

ThingFO: Ontología Fundacional útil para enriquecer diversas terminologías como las de **Proceso y Test**

Dr. Luis Olsina

GIDIS_Web, Facultad de Ingeniería, UNLPam

Argentina

E-mail olsinal@ing.unlpam.edu.ar

Agenda

Part I

Introducing and Illustrating ThingFO



establishes

helps to achieve

SET GOALS

1. **Goals for**
 - Evaluation
 - Testing
 - Development
 - Maintenance



is operationalized by



Strategy

- Process Specs (**what** to do)
- Method Specs (**how** to do it)
- Conceptual Bases (**Ontologies**)

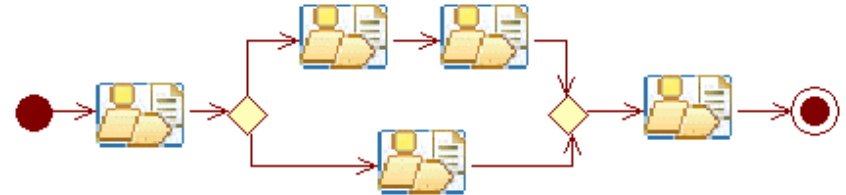
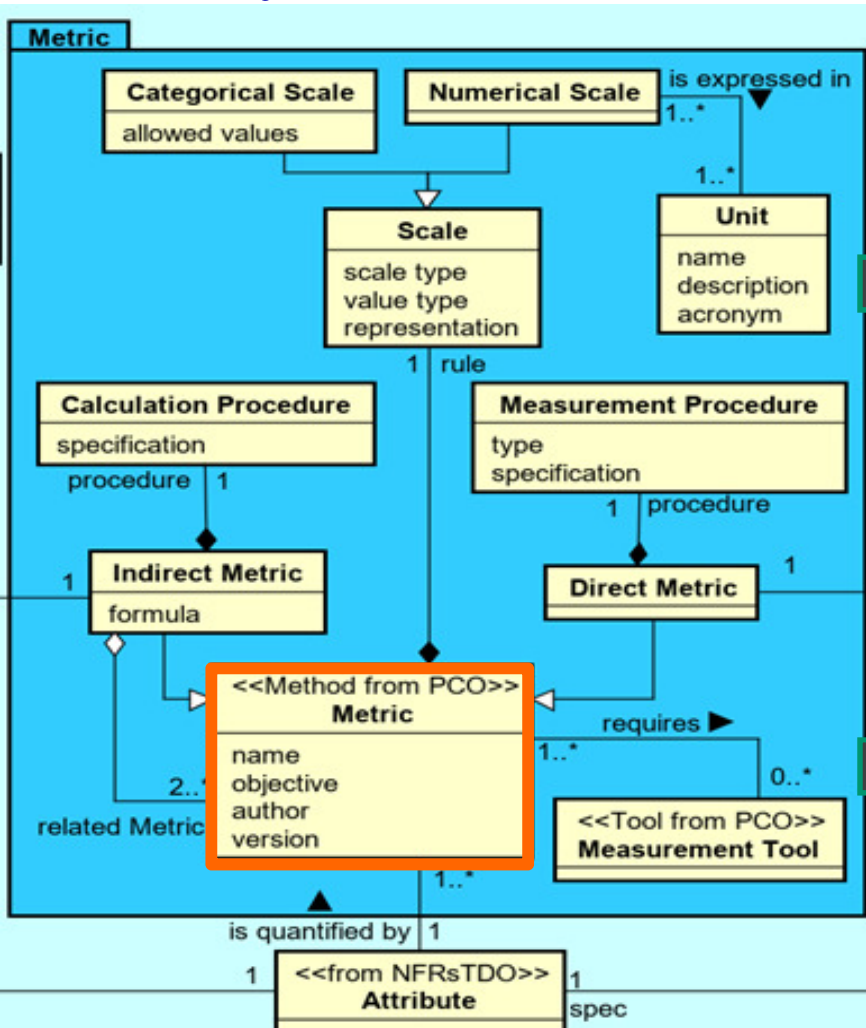
Uses

Project



Evaluation Strategies

A **Strategy** specifies concretely what should be done (work process /activity/task) and how should be performed (method/technique/tool).



Process Specifications (What)

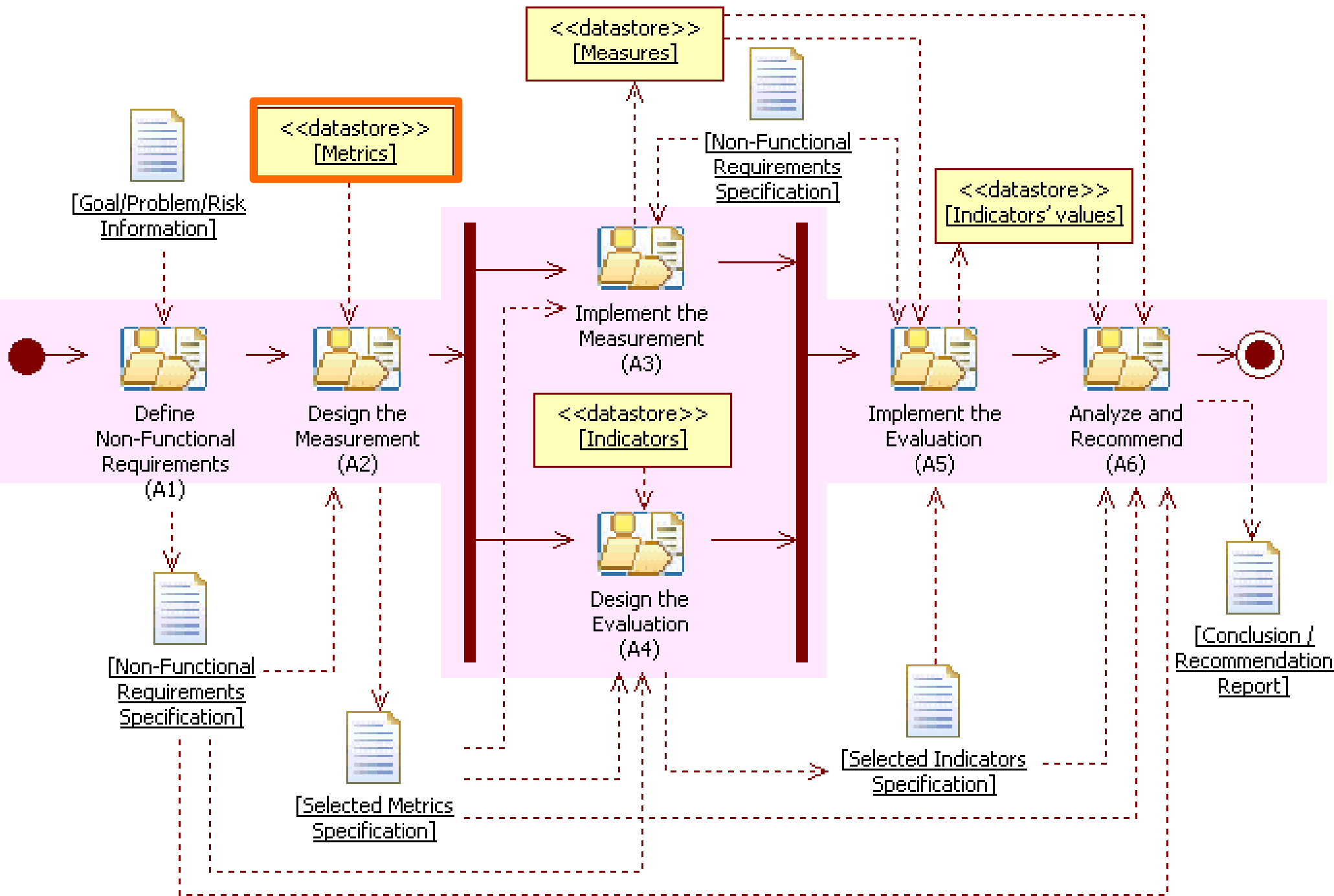
Direct Metric		
Quantified Attribute name:		
Metric name:		
Objective:	Author:	Version:
Measurement Procedure:		
Type:	Specification:	
Scale: [Numerical Categorical]		
Scale Type name:	Value Type:	Representation:
Unit:		
Name:	Description:	Acronym:
Tool: (Note: Info about the used tool if any)		

Method Specifications (How)

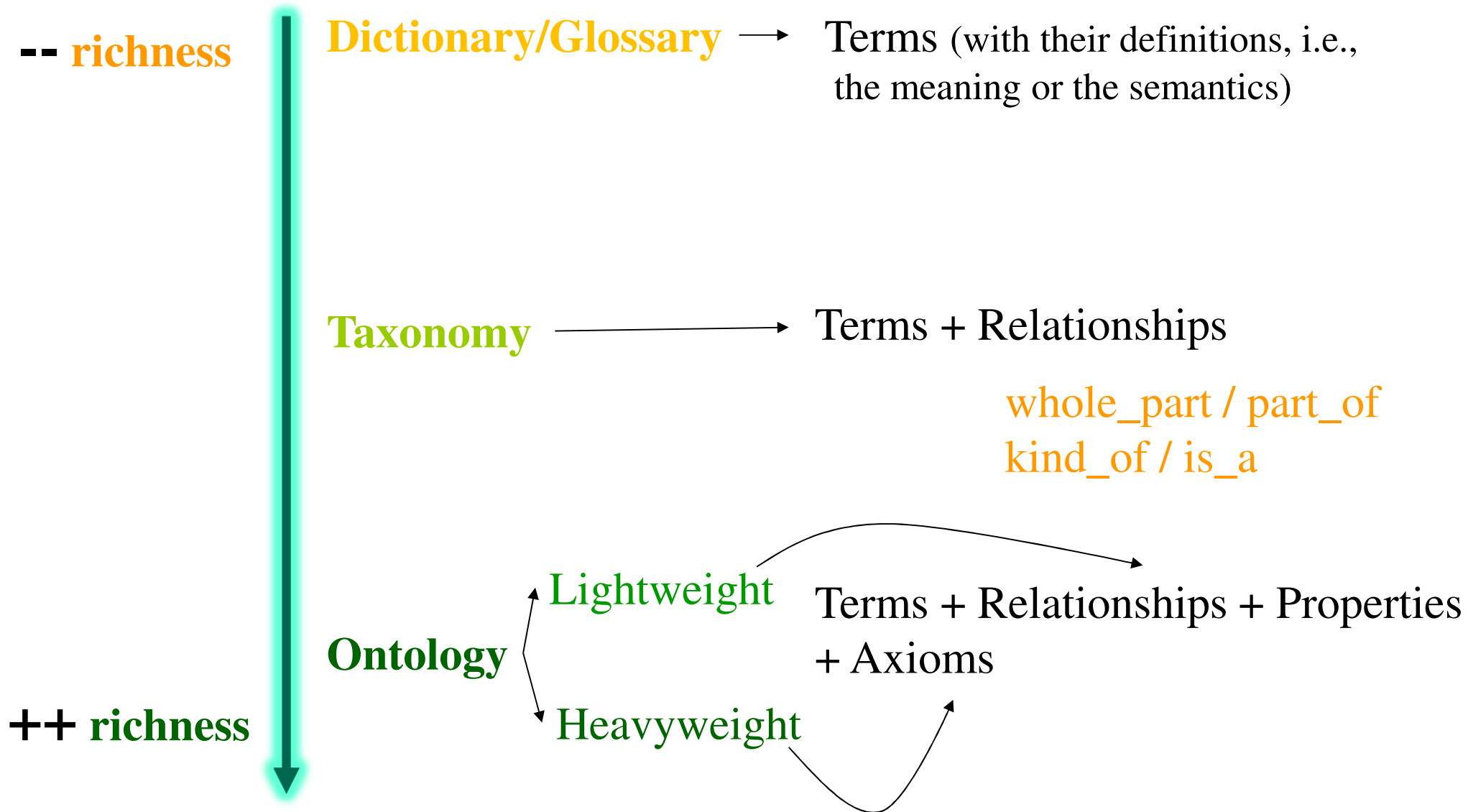
Foundational/Core/Domain Ontologies enrich the What/How specifications



Evaluation Strategy: Process Spec



Terminologies: Structural Richness



Elements of an Ontology

Terms & Properties → **Terms** with their definitions
Properties with their definitions

Taxonomic Relationships → **Aggregation/Composition**
i.e., whole_part / part_of ;
Inheritance i.e., kind_of / is_a

Non-Taxonomic Relationships → **Associations/Dependencies**
with their definitions

Axioms → **Definitions and Specifications**, e.g. in
first-order logic

Elements of an Ontology

UML
Conceptualization

Non-Taxonomic
Relationship

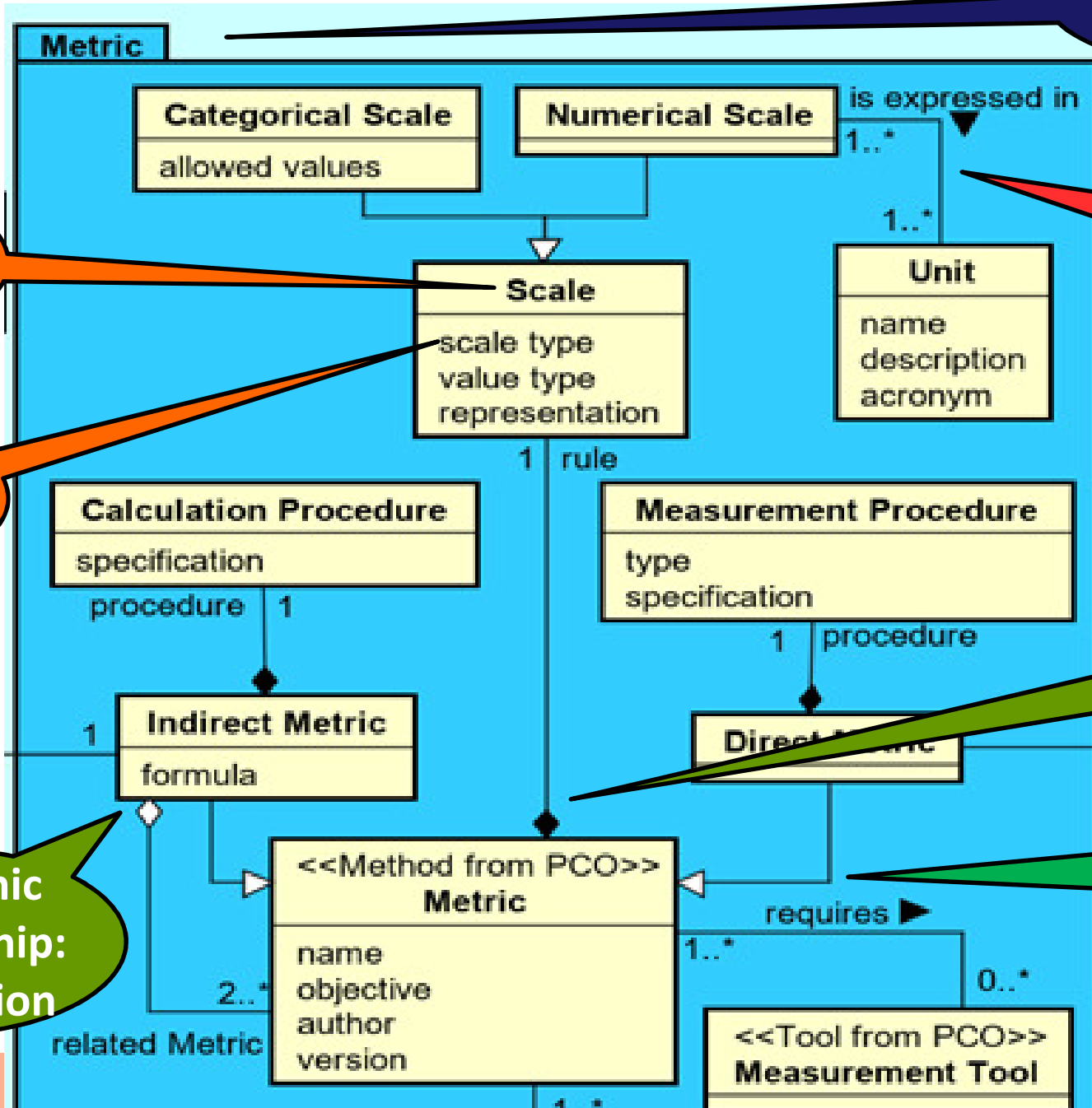
Taxonomic
Relationship:
Composition

Taxonomic
Relationship:
Inheritance

Term

Property

Taxonomic
Relationship:
Aggregation



Diapositiva 8

U1

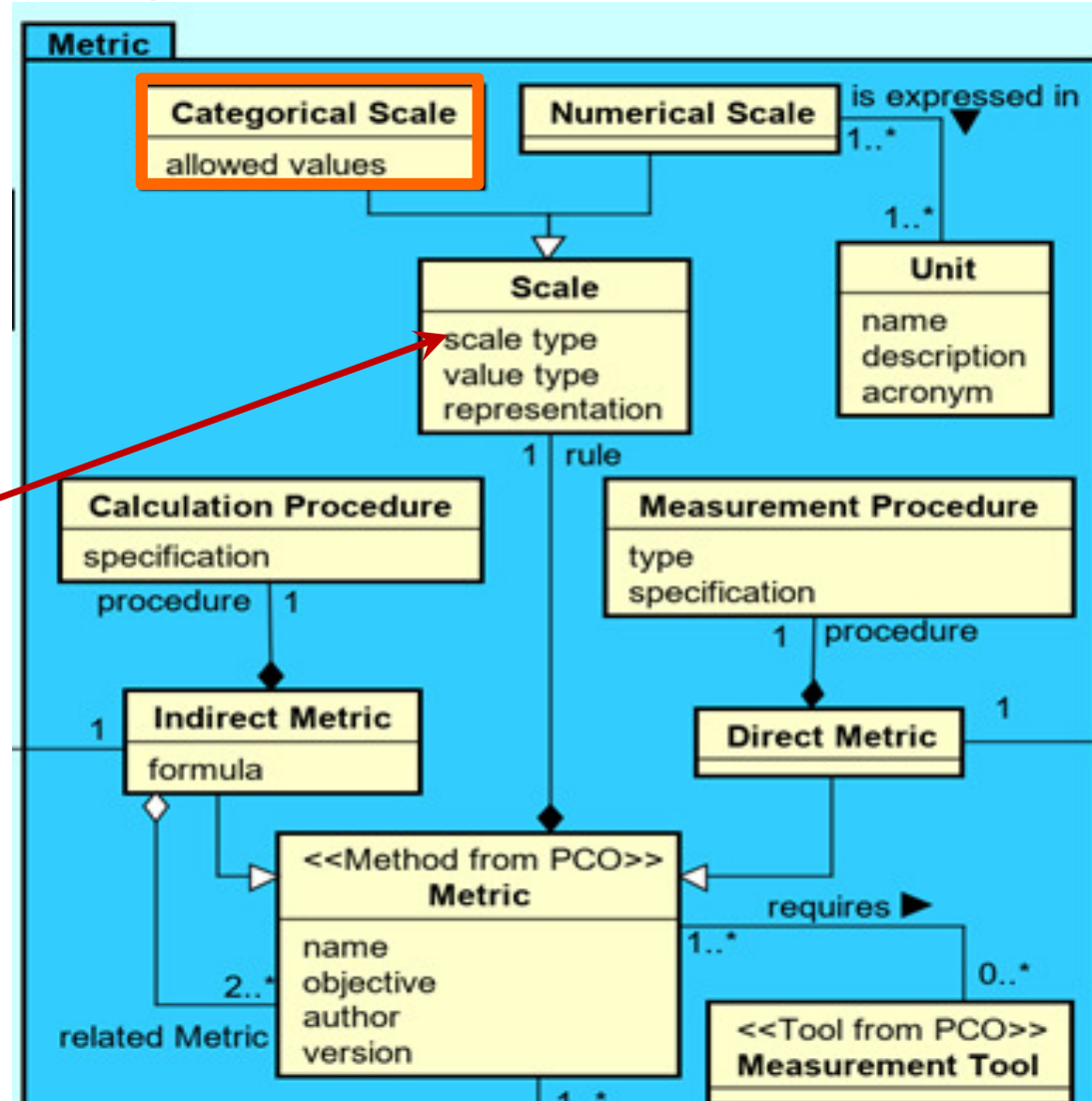
Usuario; 25/7/2021

Definitions of Terms

Metric ontology's Terms

Categorical Scale	<p>A Scale where the measured or calculated values are categories, and must not be expressed in Units, in a strict sense.</p> <p><u>Note</u>: The types of scales used in a Categorical Scale are <i>nominal</i> and <i>ordinal</i>.</p>
Calculation Procedure (synonym: Calculation Protocol)	<p>Arranged set of instructions or operations of an Indirect Metric, which specifies how the steps in the Implement Indirect Measurement task should be performed.</p> <p><u>Note</u>: Calculation Procedure has the semantics of Method procedure from ProcessCO [3].</p>
Direct Metric (synonym: Base Metric, Single Metric)	<p>It is a Metric that does not depend on other Metrics of any other Attribute.</p> <p><u>Note</u>: A Direct Metric has a Measurement Procedure but not a Calculation Procedure.</p>

