Unit ontology issues and proposed refactoring

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Goals of this discussion

- Present issues with current UO
- Units as information artifacts
- Relation of UO to SI
- Discuss the hard part: What units measure

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Issues with current UO

- Ontological status of units are unclear – there are several possible interpretations
  - Units are (sub)types of qualities
  - Units represent particular entities – kilogram represents the standard kilogram
  - 1 gram units are instantiated by material entities with mass 1 gram
  - Some discussion at **http://tinyurl.com/ylkhlj2**

Issues with current UO

- For a given theory of units, what does it mean to be derived?
  - What is a derived quality?
  - What is a derived temperature?

  degree celsius is_a **temperature derived unit**

  kelvin is_a **temperature unit**

- What does the relation unit_of mean?
- Multiple inheritence
  - mass volume percentage is_a concentration unit, percentage

Is time a quality? (no)

[Term]
id: UO:0000003
name: time unit
namespace: unit.ontology
def: "A base unit which is a standard measure of the dimension in which events occur in sequence."
is_a: UO:0000045 ! base unit
relationship: unit_of PATO:0000011 ! age
relationship: unit_of PATO:0000050 ! life span
relationship: unit_of PATO:0000081 ! period
relationship: unit_of PATO:0000165 ! time
relationship: unit_of PATO:0001309 ! duration
relationship: unit_of PATO:0001310 ! duration of temperature
relationship: unit_of PATO:0001486 ! chronological age

Really: time unit measures temporal region.

A theory of units

- Units are information artifacts, generically dependent continuants
- They are associated with ways of measuring things.
- There are ways of recombining units.
- Units are created by defined processes. Many of these social processes are those carried out by standards bodies.
- Units are used as constituents of measurement data, along with numbers, to denote entities such as qualities, temporal regions, and “other stuff”.

Proposed UO based on IAO, OBI

- Many elements of the proposed theory are present in IAO and OBI
- Measurement data using units in this way have been prototyped and are part of released OBI
- Elements: Organizations, Roles, Planned processes, Information content entities, Measurement data, is_about, is_quality_measure_of, is_specified_output_of
- Prototype:
  - http://tinyurl.com/yfxsxbe (visualize)
  - http://tinyurl.com/y94nlte (owl)

Elements

- Role
  - technical standards body role: A technical standards body role inheres in an organization and is realized in a process by which a technical norm is decided upon and documented
- Organization
  - Bureau International des Poids et Mesures(individual): The task of the BIPM is to ensure world-wide uniformity of measurements and their traceability to the International System of Units (SI). It does this with the authority of the Convention of the Metre, a diplomatic treaty between fifty-four nations, and it operates through a series of Consultative Committees, whose members are the national metrology laboratories of the Member States of the Convention, and through its own laboratory work.

