



**29<sup>th</sup>** Annual **INCOSE**  
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# Approach to structure, formalize and map MBSE meta-models and semantic rules.

Jean Duprez, Airbus Operations SAS - Paper 51



**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**.

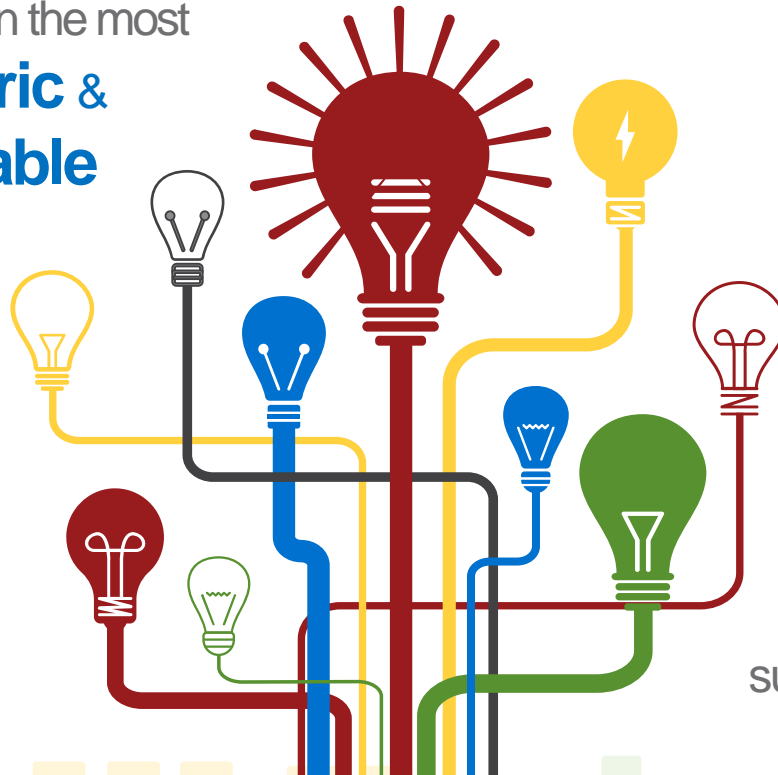


# Refer to what models represent: the System.

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 Based Systems Engineering

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**,  
with an unambiguous **syntax**  
and **semantics**.

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

**Goal** we address?  
→ **Engineering**

**Scope** of interest?  
→ **Systems**

Model





# Model

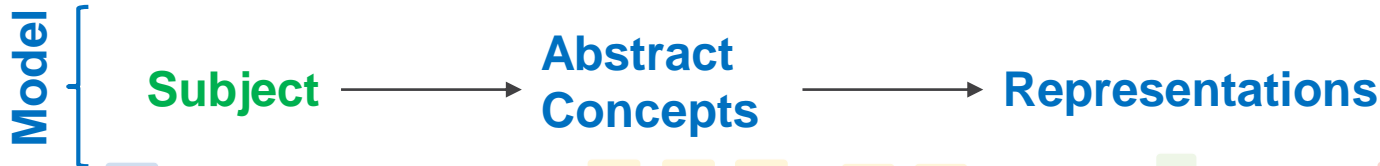
An **abstract representation** of a given set **of aspects of a subject**,  
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with an unambiguous **syntax**  
and **semantics**.



Eliciting **structuring rules & common patterns**

Allows to:

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





# Model

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# Model

An **abstract representation** of a given set **of aspects of a subject**,  
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with an unambiguous **syntax**  
and **semantics**.

## Why models:

- Scope
- Goal
- Associated concepts

## What are models:

- Viewpoints to consider
- Diagrams to use
- Diagram elements

## How to model:

- Tools
- Tools language
- Meta-Models

Model

Subject

Abstract  
Concepts

Representations

Data

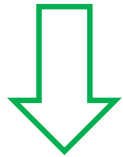


# Model

An **abstract representation** of a given set **of aspects of a subject**,  
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with an unambiguous **syntax**  
and **semantics**.

# System (ISO/IEC/IEEE 15288)

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



Model





# Model

An **abstract representation** of a given set **of aspects of:** • **used to address** given **concerns**,  
with an unambiguous **syntax**  
and **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**, with an unambiguous **syntax** and **semantics**.

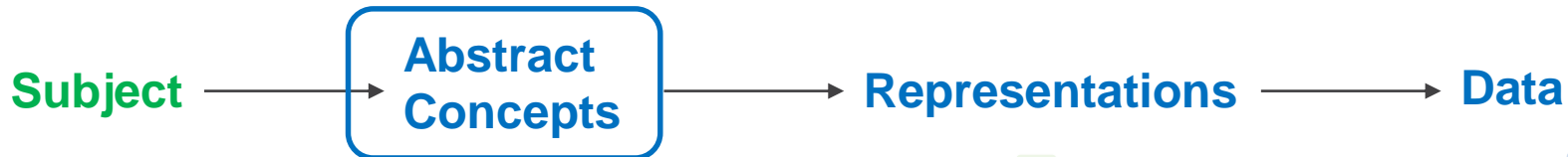
- a combination of elements
- interacting
- to achieve one or more stated purposes



**Aspects of the subject** can be represented as:

- a given set of **characteristics**
- a given set of **links** associated with **concepts** that define it.

