



# Towards Views Extraction to Ease Concurrent Review of Systems Engineering Models

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# Agenda

**Context and Problem Statement**

**Views Extraction Specification for Review**

**Implementation and Results**

**Conclusion and Perspectives**

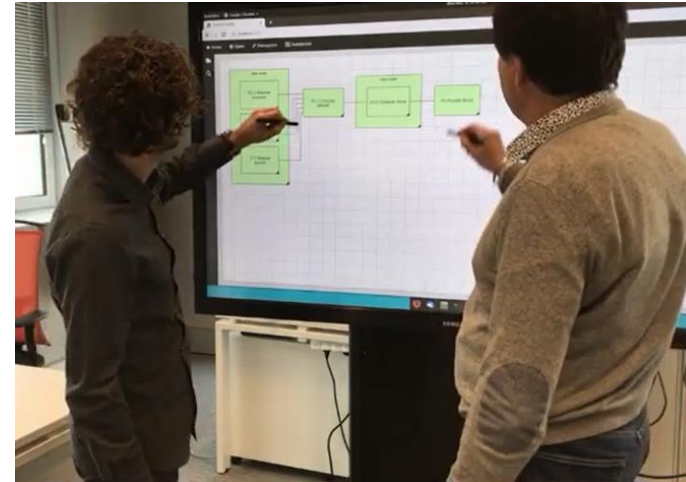
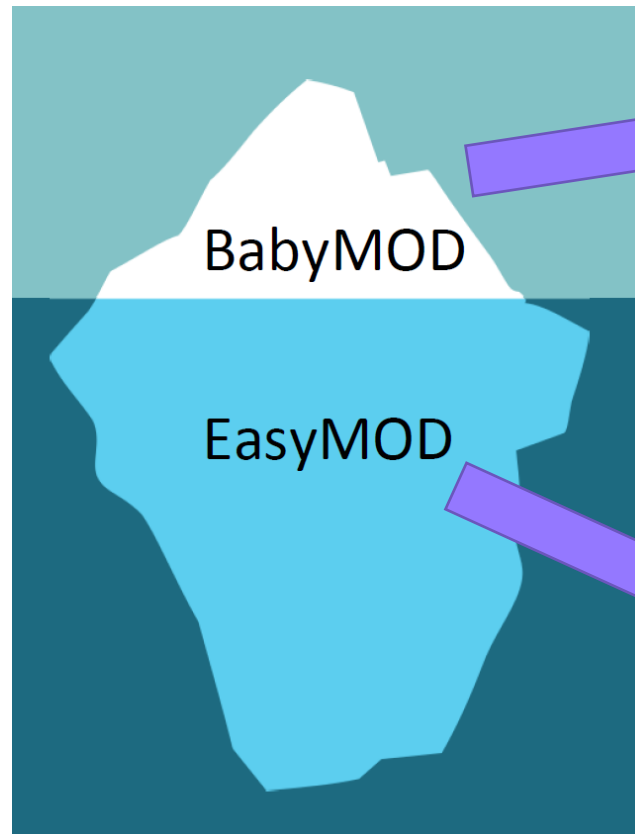


# Context and Problem Statement

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# EasyMOD@ESA Project Context

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proof of concept – [Youtube](#) Video

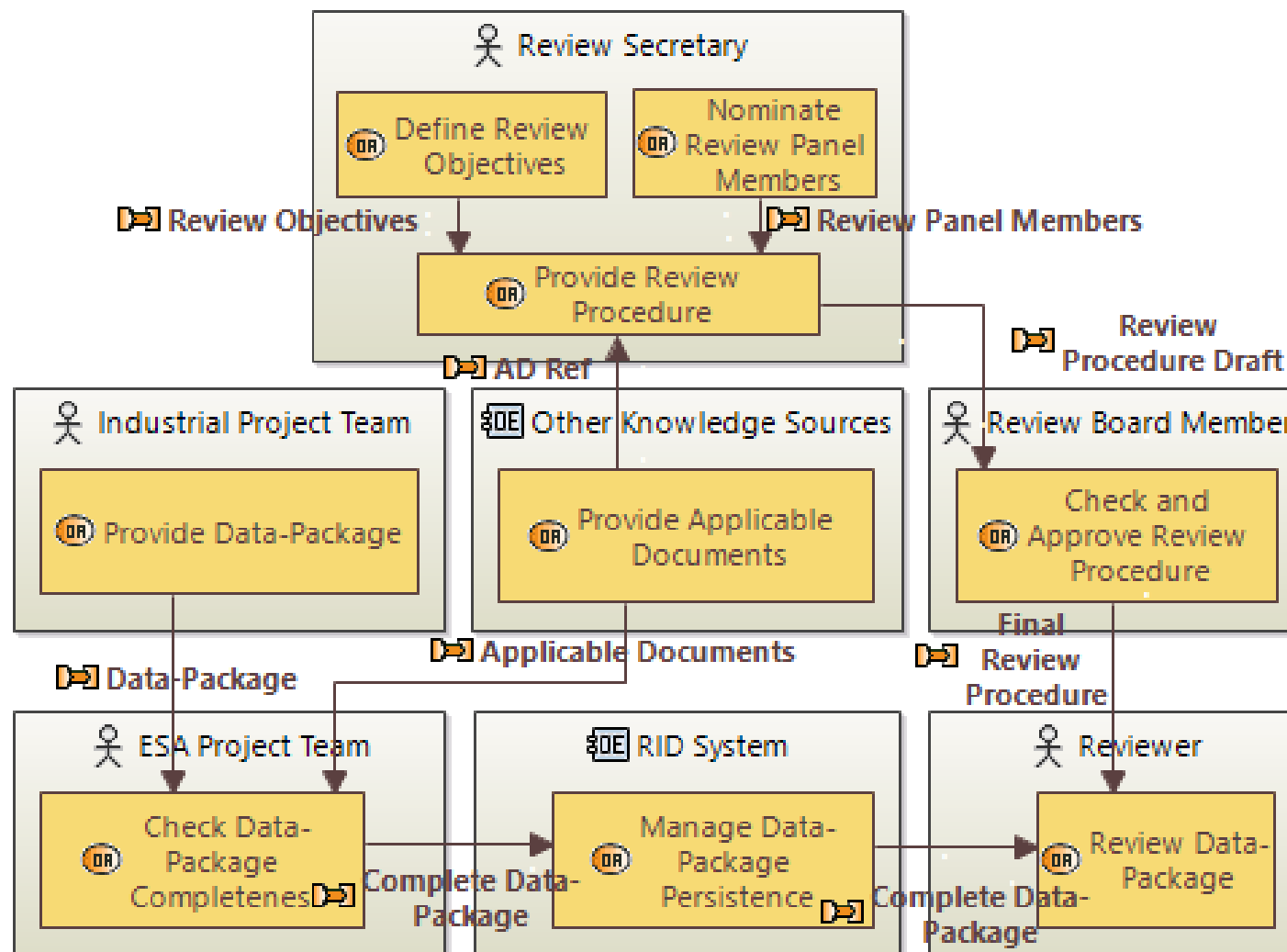
- Sketch recognition
- Voice Recognition
- Collaborative edition on touch screen



ESA OSIP – Focuses on model reviews

EasyMOD – New Hardware, Personnel Assistant, Incremental Formalisation, Enhanced Navigation....

