29th Annual INCOSE international symposium

Orlando, FL, USA

July 20 - 25, 2019

Approach to structure, formalize and map MBSE meta-models and semantic rules.

Jean Duprez, Airbus Operations SAS - Paper 51

AIRBUS

Models are key components of most advanced methods and tools, **dealing with many different disciplines** and addressing most of systems engineering **processes** and **domain specific needs.**

As a result,

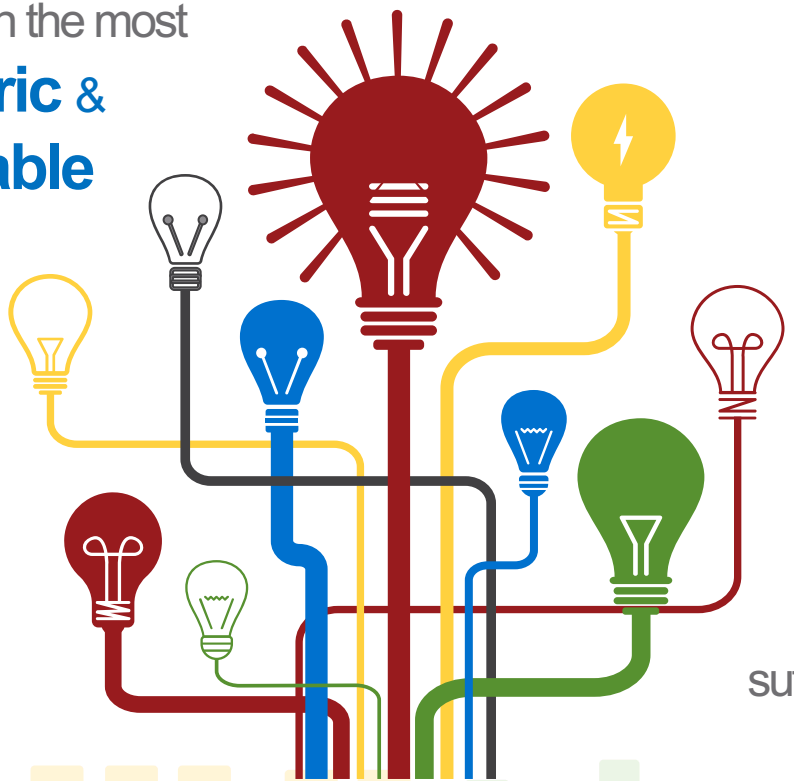
- **large variety** of modeling **tools**
- many different **diagrams & model types**
- many **domain specific languages & features**

Consistency of all the information across the different models & diagrams **need to be fully ensured.**

Refer to what models represent: the System.

Building a semantic reference.

Build it in the most **generic & reusable** way.



Use it as a **pivot for interoperability**, models exchanges, transformation and synchronization.

Use it as **semantic reference to ensure** models **consistency** and sufficient **completeness**.

What are we talking about?
➔ **Models**

Scope of interest?
➔ **Systems**

Model **B**ased **S**ystems **E**ngineering

Goal we address?
➔ **Engineering**

3dman_eu (pixabay.com)

Model (ARP4754a/ED-79A, 2.2)

An **abstract representation** of a given set **of aspects of a system/function/item** that is **used for analysis, simulation and/or code generation** and that **has** an unambiguous, well defined **syntax and semantics**.

Model

An **abstract representation** of a given set **of aspects of a subject**, **used to address** given **concerns**, **following structured semantics**.

Scope of interest?
➔ **Systems**

Approach: Based on structured semantics
➔ **Ontology**

Goal we address?
➔ **Engineering**

Model

Subject → **Abstract Concepts** → **Representations**

Model

An **abstract representation** of a given set **of aspects of a subject**,
used to address given **concerns**,
following structured semantics.

Elicit **structuring rules** & **common patterns**

Allows to:

- identify similarities → **Promote generic approaches**
- generalize principles to other concepts with same recognized structure → **Promote reusability**

Model: **Subject** → **Abstract Concepts** → **Representations**

Model

An **abstract representation** of a given set **of aspects of a subject**, **used to address** given **concerns**, **following structured semantics**.

To support collaborative work & models **configuration management**

To allow models **analysis & simulation**

To **ease** models **editing &** improve **visualization**

To **ease models exchanges & transformation**

To **reduce ambiguity** thanks to the use of a structured formal language

Digitally formalized

Model

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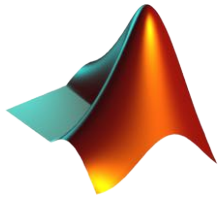

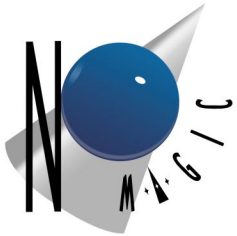

How to model:

- Tools
- Tools language
- Meta-Models

Model

Subject → **Abstract Concepts** → **Representations** → **Data**

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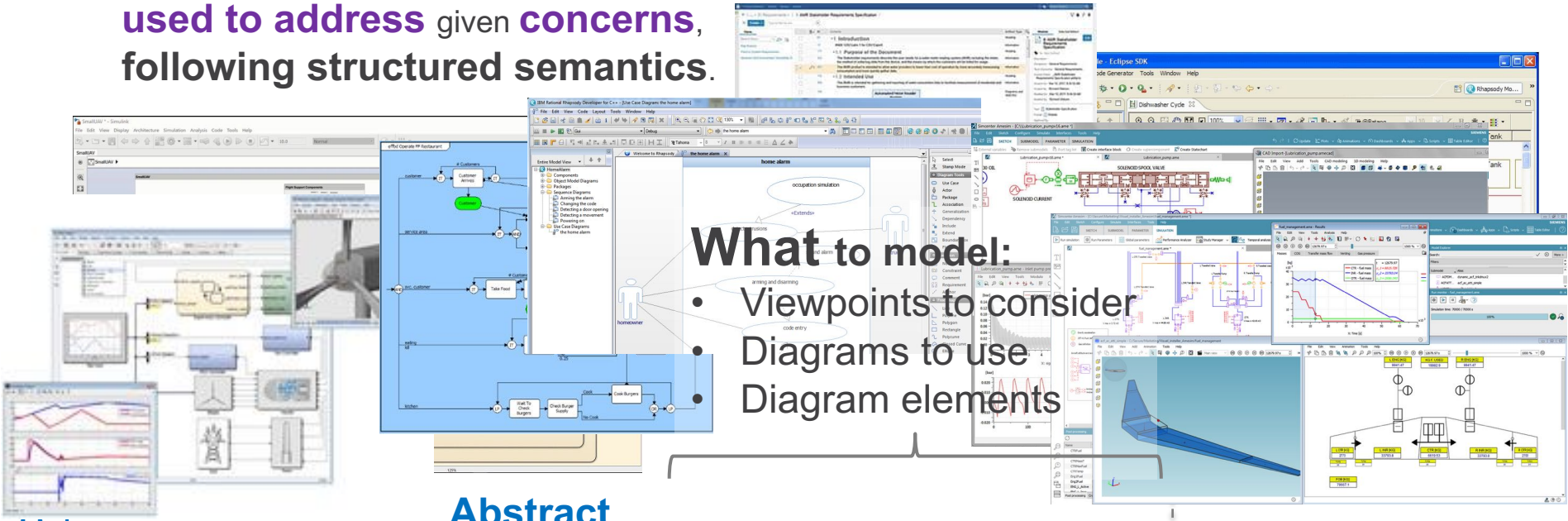

What to model:

- Viewpoints to consider
- Diagrams to use
- Diagram elements

Mod

Subject → **Abstract Concepts** → **Representations** → **Data**

Model

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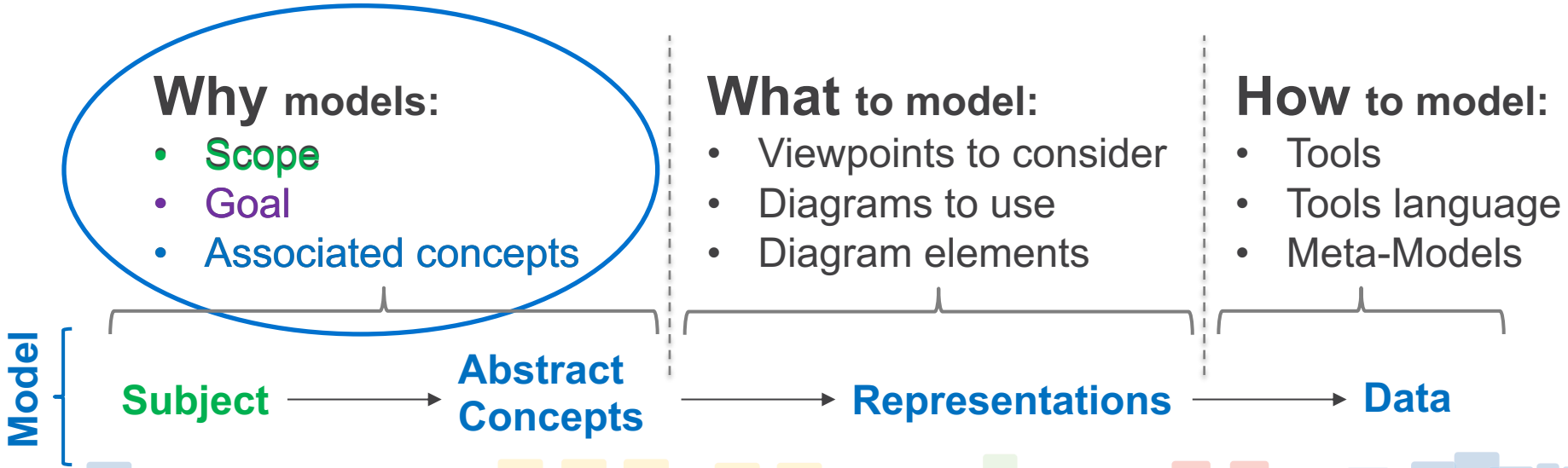

Model

An **abstract representation** of a given set **of aspects of a subject**, **used to address** given **concerns**, **following structured semantics**.

System (ISO/IEC/IEEE 15288)

A **combination** of **interacting elements** organized **to achieve** one or more stated **purposes**.

Model

An **abstract representation** of a given set **of aspects of:** **used to address** given **concerns**, **following structured semantics**.

- **a combination of elements**
- **interacting**
- **to achieve one or more stated purposes**

Model

An **abstract representation** of a given set **of aspects of:** **used to address** given **concerns**, **following structured semantics**.

