Units Markup Language (UnitsML)

Presentation for

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Outline

- Vision
- Introduction
- Background information on units and quantities
- Units Markup Language
- Units Database
- Usage of UnitsML & UnitsDB

Vision

- UnitsML schema for encoding scientific units of measure – useful for unit dictionaries and incorporating within other markup languages
- Units Database (UnitsDB) containing extensive information on units, prefixes, quantities, & dimensions
- Guidelines and tools for use of UnitsML & UnitsDB
  - Web Services
  - Unit conversions

Introduction

- Units Markup Language (UnitsML) is a proposed method of representing scientific units of measure in XML.
- Original motivation for this project came from initial effort by Frank Olken and John McCarthy of the Lawrence Berkeley National Laboratory (LBNL).
- Initial Collaborators:
  - Barry Taylor (NIST-PL,emeritus)
  - Michael McLay (NIST-EEEL)
  - Frank Olken (LBNL)
  - Peter Murray-Rust (CML - Chemical Markup Language)

Introduction

- NIST UnitsML Committee
  - Bob Dragoset (PL)
  - Simon Frechette (MEL)
  - Mark Carlisle (MEL)
  - Peter Linstrom (CSTL)
  - Gary Kramer (CSTL)
  - Martin Weber (PL – NIST Associate)
  - Kent Reed (BFRL)
  - Evan Wallace (MEL)
  - Karen Olsen (PL)
  - Several NIST Associates (CSTL, PL, BFRL)
- Funded in part by NIST's Systems Integration for Manufacturing Applications (SIMA) program.
  - http://www.nist.gov/sima

Introduction

- UnitsML OASIS Technical Committee formed on July 12, 2006
- Deliverables due by July 2007:
  - UnitsML Working Draft identifying the requirements and data-model for units of measure
  - UnitsML Proposed Standard for the representation of units information in XML
  - Guidelines for implementation of UnitsML
- Participants from NIST, Granta Design, LSC Group Ltd, IBM, NPL, Univ. of North Florida, IEM
- Soliciting additional non-NIST participants

Background Information on Units and Quantities

7 SI Base Units & Quantities

Unit Name	Unit Symbol	Quantity	Quantity Symbol	Dimension Symbol
meter	m	length	l	**L**
kilogram	kg	mass	m	**M**
second	s	time	t	**T**
ampere	A	electric current	I	**I**
kelvin	K	thermodynamic temperature	T	**Θ**
mole	mol	amount of substance	n	**N**
candela	cd	luminous intensity	I_v	**J**

Examples: $l = 7.24$ m $\quad v = 6.32$ m/s

$m = 1.53$ kg $\quad \dim v = \mathbf{L\ T^{-1}}$

22 SI Special Derived Units

Derived quantity	Special name	Special symbol	Expression in terms of	
			other SI units	SI base units
plane angle	radian	rad	1	$m \cdot m^{-1}$
solid angle	steradian	sr	1	$m^2 \cdot m^{-2}$
frequency	hertz	Hz		s^{-1}
force	newton	N		$m \cdot kg \cdot s^{-2}$
pressure, stress	pascal	Pa	N/m^2	$m^{-1} \cdot kg \cdot s^{-2}$
energy, work, quantity of heat	joule	J	$N \cdot m$	$m^2 \cdot kg \cdot s^{-2}$
power, radiant flux	watt	W	J/s	$m^2 \cdot kg \cdot s^{-3}$
electric charge, quantity of electricity	coulomb	C		$s \cdot A$
electric potential, potential difference, electromotive force	volt	V	W/A	$m^2 \cdot kg \cdot s^{-3} \cdot A^{-1}$
capacitance	farad	F	C/V	$m^{-2} \cdot kg^{-1} \cdot s^4 \cdot A^2$
electric resistance	ohm	Ω	V/A	$m^2 \cdot kg \cdot s^{-3} \cdot A^{-2}$
electric conductance	siemens	S	A/V	$m^{-2} \cdot kg^{-1} \cdot s^3 \cdot A^2$

22 SI Special Derived Units

Derived quantity	Special name	Special symbol	Expression in terms of	
			other SI units	SI base units
magnetic flux	weber	Wb	$V \cdot s$	$m^2 \cdot kg \cdot s^{-2} \cdot A^{-1}$
magnetic flux density	tesla	T	Wb/m^2	$kg \cdot s^{-2} \cdot A^{-1}$
inductance	henry	H	Wb/A	$m^2 \cdot kg \cdot s^{-2} \cdot A^{-2}$
Celsius temperature	degree Celsius	°C		K
luminous flux	lumen	lm	$cd \cdot sr$	cd
illuminance	lux	lx	lm/m^2	$m^{-2} \cdot cd$
activity (of a radionuclide)	becquerel	Bq		s^{-1}
absorbed dose, specific energy (imparted), kerma	gray	Gy	J/kg	$m^2 \cdot s^{-2}$
dose equivalent, *et al.*	sievert	Sv	J/kg	$m^2 \cdot s^{-2}$
catalytic activity	katal	kat		$s^{-1} \cdot mol$

There are also many derived quantities with SI units without special names; e.g., the quantity **area** has units of $\mathbf{m^2}$; and multiples and submultiples; e.g., km, cm.