# Review Activities at ESA



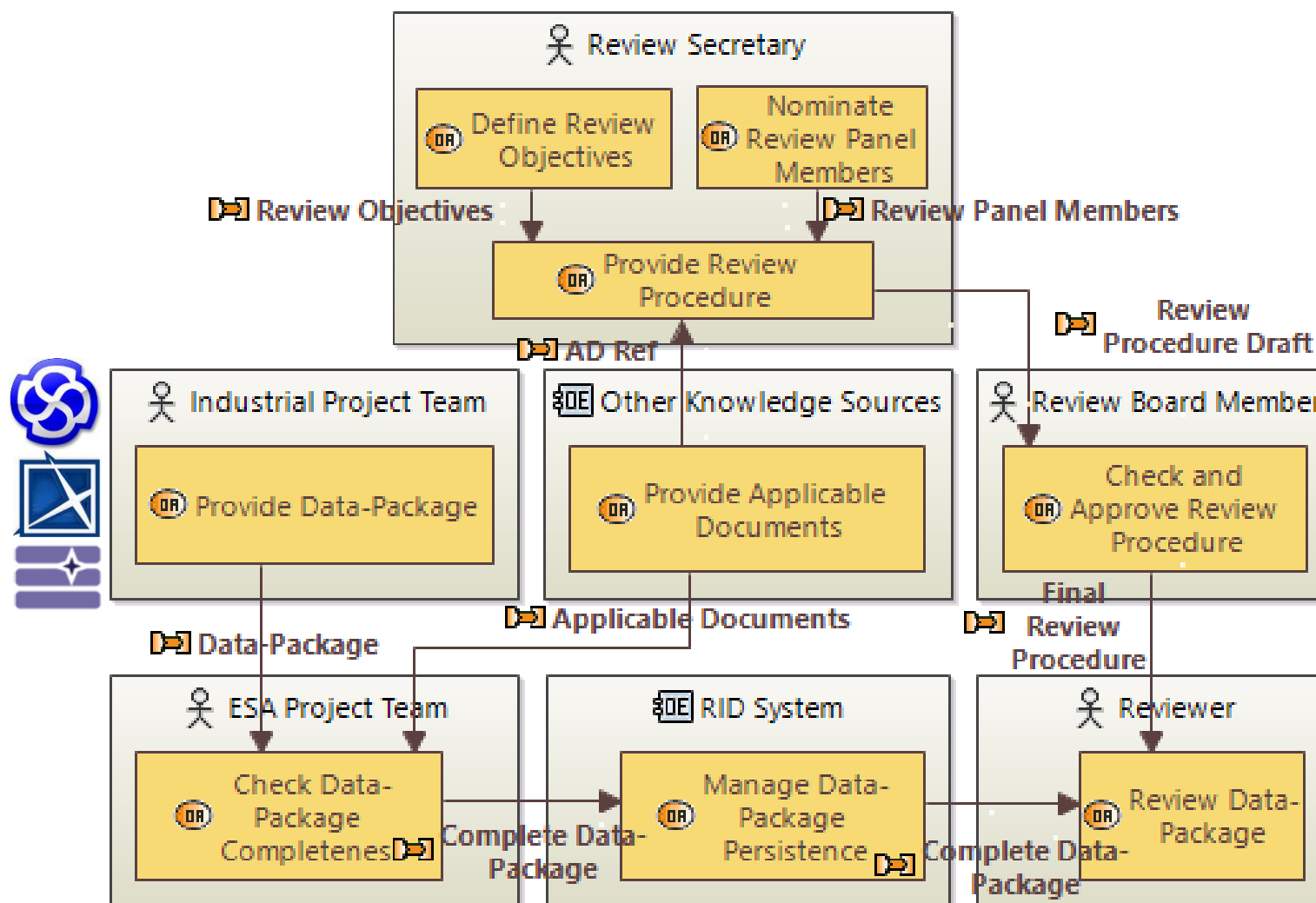
Prepare the Review



Perform the Review



# Review Activities at ESA



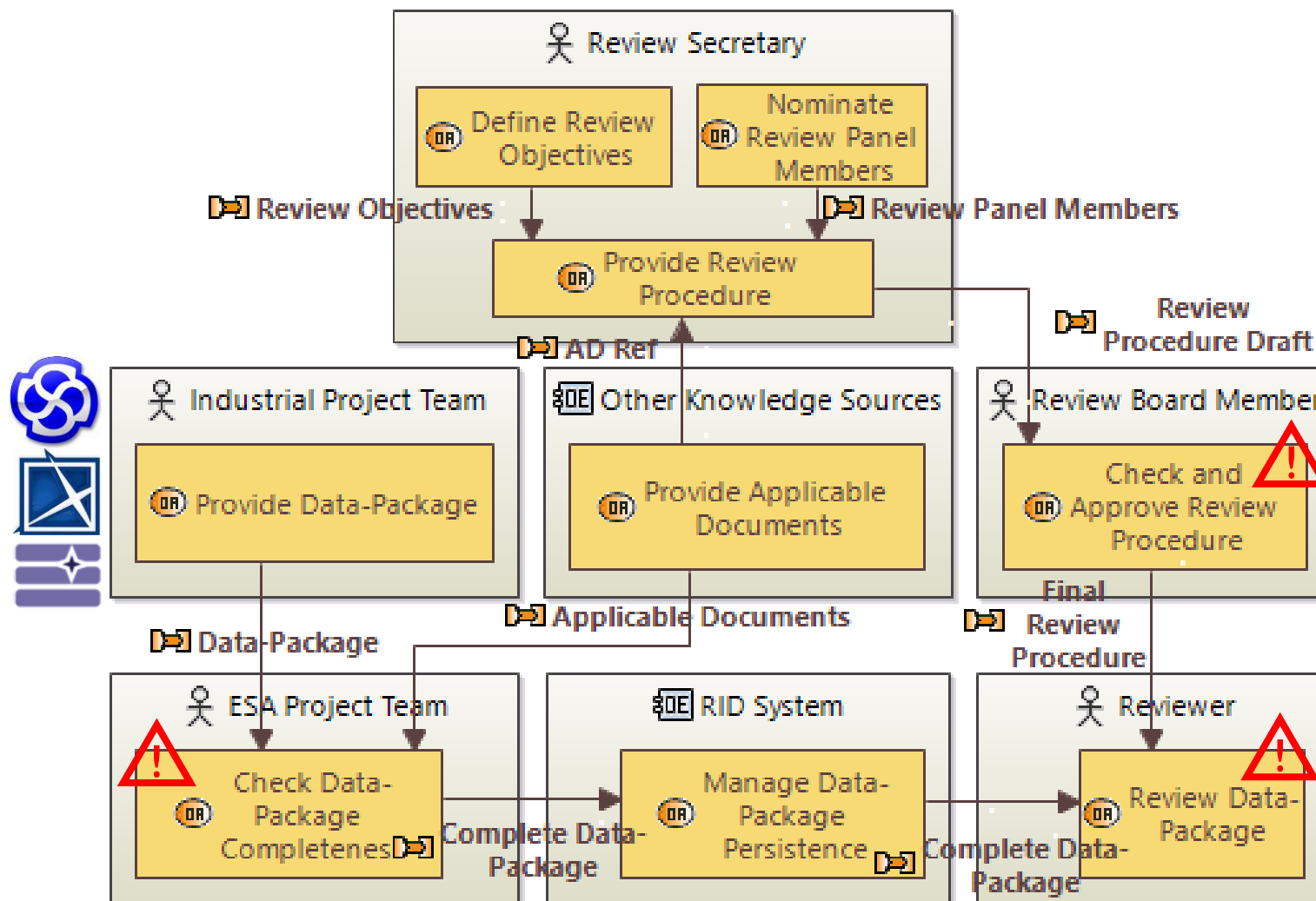
Prepare the Review



