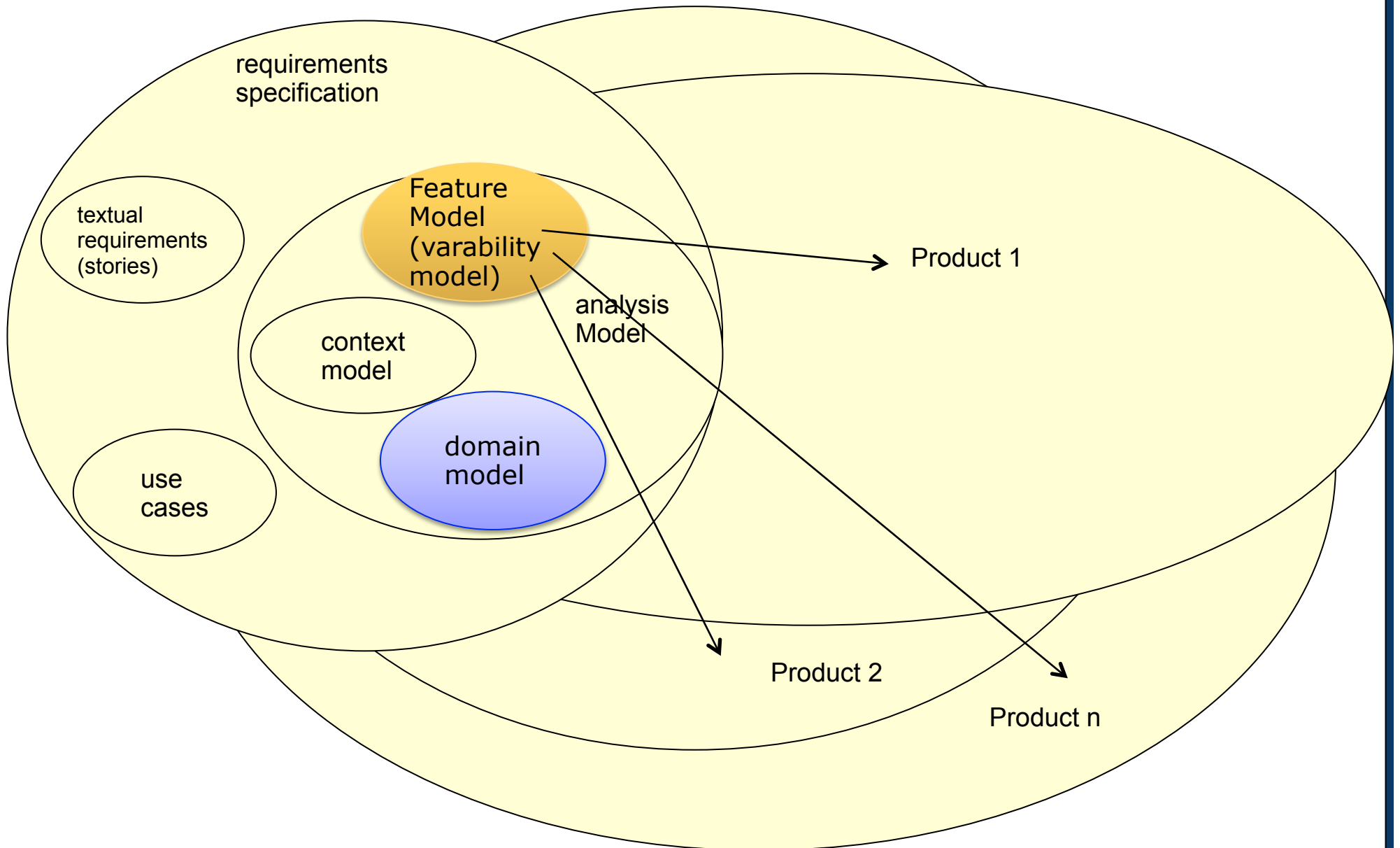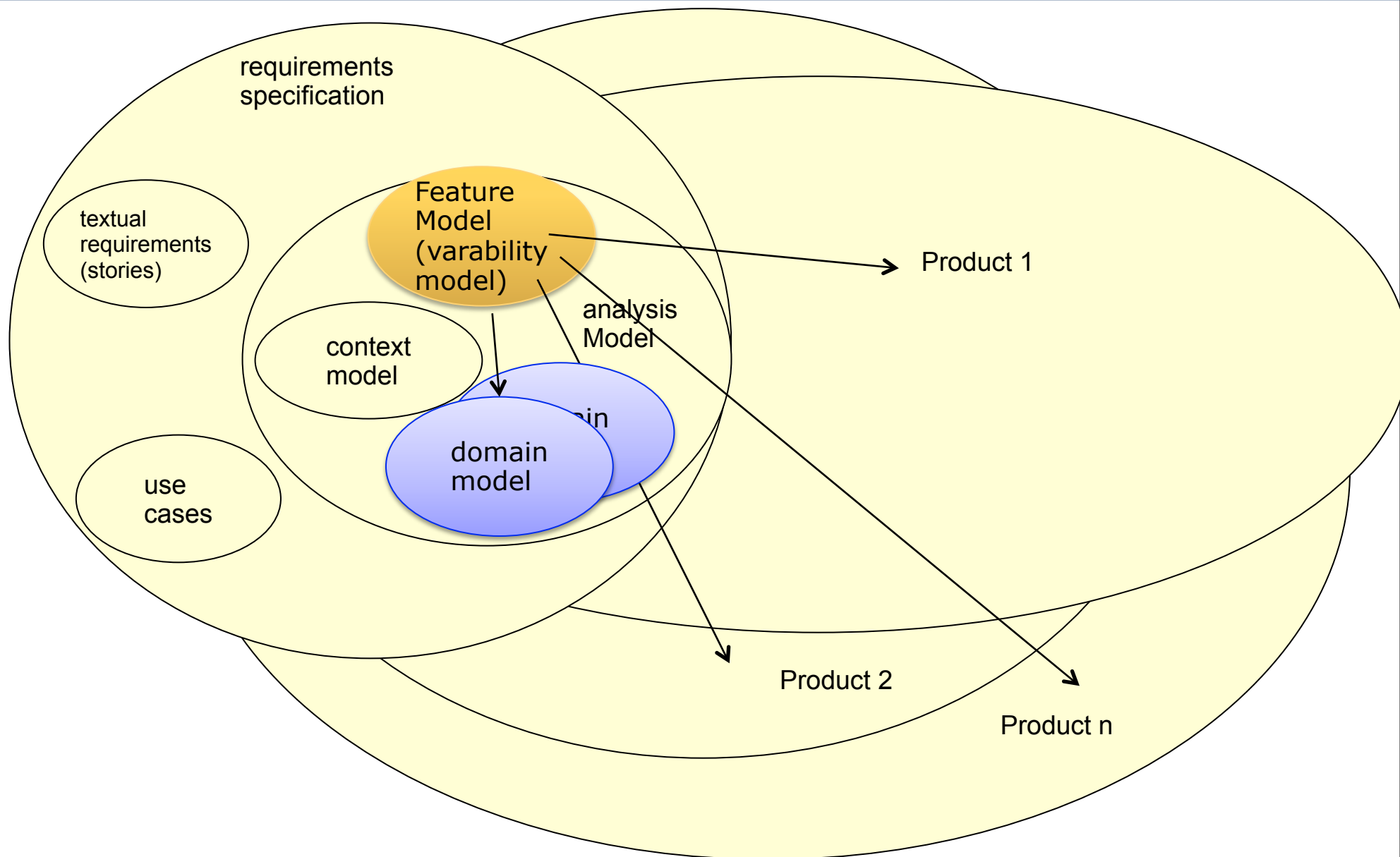# 32) Domain Models and Product Lines