Axioms

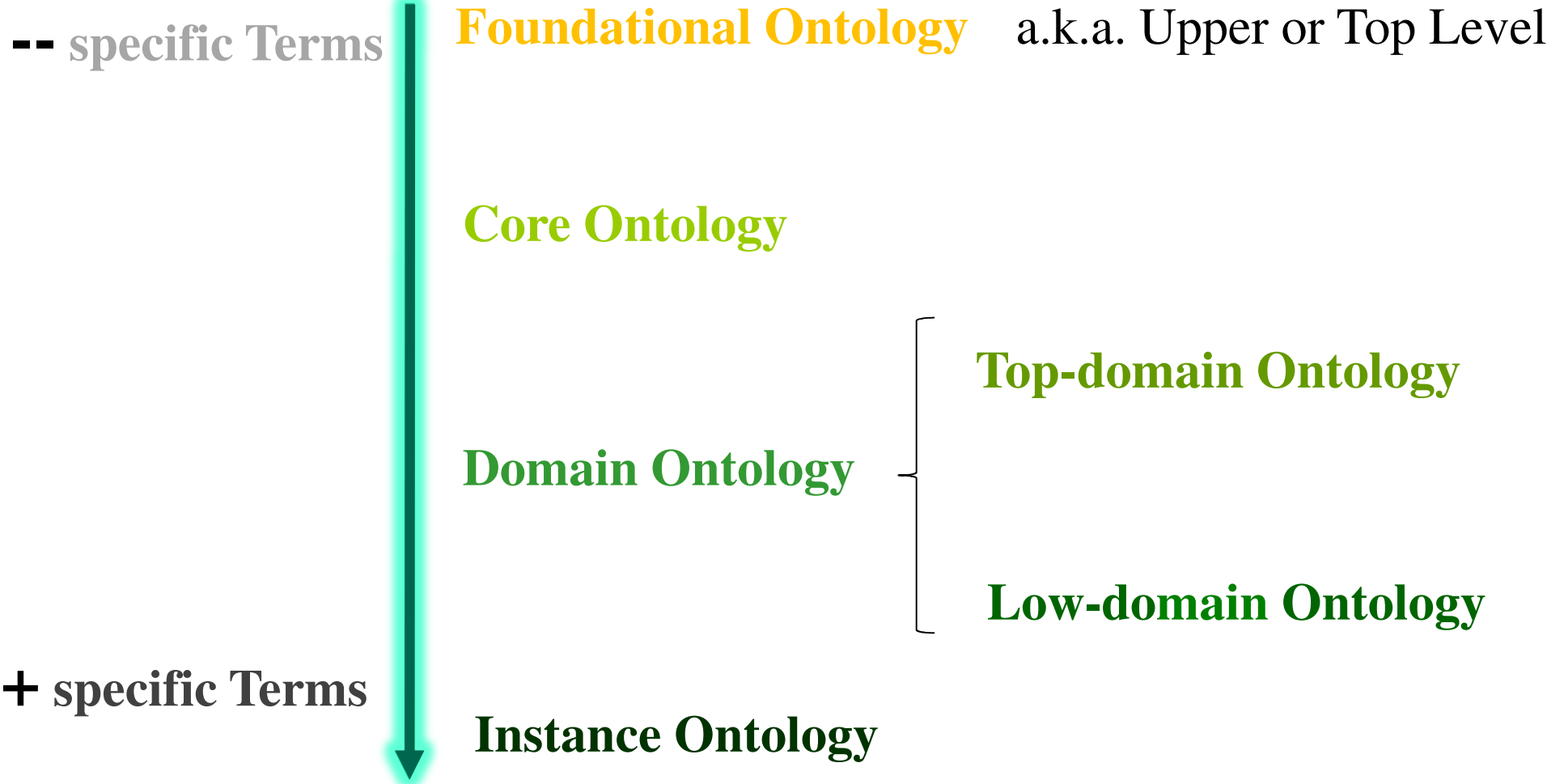


A2 description:

The scale types used in any Categorical Scale are “nominal” or “ordinal”.

A2 specification: $\forall c_{sc} \exists sc_t: CategoricalScale(c_{sc}) \wedge ScaleType(sc_t) \wedge partOf(sc_t, c_{sc}) \wedge [(sc_t = "ordinal") \vee (sc_t = "nominal")]$

Types of Ontologies



Ontologies can be **conceptualized** (e.g. in UML plus tables, etc.), and/or **implemented** (e.g. in OWL)

Foundational Ontology (FO)

- A **Foundational Ontology (FO)** is a **representation** about **top-level, domain-independent, primitive semantic concepts**.
- The primary aim (and requirement) to conceive a FO is to have a **minimum set of particular and universal concepts** of the represented world.
- That is, key **Terms, Properties, Relationships** and **Axioms** that **represent the world**.
 - They can be **reused** and **extended**, and ultimately can be **useful** and **easy to adopt/adapt** across all domains of the diverse **Sciences**.

Foundational Ontology (FO)

- W.r.t. the **effort of developing ontologies**, (Schneider, 2003) indicates that most Knowledge Engineers are unaware of the challenges of building a **Foundational Ontology**, because it involves issues that are unusual for the practice of representing concrete knowledge for specific domains.
- Thus, to build a **FO** a **transdisciplinary knowledge** is required not only in various areas of **Information Systems** and **Artificial Intelligence**, but also in **Cognitive Sciences** and **Philosophy**.

Four-layered Ontological Architecture

FCD-OntoArch

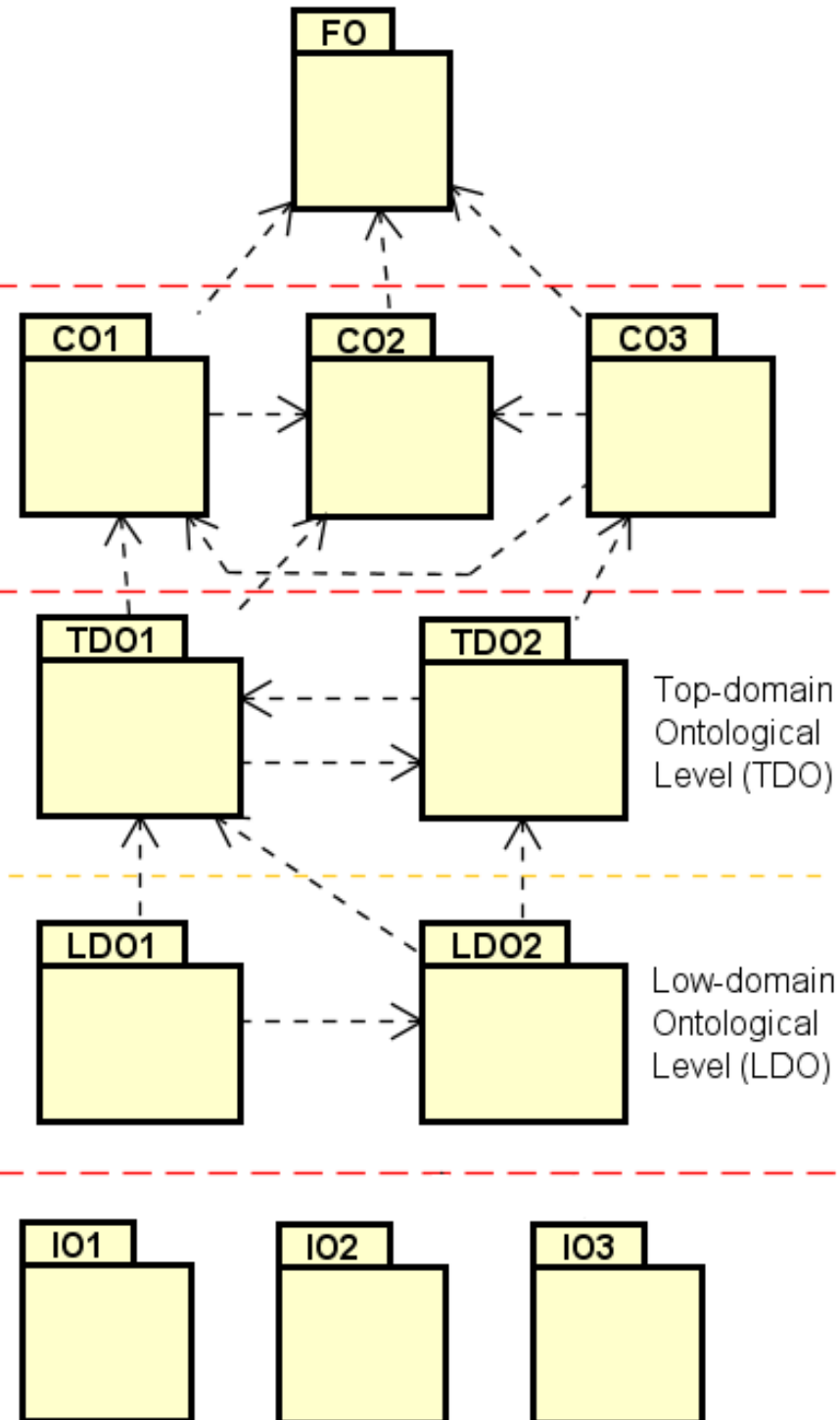
Foundational, **C**ore, and **D**omain
Ontological **A**rchitecture for
Sciences

Foundational
Ontological
Level (FO)

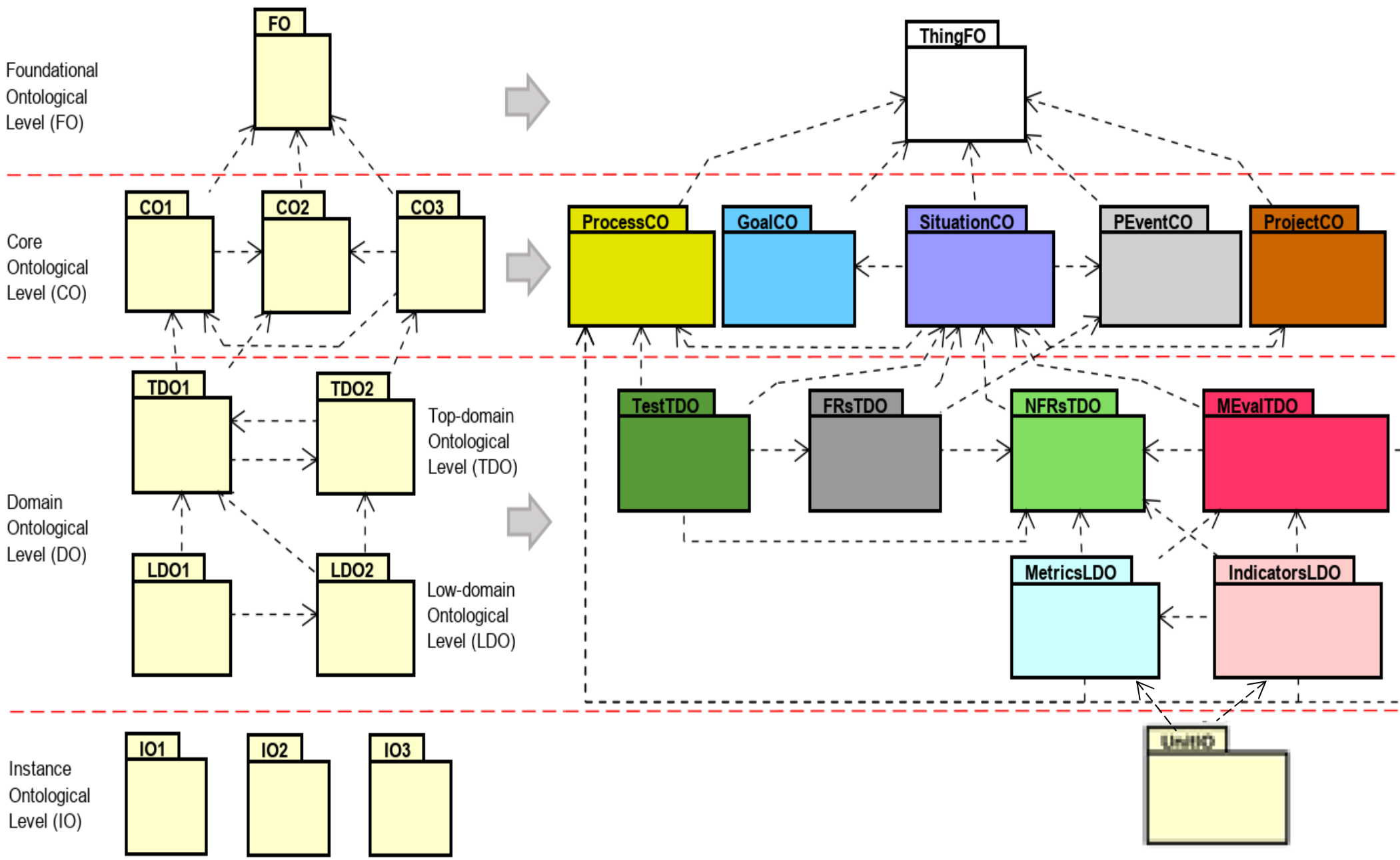
Core
Ontological
Level (CO)

Domain
Ontological
Level (DO)

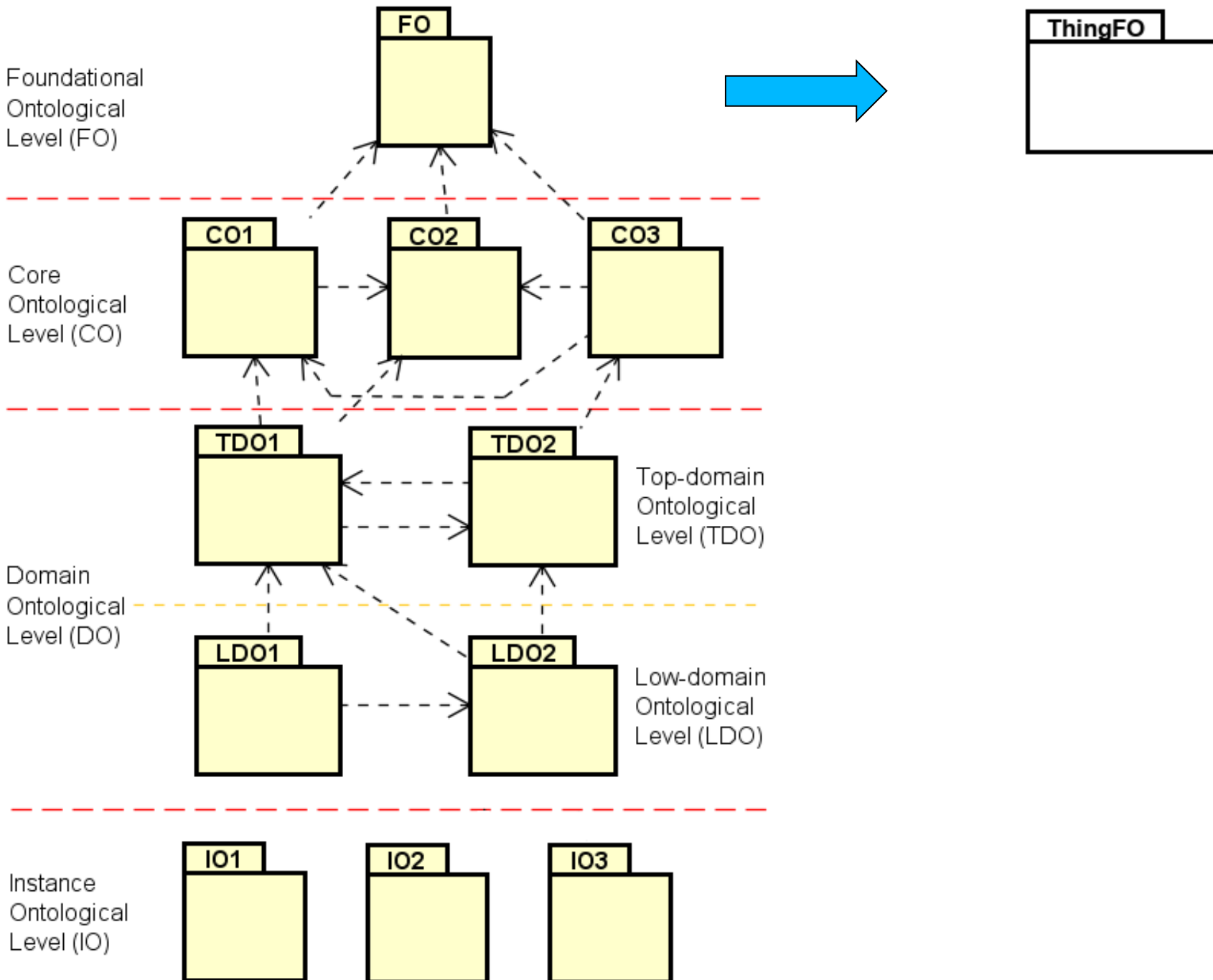
Instance
Ontological
Level (IO)



