Units and Dimensions in OpenMath

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Current State

dimension1.ocd

```
<OMA>
  <OMS cd="arith1" name="times"/>
  <OMS cd="dimensions1" name="length"/>
  <OMS cd="dimensions1" name="length"/>
</OMA>
```

units_metric1.ocd

```
  <OMS cd="units_metric1" name="metre"/>
```

units_imperial.ocd

Units in MathML

```
<apply>
  <times/>
  <cn>3.4</cn>
  <csymbol> m </csymbol>
</apply>
```

The definitionURL attribute is used to uniquely identify a unit. It is recommended that it take the the following form

http:// *base* /units/ *unit name* [/ *context*][/ *country*][# *prefix*]

```
<csymbol definitionURL='http://.../units/meter'>m</csymbol>
```

Derived Units

MathML recommends against using a single csymbol to denote a derived unit such as `<csymbol>cm/s</csymbol>` and recommends that an expression `<times>` or `<divide>` is used instead.

It doesn't have a single systen of base units though so a Watt might be represented as `<csymbol>W</csymbol>` or as

```
<apply><times/><csymbol>N</csymbol><csymbol>m</csymbol></apply>
```

Attribution

Three options for signifying units in OpenMath:

- Use times from arith1.
  Similar to MathML but perhaps an abuse of arith1 CD?

- Use a different symbol with semantics specific to units.
  Unambiguous but brings greater complexity.

- Use OpenMath attributes.

```
<OMATTR>
  <OMATP>
  <OMS name="quantity_with_units" cd="units_ops"/>
  <OMS name="gramme" cd="units_metric1"/>
  </OMATP>
  <OMI> 2 </OMI>
</OMATTR>
```

  Attributes may be silently discarded (addressed by OpenMath2 semantic attribution).

Prefixes

5 possible options

- Treat prefixed units (km) as separate units.
- MathML suggests the use of URI references using # to signify prefixes, for example a definitionURL="...paskcal#k".
- Use arith1 times using for example a kilo symbol from an SI prefix CD.
- Use a special `prefix` symbol which takes two arguments, a symbol denoting the prefix, and a symbol denoting the base unit.
- Use OpenMath Attribution

Conclusion/Recommendations

- Use times symbol from arith1 to construct compound units.

- Names of dimensions should be used as type names in STS signatures.

- We need to be able to state that two dimension expressions are equal.

- We need to be able to state that unit dimension expressions are equal.

- We should construct prefixes using a special prefix operator rather than use times.

- Force compound units to be constructed as expressions not usingnames such as metres_sqrd.