1. Domain Models and Product Lines
2. Domain Ontologies and the MDA

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- **Institut für Software- und Multimediatechnik**
- **Gruppe Softwaretechnologie**
- **http://st.inf.tu-dresden.de**
- **Version 11-0.1, Dezember 28, 2011**

> **Uwe Aßmann, Steffen Zschaler, and Gerd Wagner. Ontologies, meta-models, and the model-driven paradigm. In Coral Calero, Francisco Ruiz, and Mario Piattini, editors, Ontologies for Software Engineering and Technology. Springer, 2006.**
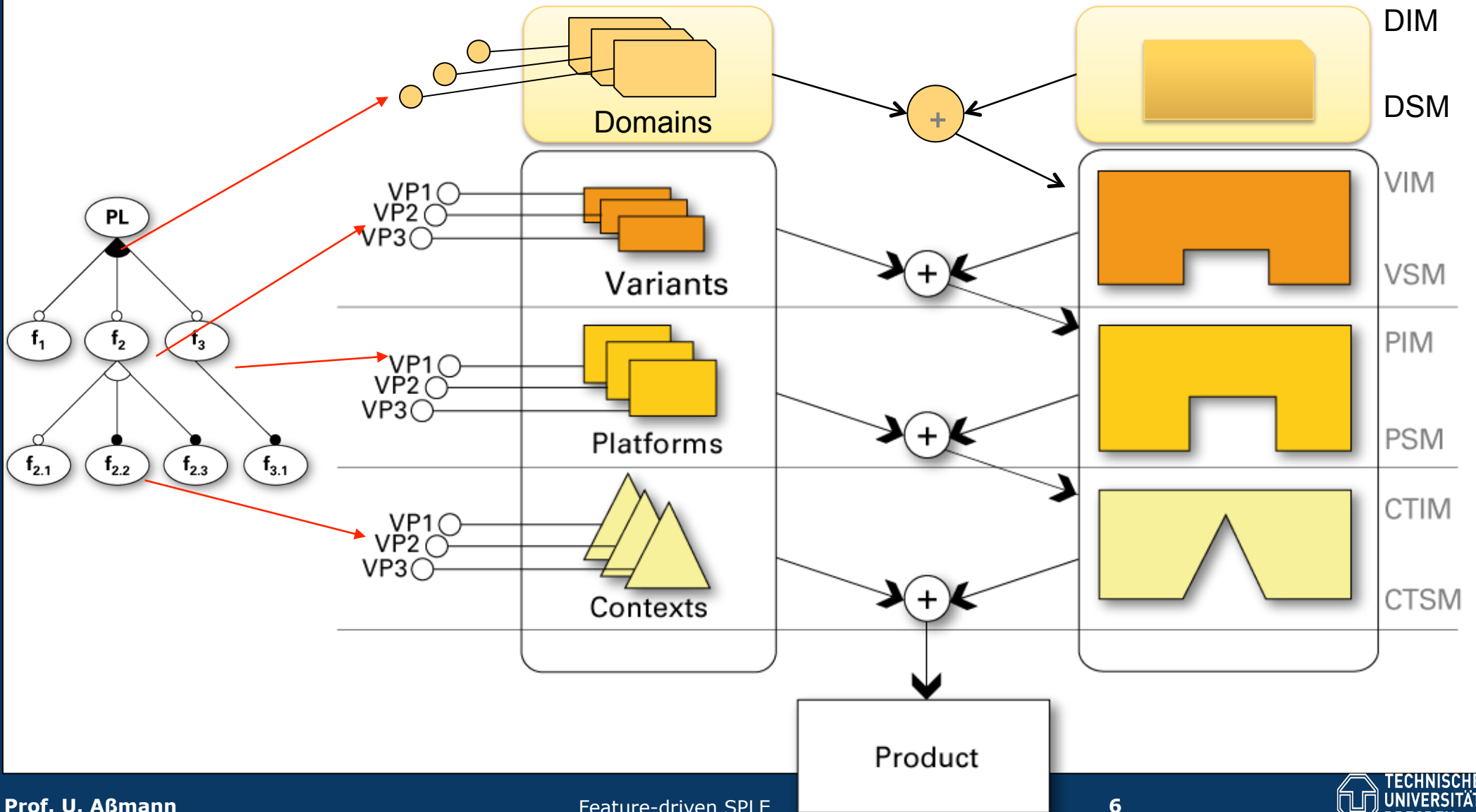
> **In a product line, domain-specific extensions can be treated like platform-specific extensions (see process FEASIPLE)**
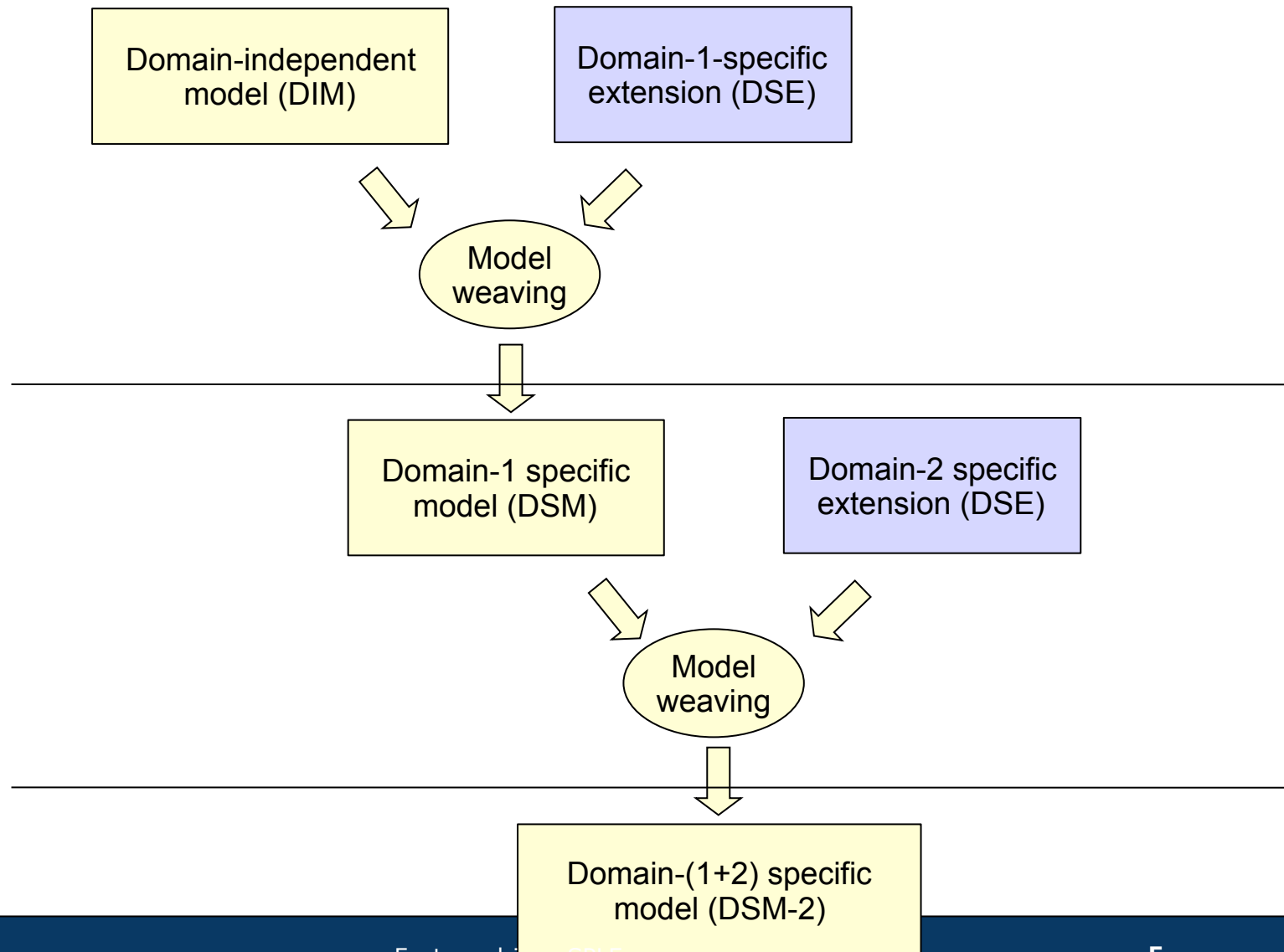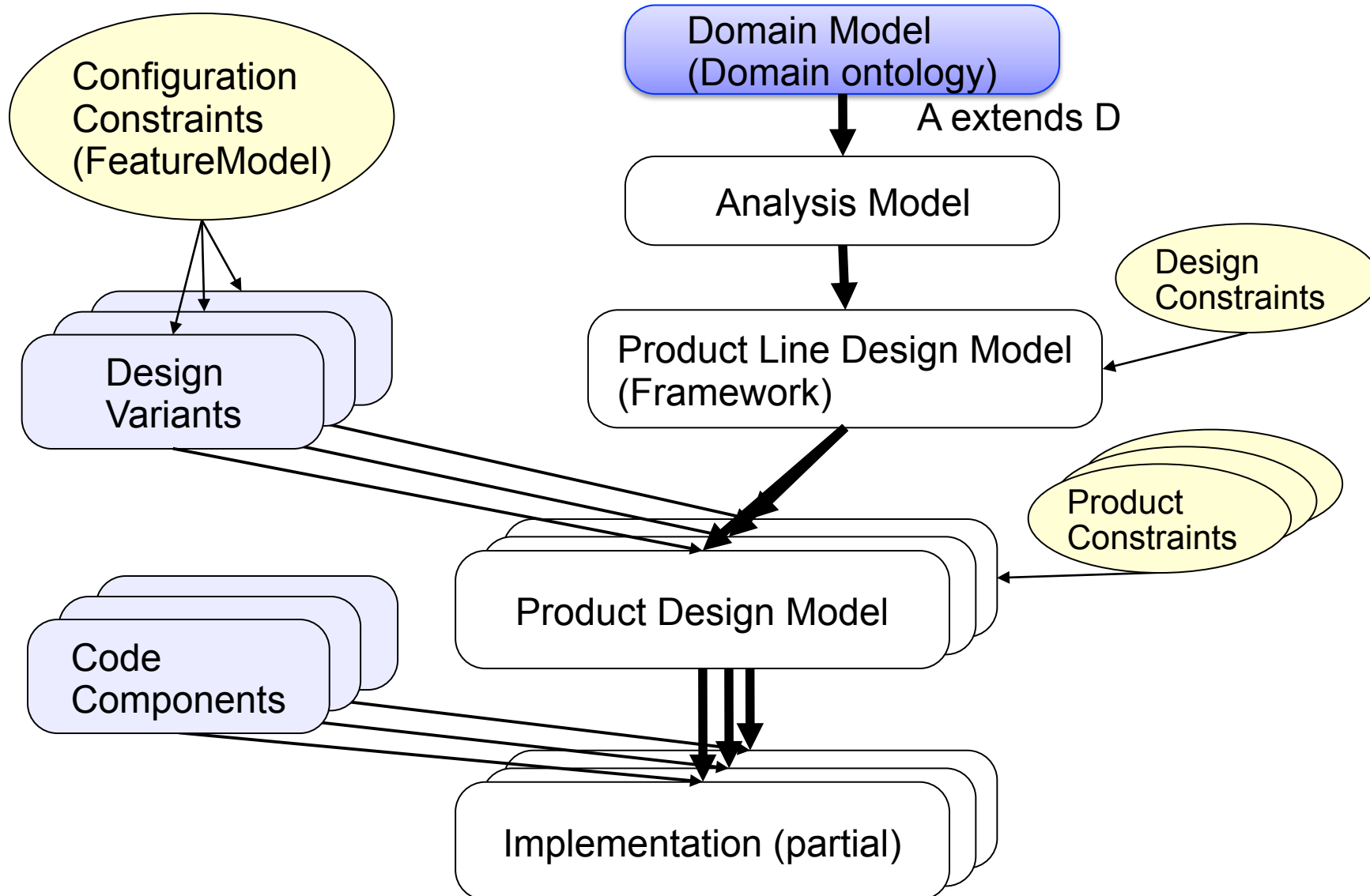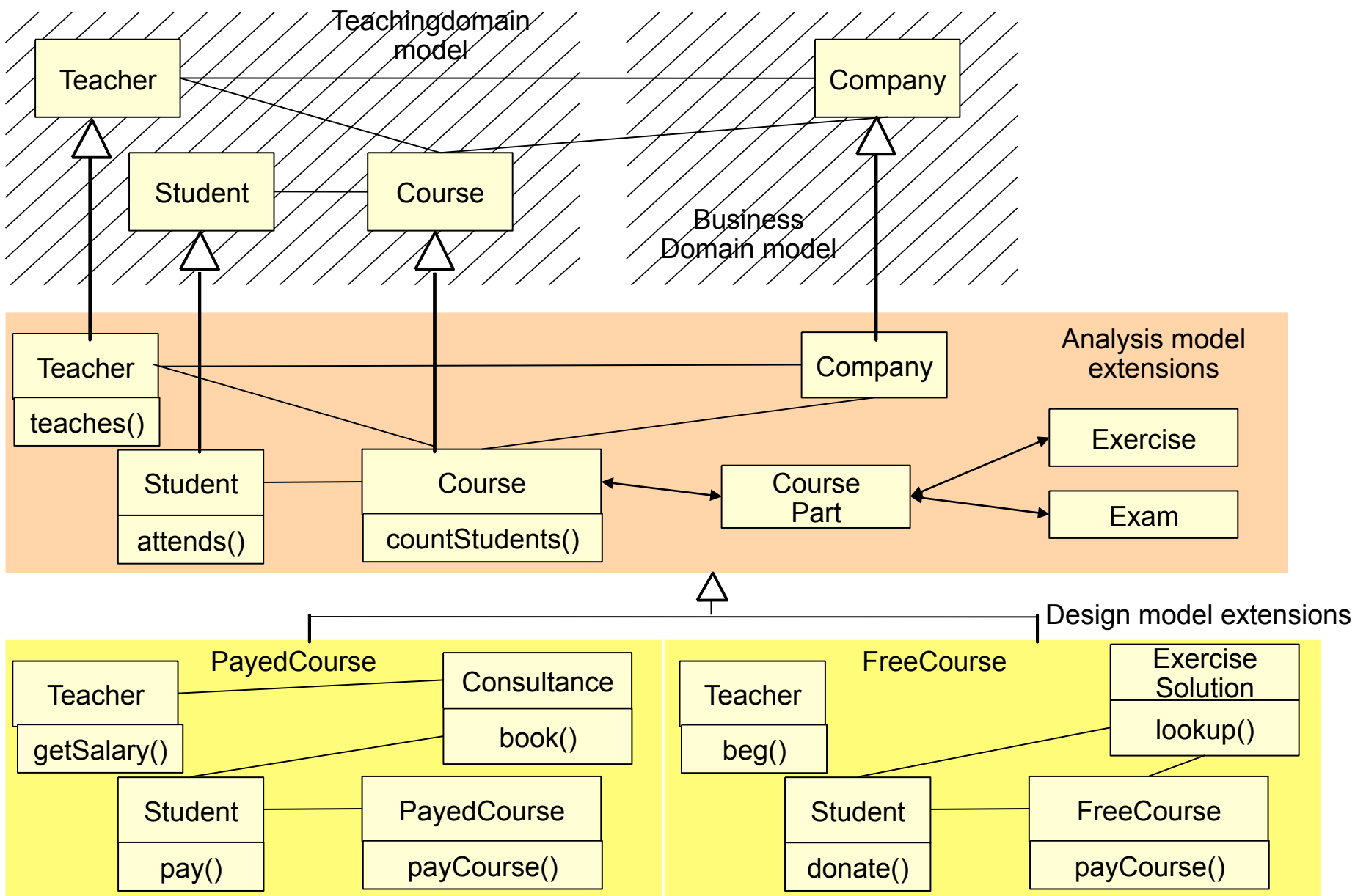
➢ **FEASIPLE can be extended by a stage for selecting domain models**