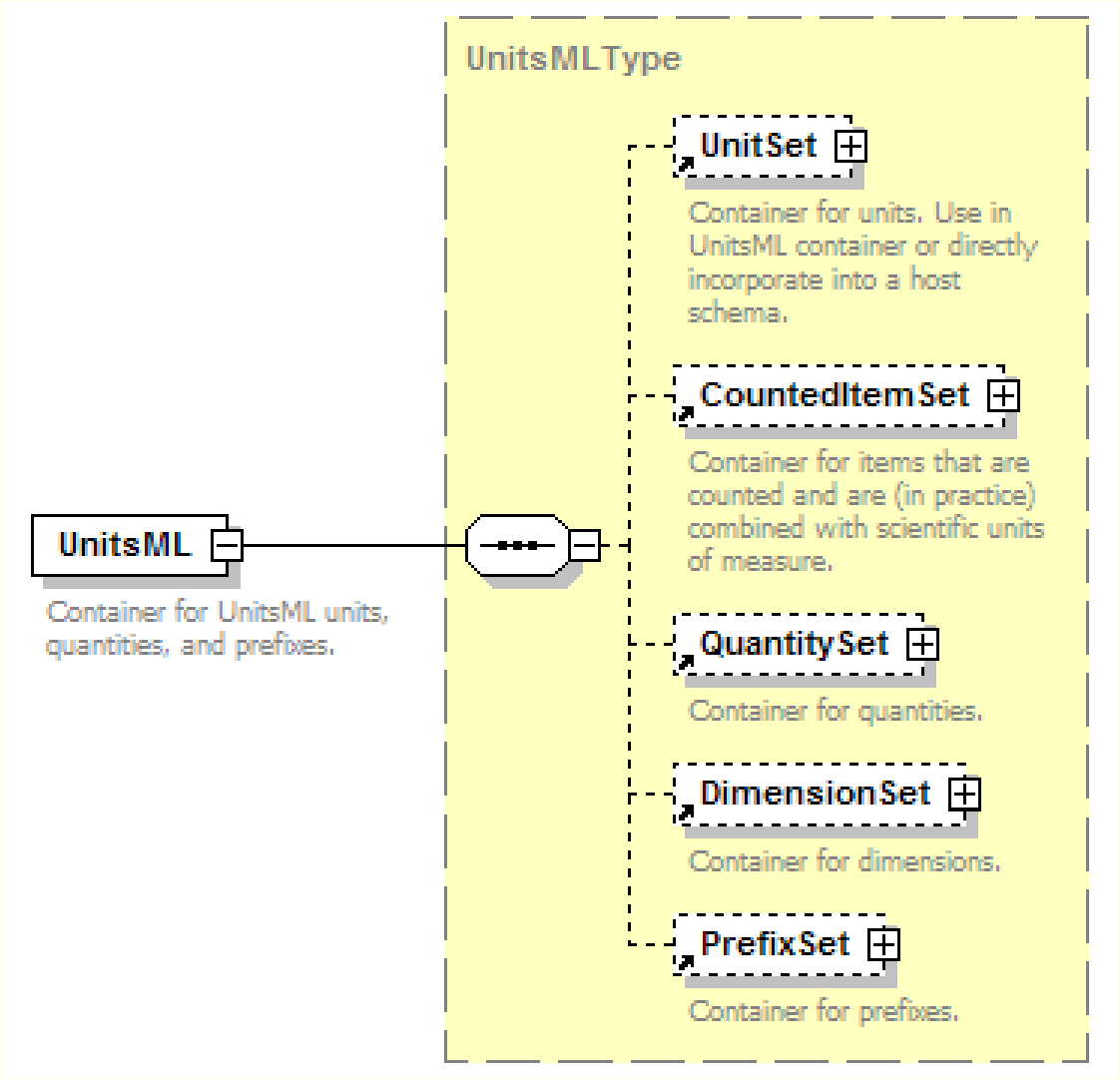
Non-SI Units

- According to SP 811, there are 3 categories of non-SI units relating to use within the SI
  - Acceptable
    - Examples: minute, hour, day, liter, metric ton, natural and atomic units
  - Temporarily acceptable
    - Examples: nautical mile, knot, ångström
  - Unacceptable
    - Examples: erg, dyne, fermi, torr, micron

