

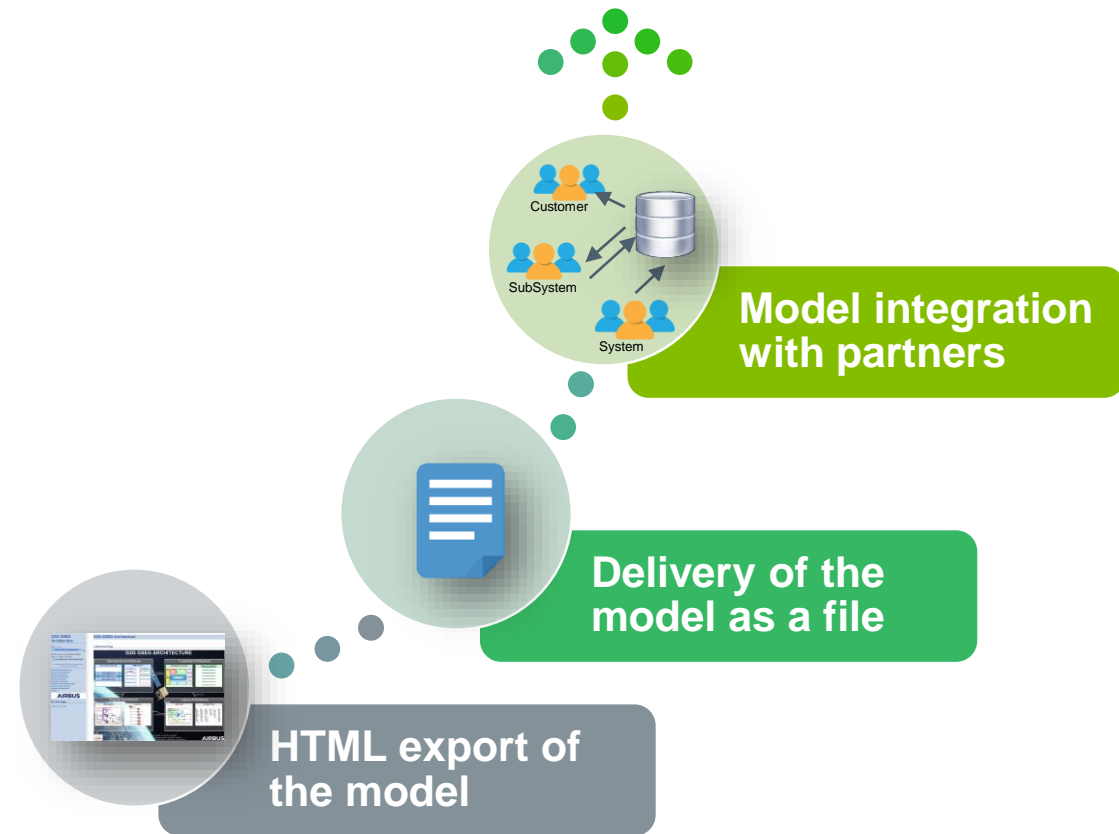
DEFENCE AND SPACE

# Ontological Approaches for Scaled MBSE Deployment

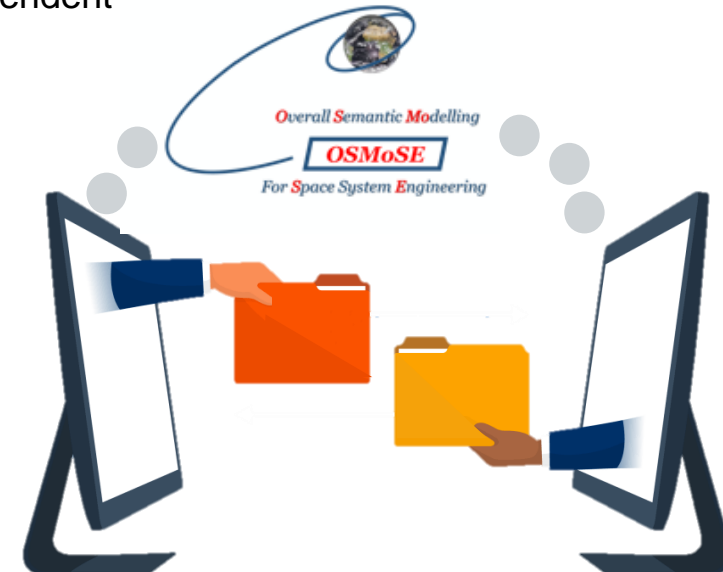
ESA MBSE2022

Lucie Laborde, Ground Systems MBSE Support and Improvement  
November 2022

# From MBSE to model-centric engineering



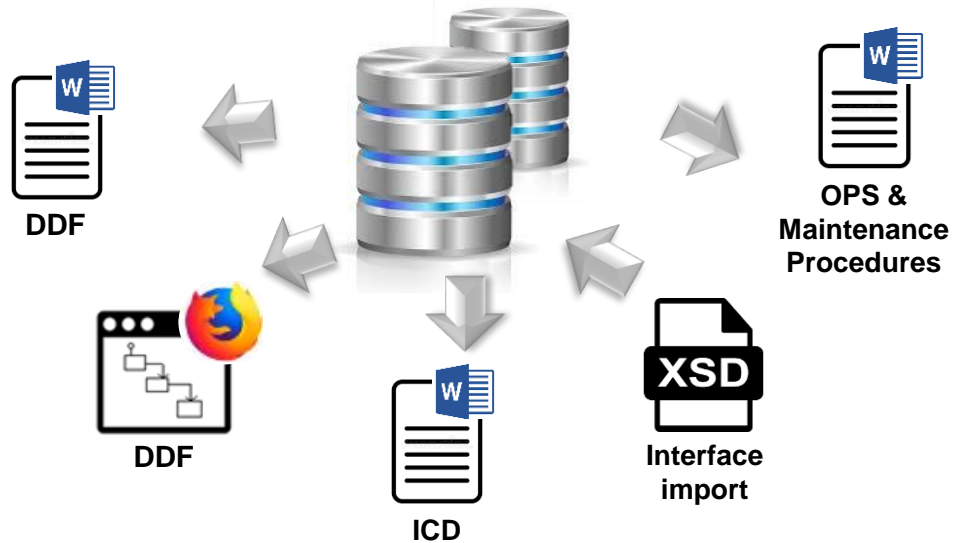
- At ADS, we are focusing on deploying MBSE to achieve model exchanges (internally and externally)
- The prerequisite is to extend and normalize MBSE
- Model exchange requires an alignment of modelling frameworks between partners (issue today)
- The Space System Ontology will enable interoperability at semantic level and remain tool-independent



