Overall Semantic Modelling

OSMoSE

For Space System Engineering

MBSE-2021 – Space System Ontology Workshop

The Space System Ontology

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Outline

- The Space System Ontology – a global data model (schema) expressed at conceptual level
- The Space System Ontology – the modelling language “Object Role Modelling – ORM”
- The Space System Ontology – the scope
- The Space System Ontology – working together
- The Space System Ontology – the skeleton
- The Space System Ontology – from modelling information to semantic interoperability

The Space System Ontology

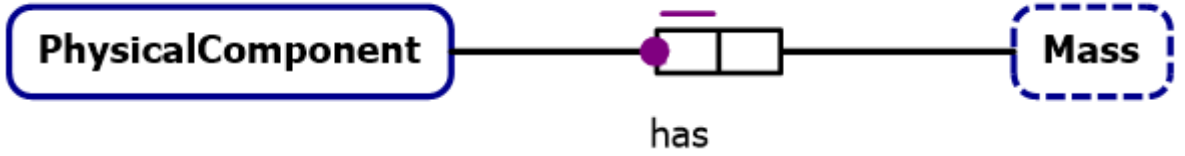
A global data model expressed at conceptual level using a language that is logic-based with associated formal graphical and textual representations

For OSMoSE, the following decisions were taken:

- the language used is the Object Role Modelling language, refer to www.orm.net
- the tool to use is NORMA in its professional version
- the Space System Ontology represents a global conceptual data model expressed in **human oriented concepts** *made of object types, fact types and constraints* -ORM
- "global as a whole" : the Space System Ontology integrates all stakeholders' needs into a conceptual data model that is valid -ORM
- "locals as views" : each stakeholder can select the subset of interest, a subset that results in a valid -ORM conceptual data model ➔ ***the locals being views of the global, the semantic interoperability is naturally enabled !***
- the Space System Ontology inherits from decades of organizational know-hows ! however enhanced, to satisfy the overall "System" meaning multi-organizational needs

The Object Role Modelling

A global data model expressed at conceptual level using a language that is **logic-based** with associated **formal graphical and textual representations**




uniqueness ➔ **Each** physical component has **at most one** mass.


mandatory ➔ **Each** physical component has **some** mass.


combining uniqueness & mandatory ➔ **Each** physical component has **exactly one** mass.

$$\forall\, pc \in PhysicalComponent \quad \exists!\, m \in Mass \quad / \quad pc\ Has\ m$$

More? refer to http://www.orm.net/pdf/ORMsyntax-semantics.pdf

The Object Role Modelling, cont. 1

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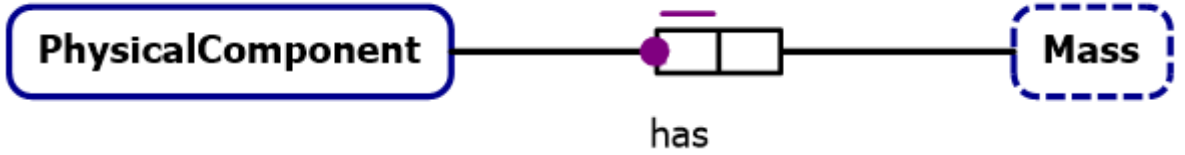
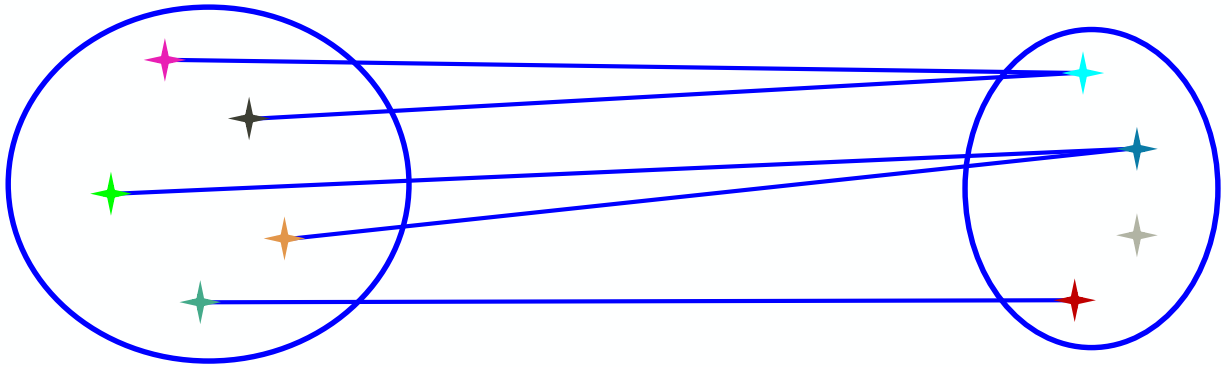
A global data model expressed at conceptual level using a language that is logic-based with associated formal graphical and textual representations