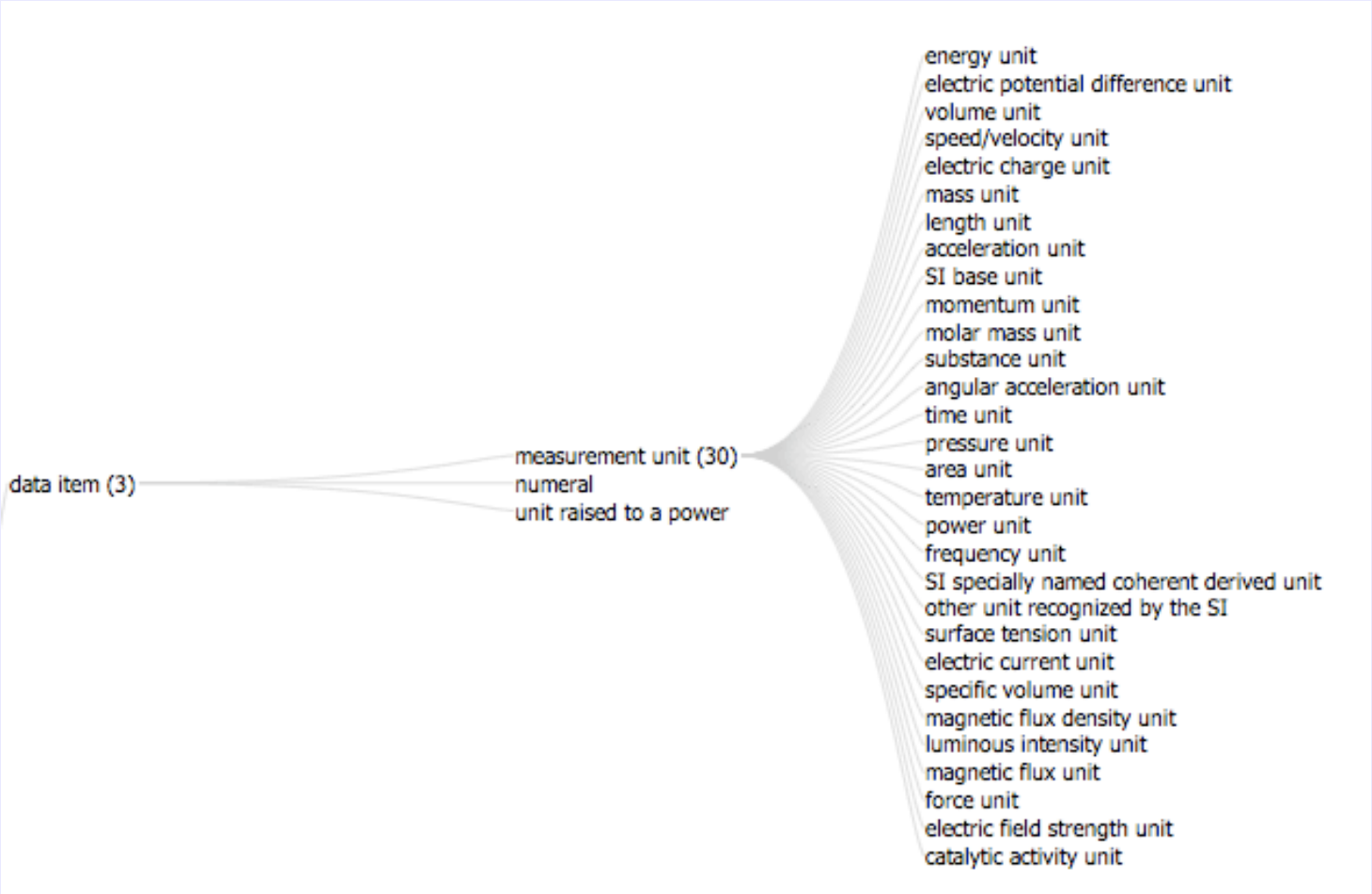
Elements

- Planned process
  - SI giving a special name to coherent derived unit: A process in which, for convenience, certain coherent derived units have been given special names and symbols.
- Unit (aka measurement unit label)
  - Joule (instance): instance_of (Unit and is_specified_output_of some SI giving a special name to coherent derived unit *+…)*

