An Engineering Approach to Ontology Engineering in Complex Environments: the role of Foundational Theories and Ontological Patterns

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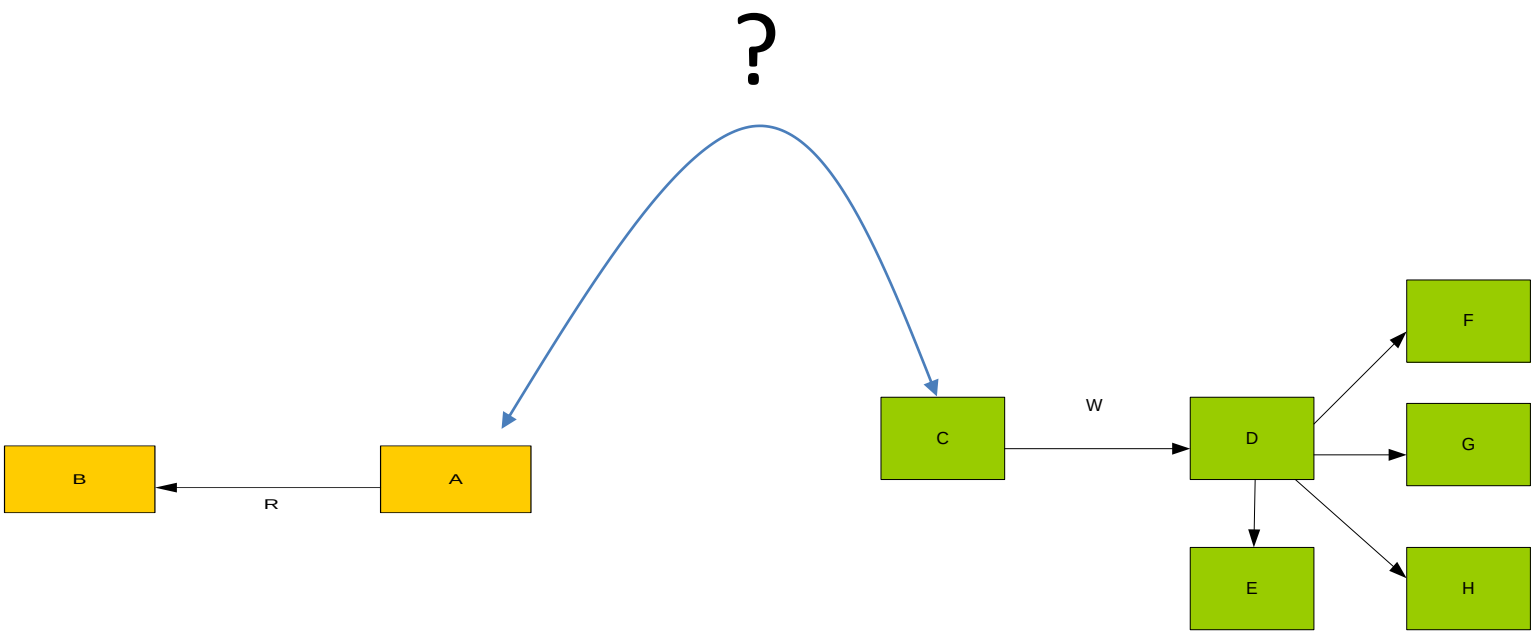
Complex Engineered Systems