Perform the Review



# Review Activities at ESA



Prepare the Review



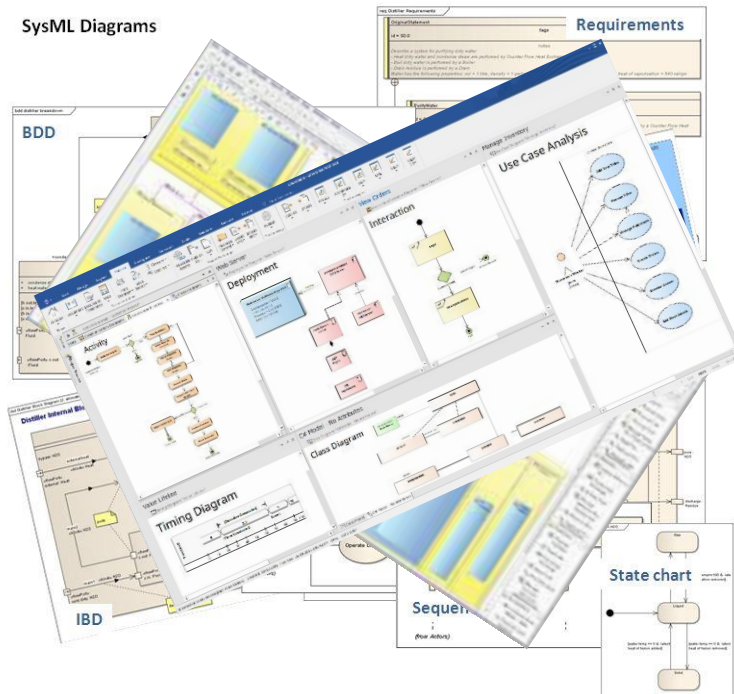
Perform the Review



Challenging for non-MBSE experts  
e.g, systems specialists (mech, elec, thermal, ....)