32.1 DOMAIN MODELS AND PRODUCT LINES

➢ **As supermodel of the analysis model: analysis classes inherit from domain classes (standard was of ST-I)**

➢ **Marked PIM in MDA**

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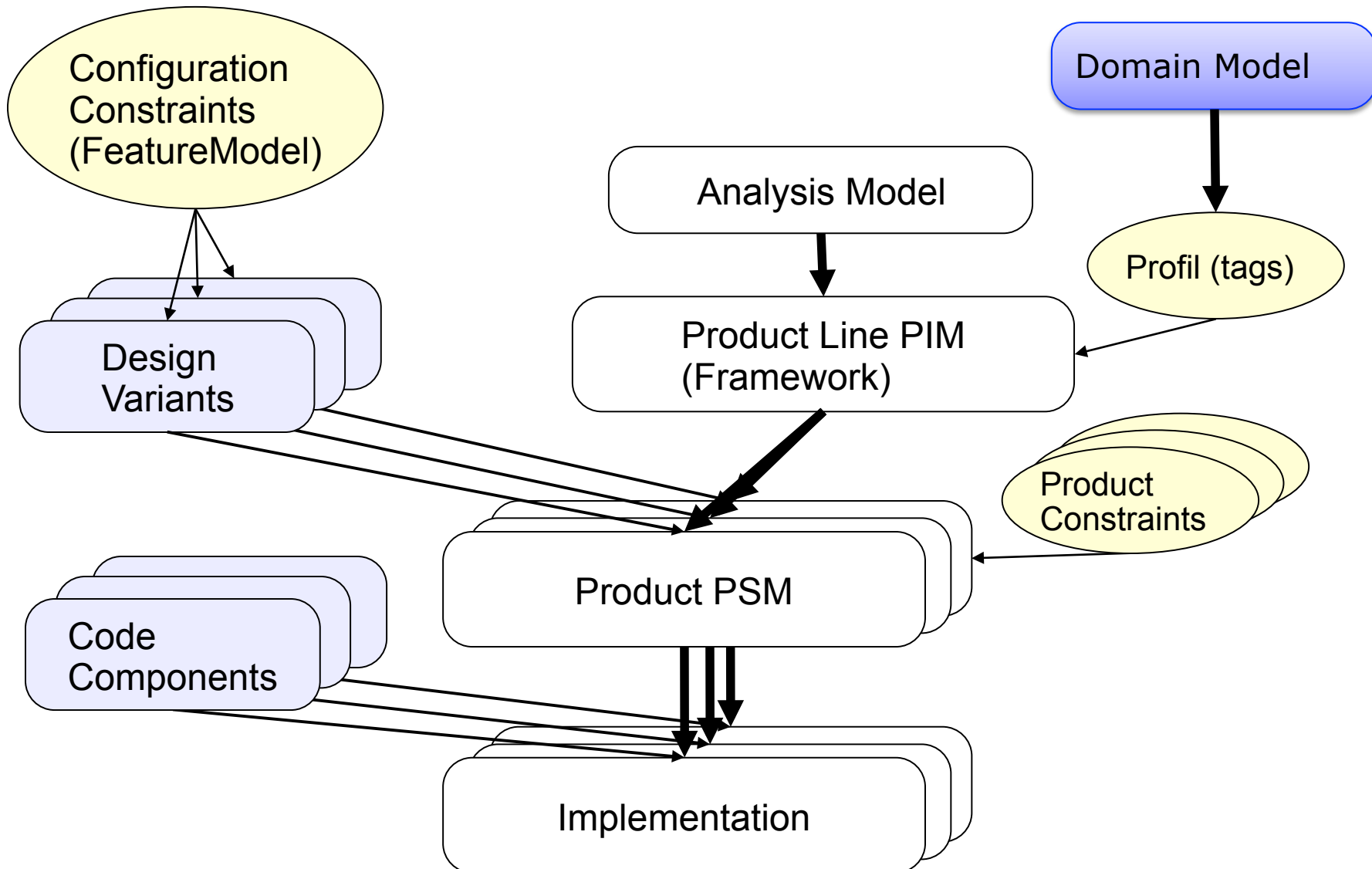
➤ **As design constraints, as product constraints, as domainenmodell**

