The Numerical Algorithms Group
Combining mathematics and technology for enhanced performance

Finalising OpenMath 2.0 (?)

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Over 30 years of mathematical excellence
Motivation for OpenMath 2

- Address specific issues and shortcomings which have arisen out of applications development
- Maintain backwards compatibility with OpenMath 1.1 objects
- As far as possible maintain backwards compatibility with existing OpenMath software
- As far as possible fit in with existing XML/Web Standardisation work
Remit from Pisa (September 2002)

- Clean separation of object model and encodings
- Make XML encoding a full XML application
- Replace DTD for XML encoding with Schema
- Support for non-OpenMath XML in annotations in XML encoding
- Compatibility with RDF-style tools (e.g. for CDs)
- Cross referencing between objects
- Types and attributions
Principle Issues Agreed in Bremen

- **Object Model**
  - Semantic attributions
  - Foreign objects
  - Elimination of old restrictions on names
  - CDBase
  - Canonical URIs for symbols

- **Encodings**
  - Support full XML syntax
  - Structure sharing in both encodings
  - Adoption of Relax NG, deprecation of XSD/DTD

- **Content Dictionaries etc.**
  - Abstract model for CDs and Signatures
  - Deprecated CDUSES
  - Reference encoding uses namespaces
Since Bremen ...

- Three New Drafts
  - November
  - April
  - May

- Many editorial changes, re-organisation of text etc.
- Updated bibliography, references to latest versions of standards and specifications
- Set of OpenMath 2 Content Dictionaries Produced
- Made a number of substantive changes ...
Indexed Variables

- Dropped from draft standard
- No advocates came forward
- Criticisms about equality etc.
Symbol Roles

- Specification proposed in Bremen was thought too prescriptive
  - e.g. A symbol with role *application* could only appear as first child of an OMA
- New specification more permissive
  - e.g. The only symbols which may appear as the first child of an OMA are those with role *application* or with no role
- Added role *constant*

- The role property now only effects how a symbol can be used to *construct* an OpenMath object
  - e.g. can now express OMA(*continuous*, *sin*) where the symbols *continuous* and *sin* both have role *application*
- (Also distinguishes semantic from ordinary attributions)
Special Values of OMF in XML Encoding

- `<OMF dec="INF">`
- `<OMF dec="-INF">`
- `<OMF dec="NaN">`
  - Interpreted as IEEE infinities and Not A Number
  - Problem that unlike ±INF, NaN does not have a unique value and the underlying bit-pattern may be significant
  - Added advice to compliance section to address this
    - Semantically `<OMF dec="NaN">` represents any NaN, whereas `<OMF hex="FFF8000000000001">` is a specific NaN.
Sharing in XML Encoding

- Dropped use of xlink
  - required extra namespace, extra xlink:type attribute on OMR
- Replaced with href attribute
Binary Encoding

- Dealt with text encoding issues
  - normally UTF-8 or UTF-16
  - UTF-16 or Latin1 in strings for compatibility
- Added support for streaming objects
OMOBJ Version Attribute

- Optional version attribute on OMOBJ
  - version is a floating-point number

- Advice in compliance section on handling OpenMath 1.x objects
  - can interpret them as being in openmath namespace or in no-namespaces
OMFOREIGN optional encoding attribute

- Indicate the encoding of the underlying object
- Decided to use a string
  - URIs XML-centric
  - MathML uses string with two pre-defined values: “MathML-Content”, “MathML-Presentation”
- Made recommendations in compliance section
  - For MathML use “MathML-Presentation” or “MathML-Content” (useful for round-tripping)
  - For other XML use namespace
  - For non-XML use MIME type
Error Objects

- Allow derived objects in error object:

```xml
<OME>
  <OMS cd="mathml" name="unhandled_csymbol"/>
  <OMFOREIGN encoding="MathML-Content">
    <mathml:csymbol xmlns:mathml="http://www.w3.org/1998/Math/MathML/"
      definitionURL="http://www.nag.co.uk/Airy#A">
      Ai</mathml:csymbol>
    </OMFOREIGN>
  </OME>
```

- Also note treatment of invalid XML:

```xml
<OME>
  <OMS cd="parser" name="invalid_XML"/>
  <OMSTR>
    &ltOMA&gt; &lt;OMS name="cos" cd="transcl"&gt;
    &lt;OMV name="v"&gt; &lt;/OMA&gt;
  </OMSTR>
</OME>
```
FMPs, DefMPs etc.

- Added optional attribute \textit{kind} to FMP
  - no defined scheme for using this
  - allows future extension
    - for example \texttt{<FMP kind="defining"> … </FMP>}
Other changes to Standard

- Moved History chapter into primer (under development)
  - agreed by Executive Committee
- Decided that XHTML+MathML version of standard is normative
  - generated from source via bespoke XSL
  - alternatives are:
    - DocBook source (very hard to read, but can be rendered with standard tools)
    - LaTeX source (derived from DocBook via XSL)
    - PDF (generated with pdflatex)
OpenMath 2 Content Dictionaries

- CD elements in namespace
  http://www.openmath.org/OpenMathCD
- OpenMath objects valid OpenMath 2
  - in http://www.openmath.org/OpenMath namespace
  - version and cdbase attributes
- Symbols all have a *role*
- No CDUSES
- All CDVersions incremented, CDRvisions set to zero
- Also STS, CD Group files

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Conclusions

- This standard is a major improvement on OpenMath 1.1, and addresses original remit
- No substantive issues were raised with last draft
- The Working Group Proposes that:
  - This document is now approved by the OpenMath Society as OpenMath 2.0
  - The CDs etc. on www.openmath.org are immediately updated to the new versions
  - The Executive Committee is mandated to approve any minor editorial revisions needed as a result of today’s discussions