Model

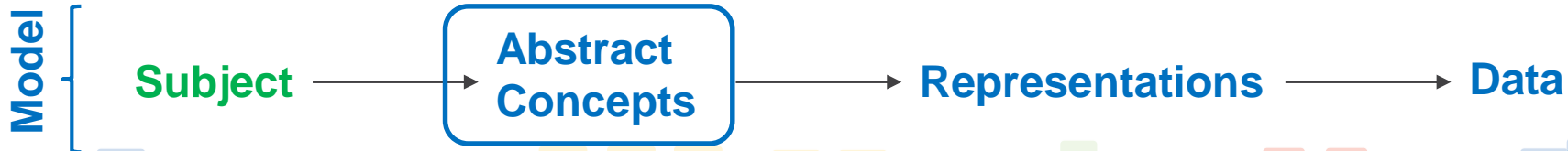
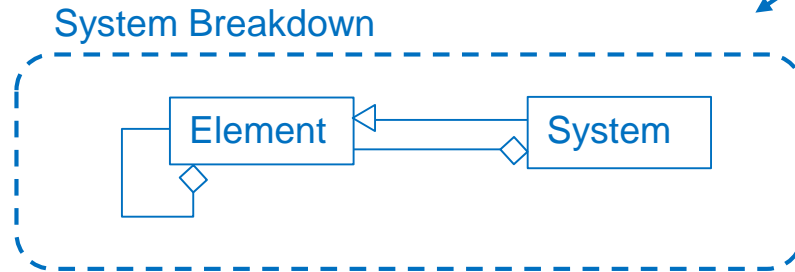




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# Interface (INCOSE SECF v1 2018)

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

Model

Subject

Abstract  
Concepts

Representations

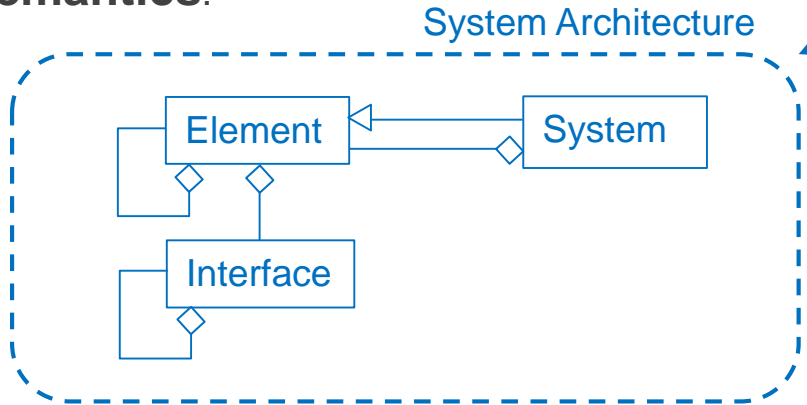
Data



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Model





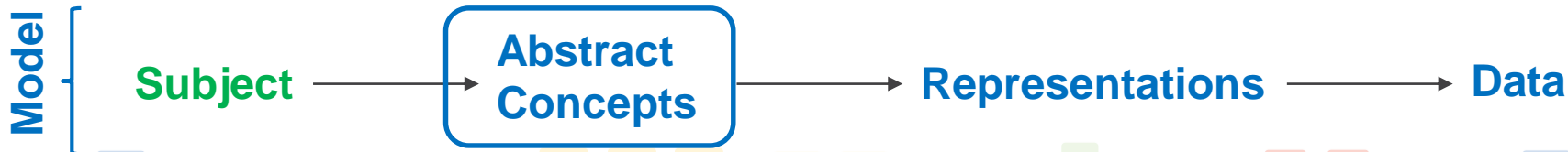
# Model

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

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

**used to address** given **concerns**,  
with an unambiguous **syntax**  
and **semantics**.

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





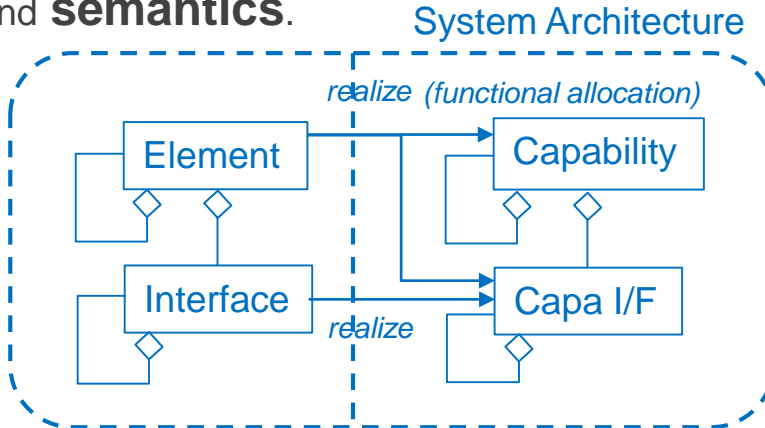


# Model

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

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

used to address given **concerns**, with an unambiguous **syntax** and **semantics**.



**Structural representation of the system ("Static").**

Model

Subject

Abstract Concepts

Representations

Data

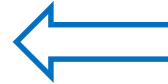


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Procedural representation of the system (“Dynamic”).