# Challenges during Review of MBSE models

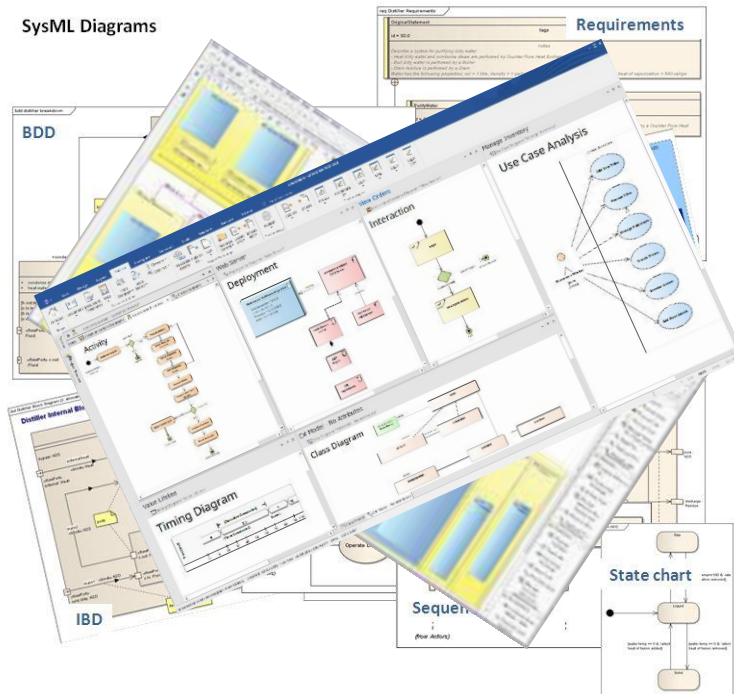
page 8



 Modelling language knowledge

# Challenges during Review of MBSE models

page 9

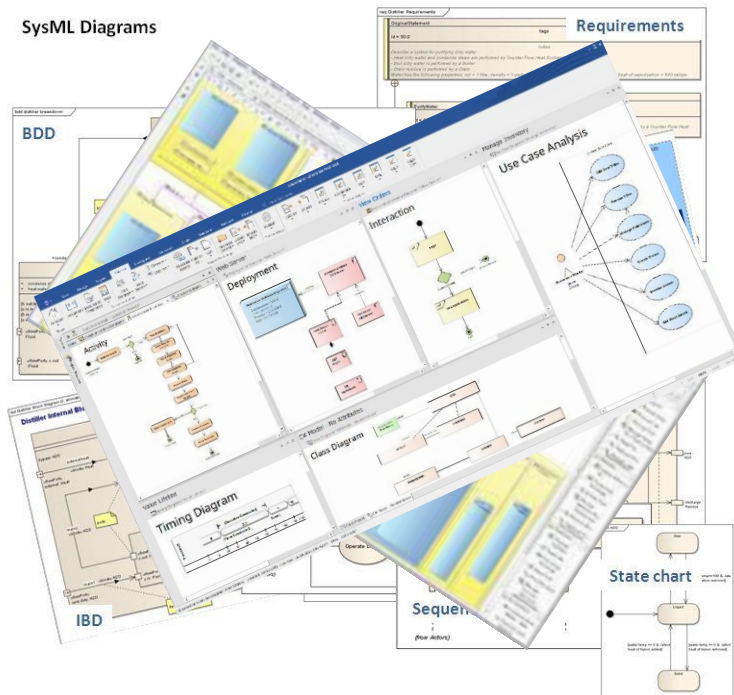


🚫 Modelling language knowledge

🚫 Navigation in scaled SE models

09/11/2022

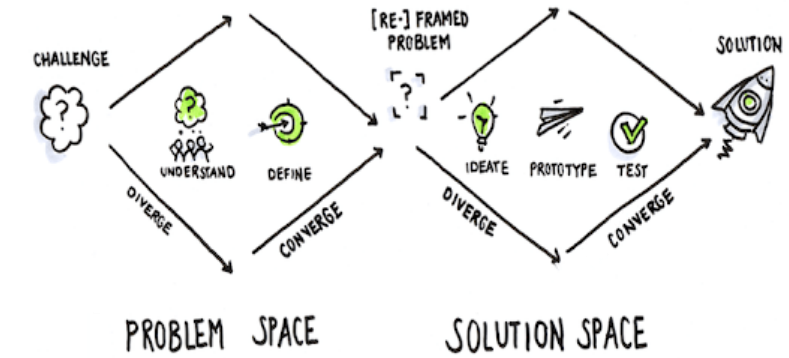
# Challenges during Review of MBSE models



🚫 Modelling language knowledge



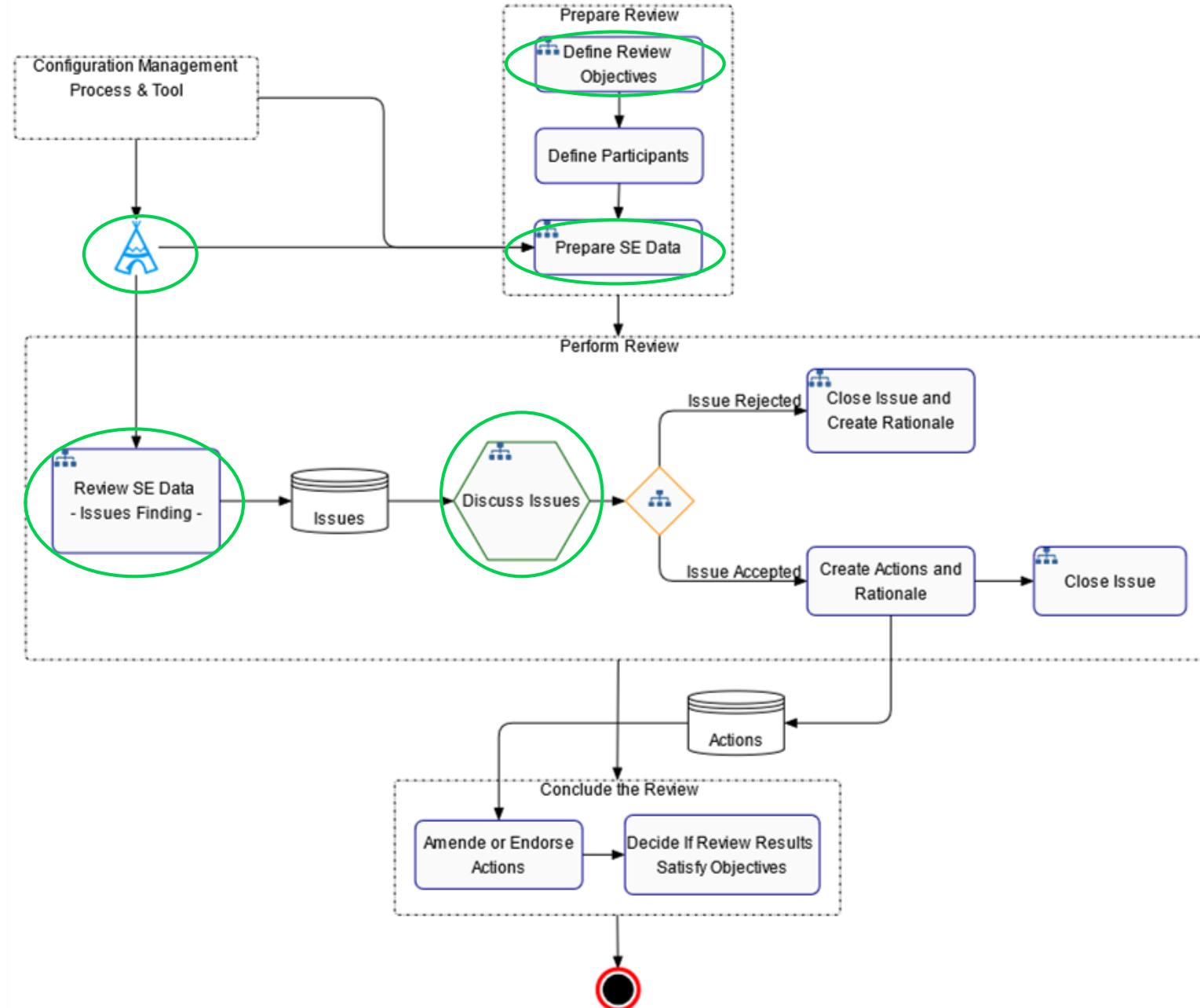
🚫 Navigation in scaled SE models



🚫 Abstraction levels

# EasyMOD@ESA Contributions

1. Extract model views abstracted from unnecessary concepts for a given review
2. Link the extracted model views with Review Objectives and integrate them within the Review Procedure
3. Navigate between concepts and views without losing the context of the review activities
4. Create comments and replies on the Review Procedure or on the model views in a collaborative way