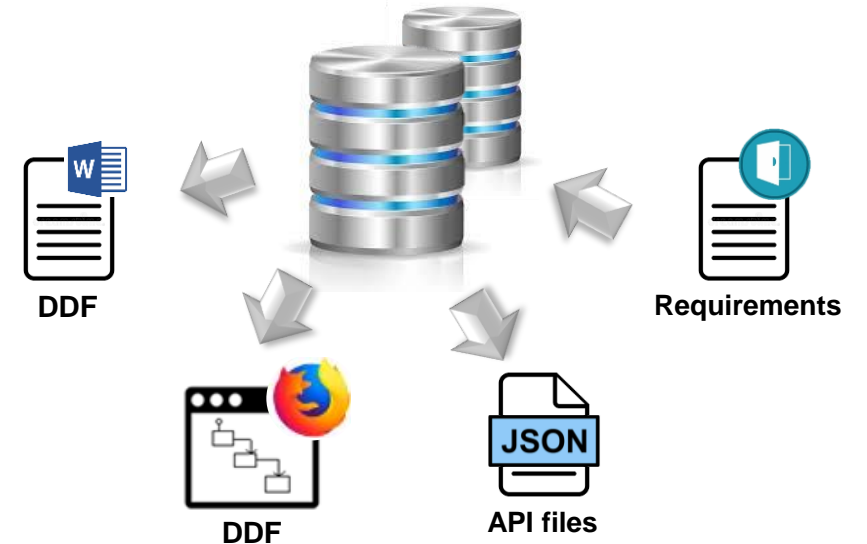
# MBSE on Navigation Ground projects



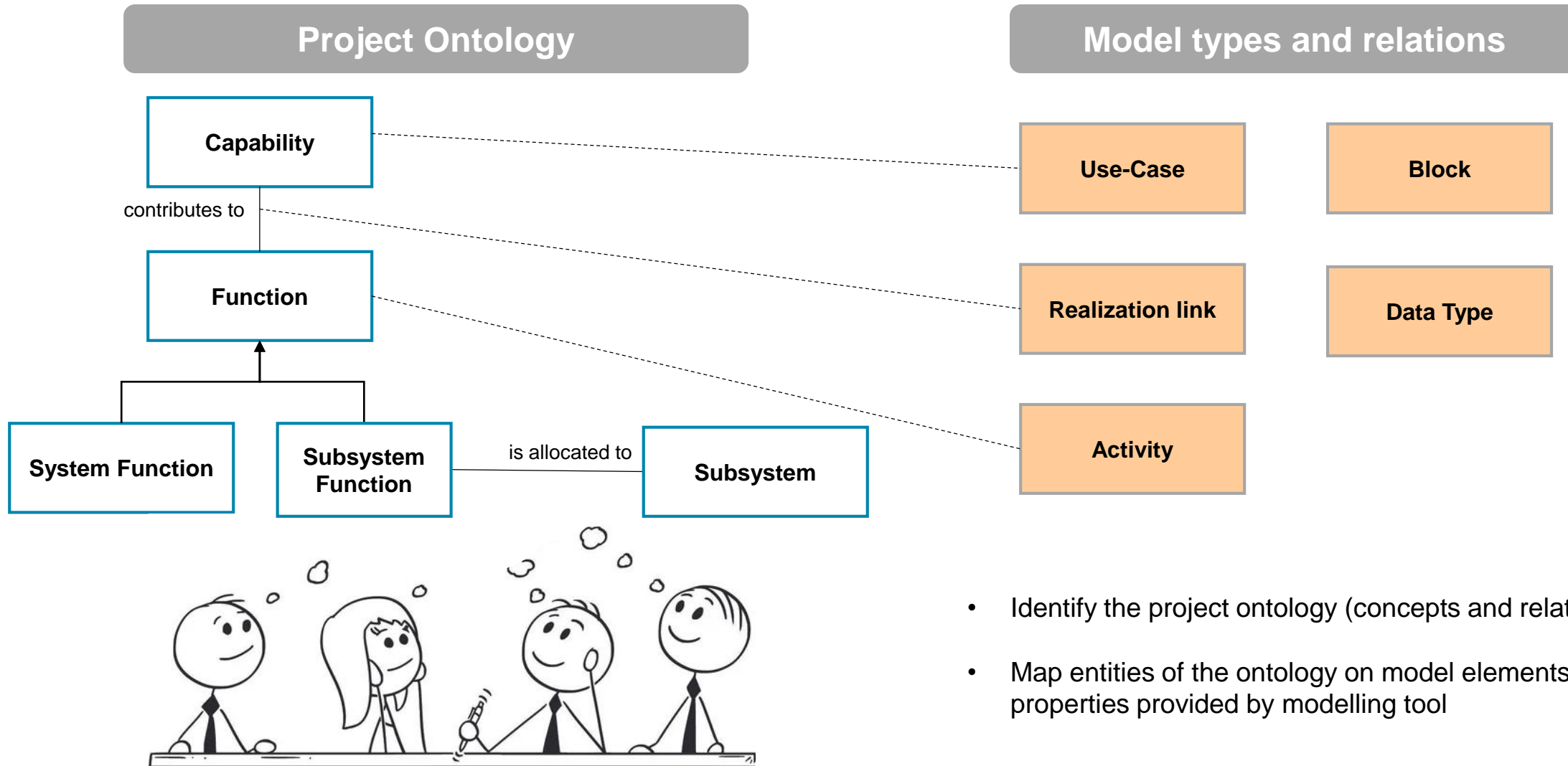
- ~75 user accounts
- 300+ diagrams
- 100+ Analysis reports
- 4 models synchronized (System and subsystems)



- ~35 user accounts
- 4000+ requirements imported and traced in the model
- 400+ diagrams
- 30+ Analysis reports
- 2 models synchronized (Classified and Unclassified)