Model

Subject

Abstract Concepts

Representations

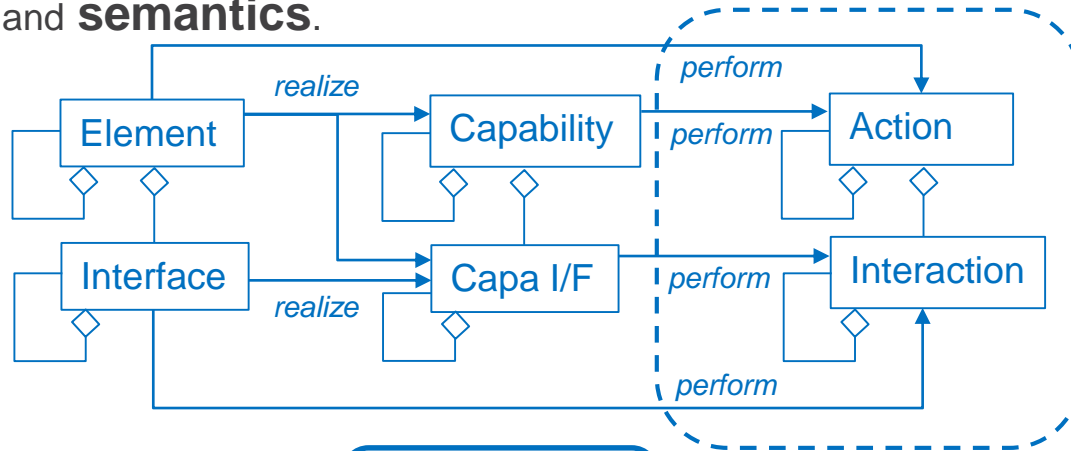
Data



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System procedural representation

Model

Subject

Abstract Concepts

Representations

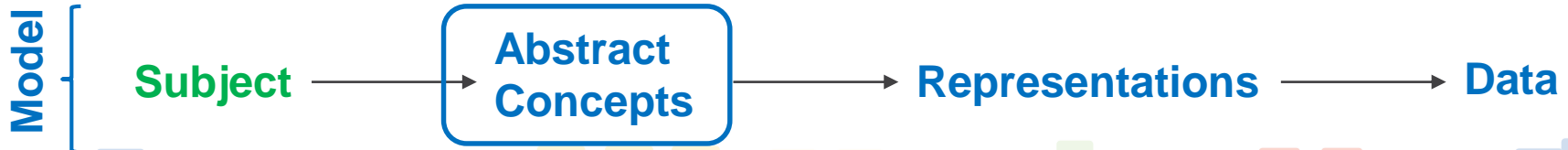
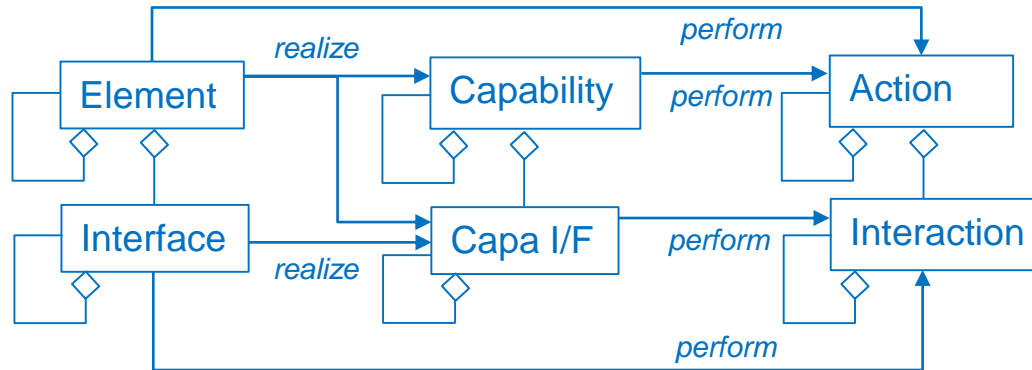
Data



## 6 main Concepts

## 4 main structuring Patterns

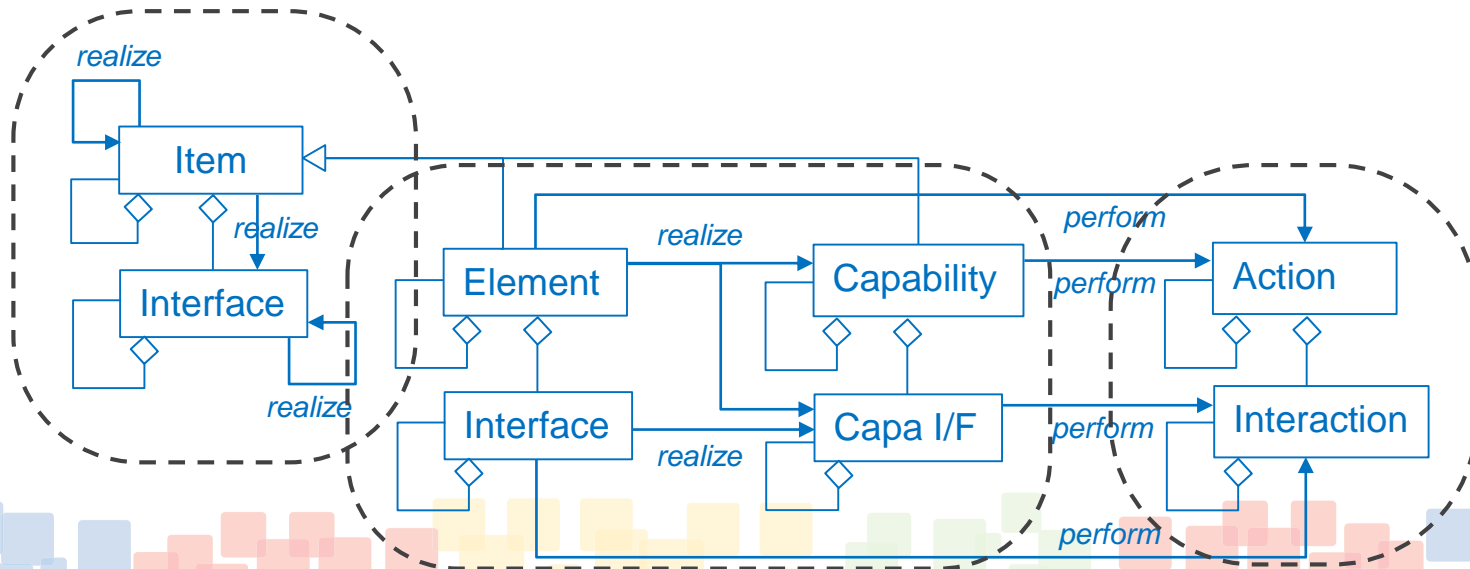
- Decomposition
- Functional allocation
- Behavior description
- Interfacing





