QUDT: An OWL Ontology for Measurable Quantities, Units, Dimension Systems, and Dimensional Data Types

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Presentation Overview

- Introductory Remarks
- Definitions of Main Concepts Modeled
- The Main Classes in the QUDT Ontology (with examples)
- Functions for Unit Conversion and Computing Products/Quotients of Quantity Kinds
- Current and Future Work
- References and Credits

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Introductory Remarks

- Sponsored by NASA's Constellation Program
  - 30+ year space exploration program to return to the moon and eventually send humans to Mars
  - Investing in Semantic Technologies to meet short term and long term '-ilities'
    - Affordability; Sustainability; Operability; etc.
- One of a set of related ontologies designed to support the Constellation Program Lifecycle, as well as domain specific areas, including
  - Telemetry and command
  - Modeling and simulation

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Main Concepts Modeled (I)

- Quantity Kind - an observable and measurable property of objects, systems, or events that is independent of any particular measurement or expression of magnitude
  - Mass, Velocity, Power, Torque, etc.
- Quantity - the magnitude of a quantity kind for a particular object, system, event, or class of that can be expressed as a numerical value with respect to a chosen scale
  - Mass of a hydrogen atom, Escape velocity of the Earth, Duration of this teleconference, etc.

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Main Concepts Modeled (II)

- Unit of Measure - a chosen scale for expressing the magnitude of a quantity as a numerical value; units are associated with the quantity kinds they quantify.
  - Meter, Kilogram, Volt, etc.
- Quantity Value - the numerical value of a quantity's magnitude with respect to a chosen unit of measure for the corresponding quantity kind
  - 2 Meters, 5 Kilograms, 1000 Volts, etc.

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Main Concepts Modeled (III)

- Quantity System - a collection of quantity kinds comprised of a base set and a derived set such that each member of the collection can be expressed as a product of members of the base set raised to a rational power.
- Unit System - a collection of units in which each member is a measurement scale for a quantity kind in a corresponding quantity system.

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Main Concepts Modeled (IV)

- System Dimension - a mapping from a tuple of rational numbers to a product of base quantity kinds such that the tuple members correspond to the exponents of the base quantity kinds; each quantity kind in a system corresponds to exactly one system dimension; multiple quantity kinds may correspond to the same dimension.

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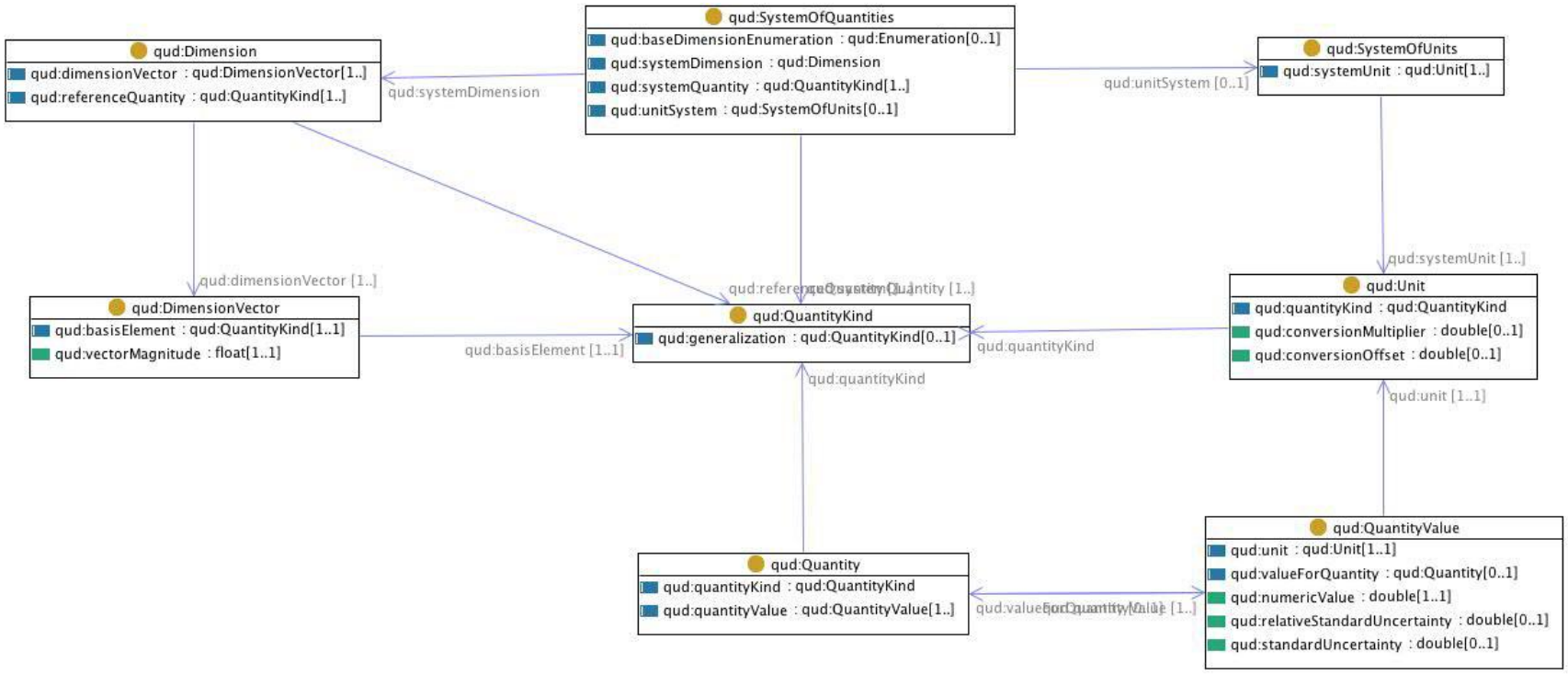
Main QUDT Class Diagram