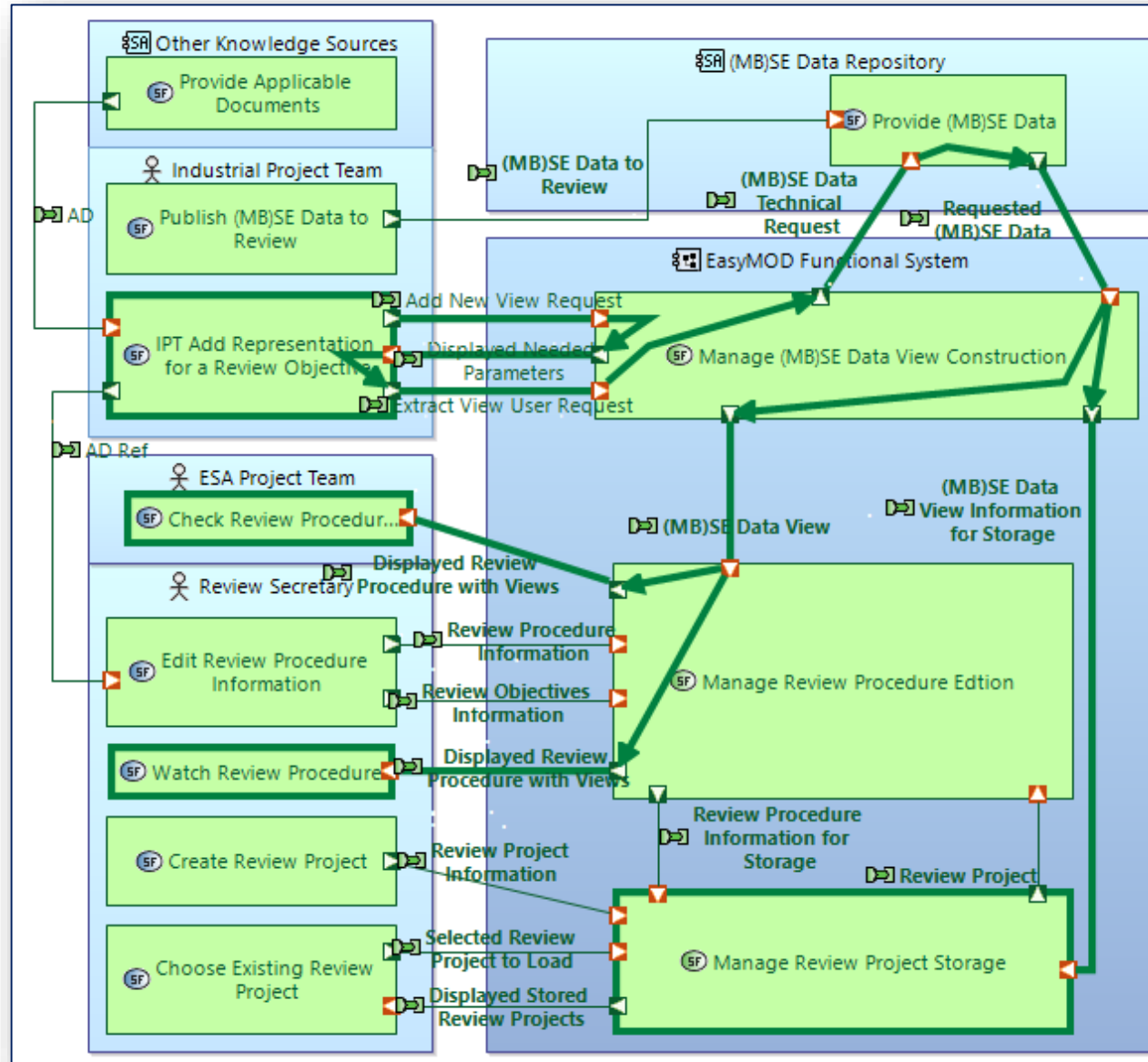





# Views Extraction Specification for Models Review

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# Capella Model System Functional Specification

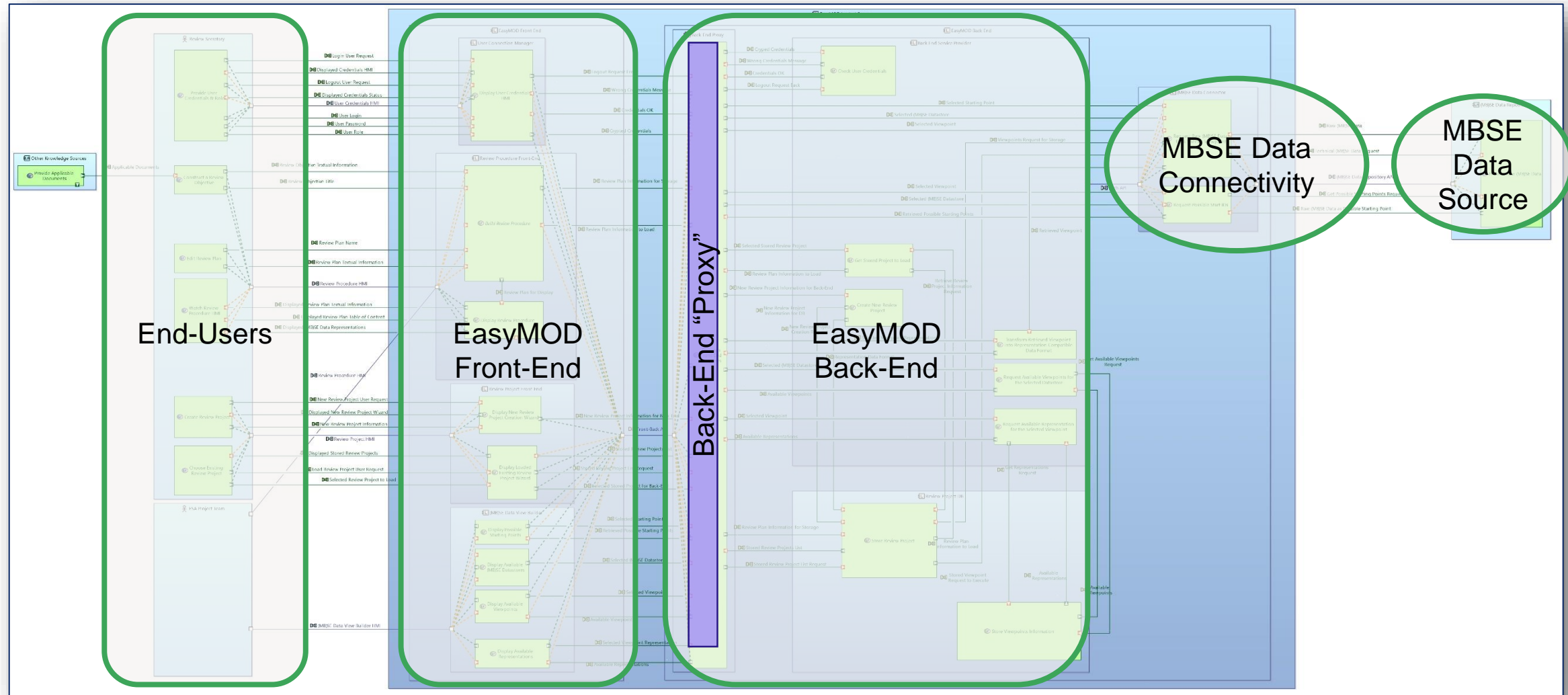


 Functional Chain focused on View Extraction for Review Procedure construction

09/11/2022



# Capella Model Logical Specification (1/2)



# HMI Mockup before Implementation

Search...

1. ESA Mission Requirements Allocation to System and Subsystem Technical Specification

+ Add a sub objective...

Add a Review Objective...

Search...

