Overall Semantic Modelling

OSMoSE

For Space System Engineering

MBSE-2022 – Space System Ontology Workshop

The Space System Ontology

Serge Valera, Quirien Wijnands

ESA ESTEC

23/11/2022

Overall Semantic Modelling

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MBSE-2022 – Space System Ontology Workshop

Session 4 – OSMoSE Design Authority

Serge Valera, Quirien Wijnands

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OSMoSE – 2nd Space System Ontology Workshop 2022

MBSE-2022 Session 4 – OSMoSE Design Authority

08:50 – 09:00 **Introduction by Session Chair**

ESA Serge Valera, Quirien Wijnands

09:00 – 09:15 **OSMoSE status and overview**

ESA Quirien Wijnands

09:15 – 10:00 **MBSE Universe of Discourse of the Space System Ontology**

ADS Jean-Baptiste Bernaudin, Lucie Laborde

OHB Michael Brahm, Stephan Jahnke

TAS Gerald Garcia, Pierre-Yves Schmerber

10:00 – 10:25 **From Conceptual Models towards Implementation**

ESA Serge Valera

10:25 – 10:40 ***Questions and Answers***

10:40 – 11:10 ***Coffee Break***

MBSE-2022 Session 5 – OSMoSE Contributors…

OSMoSE and the Space System Ontology

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WHAT ➔ The OSMoSE Objective

enabling semantic interoperability between all actors involved in the development and operations of space system products

HOW ➔ The Space System Ontology

conceptualizing the Space System knowledge taking into account the roles and domains of responsibilities of each actor involved

- shared conceptualization expressed in the ORM object role modelling language ➔ refer to www.orm.net
- covering engineering, product assurance and management ➔ refer to www.ecss.nl
- resulting from:
  - contributions ➔ the conceptualization of some universe(s) of discourse, by experts of the domain(s) *preferably involving experts from several organizations*
  - integrations ➔ integrating the contributions *after review, by consensus refinement and approbation*

The OSMoSE community & design authority

- The OSMoSE community ➔ Anyone interested by OSMoSE
  - Users of the OSMoSE product(s)
  - Participants to the “public reviews” of the OSMoSE product(s)
  - Contributors to the development of the OSMoSE product(s)

- The OSMoSE Design Authority

ESA convenors	Serge Valera, Quirien Wijnands
Airbus Defence and Space	Jean-Baptiste Bernaudin, Lucie Laborde
OHB Systems	Michael Brahm, Stephan Jahnke
Thales Alenia Space	Gerald Garcia, Pierre-Yves Schmerber
Ariane Group	Jean Albrieux
ESA	Alberto Gonzalez Fernandez

supported by experts, whenever required

Why OSMoSE?

Overall Semantic Modelling
OSMoSE
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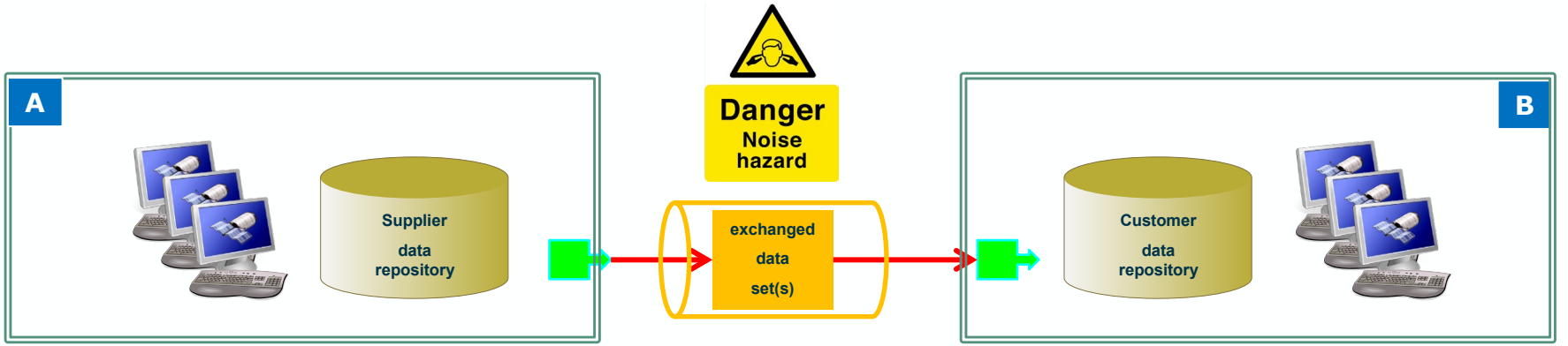
Communication is key but we all know how difficult it can be sometimes to communicate

these days, everyone is looking at **digitalization**

but for decades, software engineers/organizations $_{\text{agencies, industry}}$ are “digitalizing”.

we all have solutions to all types of problems but ***this is still not sufficient*** *!*

The problematic is **not** “*digitalizing and building some other solution(s)*” but instead, ensuring that the information exchanges, between any two entities $_{\text{human, HW, SW}}$ is done without loss of semantics !

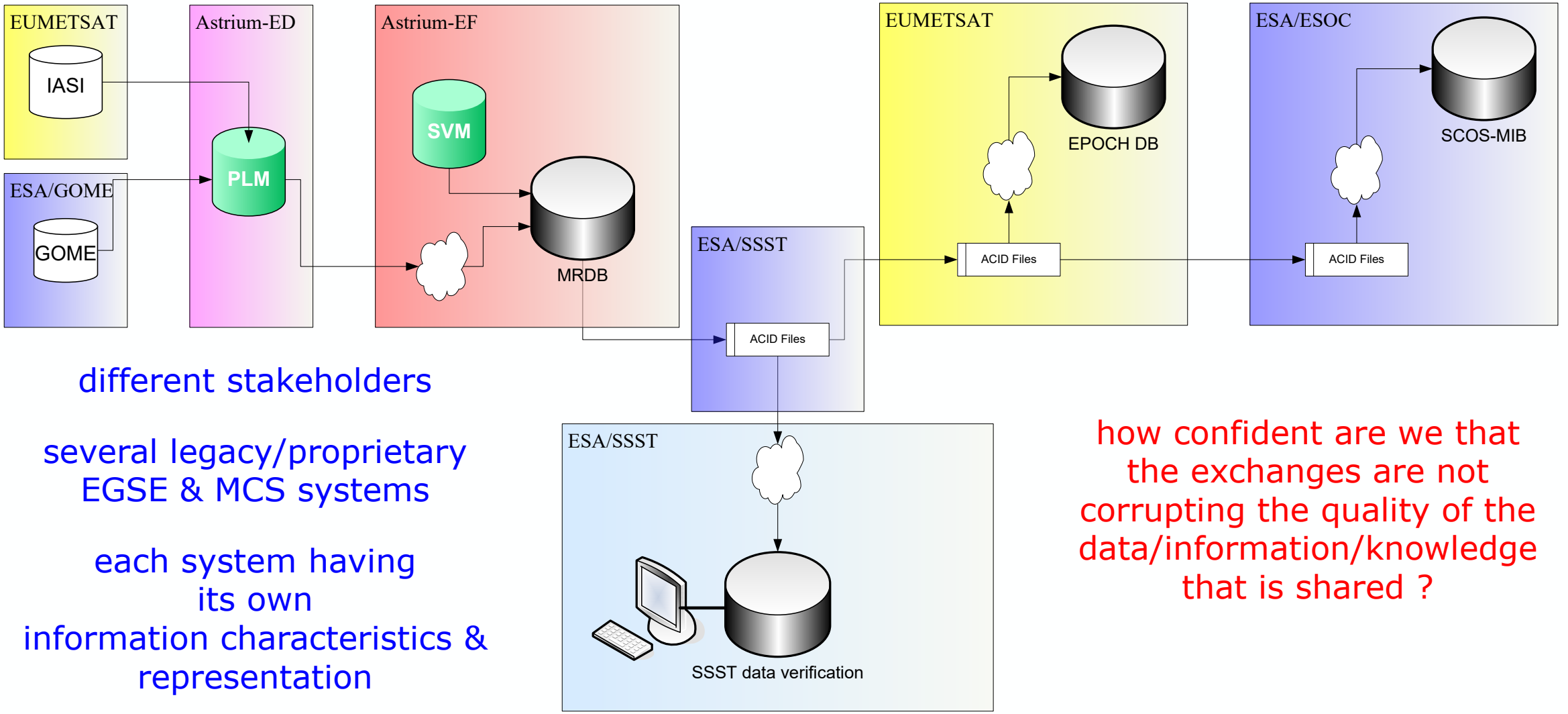


a simple example: two information systems that exchange data

A real case example: METOP

SPACE SEGMENT DEVELOPMENT

GROUND SEGMENT & OPERATIONS



different stakeholders

several legacy/proprietary EGSE & MCS systems

each system having its own information characteristics & representation

how confident are we that the exchanges are not corrupting the quality of the data/information/knowledge that is shared ?

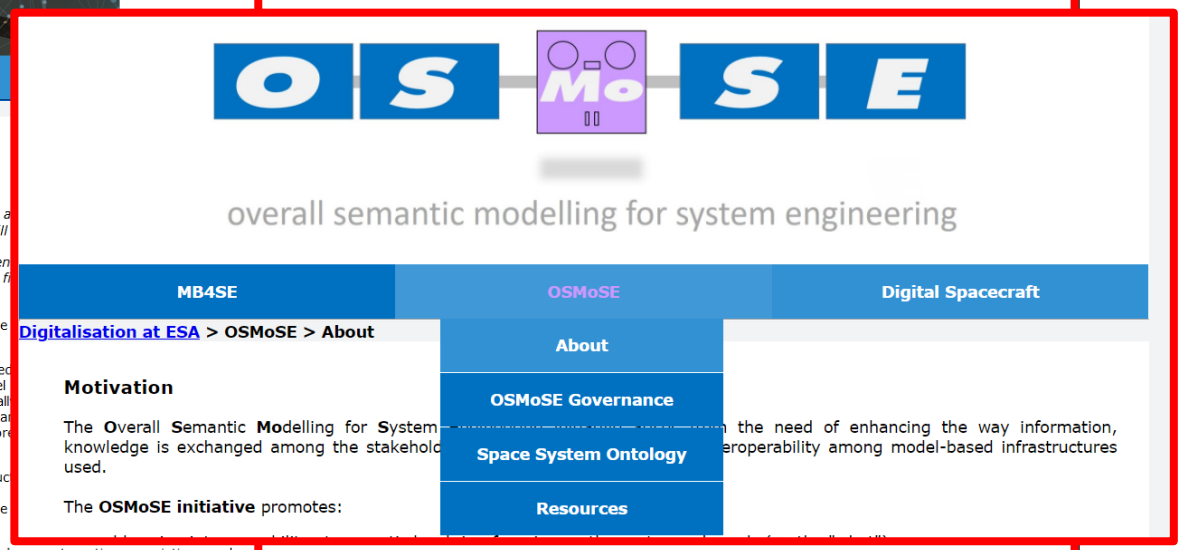
OSMoSE – 1st Space System Ontology Workshop 2021

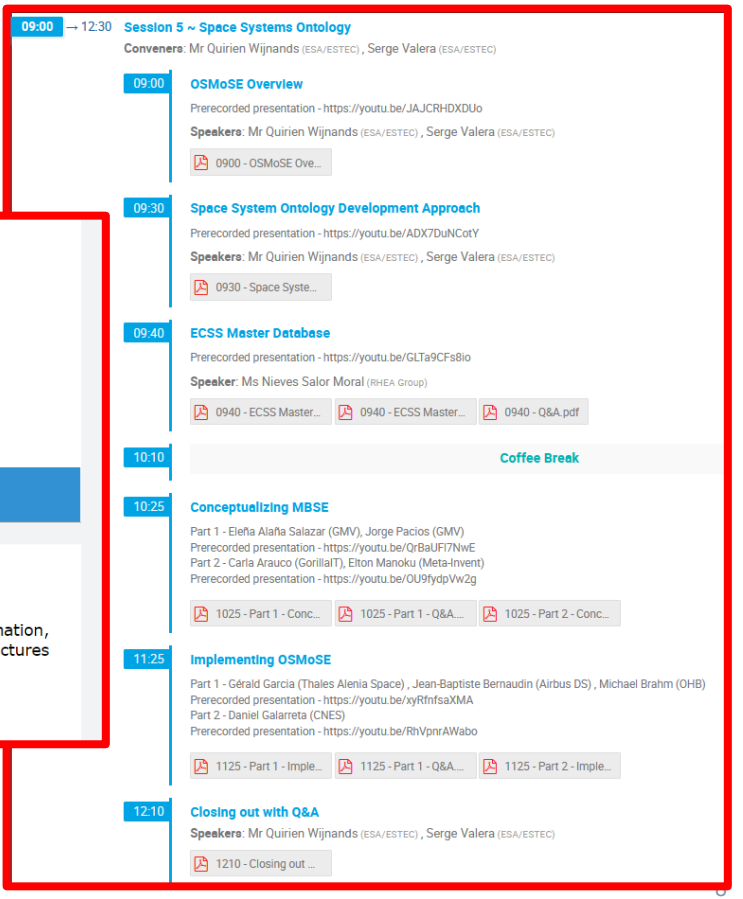
Overall Semantic Modelling OSMoSE For Space System Engineering

Digitalisation at ESA: https://mb4se.esa.int

Semantic Modelling: https://mb4se.esa.int/OSMOSE_Main.html

SSO Workshop 2021: https://indico.esa.int/event/386/timetable/#b-2065-session-5-space-systems





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MBSE-2022 – Space System Ontology Workshop

Session 4 – OSMoSE Status and Overview

Quirien Wijnands, Serge Valera

ESA ESTEC

23/11/2022

The Space System Ontology

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A global conceptual data model expressed in a formal logic based **language with associated formal representations** graphical & textual

- the language is **ORM** Object Role Modelling *refer to www.orm.net*
- the tool is **NORMA** in its professional version
- we model the real-world concepts using *object types, fact types and constraints* ORM no software artefact
- we model the global as a whole, the locals as views
  - the global integrates **all stakeholders' needs** the union, not only the intersection
  - the locals are made by the stakeholders identifying the subset of relevance for each use case
  - the global and the locals are fully **valid** ORM conceptual models

the Space System Ontology inherits from decades of organizational know-hows

however enhanced, to satisfy the overall System needs ➔

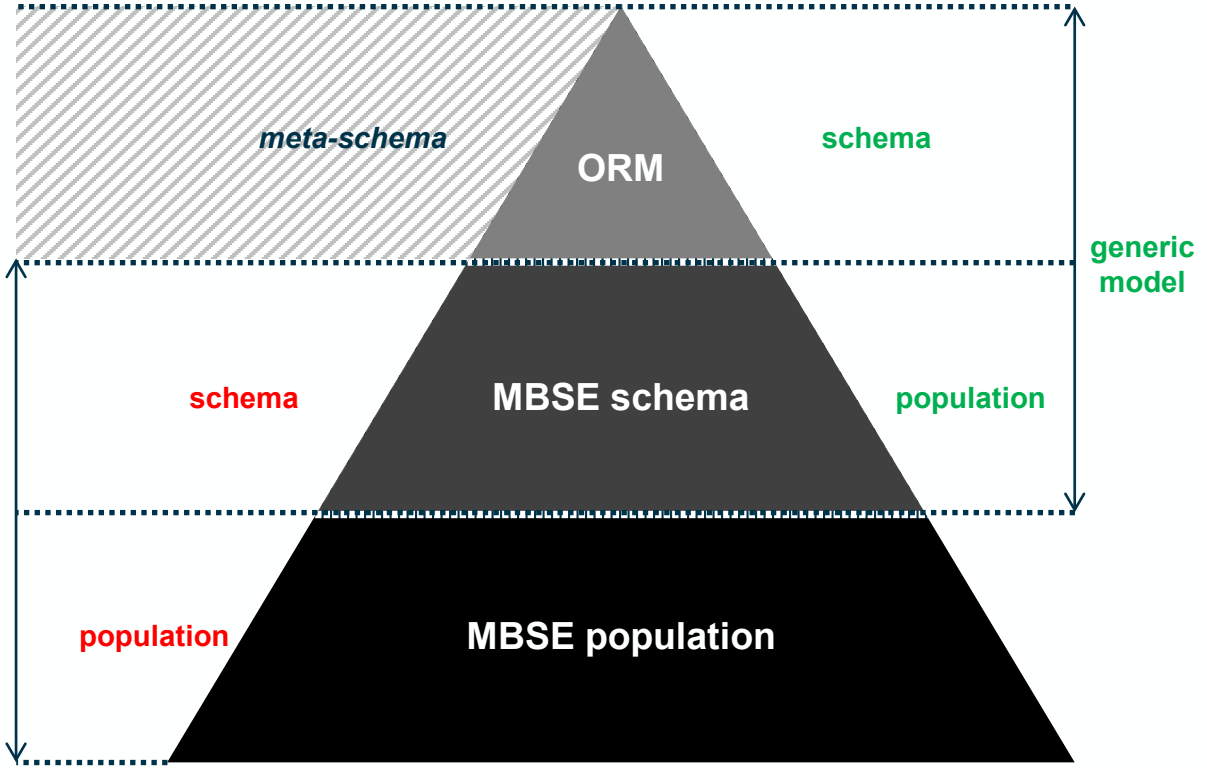
The "overall System" is multi-organizational !

using NORMA to build the locals ensures that the locals are ready for semantic interoperability

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*

MBSE – What means Modelling ?

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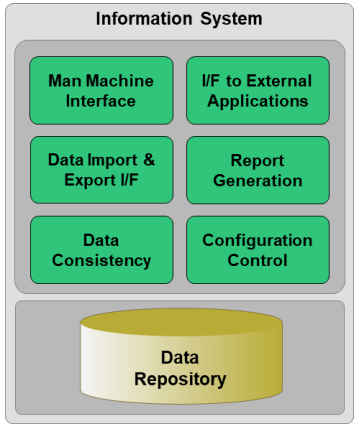
modelling for system engineers means
using some information system *software tool*
to capture the **semantics** of the **system of interest**
under the form of data *organized according to some schema*

System Modelling

transform tacit knowledge into explicit knowledge

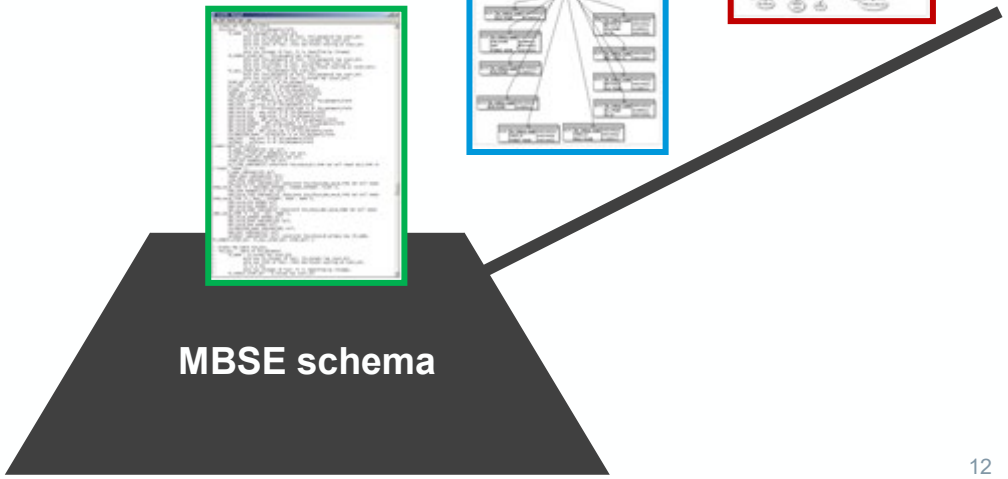


MBSE population

the schema can be of any nature, e.g. simple excel sheets where data is organised in rows and columns, or of "database" nature related to some data modelling technology, relational, SQL, object oriented, UML, ECORE, hierarchies, XML, etc.