Configuration Constraints (FeatureModel)

Domain Model (Domain ontology)

Requirements constraints

Analysis Model

Design DS

Design Constraints

Design Variants

Product Line Design Model (Framework)

Product Design Model

Product Constraints

Code Components

Implementation (partial)
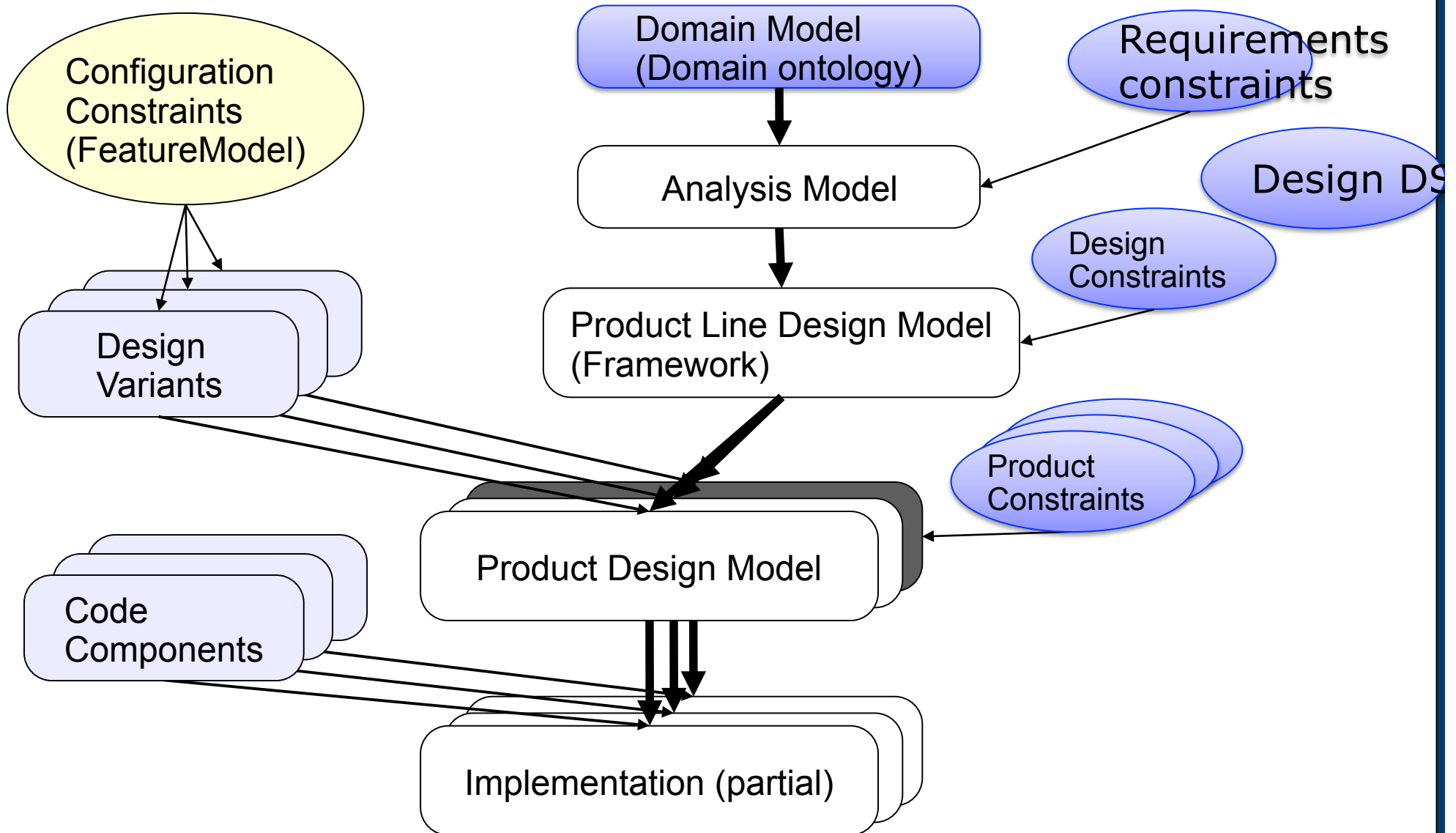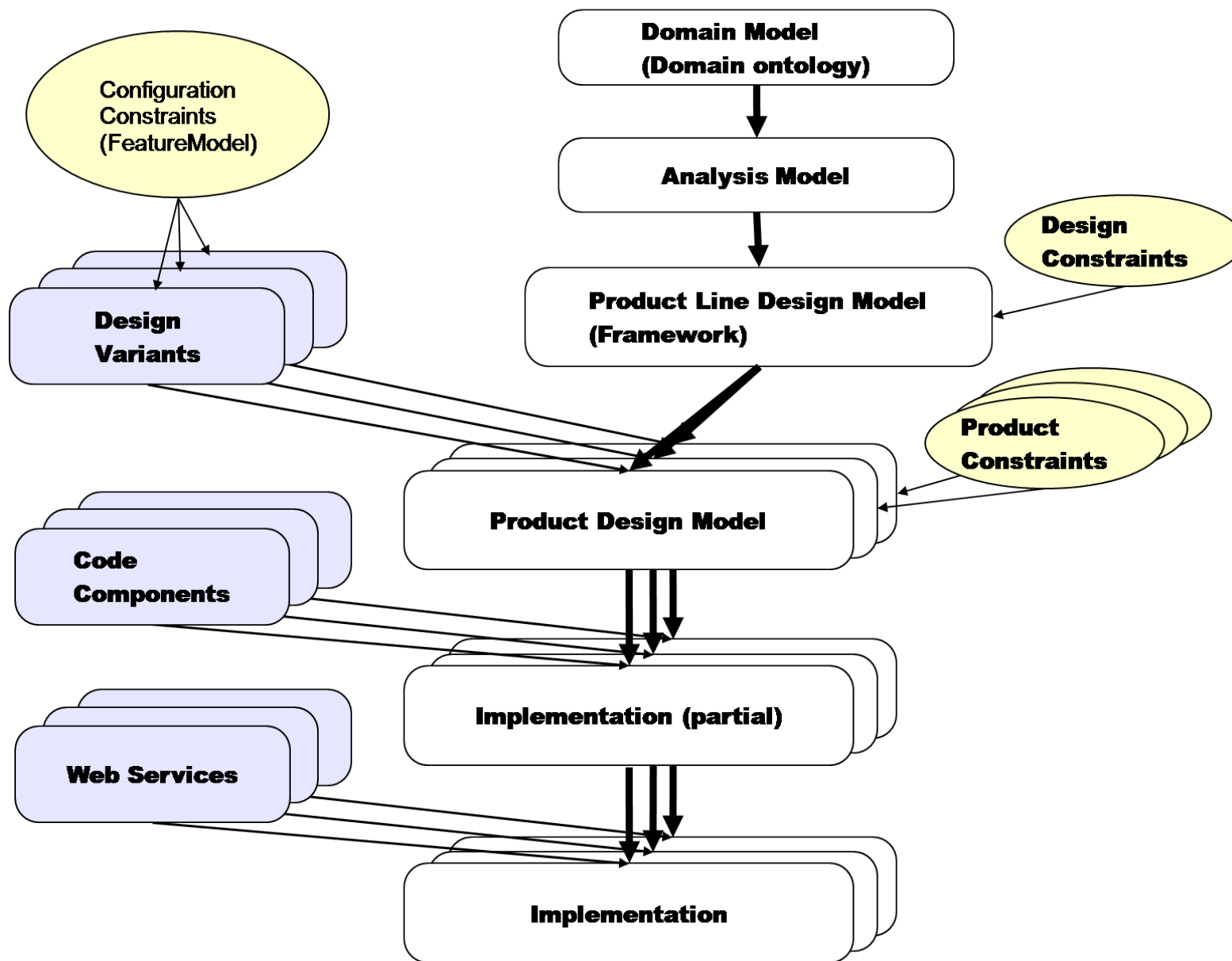
32.2 USING DOMAIN ONTOLOGIES IN THE MDA