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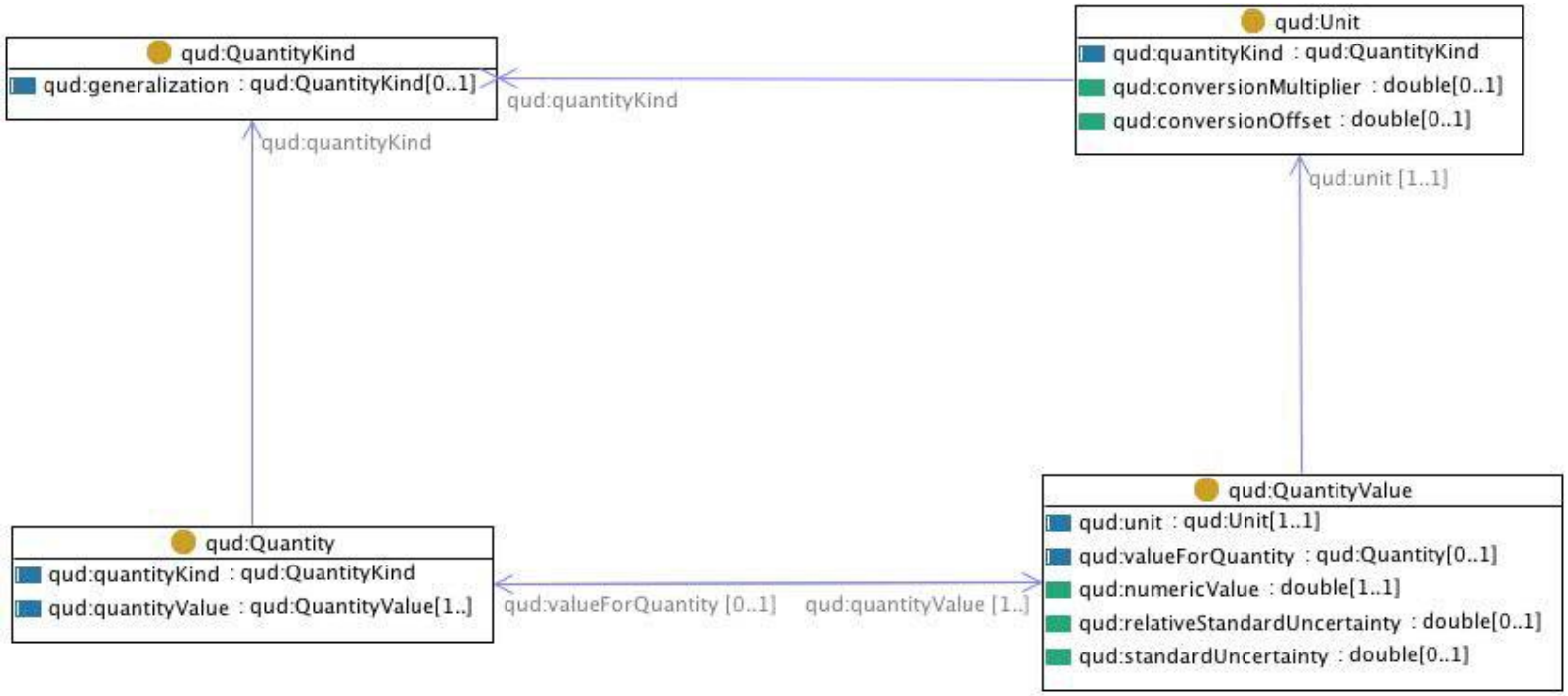
Expressing Quantity Values