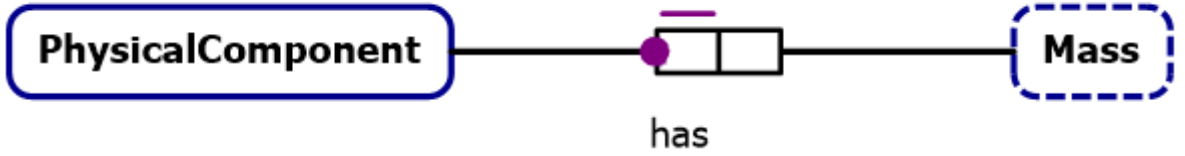
another graphical representation using an example of a possible population

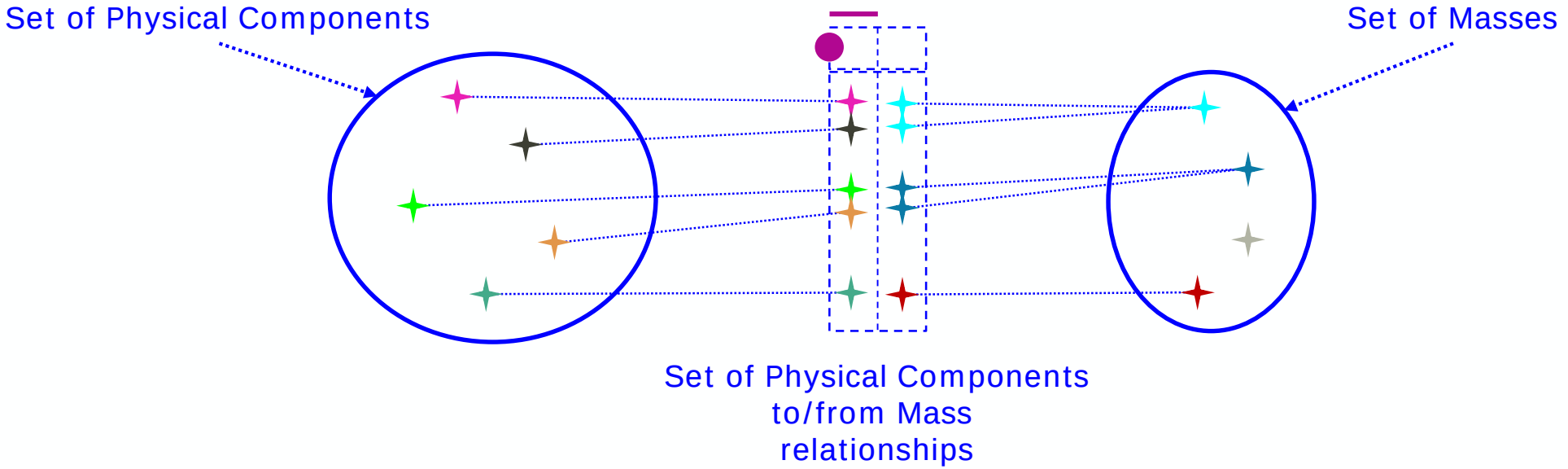


informal *but nice to use for clarification*

The Object Role Modelling, cont. 2

A global data model expressed at conceptual level using a language that is logic-based with associated formal graphical and textual representations