Units Markup Language

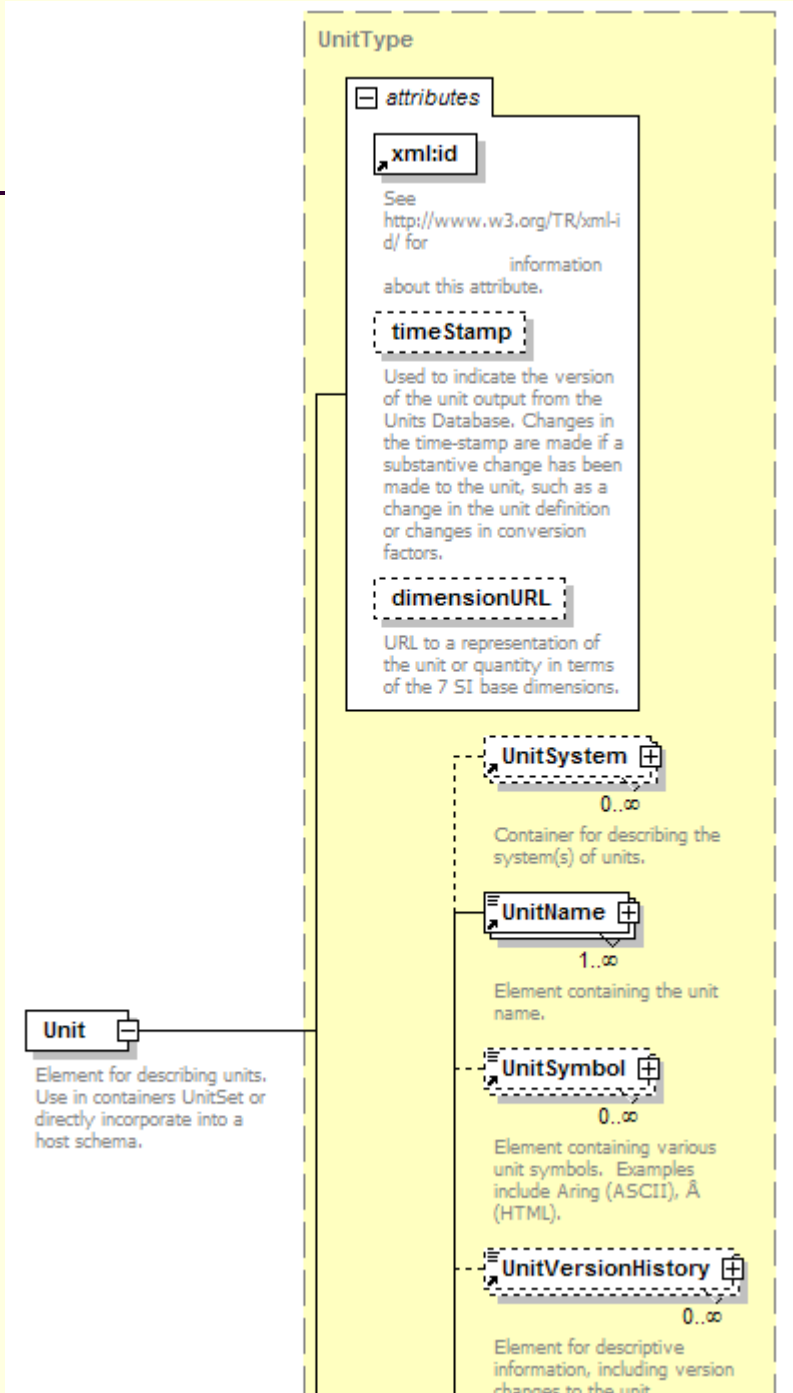
(UnitsML)