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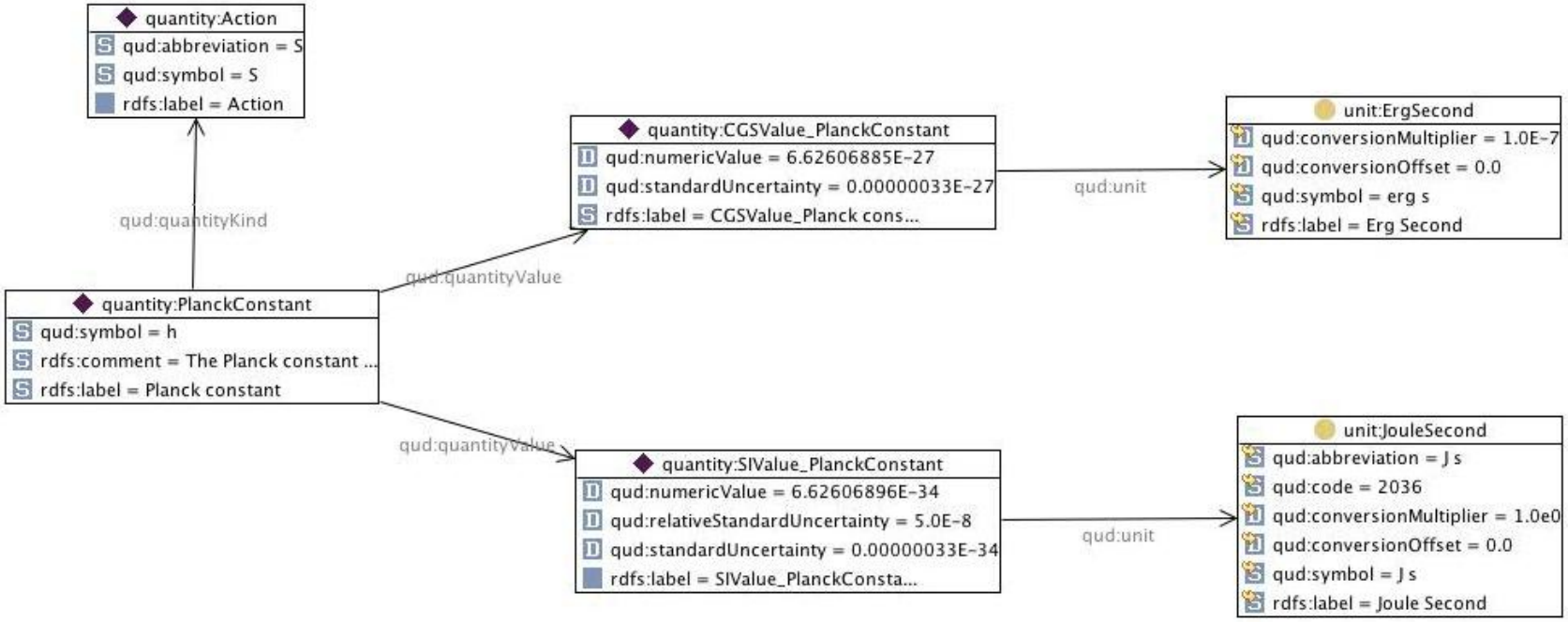
Example: Value of Planck's Constant in SI and CGS Units