- SF1 – Monitor Subsystem
  - SF1.1 – Retrieve Attitude
  - SF1.2 – Compute Speed
    - SF1.2.1 – Title
    - SF1.2.2 – Title

**Power Consumption by Mode and by Physical Constituent**

Product Breakdown Structure	Observation High Definition (Target: 300.000)	Measurements (Target: 300.000)
Spacecraft	313.590W (Observation High Definition)	313.590W (Measurements)
Physical Module	70.00W (Observation High Definition)	0.00W (Safe)
- Master Assembly Module	50.00W (not up)	0.00W (not up)
Deployable sun shield	50.00W (not up)	0.00W (not up)
- Mirror module 3.5	0.00W (not up)	0.00W (not up)
- Mirror module 3.5 - 1		
- Mirror module 3.5 - 2		
- Mirror module 3.5 - 3		
- Final Plan Module	20.00W (not up)	0.00W (not up)
Control electronics	15.00W (not up)	0.00W (not up)
Final plan assembly	5.00W (not up)	0.00W (not up)
- Service Module	113.590W (not up)	113.590W (not up)

**Mass margin Sunburst**

Namescope: esa  
Id: 06d8f73c-0b30-42e3-8d00-0f75c08023  
EE\_depth: -2

- Undefined target or estimated
- Mass margin > 5%
- 5% <= mass margin <= 5%
- Exceeding mass > 5%

**Power Consumption by Mode**

Namescope: esa  
Id: 30a0b522-7d6a-40b5-a433-3108c055768575cb-9ab3-4cde-9d2-d5bdc6167347d15-cfa-4a7b-a4aa-564101ba0ba110  
EE\_depth: -2

Select Started Connector

Capella Connector

Select New File

Browse

...

Available Files

ECLSS.capella

Select Viewpoint

Functional Flow

Select Representation

Flow Diagram

Select Starting Element

Root Logical Function

Link to Review Objectives

1. ESA Mission Requir...

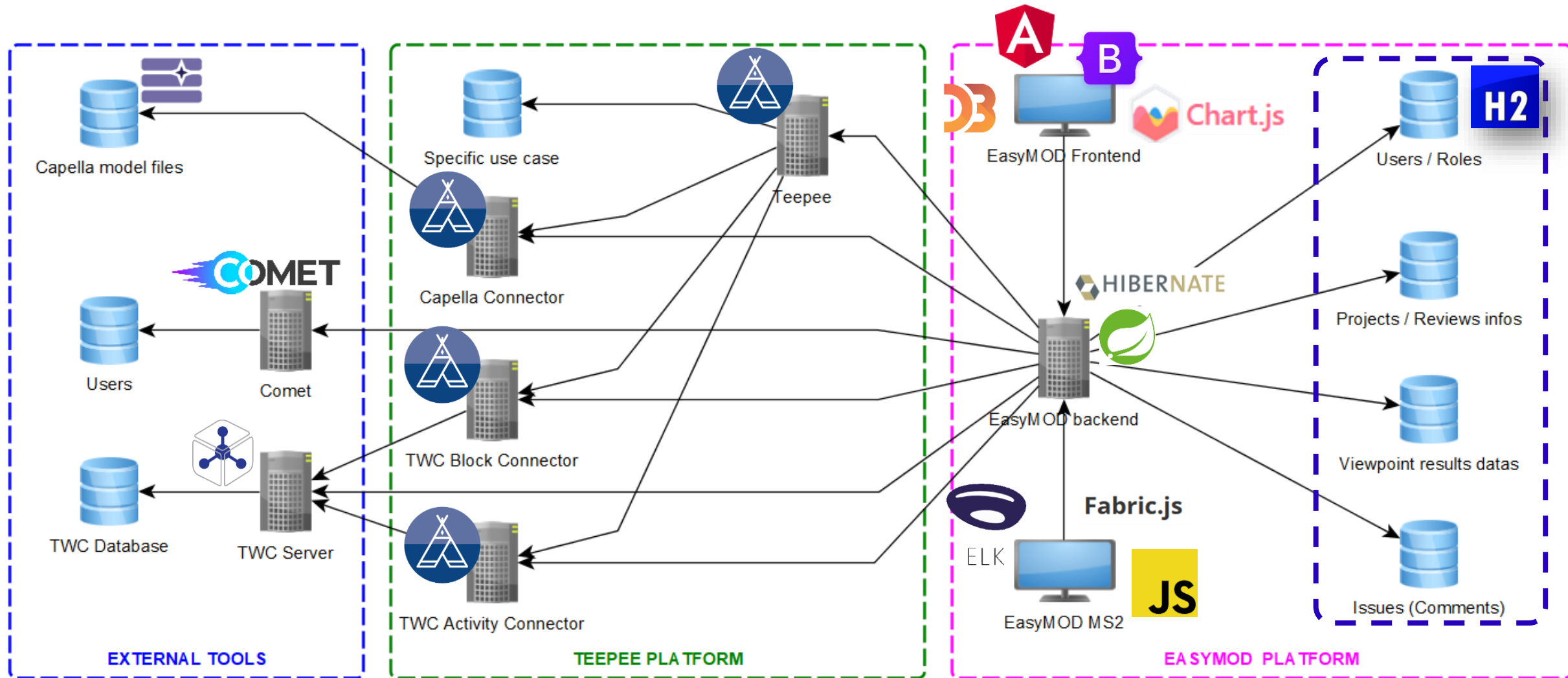
OK



# Implementation and Results

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# Global Software Architecture and Technologies



# Resulting HMI (1/4) – Navigation and textual elements

EasyMOD Review interface (V3.2)

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AIDA Airbus project

Aida PDR Review

1. Mechanical Review

Hereafter diagram that show Mass budget has to be reviewed.

2. General design

reviewObjective of the review is to validate preliminary and global principles of the design

Review Procedure Navigation


AIDA Airbus project

AIDA Airbus is a project to show EasyMOD MS3 capabilities.

You can see here different chapters created with different viewpoints, and different arrangements.

You can modify it as you want.

Aida PDR Review



Review Procedure Main HMI

Review to validate all items for preliminary design : Mechanical design, General design review, Component decomposition and relations, Function decomposition and relations, Functional flows, Function allocation to components, Electrical design

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1. Mechanical Review

Hereafter diagram that show Mass budget has to be reviewed.