UnitsML Root Level



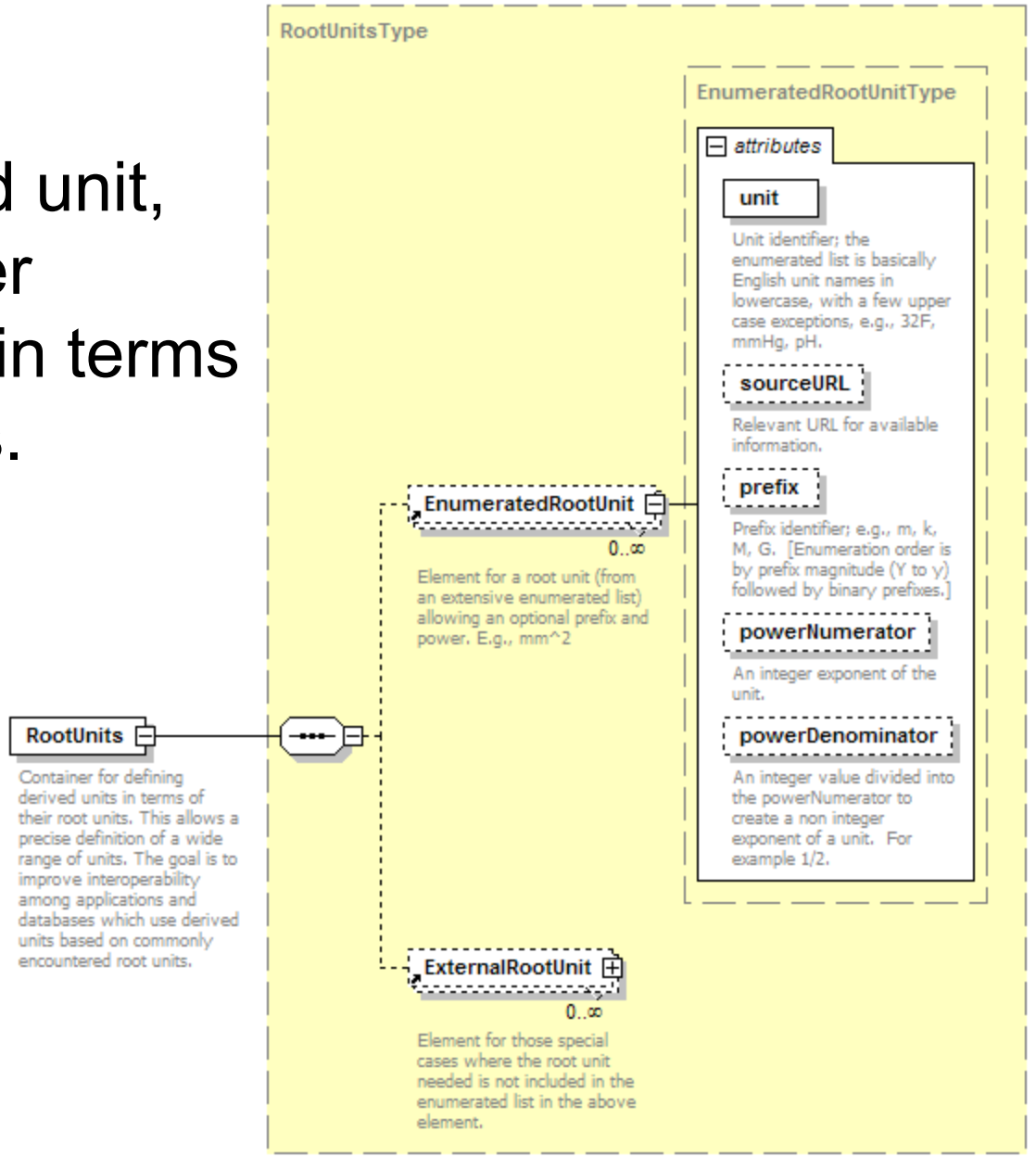
'Unit' Element

- Attributes
  - xml:id
  - dimensionURL
- Elements
  - RootUnits
  - Conversions
  - CodeListValue



'RootUnits' Element

Express a derived unit, e.g., millimeter per second squared, in terms of its components.