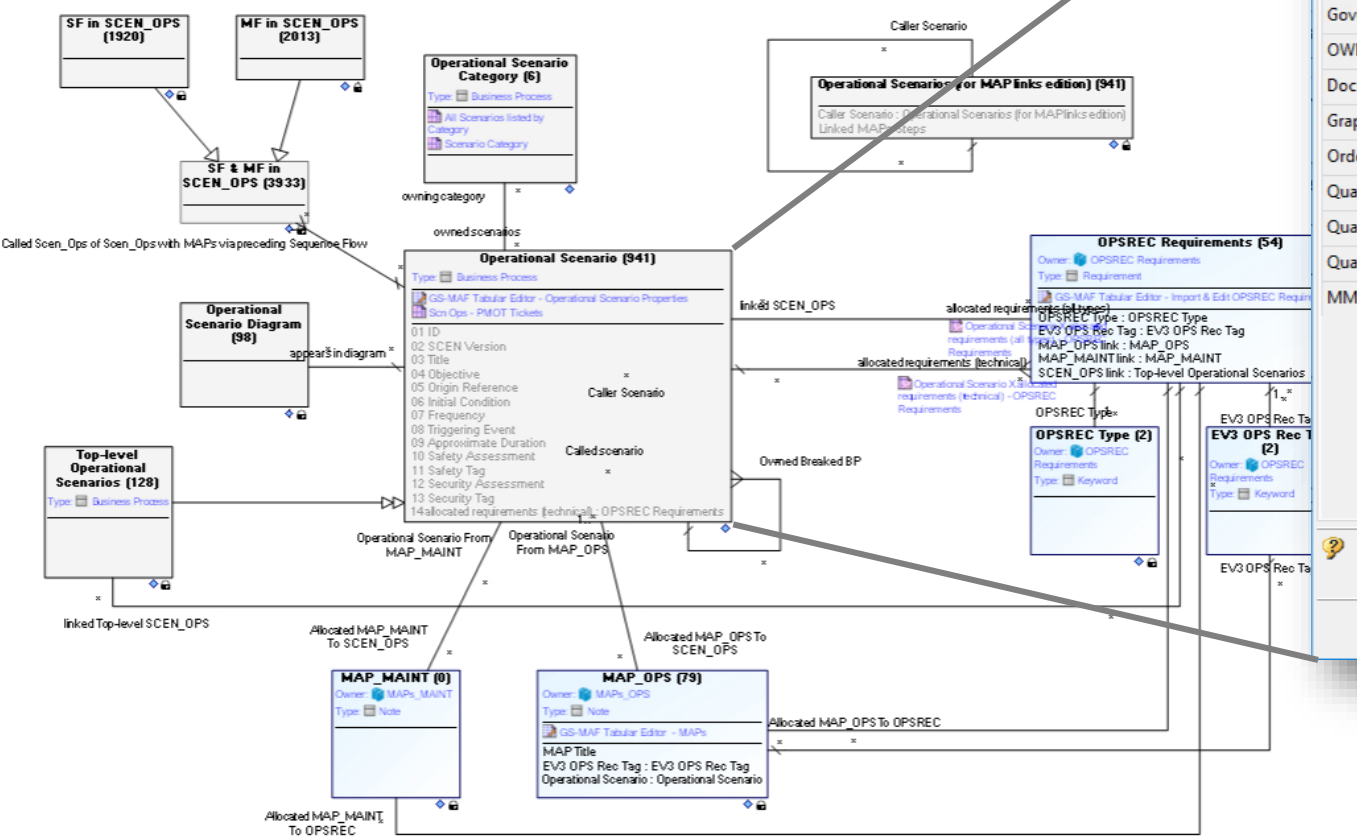


# How to define a project ontology



- Identify the project ontology (concepts and relations)
- Map entities of the ontology on model elements and properties provided by modelling tool

# Implementation of the project ontology



Properties of Operational Scenario

General Characteristics Attributes Inherited Attributes User Data Models Identifier Property Values Properties CRUD Monitoring

Objectives and Requirements MBSELab Complements Texts

Annotations MMP implementation macro (Obsolete):

MMP Settings Basic Settings

Governance **Type of Entities: Business Process**

OWL Extensions **Owner of Entities:**

Documents Image:

Graph Node **Name Prefix:**

Ordering Keywords:

Quality Settings

Quality Review

Quality Assessment

MMP Types

Queries, read-only entity:

**Name**  
**\*\* GS-MAF - EGNOS V3 - All Operational Scenarios**

MMP implementation macro (Obsolete)

