdoc/omdobj.xsd (released)
      URL: http://www.mathweb.org/src/mathweb/omdoc/xsd/omdobj.xsd (experimental)
      This Schema is still experimental, it is intended as a basis for discussion.
      Comments are welcome! (send mail to kohlhase@mathweb.org)
      See the documentation and examples at http://www.mathweb.org/omdoc
      (c) 2000,2001 Michael Kohlhase, released under the GNU Public License
    </xsd:documentation>
 </xsd:annotation>
```

```
<xsd:complexType name="idxref">
 <xsd:annotation>
  <xsd:documentation>
       An abstract type for elements with identity and crossreferencing. The
       'xref' attribute points to an OpenMath element of the same kind. It is of
       type IDREF instead of uriReference, since we only want to allow local
       structure sharing.

       Taking this type as the base for the OpenMath element declarations extends
       them with coreferences and thus allows structure sharing.

       This extensions is licensed by the OpenMath Standard that says that any
       extension, from which valid OpenMath can be directly be generated is
       allowed.
     </xsd:documentation>
 </xsd:annotation>
 <xsd:attribute name="id" type="ID" use="optional"/>
 <xsd:attribute name="xref" type="IDREF" use="optional"/>
</xsd:complexType>

<xsd:element name="OMS">
 <xsd:complexType>
  <xsd:complexContent>
   <xsd:extension base="idxref">
```

```
    <xsd:attribute name="name" type="xsd:string" use="optional"/>
    <xsd:attribute name="cd" type="xsd:string" use="optional"/>
   </xsd:extension>
  </xsd:complexContent>
 </xsd:complexType>
</xsd:element>

<xsd:element name="OMV">
 <xsd:complexType>
  <xsd:complexContent>
   <xsd:extension base="idxref">
    <xsd:attribute name="name" type="xsd:string" use="optional"/>
   </xsd:extension>
  </xsd:complexContent>
 </xsd:complexType>
</xsd:element>

<xsd:element name="OMI">
 <xsd:complexType>
  <xsd:complexContent>
   <xsd:extension base="integer">
    <xsd:attribute name="mid" type="uriReference" use="optional"/>
    <xsd:attribute name="id" type="uriReference" use="required"/>
    <xsd:attribute name="xref" type="IDREF" use="optional"/>
```

```
    </xsd:extension>
   </xsd:complexContent>
  </xsd:complexType>
</xsd:element>

<xsd:element name="OMB">
 <xsd:complexType>
  <xsd:complexContent>
   <xsd:extension base="xsd:string">
    <xsd:attribute name="mid" type="uriReference" use="optional"/>
    <xsd:attribute name="id" type="uriReference" use="required"/>
    <xsd:attribute name="xref" type="IDREF" use="optional"/>
   </xsd:extension>
  </xsd:complexContent>
 </xsd:complexType>
</xsd:element>

<xsd:element name="OMSTR">
 <xsd:complexType>
  <xsd:complexContent>
   <xsd:extension base="xsd:string">
    <xsd:attribute name="mid" type="uriReference" use="optional"/>
    <xsd:attribute name="id" type="uriReference" use="required"/>
    <xsd:attribute name="xref" type="IDREF" use="optional"/>
```

```
   </xsd:extension>
  </xsd:complexContent>
 </xsd:complexType>
</xsd:element>

<xsd:element name="OMF">
 <xsd:complexType>
  <xsd:complexContent>
   <xsd:extension base="idxref">
    <xsd:attribute name="dec" type="xsd:string" use="optional"/>
    <xsd:attribute name="hex" type="xsd:string" use="optional"/>
   </xsd:extension>
  </xsd:complexContent>
 </xsd:complexType>
</xsd:element>

<xsd:group name="omel">
 <xsd:choice>
  <xsd:element ref="OMS"/>
  <xsd:element ref="OMV"/>
  <xsd:element ref="OMI"/>
  <xsd:element ref="OMB"/>
  <xsd:element ref="OMSTR"/>
  <xsd:element ref="OMF"/>
```

```
  <xsd:element ref="OMA"/>
  <xsd:element ref="OMBIND"/>
  <xsd:element ref="OME"/>
  <xsd:element ref="OMATTR"/>
 </xsd:choice>
</xsd:group>

<xsd:element name="OMA">
 <xsd:complexType>
  <xsd:complexContent>
   <xsd:extension base="idxref">
    <xsd:group ref="omel" minOccurs="0" maxOccurs="unbounded"/>
   </xsd:extension>
  </xsd:complexContent>
 </xsd:complexType>
</xsd:element>

<xsd:element name="OMBIND">
 <xsd:complexType>
  <xsd:complexContent>
   <xsd:extension base="idxref">
    <xsd:sequence minOccurs="0" maxOccurs="1">
     <xsd:element ref="OMS"/>
     <xsd:element ref="OMBVAR"/>
```

```
     <xsd:group ref="omel"/>
    </xsd:sequence>
   </xsd:extension>
  </xsd:complexContent>
 </xsd:complexType>
</xsd:element>

<xsd:element name="OMBVAR">
 <xsd:complexType>
  <xsd:choice maxOccurs="unbounded">
   <xsd:element ref="OMV"/>
   <xsd:element ref="OMATTR"/>
  </xsd:choice>
 </xsd:complexType>
</xsd:element>

<xsd:element name="OME">
 <xsd:complexType>
  <xsd:sequence>
   <xsd:element ref="OMS"/>
   <xsd:group ref="omel"/>
  </xsd:sequence>
 </xsd:complexType>
</xsd:element>
```

```
<xsd:element name="OMATTR">
 <xsd:complexType>
  <xsd:complexContent>
   <xsd:extension base="idxref">
    <xsd:sequence minOccurs="0" maxOccurs="1">
     <xsd:element ref="OMATP"/>
     <xsd:group ref="omel"/>
    </xsd:sequence>
   </xsd:extension>
  </xsd:complexContent>
 </xsd:complexType>
 <xsd:unique name="uniquefeature">
  <xsd:selector xpath="OMATP/OMS"/>
  <xsd:field xpath="@cd"/>
  <xsd:field xpath="@name"/>
  <xsd:field xpath="@ref"/>
 </xsd:unique>
</xsd:element>

<xsd:element name="OMATP">
 <xsd:complexType>
  <xsd:sequence maxOccurs="unbounded">
   <xsd:element ref="OMS"/>
```

```
    <xsd:group ref="omel"/>
   </xsd:sequence>
  </xsd:complexType>
 </xsd:element>

 <xsd:element name="OMOBJ">
  <xsd:complexType>
   <xsd:complexContent>
    <xsd:extension base="idxref">
     <xsd:group ref="omel"/>
     <xsd:attribute name="xmlns" fixed="http://www.openmath.org/OpenMath"/>
    </xsd:extension>
   </xsd:complexContent>
  </xsd:complexType>
 </xsd:element>
</xsd:schema>
```