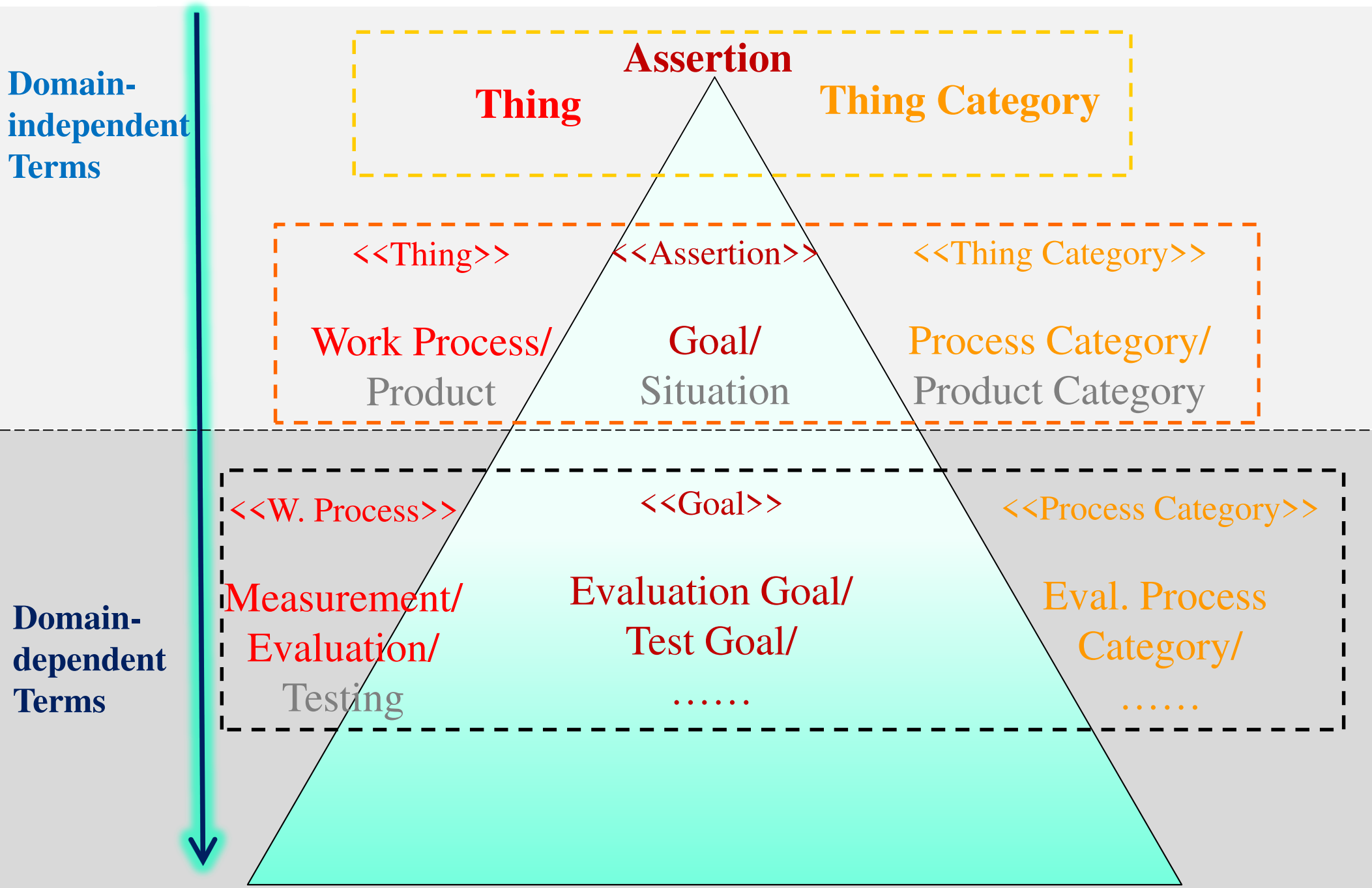
Ontologies placed in the Architecture



FCD-OntoArch and ThingFO

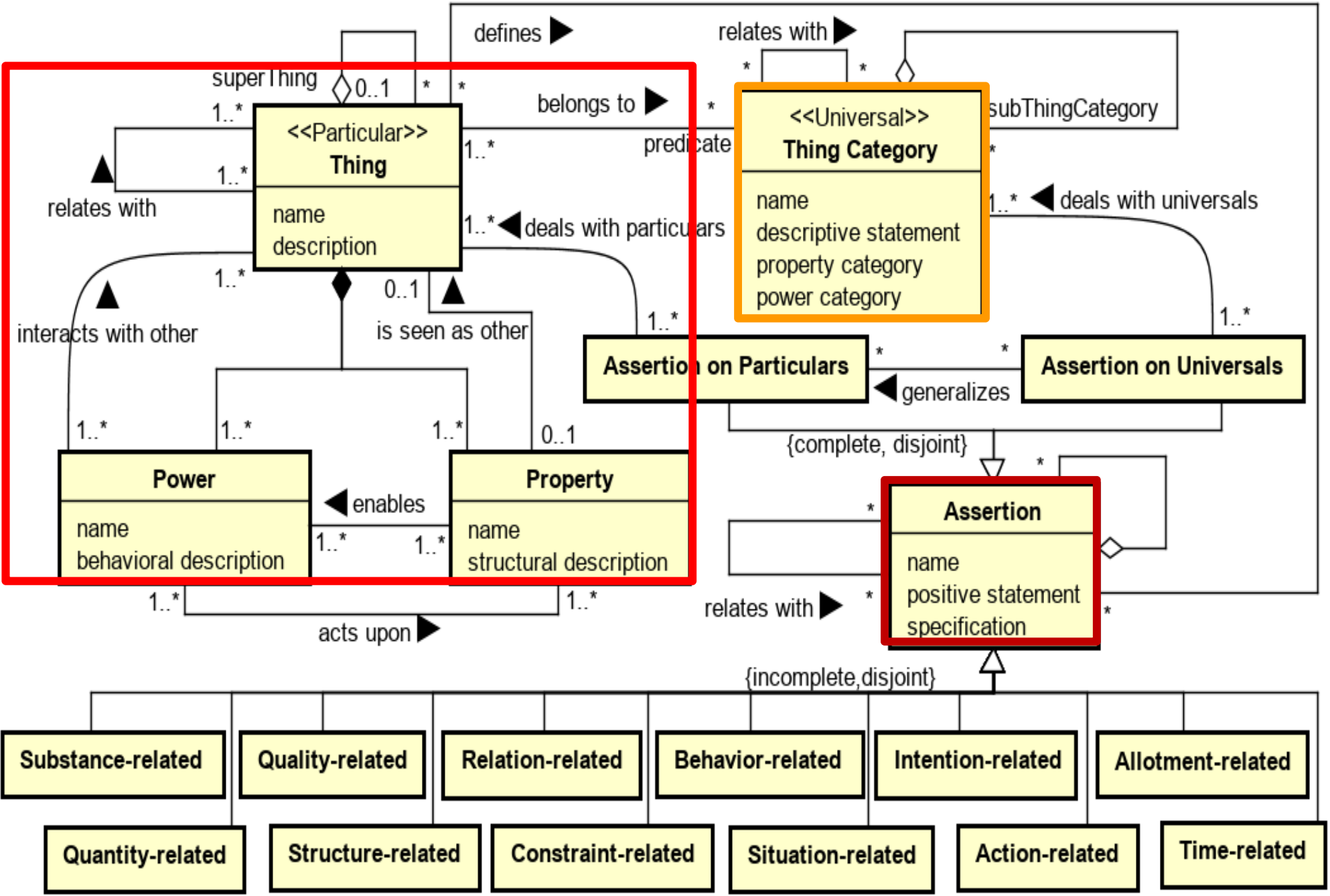


Ontological Conceptual Architecture



Thing Foundational Ontology

ThingFO



ThingFO: Term Thing

Thing (synonym: **Object, Entity, Particular, Instance**)

It represents (a class of) a particular or concrete, tangible or intangible object of a given particular world.

- Note 1: A (class of) particular object **represents and implies unique individuals or instances**, not a universal category. Therefore, a particular Thing results in instances, whereas a universal thing (Thing Category) does not result in instances, at least with valuable meaning of individual.
- Note 2: A **Thing cannot exist or be in spatiotemporal isolation from other Things** in a given particular world. In other words, a target Thing is always surrounded by other context Things, in any particular situation.
- Note 3: A Thing is not a thing (particular object) without its **Properties** and its **Powers**, so *“things, properties and powers all emerge simultaneously to form a unity”*.

ThingFO: Terms Property/Power

Thing

Property

It refers to the intrinsic constitution, structure, or parts of a particular Thing.

- Note 1: A Property is one member of the triad that conforms the unique individual named Thing.
- Note 2: A Property, which is one member of the triad that conforms a particular Thing is seen as other particular Thing with its own Properties and Powers.

Power

It refers to what a particular Thing does, can do or behave.

- Note 1: A Power is one member of the triad that conforms the unique individual named Thing.
- Note 2: According to Fleetwood “*Powers are the way of acting of a things’ properties; powers are a things’ properties in action*”. Also, he states that “*Things have properties, these properties instantiate [...] acting powers, and this ensemble of things, properties and powers cause any events that might occur*”.

ThingFO: Term Thing Category

Thing Category (synonym: Entity Category, Universal)

It represents a universal of concrete Things conceived by the human being's mind for abstraction and classification purposes.

- Note 1: A Thing Category does not exist, is or can be in a given particular world as a Thing does. Conversely, it may only be formed or developed mentally by human beings.
- Note 2: A Thing Category as universal does not result in instances –at least with valuable meaning of individual- but rather can be represented by more specific sub-categories of Things.

Example of Thing/Thing Category

Level

FO

Thing

(Instances of **Particulars**)

Thing Category

(Names of **Universals**)

CO

Product/Resource

Product/Resource Category

DO

Transport (Vehicle)

Transport Category

by physical means

Plane, Helicopter,

Air Transport

Car, Bike, Truck, Horse, Train,

Ground Transport

Launch, Vessel, Catamaran,

Waterborne Transport

Tank, ...

Amphibious Transport

by speed or by size

IO

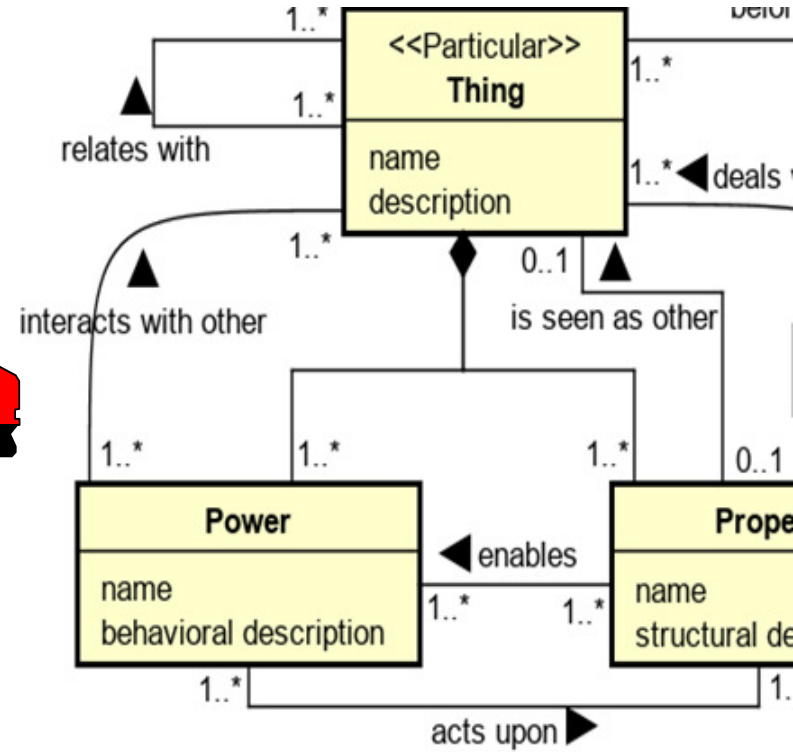
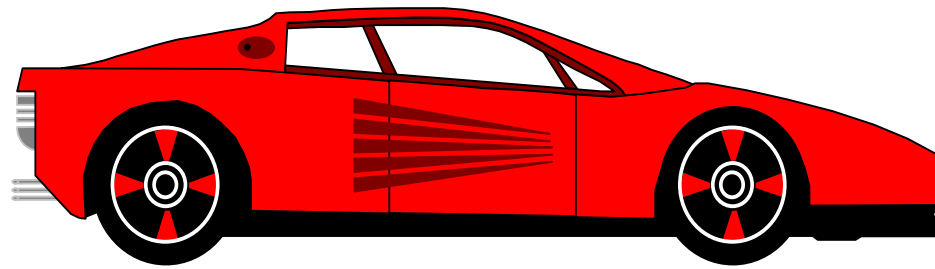
All Instances or Individuals

.....



Example of Thing

Thing: Car, Bike, ...

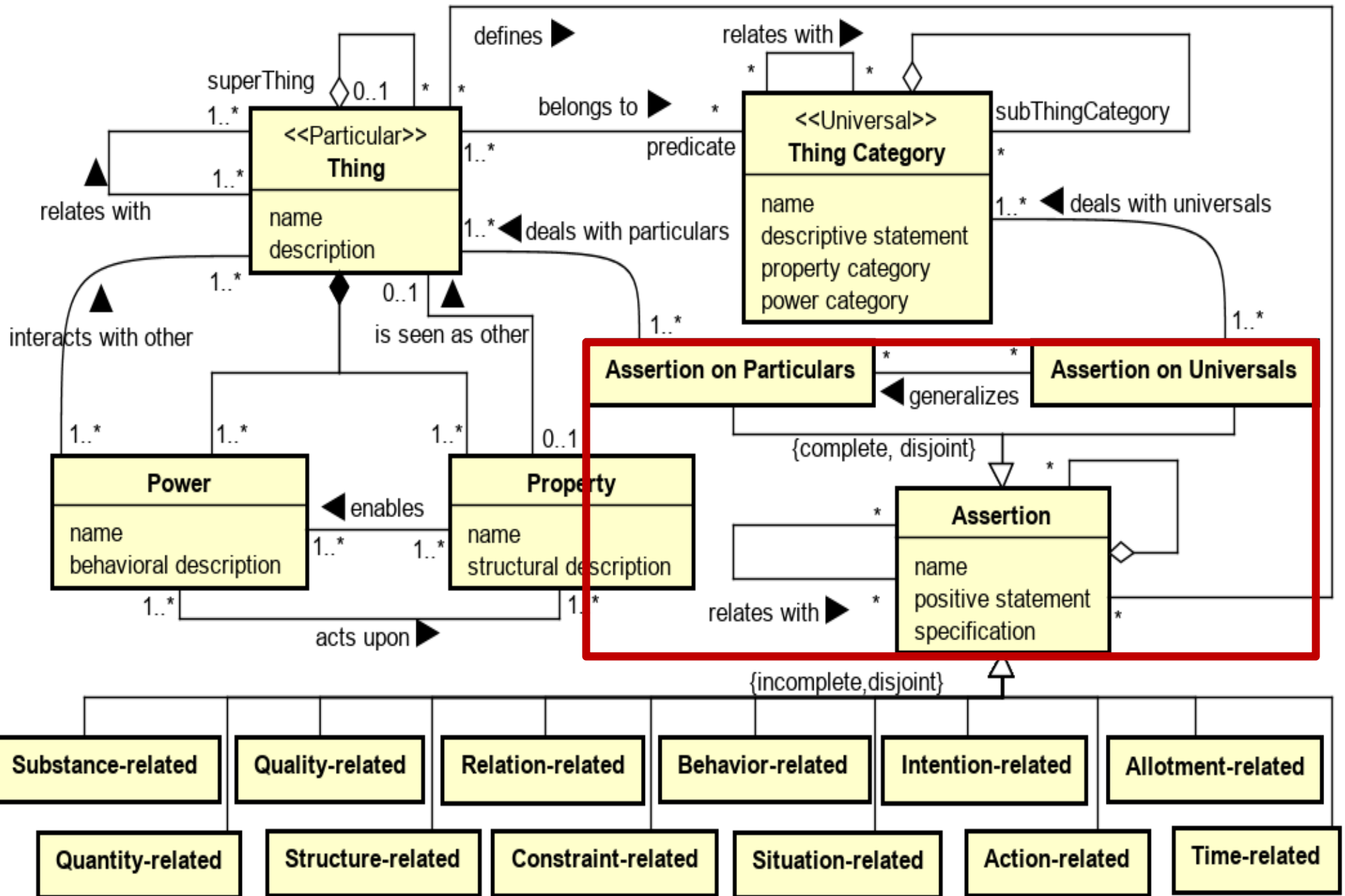


Ground
Transport
Category



ThingFO: Term Assertion

ThingFO



ThingFO: Term Assertion

Assertion

A positive and explicit statement that somebody makes about something concerning Things or their categories based on thoughts, perceptions, facts, intuitions, intentions, and/or beliefs that is conceived with an attempt at furnishing current or subsequent evidence.

- Note 1: A **positive statement** refers to what it is, was, or will be -no indication of approval.
- Note 2: The part of the phrase that indicates “...*that somebody makes about* ...” means that for instance a concrete human being –a Thing- defines or conceives Assertions.
- Note 3: The part of the phrase that indicates “...*about something concerning Things*...” means for example about the substance, structure, behavior, quantity, quality, among other aspects of Things and Thing Categories.
- Note 4: In order to be valuable, actionable and ultimately useful for any science, **an Assertion** should to a great extent **be verified** and/or **validated** by theoretical and/or empirical **evidence**.
- Note 5: An Assertion can be **represented and modeled** by means of informal, semiformal or formal **specification languages**.