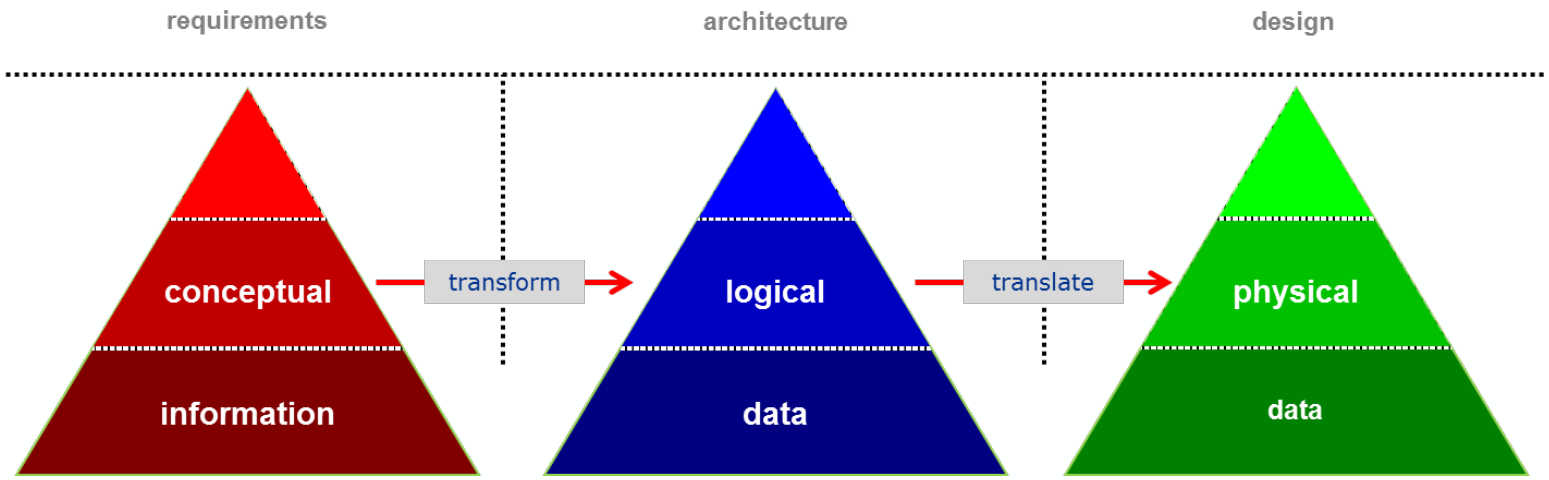
--- OSMoSE ---

we focus on enabling the capturing of
the **semantics of interest** **conceptual modelling**
and ensuring that the software are
adequately designed **logical modelling** & **physical modelling**



MBSE schema

Information Modelling, Conceptual / Logical / Physical

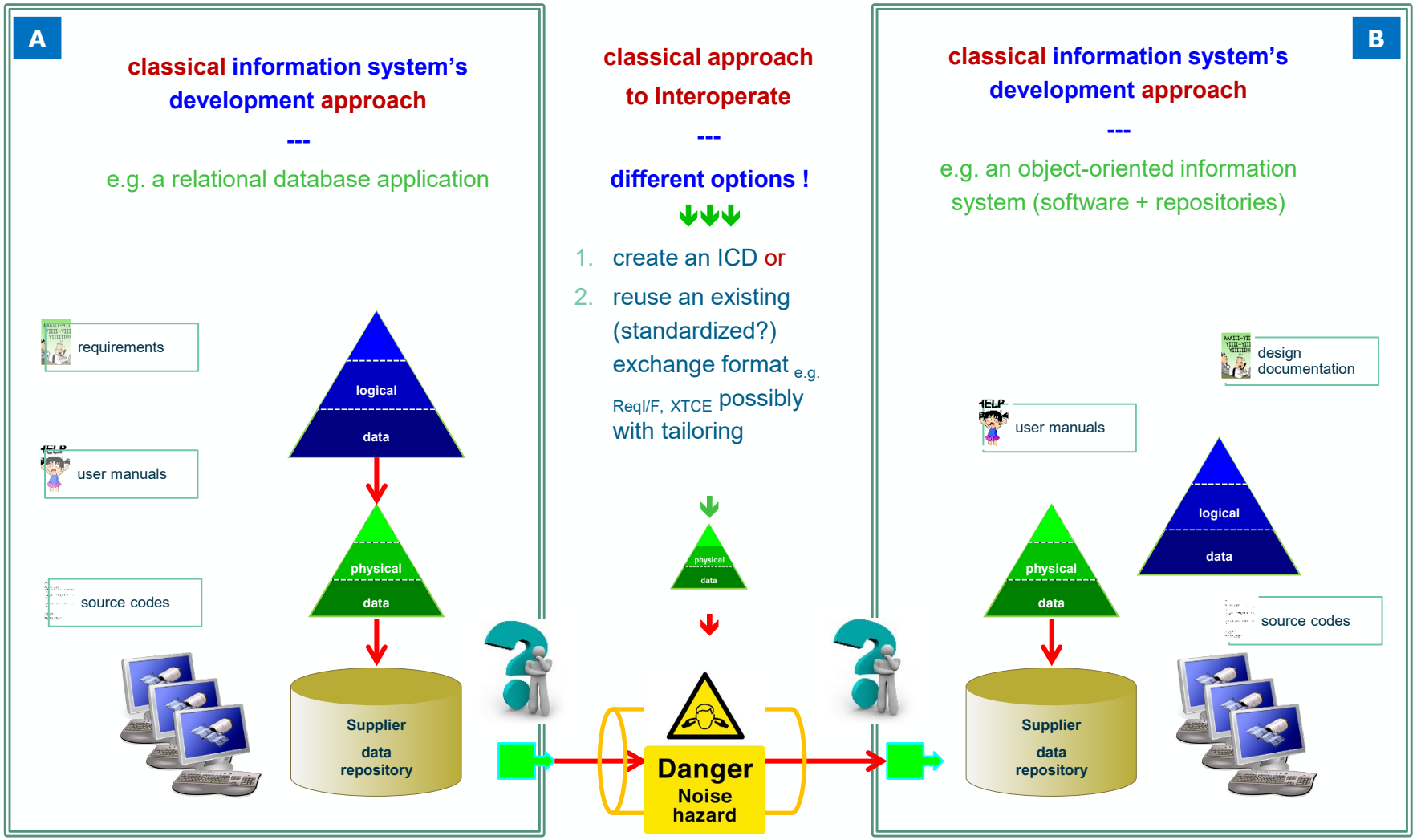


conceptual modelling language → language used during the requirements engineering process to express the semantics and to specify what information needs to be managed

→ *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 for Semantic Interoperability

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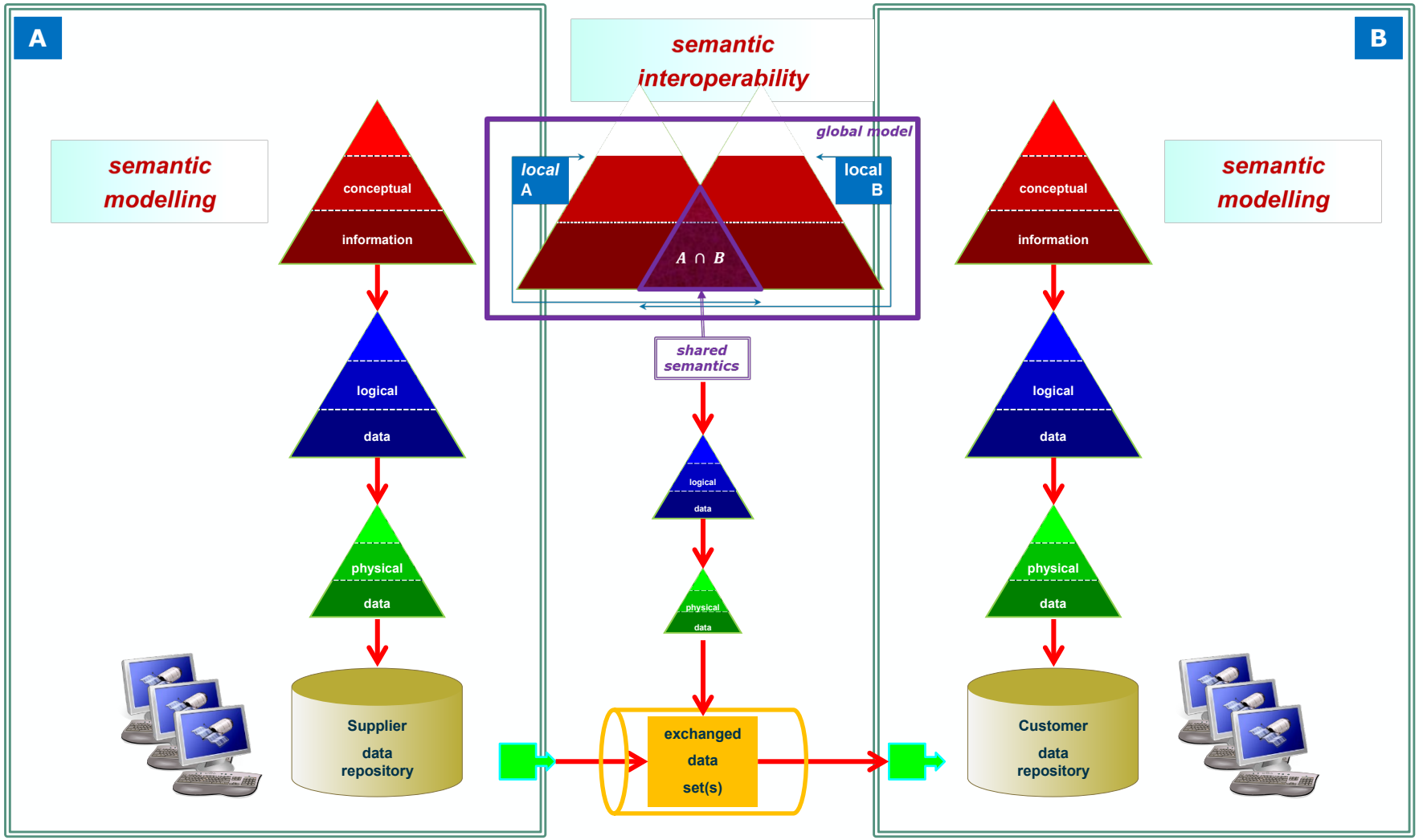

OSMoSE – on the way to Semantic Interoperability

- The Space System Ontology Development *making benefit of the overall OSMoSE Community*
  - How to support the SSO development ➔ Your contributions
  - From your contribution to its (potential) integration in the Space System Ontology
- Using the Space System Ontology to ensure the no-loss of semantics during the exchanges
  - Upgrading existing solutions for compliance to the SSO
  - Developing new solutions compliant to the SSO
  - Developing means to verify the adequacy of the exchanges and their compliance with the SSO
- Using the FBM fact based modelling / ORM object role modelling formalism to enable (semi-) automatic generation of Products e.g. documentation, HW, SW
- The Ontology Development Tool
  - NORMA Natural Object-Role Modeling Architect ➔ NORMA Pro ➔ FAMOUS FAct based MOdelling Unifying System

Session 4 – MBSE Universe of Discourse of the Space System Ontology

Session 4 – From Conceptual Models towards Implementation

Session 5 – Contributing to OSMoSE and the Space System Ontology

Contributions: *some* on-going conceptualizations

Overall Semantic Modelling
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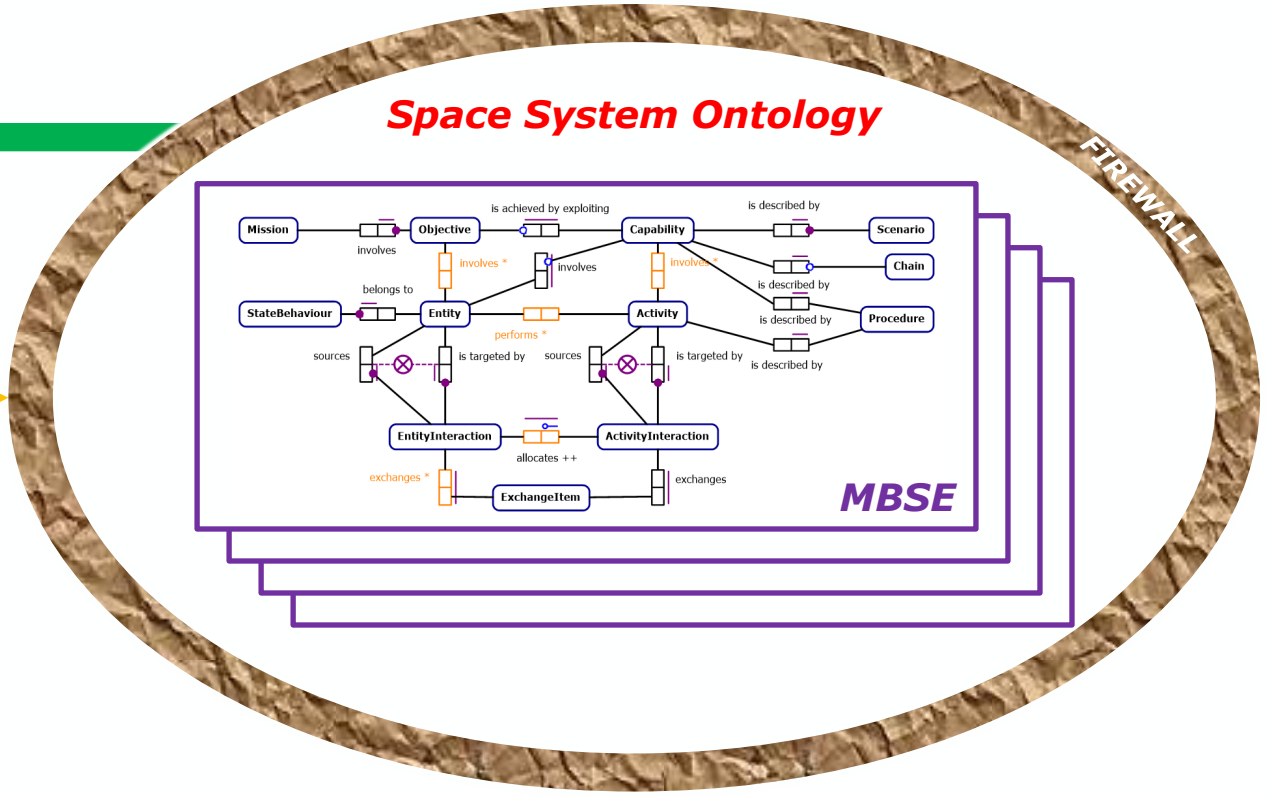
Requirement Management UoD
E-RMS1.2 R&D: ECSS req. man.

Ground Segment and Operations UoD
ECSS-E-ST-70-41 WG: PUS Foundation
ATOP R&D: E-70-31 M&C
ATOP R&D: E-70-32 PLUTO
2X MBSE Data Hub R&D: Operations

RAMS UoD
2x RAMS Data Hub R&D

AIT/AIV UoD
AIV & Test Reporting R&D

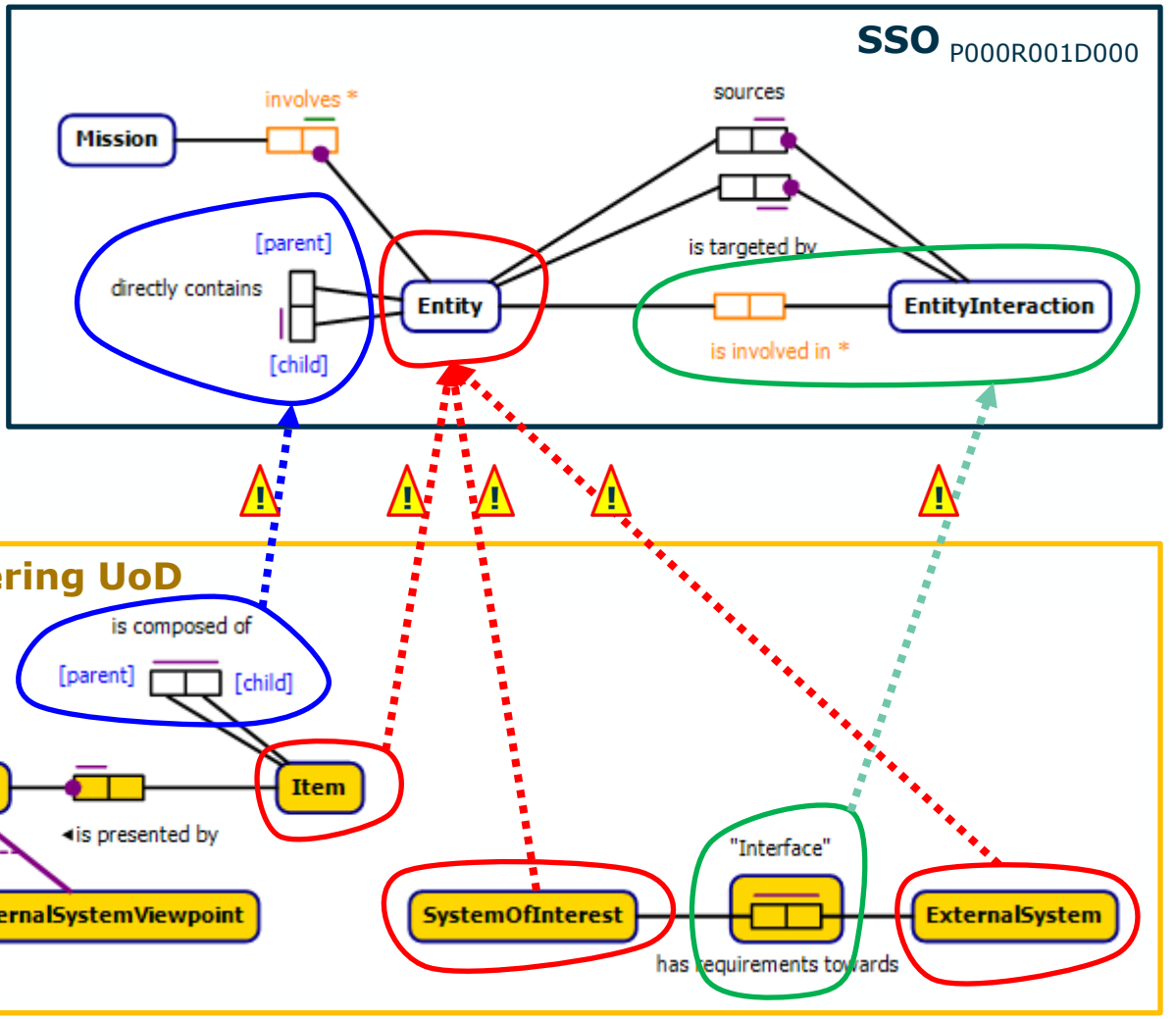
Thermal Control UoD
ESA internal



SemICoMa
Semantic Interoperability Configuration Management

UoD contribution – guideline

- seek common understanding and agreement with main UoD related stakeholders
- leverage on any published versions of the SSO including MBSE,…
- only model the SEMANTICS
- uses ORM with NORMA
- ensure that the contribution is self-standing glossary of concept definitions
- comply with the OSMoSE CLA Contributor Licence Agreement
- support the OSMoSE Design Authority in verifying the adequacy of the contribution and its integration to the SSO



OSMoSE – the licences *ESA on behalf of the OSMoSE Community*

OSMoSE Contributor Licence Agreement

Only relevant to the contributors

- *domain-specific conceptual models*
- *concomitant product*

The Contributors shall sign the OSMoSE CLA prior to any delivery to the OSMoSE Community

The CLA ensures that each contribution is granted to the OSMoSE Community under a non-exclusive, perpetual, irrevocable, world-wide, royalty-free, no-charge licence to use the contributions, including, without any limitation, the right to reproduce, modify and exploit, to produce the Space System Ontology and the Concomitant Products for and by any member of the OSMoSE Community

contact ESA/ESTEC Contract Office

OSMoSE Product Licence Agreement

Relevant to all interested by

- *the Space System Ontology*
- *The concomitant products*

No agreement yet reached by

the main European Space Actors

The PLA grants a royalty-free, non-exclusive licence under Copyright, to use the OSMoSE Product, to reproduce it by any or all means or in any or all forms, to modify it and create “Derivative Work” and to communicate to the public

open issue: are all components of the OSMoSE product accessible to non-ESA-Member States?

contact ESA/ESTEC Contract Office

Overall Semantic Modelling

OSMoSE

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Session 4 – MBSE Universe of Discourse of the Space System Ontology

Jean-Baptiste Bernaudin, Lucie Laborde | Airbus Space & Defence
Michael Brahm, Stephan Jahnke | OHB Systems
Gerald Garcia, Pierre-Yves Schmerber | Thales Alenia Space

23/11/2022

MBSE – The Contributions

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- ***ESA contract 4000126123 Configuration Database need for Modelling and Simulation - CDMS***

  Contractor: GorillaIT (NL) – contact: Carla Arauco

  Objective: modelling the System and Simulation Knowledge, reverse engineering Capella ECORE model

- **ESA Contract 4000133637 Space System Ontology Development (part 1)**

  Prime Contractor: GorillaIT (NL) – contact: Carla Arauco

  Sub-contractors: ADS, OHB and TAS

  Objective: further develop the CDMS by conceptualizing the Dynamic aspects of the MBSE UoD

- **ESA Contract 4000132827 Space System Ontology Development (part 2)**

  Prime Contractor: GMV Aerospace and Defence, S.A.U. (ES) – contact: Elena Alaña Salazar

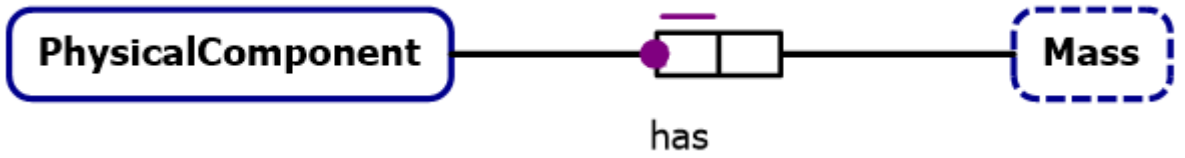
  Sub-contractors: ADS, OHB and TAS

  Objective: Reusing the CDMS outputs, conceptualize the static aspects and integrate the dynamic aspects of the MBSE UoD

Modelling with ORM

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

ORM = Fact Type – Object Type – Constraint



 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

Modelling with ORM ➔ conceptualizing using exactly 3 concepts

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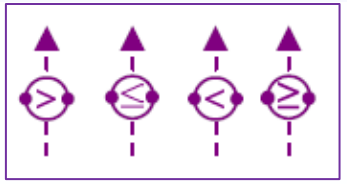
ORM = Fact Type – Object Type – Constraint

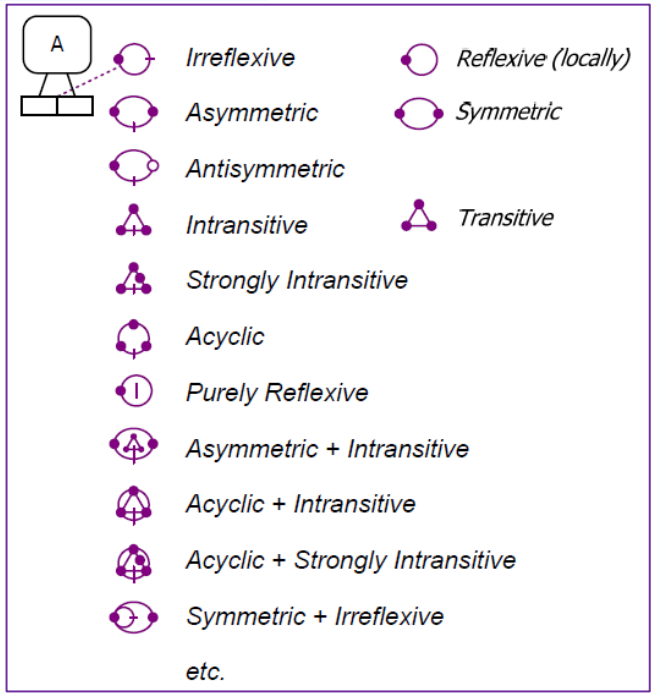
of Alethic Modality (SHALL)