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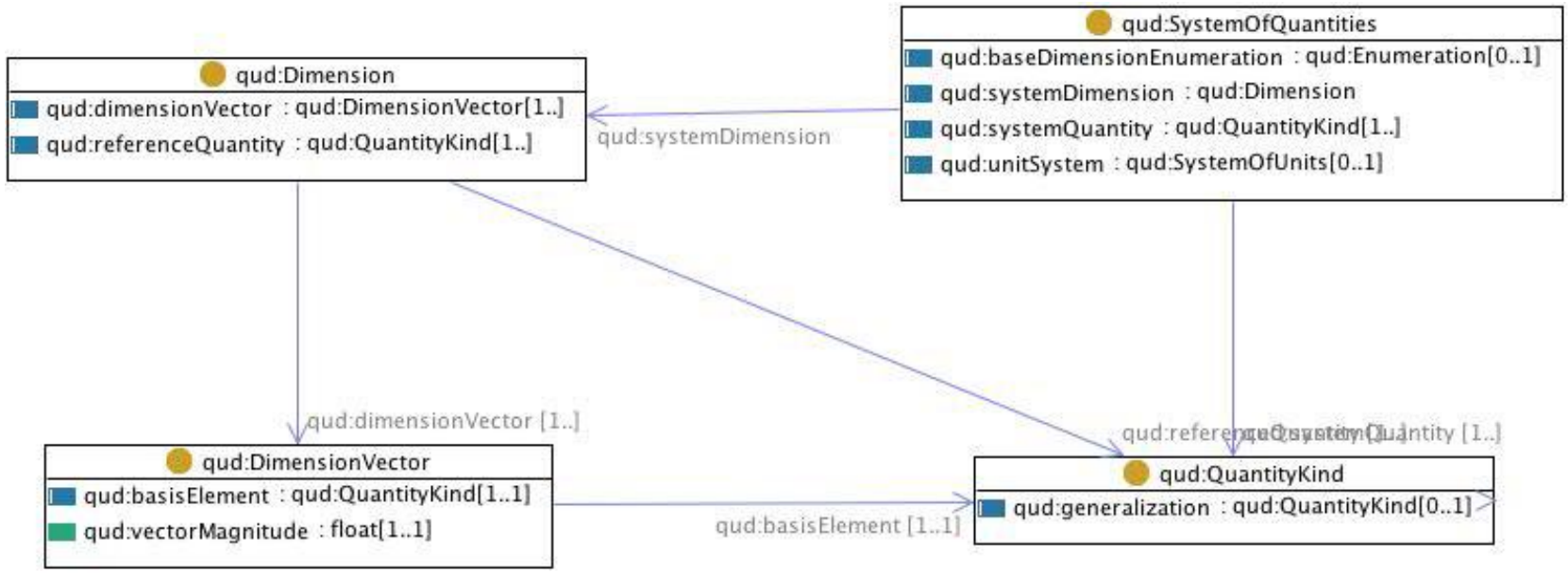
System Dimensions for Quantity Kinds



Example: Dimensions for Permittivity

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SPIN Functions Using QUDT

- SPARQL Inference Notation (SPIN) -- RDF vocabularies enabling the use of SPARQL to define constraints and inference rules on Semantic Web models
- QUDSPIN -- A library of SPIN functions and templates utilizing the QUDT ontology to convert between units, calculate products and quotients of quantities, etc.