ThingFO: Term Assertion

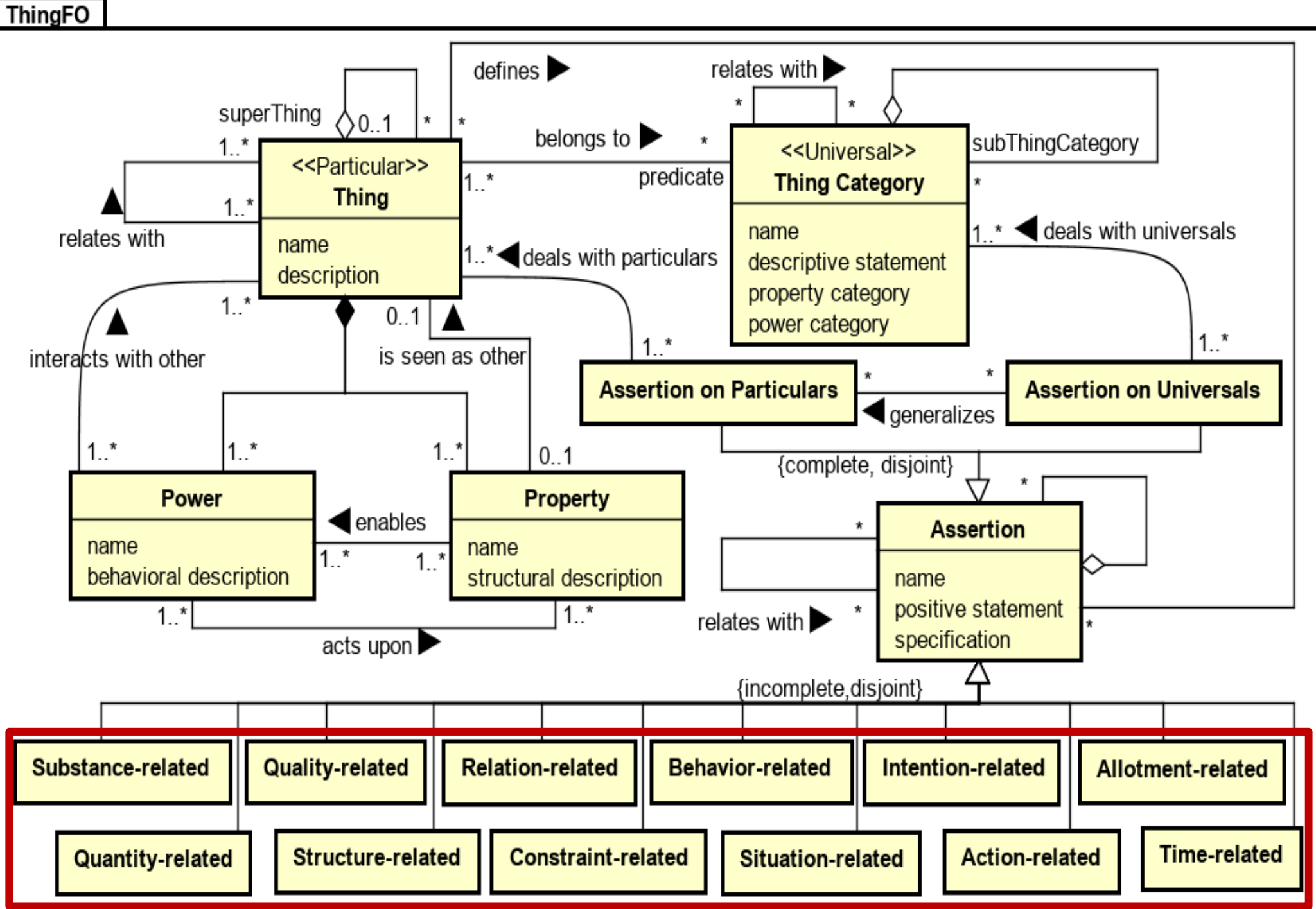
Assertion on Particulars

It is an Assertion that somebody makes about something of one or more **particular Things**.

Assertion on Universals

It is an Assertion that somebody makes about something of one or more **Thing Categories**.

ThingFO: Types of Assertions



ThingFO: Types of Assertions

Substance-related Assertion

It is related to the ontological significance and essential import of a Thing as a whole entity, or a set of Things.

Structure-related Assertion

It is related to the Property term, which represents the intrinsic constitution, structure, or parts of a Thing.

Relation-related Assertion

It refers to logical or natural associations between two or more Things (and their categories).

A Thing cannot exist or be in spatiotemporal isolation from other Things in a given particular world.

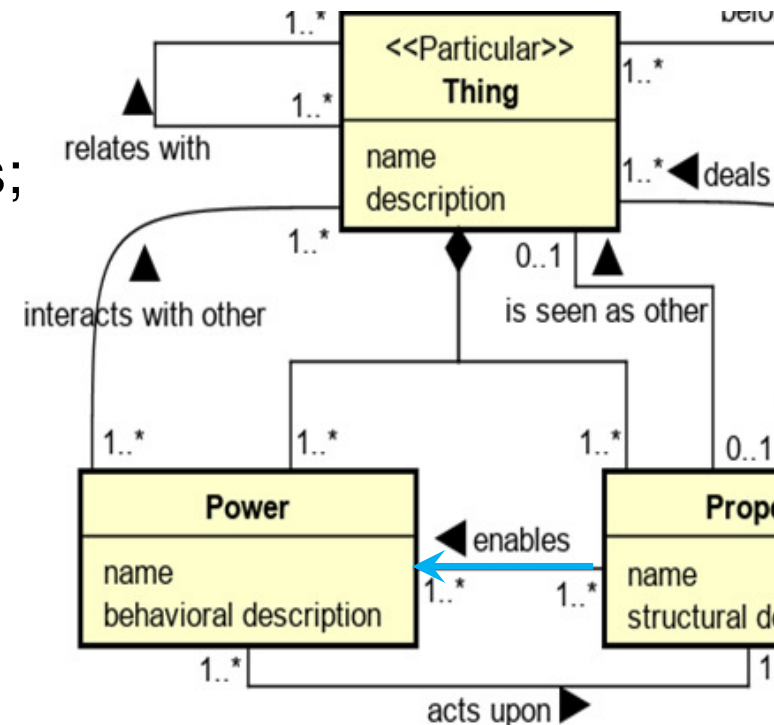


ThingFO: Types of Assertions

Constraint-related Assertion

It is related to the specification of restrictions or conditions imposed to Things, Properties, relationships, interactions or Thing Categories that must be satisfied or evaluated to true.

All Property of a Thing enables only its Powers;

$$\forall t, \forall prop, \forall pow: [Thing(t) \wedge Property(prop) \wedge partOf(prop, t) \wedge Power(pow) \wedge enables(prop, pow) \rightarrow partOf(pow, t)]$$


ThingFO: Types of Assertions

Constraint-related Assertion: Axioms

For ThingFO to be actionable at lower levels, three axioms were specified in first-order logic:

- All Property of a Thing enables only its Powers;
- The Power of a Thing only acts upon its Properties;
- The Power of a Thing only interacts with other Things.

ThingFO: Types of Assertions

Intention-related Assertion

It is related to the aim to be achieved by some agent.

The statement of an Intention-related Assertion considers the propositional content of a goal purpose in a given situation and time frame.

Situation-related Assertion

It is related to the combination of circumstances, episodes, and relationships/events between target Things and context entities that surround them, or their categories, which is of interest or meaningful to be represented or modeled by an intended agent.

A **Situation** can be represented **statically** or **dynamically** depending on the intention of the agent. The conceptualization of an ontology embraces a static representation.

ThingFO as a set of Artifacts

Types of Assertions that any Ontology combines

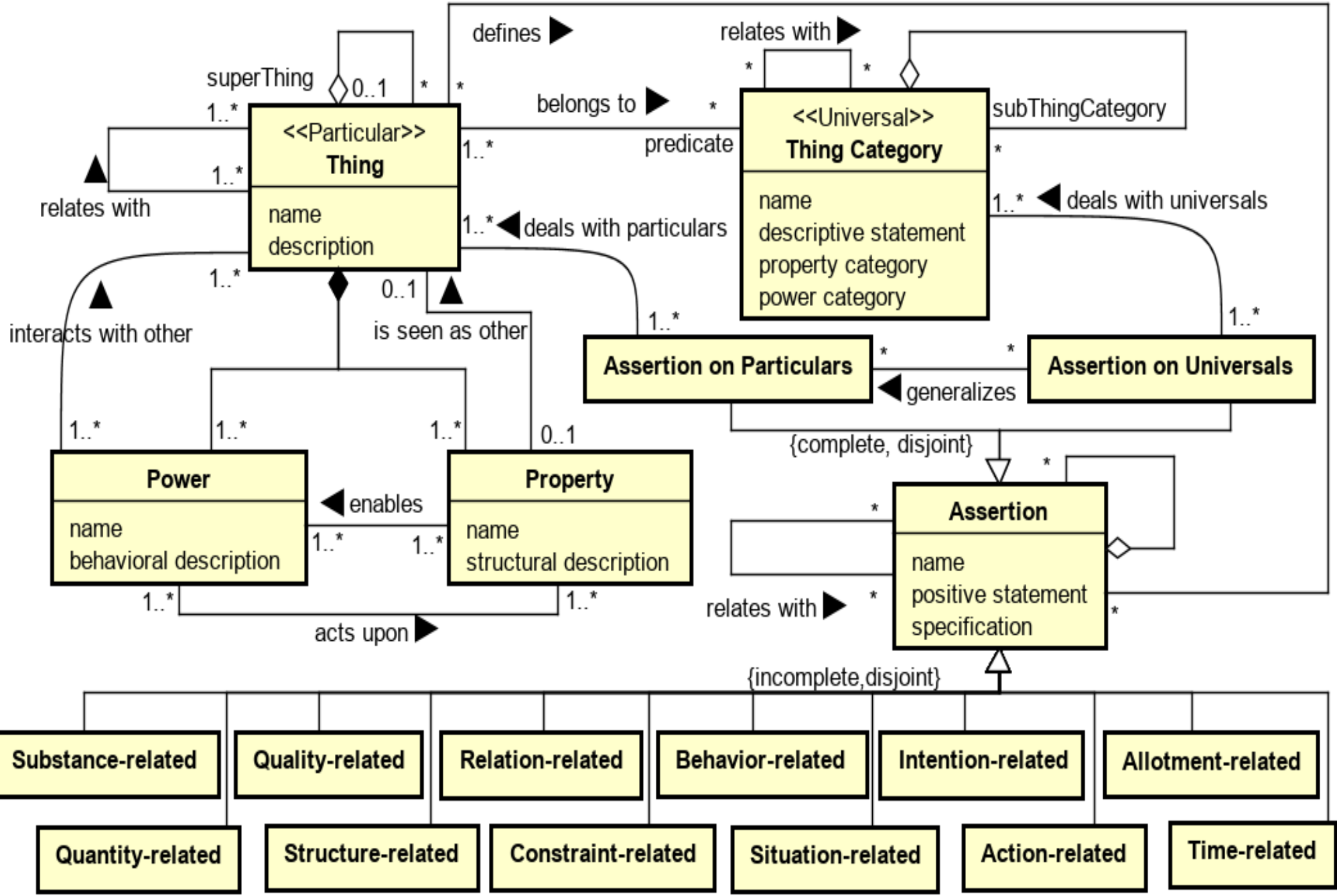
A **conceptualization** of an **ontology** as an **artifact** (e.g., the *ThingFO UML diagram*, plus the linked *documents* with the definition of terms, properties, and non-taxonomic relationships as well as specifications of axioms) represents a **combination of assertion types**:

Substance-, Relation-, Structure-, Intention-, Situation- and Constraint-related Assertions.

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ThingFO as a set of Artifacts

ThingFO



ThingFO as a set of Artifacts

Thing Component – ThingFO v1.2’s Terms	
Term	Definition
Thing (synonym: Entity, Object, Particular, Instance)	<p>It represents a particular or concrete, tangible or intangible object of a given particular world.</p> <p><u>Note 1:</u> A particular object represents and implies unique individuals or instances, not a universal category. Therefore, a particular Thing generates instances, whereas a universal thing (Thing Category) does not generate instances, at least with valuable meaning of individual.</p> <p><u>Note 2:</u> A Thing is not a Thing (particular object) without its Properties and its Powers, so <i>“things, properties and powers all emerge simultaneously to form a unity”</i> ... <i>“Things, properties and powers are necessary and sufficient for the existence of this unity”</i> [1].</p> <p><u>Note 3:</u> A Thing cannot exist or be in spatiotemporal isolation from other Things in a given particular world. In other words, a target Thing is always surrounded by other context Things, in any particular situation.</p>
Property	<p>It refers to the intrinsic constitution, structure, or parts of a particular Thing.</p> <p><u>Note 1:</u> A Property is one member of the triad that conforms the unique individual named Thing.</p> <p><u>Note 2:</u> A Property, which is one member of the triad that conforms a particular Thing can be seen as another particular Thing in another situation with its own Properties and Powers.</p>

ThingFO as a set of Artifacts

Axioms

- All Property of a Thing enables only its Powers;
$$\forall t, \forall prop, \forall pow: [Thing(t) \wedge Property(prop) \wedge partOf(prop, t) \wedge Power(pow) \wedge enables(prop, pow) \rightarrow partOf(pow, t)]$$
- The Power of a Thing only acts upon its Properties;
- The Power of a Thing only interacts with other Things.

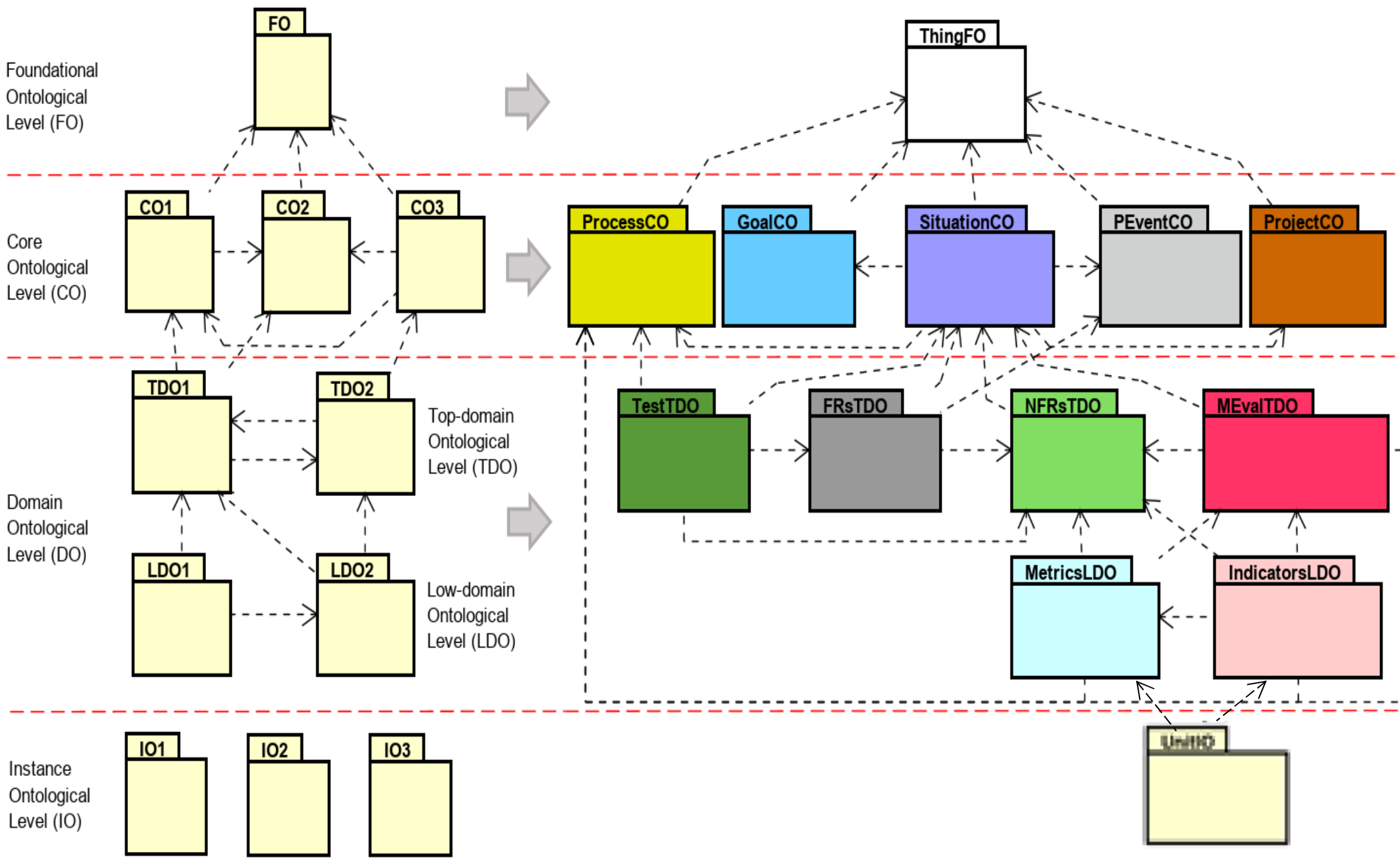
Agenda

Part II

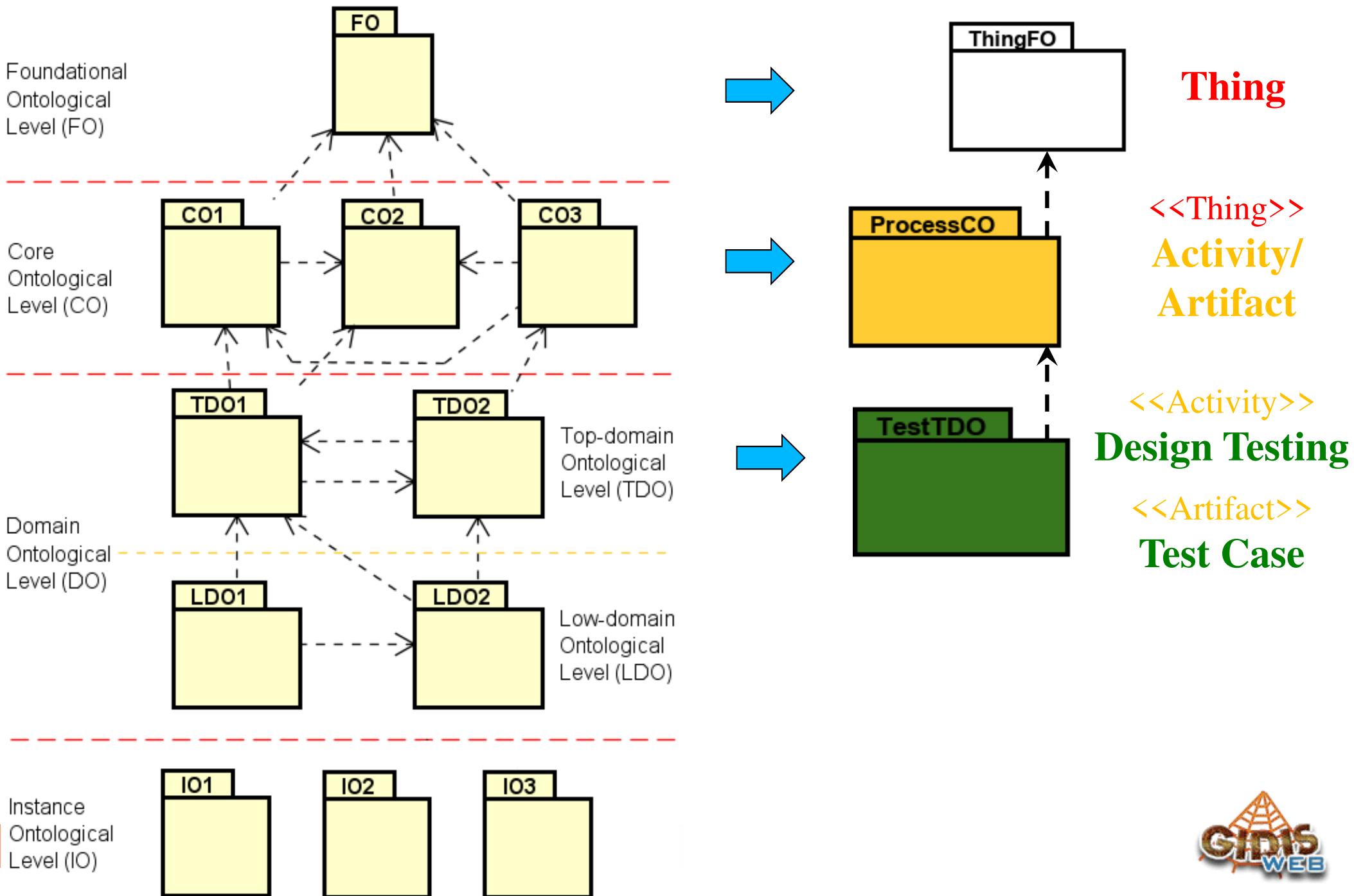
Applicability of ThingFO to semantically enrich Core and Domain Terminologies:

The ProcessCO and TestTDO cases

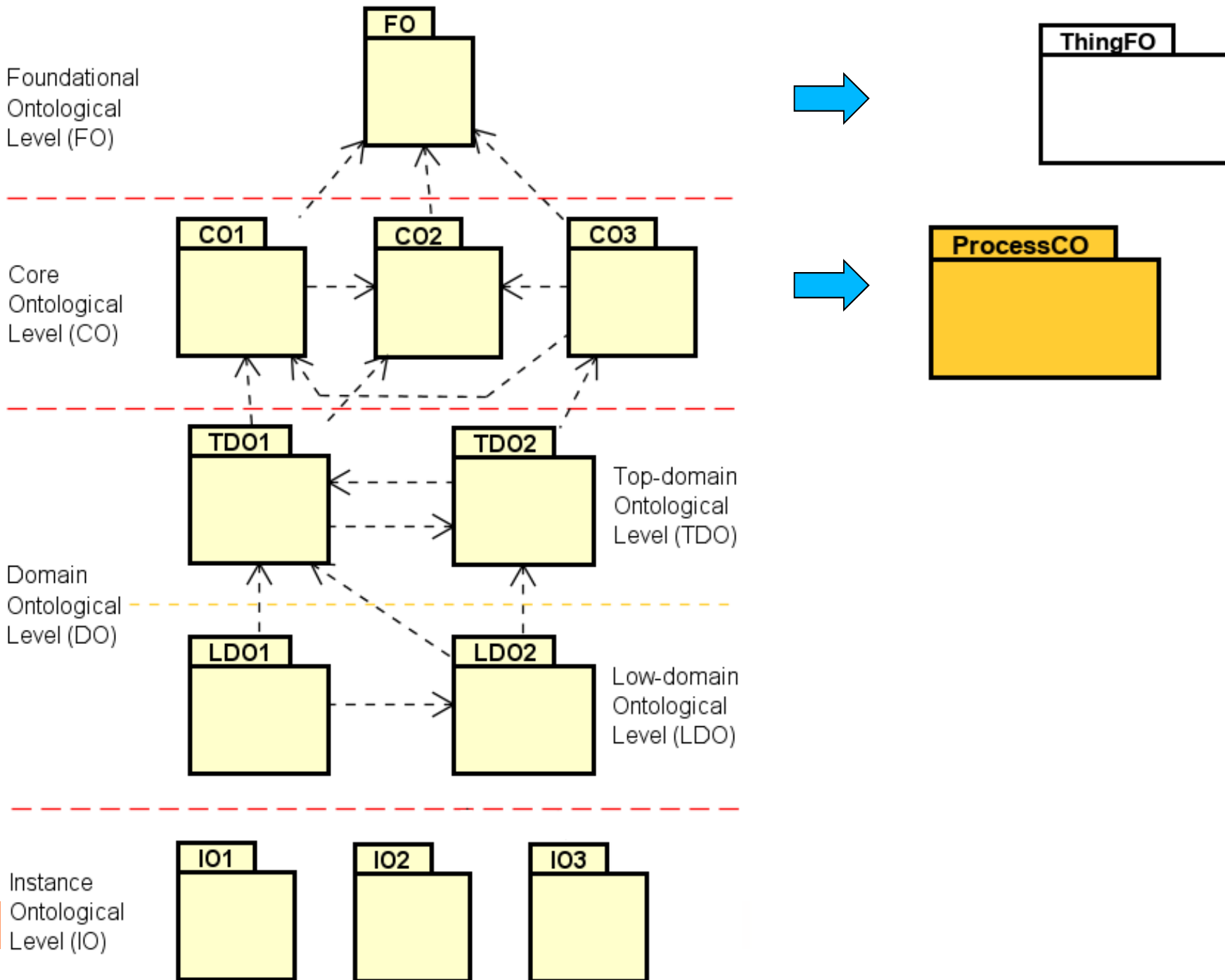
Ontologies placed in the Architecture

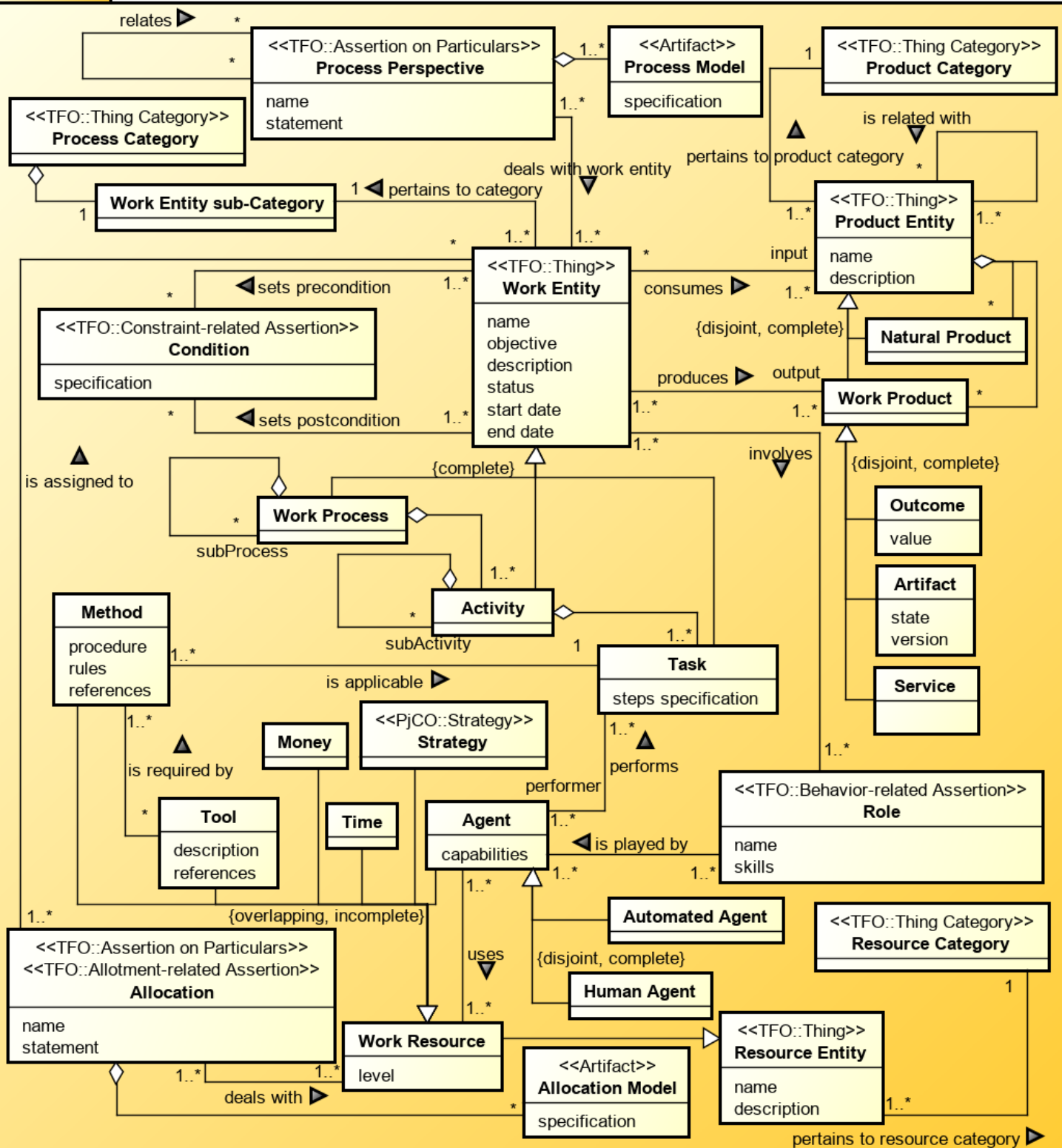


FCD-OntoArch: ProcessCO & TestTDO



FCD-OntoArch and ProcessCO

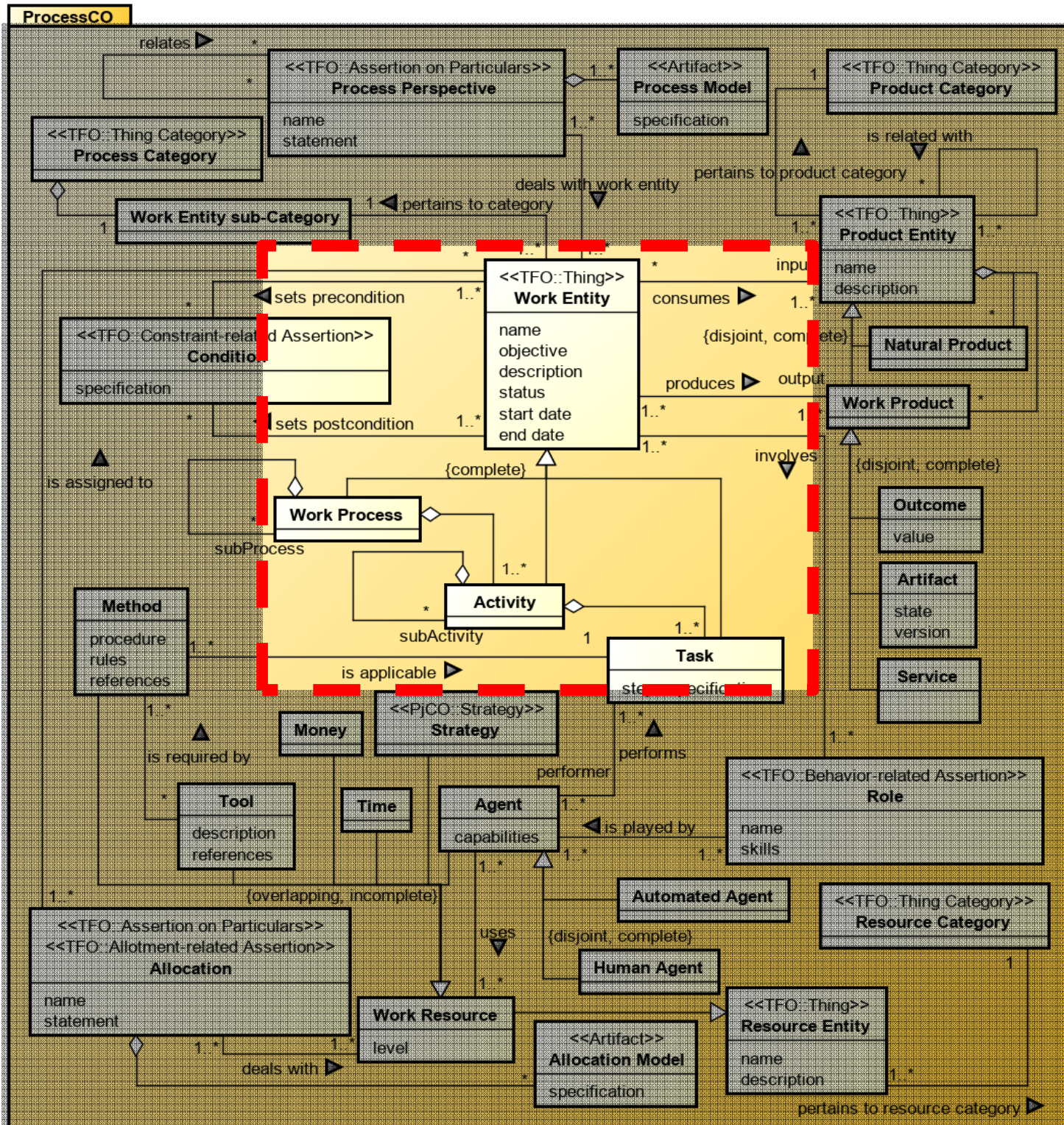


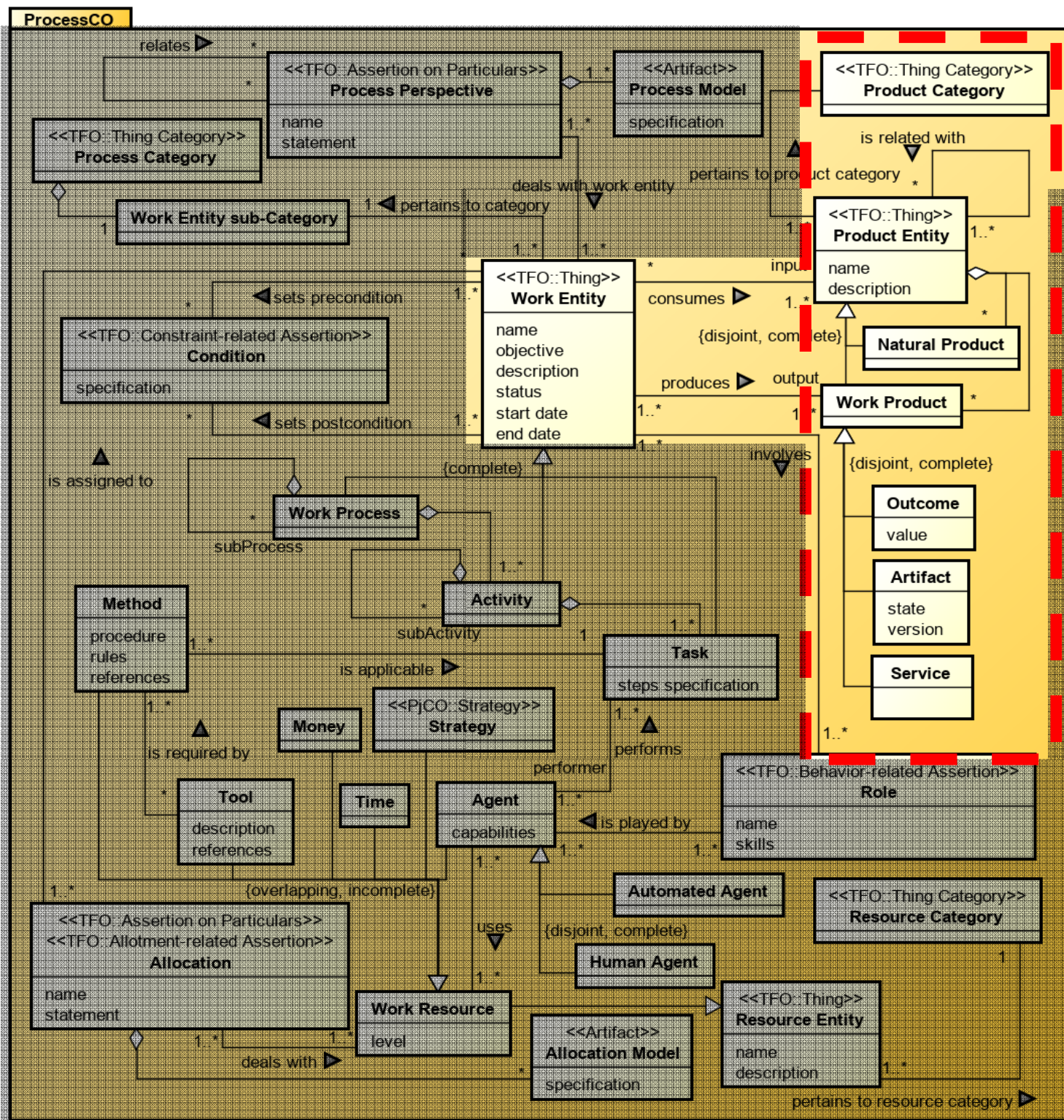


Process Core Ontology v 1.3



Process Core Ontology v 1.3