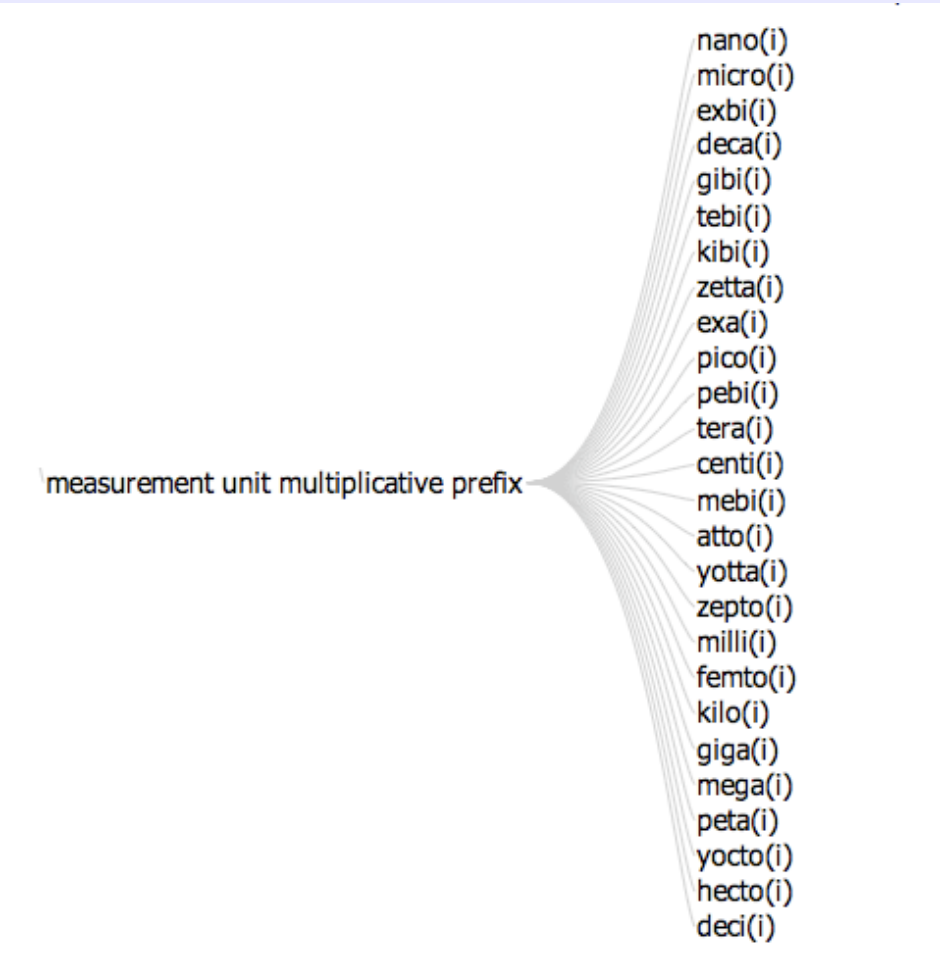
Elements

- Defined classes
  - SI base unit =def unit and is_specified_output_of some 'SI base unit standardization process'
  - Similarly defined classes for SI sanctioned outside units, SI specially named coherent derived units, IEC defined binary power prefixes…