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Goal

- Describe system architecture

Model

An **abstract representation** of a given set **of aspects of:**
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- **a combination of elements**
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Goal

- Describe system architecture
- Capture what the system shall do
  - What is the need the system shall answer?
  - What the system is expected to do? (to answer this need)

Model

An **abstract representation** of a given set **of aspects of:**
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- **a combination of elements**
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Goal

- Describe system architecture
- Capture what the system shall do
- Capture the system behavior

Model

An **abstract representation** of a given set **of aspects of:**

- **a combination of elements**
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- **to achieve one or more stated purposes**

used to address given **concerns**,
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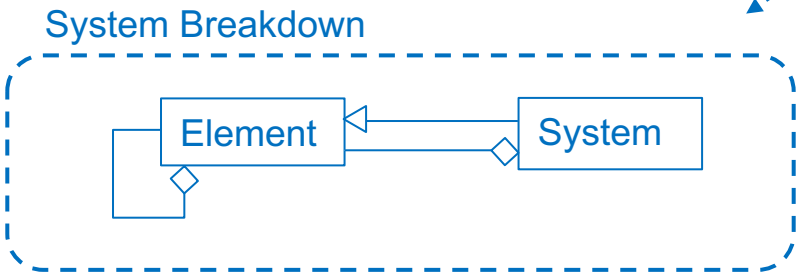

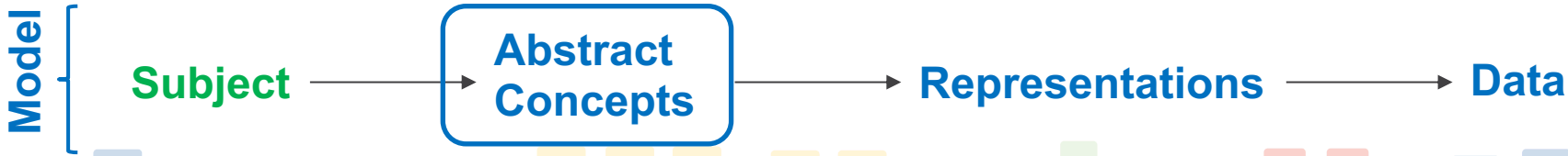

Model

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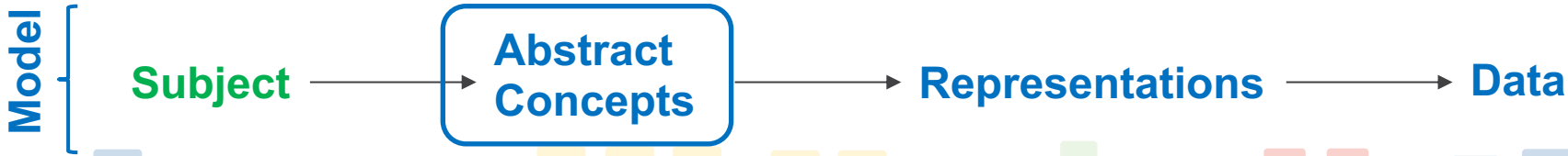
Interface (INCOSE SECF v1 2018)

A **point where** two or more **entities interact.**



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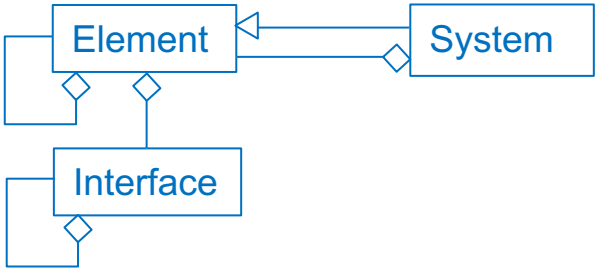
System Architecture



Model

Subject → **Abstract Concepts** → **Representations** → **Data**

Model

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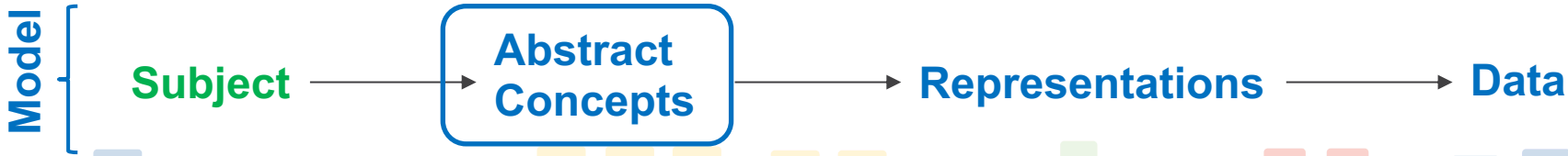
Capability (INCOSE Systems Engineering Handbook)
"Ability to achieve a specific objective under stated conditions".



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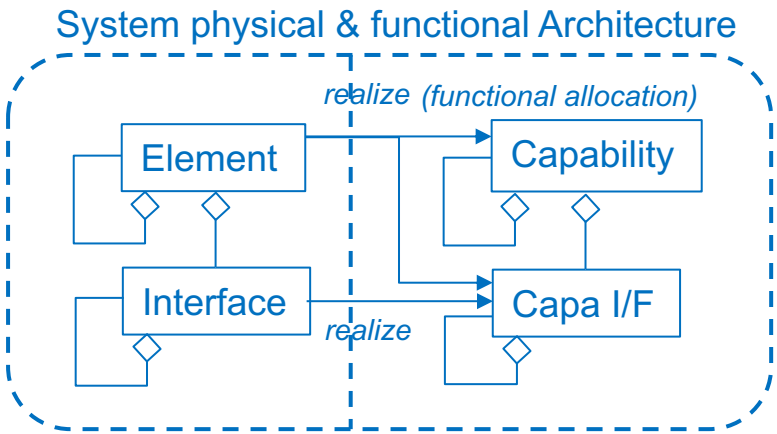

Structural representation of the system ("Static").

Model

Subject → **Abstract Concepts** → **Representations** → **Data**

Model

An **abstract representation** of a given set **of aspects of:**
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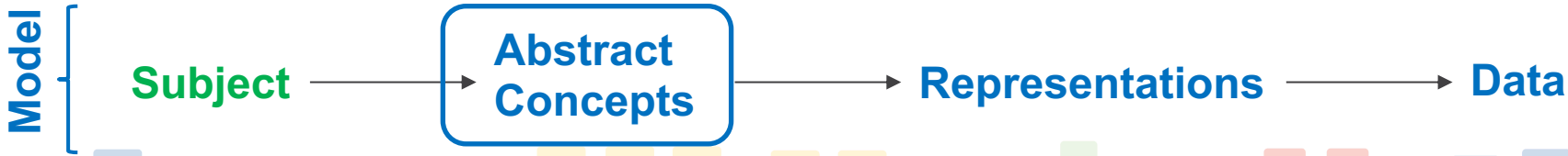
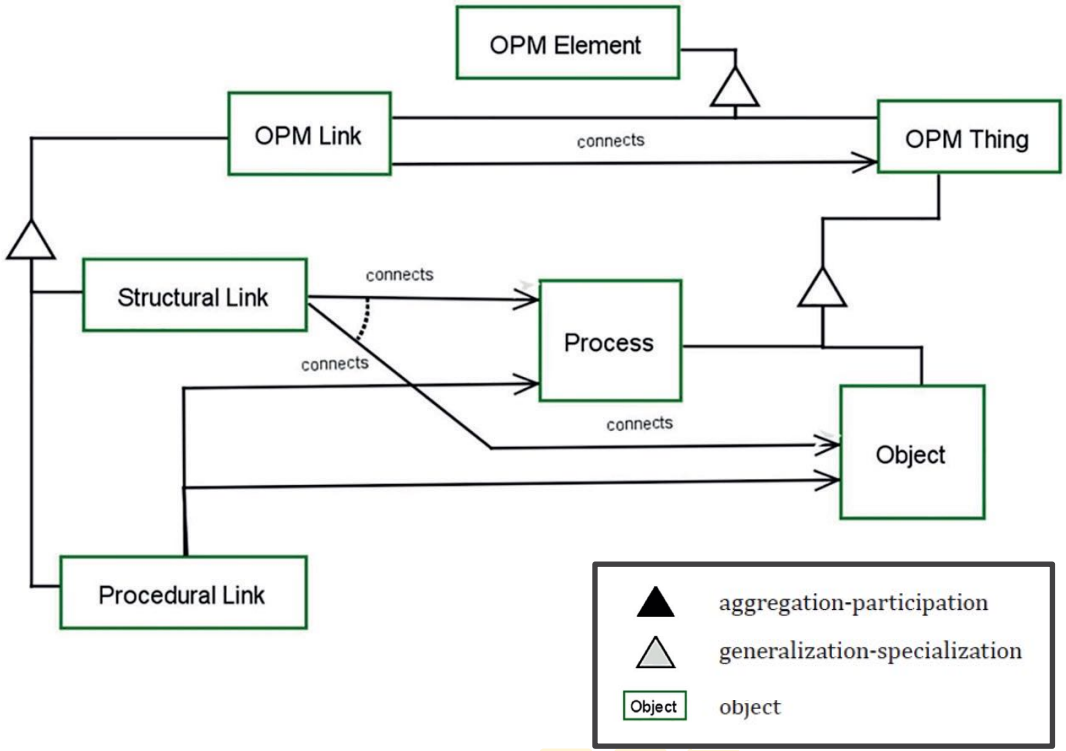
Procedural representation of the system ("Dynamic").