## 2 Generic constructs

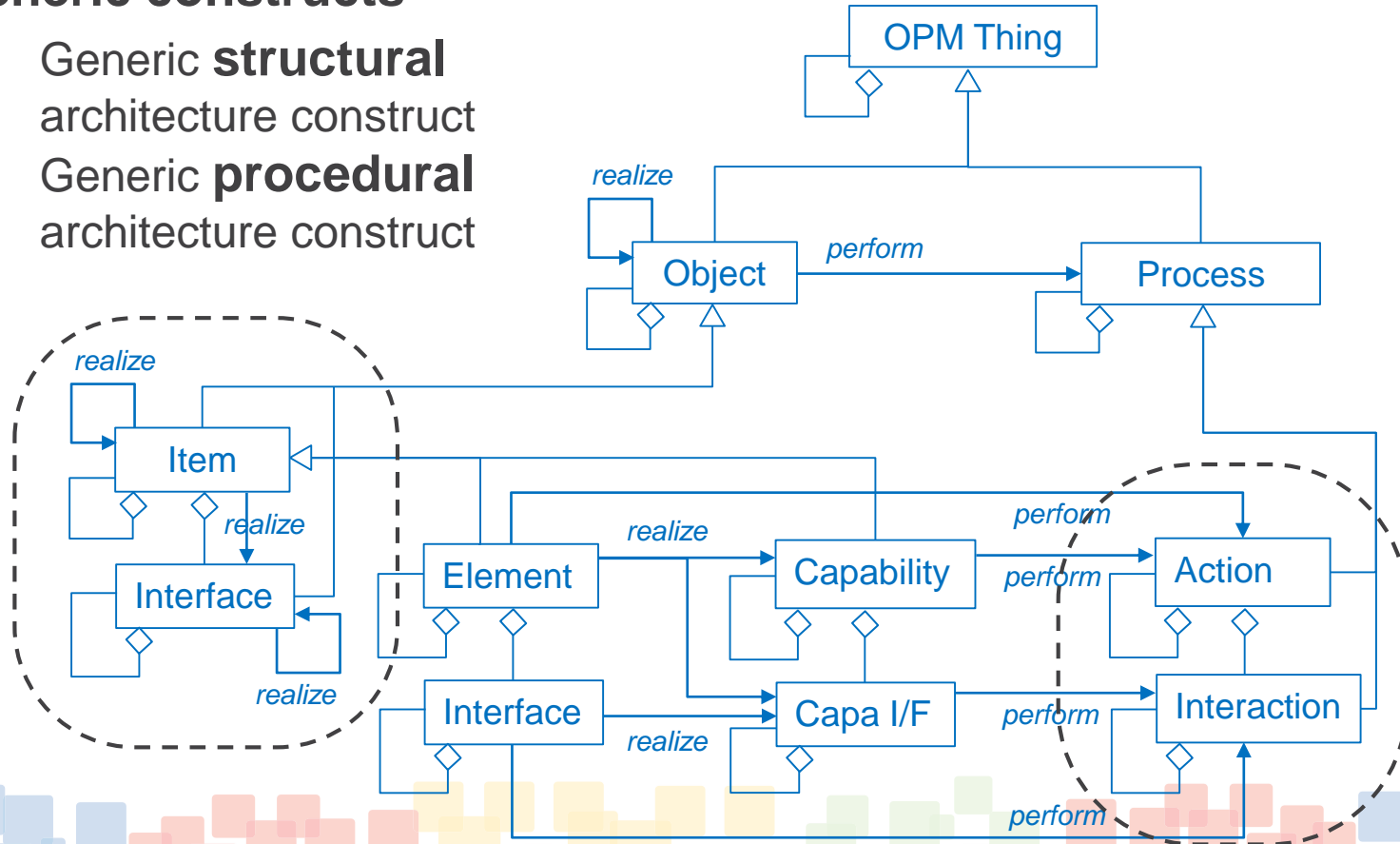
- Generic **structural** architecture construct
- Generic **procedural** architecture construct