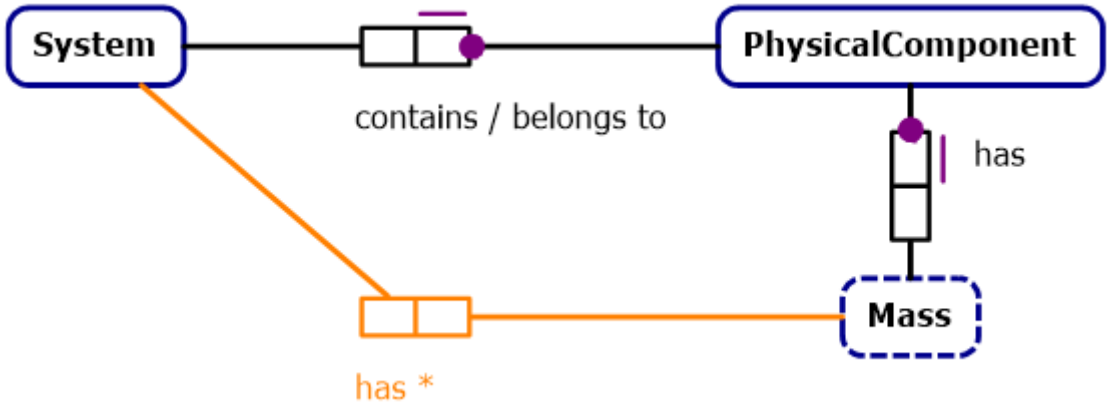




The Object Role Modelling, cont. 3

A global data model expressed at conceptual level using a language that is **logic-based** with associated **formal graphical and textual representations**

Asserted vs Derived vs Semi-Derived (asserted and derived) Fact Types



Derived fact type ➔ ***System has mass$_1$**
if and only if
that system contains **some** physical component **that** has **some** mass$_2$
where mass$_1$ **=** sum(**each** mass$_2$).

The Object Role Modelling, cont. 4

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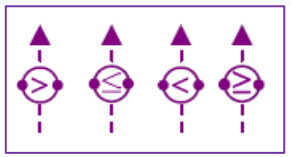
A global data model expressed at conceptual level using a language that is logic-based with associated formal graphical and textual representations

Constraint types

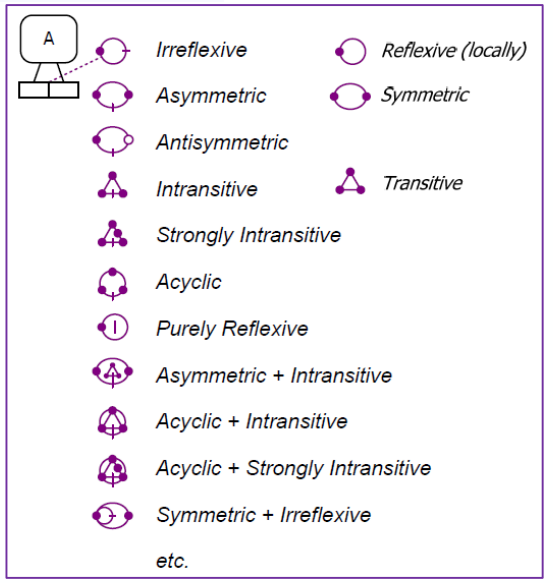
of Alethic Modality (SHALL)

- Internal Uniqueness Constraint
- External Uniqueness Constraint
- Equality Constraint
- Exclusion Constraint
- Inclusive Or Constraint
- Exclusive Or Constraint
- Subset Constraint
- Frequency Constraint

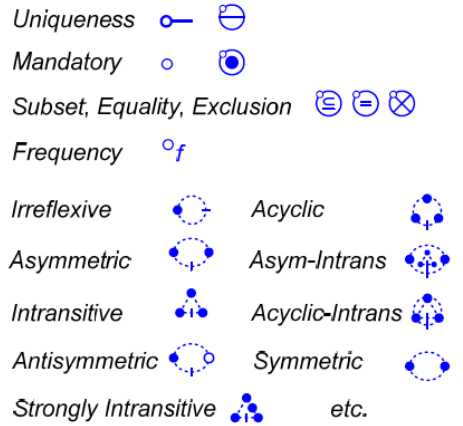
Value Comparison Constraint



Ring Constraint



of Deontic Modality (SHOULD)