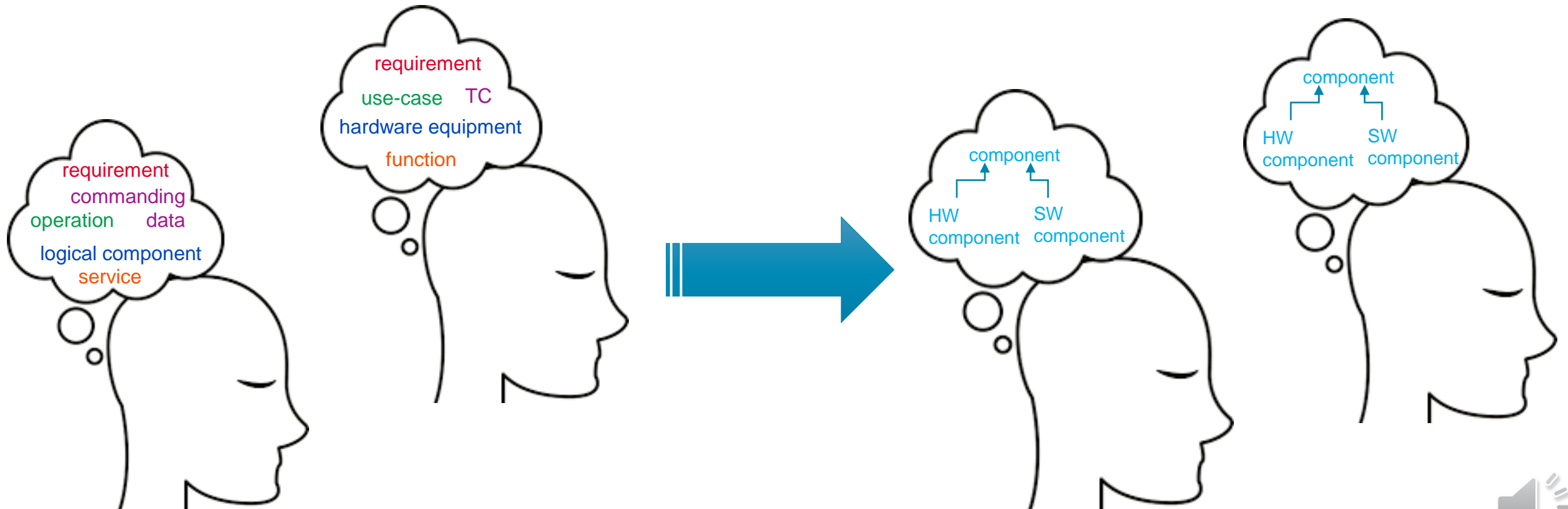
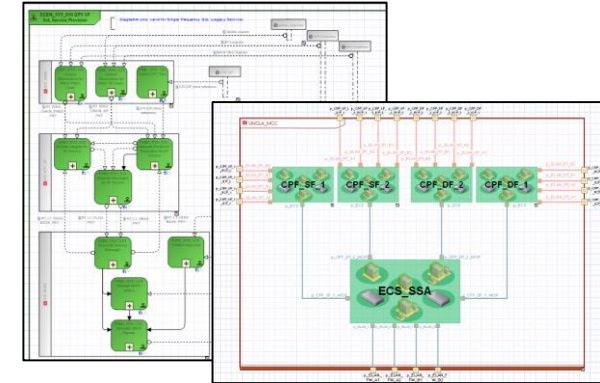
OK Cancel Apply Help

## Extract of EGNOS V3 ontology implementation



# The project ontology as shared “language”

- The result is a consistent and homogenous model
- Facilitates MBSE adoption using domain-specific terms

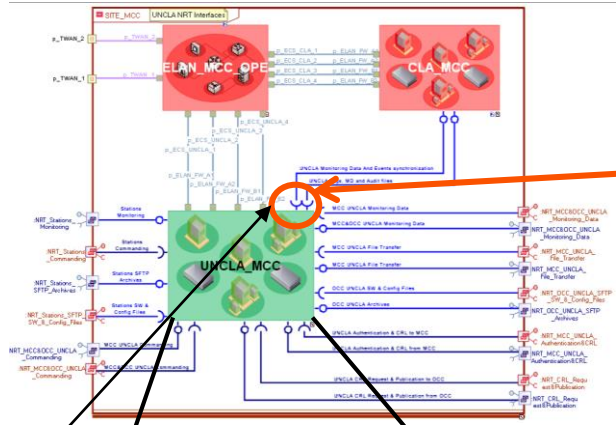




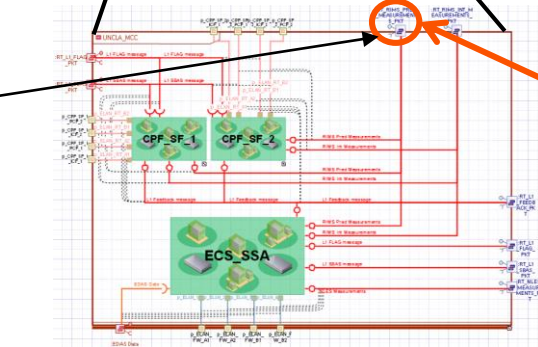
# The ontology helps modelling complex aspects

- A single model element can simultaneously belong to several ontology concepts depending on the perspective
- Creating these “smart” datasets on top of the modelling tool really facilitates the work of architects in their modelling process.