## 2 Generic constructs

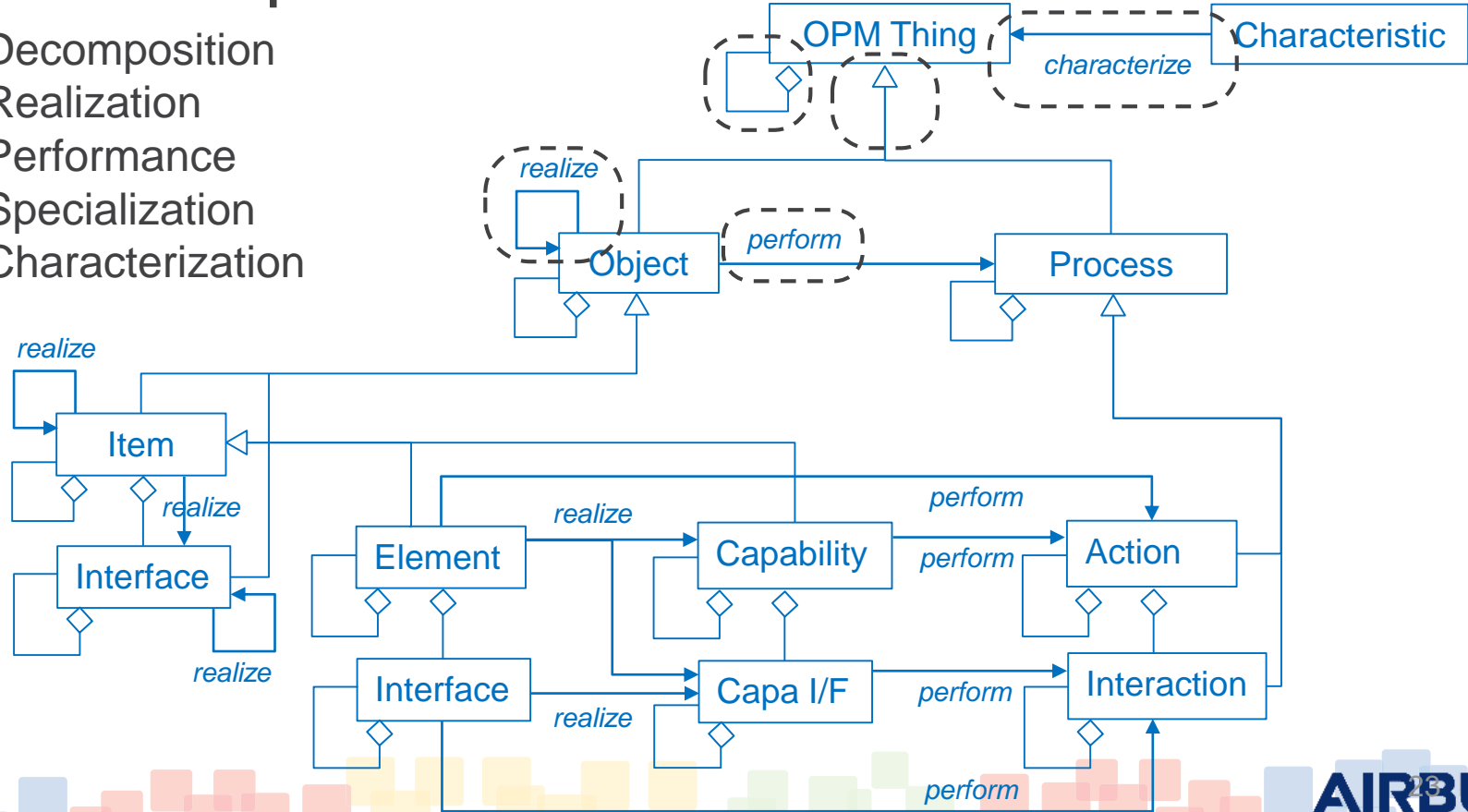
- Generic **structural** architecture construct
- Generic **procedural** architecture construct