- 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

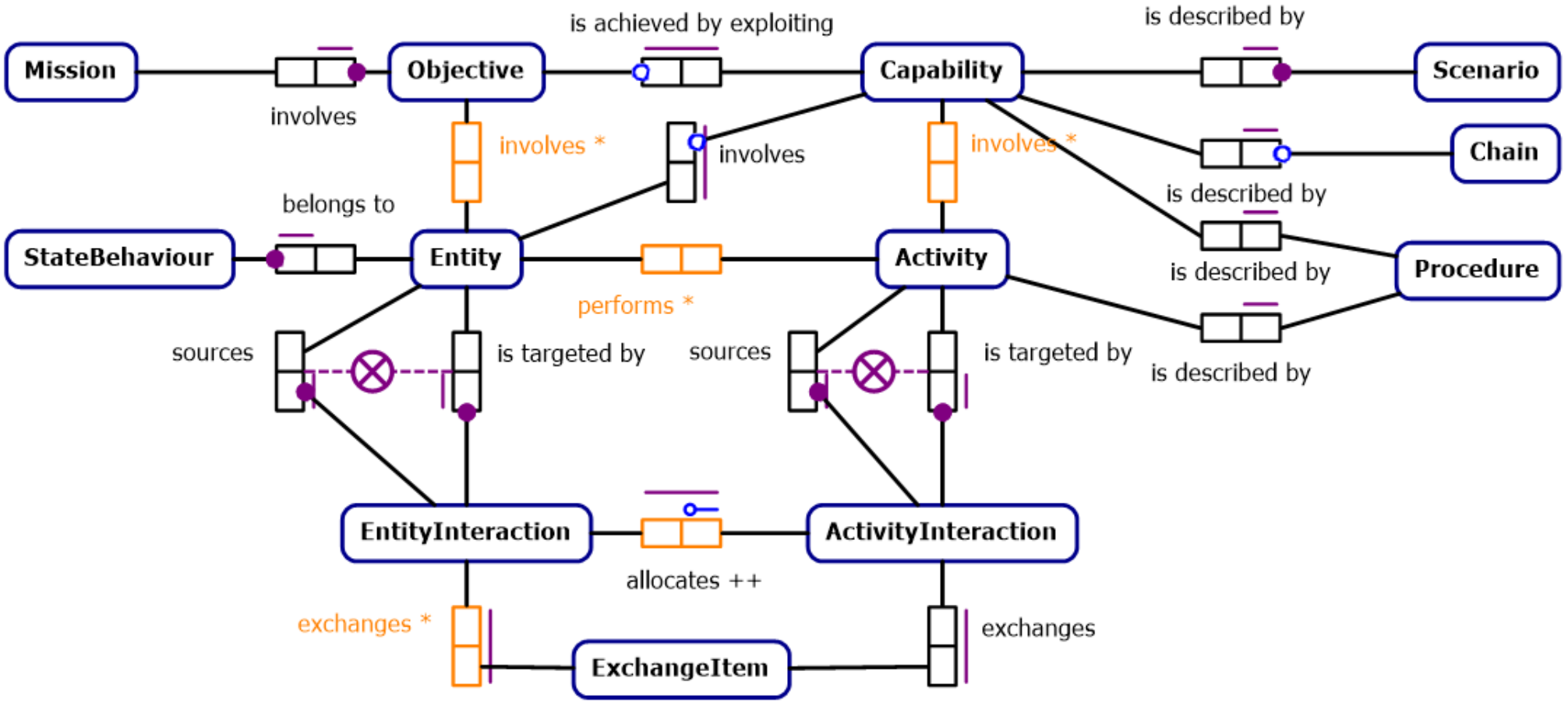


of Deontic Modality (SHOULD)

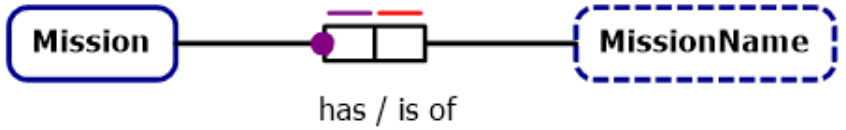
Uniqueness
Mandatory
Subset, Equality, Exclusion
Frequency ^{o}f

Irreflexive	*Acyclic*
Asymmetric	*Asym-Intrans*
Intransitive	*Acyclic-Intrans*
Antisymmetric	*Symmetric*
Strongly Intransitive	*etc.*

MBSE main concepts – overview



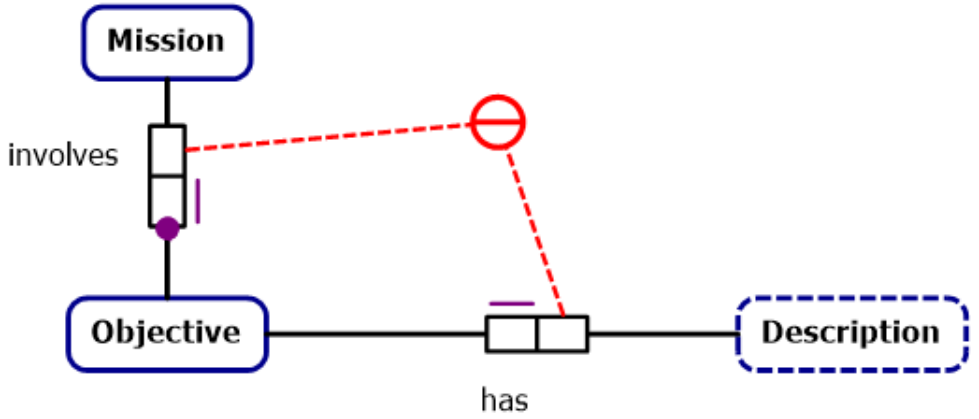
MBSE main concepts – Mission



Mission has MissionName.
Each Mission has **exactly one** MissionName.
Each MissionName is of **at most one** Mission.

- The Mission represents an assignment given to a community involved in the development or operations of the space system or one of its components *e.g. a spacecraft, a payload subsystem*
- It is the starting point of the Ontology.
- Highest level of the MBSE UoD → Everything belongs to it, directly or indirectly.

MBSE main concepts – Objective



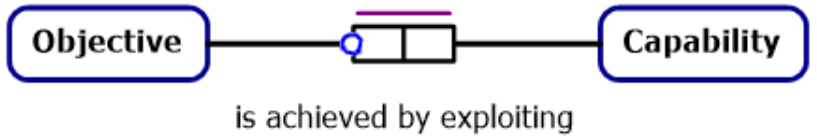
- An Objective is a goal that is intended to be attained *e.g. "forecast atmospheric and oceanic weather"*
- Normally defined by the 'Customer' (who can be external or internal w.r.t. the organisation in charge of the system analysis).

Mission involves Objective.
Each Objective is involved in **exactly one** Mission.
It is possible that some Mission involves **more than one** Objective.

For each Mission **and** Description,
at most one Objective is involved in **that** Mission **and** has **that** Description.

Objective has Description.
Each Objective has **at most one** Description.
It is possible that more than one Objective has **the same** Description.

MBSE main concepts – Capability

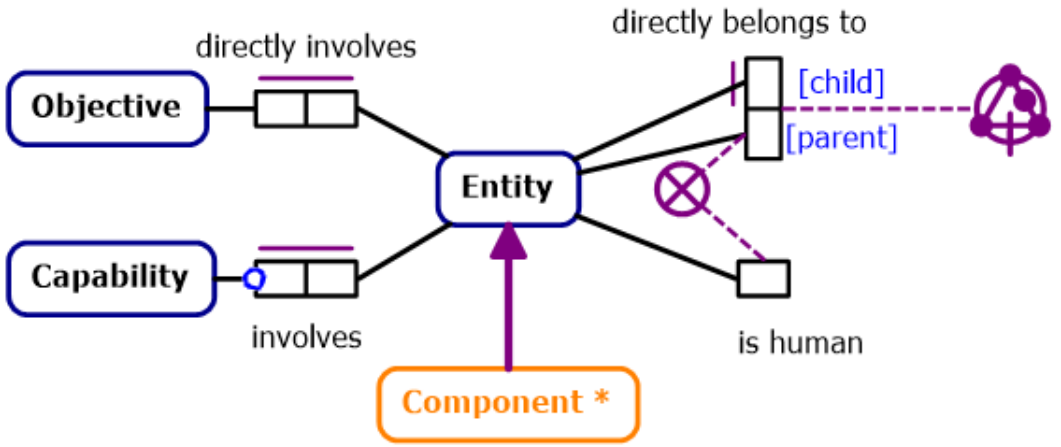


- A Capability represents the ability of a system to fulfil a need.
- Capabilities are the means that support the achievement of Objectives

e.g. "obtain data systematically"

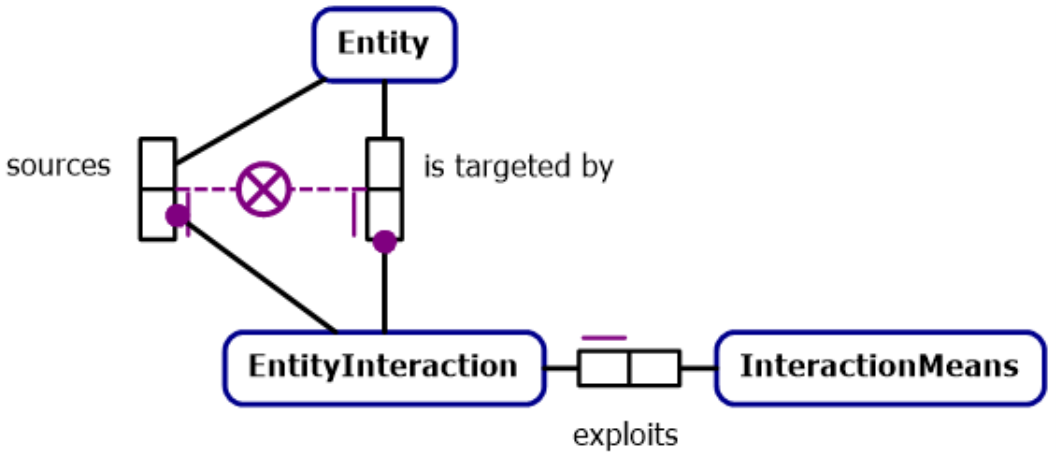
Capability is involved in achieving objective.
It is possible that some objective is achieved by exploiting **more than one** capability
and that some capability is involved in achieving **more than one** objective.
In each population of capability is involved in achieving objective, **each** objective, capability **combination occurs at most once.**
This association with objective, capability **provides the preferred identification scheme for** capability is involved in achieving objective.
It is obligatory that each objective is achieved by exploiting **some** capability.

MBSE main concepts – Entity



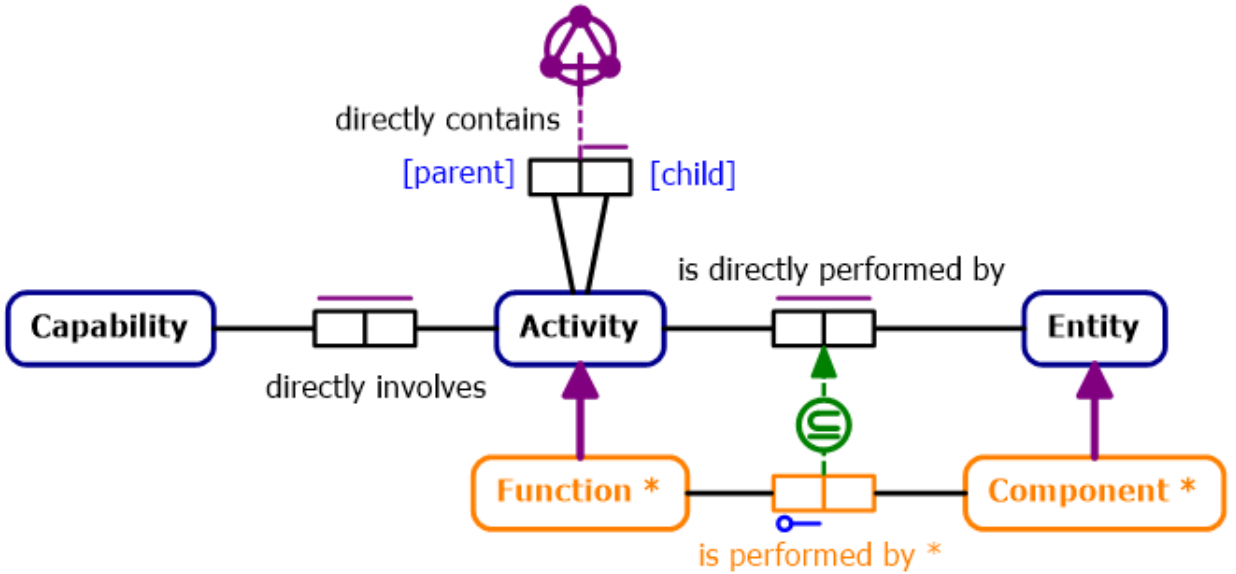
- Entities represent relevant real-world systems *e.g. the space system, a device...*, organisations *e.g. ESA / ESOC* or human beings *e.g. Operator.*
- Entities are involved in objectives and capabilities
- Entities can be decomposed into a tree of sub-entities to provide a higher level of detail if needed
- Entities can also be specialised as actors or components, including logical components and hosting components.

MBSE main concepts – Entity Interactions



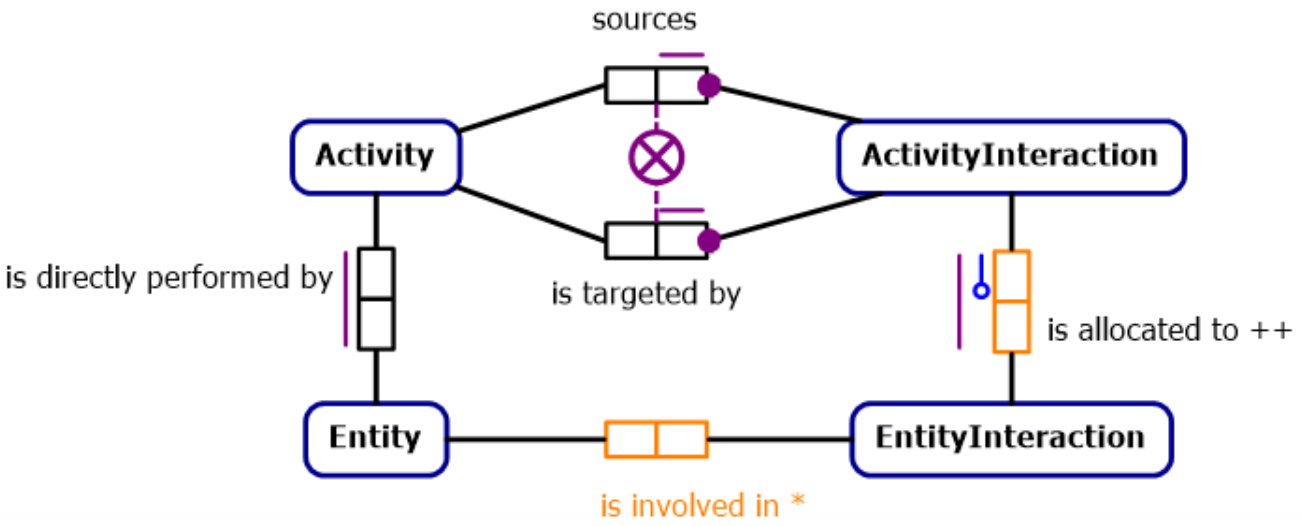
- Directional link between two entities, the source and the target of the interaction that is produced through an interaction means.
- For instance, an entity interaction can be the sunlight emission that goes from the Sun to the solar panel of a spacecraft. The interaction means in this case would be the space vacuum.
- When entity interactions are used to express links between components, they connect component ports

MBSE main concepts – Activity



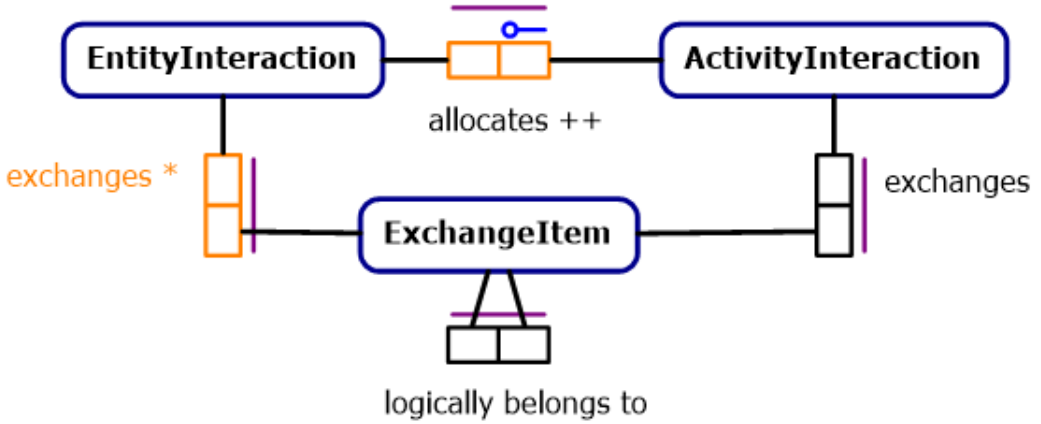
- Activities represent actions, operations or services *e.g. “acquire temperatures", "provide power".*
- Activities are involved in the realization of capabilities
- Activities can be decomposed into a tree of activities to provide a higher level of detail if needed
- Activities can also be specialised as operational activities or functions.
- Activities are performed by entities (and functions are performed by components)

MBSE main concepts – Activity Interaction



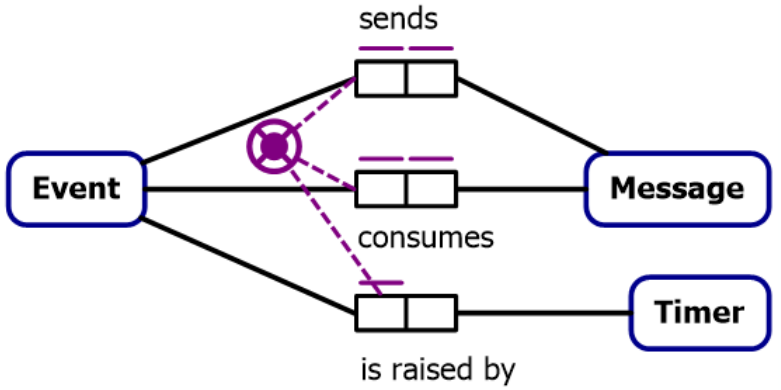
- An activity interaction represents a directional link between two activities (the source and the target).
- An example is the sunlight exchange between the Sunlight Production activity of the Sun and the Sunlight Capturing activity of the Solar Panel.
- As activities are performed by entities, activity interactions are allocated to entity interactions

MBSE main concepts – Exchange Item



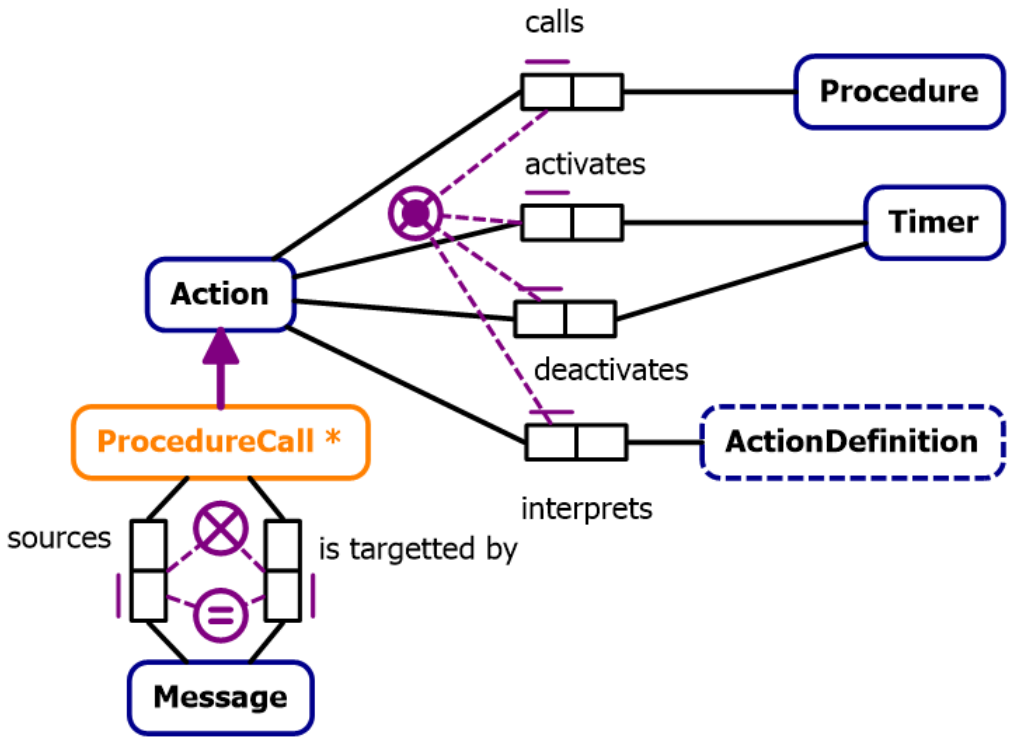
- Exchange Items represent the elements exchanged in an interaction between activities.
- Examples of exchange items are heat, oxygen, hydrazine, electrical current, temperature, etc.
- Exchange Items can be decomposed into a tree of exchange items to provide a higher level of detail if needed.
- As activity interactions are allocated to entity interactions, exchange items also represent elements exchanged in interactions between entities

MBSE main concepts – Event



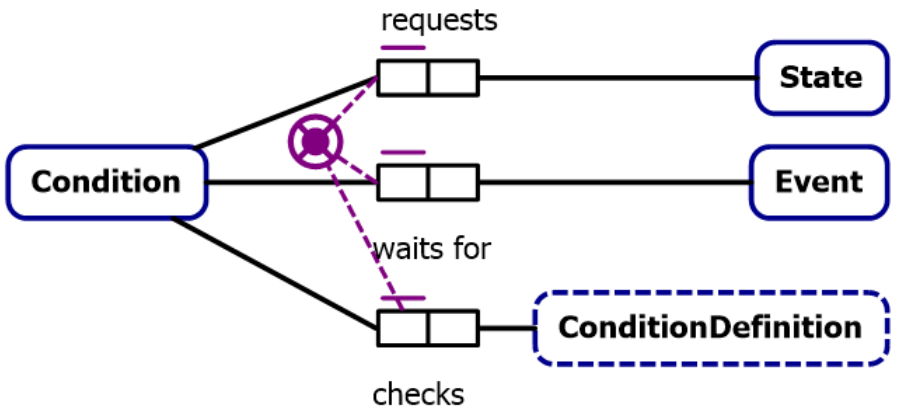
- An Event is something that can happen or can be raised internally or externally and that may trigger or constrain behavioural effects on the system.
- An event happen when a message that implement an activity interaction is sent, or received.
- An event can also be raised by a timer.