**Model**



At System level the interface is INTERNAL



At Sub-system level the interface is EXTERNAL

**Project Ontology**

**Interface**

**Internal interface**

**External interface**

**Component**

- To\_Stations\_NRT\_Stations\_Commanding
- To\_Stations\_NRT\_Stations\_SFTP
- To\_Stations\_NRT\_Stations\_SFTP\_SW\_& Config\_Files
- From\_CPF\_DF\_RT\_L5\_FLAG\_PKT
- From\_CPF\_DF\_RT\_L5\_SBAS\_PKT
- From\_CPF\_SF\_RT\_L1\_FLAG\_PKT
- From\_CPF\_SF\_RT\_L1\_SBAS\_PKT
- From\_ELAN\_NRT\_Authentication\_ELAN\_MnC
- From\_MCC&OCC\_NRT\_MCC&OCC\_UNCLA\_Monitoring\_Data
- From\_MCC\_NRT\_MCC&OCC\_UNCLA\_Commanding
- From\_MCC\_NRT\_MCC\_UNCLA\_Authentication&CRL
- From\_MCC\_NRT\_MCC\_UNCLA\_File\_Transfer
- From\_NLES\_RT\_L1\_FEEDBACK\_PKT
- From\_NLES\_RT\_L5\_FEEDBACK\_PKT
- From\_NLES\_RT\_NLES\_MEASUREMENTS\_PKT
- From\_OCC\_NRT\_CRL\_Request&Publication
- From\_OCC\_NRT\_OCC\_Authentication
- From\_OCC\_NRT\_OCC\_UNCLA\_SFTP\_Archives
- From\_RIMS\_RT\_RIMS\_INT\_MEASUREMENTS\_PKT**
- From\_RIMS\_RT\_RIMS\_PRED\_MEASUREMENTS\_PKT
- From\_Stations\_NRT\_Stations\_Monitoring
- From\_Stations\_NRT\_Stations\_SFTP\_Archives

belongs to

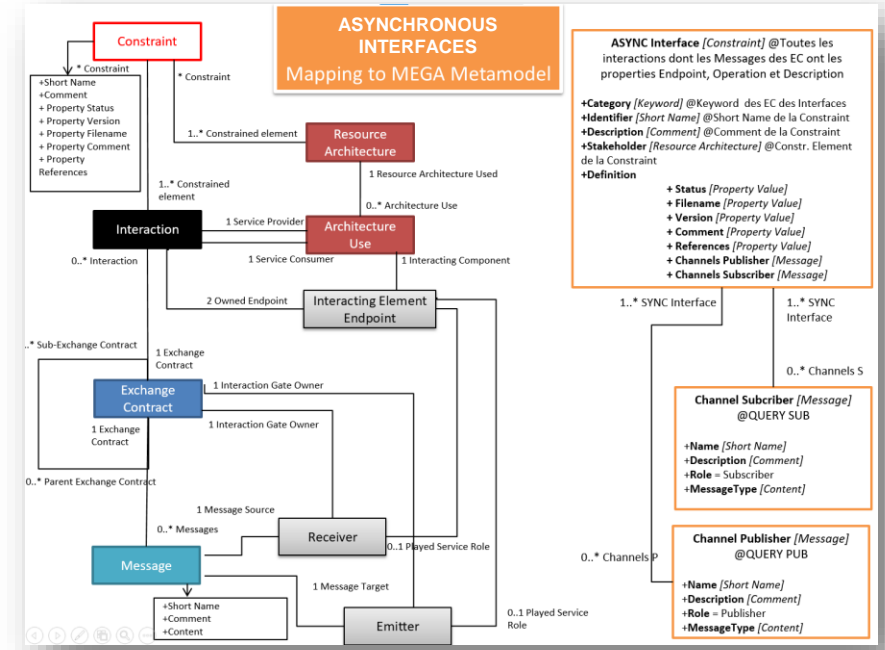
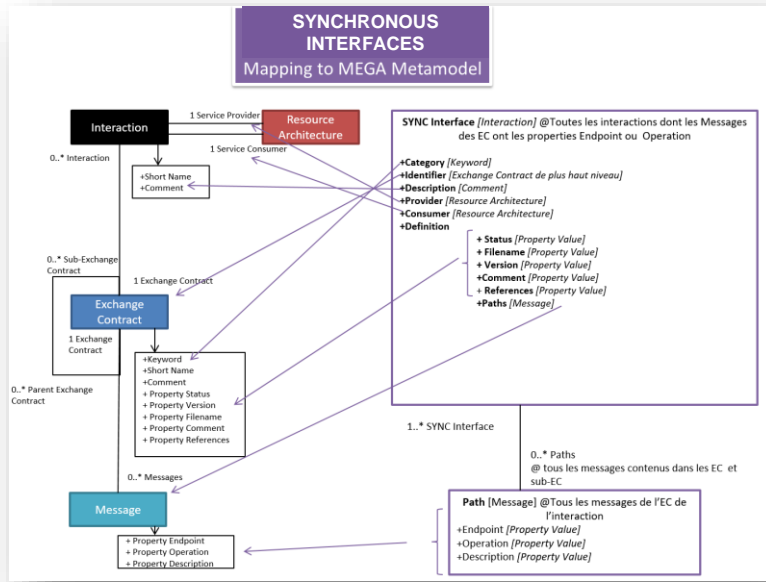
belongs to



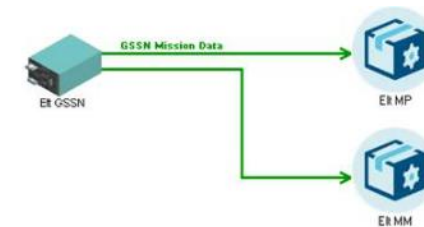
# The ontology helps modelling complex aspects