- Engineered systems are often characterized by concurrently developed, autonomous and heterogeneous components.
- One key aspect in these complex systems is *Semantic Interoperability*.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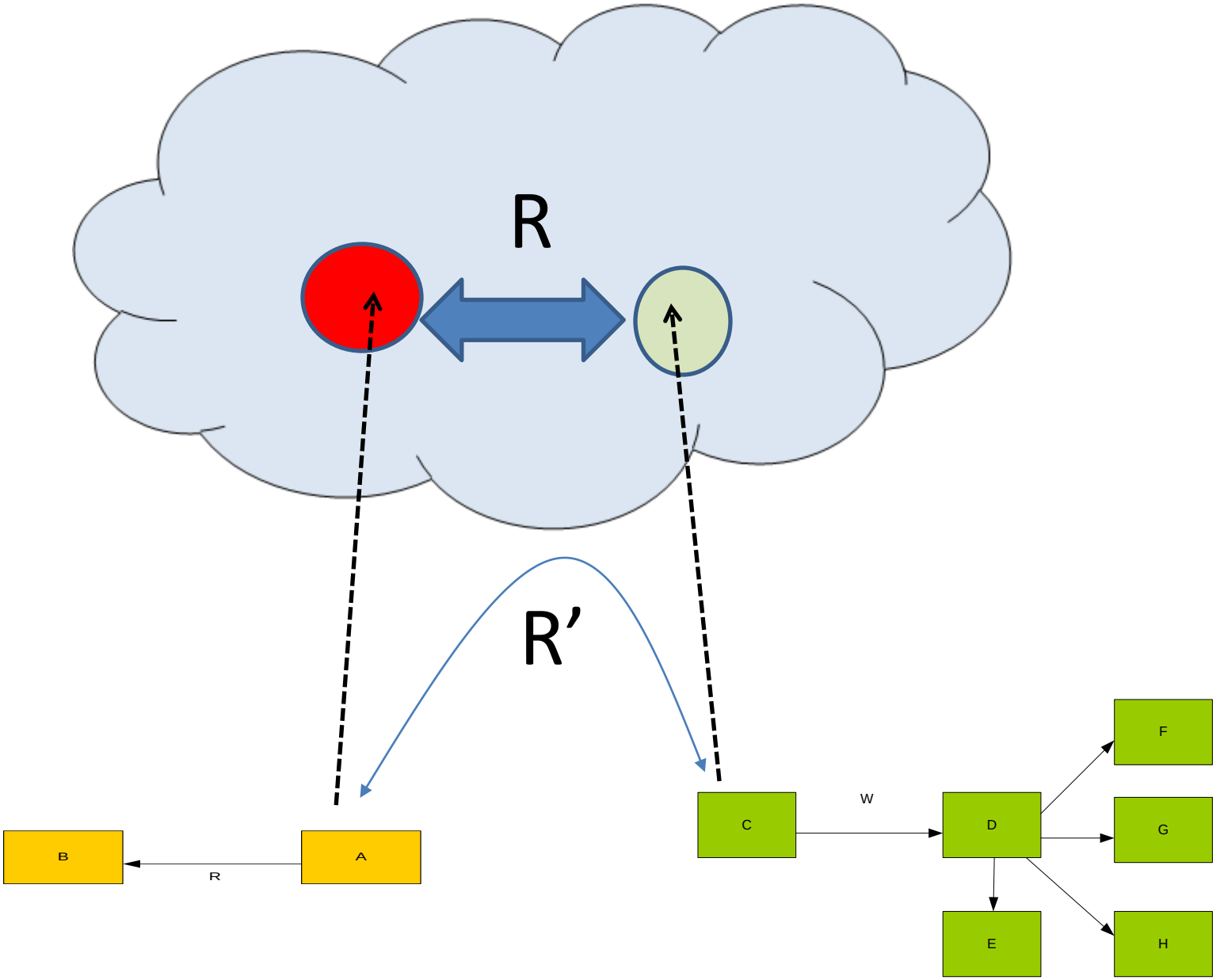
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