The Space System Ontology, its scope

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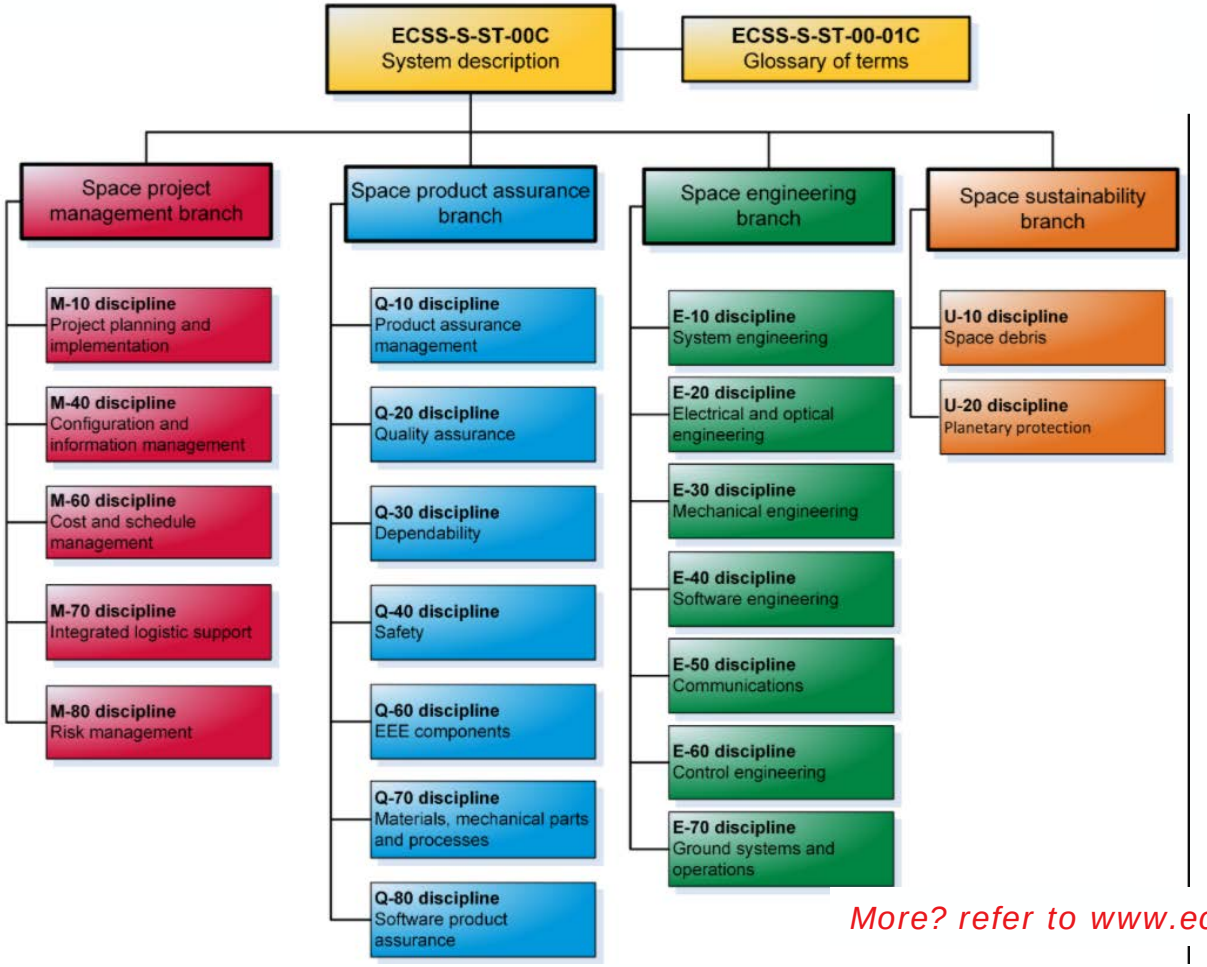
A global data model expressed at conceptual level using a language that is logic-based with associated formal graphical and textual representations covering all ECSS disciplines

applying a model based approach to the modelling of the space system information

in a long term, the Space System Ontology should cover all exchanges, meaning covering:

- all ECSS branches management, product assurance, engineering, sustainability
- all disciplines within these ECSS branches

Change requests will be issued to ensure the consistency between the Space System Ontology and ECSS



More? refer to www.ecss.nl

The Space System Ontology, working together

Working together is required !

