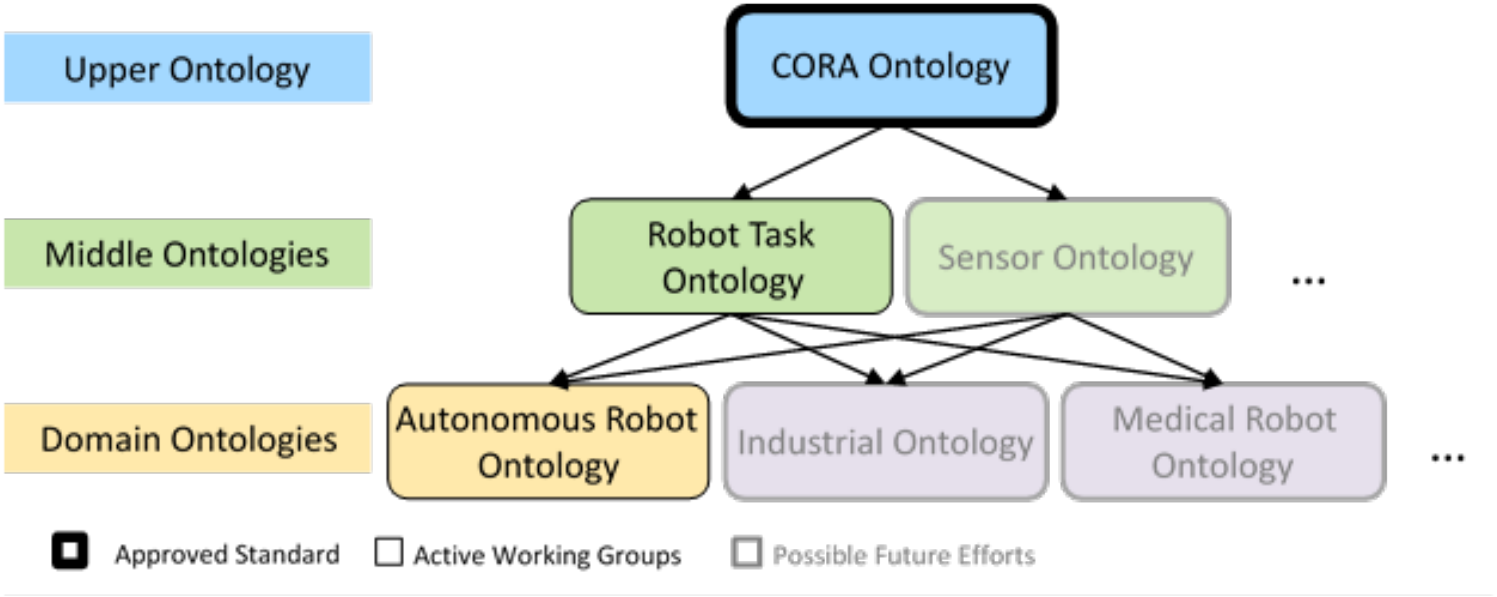
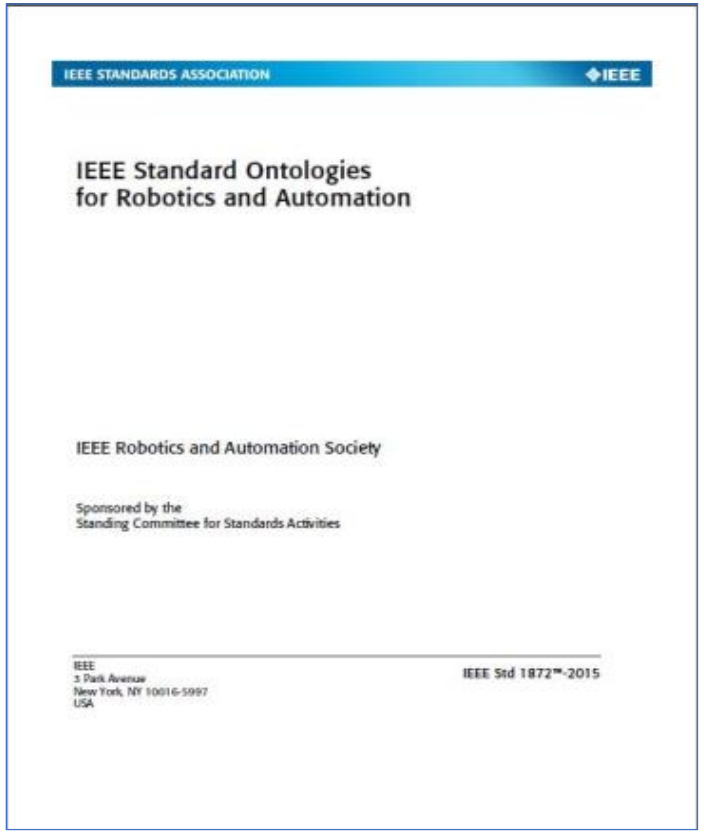
Structure of the IEEE Robotics and Automation Ontologies