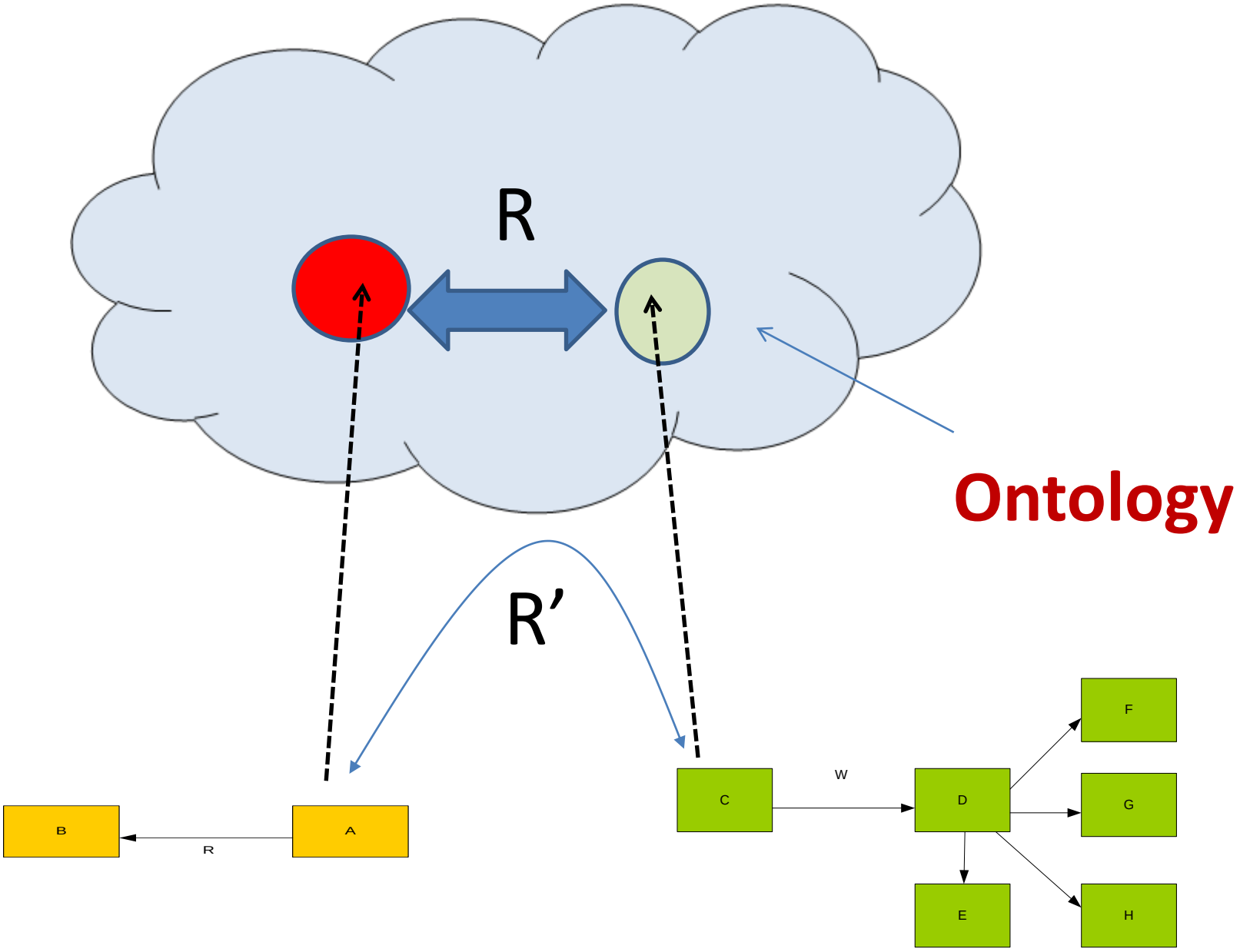
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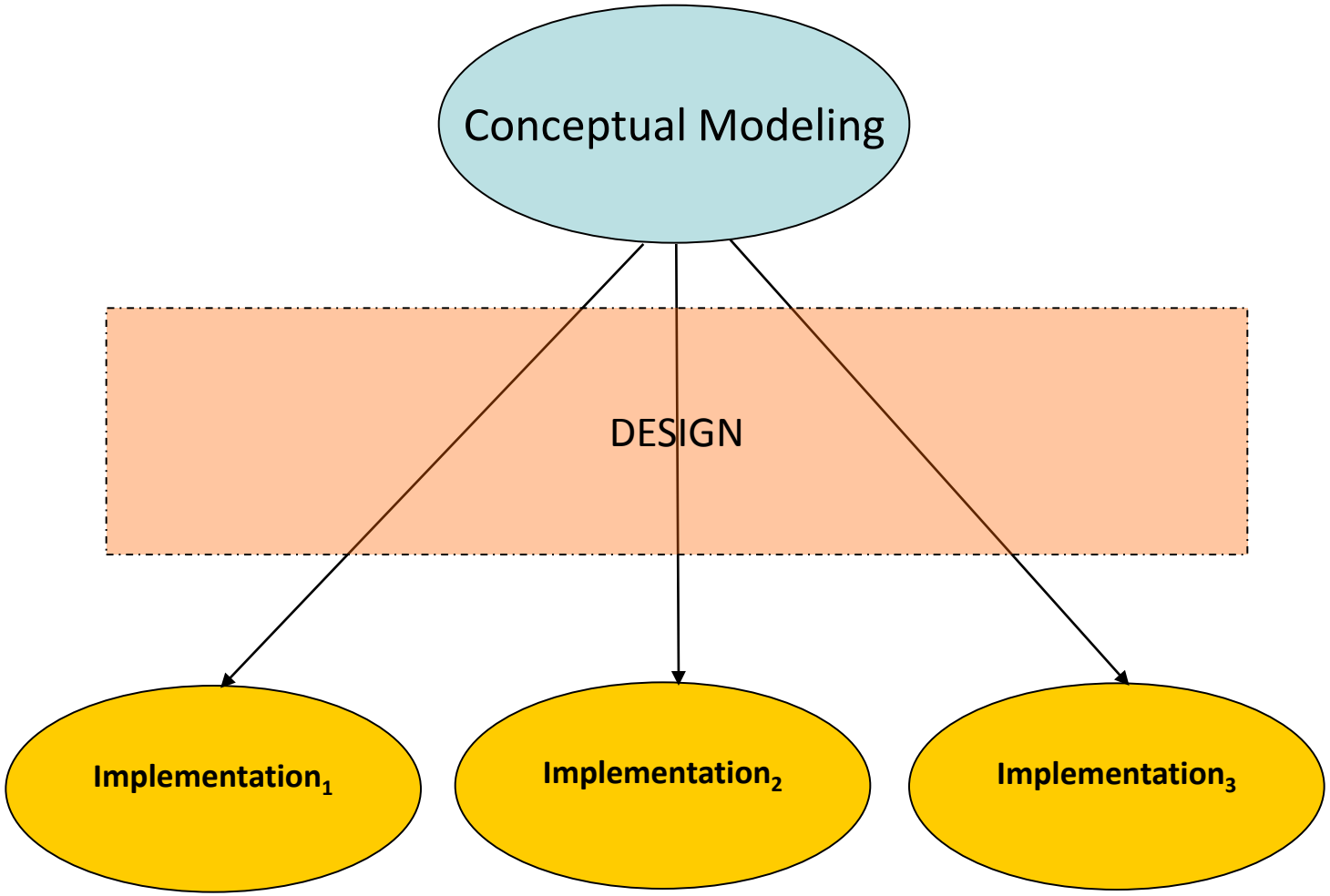
Ontology