Developing a Space System Ontology that covers all exchanges, that satisfies all stakeholders is extremely ambitious and will take years to realize.

To ease its development, the ontology is decomposed in parts, each part being subject to a development activity

The concept of “Universe of Discourse” is introduced to refer to all “things” of a part, all what needs to be conceptualized for that part.

Within an activity, conceptualizing, in ORM, a universe of discourse and applying the rules that govern the development of the Space System Ontology, the produced conceptual model has the potential to be integrated in the Space System Ontology **subject to compliance with the OSMoSE Contributor Licence Agreement and of full OSMoSE Design Authority responsibility !**

The Space System Ontology, its skeleton

The development of the Space System Ontology has been initiated

*The concept of a "**skeleton**" for the Space System Ontology is introduced to refer to a number system-related universes of discourse to develop first*

The following UoD have been considered of relevance to include in the skeleton:

- ***Requirement management** both seen from ECSS and Product development viewpoints*
- ***Missions and Operations***
- ***Functional Description** static and dynamic*
- ***Architecture/Logical Description***
- ***Physical Description***
- ***Management and Planning***
- ***Support to configuration control, change management and non-conformance control***
- *Others TBD/TBC*

*The OSMoSE Governance objective when developing that skeleton is **to provide a framework, a core that will permit to aggregate, in a consistent way, the conceptualization of the other universes of discourse***

For each UoD, the challenges are:

- *properly scope the UoD to avoid collisions during later integrations*
- *ensure that the modelling is done at the right level, i.e. the WHAT and not the HOW.*
- *ensure that the many communities interested are properly represented*
- *for each concept, each fact type, each constraint, obtain agreement & reach consensus*
- *for later integration, ensure that external interfaces (between UoDs) are properly identified*

The Space System Ontology, its skeleton, cont.

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Some Universes of Discourse related to the Skeleton are under development

Conceptualizing the Requirement Management seen by ECSS Universe of Discourse

Inputs come from:

- ***Lessons learned from Agencies and Large Spacecraft Integrators***
- ***Existing standards such as ReqIF, ECSS-E-ST-10-06***
- ***Tools such as Doors, DoorsNG, Polarion, Visure, Laces, The Reuse Company, JAMA***

See 09:40 – 10:10 ECSS Master Database

Conceptualizing the MBSE Universes of Discourse :

- ***Missions and Operations***
- ***Functional Description static and dynamic***
- ***Architecture/Logical Description***
- ***Physical Description***

Inputs come from:

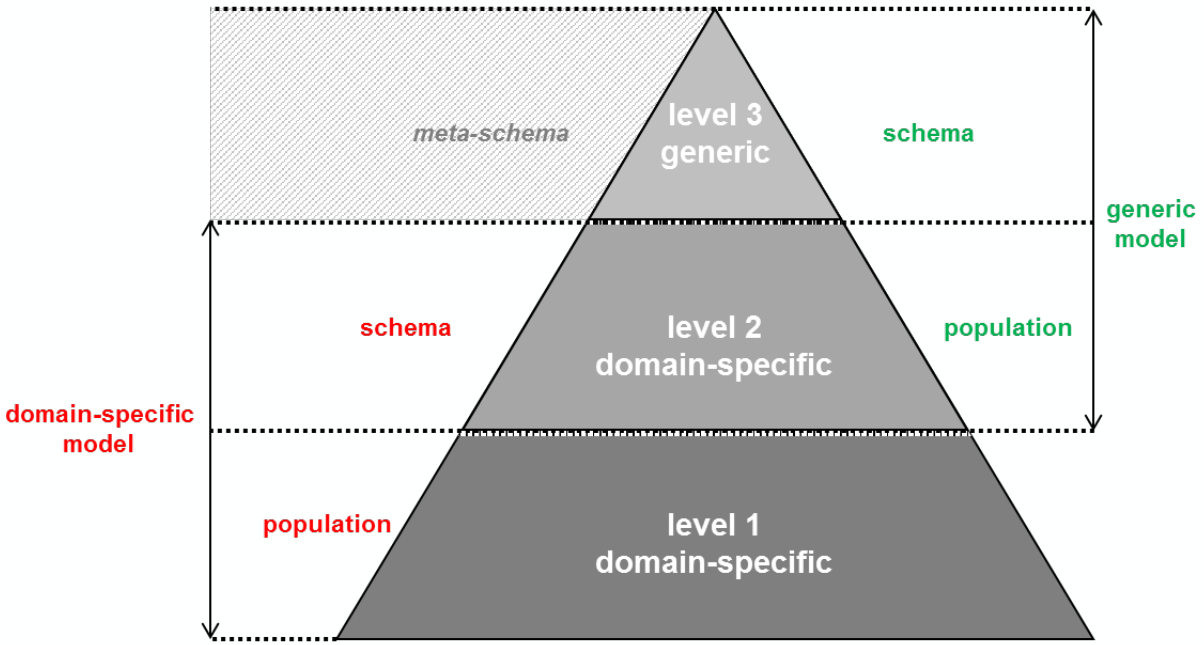
- ***Lessons learned from Agencies and Large Spacecraft Integrators***
- ***Existing standards such as ECSS-E-ST-10, SysML , ITU MSC, ITU SDL***
- ***Tools such as Capella, SECAM, TASTE***