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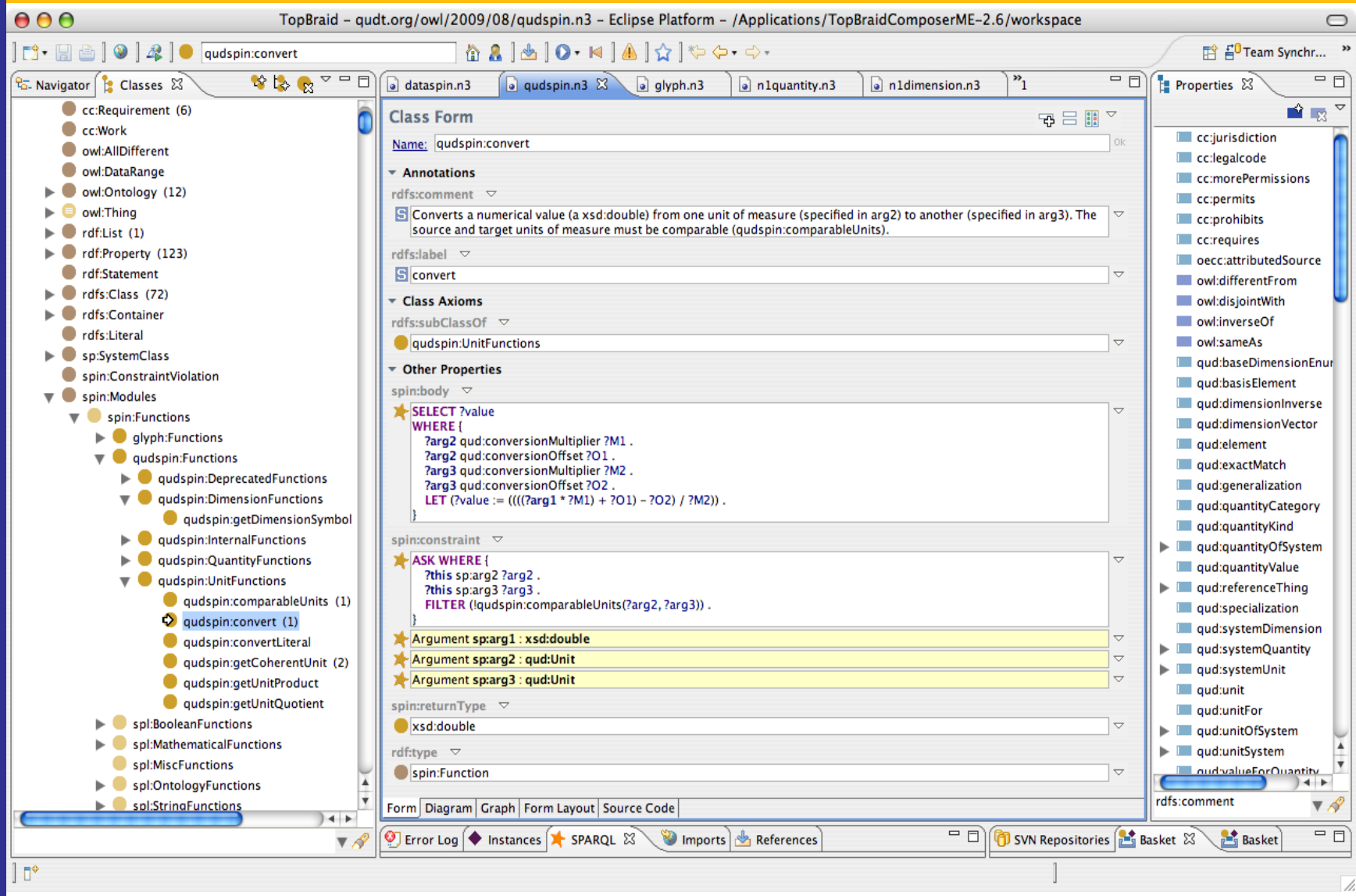