'Conversions' Element

$$y = d + ((b / c) (x + a))$$

Attributes

x, initialUnit

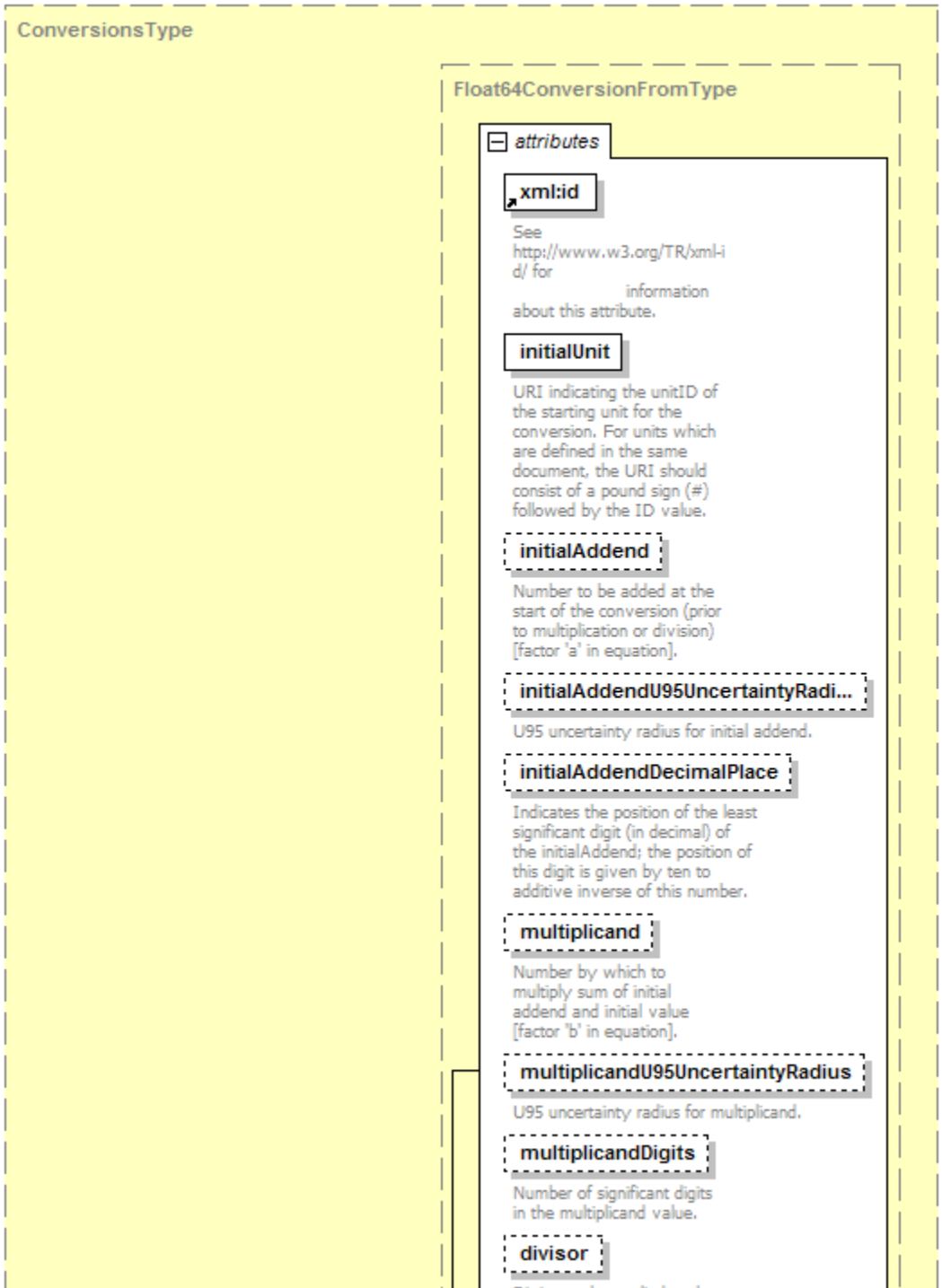
a, initialAddend

b, multiplicand

c, divisor

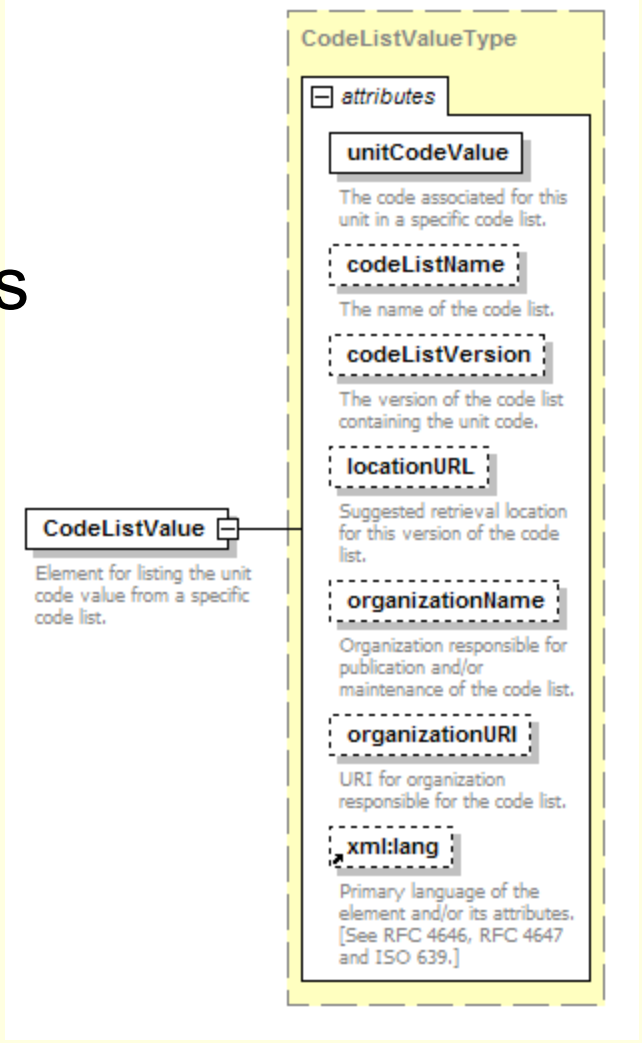