Here, the ontology facilitates the defintion and production of standardized interfaces (OpenAPI and AsyncAPI)

Project Ontology

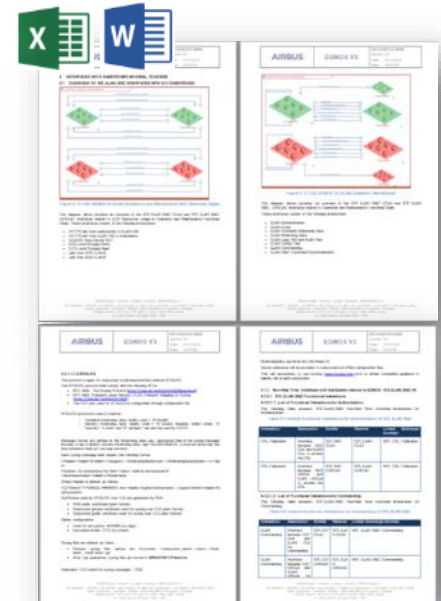
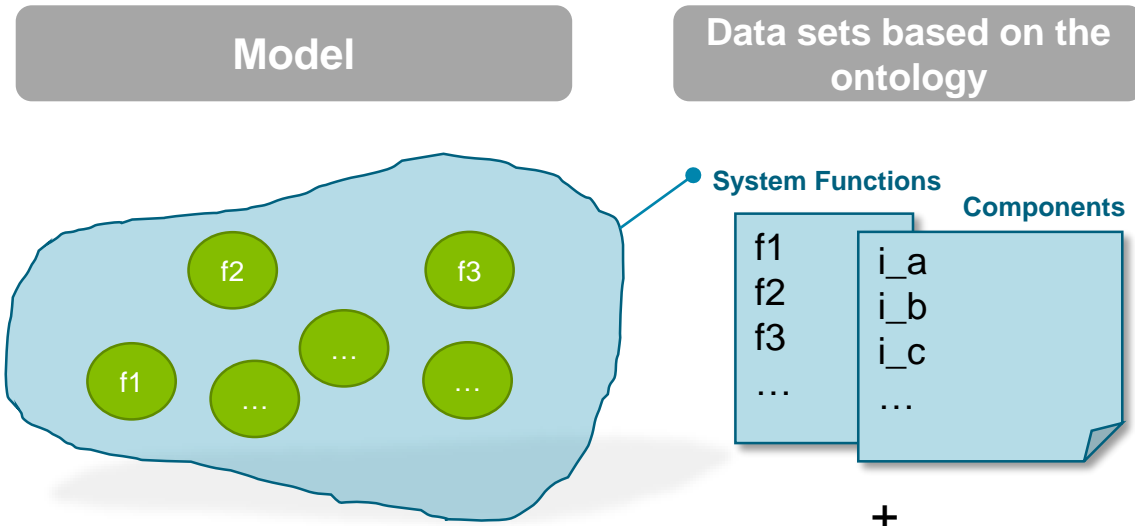


Model





# The ontology as enabler for model exploitation



- Reuse of element sets for document generators (when implemented)
- Bridges the gap between modelling and software development
- Improves the quality, the reliability and the time to produce documents and reports.

```

> 1 Introduction
> 2 References
> 3 System Overview
> 4 System Context
> 5 System Logical Architecture
> 6 EGNOS V3 Sites
> 7 System Dynamic Architecture
  > 7.1 Concept of SFC Design & System Scenarios
  > 7.2 General SFC Service Provision Concepts
  > 7.3 General SFC Operations Concepts
  > 7.4 SCEN_SYS_CAT_010_Service Provision
  > 7.5 SCEN_SYS_CAT_020_System Time Synchronisation
  > 7.6 SCEN_SYS_CAT_030_Message Scheduling and Flag Raising Strategy
  > 7.7 SCEN_SYS_CAT_040_Service Provision Redundancy Management
  > 7.8 SCEN_SYS_CAT_050_System Start-up
  > 7.9 SCEN_SYS_CAT_100_Monitoring
  > 7.10 SCEN_SYS_CAT_110_File Transfer
  > 7.11 SCEN_SYS_CAT_120_States and Modes
  > 7.12 SCEN_SYS_CAT_130_Configuration Management
  > 7.13 SCEN_SYS_CAT_140_Upgrades
  > 7.14 SCEN_SYS_CAT_150_Specific Functional Commanding
  > 7.15 SCEN_SYS_CAT_160_Maintenance
  > 7.16 SCEN_SYS_CAT_170_Archiving and Trouble Shooting
  > 7.17 SCEN_SYS_CAT_190_Certificates, Accounts and Keys management
  > 7.18 SCEN_SYS_CAT_220_Operator or Asset Authentication
    
```