MBSE main concepts – Action



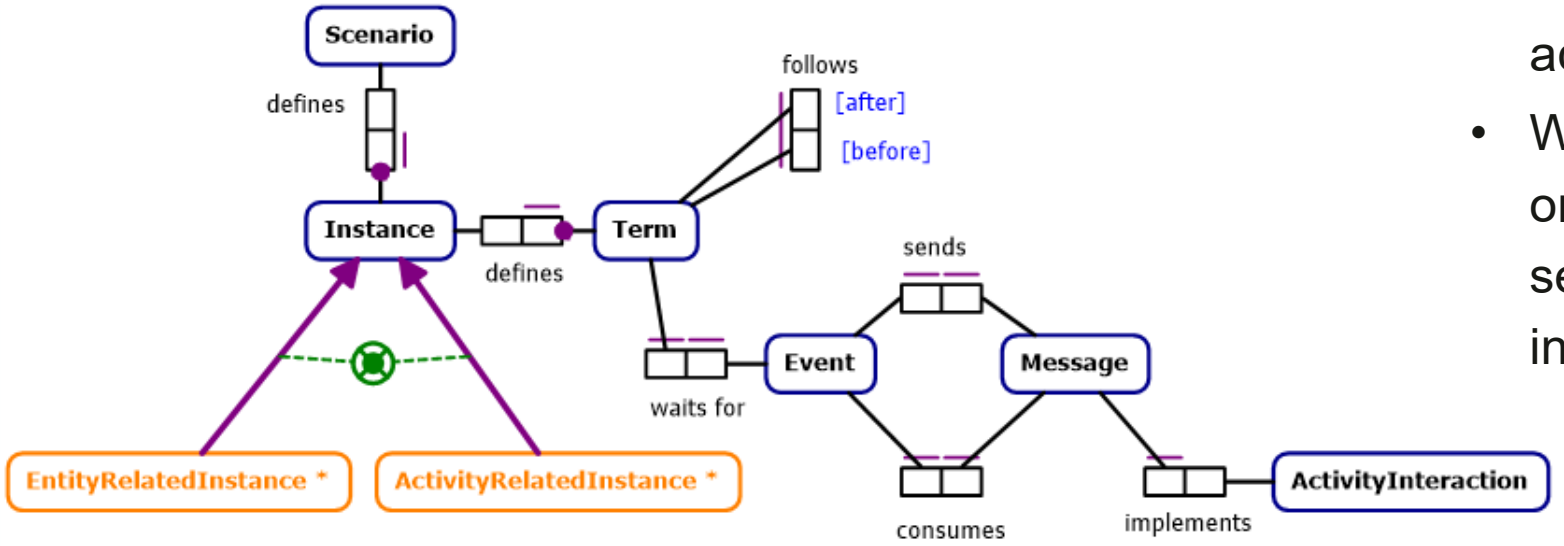
- An action is a dynamic functionality that either:
  - calls a procedure that details an activity,
  - interpret some action text,
  - activates a timer, or de-activate a timer.
- Procedure calls are actions that call a procedure. They are the source and target of messages that implement the activity interactions

MBSE main concepts – Condition



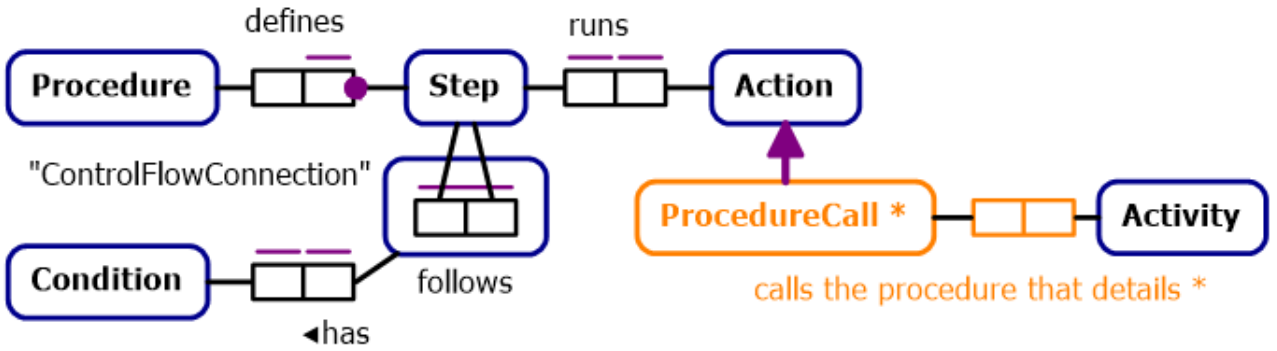
- A condition is defined either:
  - by the check of a condition text,
  - by waiting for the occurrence of an Event,
  - or by requesting to be in a specific State.
- Conditions are used to guard state transitions, to constrain procedure control flows, and can be sequenced in scenarios

MBSE main concepts – Scenario

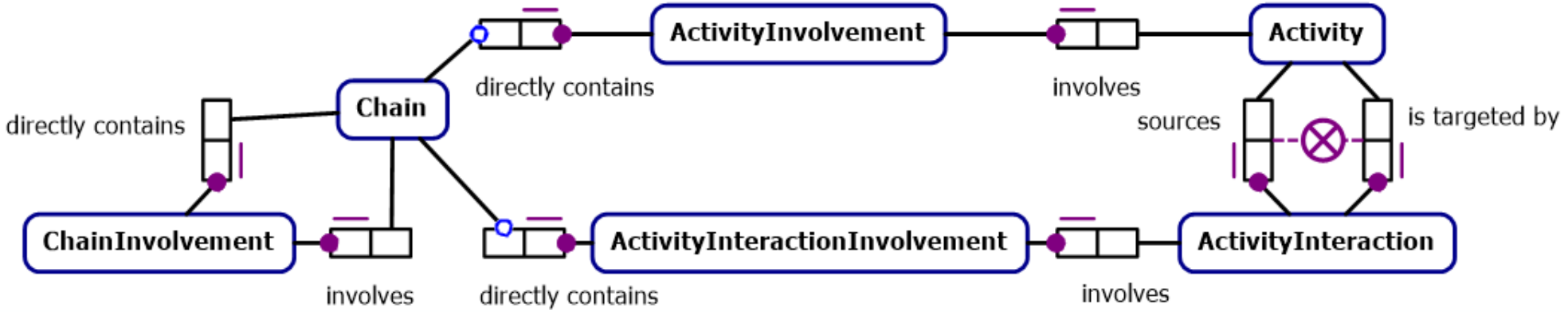


- A scenario defines a sequence of interactions between instances of entities or activities that allow to achieve a capability
- Within a scenario, each instance (of entity or activity) defines a timeline with a sequence where emission or reception of interactions occur.

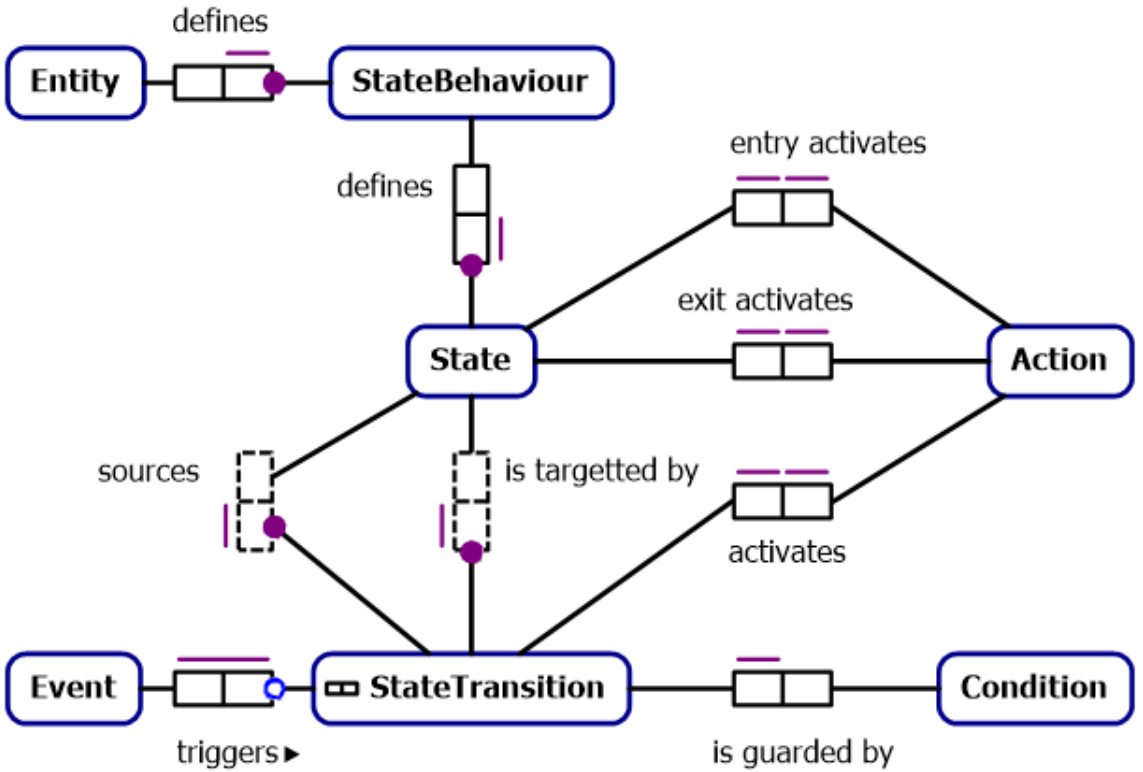
MBSE main concepts – Chain and Procedure



- Chains and Procedures define a sequence of activities that describe the performance of a capability or a higher level activity. Chains focus on the static aspect where the sequence of involved activities is deduced from their interactions, while Procedures focus on the dynamic aspects where additional explicit sequencing may be needed.
- Chains only involve activities and activity interactions, while Procedures have an explicit sequence of steps that may run activity calls or other actions

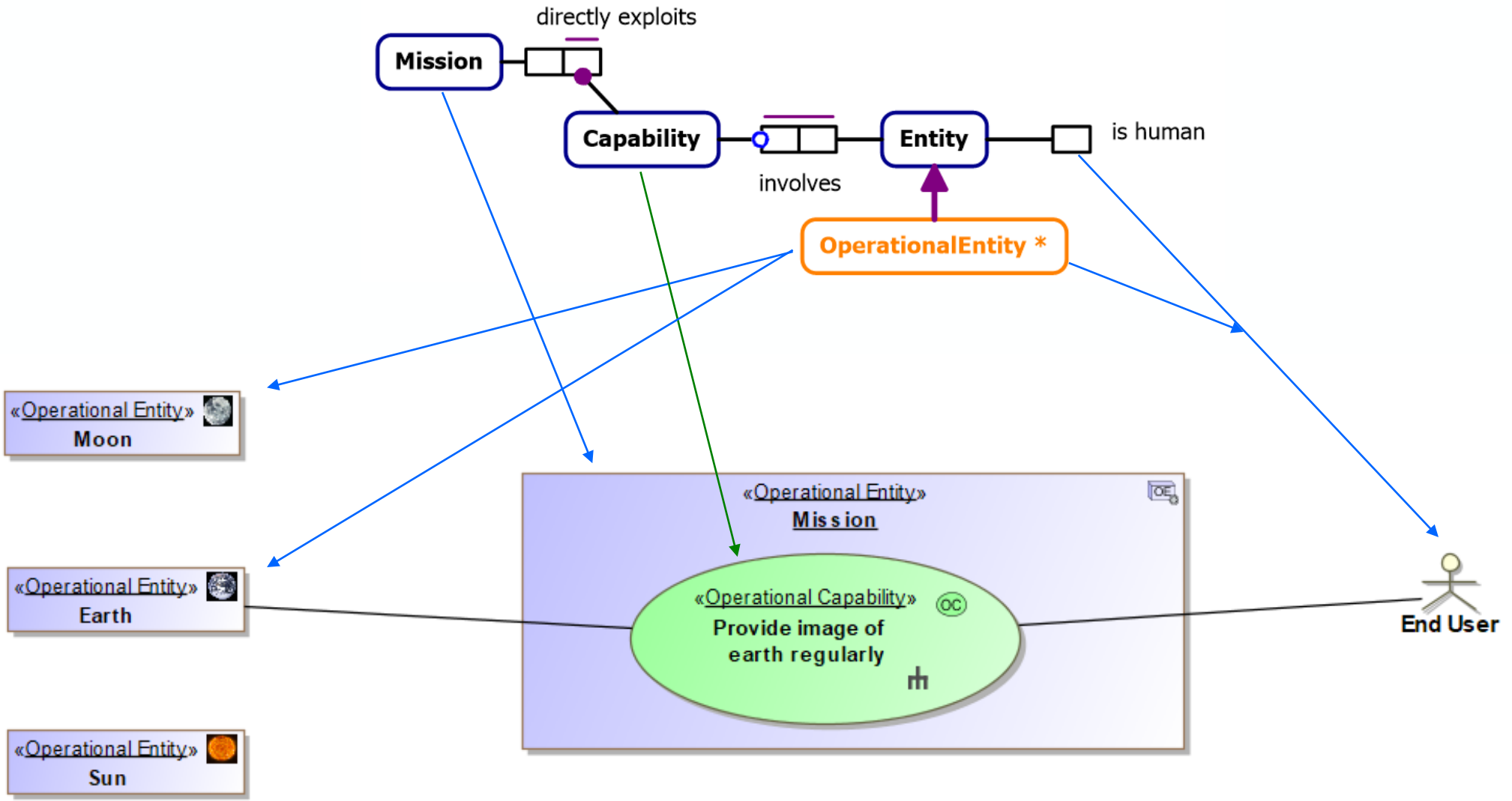


MBSE main concepts – State Behaviour

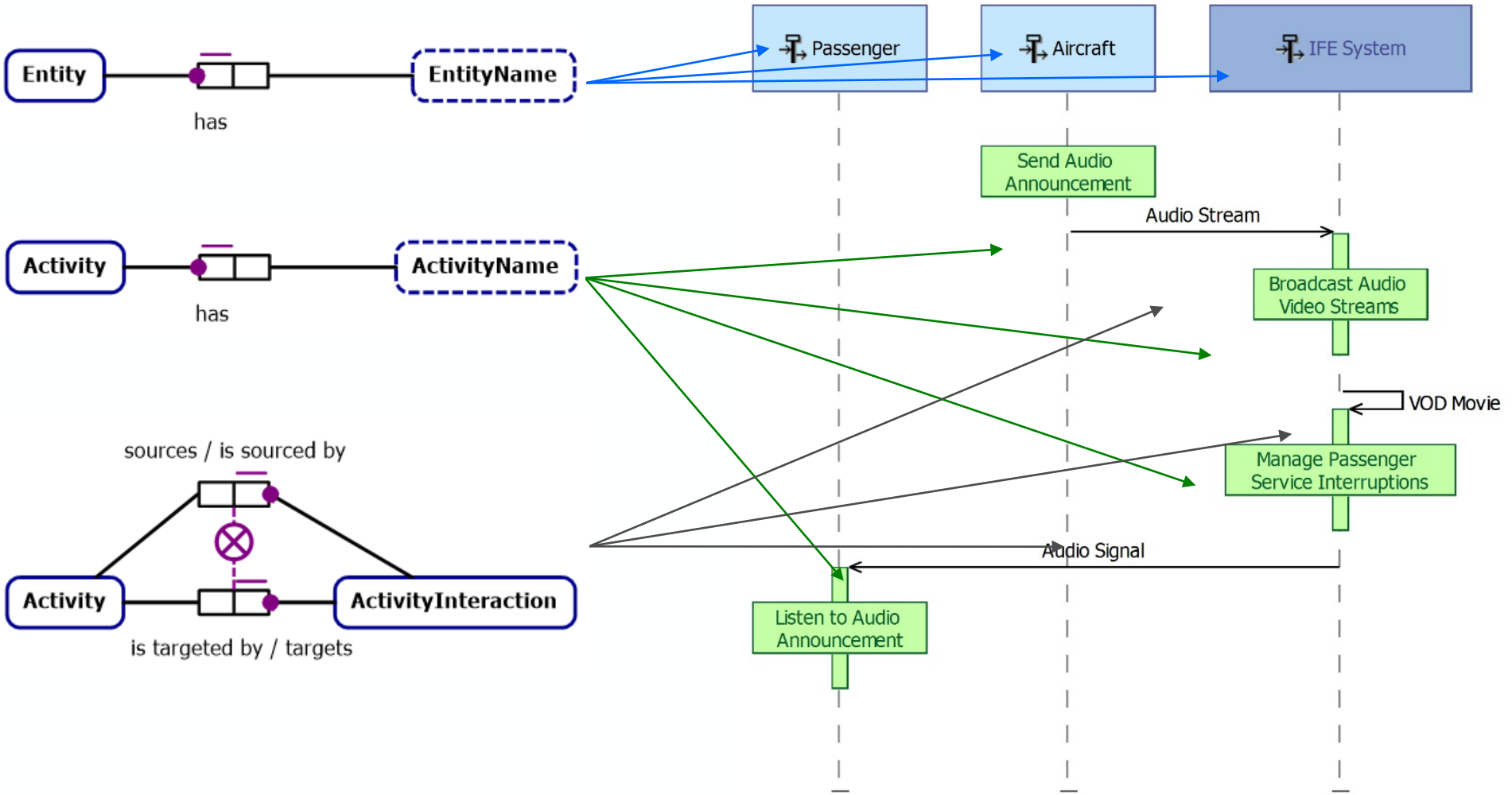


- A state behaviour defines the states of an entity and the allowed transitions between these states.
- States can limit the activities that an entity can perform, and state transitions can activate activity calls or other actions
- State transitions are triggered by events, and can be guarded by conditions

Example OHB – Operational Analysis



Example Thales Alenia Space – Operational Analysis



Tips and tricks

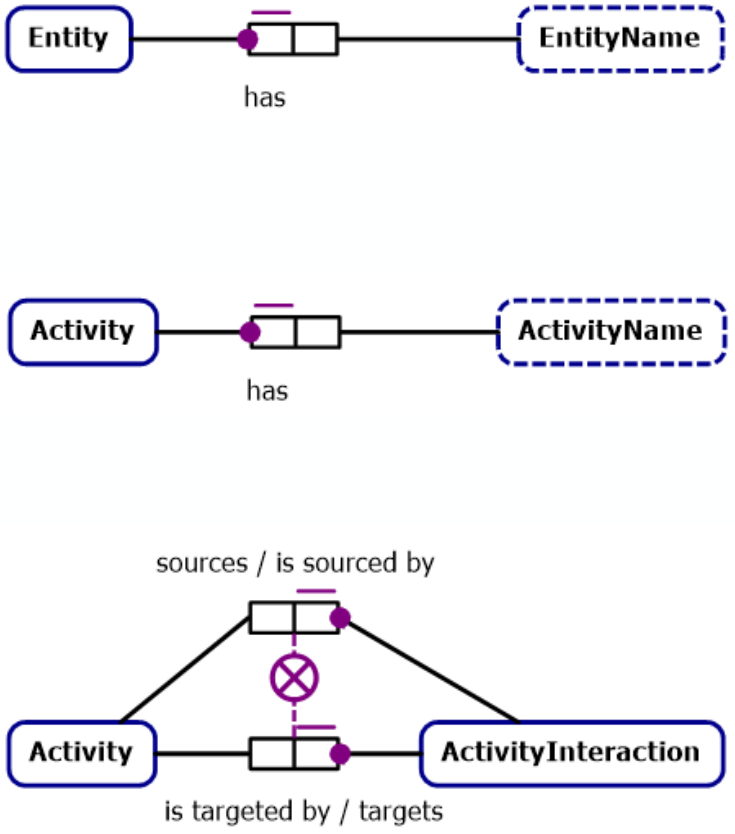
This Exchange Scenario has been automatically initialized from the corresponding Functional Scenario.

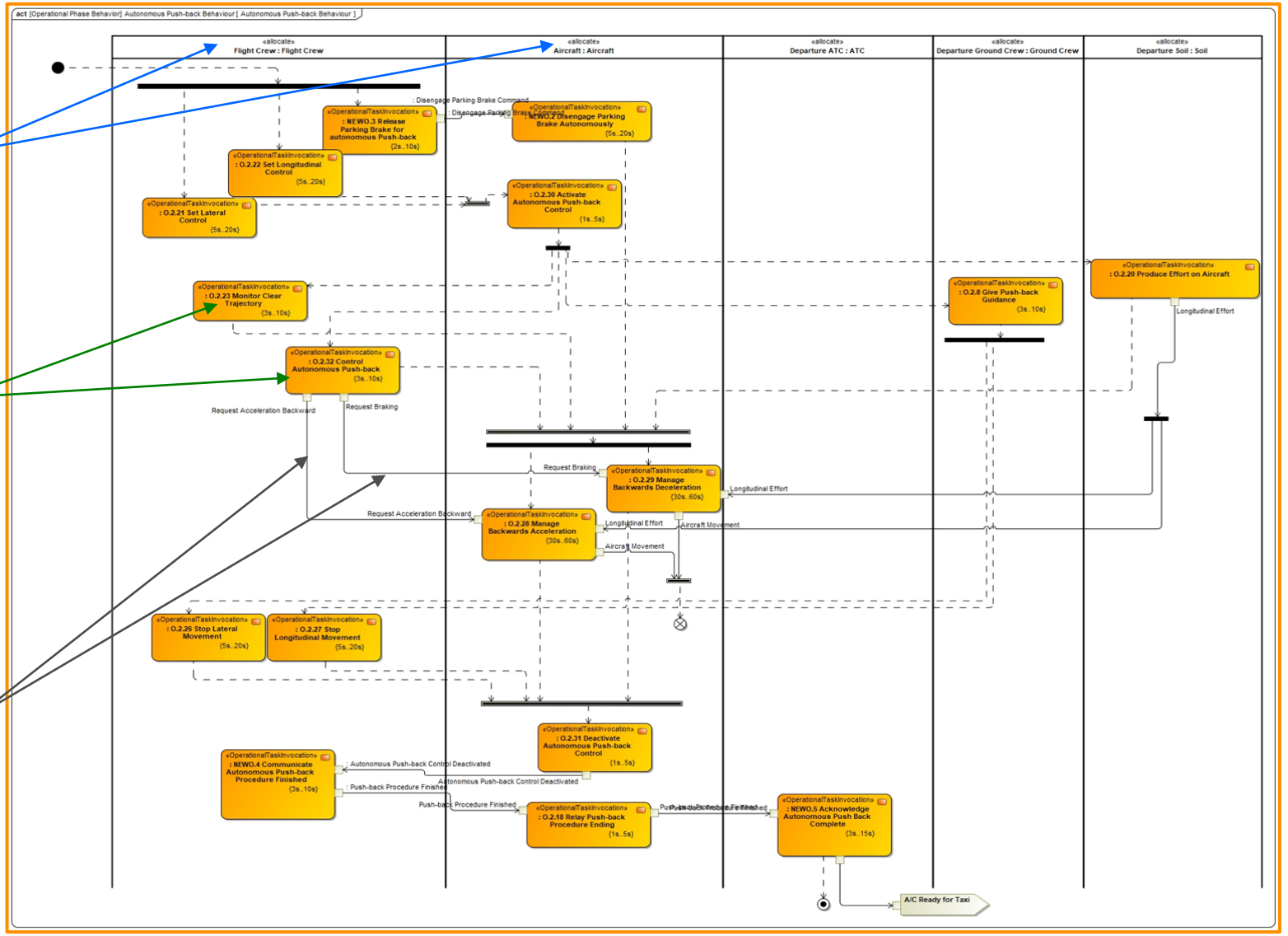
Function "boxes" have then be added.

The Audio announcement is performed by the crew members using the aircraft built-in equipments (microphone, cabin speakers). The goal of the IFE is to forward the audio stream towards each Seat TV and to display an interruption message.