The **OPM** (Object-Process Methodology) - *ISO 19450*

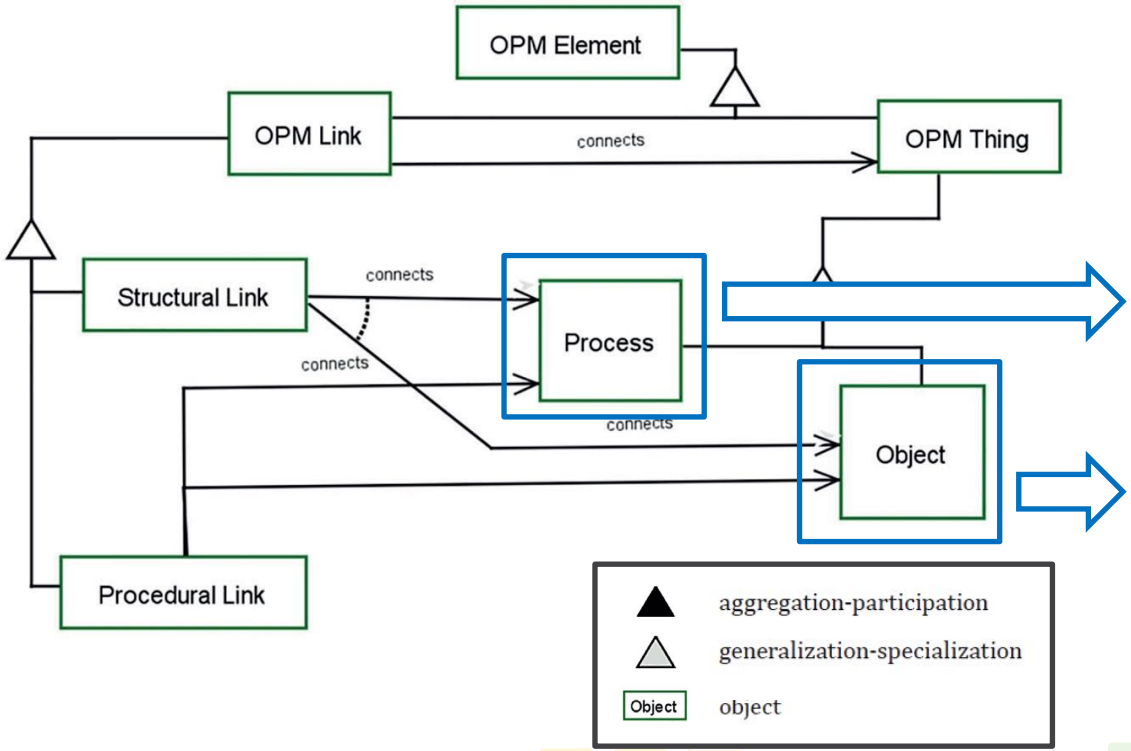


An **OPM object** is an abstract category identifier for a **pattern of structure**, properties and features.

A process transforms one or more object.

An **object exists** while a **process happens** to one or more objects.

The **OPM** (Object-Process Methodology) - *ISO 19450*



Procedural representation of the system (“Dynamic”).

Structural representation of the system (“Static”).

Model

An **abstract representation** of a given set **of aspects of:**
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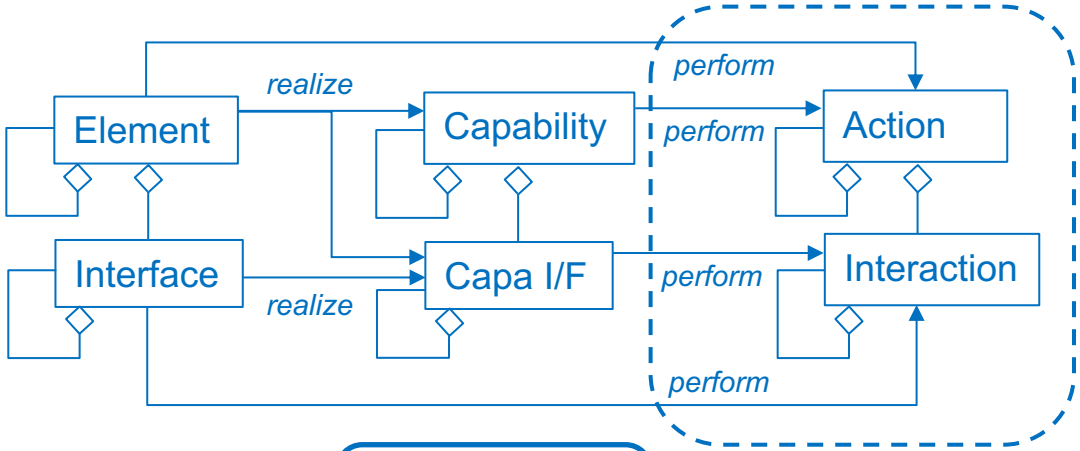


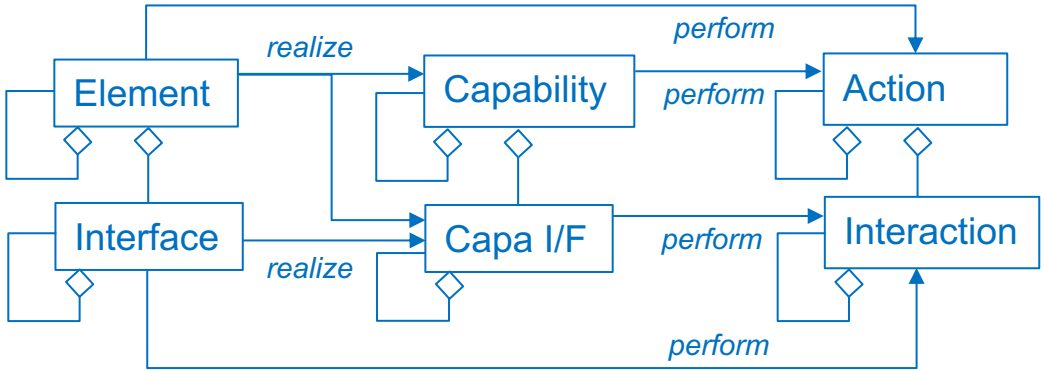
System procedural representation

Model

Subject → **Abstract Concepts** → **Representations** → **Data**

6 main Concepts
4 main structuring Patterns

- Decomposition
- Functional allocation
- Behavior description
- Interfacing

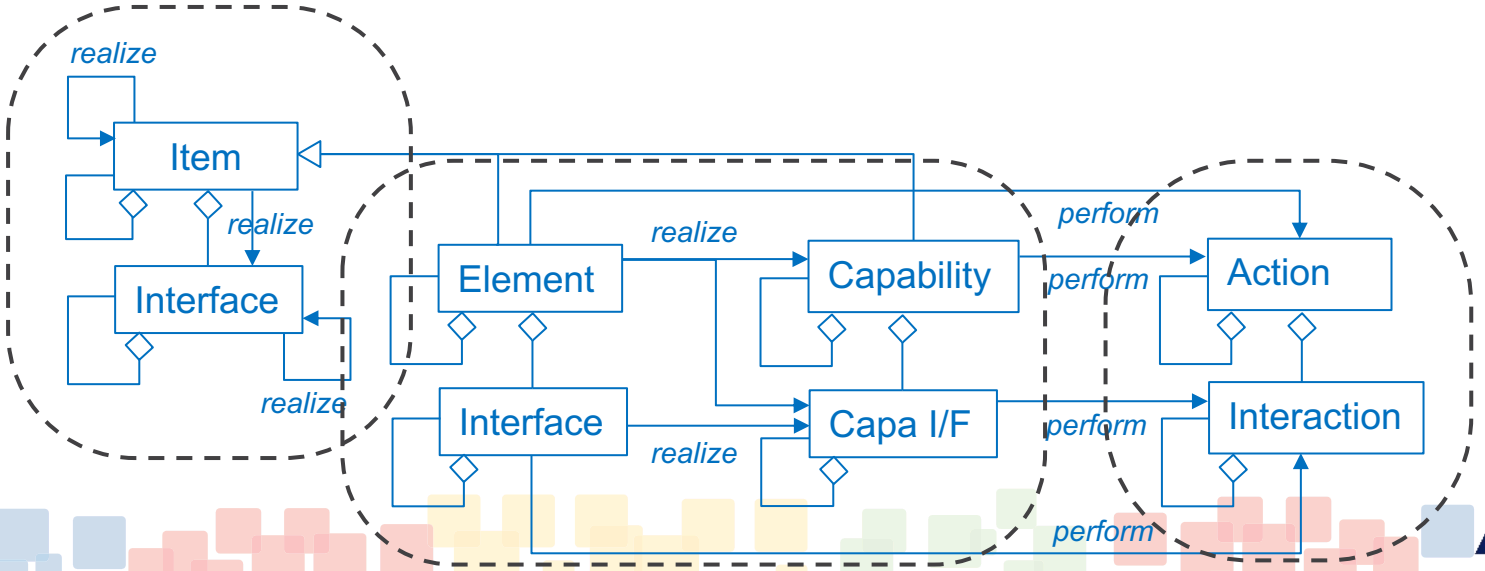


Model

Subject → Abstract Concepts → Representations → Data

2 Generic constructs

- Generic **structural** architecture construct
- Generic **procedural** architecture construct