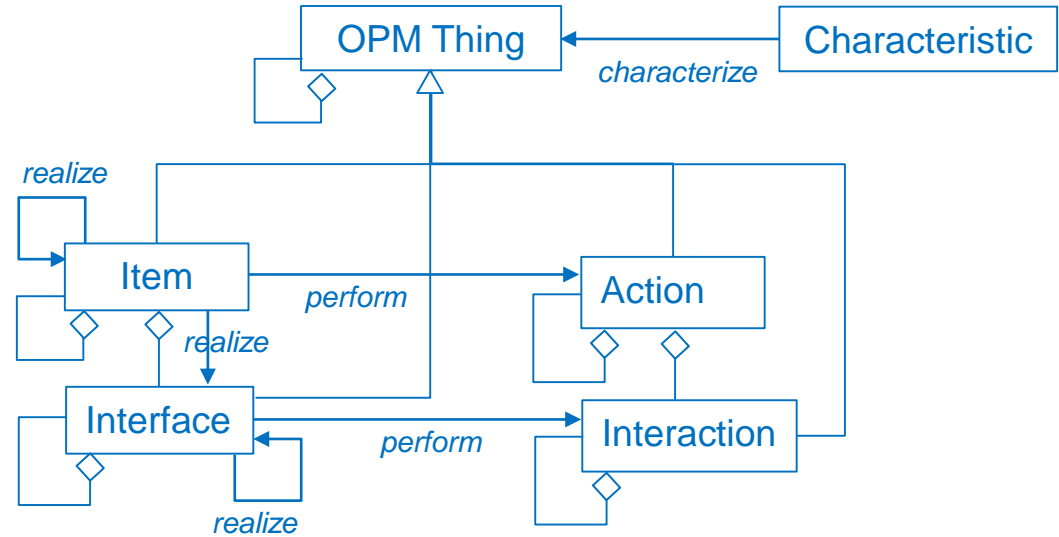
## 5 main relationships

- Decomposition
- Realization
- Performance
- Specialization
- Characterization





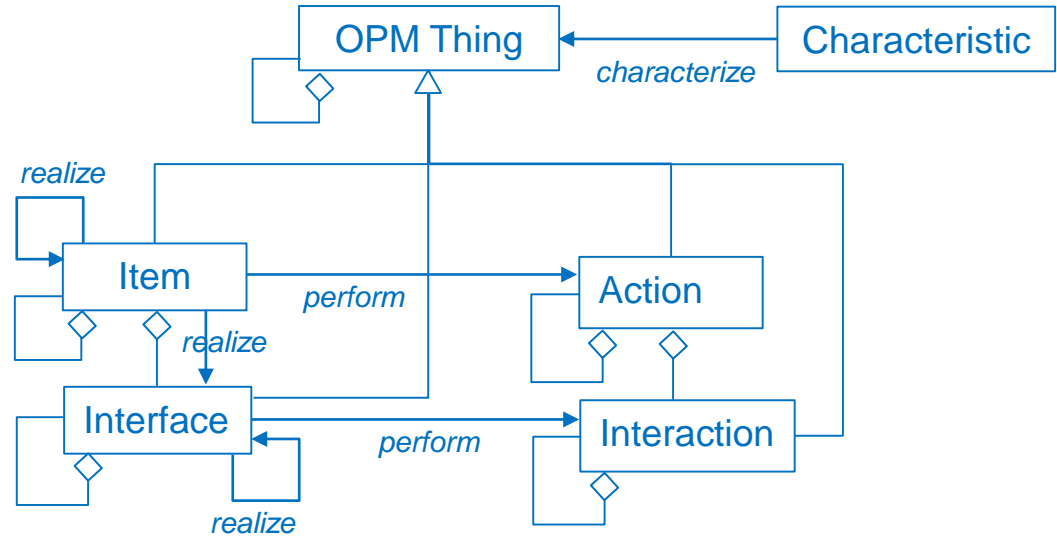
Compact concept  
description:







# How concepts are represented in models ?





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

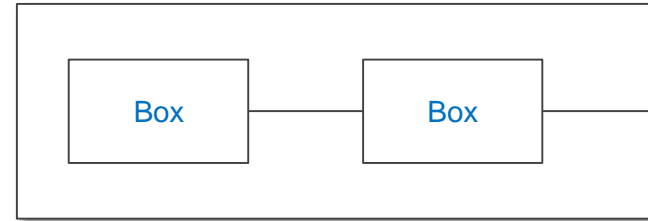
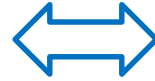
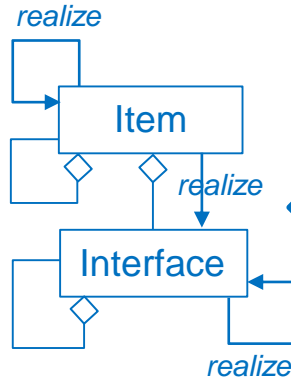


**Architecture**  
description

↳ **“Box & Pipes”  
diagrams**

Decomposition  
representation

Interfaces  
representation



Model

Subject

Abstract  
Concepts

Representations

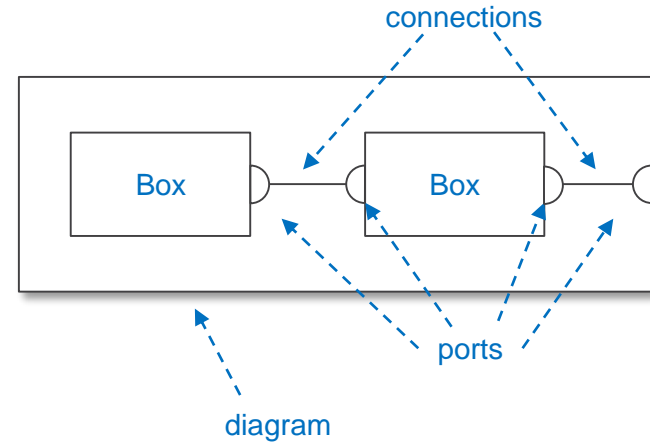
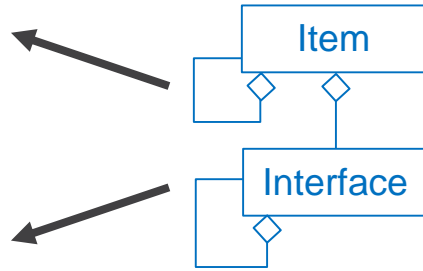
Data