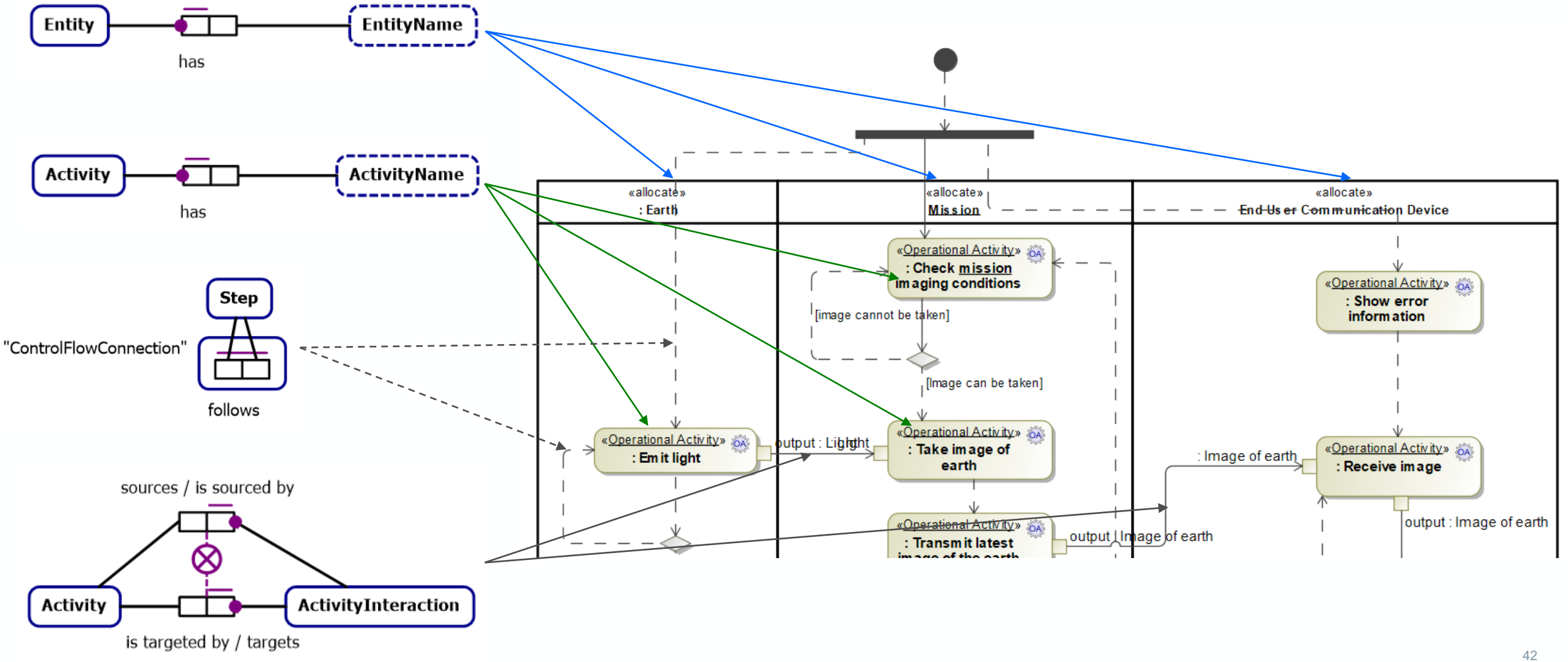
This is why, from the IFE system point of view, Cabin Crew is actually not part of the scenario.

Example Airbus DS – Operational Analysis

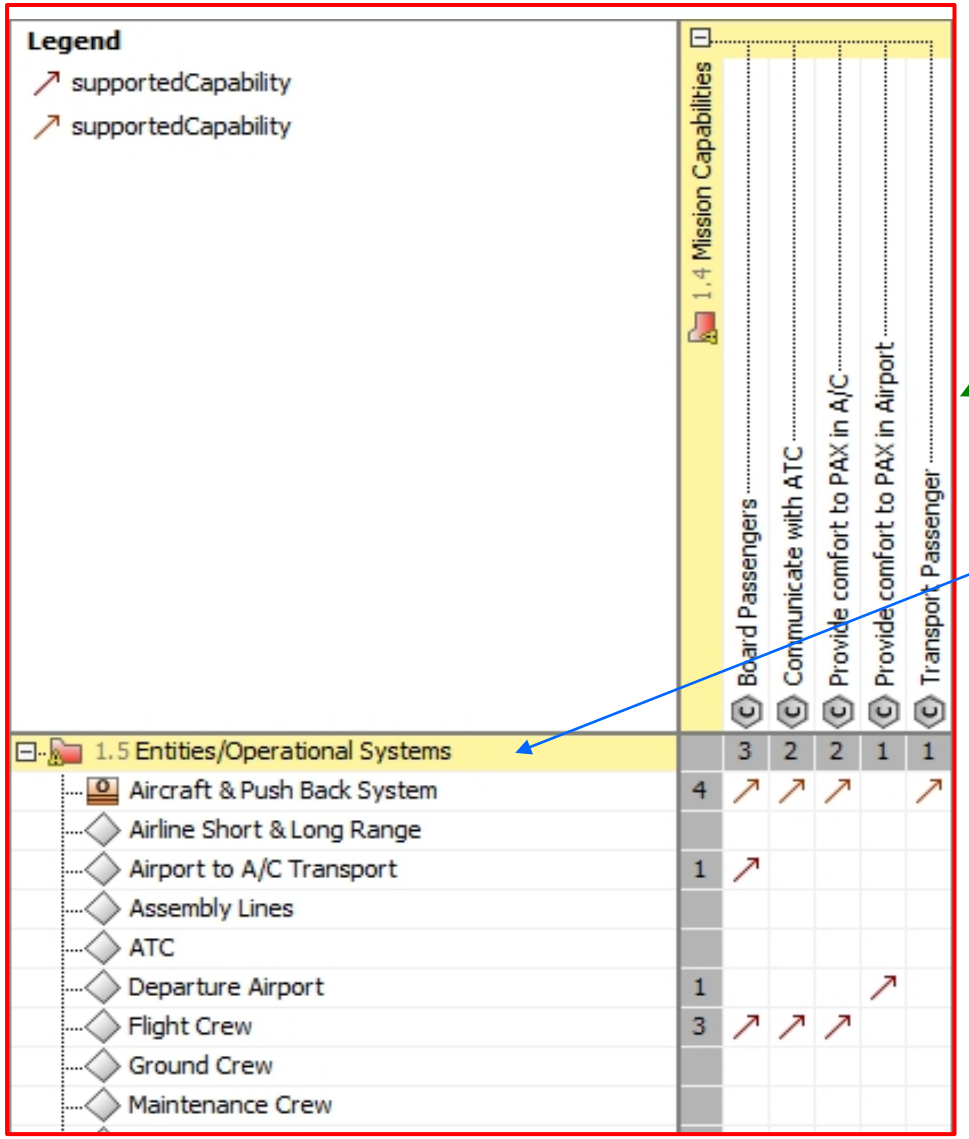


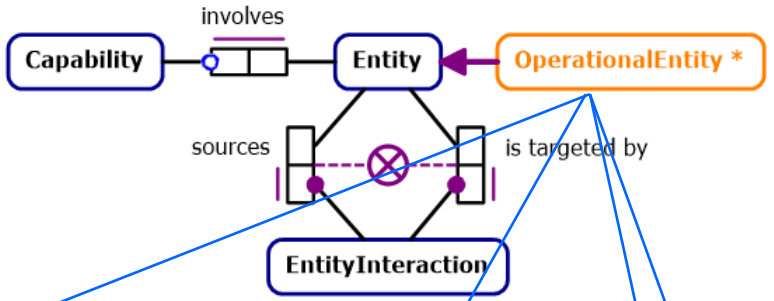


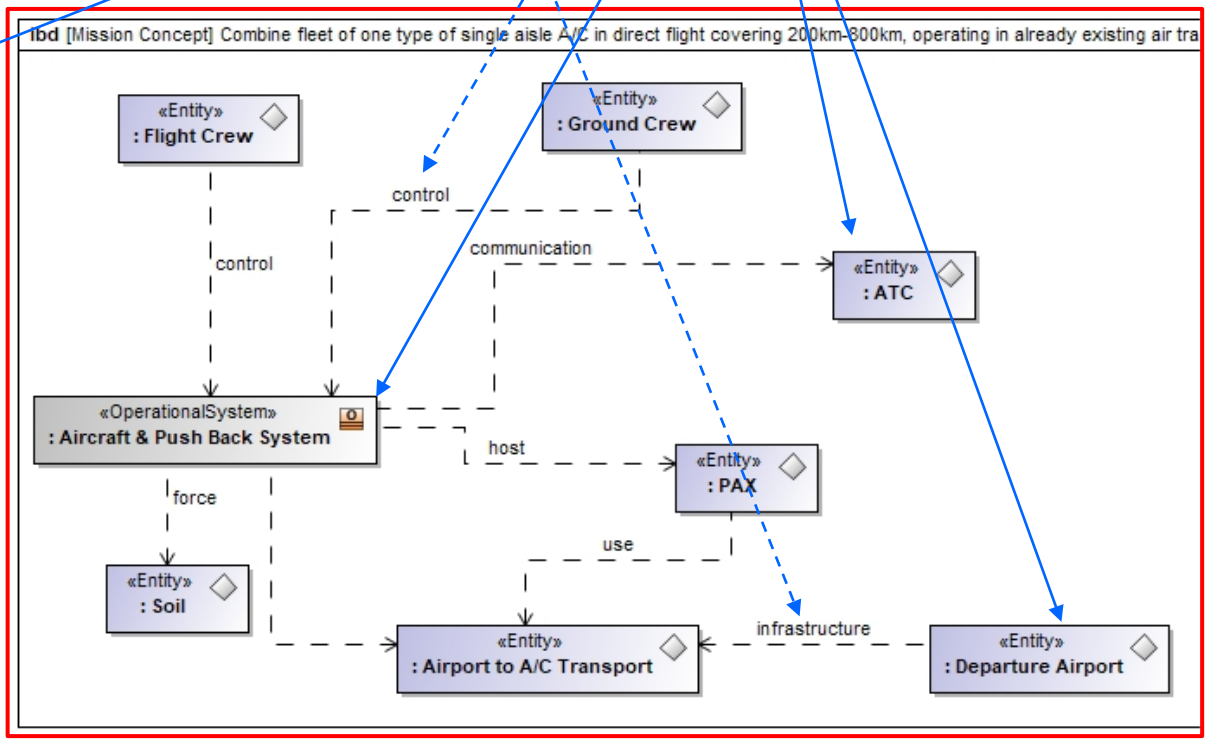
Example OHB – Operational Analysis



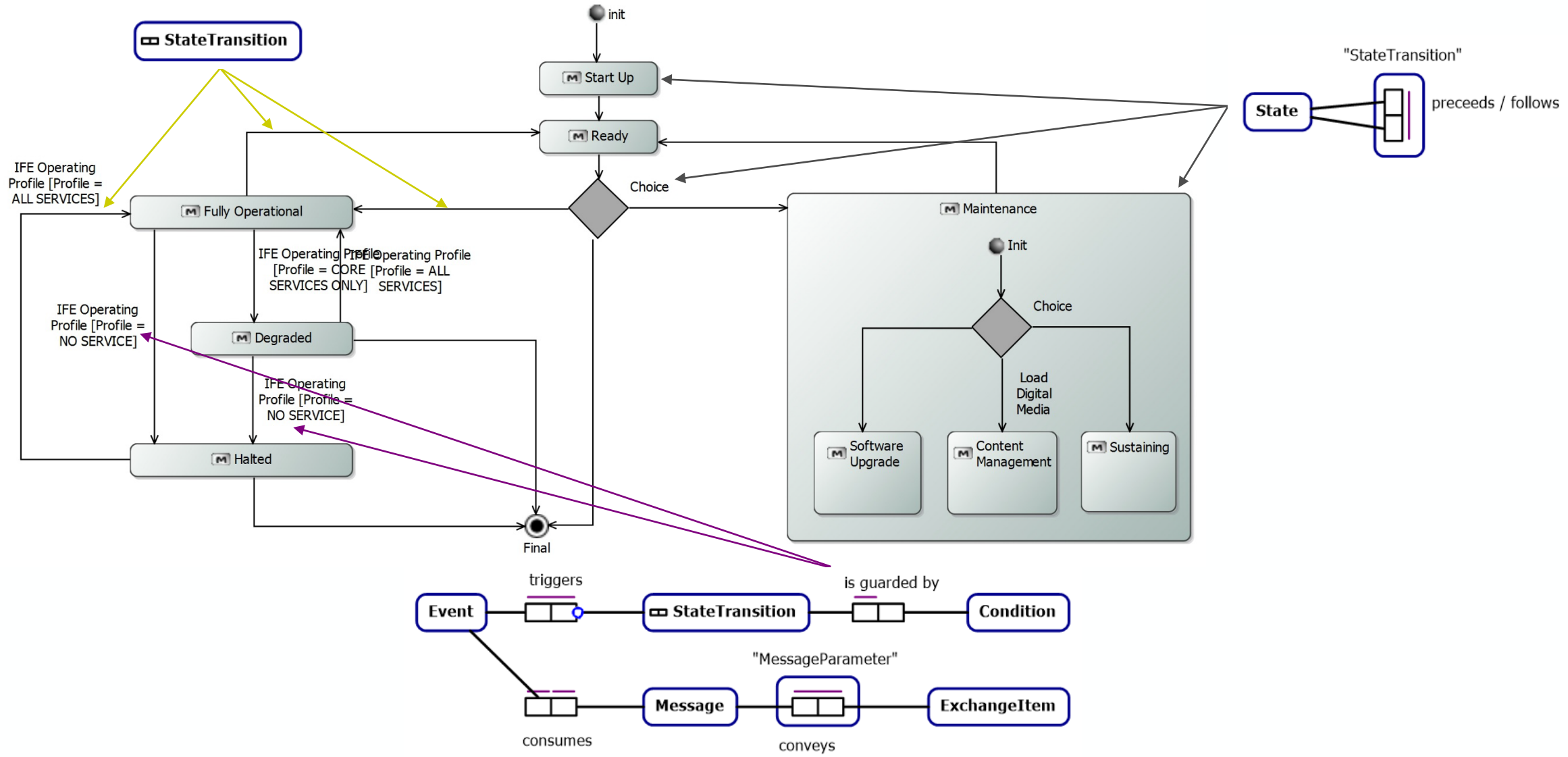
Example Airbus DS – Operational Mission Analysis



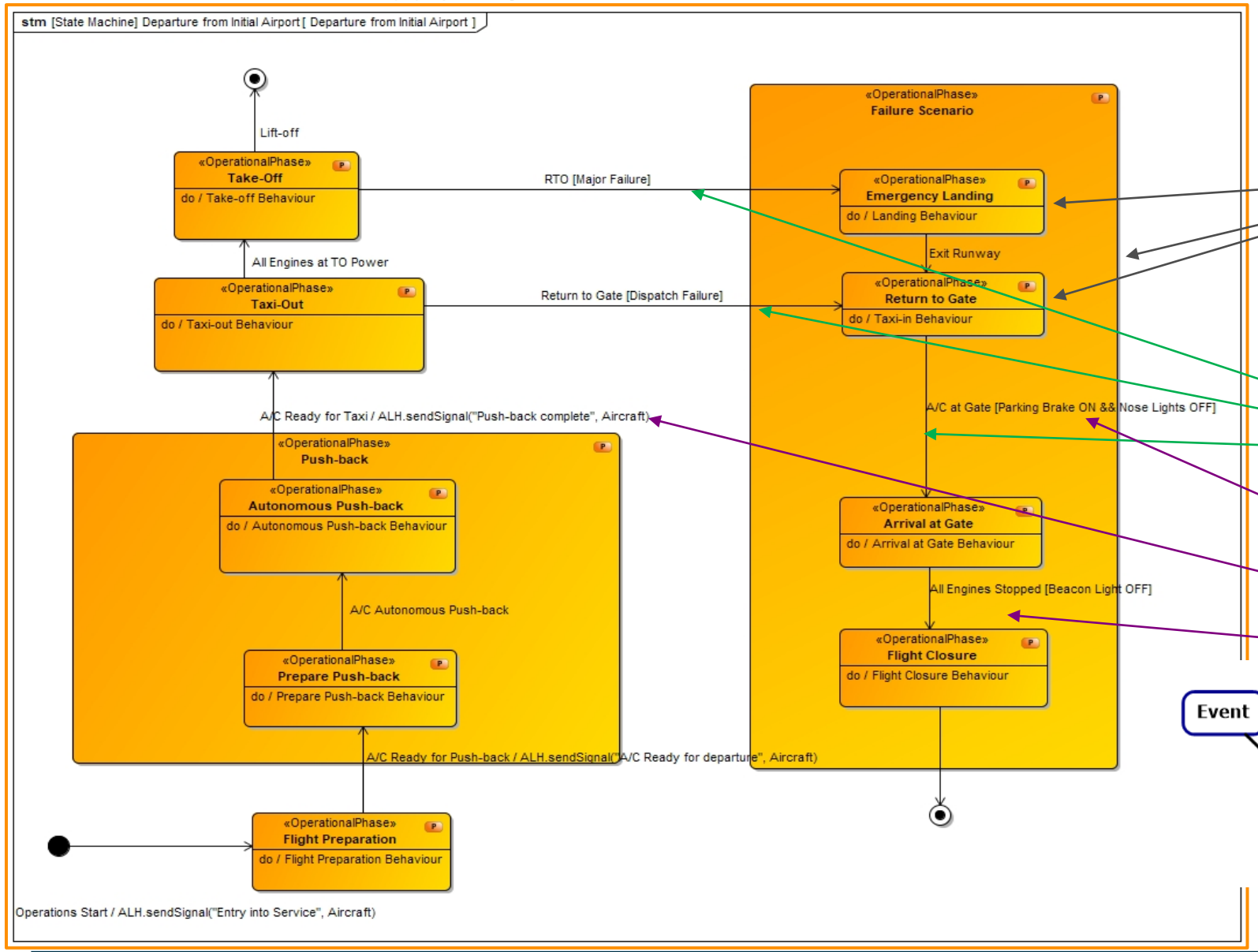


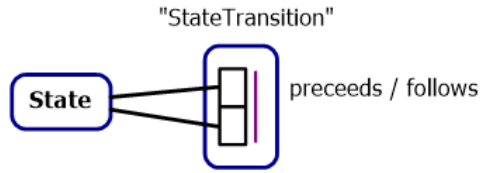


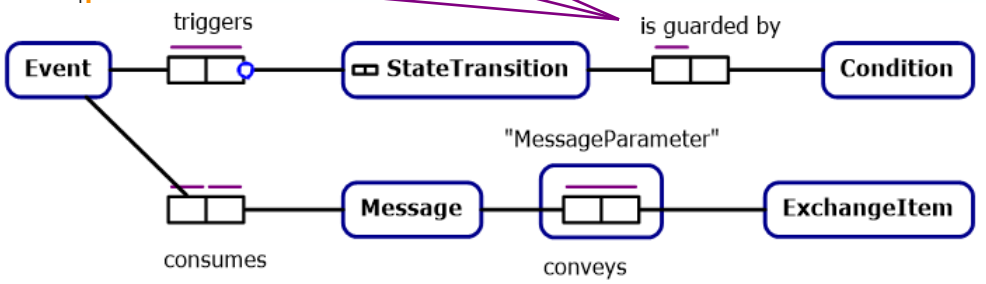
Example Thales Alenia Space – State Behaviour