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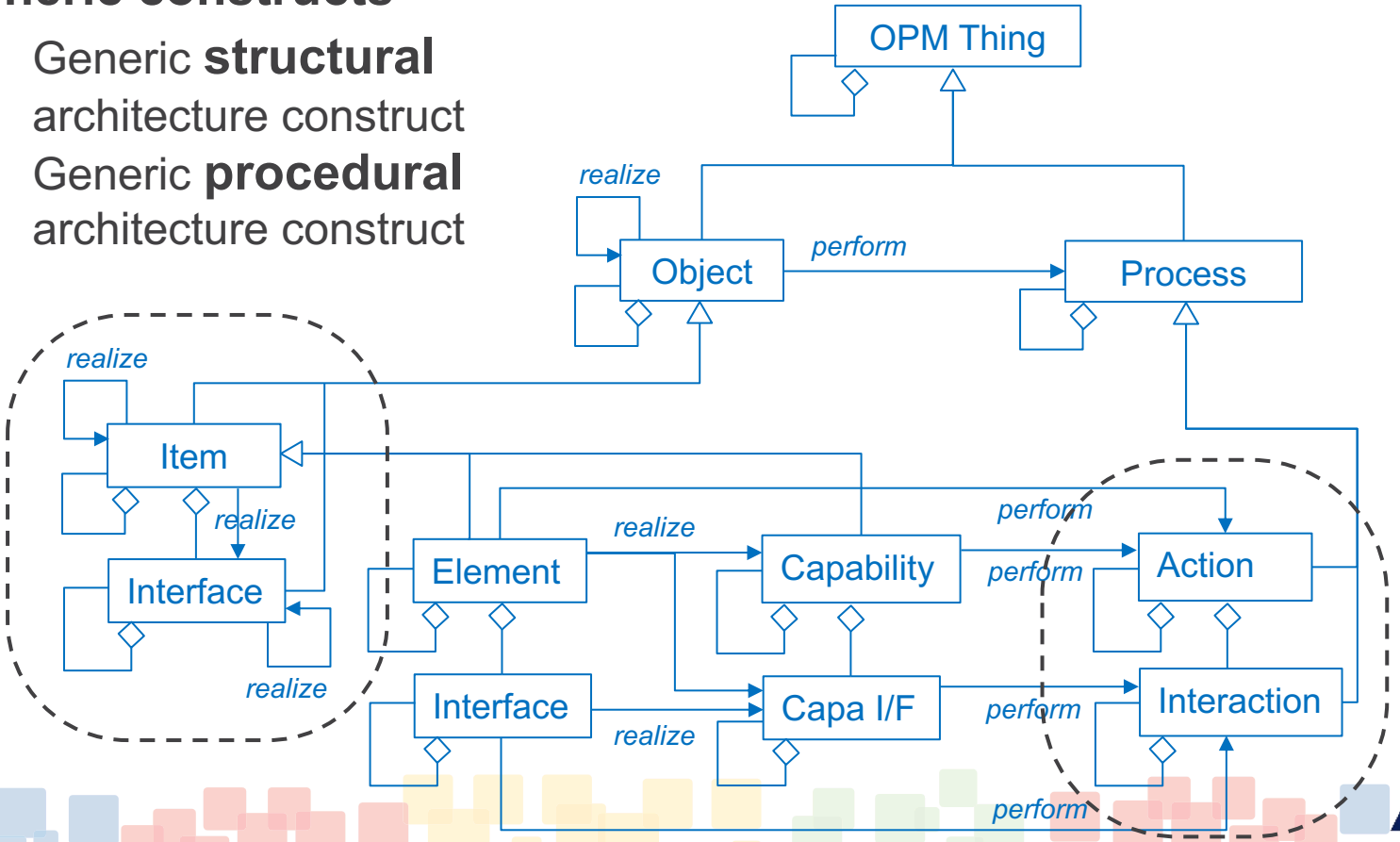
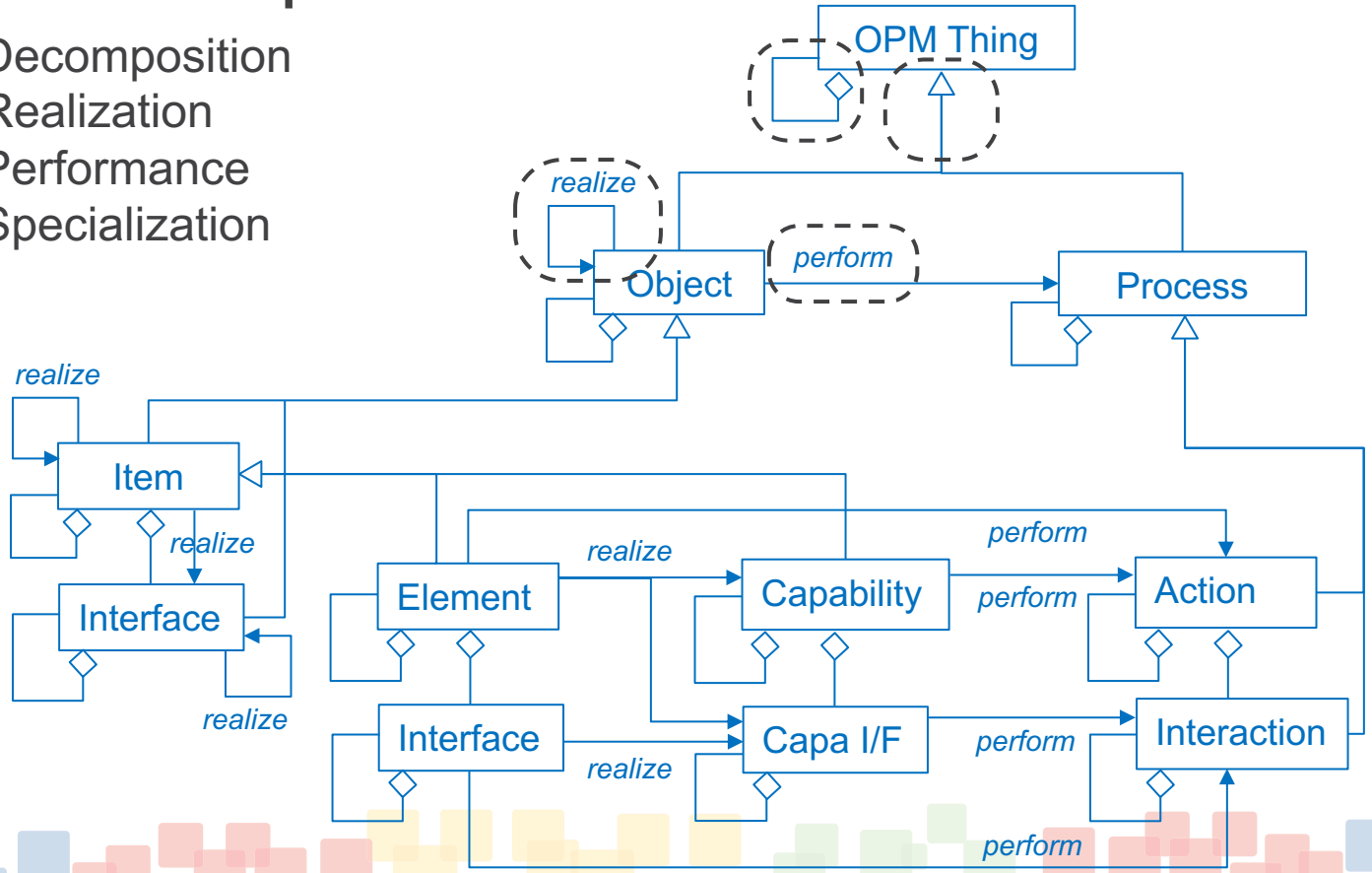


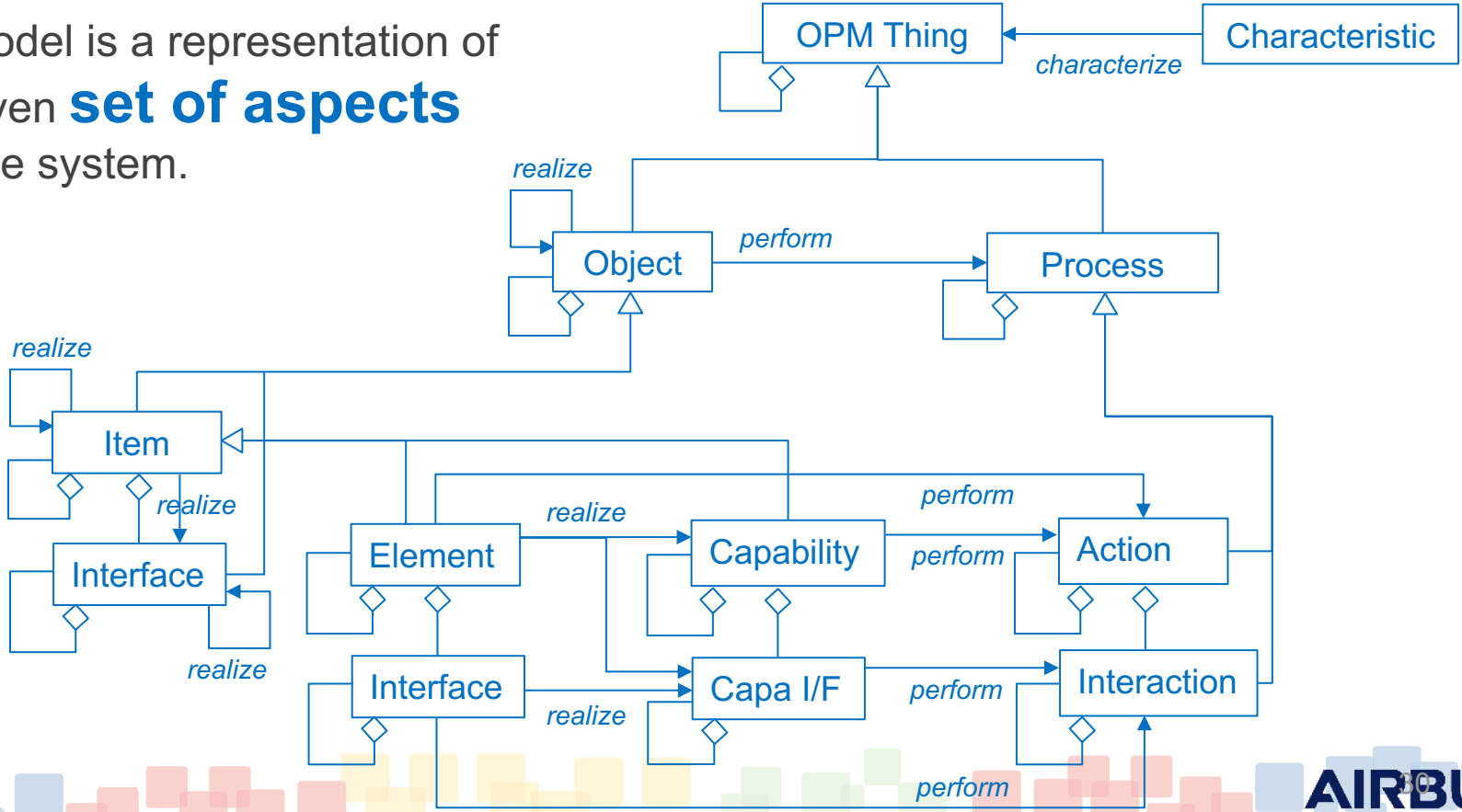
4 main relationships

- Decomposition
- Realization
- Performance
- Specialization



In addition:

A model is a representation of a given **set of aspects** of the system.