1. *Reference Model of Consensus* to support different types of *Semantic Interoperability* Tasks
2. Explicit, declarative and machine processable artifact coding a domain model to enable efficient automated reasoning

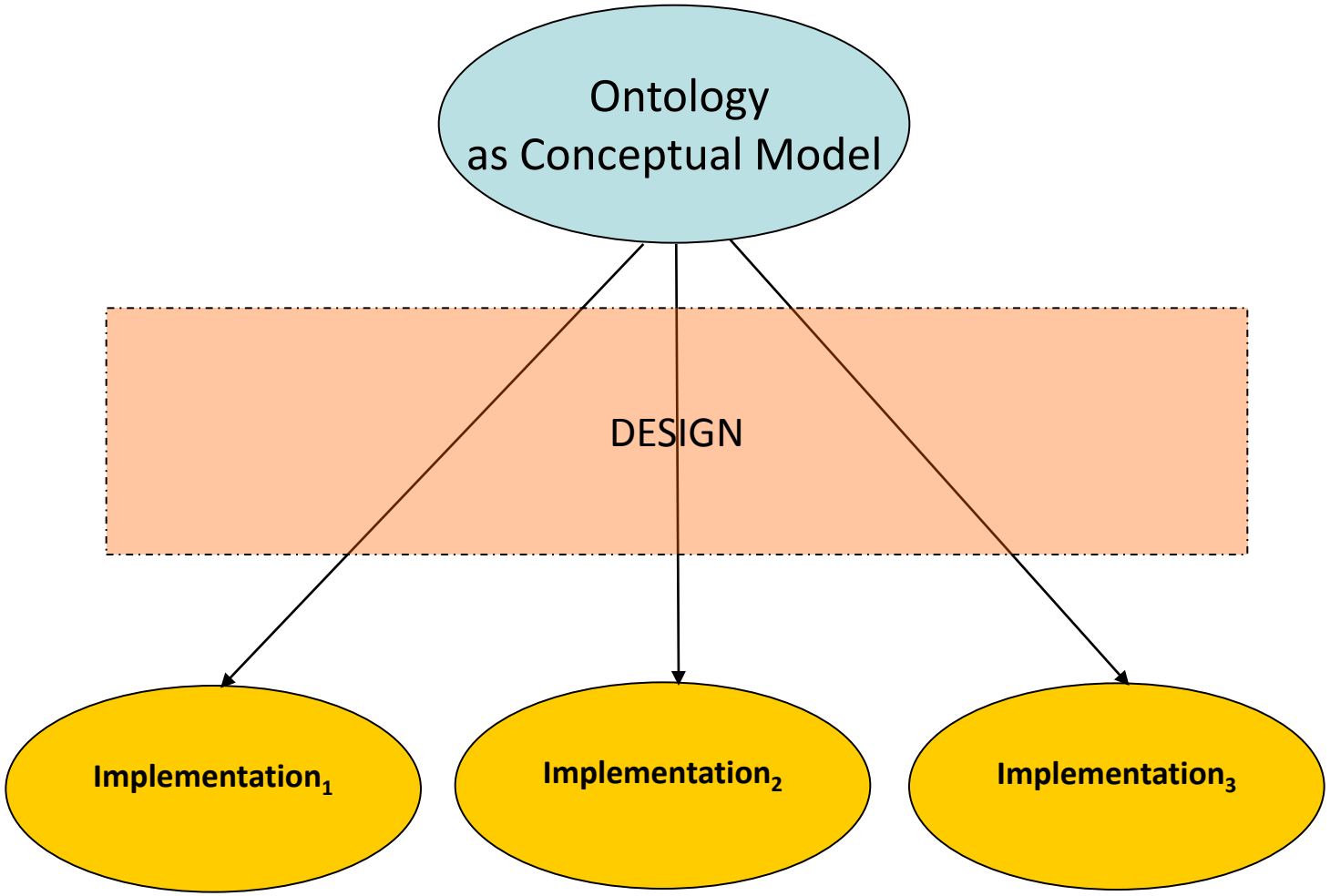
A Software Engineering view…



Ontology as Reference Conceptual Models

- Ontologies as reference conceptual models should be constructed in manners that maximize:
  - the expressivity in capturing fundamental aspects of the underlying domain and in making explicit the underlying ontological commitments.
  - conceptual clarity (or pragmatic efficiency) to afford the tasks of communication, domain understanding, problem-solving and meaning negotiation among human users.