See 10:25 to 11:25 Conceptualizing MBSE parts 1 & 2

Information Modelling, Terms & Definitions

information → statement of fact or belief

data → representation of the *information* in compliance with a *logical schema* and a *physical schema* used for its preservation within a *data repository*



model → combination of a *schema* and a *population*

schema → structure that determines the regulations for a *universe of discourse*

population → data captured according to a *schema* organization during the overall life-cycle of the related *data repository*

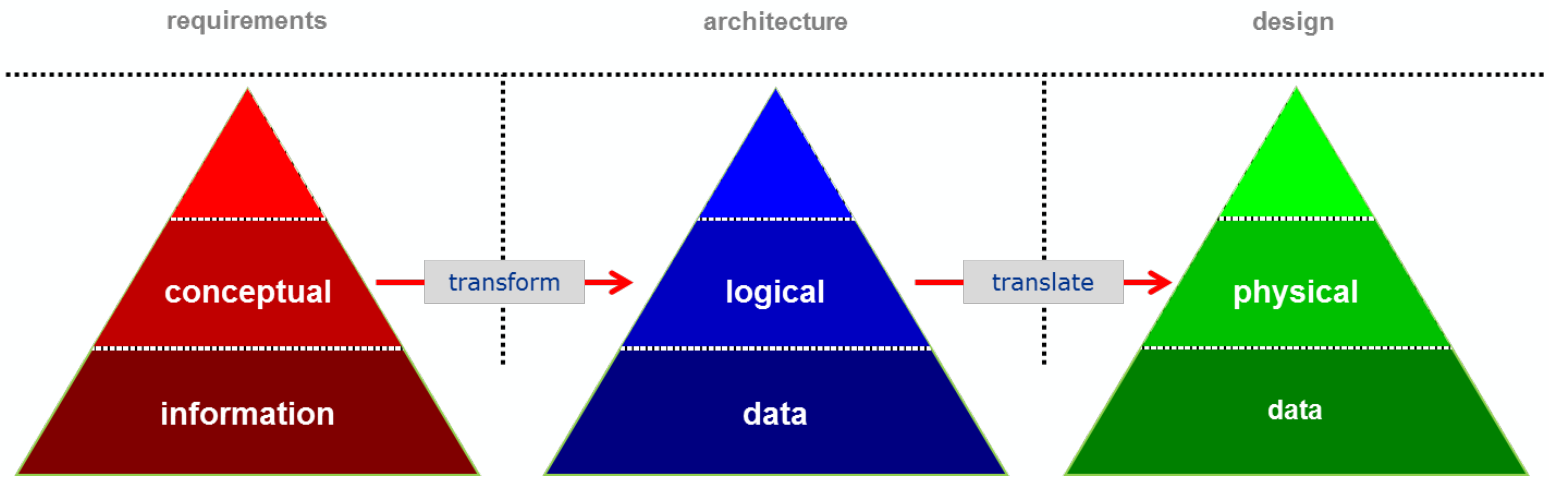
domain-specific model → *model* that corresponds to the "Business"

generic model → *model* that corresponds to one of the many languages used to specify a *domain specific model*

universe of discourse → *aspects of the world that the related community wishes to talk about, is concerned about*

data repository → *data storage entity or entities into which data has been partitioned*