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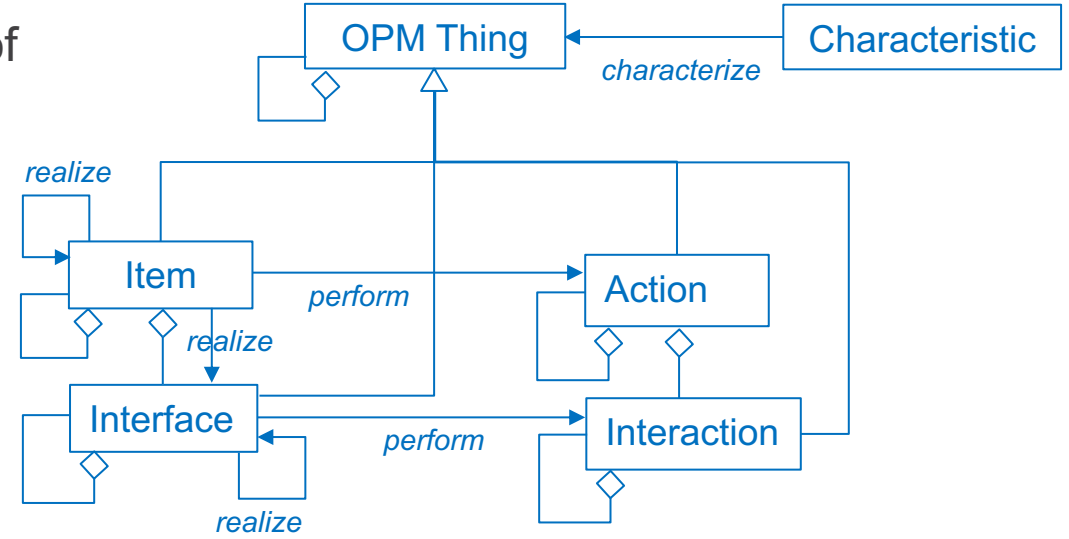
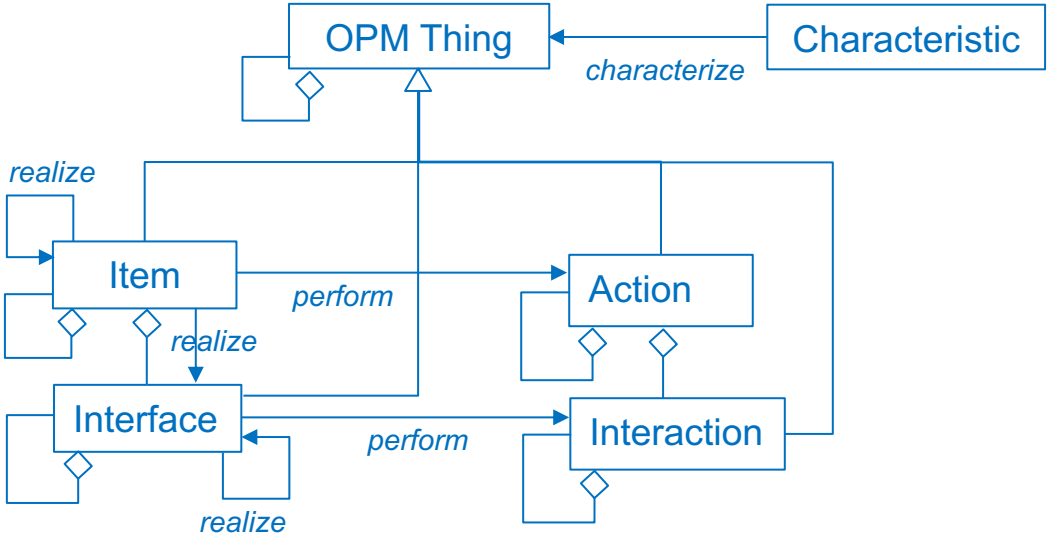


How concepts are represented in models



Model

Subject → Abstract Concepts → Representations → Data

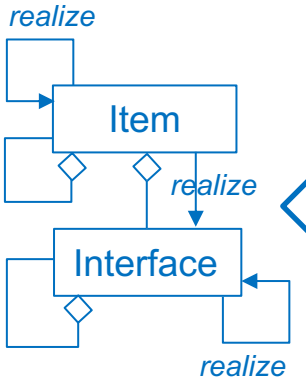
Let's **focus** on the
structural architecture
construct

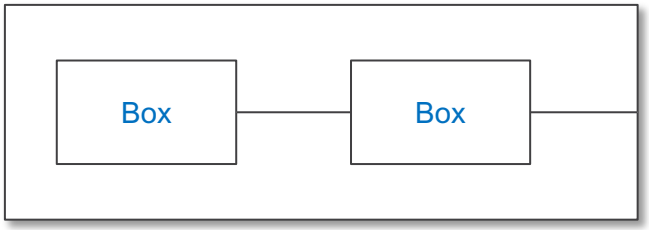
Architecture
description

"Box & Pipes"
diagrams

Decomposition
representation

Interfaces
representation





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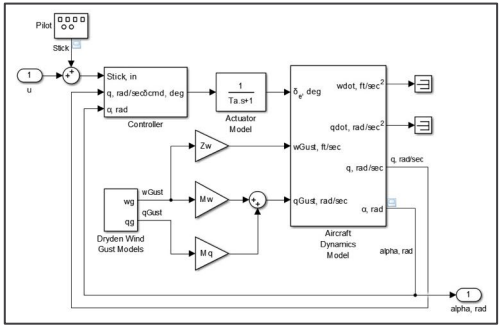
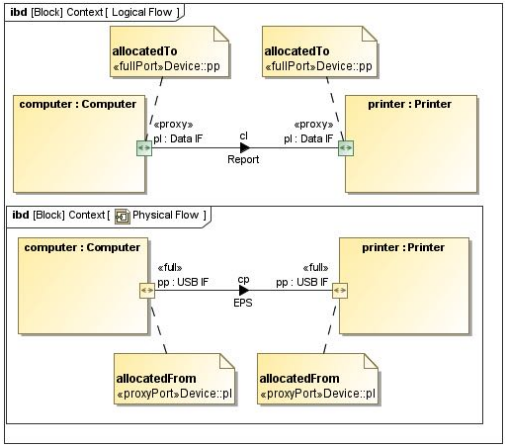
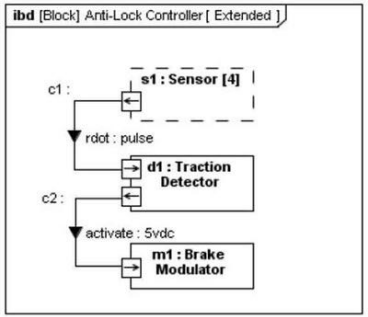
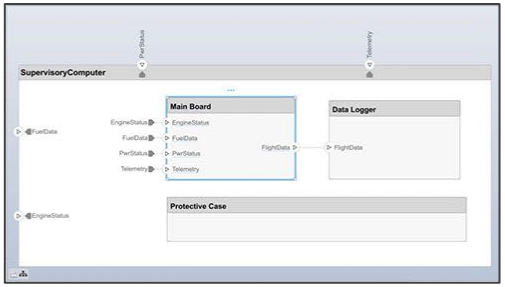
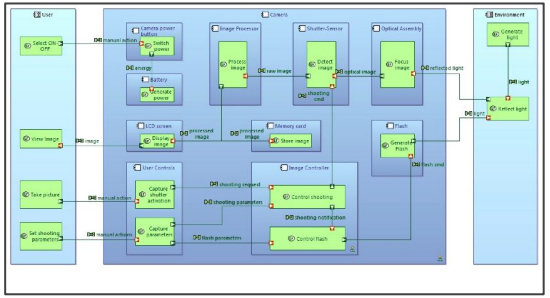
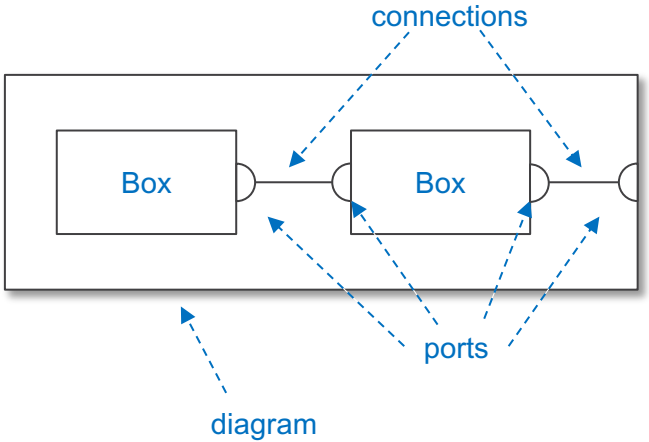












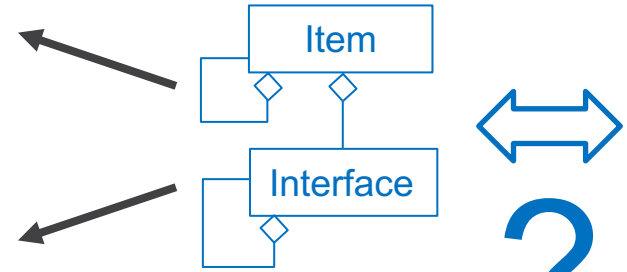
Model

Subject → Abstract Concepts → Representations → Data

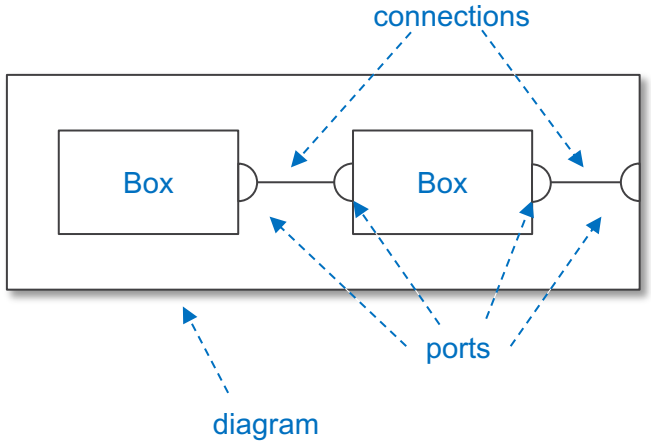
What does each architecture description element represent ?

Decomposition representation

Interfaces representation



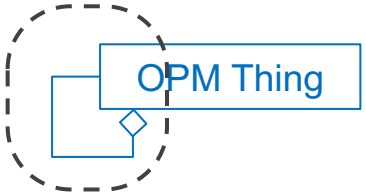
?