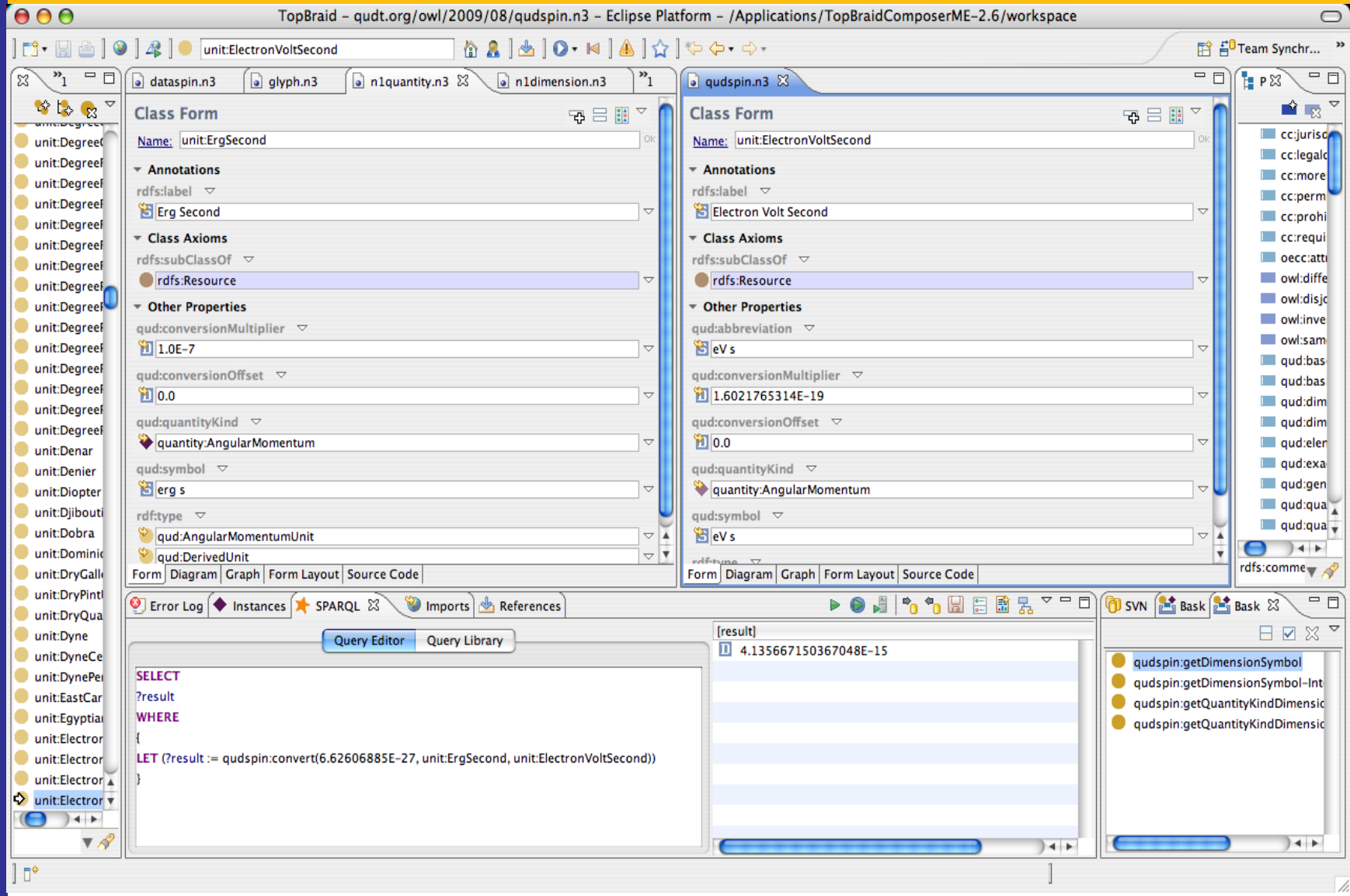
Unit Conversion Function