d, finalAddend

$$x = ((c / b) (y - d)) - a$$



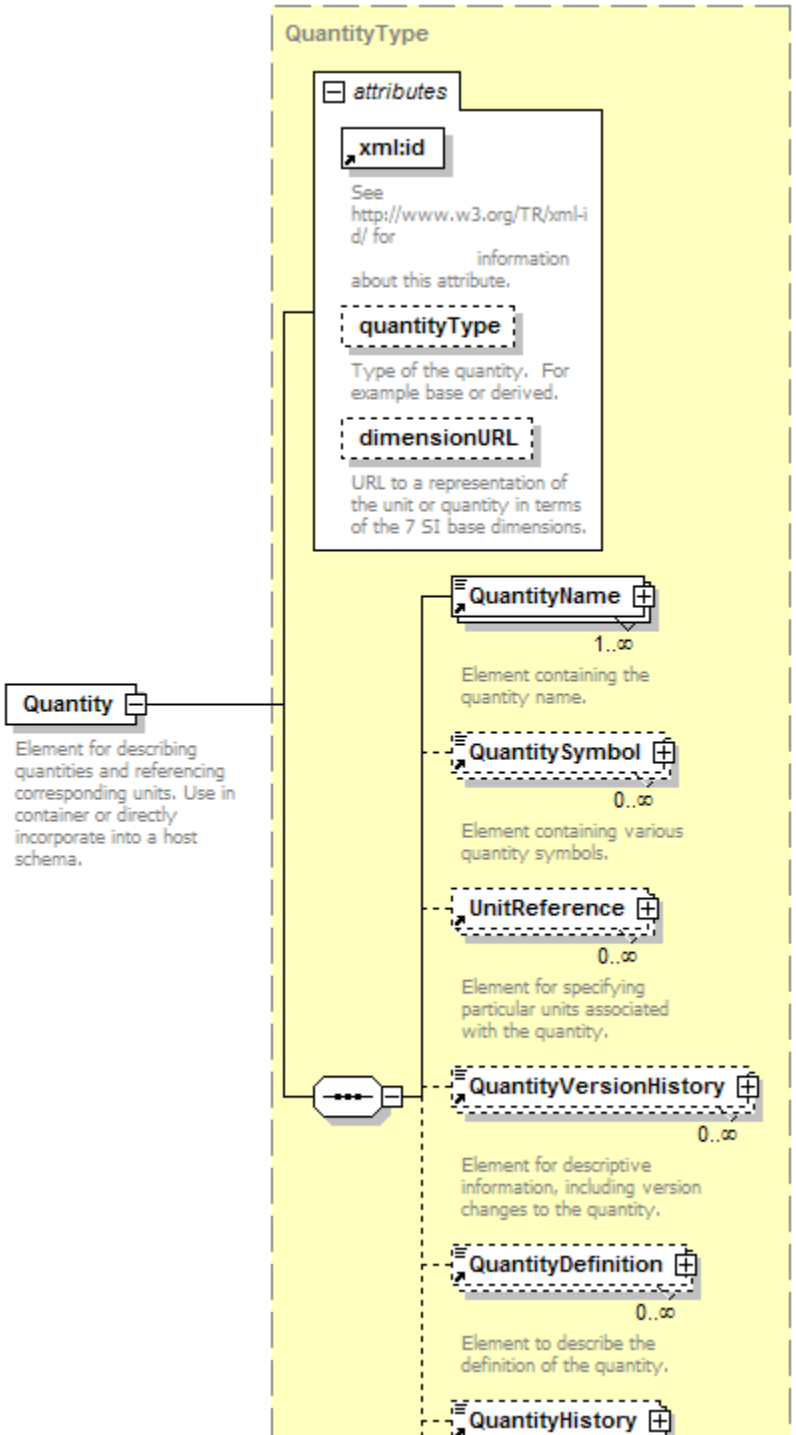
'CodeListValue' Element

Equate a unit with a code provided in a specific community's code list.