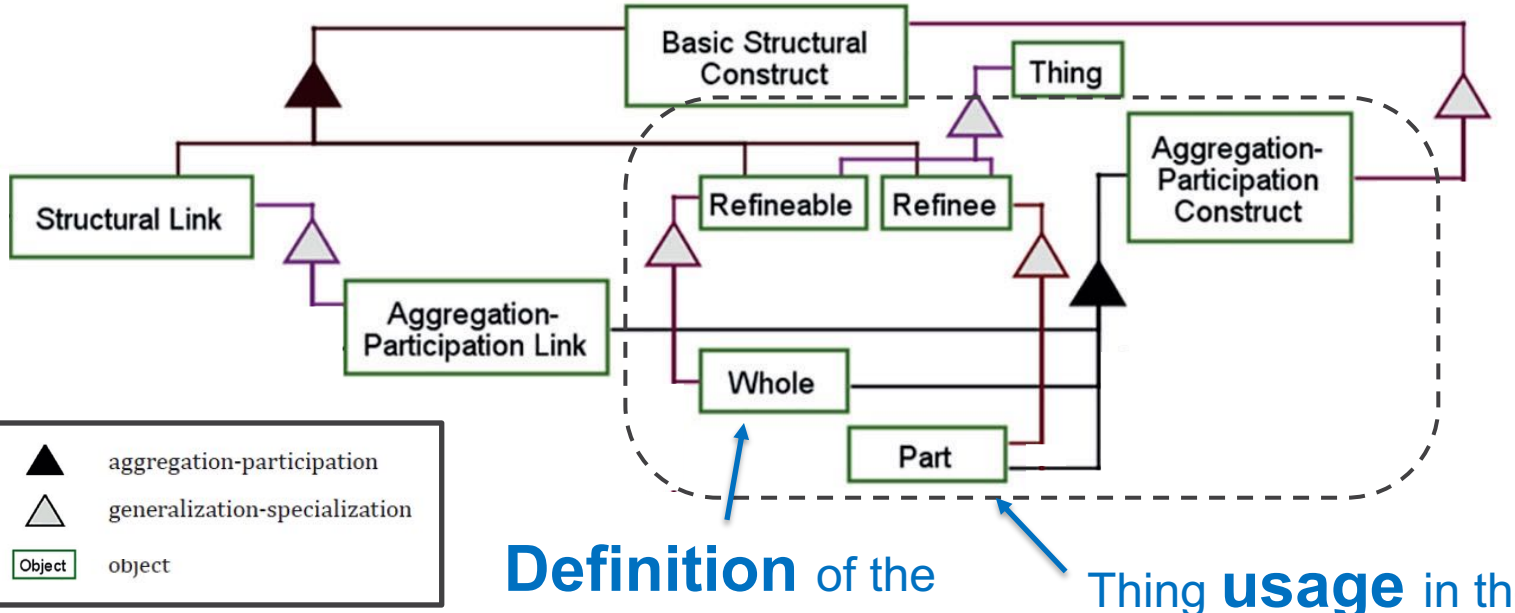


Model

Subject → Abstract Concepts → Representations → Data

Decomposition pattern

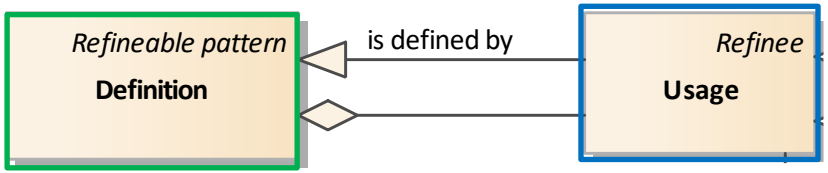


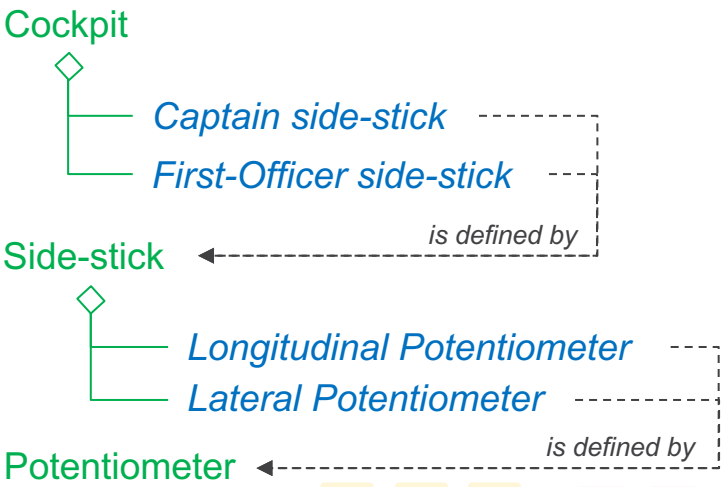


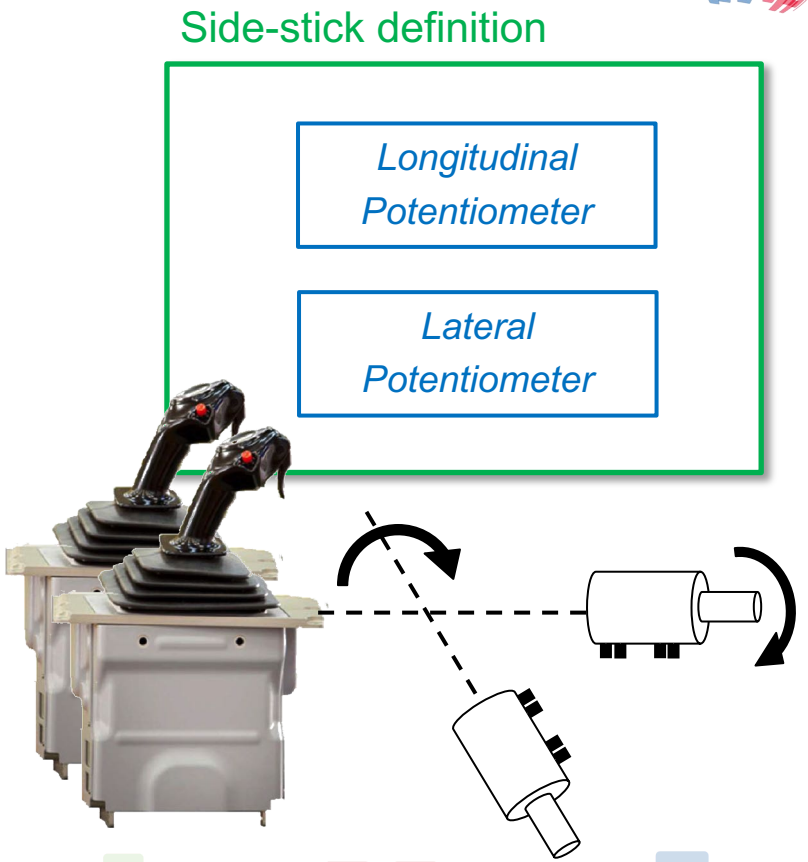
Definition of the thing decomposition

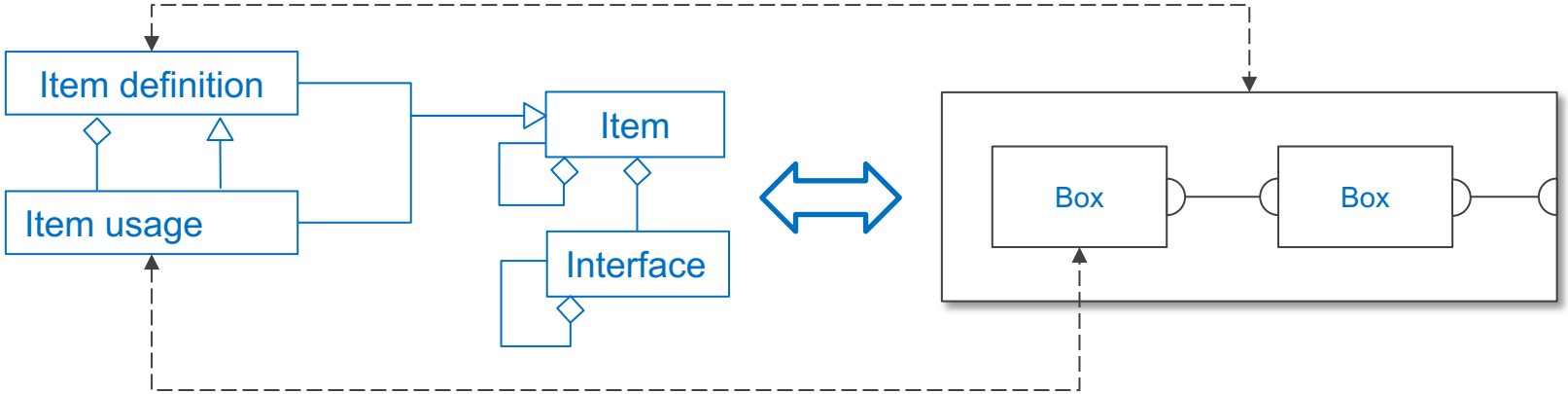
Thing **usage** in the frame of a parent thing decomposition