Unit Conversion Example



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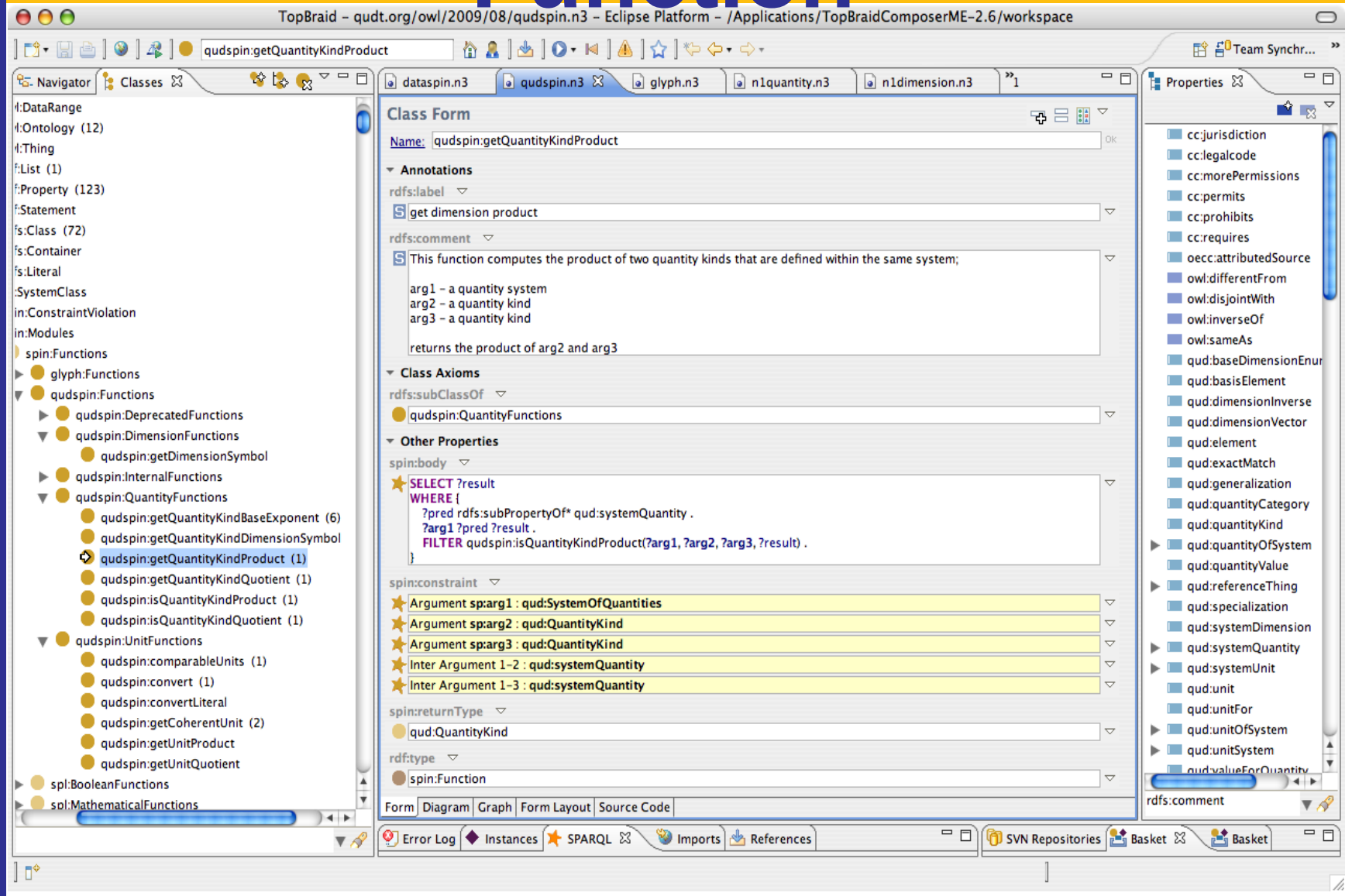
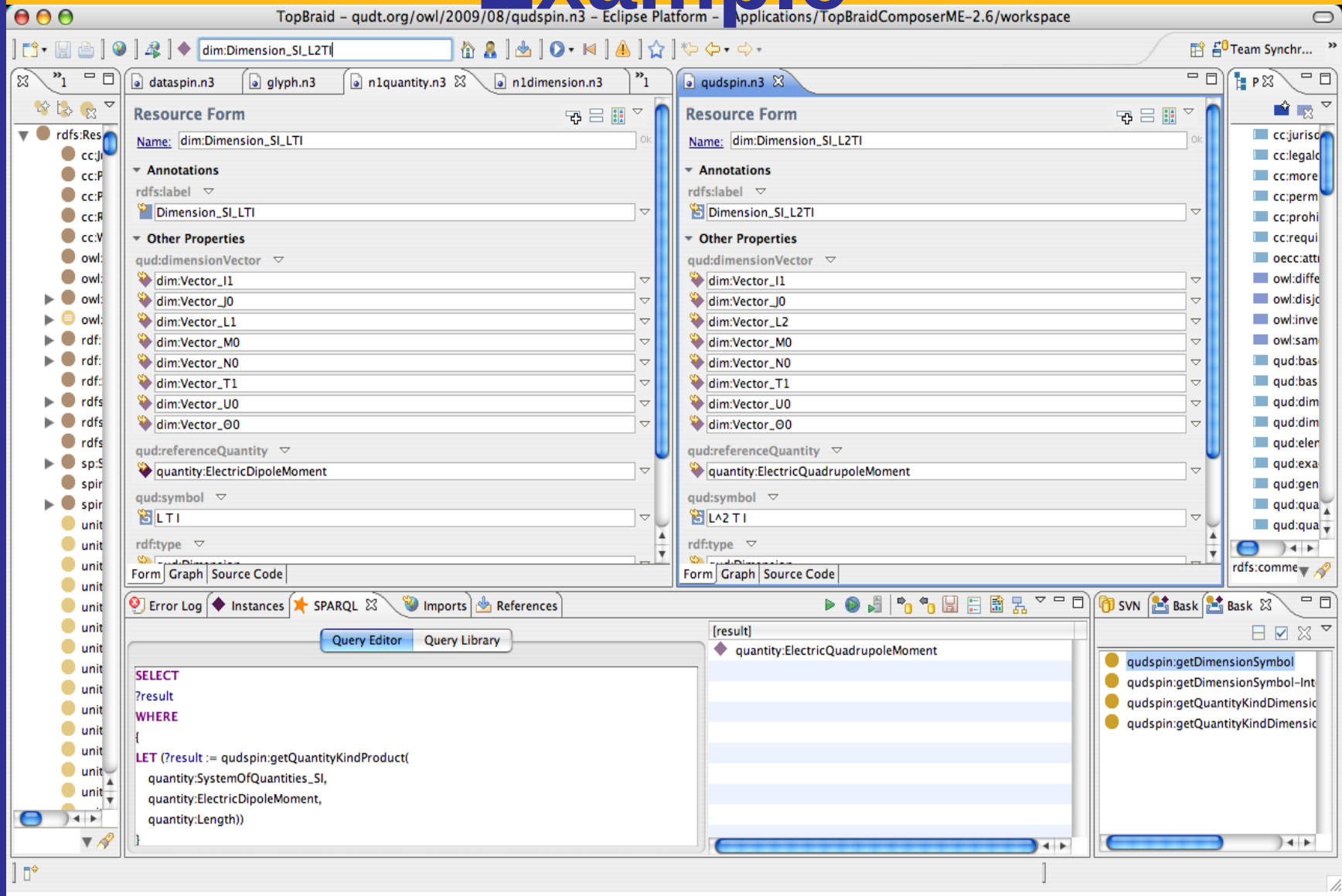
Quantity Kind Product Function



Quantity Kind Product Example



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Current and Future Work

- Dimensional Data Type Systems
- Equations (Physical Laws) Relating Quantity Kinds
- Structural Type of Quantity Kinds (scalar, vector, tensor, etc.)
- Association Between Measurement Events, Measured Quantities, and Expression in Engineering Units
- Dimensionless Numbers

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References and Sources

- Bureau International des Poids et Mesures
- The NIST Reference on Constants, Units, and Uncertainty
- VIM 3: International Vocabulary of Metrology
- Eric Weisstein's World of Science
- Classical Electrodynamics, J.D. Jackson, Wiley & Sons, 3rd Edition (1998)

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Links

- The QUDT Ontology is available at http://www.qudt.org. Includes:
  - QUDT Schema and Instance Data
  - Physical Constants published in the NIST Reference on Constants, Units and Uncertainty
  - Links between QUDT URIs and DBPedia URIs (uses SKOS ontology for linking)

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