Information Modelling, Conceptual / Logical / Physical

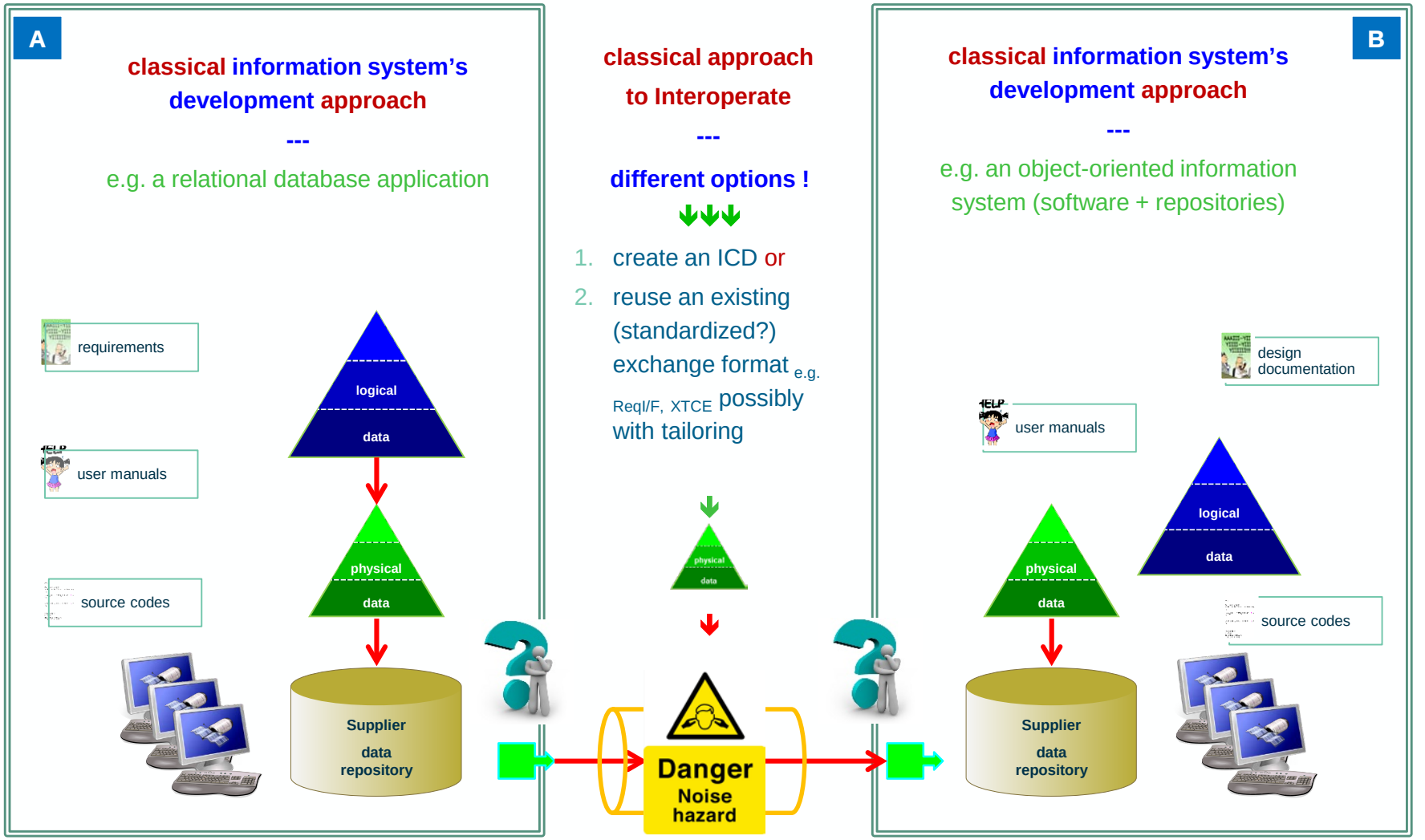


conceptual modelling language → language used during the requirements engineering process to express the semantics and to specify what information needs to be managed