Example of decomposition





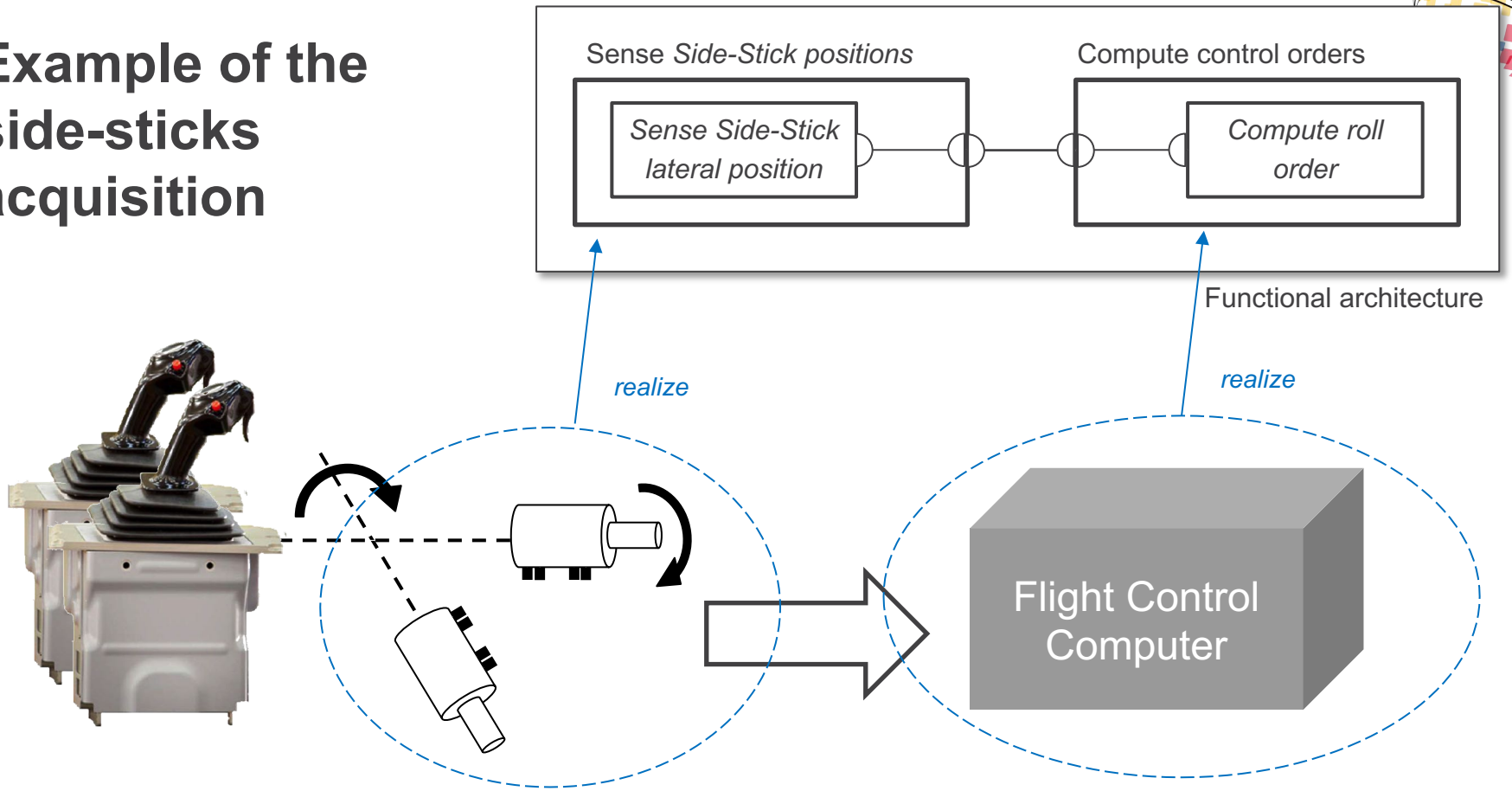




Model

Subject → Abstract Concepts → Representations → Data

Example of the side-sticks acquisition



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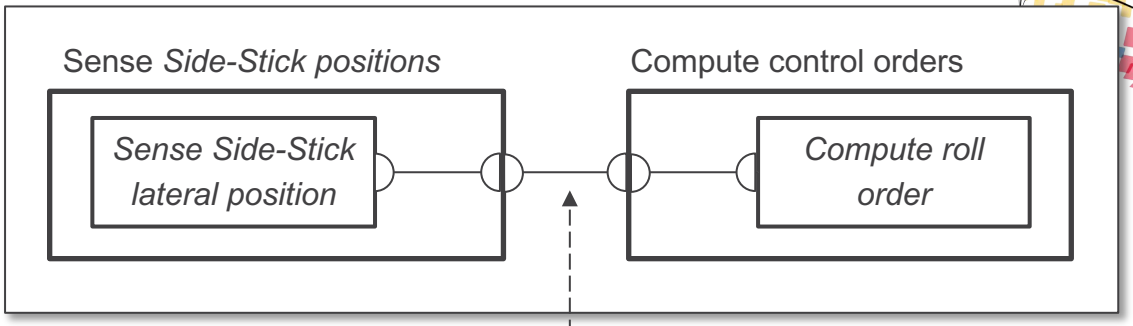
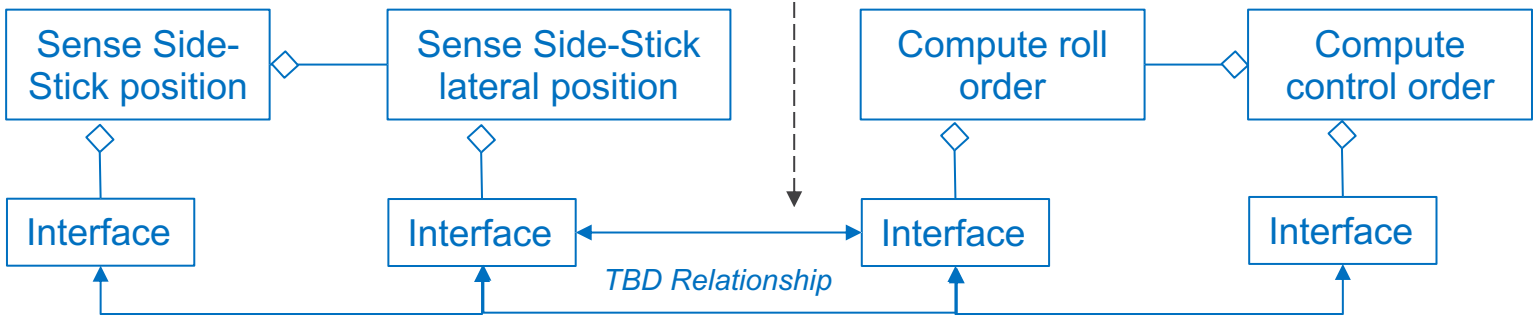


Same interface is shared.

What do the connections mean?



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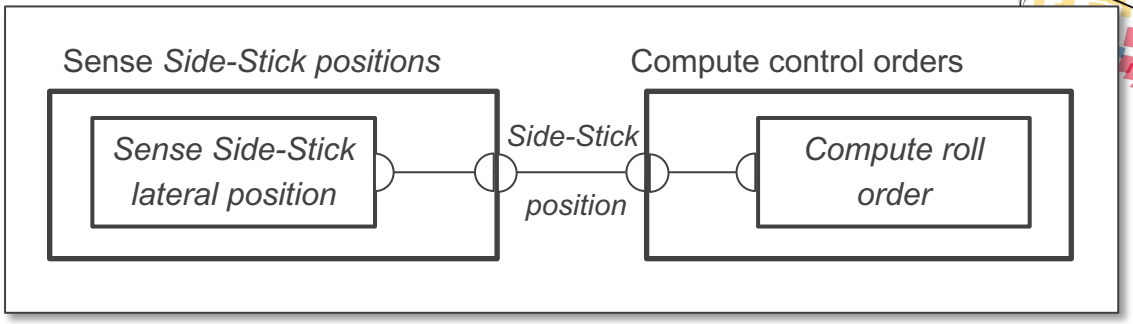
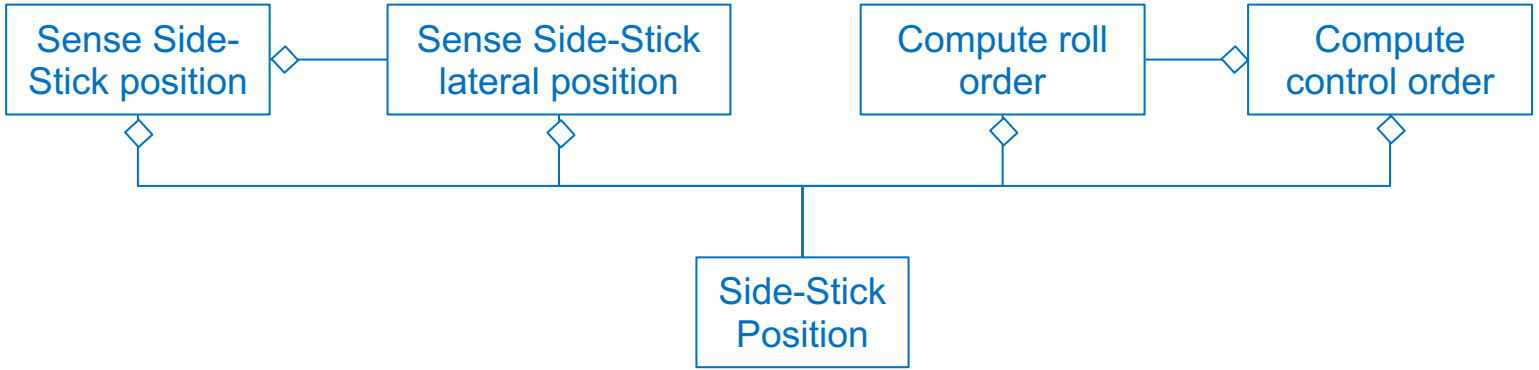
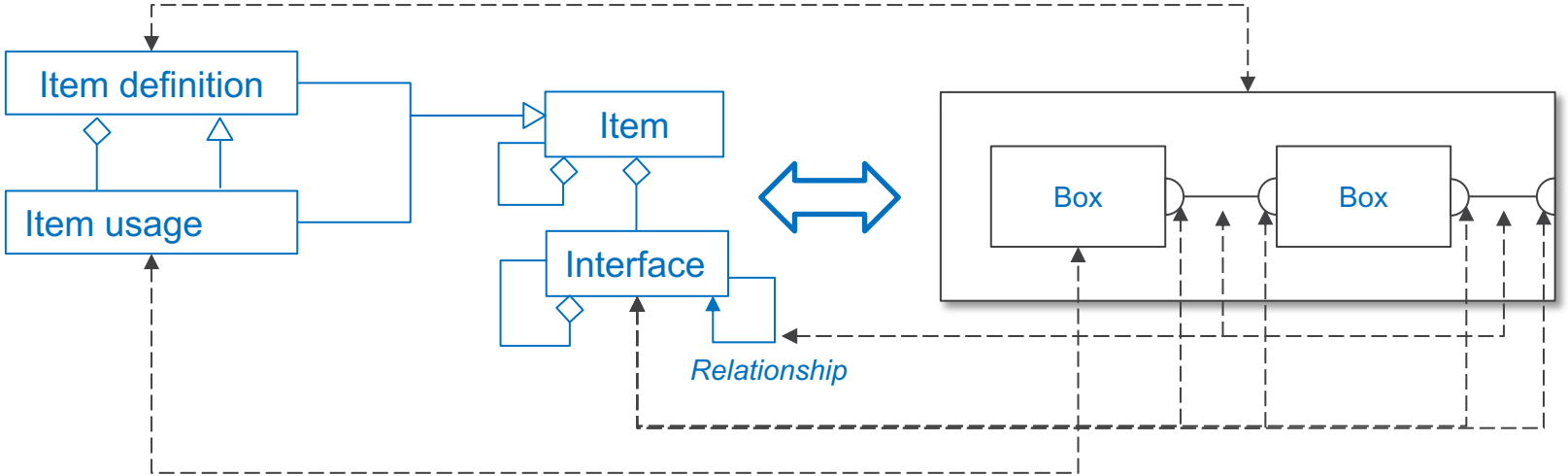


Functional architecture

Same interface is shared.