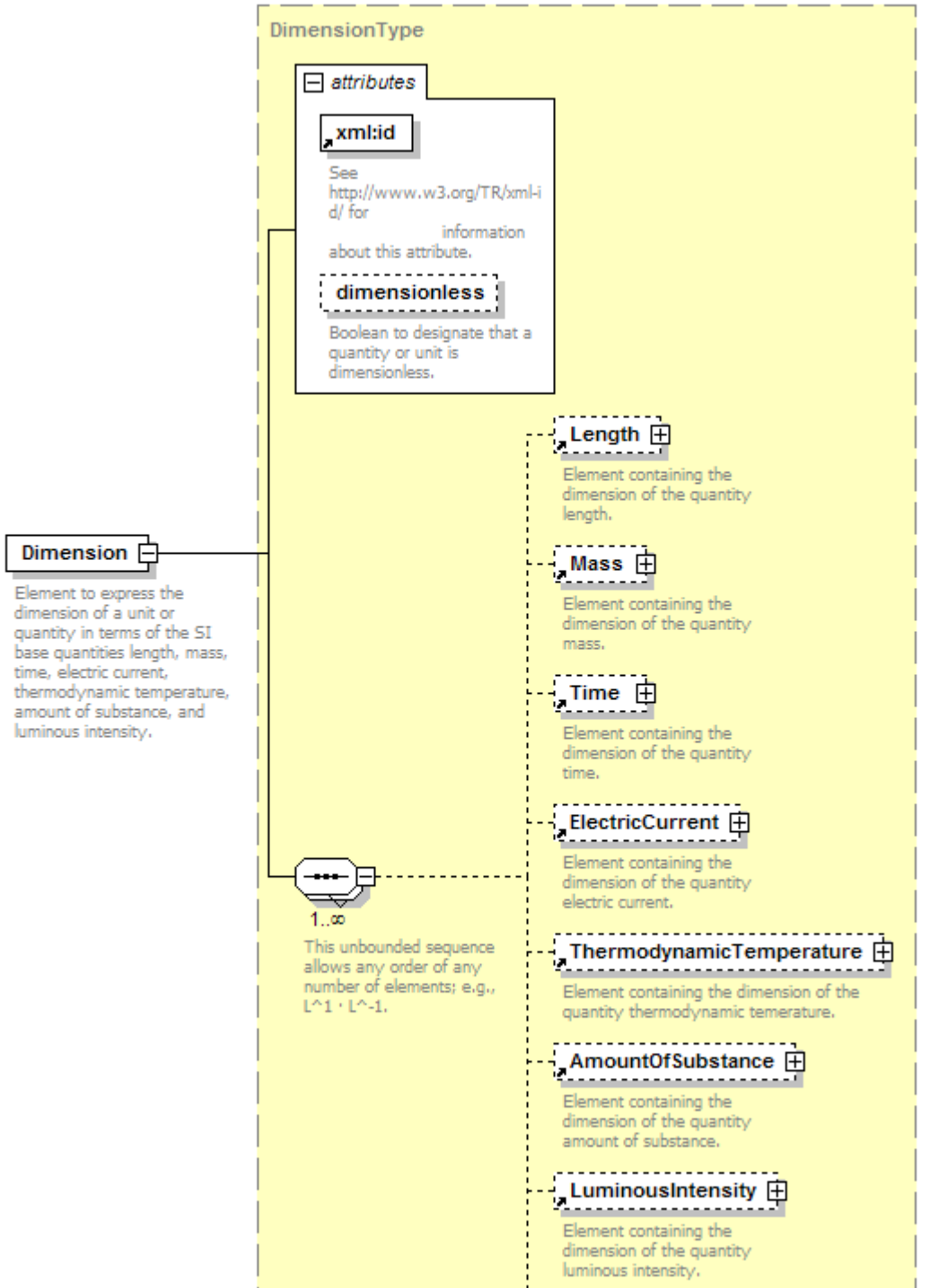
'Quantity' Element

- Attributes
  - xml:id
  - dimensionURL
- Elements
  - UnitReference

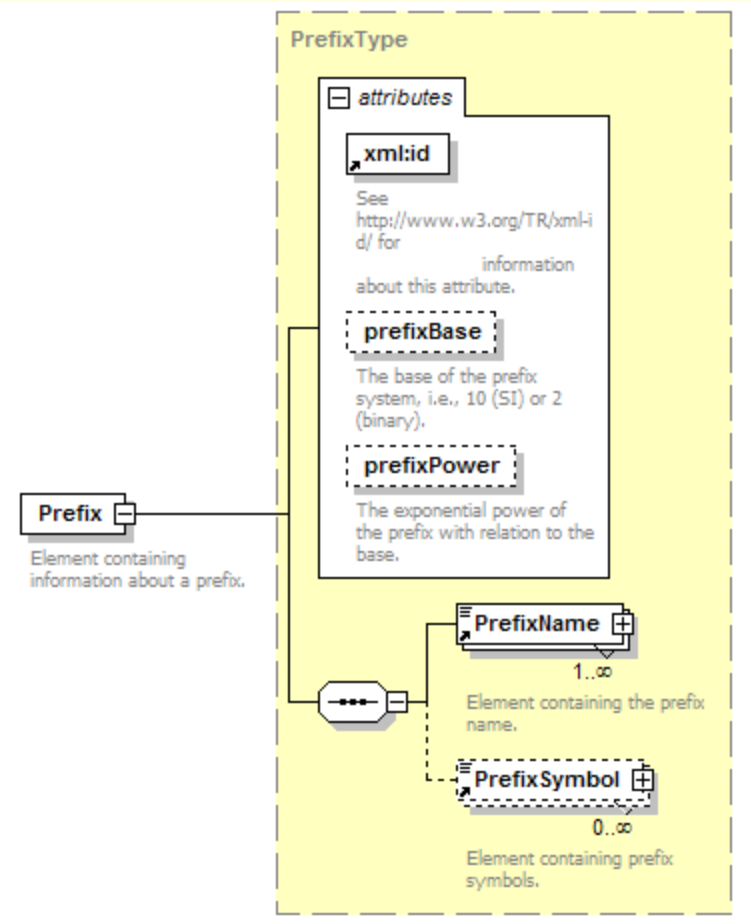


'Dimension' Element

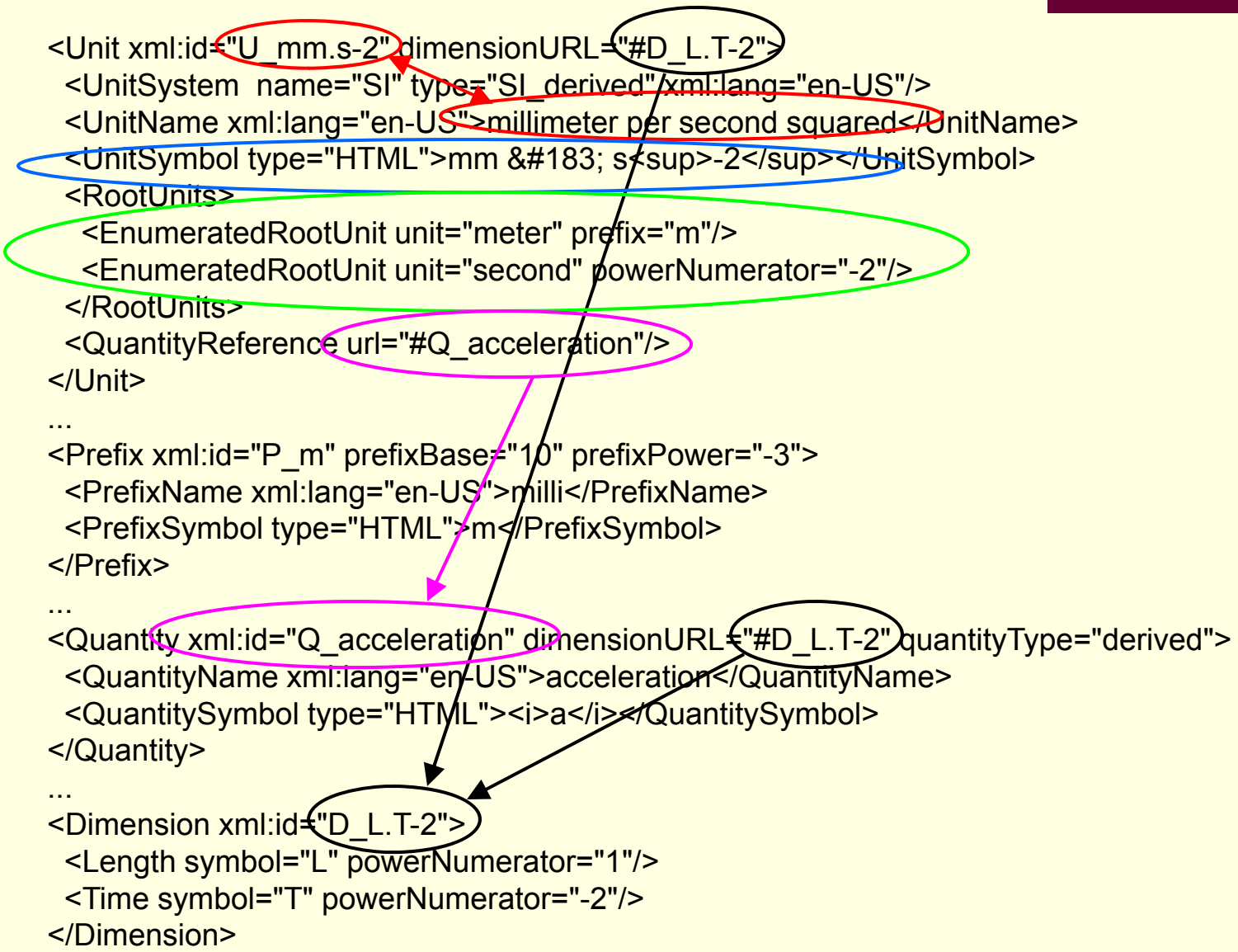
Express the dimensionality of a quantity or unit.



'Prefix' Element



Instance Document Snippets



UnitsML Schema 0.9.18

```
<?xml version="1.0" encoding="UTF-8"?>
<!--
   Units Markup language (UnitsML) Schema
    Website: http://unitsml.nist.gov
    Version History: http://unitsml.nist.gov/Schema/schema_changes.txt
-->
<xsd:schema xmlns="urn:oasis:names:tc:unitsml:schema:xsd:UnitsMLSchema-0.9.18" xml
        <xsd:import namespace="http://www.w3.org/XML/1998/namespace" schemaLocatio
        <!--=== Root-Node of an UnitsML document ===-->
        <xsd:element name="UnitsML" type="UnitsMLType">
                <xsd:annotation>
                        <xsd:documentation>Container for UnitsML units, quantities, and prefix
                </xsd:annotation>
        </xsd:element>
        <xsd:complexType name="UnitsMLType">
                <xsd:annotation>
                        <xsd:documentation>ComplexType for the root element of an UnitsML
                </xsd:annotation>
                <xsd:sequence>
                        <xsd:element ref="UnitSet" minOccurs="0"/>
                        <xsd:element ref="CountedItemSet" minOccurs="0"/>