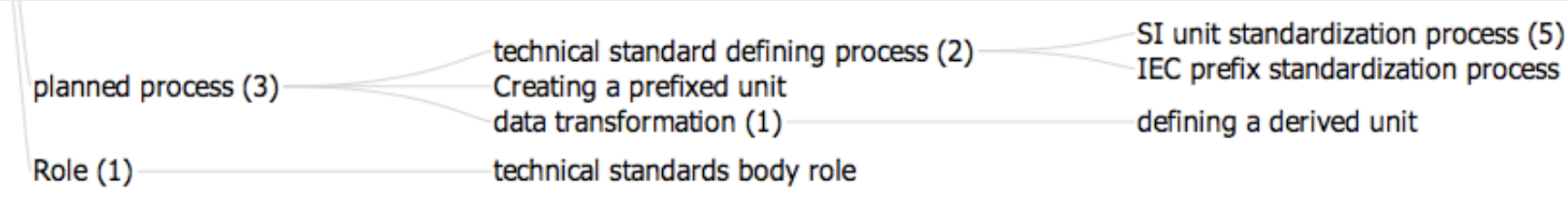
Unit hierarchy



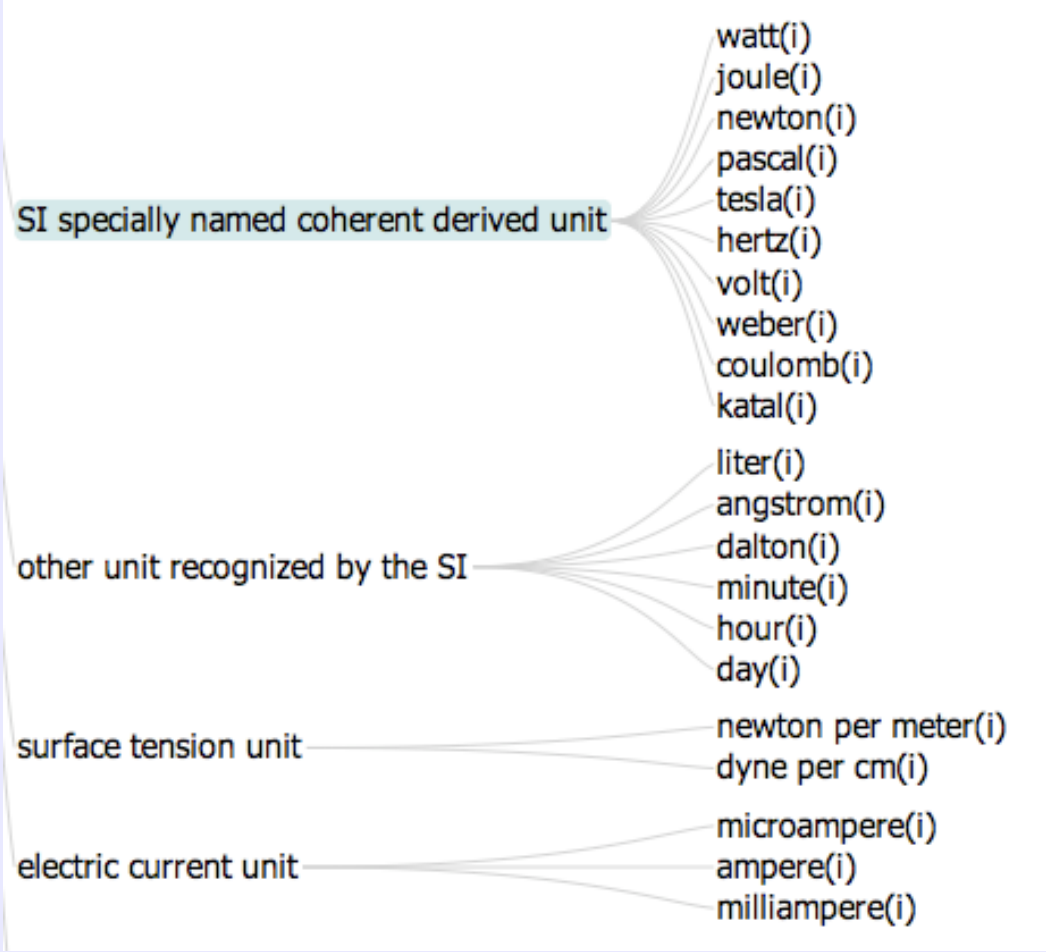
Prefixes


measurement unit multiplicative prefix
nano(i)
micro(i)
exbi(i)
deca(i)
gibi(i)
tebi(i)
kibi(i)
zetta(i)
exa(i)
pico(i)
pebi(i)
tera(i)
centi(i)
mebi(i)
atto(i)
yotta(i)
zepto(i)
milli(i)
femto(i)
kilo(i)
giga(i)
mega(i)
peta(i)
yocto(i)
hecto(i)
deci(i)

Planned processes



Unit classes/Instances.
Defined unit classes



The hard part: What do units measure?

- In many cases qualities. Units currently are related to PATO using the relation "unit_of".
- Reviewing these relations exposes issues with PATO
- Time as quality cited above
- What do units of magnetic flux, power, etc. measure?
- SI sanctions any unit that is a product of powers of base units. Figuring out what these denote is hard.
- A not crazy unit: "wrecked cars per snow-inch per month per mile" (coherent unit: mole/meter^2 sec)

Are inverses of qualities qualities?

```
[Term]
id: PATO:0001019
name: density
def: "A physical quality which inheres to the bearer by virtue of some
influence is exerted by the bearer's mass per unit size."
[WordNet:WordNet "http://wordnetweb.princeton.edu/perl/webwn"]
subset: attribute_slim
is_a: PATO:0001018 ! physical quality

[Term]
id: PATO:0001679
name: specific volume
def: "A volume quality inhering in a mass of substance by virtue of
the amount of 3-dimensional space it occupies."
[Wikipedia:http\://en.wikipedia.org/wiki/Specific_volume]
comment: The reciprocal of density.
is_a: PATO:0000918 ! volume
```

Migration path

- Rewrite unit ontology in OWL as proposed. (not all units are in current prototype)
- Deprecate some classes, give N&S conditions for others
- Use is_quality_measure_of to relate measurement data w/particular units -> qualities.
- Use is_about, or subproperties to relate measurement data to non-qualities (e.g. temporal region)
- Fill in more relations – equations that relate derived units to base units, prefixes
- Process for standard measurements
- Further develop ontology to account for units about current BFO unplaceable entities