- ➢ **Ontologies offer reasoning power**
  - ➢ Ontologies are modeled by domain experts and standardized
    - ➢ Gene Ontology, SnoMed, Mouse Ontology, ..
  - ➢ OWL language is standardized, reasoners are available
- ➢ **Can we use them in the Product-Line Engineering, resp. MDA?**
- ➢ **How do ontologies and system models relate?**
  - ➢ Ontology
  - ➢ Metamodels
  - ➢ Model-Driven Engineering (MDE)
  - ➢ Model-Driven Architecture (MDA)

➢ **How can we find a place for ontologies in the world of MDA?**

A model is an external and explicit representation of a part of reality as seen by the people who wish to use that model to understand, change, manage, and control that part of reality. [Pidd]

A model of a system is a description or specifiation of that system and its environment for some certain purpose. [MDA Guide]

But....

Ontologies are formal explicit specifications of a shared conceptualization.[Gruber]

> **[Aßmann, Zschaler, Wagner 06]**

An **ontology:**

a standardized,
descriptive model,

representing reality
by a set of concepts, their
interrelations, and constraints
under
open-world assumption.

A **system model:**

a non-standardized,
prescriptive model,

representing a set of systems
by a set of concepts, their interrelations,
and constraints
under
closed-world assumption.

A model can be *descriptive* or *prescriptive*.
[Seidewitz CACM 03]

• Models describe or control reality.

• If they describe, they monitor reality and form true, or faithful, abstractions (Analysis, Reengineering)

• If they control, they prescribe reality (Construction, Specification)

► Ontologies need the **open-world assumption**

- Analysis perspective

- **Anything not explicitly expressed is unknown**

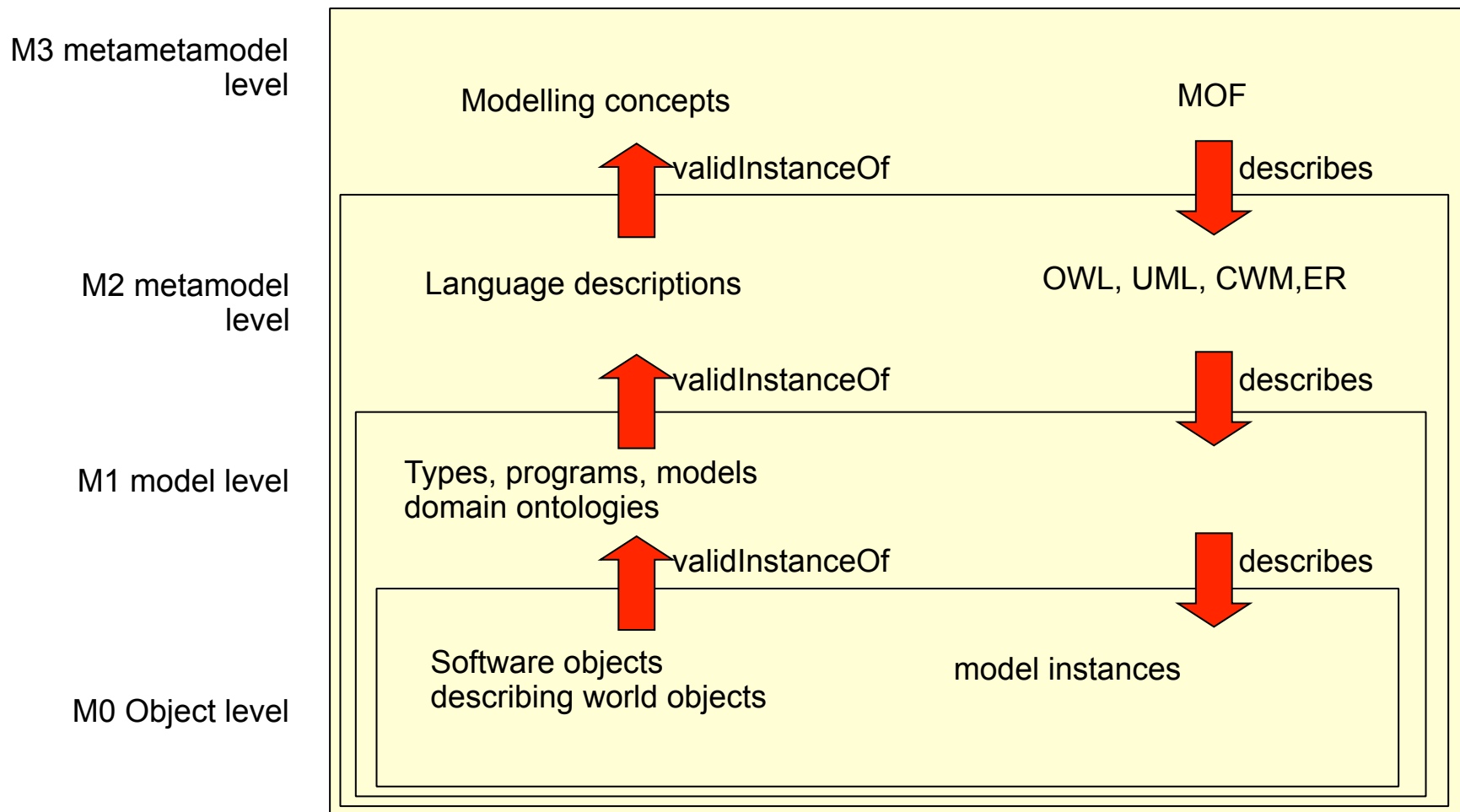- Ontologies use a form of partial description to abstract