# What does each architecture description element represent ?

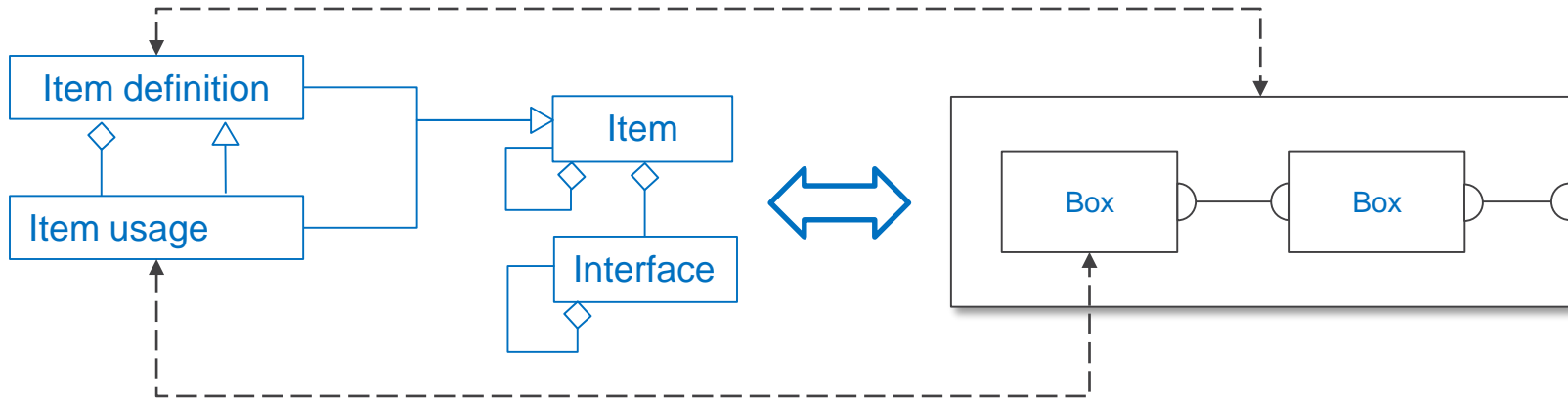
Decomposition representation

Interfaces representation



Model





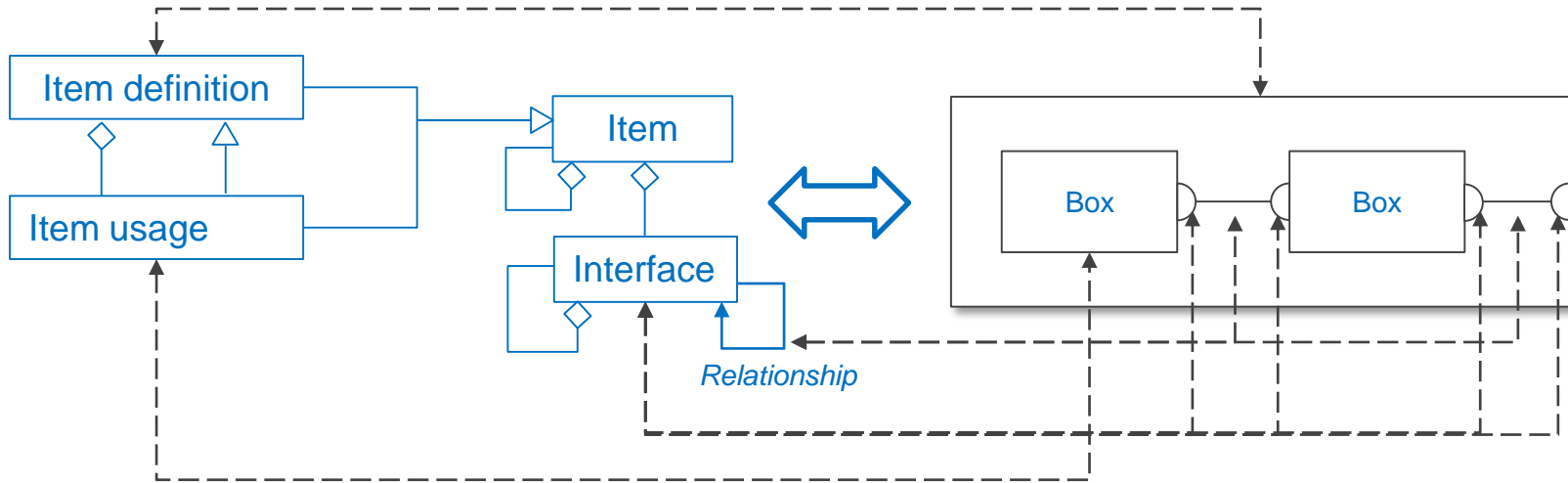
Model

Subject

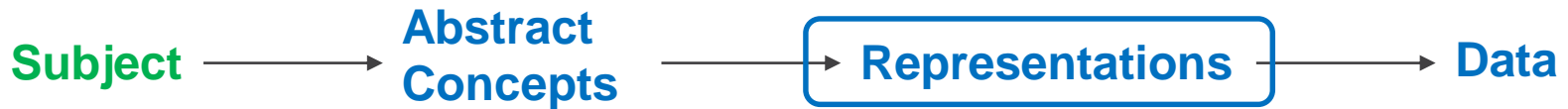
Abstract Concepts

Representations

Data



Model





*Diagrams update  
or (re)generation*

*Other models generation  
and/or synchronization*

*Model edition*

**Model**



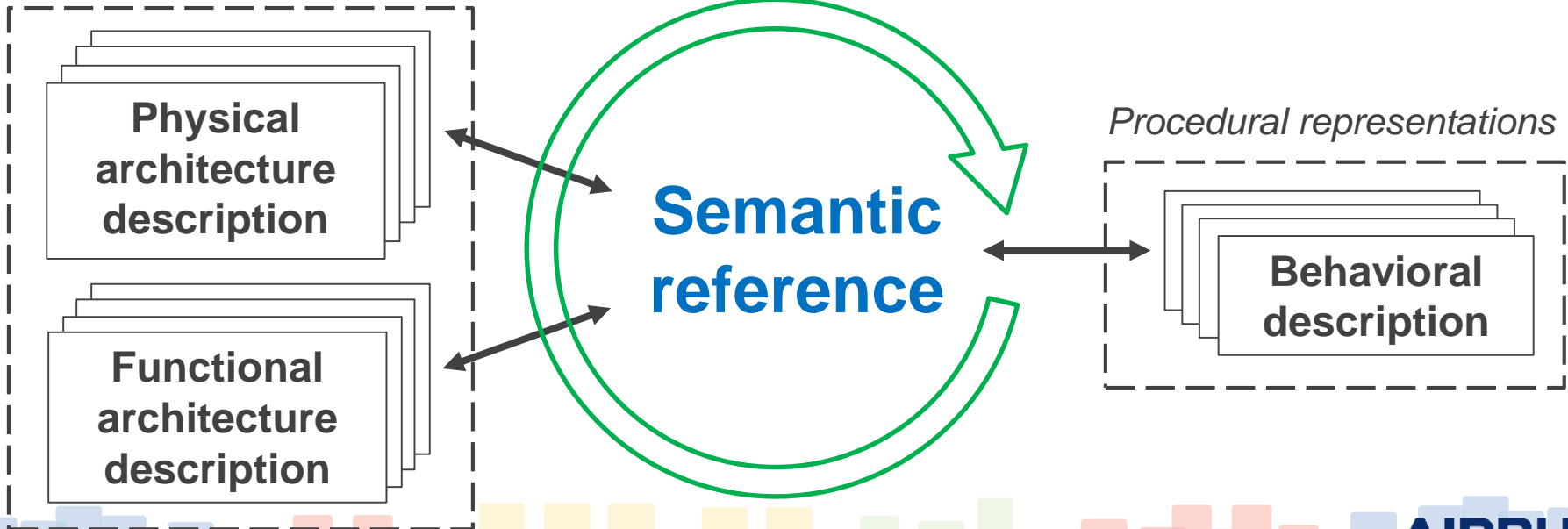
*Information  
edition*