Text editor

09/11/2022

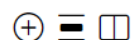

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# Resulting HMI (2/4) – View extraction feature

EasyMOD Review interface (V3.2)

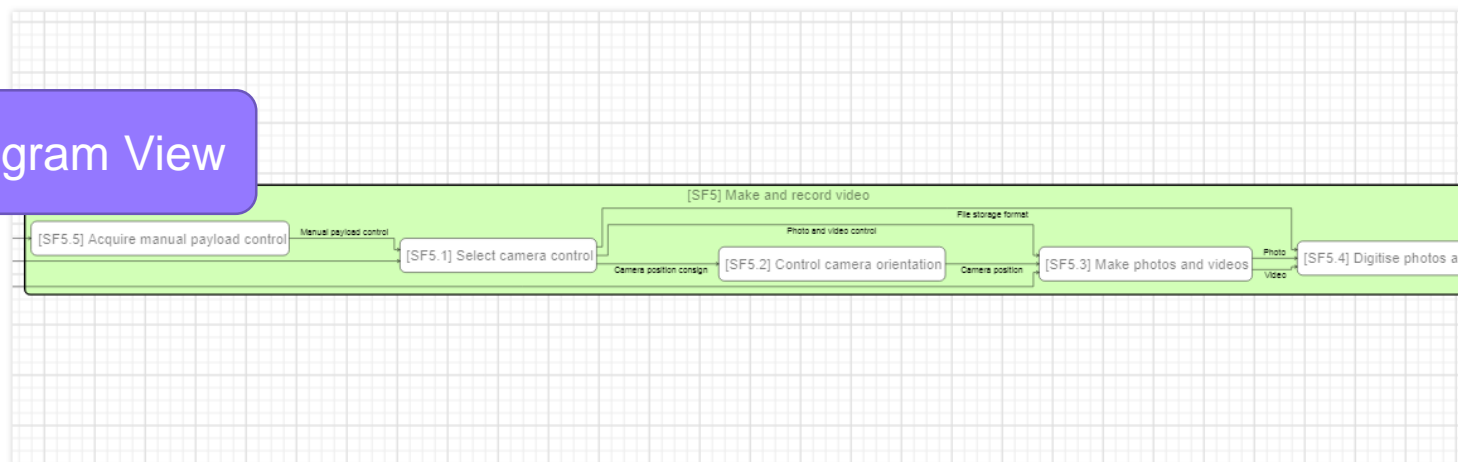
Validate function flows with input/output interactions.

Following diagram is expandable in full screen mode to manage comments on sub-elements



Tools for layouting

Diagram View



Functional flows focused on [SF5] Make and record video



- ▼ [PF] [SF5.1] Select camera control
  - File storage format
  - Automatic payload control
  - Photo and video control
  - Camera position consign
  - Manual payload control

- ▼ [PF] [SF5.2] Control camera orientation
  - Camera position
  - Camera position consign

- ▼ [PF] [SF5.3] Make photos and videos
  - Camera position
  - Video
  - Photo and video control
  - Photo
  - Aircraft sight

Tree Views

Viewpoint selection (Review Facilitator)

Connector Type

TWC Block Connector

Select the type of connector here

Available Resources

In\_Space\_Habitat\_SP2

Select the resource...

Available Tags

Test4EasyMOD

Select the tag...

View point type

Functions Breakdown

Select the view point type...

Start ids

▼ In-Space Habitat Functional Architecture

▼ Functional Sol In-Space Habitat

► Move Spacecraft

► Protect Crew

Provide Experiments Facilities and Results

► Provide Extravehicular Mobility

► Sustain Crew

► Upgrade

Ground Station

Select the start id 2...

Representation

Horizontal Tree

Select the representation...

Get viewpoint

View Extraction Panel

# Resulting HMI (3/4) – Commenting feature

EasyMOD Review interface (V3.2)

(Reviewer)

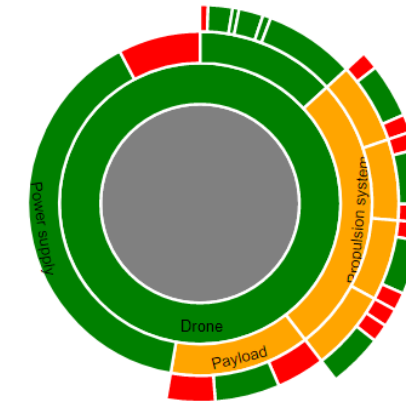
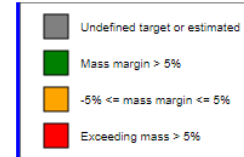
## AIDA Airbus project Aida PDR Review

1. Mechanical Review  
Hereafter diagram that show Mass budget has to be reviewed.

2. General design review  
Objective of the review is to validate preliminary and global principles of the design

Tabular View			
	Targ. Mass	Est. Mass	Diff
- Drone	4000	2825	1175
+ Flight control system	500	372	128
+ Propulsion system	1000	968	32
+ Payload	500	498	2
Power supply	1500	1075	425
Structure	500	880	-380

Mass Budgets focused on Drone



Mass Budgets focused on AIDA System

## 2. General design review

Objective of the review is to validate preliminary and global principles of the design