► System models need **closed-world assumption**

- Design perspective

- **Anything not explicitly expressed is wrong**

- System models specify completely

Descriptive

Prescriptive

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- ➢ **With Closed World Assumption (Reasoning)**
  - ➢ Querying
    - ➢ needs CWA to exclude erroneous data
  - ➢ Metamodeling:
    - ➢ needs CWA to exclude erroneous programs
  - ➢ Integrity constraints
    - ➢ needs CWA to exclude erroneous models
- ➢ **With Open World Assumption**
  - ➢ Domain modeling
    - ➢ needs OWA because of partial specification of domain

➢ **aka *metapyramid***

Level		
M3 metametamodel level	Modelling concepts	MOF
	↑ validInstanceOf	↓ describes
M2 metamodel level	Language descriptions	OWL, UML, CWM,ER
	↑ validInstanceOf	↓ describes
M1 model level	Types, programs, models domain ontologies	
	↑ validInstanceOf	↓ describes
M0 Object level	Software objects describing world objects	model instances

M3 metametamodel level

MetaMetamodels

M2 metamodel level

Metamodels (languages)

M1 model level

Models

M0 object level

Modelling concepts

MOF

CIM-MM

Language specifications

PIM-MM

<<instance-of>>

PSM-MM

Instance specifications

CIM

<<instance-of>>

PIM
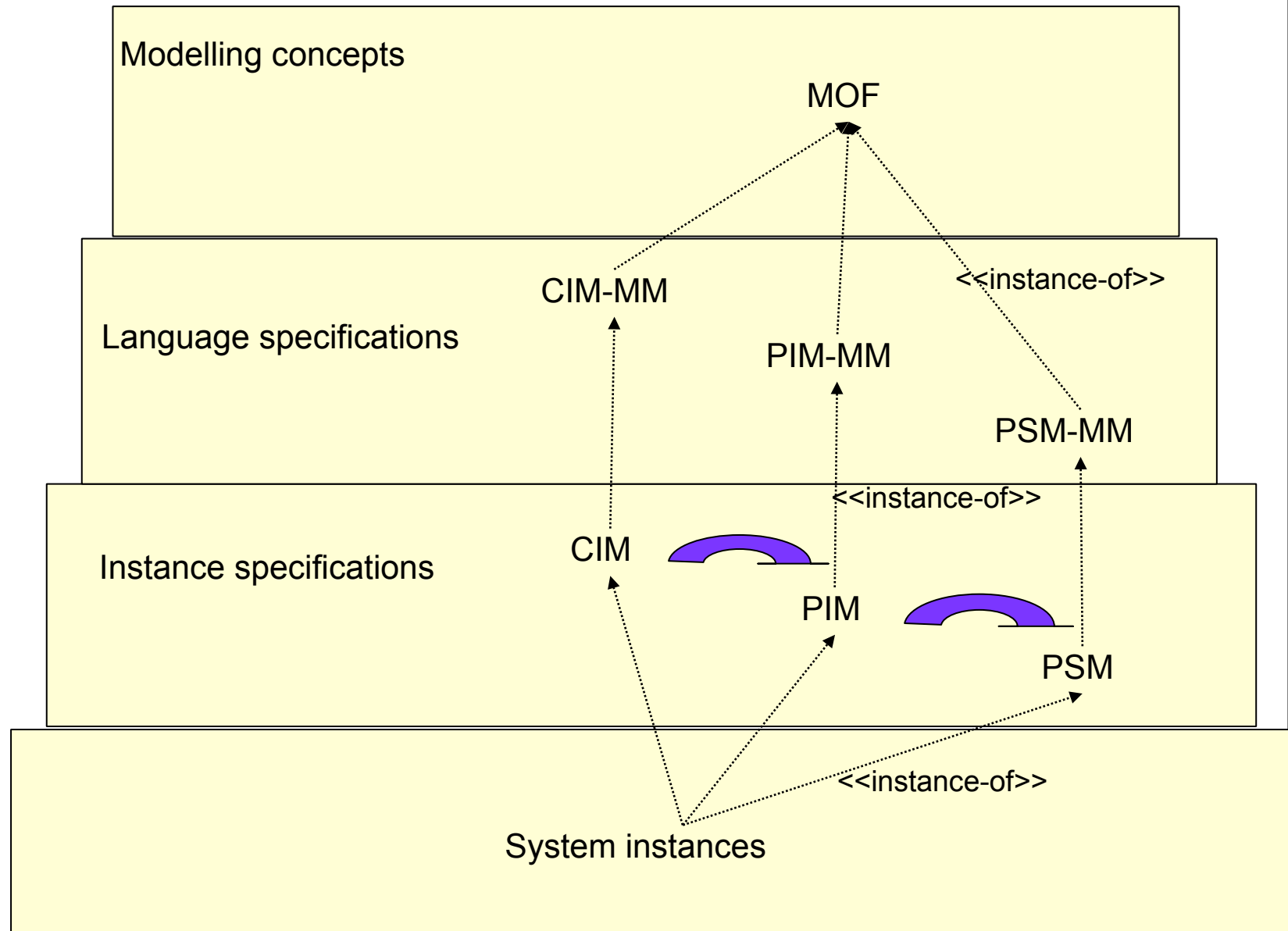
PSM
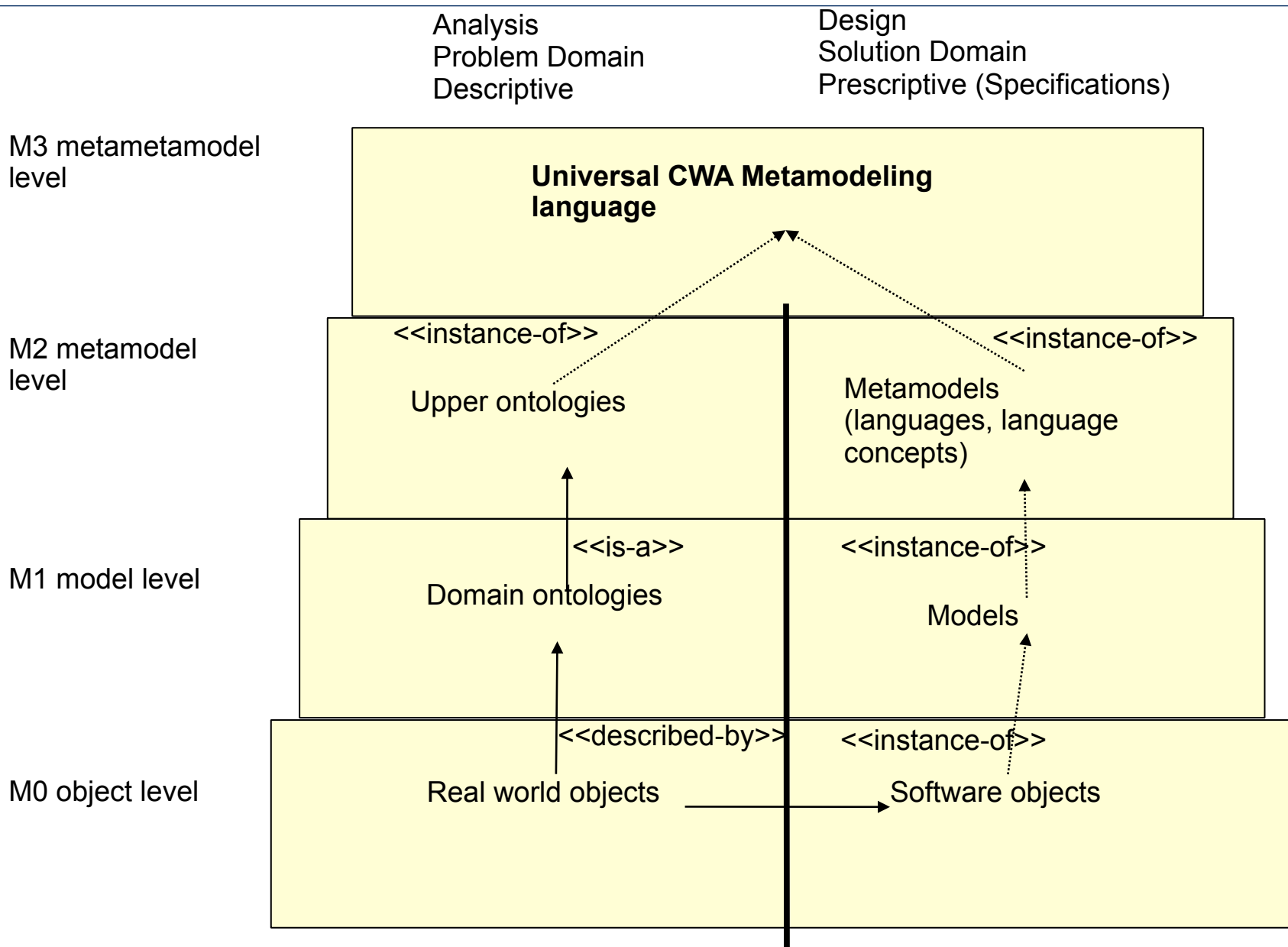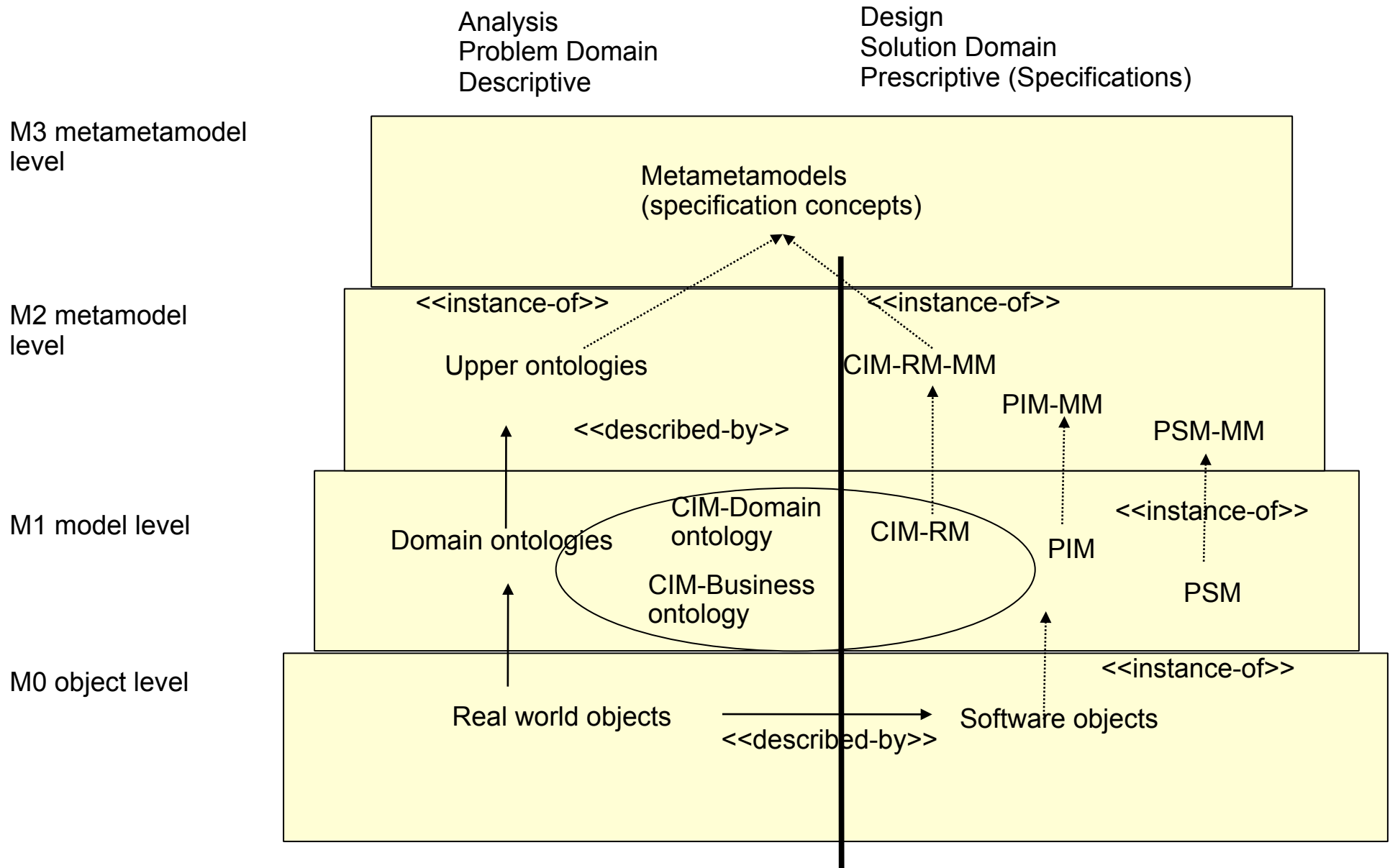
<<instance-of>>

System instances

- **Ontologies are advantageous in PLE for**
  - domain ontologies
  - integrity constraint ontologies in product lines
- **but...**
  - Ontologies should not be misused as system models
  - Ontologies *complement* system models
  - Ontologies in OWA for domain modeling, CWA for the rest
- **Integration technology and tools needed!**
  - **MOST project (Marrying Ontologies and Software Technology)**
  - **www.most-project.eu**

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Softwaretechnologie II
Entwurfsmethoden
Elementares über Produktlinien

Design Patterns and Frameworks
Produktlinien mit objektorientierter Programmierung (OO Komponentenmodell)

Software-Werkzeuge
Produktlinien mit Werkzeugen
Technikräume

Component-Based Software Engineering
Produktlinien mit anderen Komponentenmodellen

Software-Management
Wie man Projekte macht