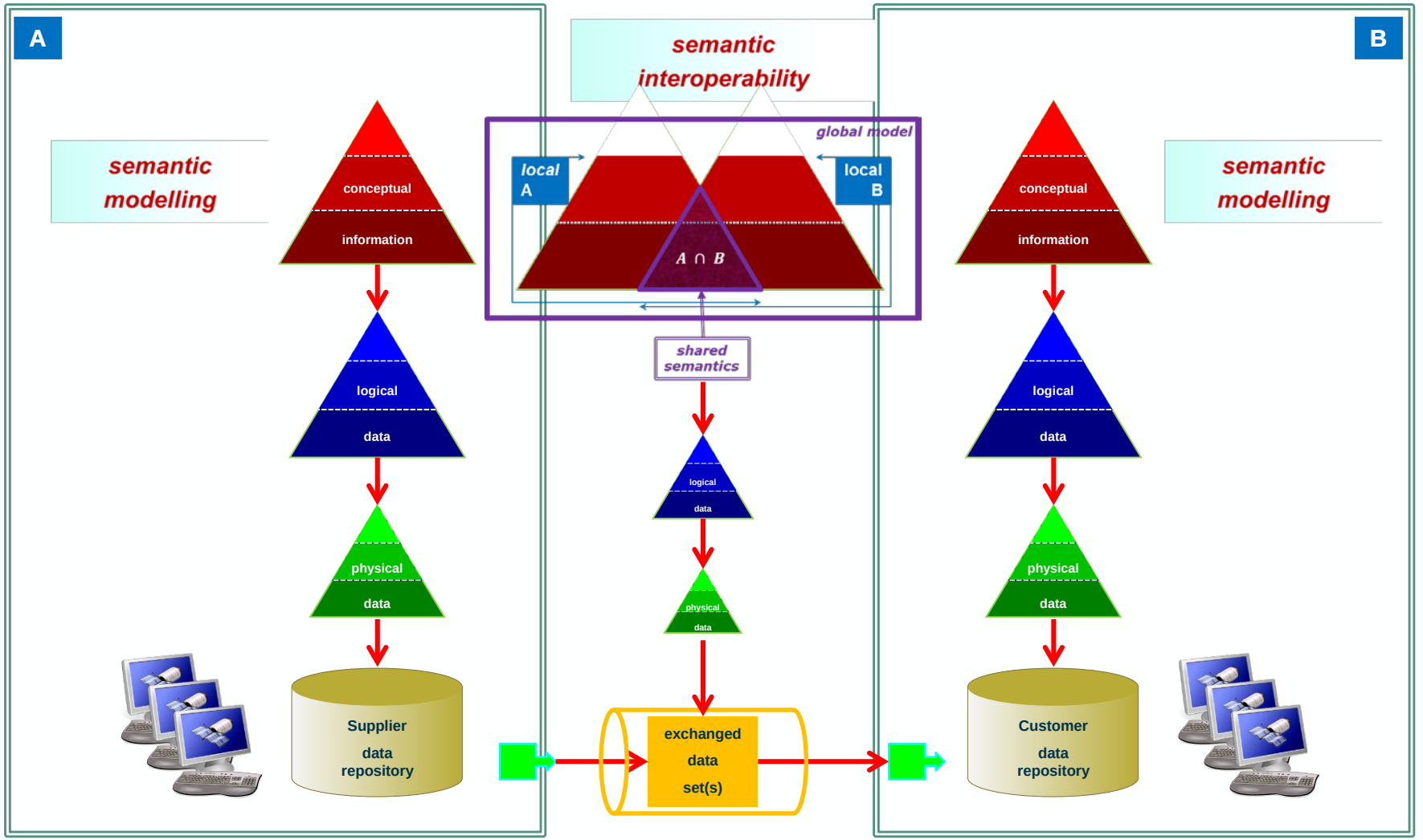
→ *when modelling is applied to the development of information systems (Databases) or means to exchanges (ICDs)*

- **logical modelling language** → language used **during the architecture engineering process** to represent how the required information is to be structured from a functional and technological viewpoint to satisfy the information system's performance requirements
- **physical modelling language** → language used **during the design engineering process** to translate the architectural models in the data definition languages exposed by the tools used to produce the data repositories required by the information system

Exchanging, current practices



Semantic Modelling & Semantic Interoperability



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The Space System Ontology ➔ Questions & Answers