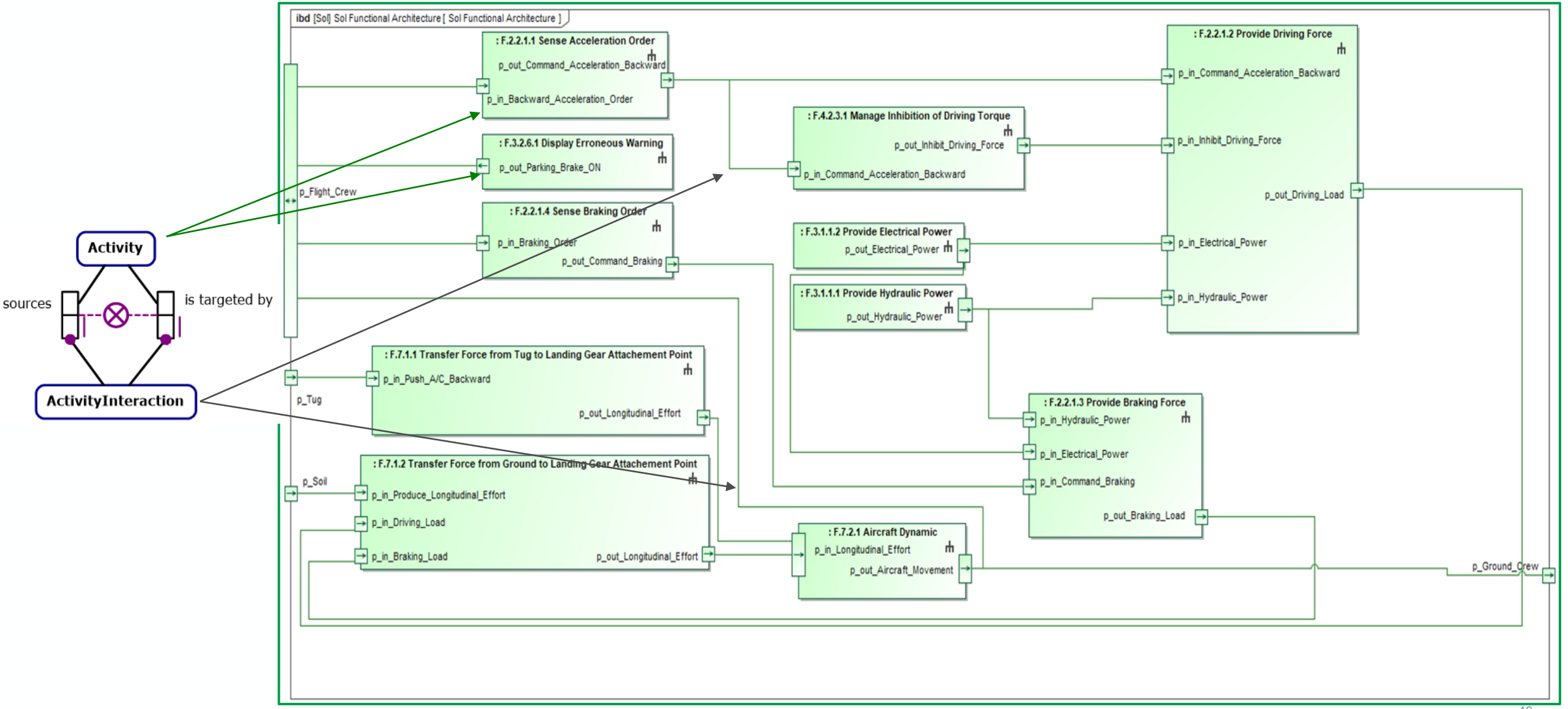
Example Airbus DS – State Behaviour



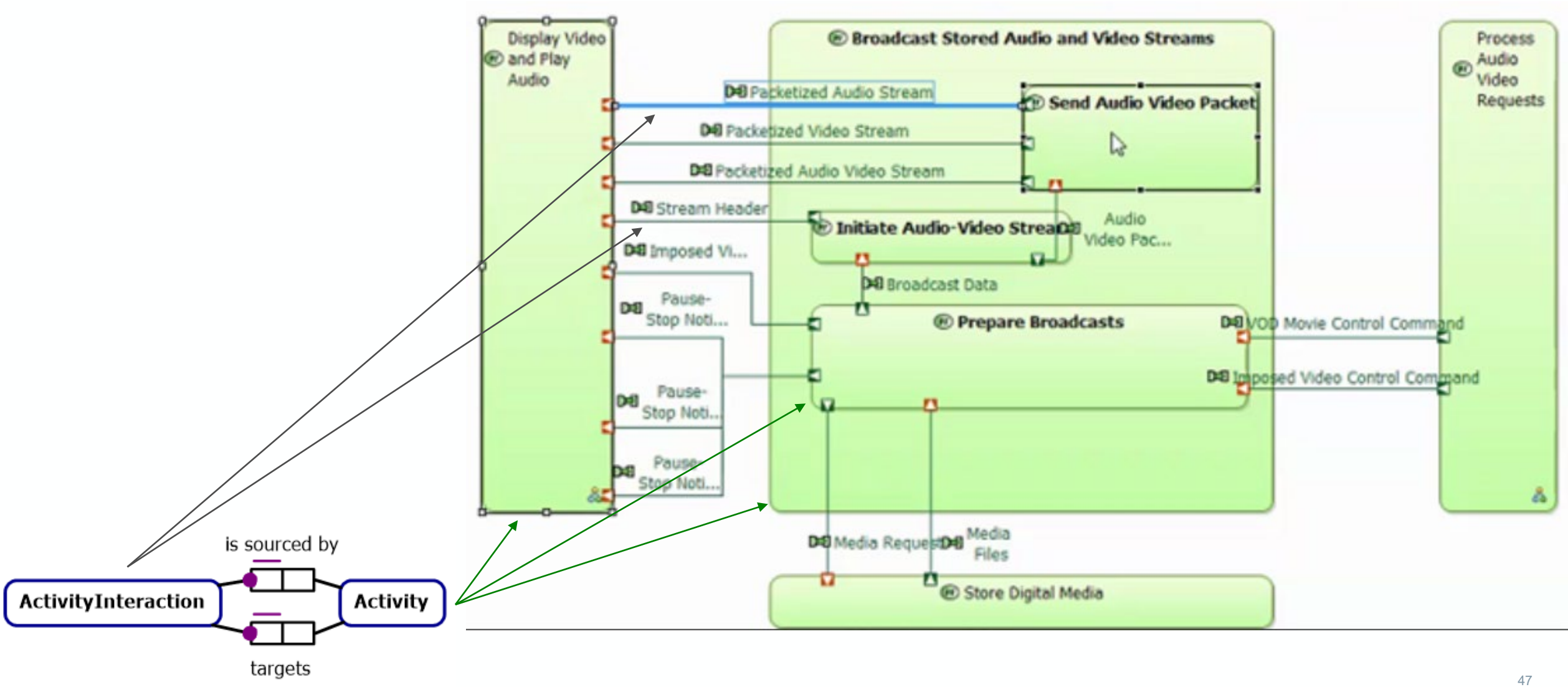




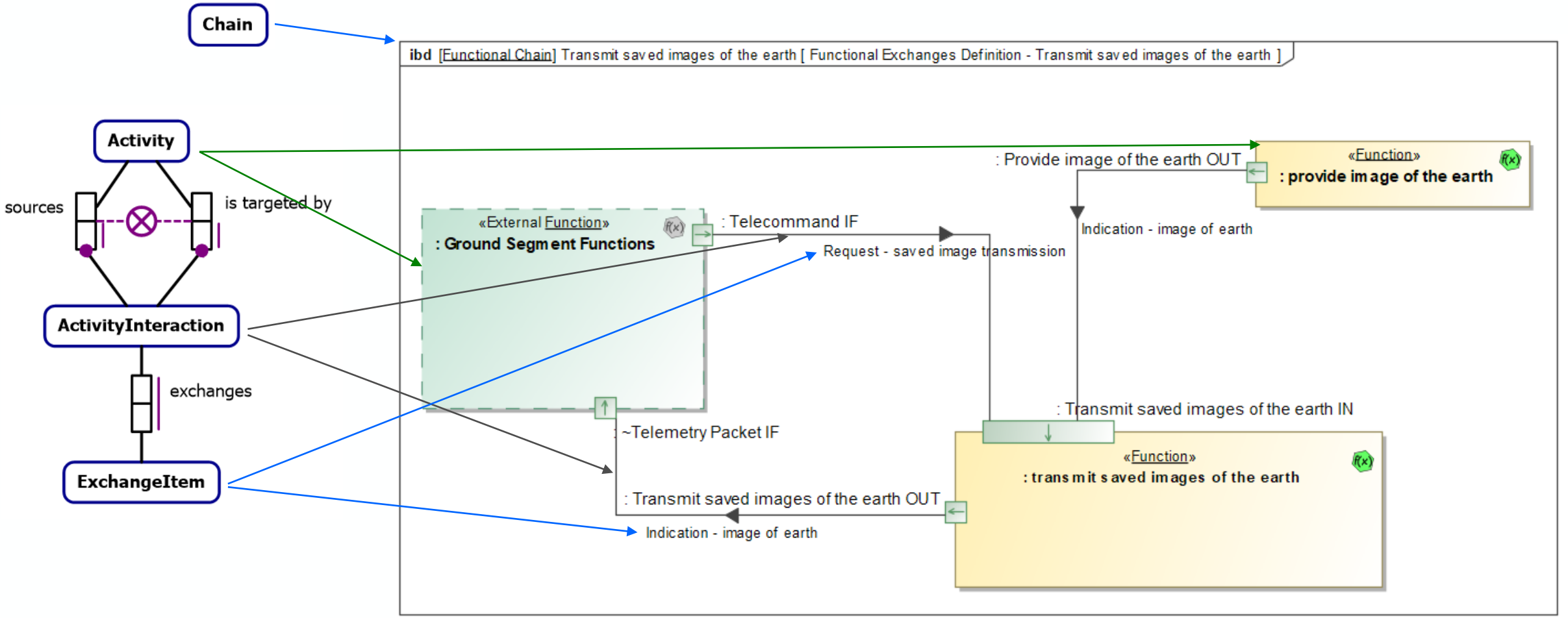
Example Airbus DS – Functional Analysis



Example Thales Alenia Space – Functional Analysis



Example OHB – Functional Analysis



Example Airbus DS – Logical Analysis Architecture

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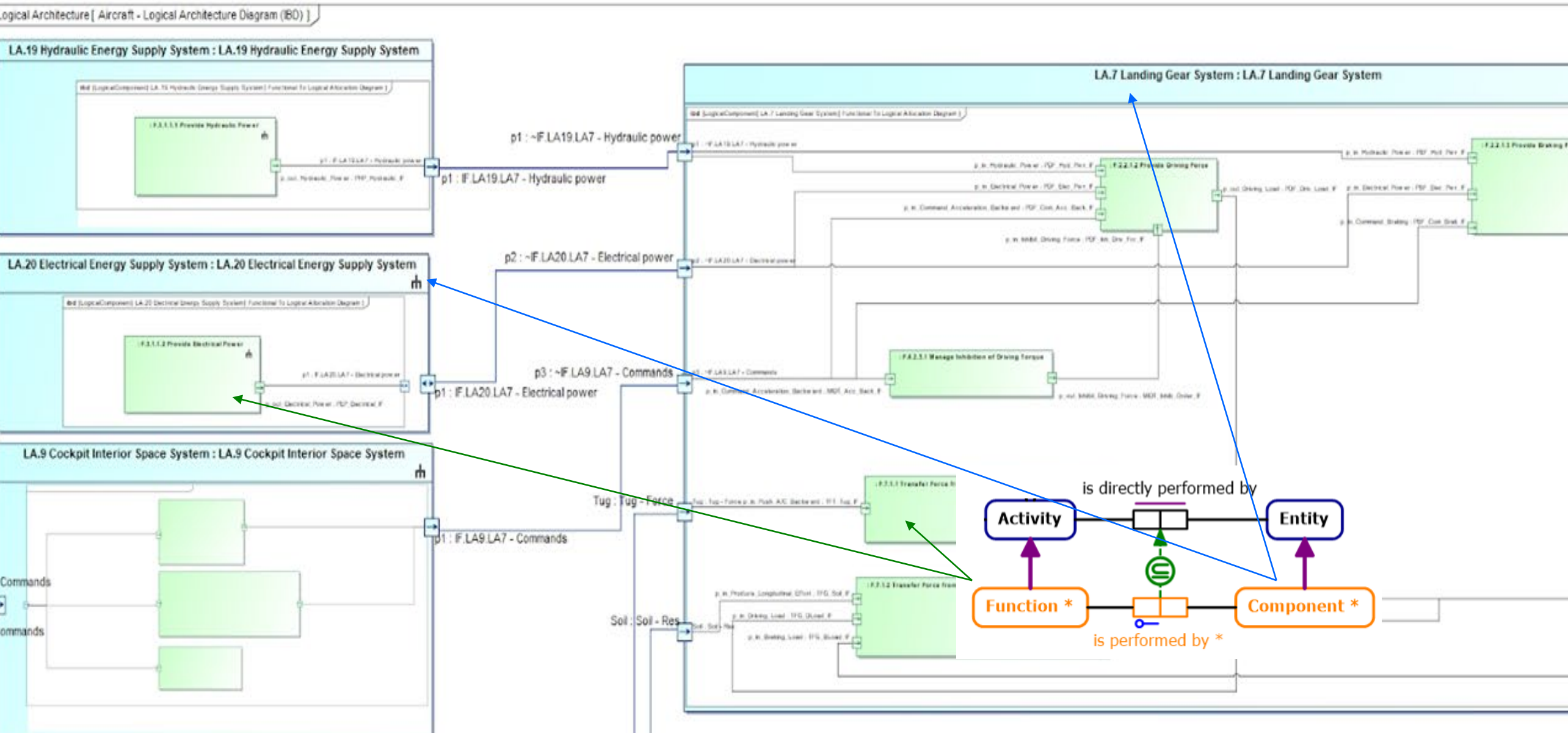

Example Thales Alenia Space – Logical Analysis

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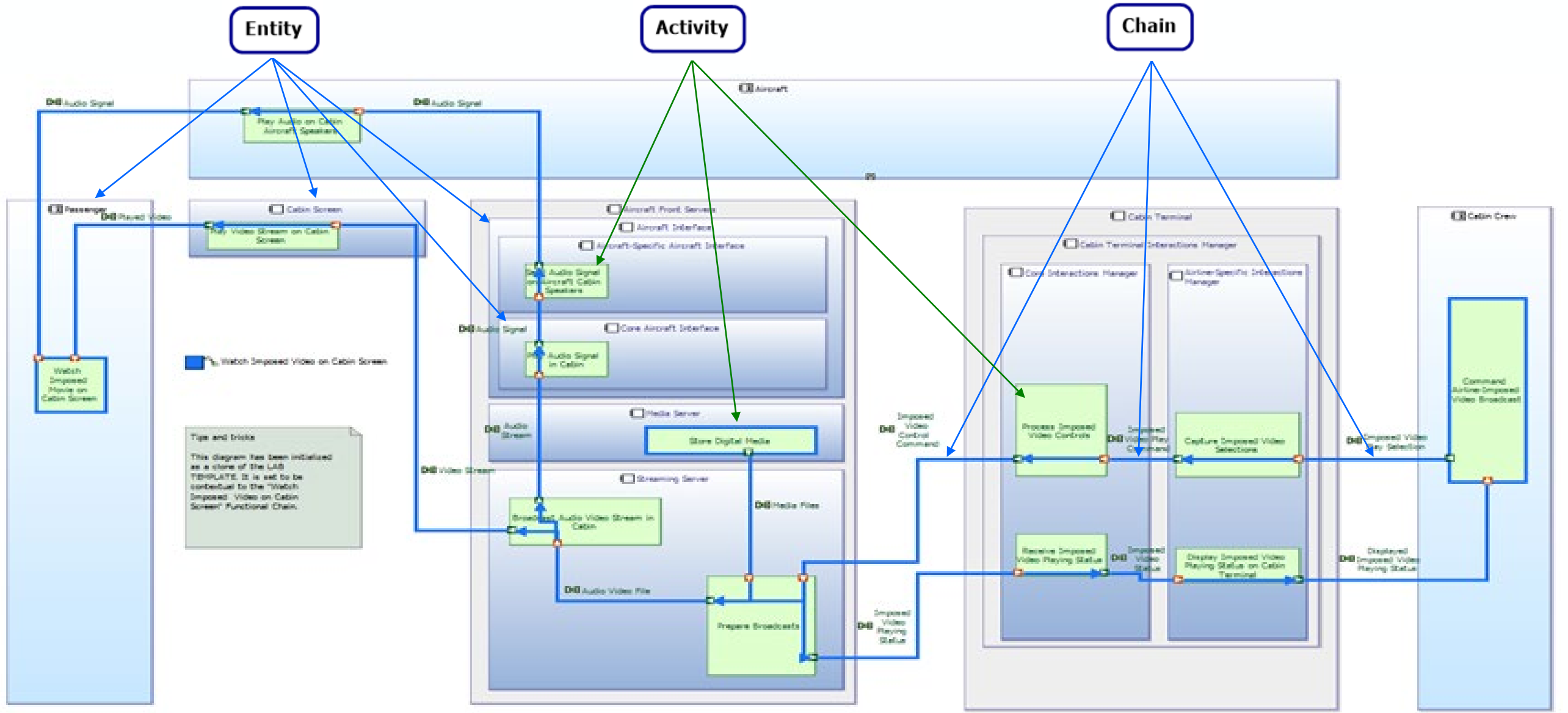
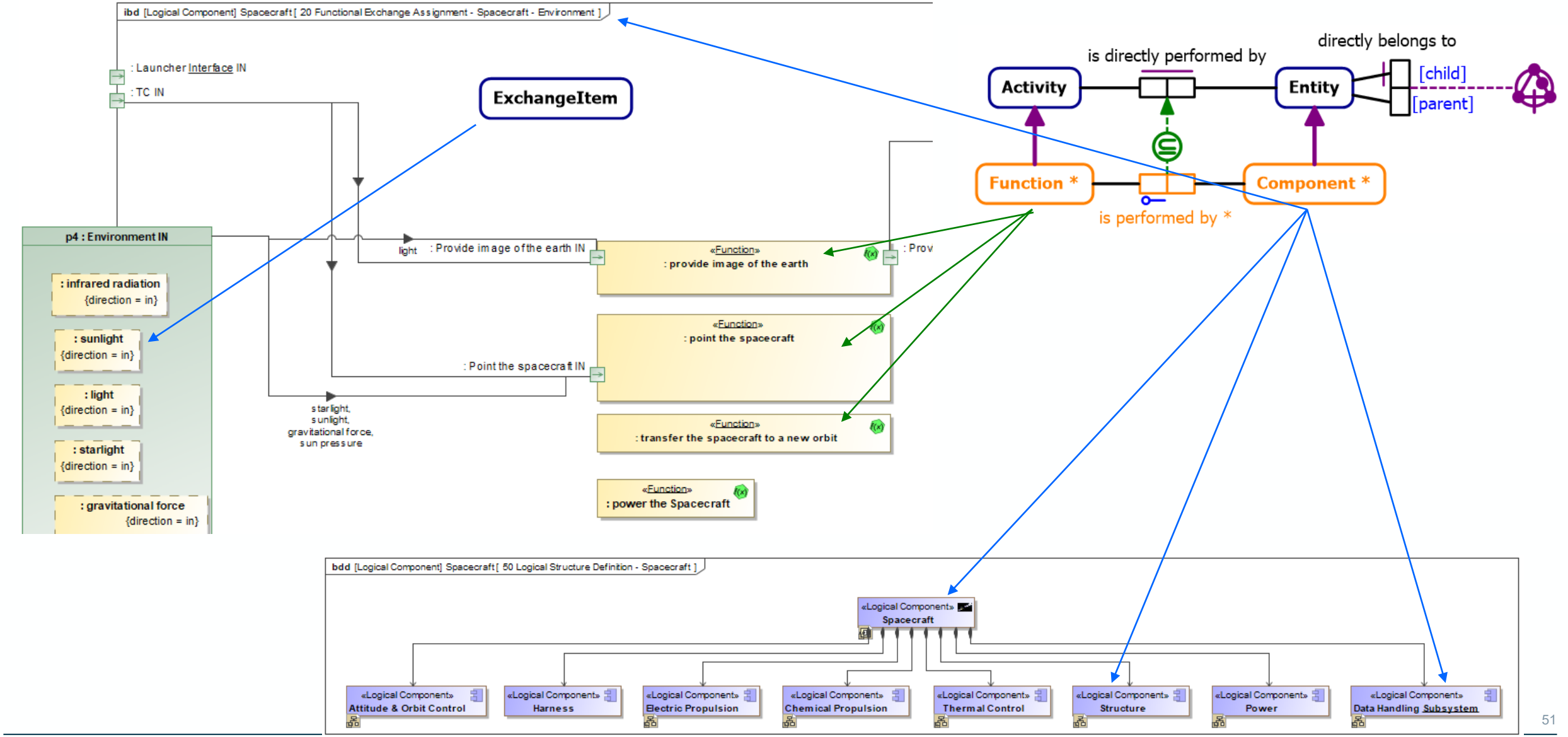
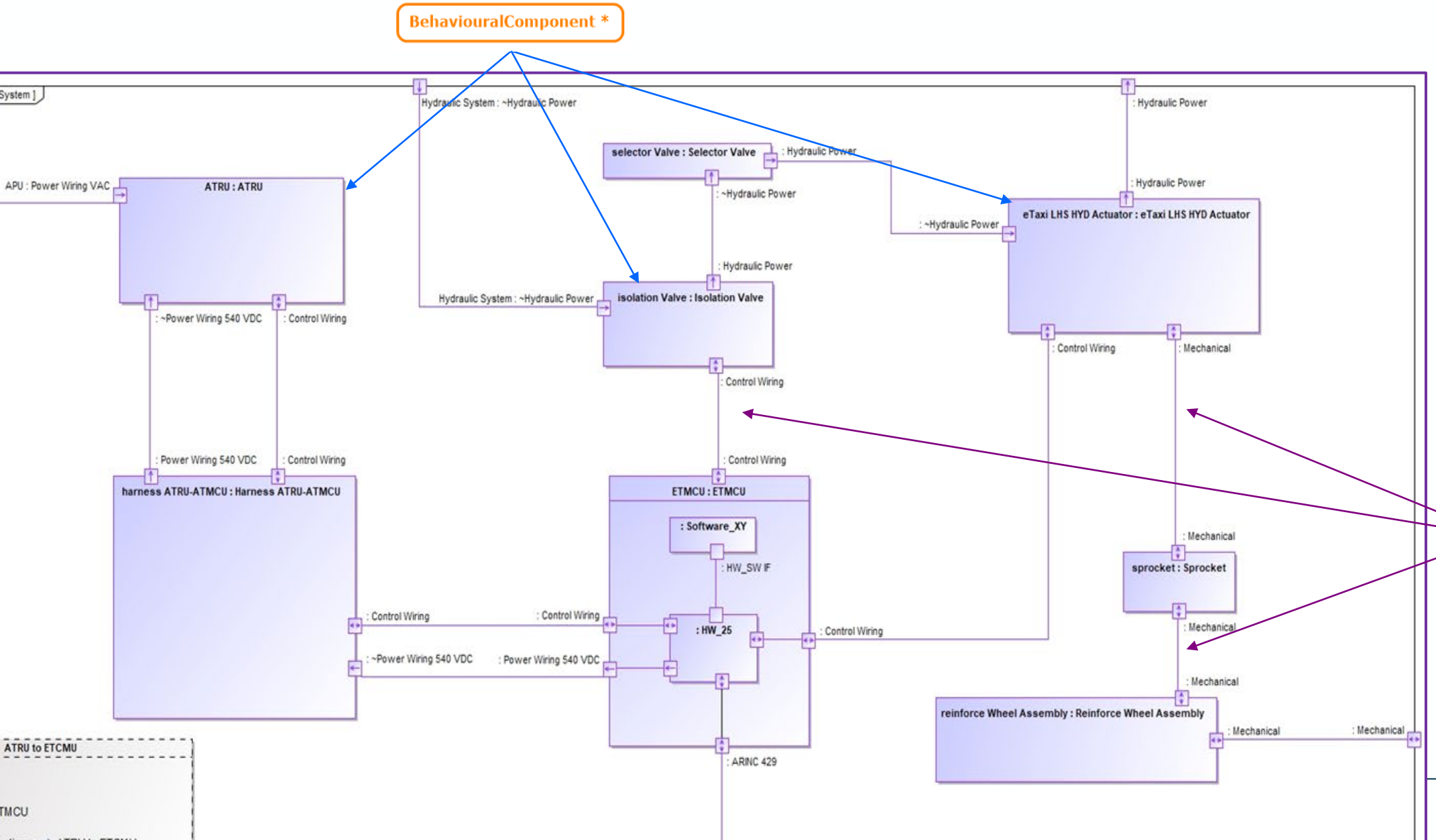


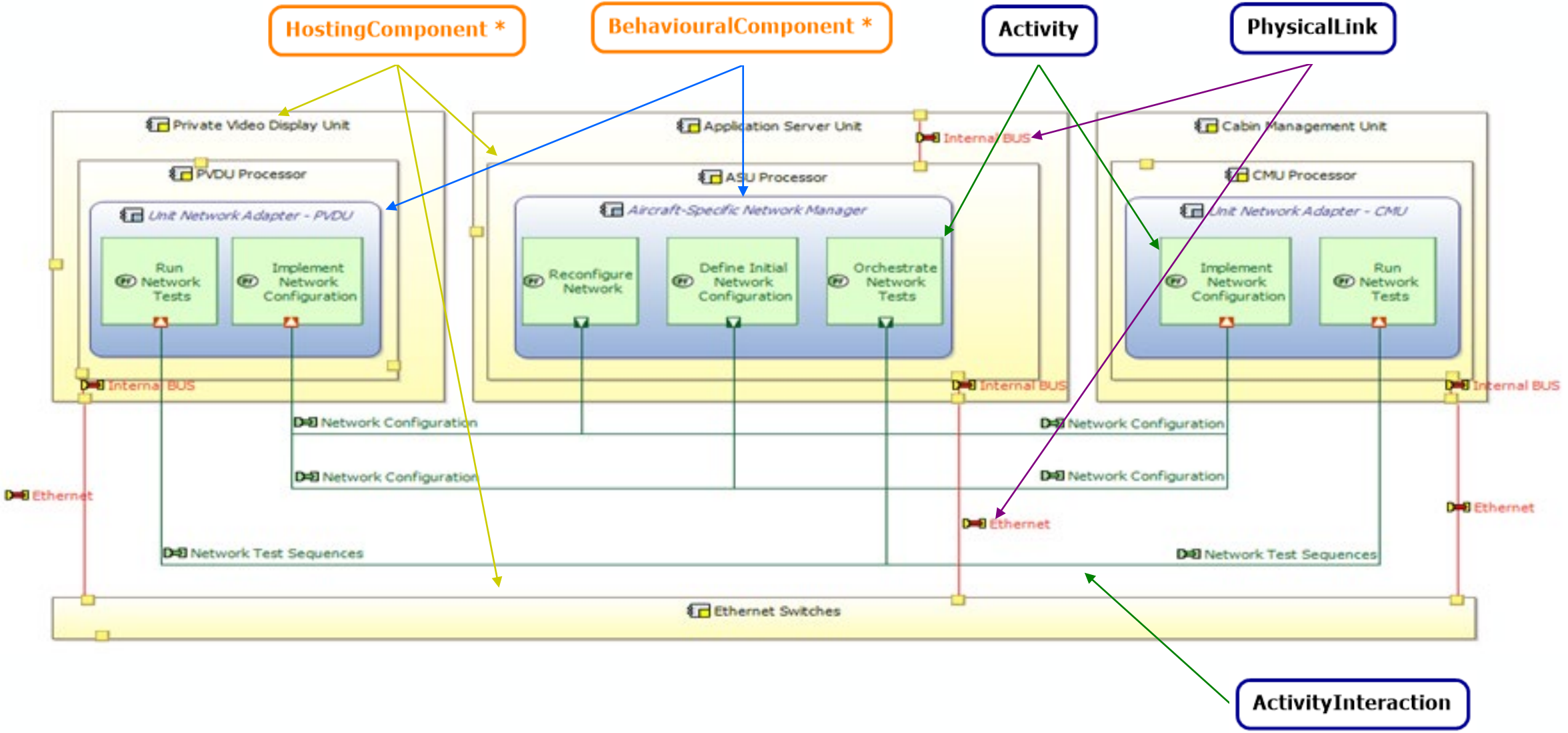
Example OHB – Logical Analysis



Example Airbus DS – Physical Technical Architecture



Example Thales Alenia Space – Physical Analysis



OSMoSE Community Review of the MBSE contributions

The MBSE contribution developed by GMV - Spain and GorillaIT - NL with LSI support was delivered to the OSMoSE Design Authority for inclusion in the first Space System Ontology

On 19th September 2022, the OSMoSE Design Authority has initiated the review of this MBSE contribution by the OSMoSE community !