- Upper Ontology: Specifies the meaning of high-level, general terms that are applicable across all of the robotics domain.
- Middle Ontology: Specifies the meaning of ubiquitous terms are applicable to many robotics domains. Specializes concepts in the upper ontology.
- Domain Ontology: Specifies the meaning of terms that are primarily relevant to a specific domain. Specializes concepts in the middle ontologies.

Core Ontologies for Robotics and Automation Standard

- IEEE 1872 -Core Ontology for Robotics and Automation (CORA)
  - "… allows for the representation of, reasoning about, and communication of knowledge in the robotics and automation domain."
  - http://standards.ieee.org/findstds/standard/1872-2015.html
  - First ontology-based IEEE RAS standard
- IEEE Ontologies for Robotics and Automation Standards Working Group
  - November 2011 – Became a working group
  - July 2014 – Initial standard applied to robots at NIST and Georgia Tech
  - April 2015 – CORA Becomes a Standard (unanimous approval from ballot group)
  - 175 members representing 23 countries
    - ~50% educational institutions, ~25% industry, ~25% government
    - ~50% US, ~50% non-US



IEEE STANDARDS ASSOCIATION IEEE

IEEE Standard Ontologies for Robotics and Automation

IEEE Robotics and Automation Society

Sponsored by the Standing Committee for Standards Activities

IEEE
3 Park Avenue
New York, NY 10016-5997
USA

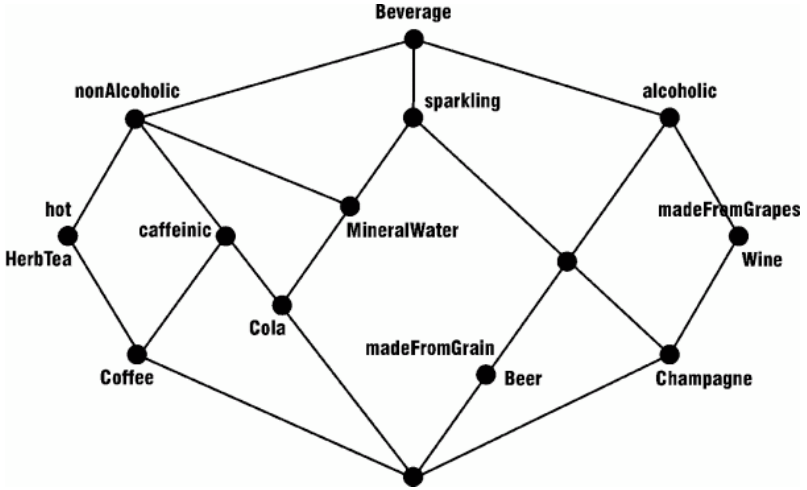
IEEE Std 1872™-2015

C. I. Schlenoff, "Let's Talk, Robots" Scientific Computing Magazine, Scientific Computing, 100 Enterprise Dr. Suite 600, Rockaway, NJ, 07866, United States, (21-Nov-2016)

How does your group define terminology?