                        <xsd:element ref="QuantitySet" minOccurs="0"/>
                        <xsd:element ref="DimensionSet" minOccurs="0"/>
                        <xsd:element ref="PrefixSet" minOccurs="0"/>
                </xsd:sequence>
```

Units Database

(UnitsDB)

UnitsDB

- UnitsDB is based on MySQL
- JAVA & PHP is used to query the MySQL database
- Human Web interface – possible search methods
  - Unique ID – e.g., U_m.s-1
  - Name search with close and partial matches
  - Scrollable list
  - A-Z alphabetic list
- Version 1.0 will provide XML & HTML
- Web Services interface planned

Usage of UnitsML & UnitsDB

Usage of UnitsML & UnitsDB

- Methods of using UnitsML & UnitsDB with other markup languages
  - Incorporating part or all of the UnitsML schema:
    - Refer to the schema
    - Include the schema
    - Import the schema
  - Provide a choice of unit markup
  - Reference the unique IDs in UnitsDB
- We are working with members from other MLs to implement using UnitsML
  - AnIML – Analytical Information Markup Language
  - MatML – Materials Property Data Markup Language
  - AMDML – Atomic and Molecular Data Markup Language

Resources

For the most recent UnitsML schema and documentation with images, go to:
http://unitsml.nist.gov

For information about SI units and non-SI units for the U.S., go to:
http://physics.nist.gov/sp811

Thank you for your attention.

Questions/Comments?