- Some 250 RIDs have been received
- *They are currently being processed by the OSMoSE Design Authority*

***The Major outputs** are:*

- *The need to extend the MBSE contribution to cover the exchanges of MBSE models between Suppliers and Customers*
- *The need to highlight what MBSE exchanges are required for each ECSS-E-ST-10 review*
- *The difficulty for some reviewers to understand the MBSE documentation (formalism, lack of examples, …)*

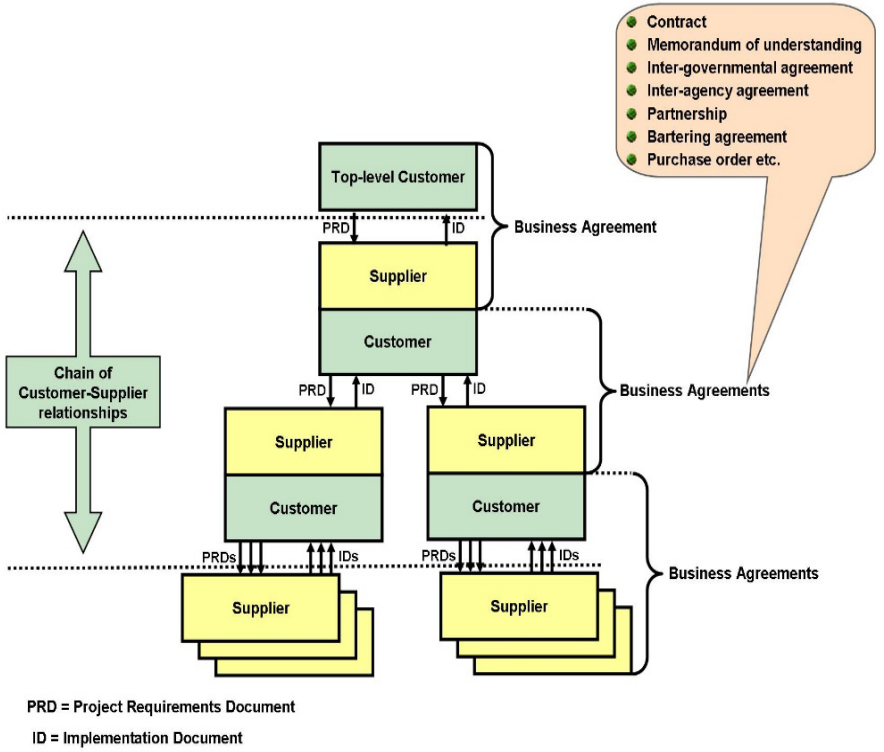
Consolidation of the MBSE contributions

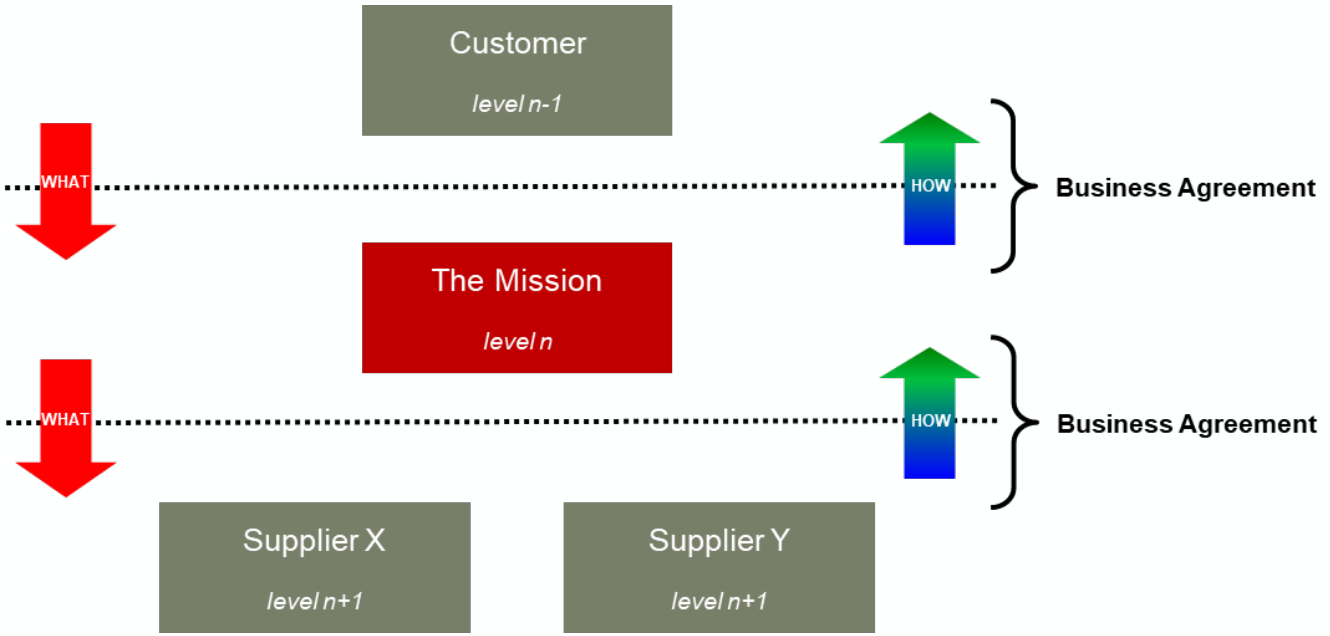
ECSS-E-TM-10-23A

- the Supplier/Customer chain

Extending the MBSE Mission to address, where relevant:

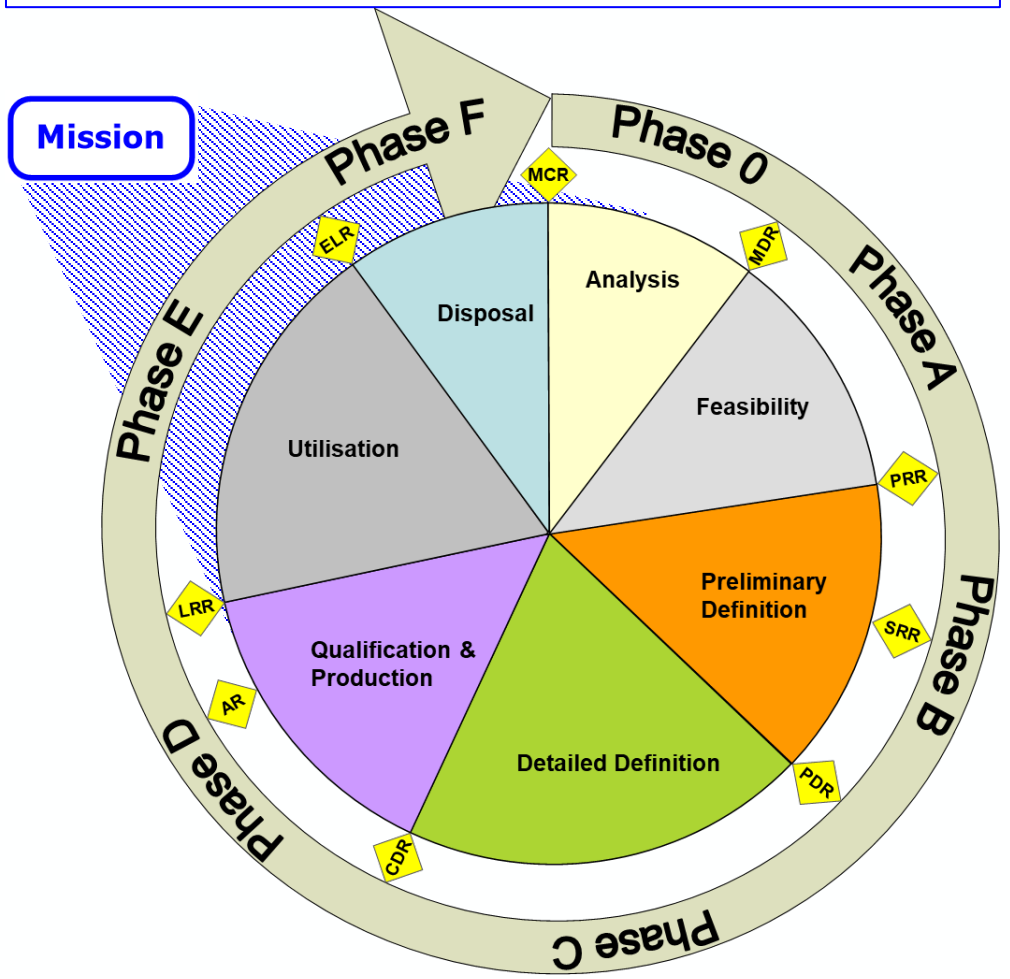
- The exchanges with the supplier(s)
- The exchanges with the customer(s)



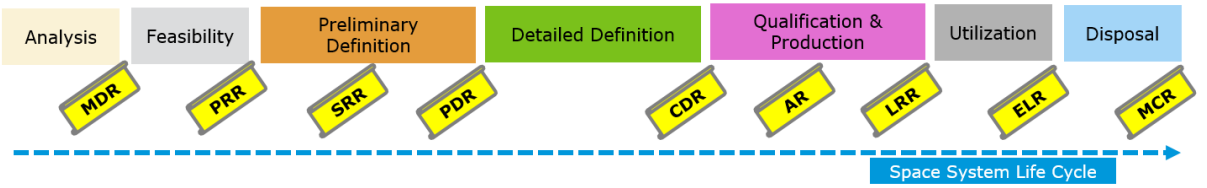


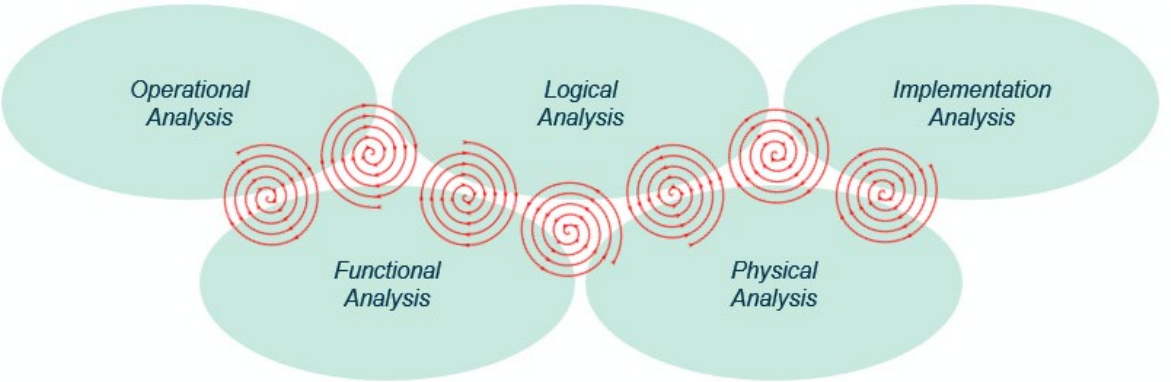
Consolidation of the MBSE contributions, cont. 1

ECSS-E-TM-10-23A
Space System Model



Many MBSE methodologies exist: Focus on the Exchanges as required by ECSS





Step	MBSE development phase	MDR	SRR	PDR	CDR	QR	AR
1	operational analysis	**P001**	*P002 ?*	*P003 ?*	*P004 ?*	*P005 ?*	*P006 ?*
2	functional analysis	*R001 ?*	**P001**	*P002 ?*	*P003 ?*	*P004 ?*	*P005 ?*
3	logical analysis	*R001 ?*	*R002 ?*	**P001**	*P002 ?*	*P003 ?*	*P004 ?*
4	physical analysis	*R001 ?*	*R002 ?*	*R003 ?*	**P001**	*P002 ?*	*P003 ?*
5	*implementation analysis*	*R001 ?*	*R002 ?*	*R003 ?*	*R004 ?*	**P001**	*P002 ?*

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MBSE-2022 – Space System Ontology Workshop

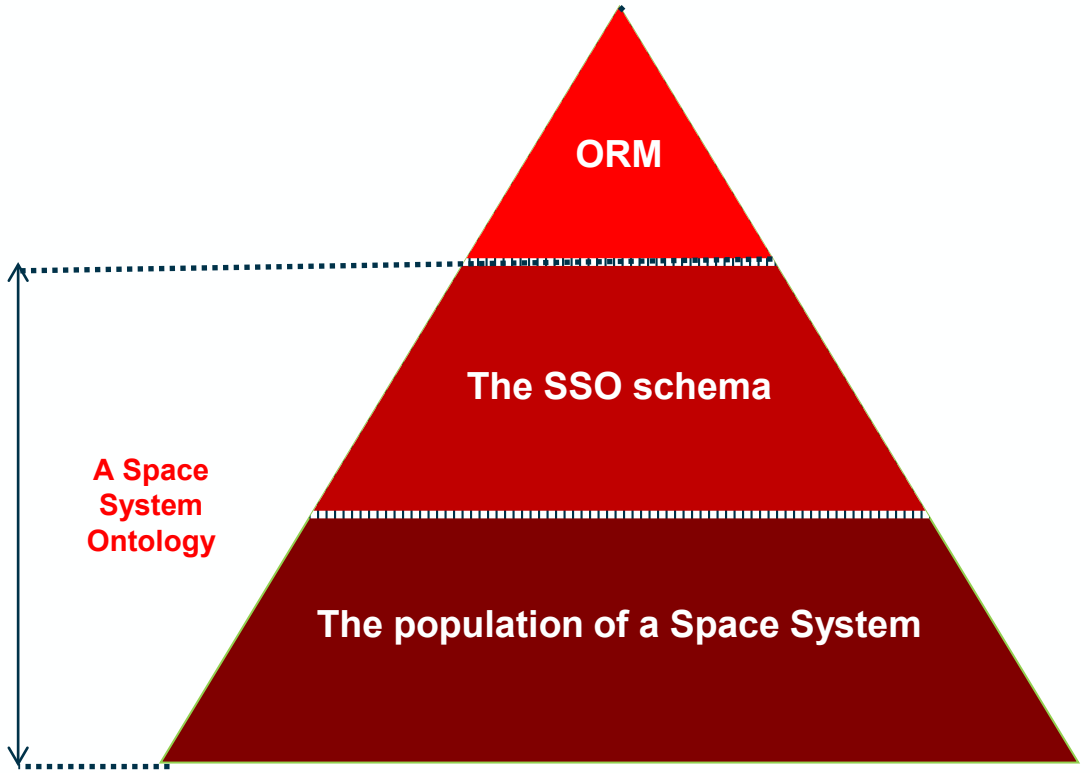
Session 4 – From Conceptual Models towards Implementation

Serge Valera, Quirien Wijnands

ESA ESTEC

23/11/2022

Semantic Modelling for Semantic Interoperability



The Space System Ontology is a valid semantic model !

- It represents a consistent merge of many Universes of Discourse, *each one being of engineering, quality and/or management relevance*
- Its deployment shall take into account the life cycle of each Space System, *distributed in time and geographically*
- As such, its realization can only be seen as a collection of information systems *time and geographically deployed* communicating together
- Each Space System has its own population life cycle
- The SSO schema itself has a life cycle

Specifying and developing information systems

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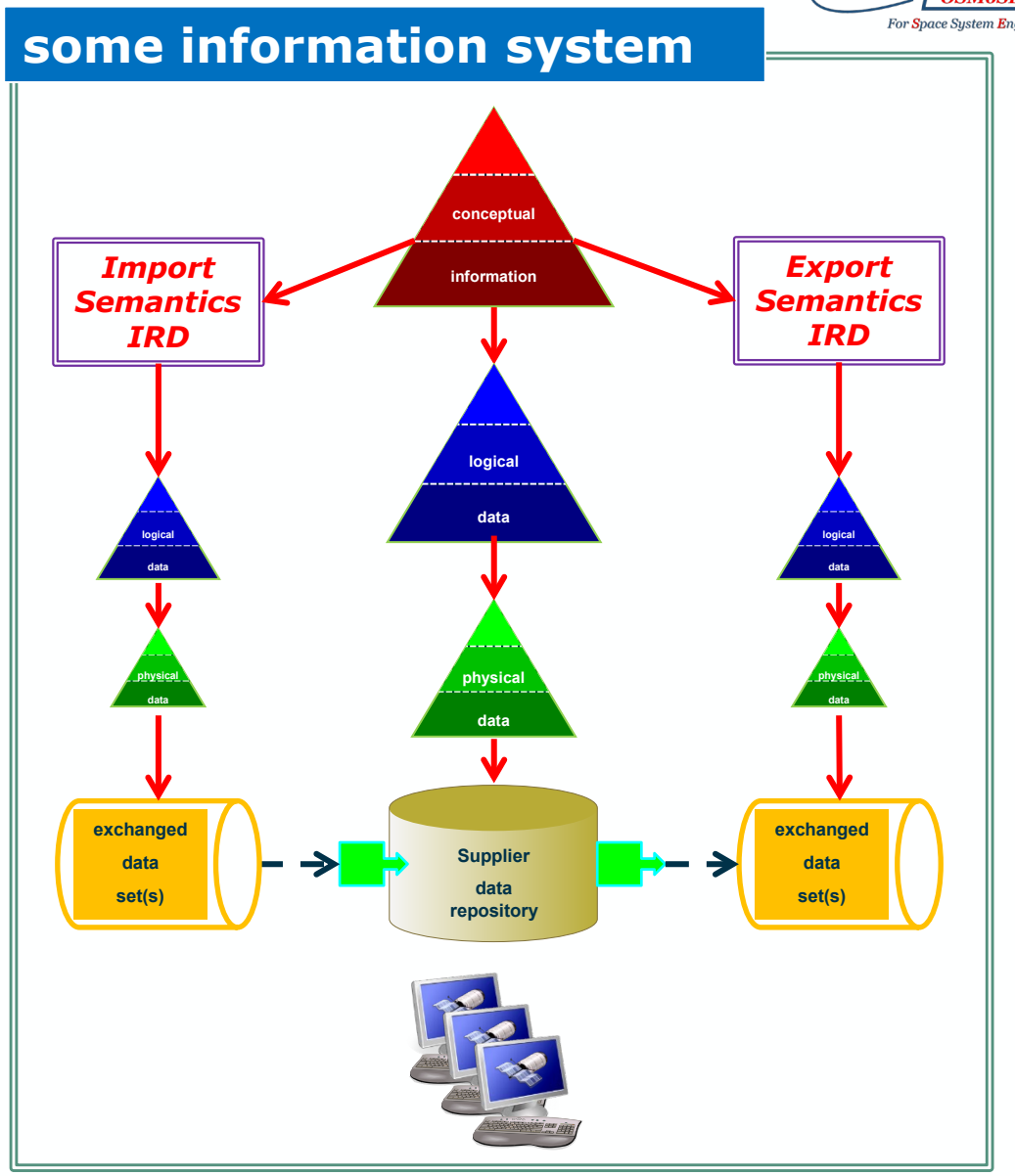
Semantic Modelling takes time !

Is the effort worthwhile?