### 2.1 Component decomposition and relations

Tabular View			
- AIDA System			

## Mass Budgets - Sunburst

Jean-Marie.Gauthier  
Nov 7, 2022

My comment on mass budget

2 replies

Jean-Marie.Gauthier  
Nov 7, 2022

This is a reply to a comment

Romarc.Demachy  
Nov 7, 2022

Reply of another user on this comment

Write a reply

Cancel

Submit

## Components Breakdown - Horizontal Tree

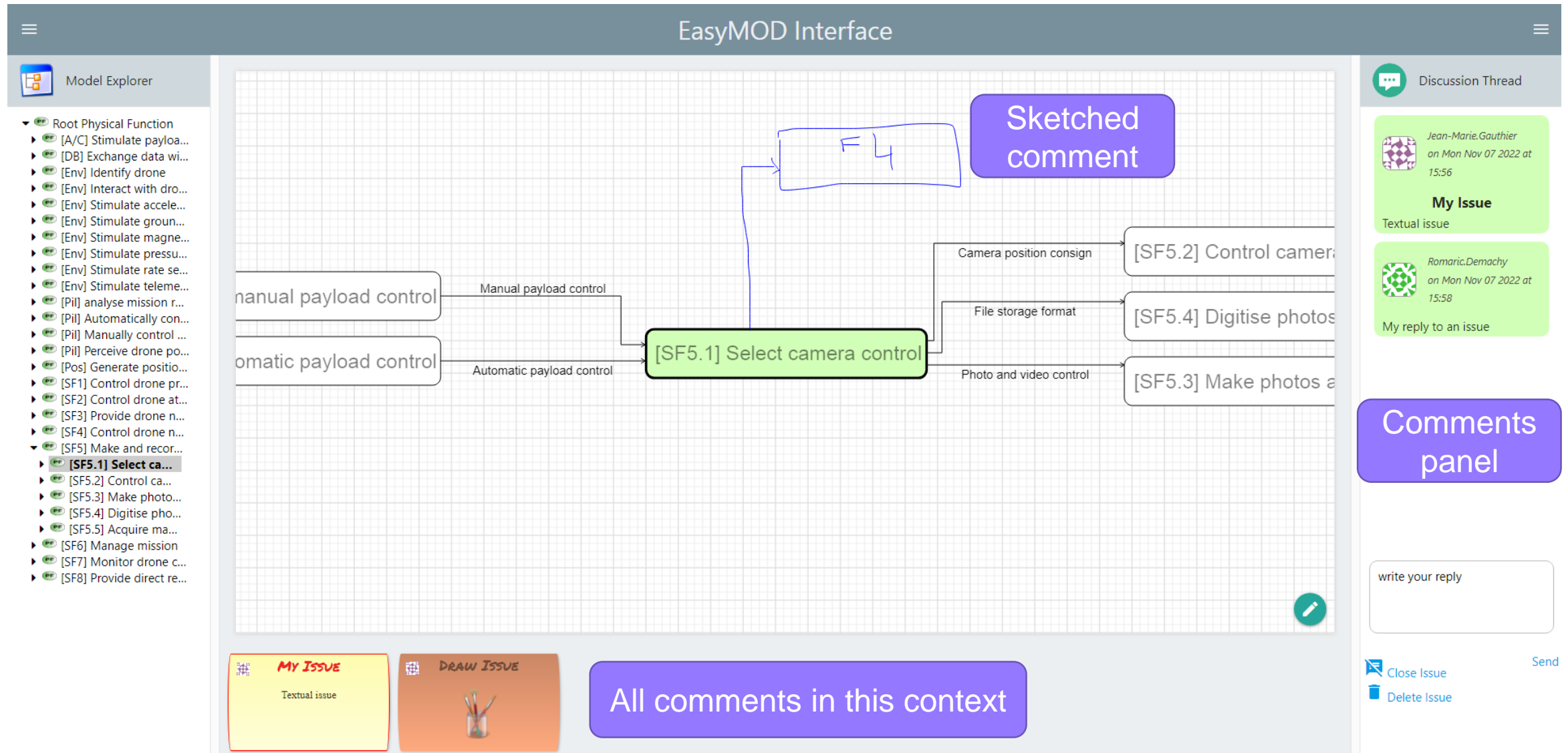
Romarc.Demachy  
Nov 7, 2022

Another comment on another view

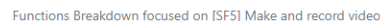
Comments Panel



# Resulting HMI (4/4) – Full screen mode for Diagram



## 09/11/2022



#### Components Breakdown focused on AIDA System



- [SF5.1] Select camera control
- File storage format
- Automatic payload control
- Photo and video control
- Camera position consign
- Manual payload control

The diagram illustrates the system architecture, divided into two main sections: 'Tabular View' and 'Main flight control board'.

**Tabular View:**

- Power supply behavior
- Flight control system behavior
- Optical flow sensor behavior
- LIDAR altimeter behavior
- GPS receiver behavior
- Flight control main channel behavior
- Flight control monitoring channel behavior

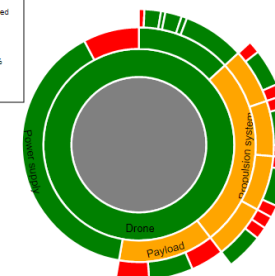
**Main flight control board:**

- [SF3.1.8] Acquire positioning signal
- [SF3.1.7] Compute ground speed
- [SF3.1.6] Film ground
- [SF3.1.2] Measure drone rate
- [SF3.1.3] Measure magnetic north direction
- [SF3.1.4] Measure ground distance
- [SF3.1.5] Measure ambient pressure
- [SF3.2] Compute navigation data
- [Env] Stimulate telemetric sensors

Connections are shown between the components, indicating data flow and dependencies. For example, the 'Flight control system behavior' is connected to the 'Optical flow sensor behavior', 'LIDAR altimeter behavior', 'GPS receiver behavior', and 'Flight control main channel behavior'. The 'Flight control main channel behavior' is connected to the 'Flight control monitoring channel behavior' and the 'Main flight control board' components.

Product Breakdown Structure		Observation High Declination (Target: 350.0W)	Manoeuvre (Target: 300.0W)
Spacecraft		372.566W (Observation High Declination)	302.766W (Manoeuvre)
Service Module		302.37W (roll-up)	302.77W (roll-up)
AOGNC		154.52W (roll-up)	154.52W (roll-up)
STR Sodern Hydra Electronics Unit 1		1.12W (On)	1.12W (On)
MTQ Zarm MT110-2		2.9W (On)	2.9W (On)
GYRO Selex Galileo Sireus 1		0.0W (Standby)	0.0W (Standby)
GYRO Selex Galileo Sireus 2		0.0W (Standby)	0.0W (Standby)
RW Rockwell Collins RSI 12		90.0W (On)	90.0W (On)
STR Sodern Hydra Electronics Unit 2		11.0W (On)	11.0W (On)

Tabular View		Targ. Mass	Est. Mass	Diff
-	Drone	4000	2825	1175
+	Flight control system	500	372	128
+	Propulsion system	1000	968	32
+	Payload	500	498	2
	Power supply	1500	1075	425
	Structure	500	880	-380

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# Practices at the ESA's CDF

## Validation at ESA

- 7 participants
- Two exercises: prepare a review procedure and performing the review

How familiar are you with the MBSE topic?

007

I'm an expert



I have some solid background



I have some basic knowledge



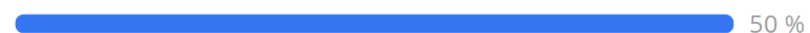
I'm completely noob



Did you find easily the elements you wanted when you added a view ?

006

Yes



No



Did you find the views self-explanatory ?

007

Yes



No





# Conclusion and Perspectives

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# Conclusion & Perspectives

## Achievements

- Creation & edition of a review procedure
  - Review objectives
  - Textual elements
  - Chart based and diagram based interactive views from heterogeneous MBSE data
- Comments and discussion threads
  - At review procedure level
  - At diagram element level
  - Assessment of graphical comments
- Validation at ESA's CDF

## Long-term perspectives :

- Integration of Extended Enterprise TeePee features
  - Review of unified aggregated models
- Edition of models
  - Personal Assistant
  - Sketch recognition integration from BabyMOD
- Integrate other viewpoints
  - Physical Archi. & Interfaces, functional chains, ...
  - Other viewpoints defined directly by end-users
- Ontology definition as pivot metamodel
  - OSMOSE, SECAM, OpenCAESAR, ...
- Partnerships with tool vendors to mature TRL



# Thank you for you attention.



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[jerome.fasquel@irt-saintexupery.com](mailto:jerome.fasquel@irt-saintexupery.com)  
[systems-engineering@irt-saintexupery.com](mailto:systems-engineering@irt-saintexupery.com)

[david.Brandao@ext.esa.int](mailto:david.Brandao@ext.esa.int)