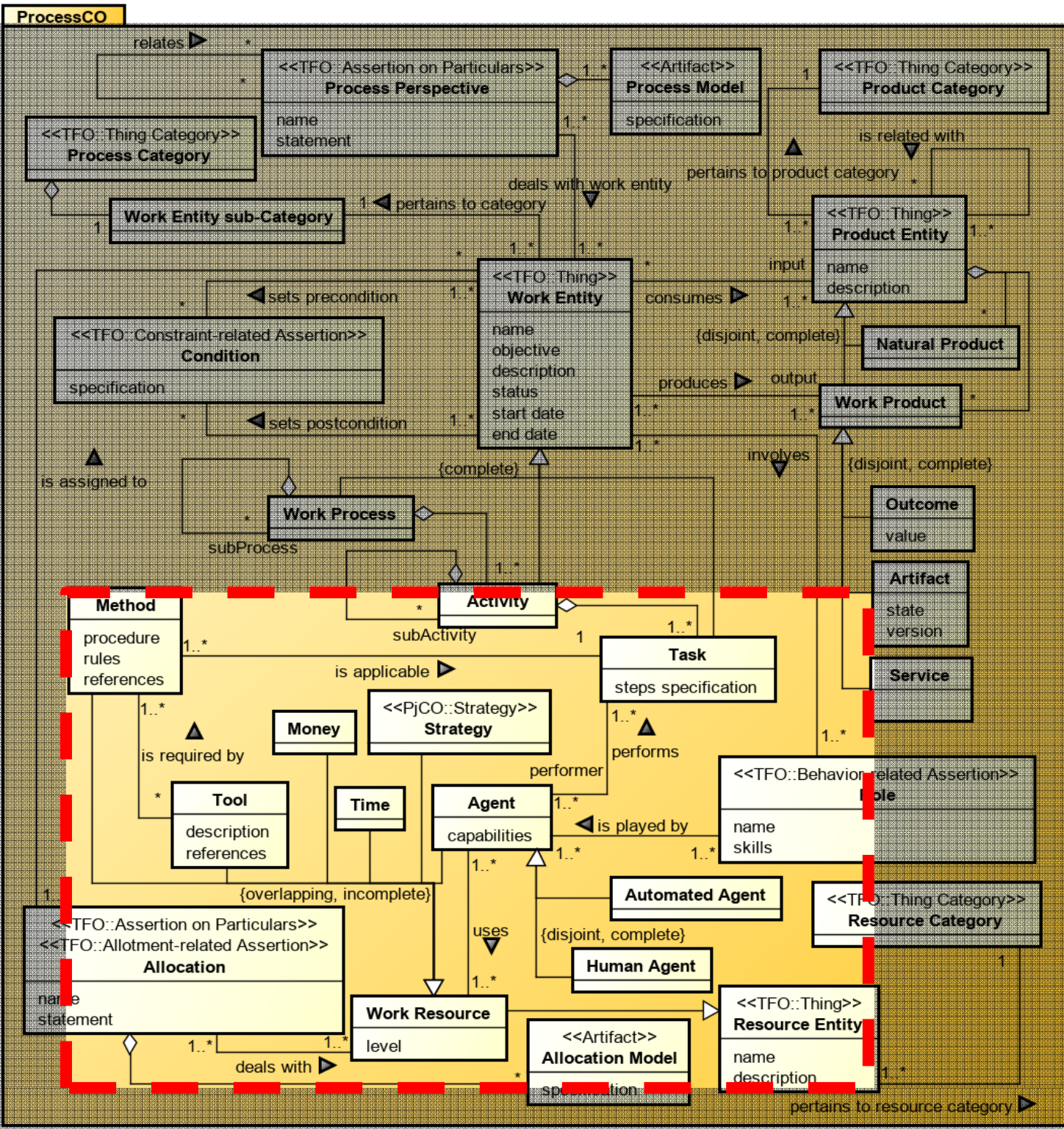


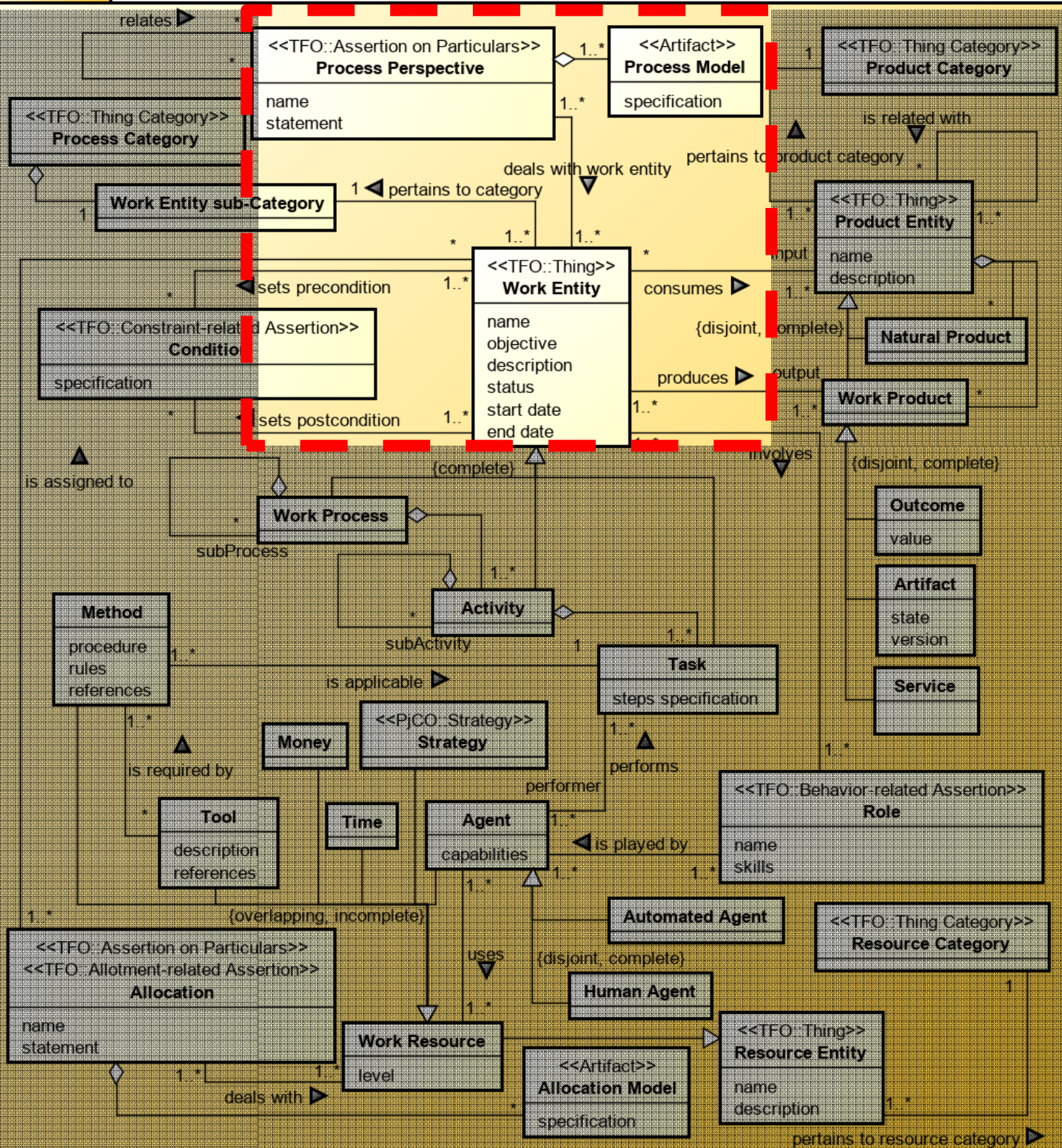


Process Core Ontology v 1.3



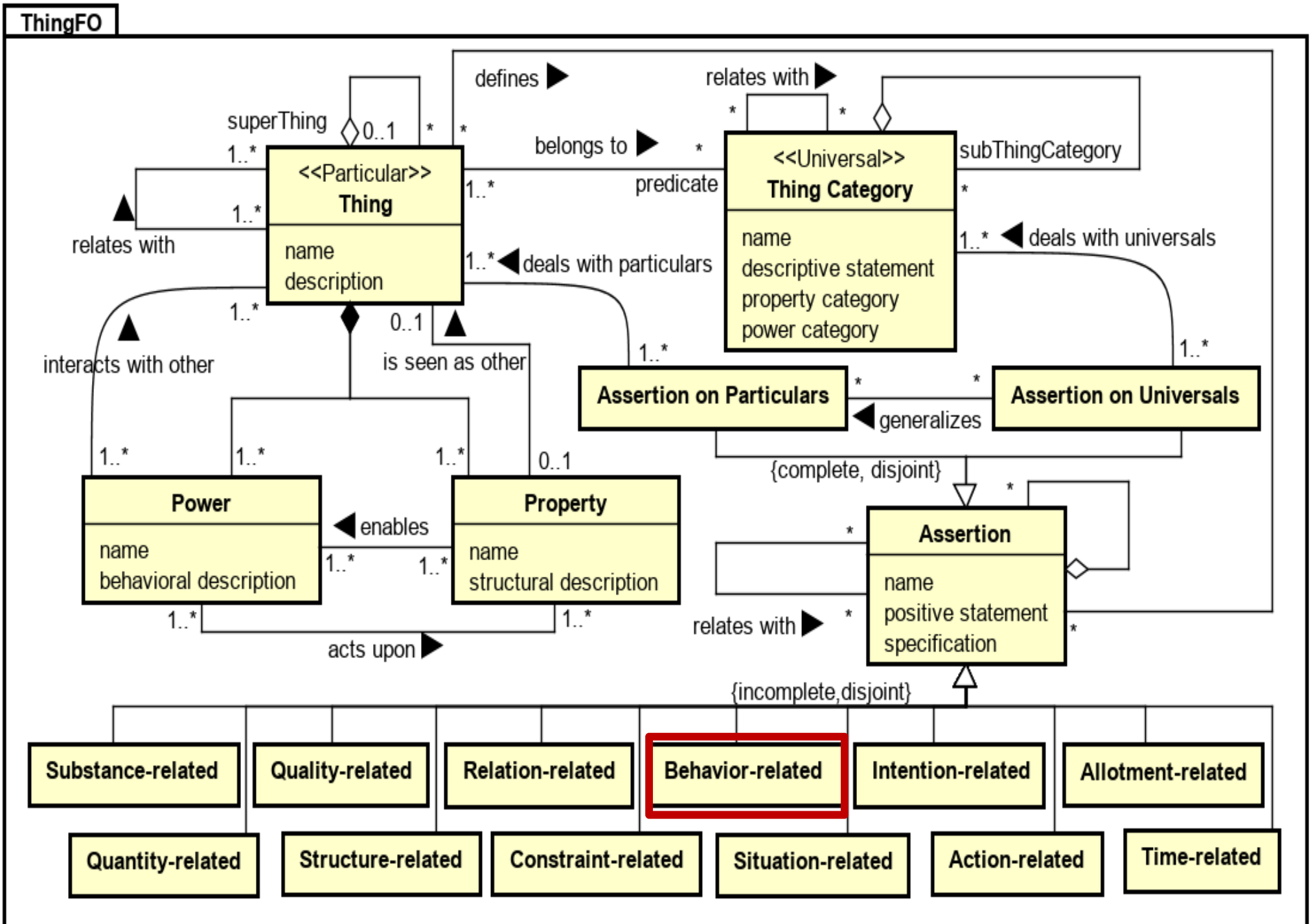
Process Core Ontology v 1.3



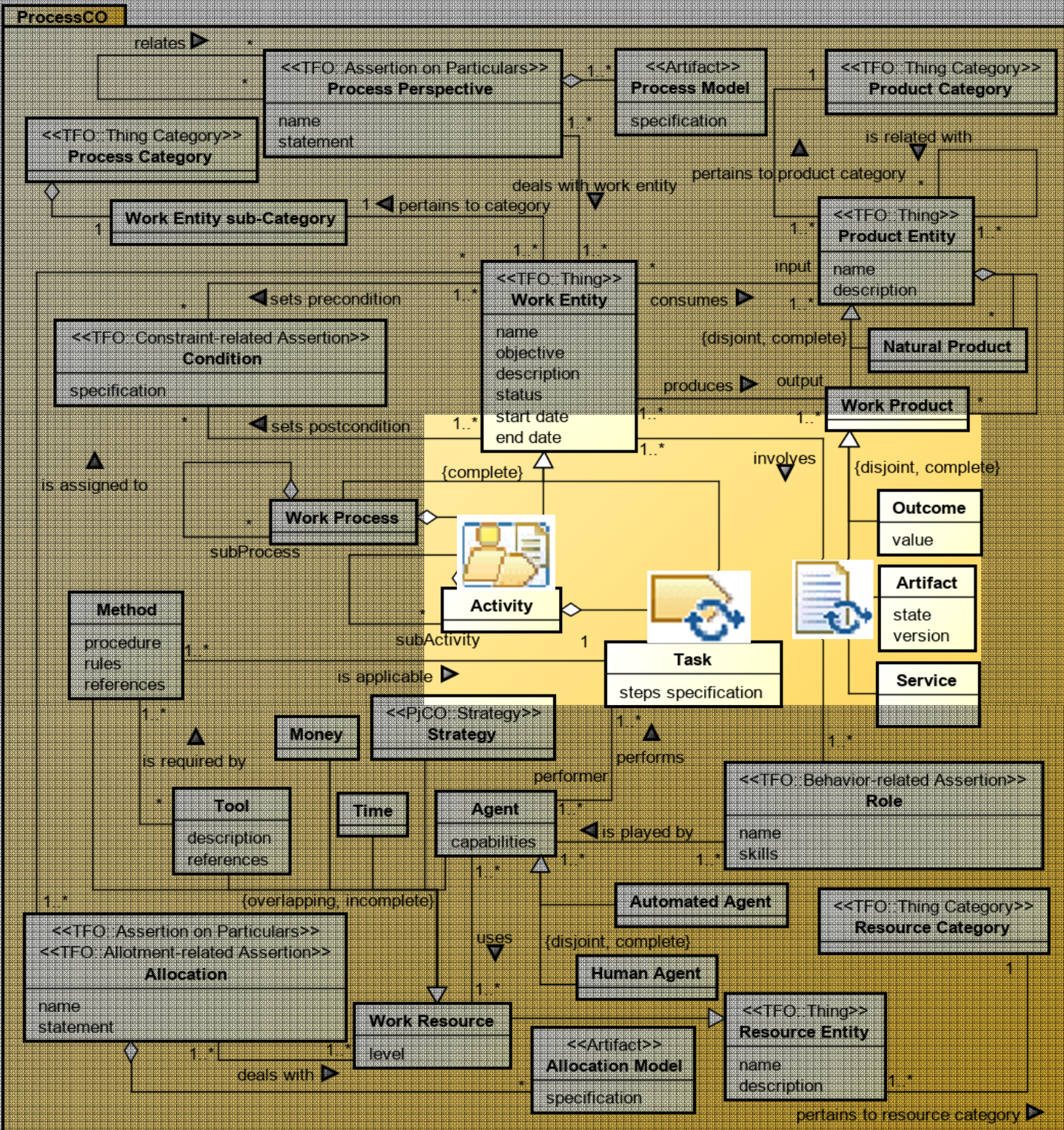


Process Core Ontology v 1.3

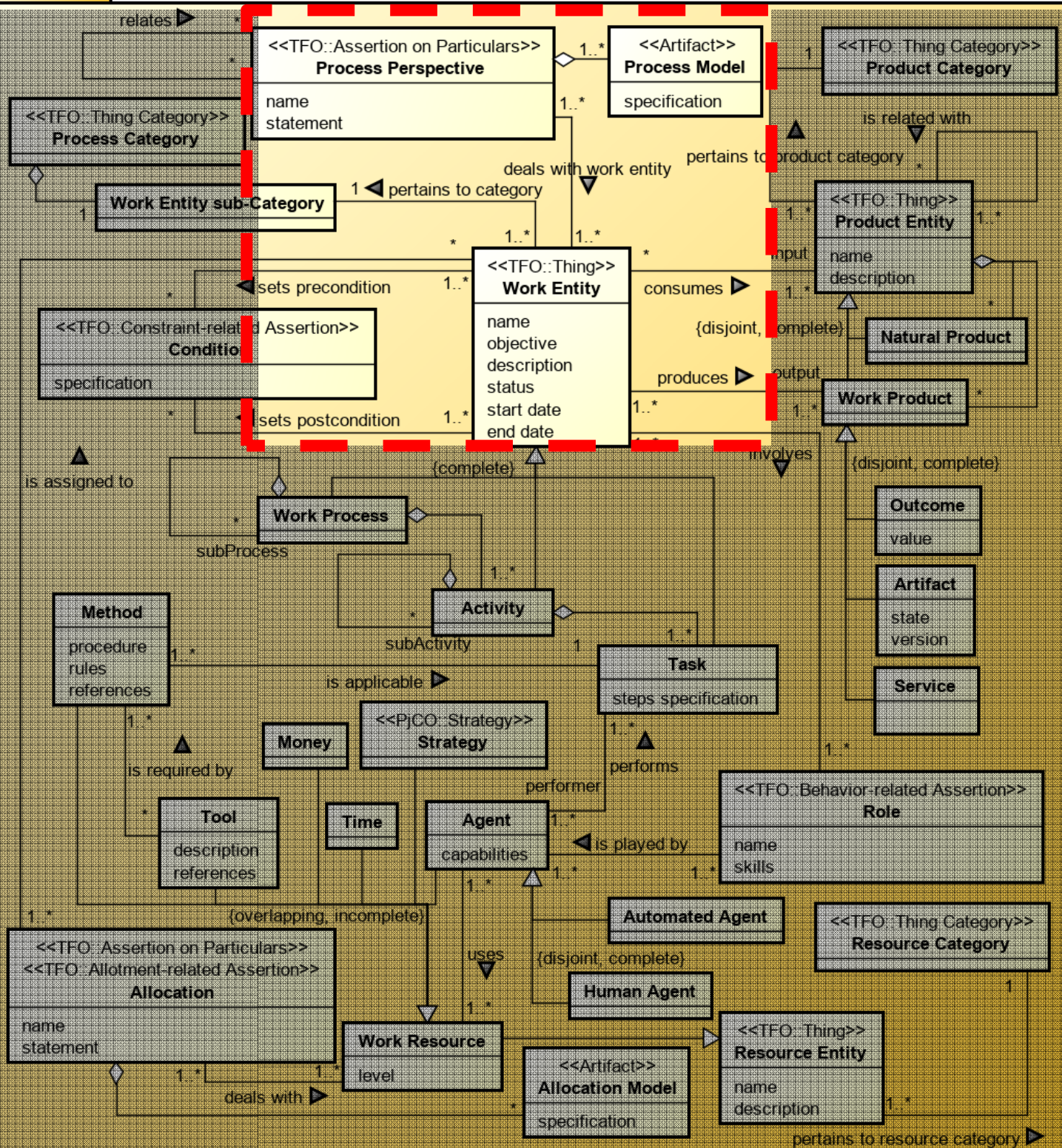
ThingFO: Term Assertion



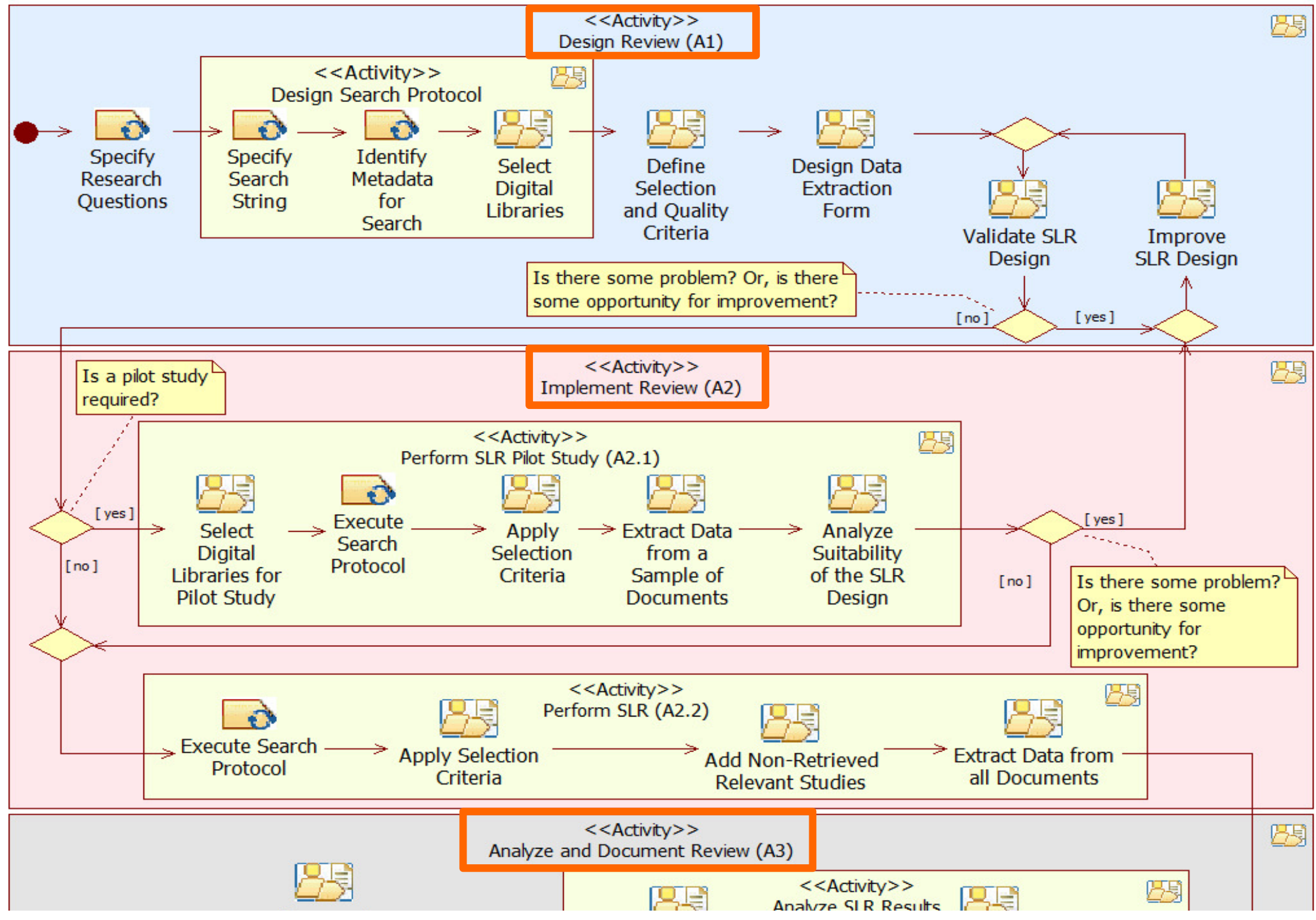
Process Core Ontology v 1.3