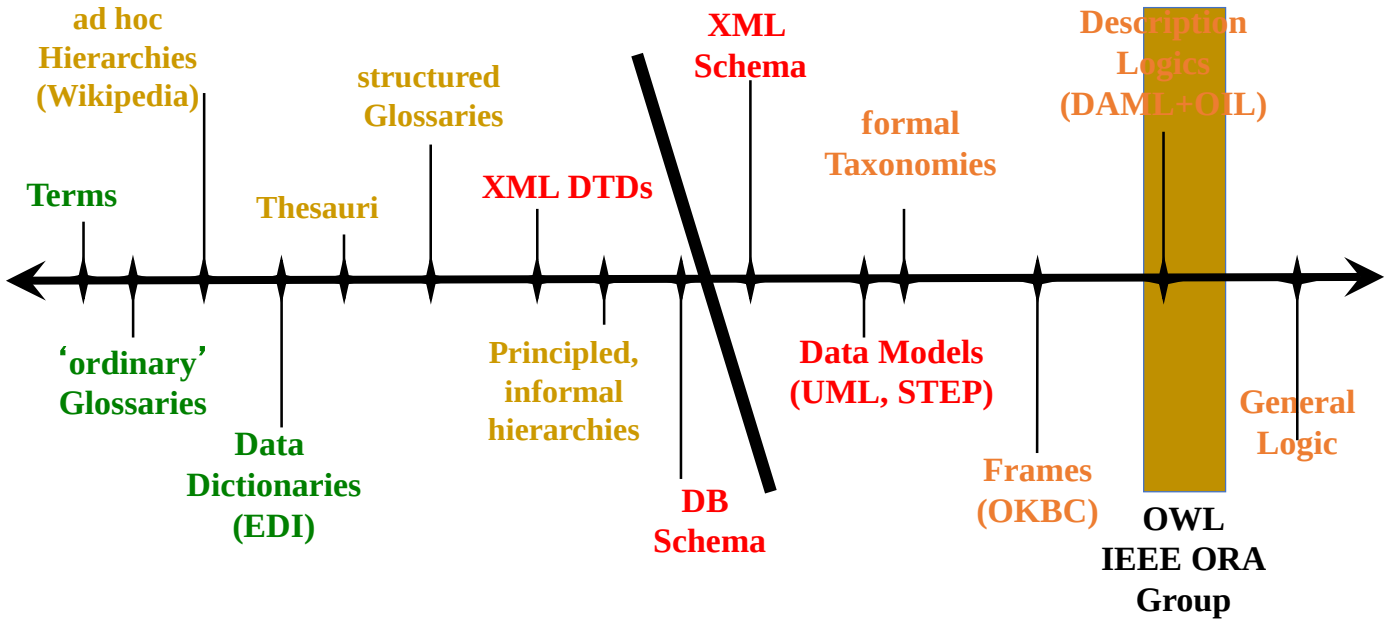
- What is an ontology?
  - “a specification of a conceptualization”*
  - Ontologies *explicitly* represent key concepts, their properties, their relationships, and their rules and constraints.
  - Ontologies often focus more heavily on the *meaning* of concepts as opposed to terms that are used to represent them

- Vocabulary + Structure = Taxonomy
- Taxonomy + (Relationships and Constraints) = Ontology



*Tom Gruber, Stanford Univ.

Formalities of Knowledge Representations



Glossaries & Data Dictionaries

Thesauri, Taxonomies

MetaData, XML Schemas, & Data Models

Formal Ontologies & Inference

How do you define the following terms?

- **Automated Robot** - A role for a robot performing a given task in which the robot acts as an automaton, not adapting to changes in the environment and/or following scripted plans. **Contrast**: fully autonomous robot; semi-autonomous robot; teleoperated robot; remote controlled robot.
- **Teleoperated Robot** - A role for a robot performing a given task in which a human operator, using sensory feedback, either directly controls the actuators or assigns incremental goals on a continuous basis, from a location off the robot. A teleoperated robot will complete its last command after the operator stops sending commands, even if that command is complex and time-consuming. **Contrast**: fully autonomous robot; semi-autonomous robot; remote controlled robot; automated robot.
- **Physical Environment** – An object that has at least one specific part: a region (*Region*, in SUMO) in which it is located. In addition, a physical environment relates to at least one reference object (*Object*, in SUMO) based on which its region is defined.
- **Pose** - A position and an orientation constitute a pose. The pose of an object is the description of any position and orientation bearing the same object. **See also:** position measure; orientation measure.

How did you determine these definitions?

- Natural language definitions were determined through a consensus process within the working group. Often one person took the lead on proposing definitions and then the consensus process began.
- Once consensus was reached on the natural language definition, we had a small team on ontologists develop the first order logic-based definition.
- We made the decision early in the process to build down from SUMO, so specializations were created from SUMO terms to fully capture the natural language definitions.