Transported to Ontology Engineering…



Ontology-Driven Conceptual Modeling

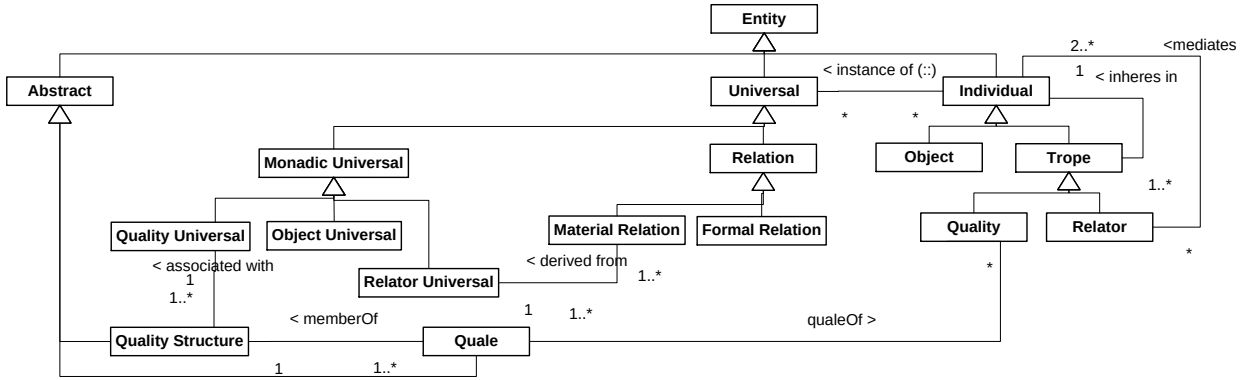
- We cannot eschew *truly ontological questions*, i.e., conceptual modeling should be supported by *Formal Ontological theories* (e.g., identity, dependence, classification and taxonomic structures, composition, causality, intentionality, systems, commitments and claims).

Ontological Patterns

- Besides enriching the modeling primitives of conceptual modeling languages, foundational theories can in the identification of both ***Modeling Patterns*** and ***Analysis Patterns***
- Empirical Knowledge of recurrent problems that arise in practice can help us identify ***Problem Patterns***
- Knowledge of the Design Space and Codification Environments can help us to identify ***Codification and Transformation Patterns***

Modeling Language Federation

- Despite the “vertical complexity” of having several codification models related to the same (set of) conceptual models, in complex engineered systems (e.g., organizations) there is also typically “horizontal complexity”
- We have the case of multiple conceptual modeling languages capturing complementary viewpoints of the same underlying system



Foundational Ontology

Language Metamodels

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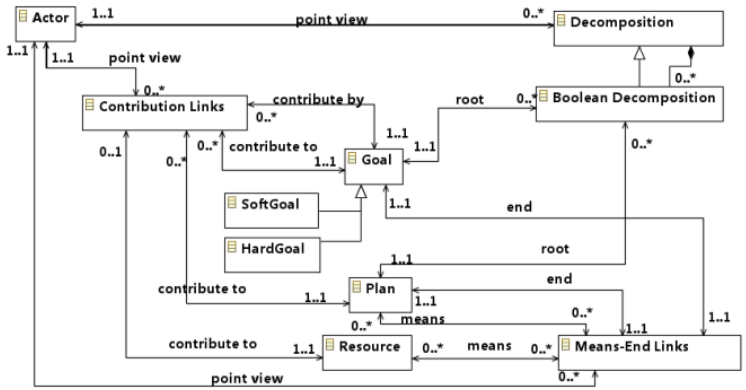

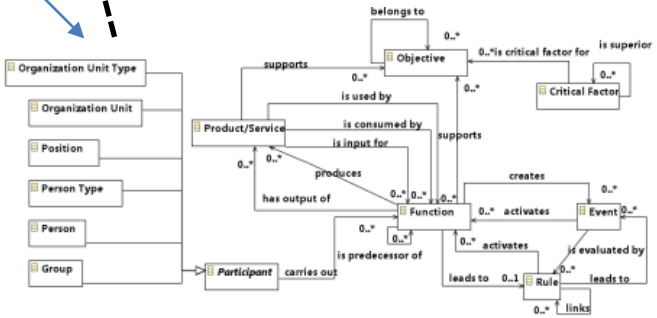

Summary

- We need different representation and analysis approaches with different characteristics for different phases on analysis and design of complex (ontology-based) engineered systems
- We need a conceptual modeling approach supported by well-founded ontological theories (in the true ontological sense)
- We need a mature body of knowledge organized as Ontological Patterns (Modeling Patterns, Analysis Patterns, Codification and Transformation Patterns, Problem Patterns)

SIG on Ontologies and Conceptual Modeling

(http://ontolog.cim3.net/mailman/listinfo/iaoa-conceptual-modeling)

(co-chaired with
Yair Wand – University of British Columbia, Canada and
Oscar Pastor - Universidad Politecnica de Valencia, Spain)