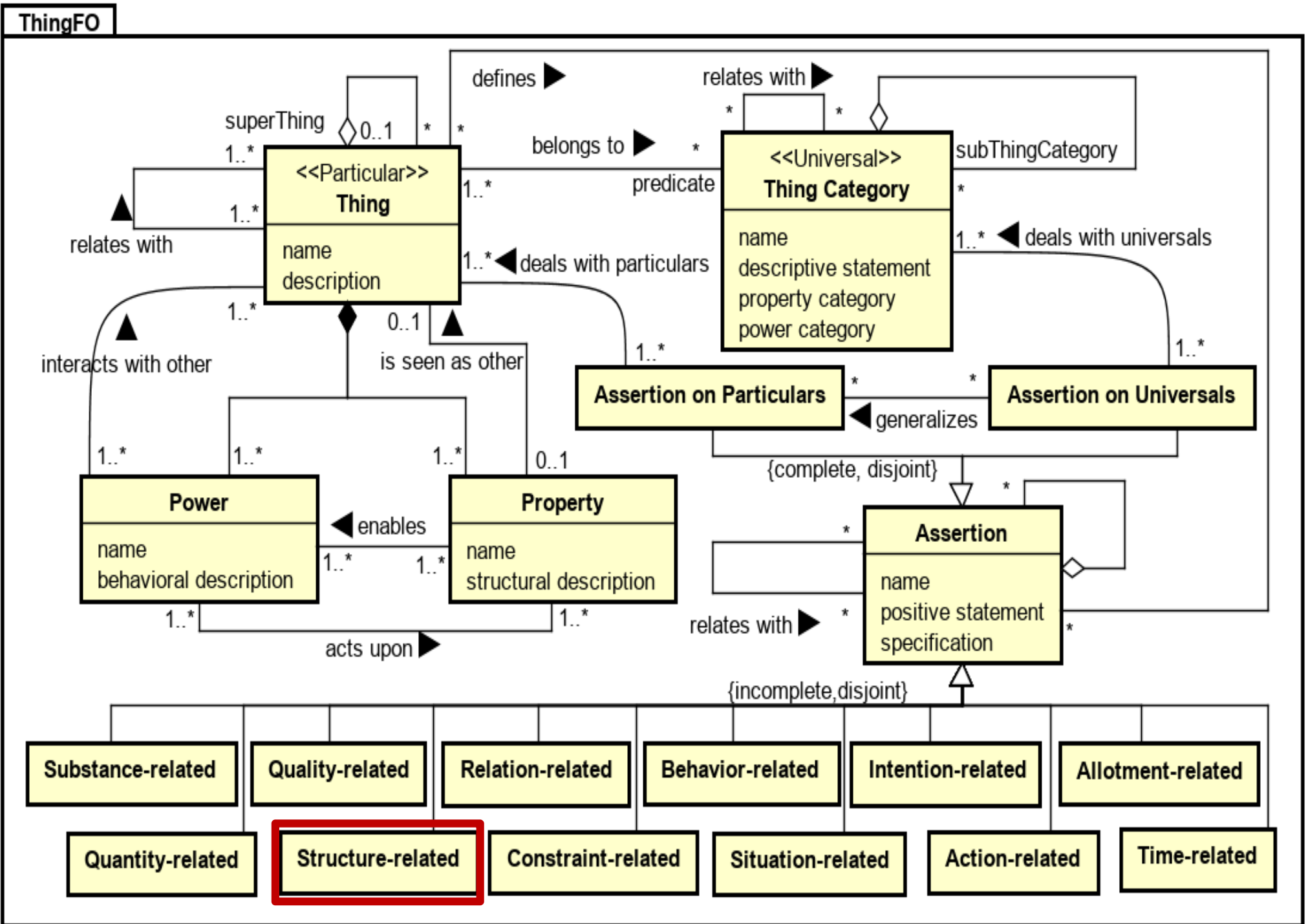
Process Core Ontology v 1.3



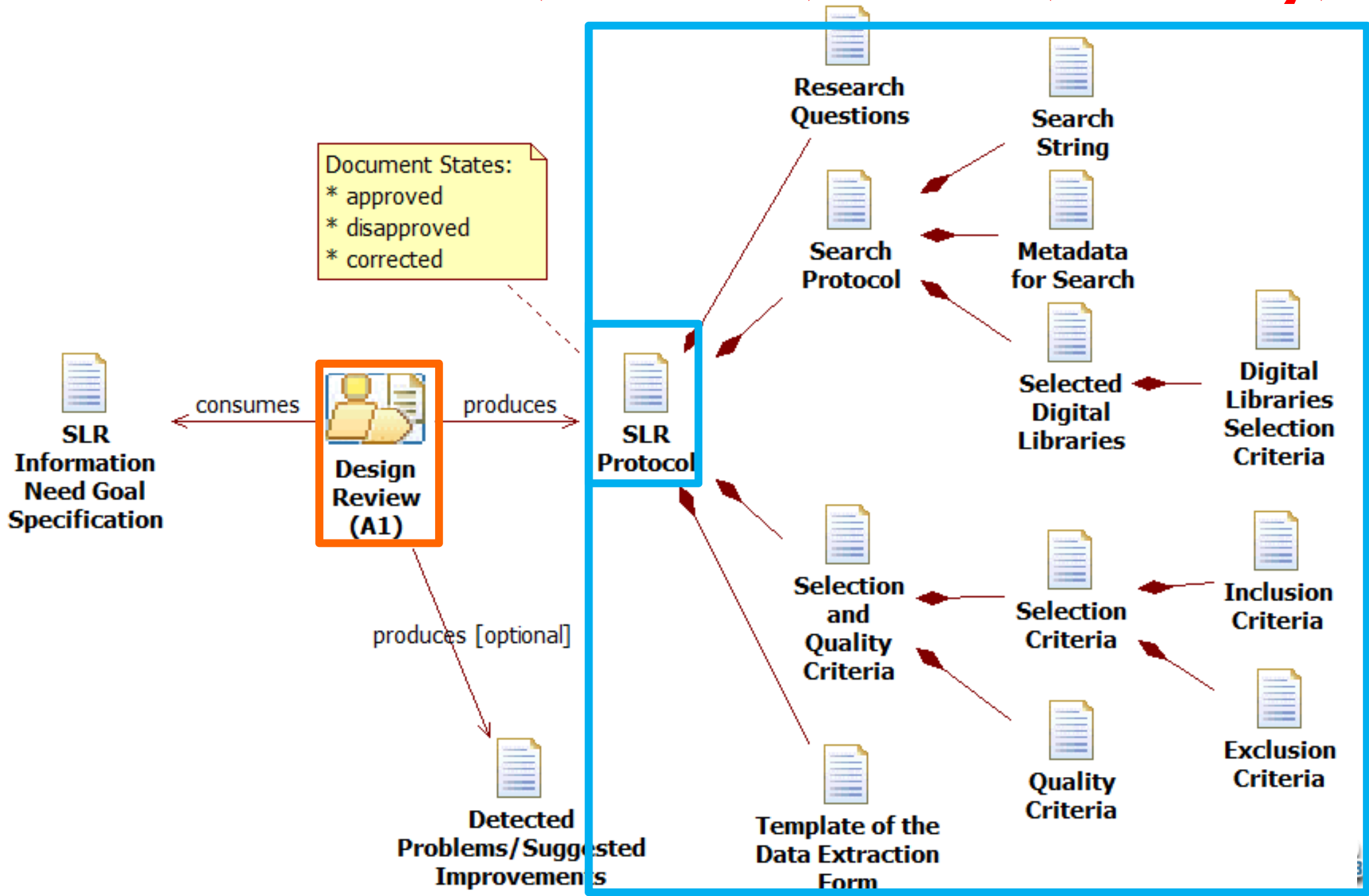
Behavioral Perspective of the SLR Process



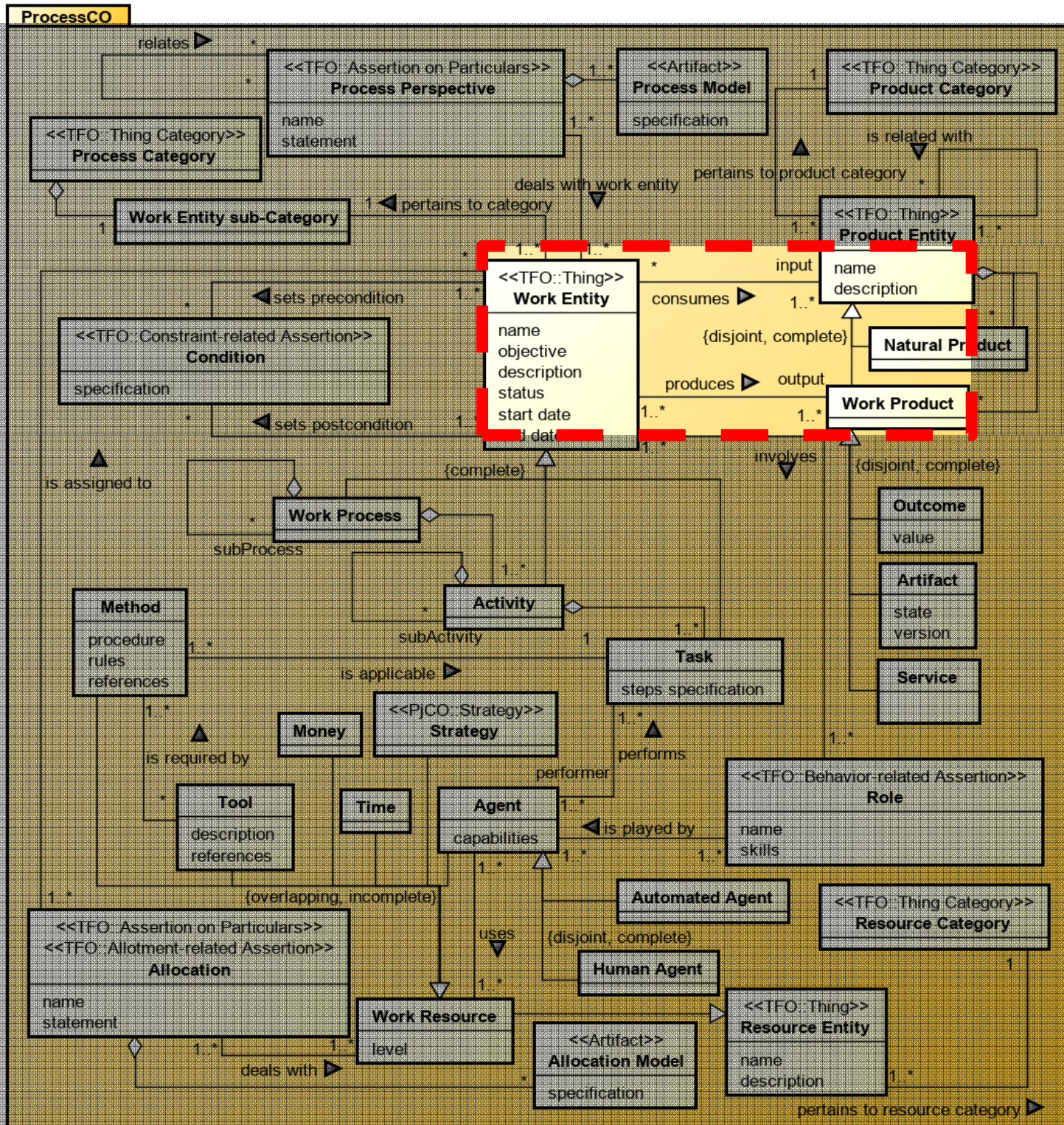
ThingFO: Term Assertion



Informational Perspective of the SLR Protocol (artifact) in AI (activity)

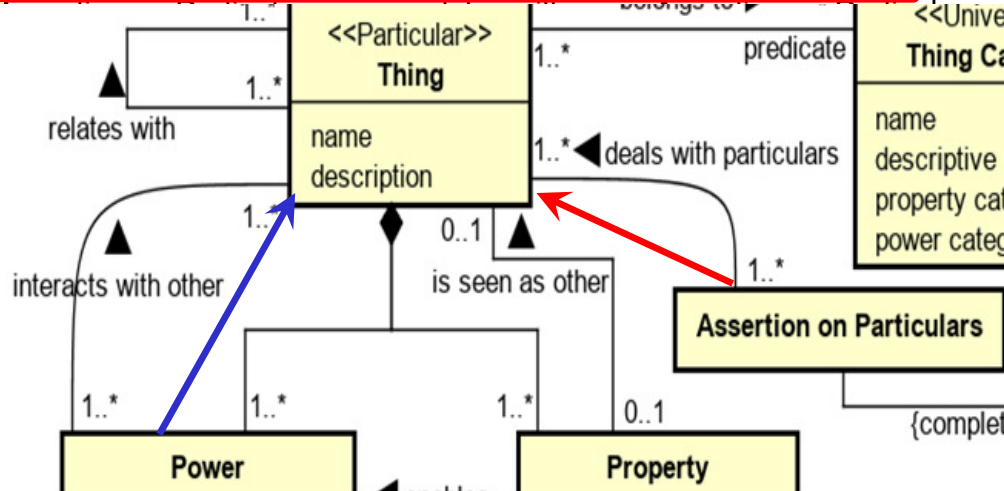
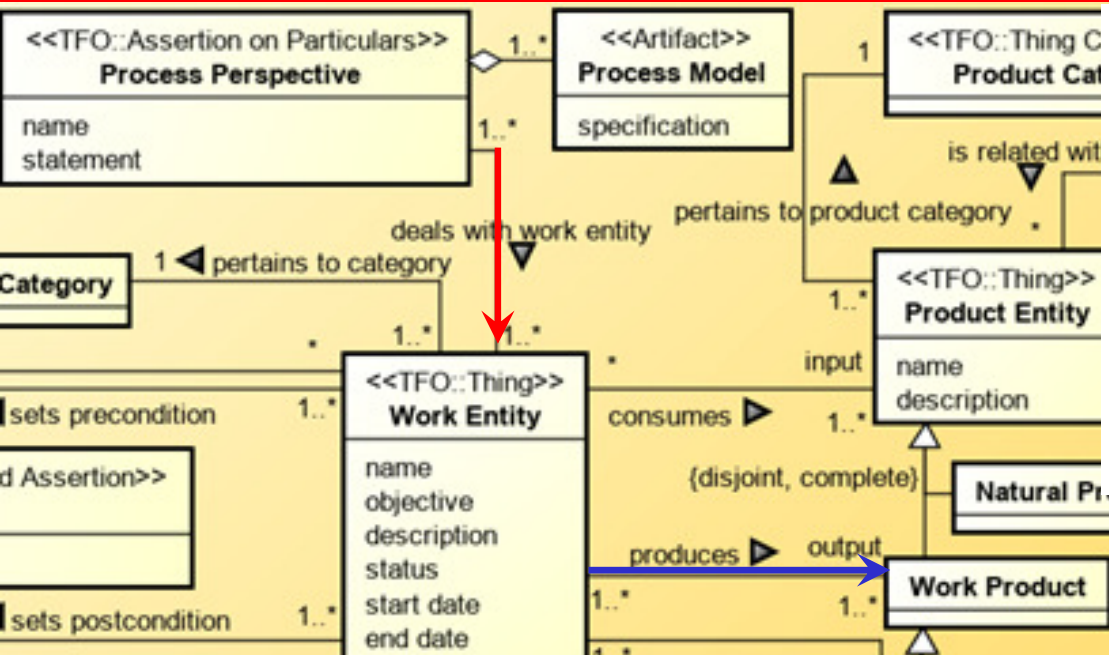