Model

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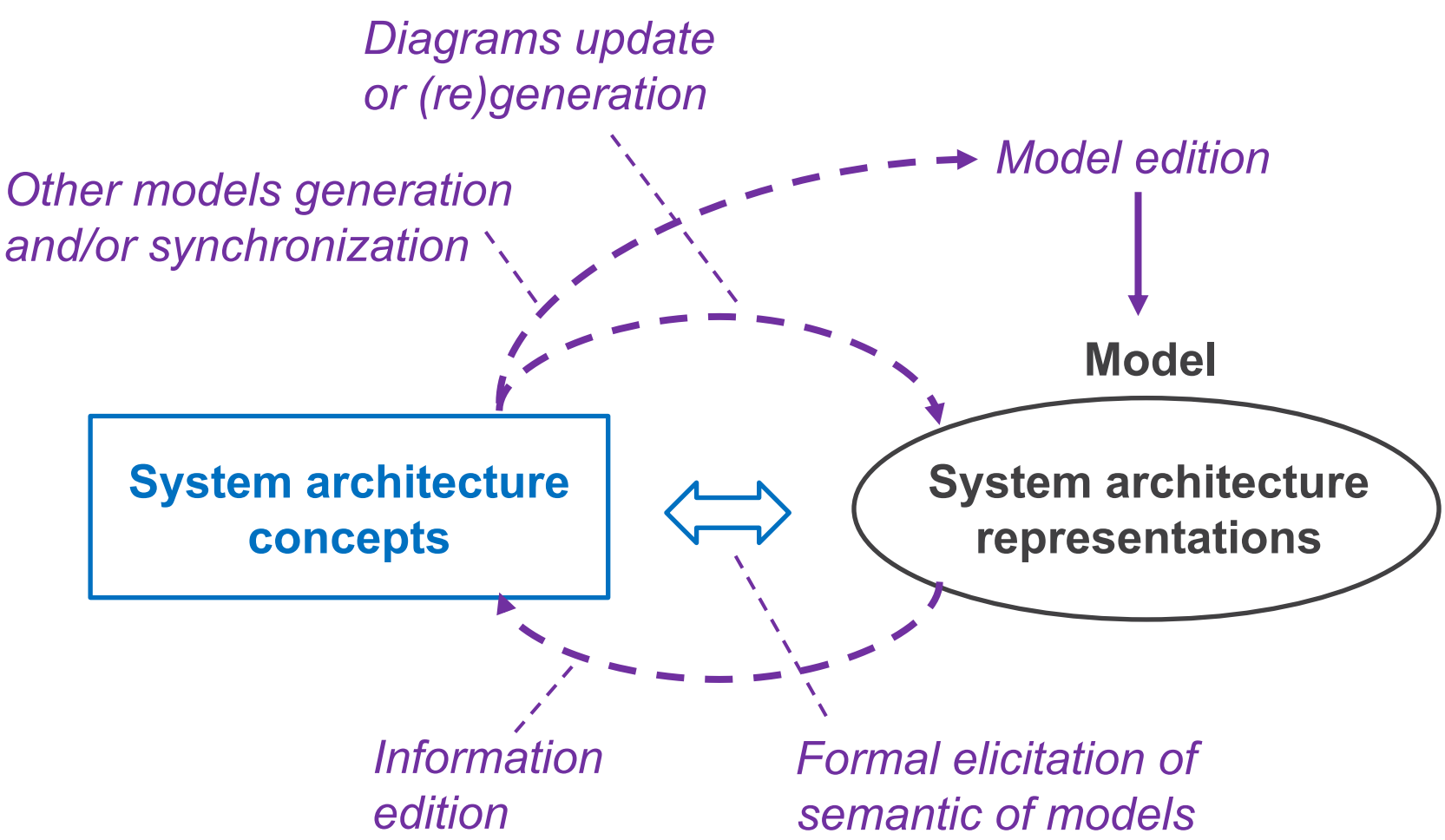
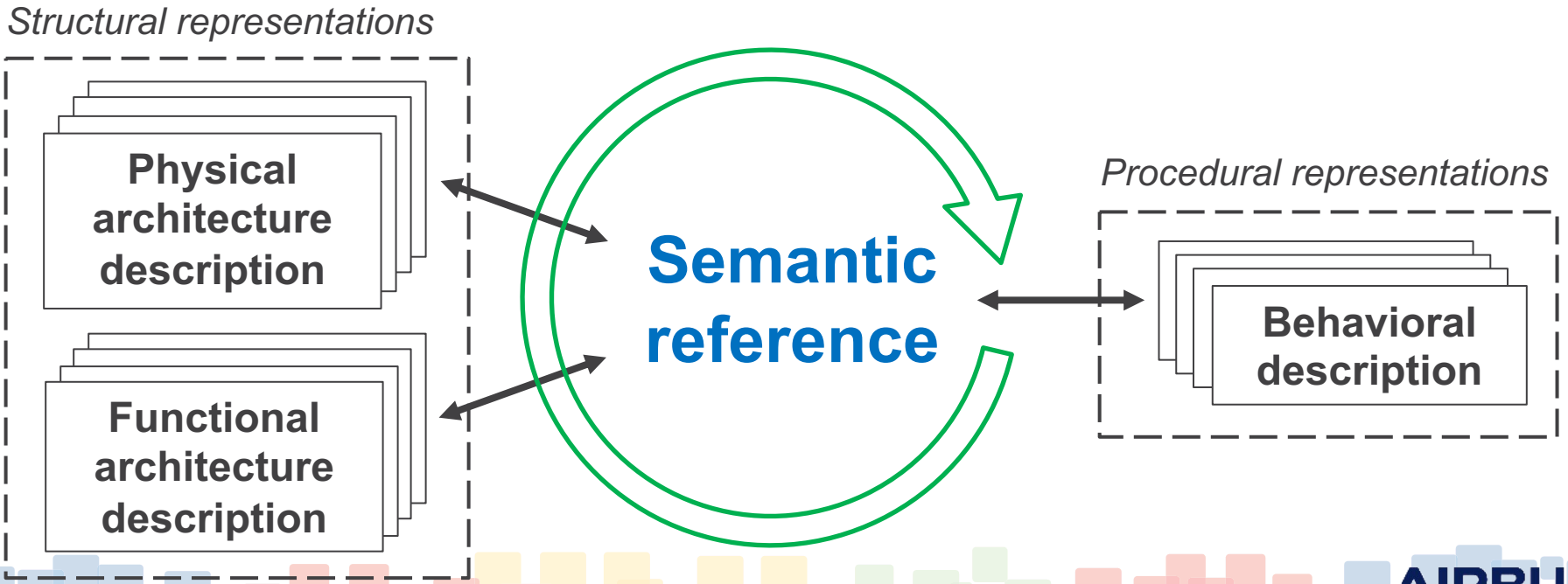
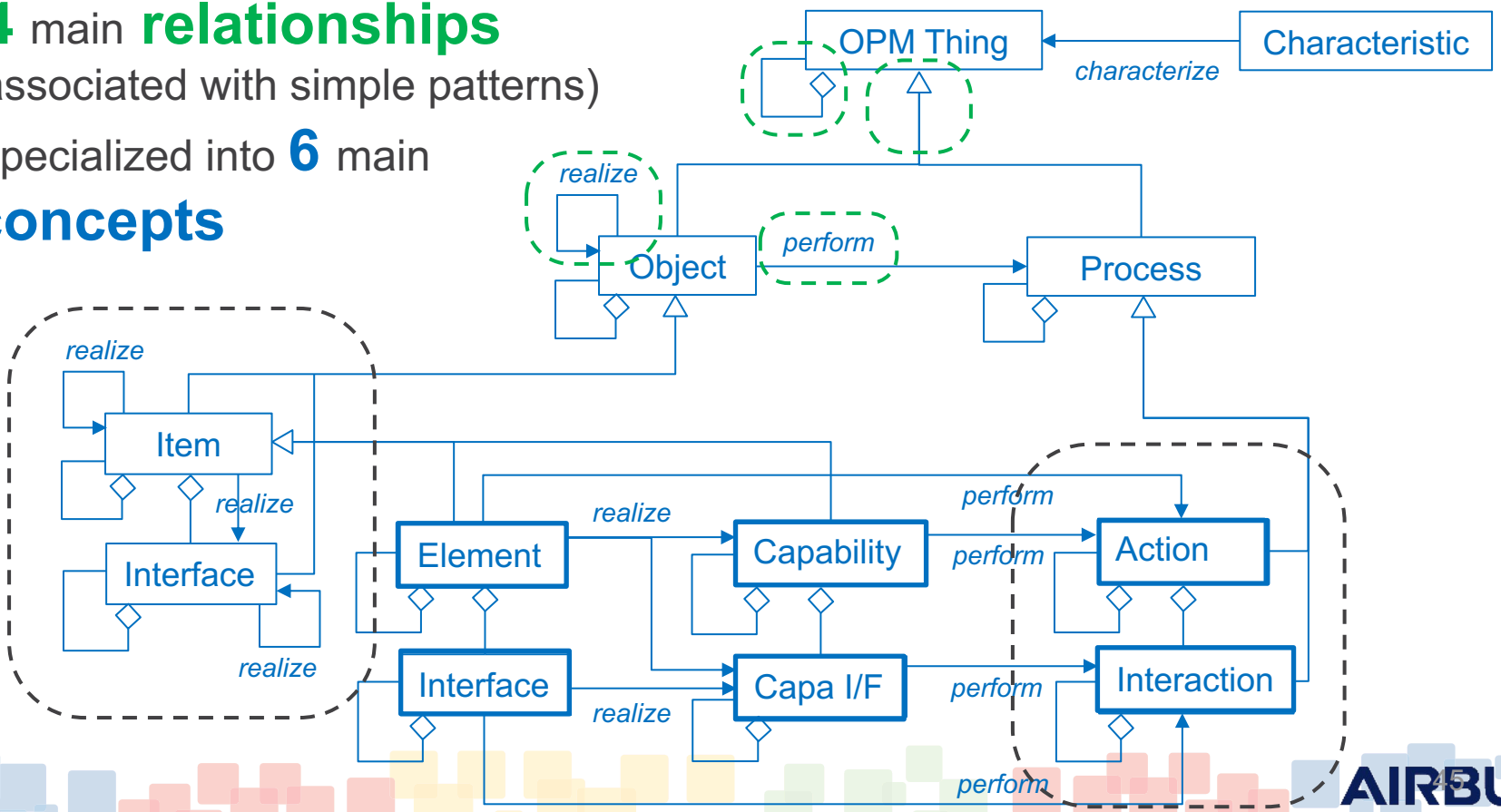

Diagrams update
or (re)generation
Other models generation
and/or synchronization
Model edition
Model
System architecture
concepts
System architecture
representations
Information
edition
Formal elicitation of
semantic of models

- **Automatically ensure continuous consistency** of all models & diagrams.
- **Promote the use of as many diagrams, models types** and modeling features **as needed**, in an easy and efficient way, in order to address all specific needs and concerns **in the most relevant** way.



- **2** Generic **constructs**
- **4** main **relationships**
  (associated with simple patterns)
- Specialized into **6** main **concepts**



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