- How many time we, *stakeholders ! end users !* have been provided an information system that does not satisfy our needs?
- What is the risk of corrupting qualified data during the exchanges?
- What is the cost of reducing the risk? of fixing these corruptions?
- Do we always discover the corruptions on time?
- *other lessons learned?*

Semantic modelling with ORM is logic-based

➔ **This permits automating some developments**



Transfer of Academic Research to Industry

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- The Fact based Modelling Working Group: NIAM, ORM, DOGMA, FCO-IM, OWL → FBM for industry
- ESA contract 4000107725 – PNA Group & ORM Solutions

  Fact based Modelling Unifying System / Toward implementing solutions for ECSS-E-TM-10-23A
- ESA contract 4000108703 – GMV

  Automatic Generation of Man Machine interface from a Domain Ontology
- ESA contract 4000127988 – Libera Università di Bolzano

  Intelligent Reasoner for Fact Based Models
- ESA contract 4000133538 – GorillaIT & ORM Solutions

  FAMOUS improvement – Transfer of academic knowledge to semantic interoperability

From NORMA to Semantic Interoperability in use

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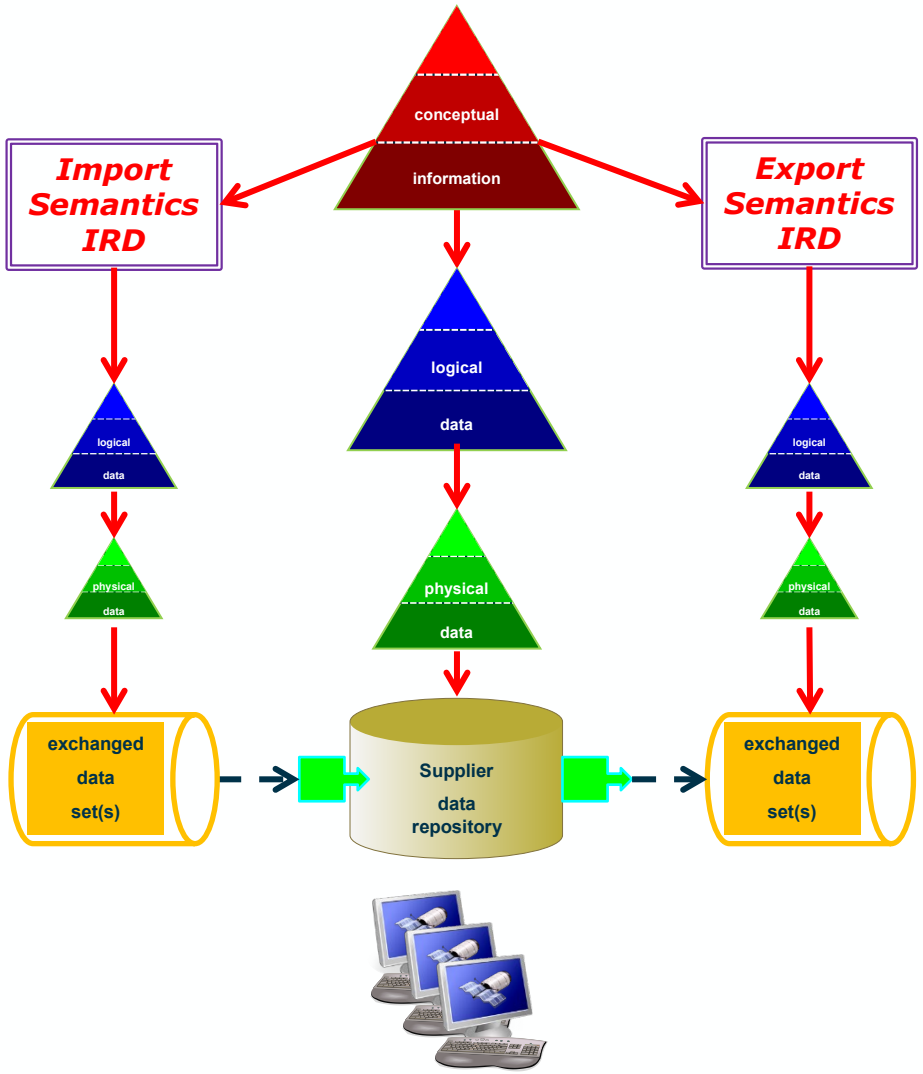
some information system



NORMA transforms the conceptual models [ORM] into logical and physical data models

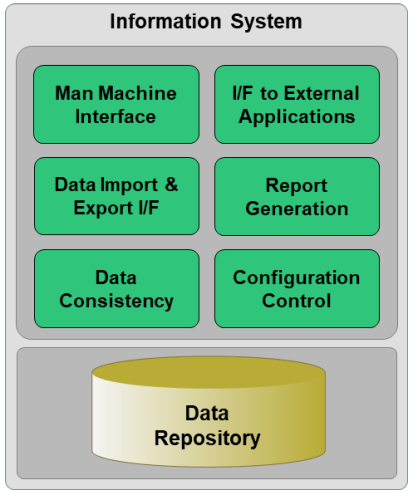
- **DDL** for RDBMS
- **XSD** e.g. for ICDs
- **O/RM** for object abstraction against chosen RDBMS

with its Javascript Fact Engine in software code

- **Javascript structures** model declaration
- **JSON** raw forms & change set
- **I/O layer** translate from JSON bidirectional

The JFE client libraries form a rich data environment ***with rules engine transactions, state changes, undo/redo, JSON serialization, data bound UI***

ready for being used to develop the required web application (MMI) making calls to the generated I/O service.



MBSE Independent Verification & Validation Facility

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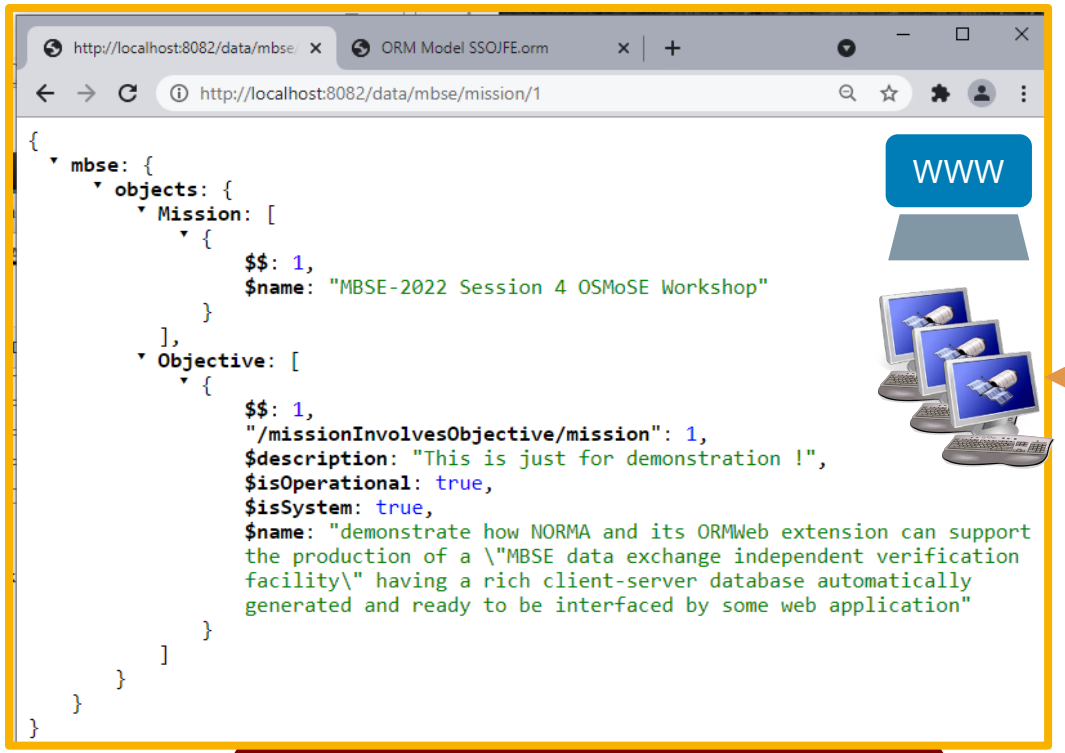
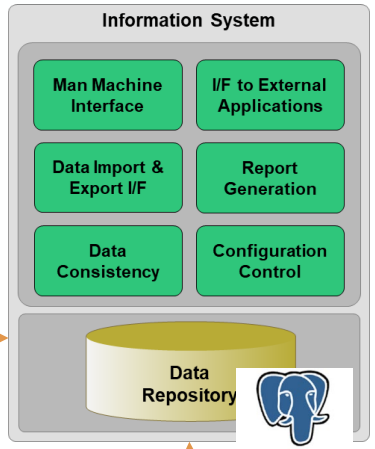
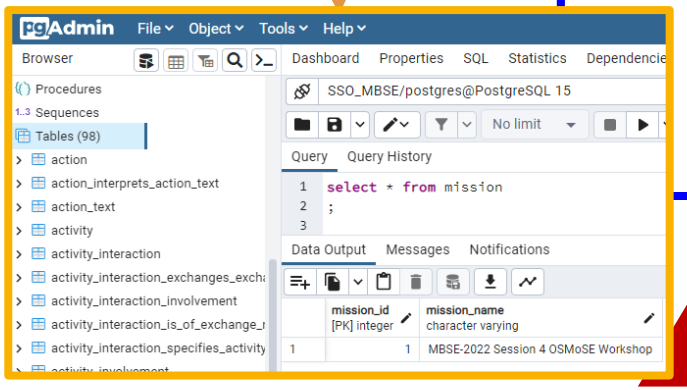
The **SSO-MBSE conceptual** data model is used by NORMA to generate:

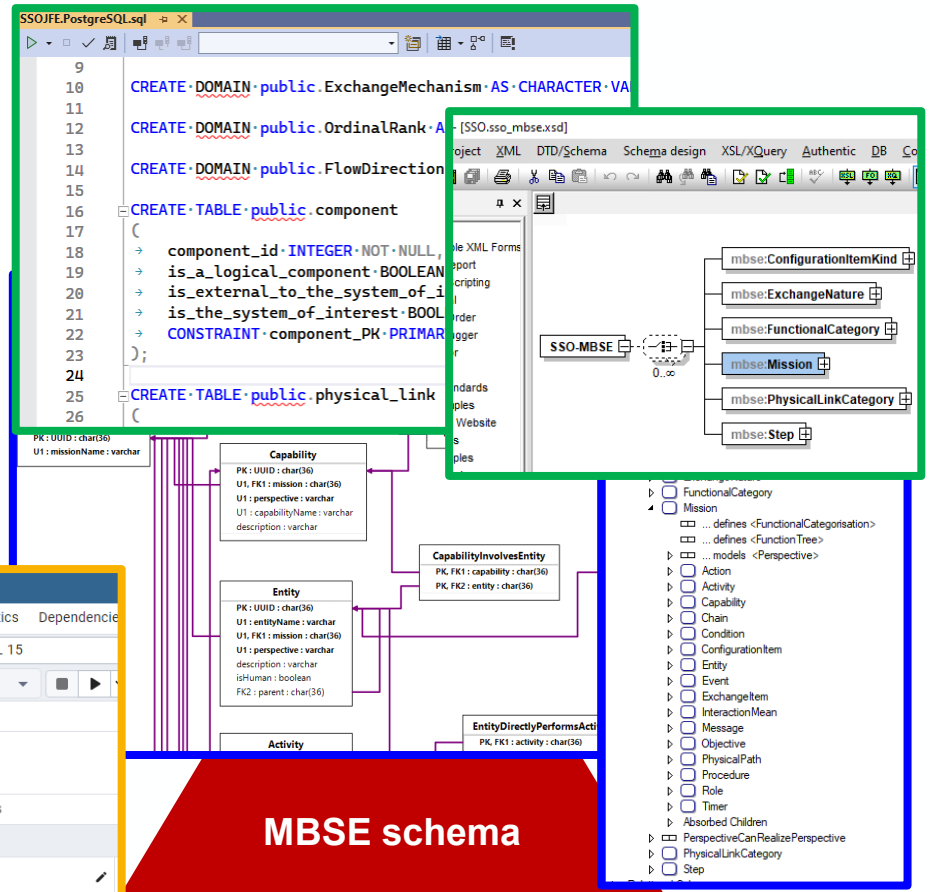
- ***PostGreSQL*** *for the data repository* – ***O/RM*** *for object abstraction against PostGreSQL*
- ***Javascript structures*** *model declaration* – ***JSON*** *raw forms & change set* – ***I/O layer*** *translate from JSON bidirectional*



MBSE population







MBSE schema

From NORMA single-user to FAMOUS collaborative

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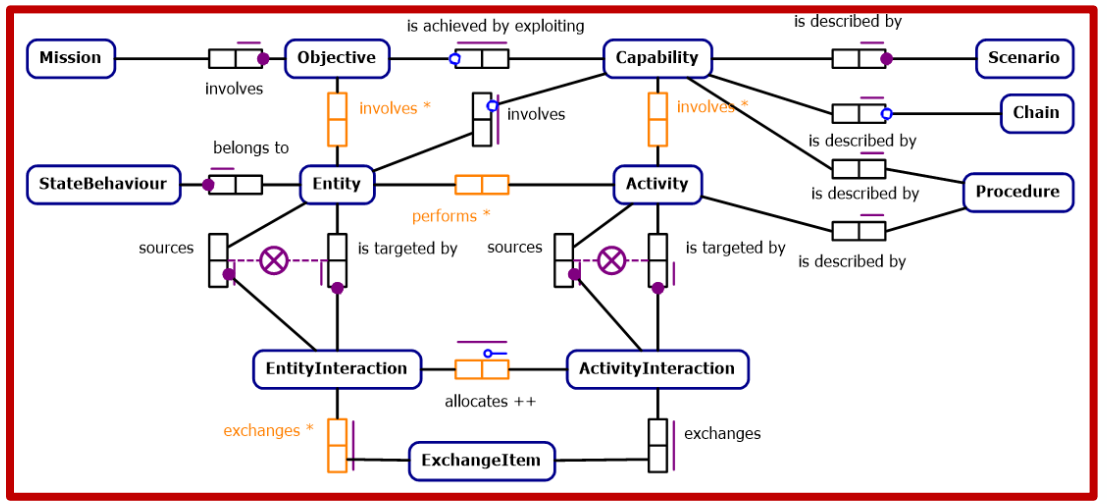
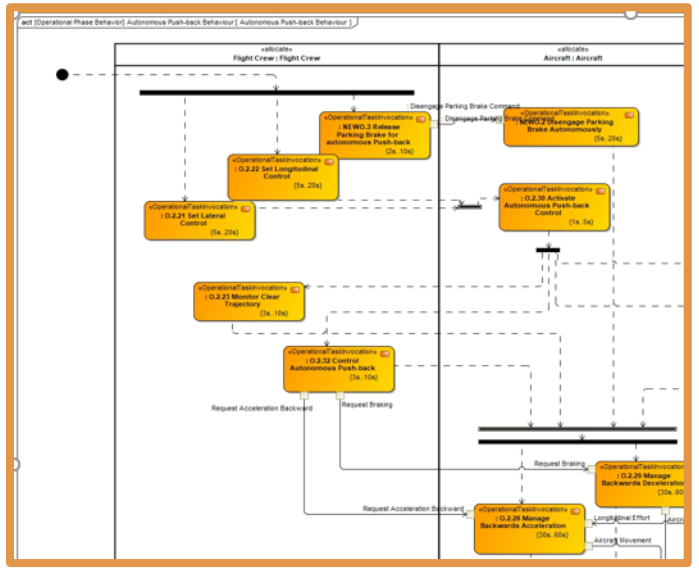
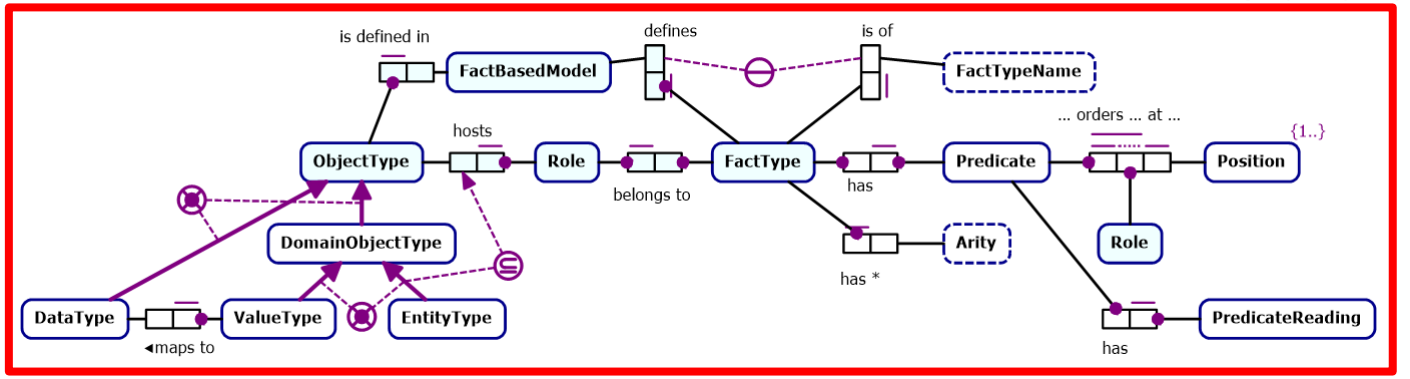


SCHEMA

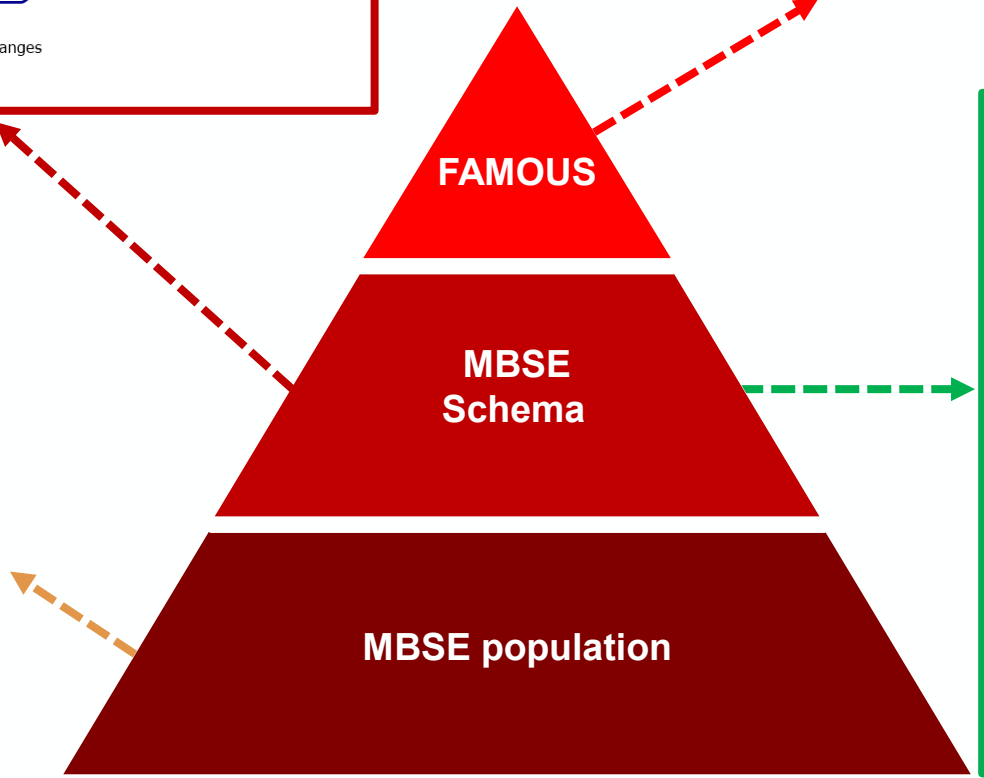
POPULATION

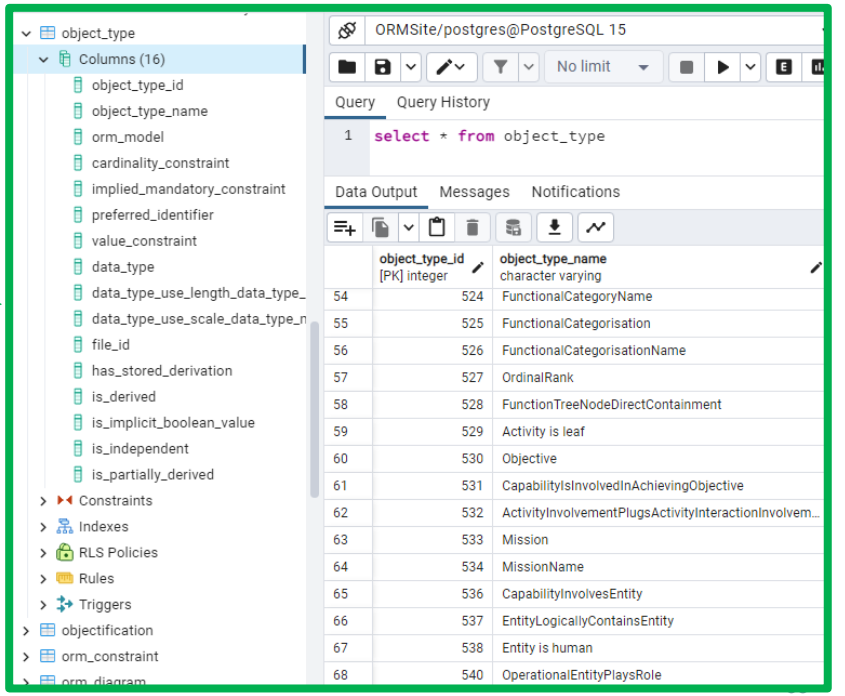




SCHEMA

POPULATION





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MBSE-2022 – Space System Ontology Workshop

Session 4 – Questions & Answers

Quirien Wijnands, Serge Valera

ESA ESTEC

23/11/2022

Overall Semantic Modelling

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For Space System Engineering

MBSE-2022 – Space System Ontology Workshop

Session 5 – Contributing to OSMoSE and the Space System Ontology

Quirien Wijnands, Serge Valera

ESA ESTEC

23/11/2022

Session 5 – OSMoSE Contributors…

Overall Semantic Modelling OSMoSE For Space System Engineering

11:10 – 11:20 **Introduction by Session Chair**

Q. Wijnands (ESA)

11:20 – 11:40 **Ontological Approaches for Scaled MBSE Deployment**

L. Laborde (ADS)

11:40 – 12:00 **Domain-specific ontology for digital continuity: Thermal engineering case**

E. Maleki (ESA), A. Darrau (ESA), JL. Terraillon (ESA)

12:00 – 12:20 **Model Based Engineering Hub – a firm foundation for a new generation of MBSE exchange**

T. Hoppe (ADS), T. Stoitsev (SpaceCube GmbH), C. Borrett (ADS)

12:20 – 12:40 **Model Based System Engineering Hub**

A. Vorobiev (RHEA Group), K. Tiensuu (RHEA Group), S. Gerené (RHEA Group), S. Jahnke (OHB), L. Bitetti (TAS), HP. De Koning (DEKonsult)

12:40 – 13:00 **Enhancing the MBSE-HUB for AIV Reporting Needs**

N. Salor Moral (RHEA Group), P. Beltrami (RHEA Group)

13:00 – 14:00 ***Lunch***