ProcessCO vs. ThingFO relations

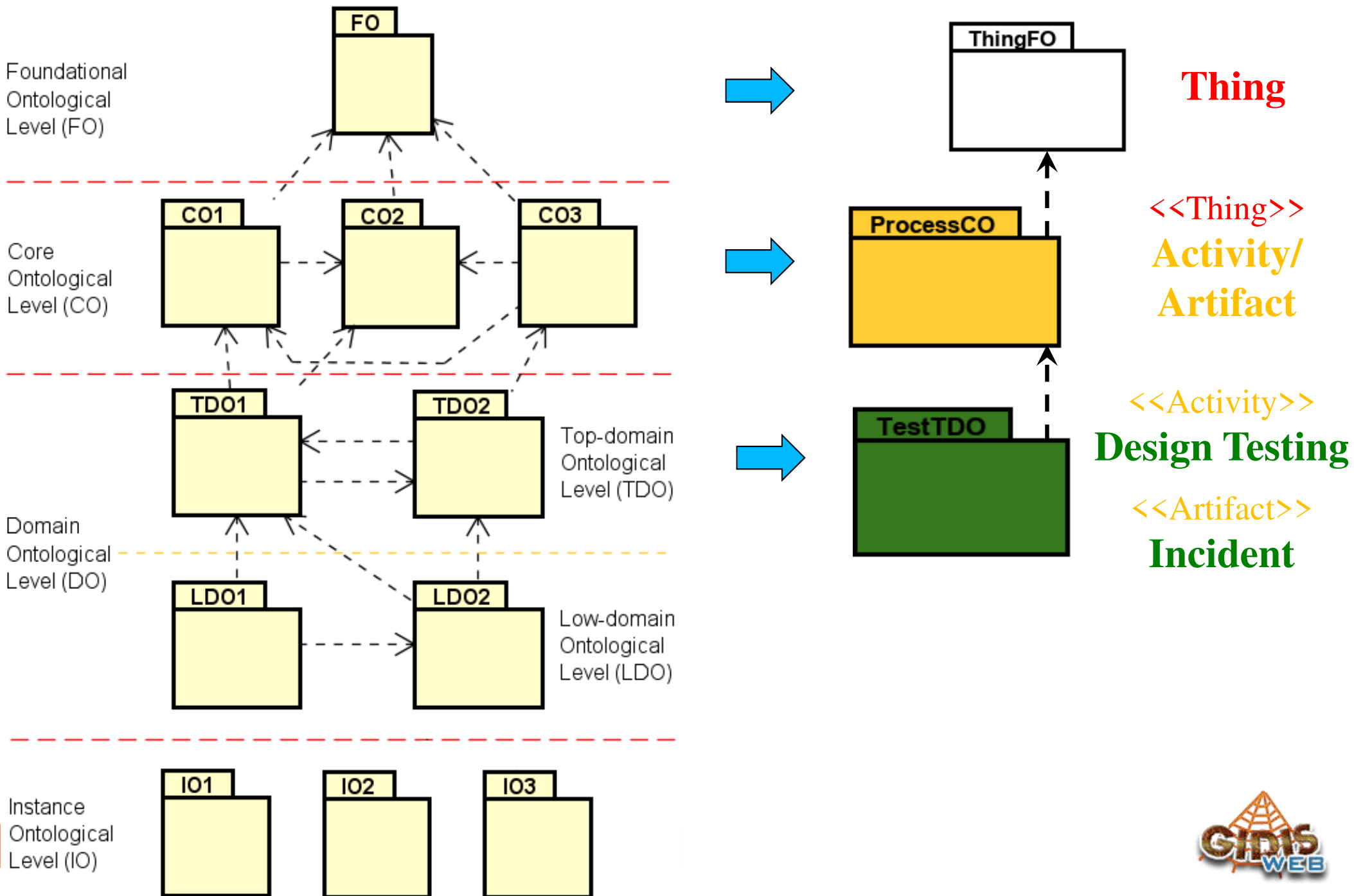


ProcessCO vs. ThingFO non-tax. relations

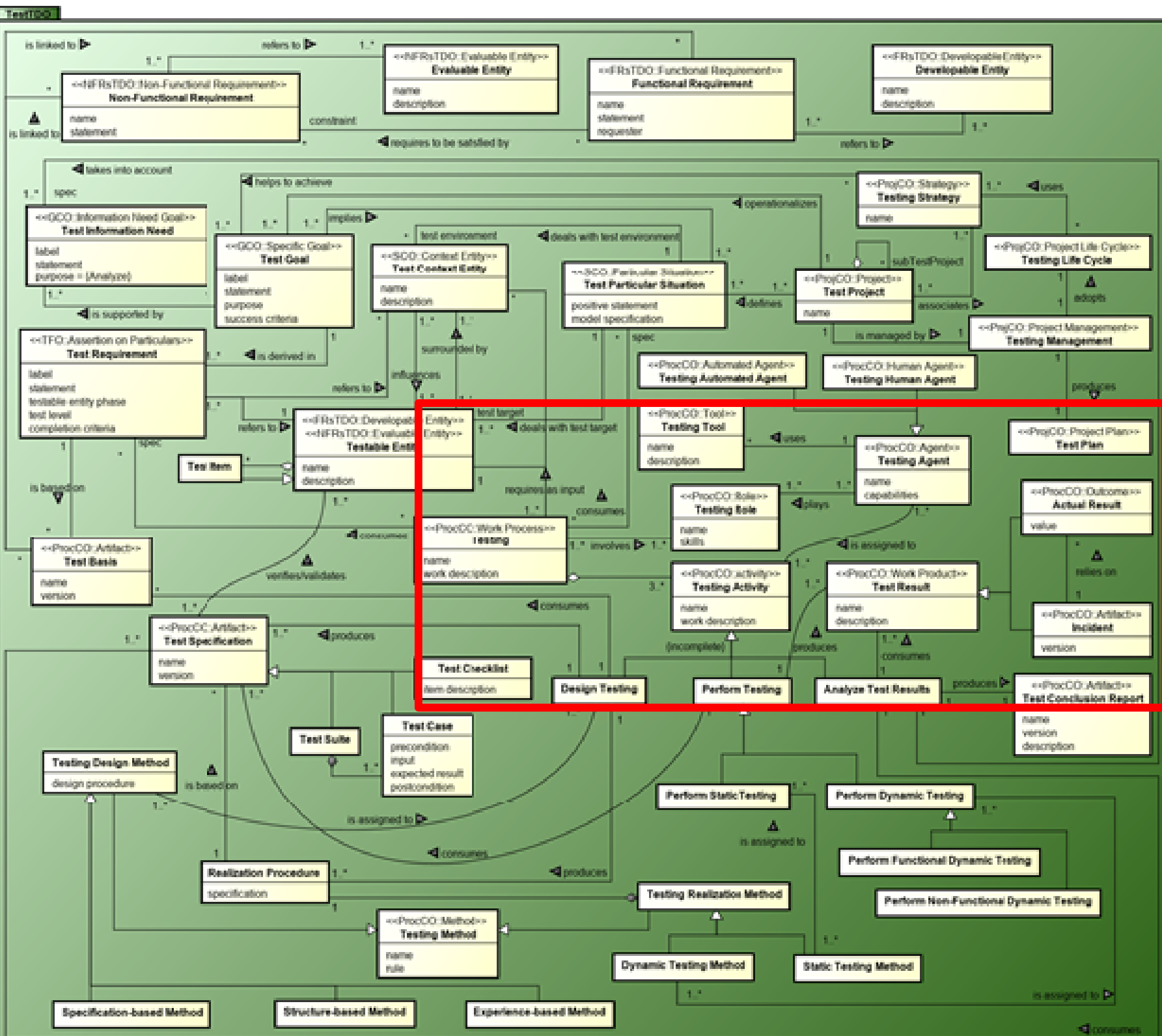
ProcessCO's Non-taxonomic Relationships			ThingFO's Non-taxonomic Relationships		
Term 1	Relationship name	Term 2	Term 1	Relationship name	Term 2
Work Entity	consumes	Product Entity	(Power of) Thing	interacts with other	Thing
Work Entity	involves	Role	Thing	defines	Assertion
Work Entity	pertains to category	Work Entity sub-Category	Thing	belongs to	Thing Category
Work Entity	produces	Work Product	(Power of) Thing	interacts with other	Thing
Work Entity	sets postcondition	Condition	Thing	defines	Assertion
Work Entity	sets precondition	Condition	Thing	defines	Assertion
Product Entity	is related with	Product Entity	Thing	relates with	Thing
Product Entity	pertains to product category	Product Category	Thing	belongs to	Thing Category
Process Perspective	deals with work entity	Work Entity	Assertion on Particulars	deals with particulars	Thing



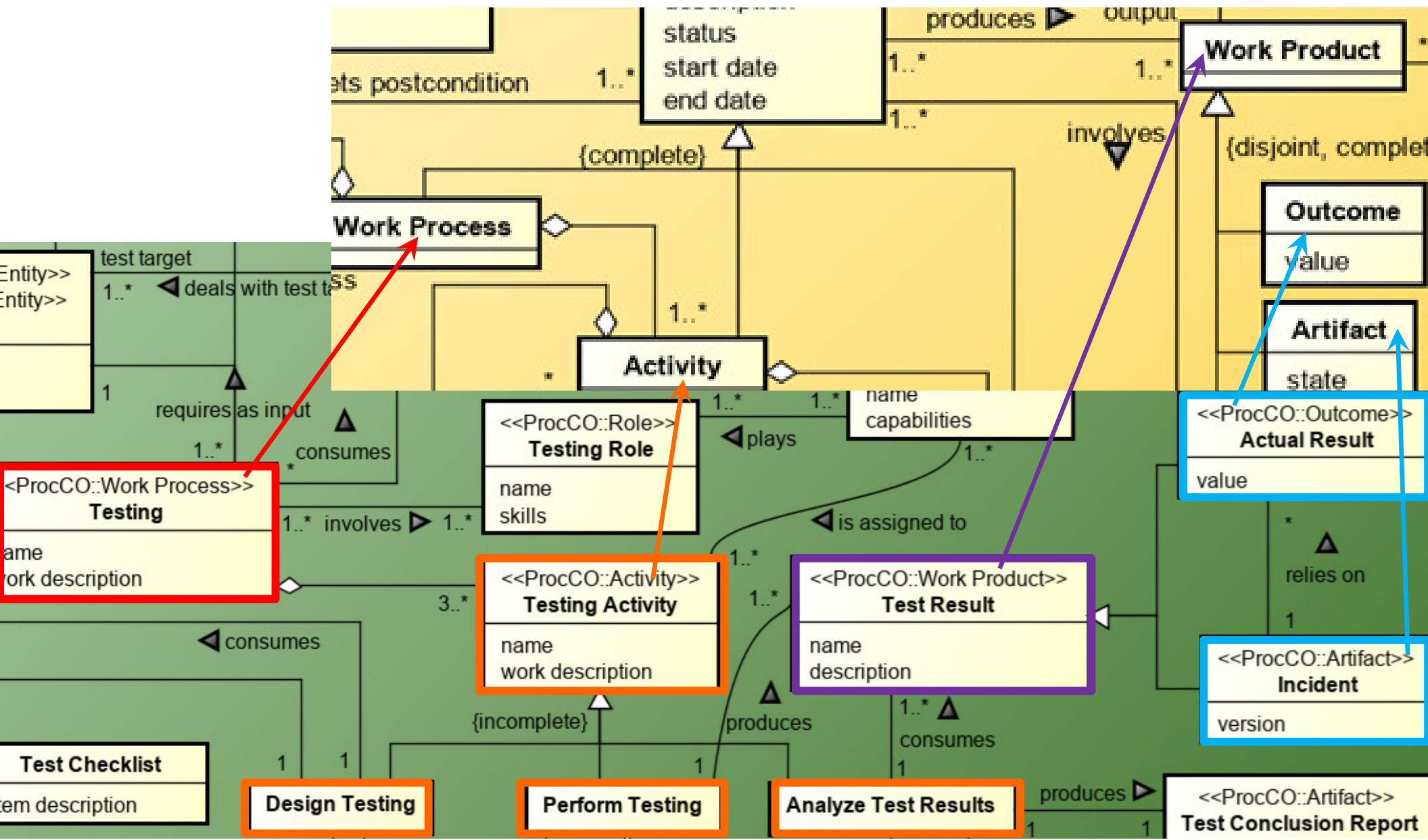
FCD-OntoArch: ProcessCO & TestTDO



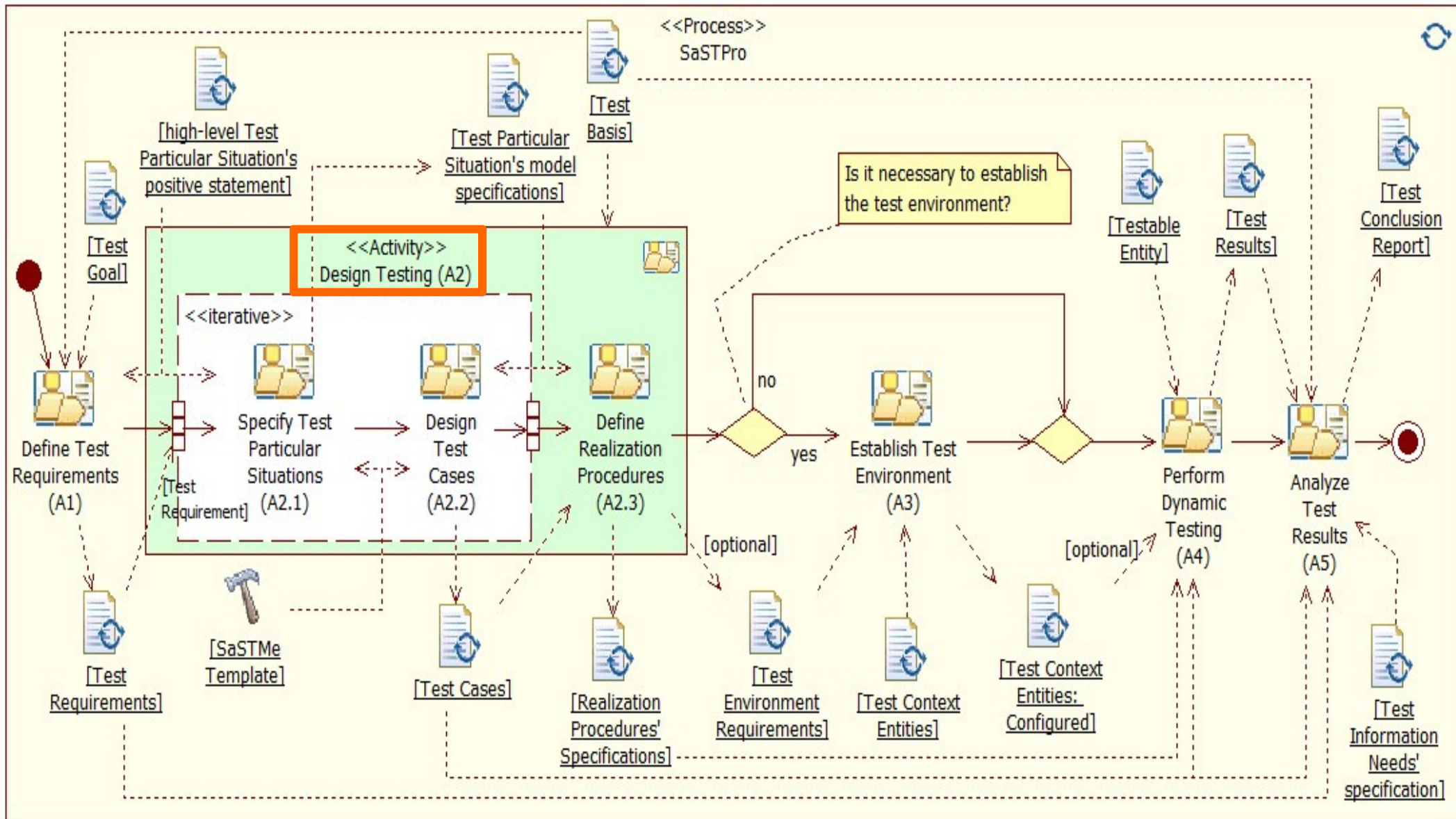
TestTDO v 1.3



ProcessCO enriches TestTDO



Behavioral and Functional Perspective of a Dynamic Testing Process



Conclusions

- **FCD-OntoArch** promotes a **clear separation of concerns** by considering ontological levels that allow the **allocation of ontologies accordingly**.
- **FCD-OntoArch** encourages **modularity, extensibility** and **reuse** of ontological elements at **all lower levels**.
- **ThingFO** is at the highest level; ontologies at lower levels benefit from reusing and extending its **three key concepts (Thing, Thing Category and Assertion)**, in addition to its **relationships**
 - Lower-level ontologies are under the umbrella of **ThingFO**.
- **ThingFO**, and concepts of **ProcessCO**, among other core ontologies as **SituationCO**, are cross-cutting concerns for domain ontologies (e.g. **TestTDO**) of any Science.

References for ThingFO

Olsina L.: Applicability of a Foundational Ontology to Semantically Enrich the Core and Domain Ontologies. To appear in proceedings of KEOD'21, 13th International Conference on Knowledge Engineering and Ontology Development, IC3K, held virtually in Oct. 2021, Portugal, pp. 1-8, (2021).

Olsina L.: Analyzing the Usefulness of ThingFO as a Foundational Ontology for Sciences. In proceedings of Argentine Symposium on Software Engineering, ASSE'20, 49 JAIIO, CABA (virtual event), Argentina, Oct.2020, 172-191, ISSN: 2451-7593. Available at https://www.researchgate.net/publication/343609747_Analyzing_the_Usefulness_of_ThingFO_as_a_Foundational_Ontology_for_Sciences, (2020).

Olsina L.: ThingFO v1.2's Terms, Properties, Relationships and Axioms -- Foundational Ontology for Things. Preprint in Research Gate, https://www.researchgate.net/publication/351087975_ThingFO_v12's_Terms_Properties_Relationships_and_Axioms_-_Foundational_Ontology_for_Things, April (2021). Also available at <http://arxiv.org/abs/2107.09129>, July (2021)

References for ProcessCO

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Questions?

“One thing I have learned in a long life: that all our science, measured against reality, is primitive and childlike -- and yet it is the most precious thing we have.” ~ Albert Einstein

Dr. Luis Olsina

E-mail: olsinal@ing.unlpam.edu.ar



GIDIS_Web (*Grupo de Investigación y Desarrollo en Ingeniería de Software y Web*)

Departamento de Informática – Facultad de Ingeniería – Universidad Nacional de La Pampa

General Pico – La Pampa

Argentina