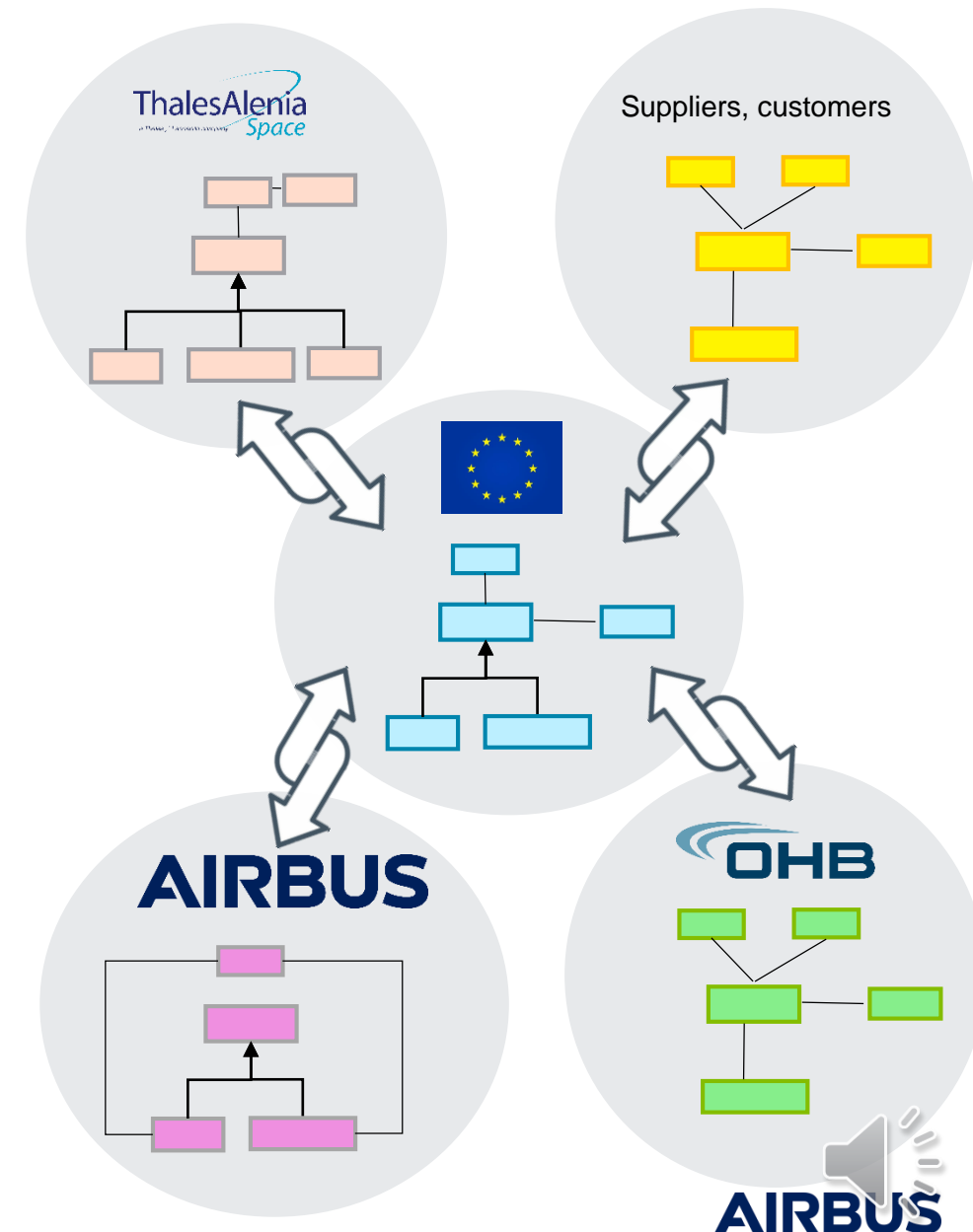
Document structure



# Conclusion

- Ontologies combined with MBSE capture engineering concepts contained in the model when sometimes language elements can be limited in terms of semantics.
- The use of a project-specific ontology has been key to establish model-based system engineering on large scale projects like EGNOS V3 and G2G GSEG.
- Many model enablers like interface definition exporters, document generators, analysis reports are based on the project ontology.
- By being tool-independent, ontologies offer a great opportunity to capitalize knowledge about architectures and system definitions over time.
- They provide resilience towards tool changes.
- Soon, when sharing a common Space Systems Ontology, it will be possible to exchange models between European Space community.

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# Thank you

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