*Formal elicitation of  
semantic of models*



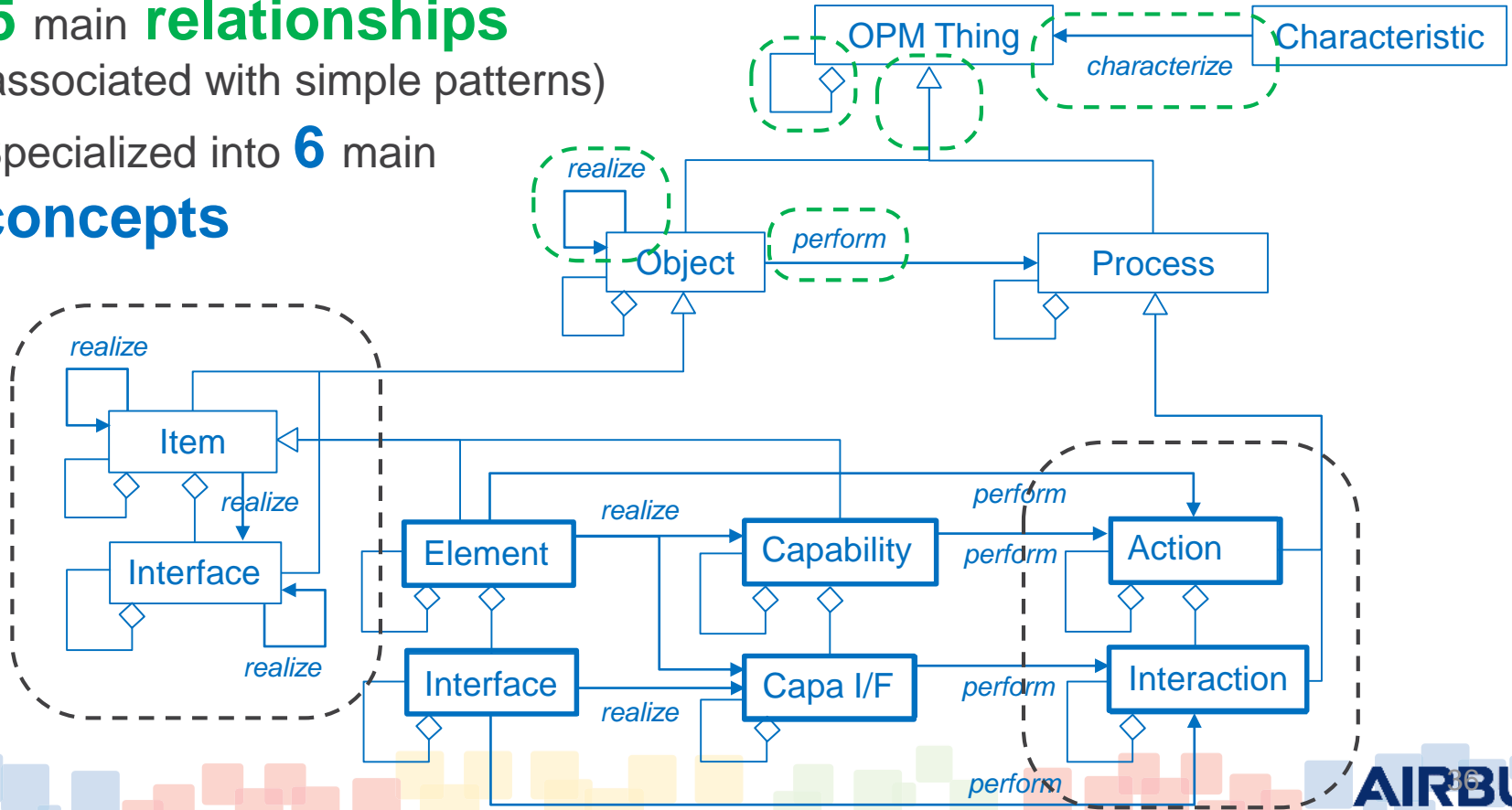
- **Automatically ensure continuous consistency** of all models & diagrams.
- **Promote the use of as many diagrams, models types** and modeling features **as needed**, in an easy and efficient way, in order to address all specific needs and concerns **in the most relevant** way.

*Structural representations*





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







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