



# **MBSE2021 - ESA**

# **TeePee4Space**

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A practical application of Information Sharing  
in Extended Enterprise to the space industry



# Context



→ Private research foundation supported by the French government

System Engineering Center of Competence

Digital continuity

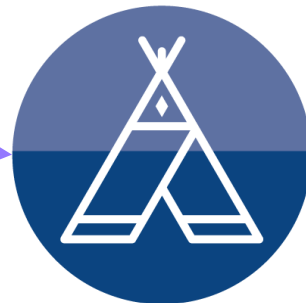
New approaches

*EasyMOD project*

- Natural and smart interfaces
- AI assistants

...

*MOISE project*



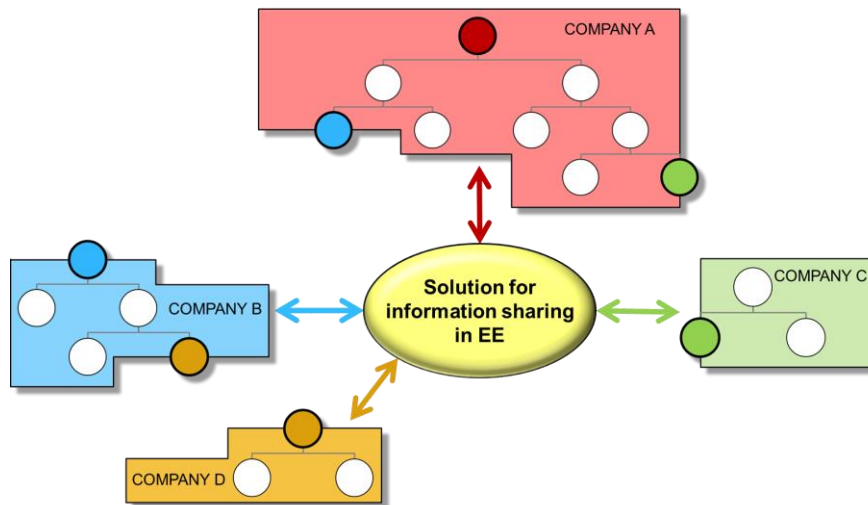
***TeePee4Space : demonstration of the usage of TeePee on a space use case***

***Teepee is an Enhanced Engineering Platform for the Extended Enterprise***



# Information sharing in Extended Enterprise

- **Extended Enterprise** : An ecosystem constituted of a system integrator and several suppliers, which may also subcontract with other suppliers



- **Problem to be solved** : the companies decision management process needs to be fed by federated SE data coming from their own data warehouse and from their direct and indirect partners

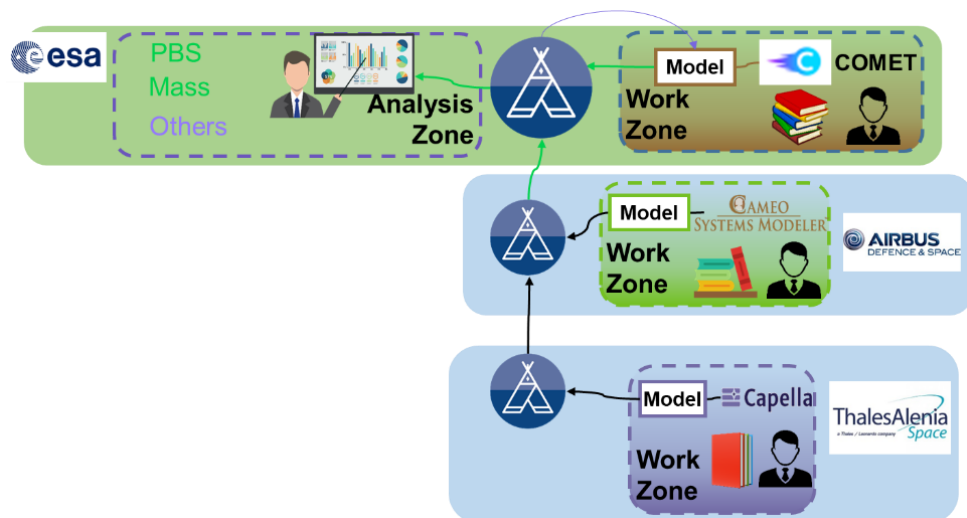
- **Challenges** :

- Build a shared vocabulary
- Specify the collaboration in the extended enterprise
- Control data exposure
- Ensure the consistency of the exposed data

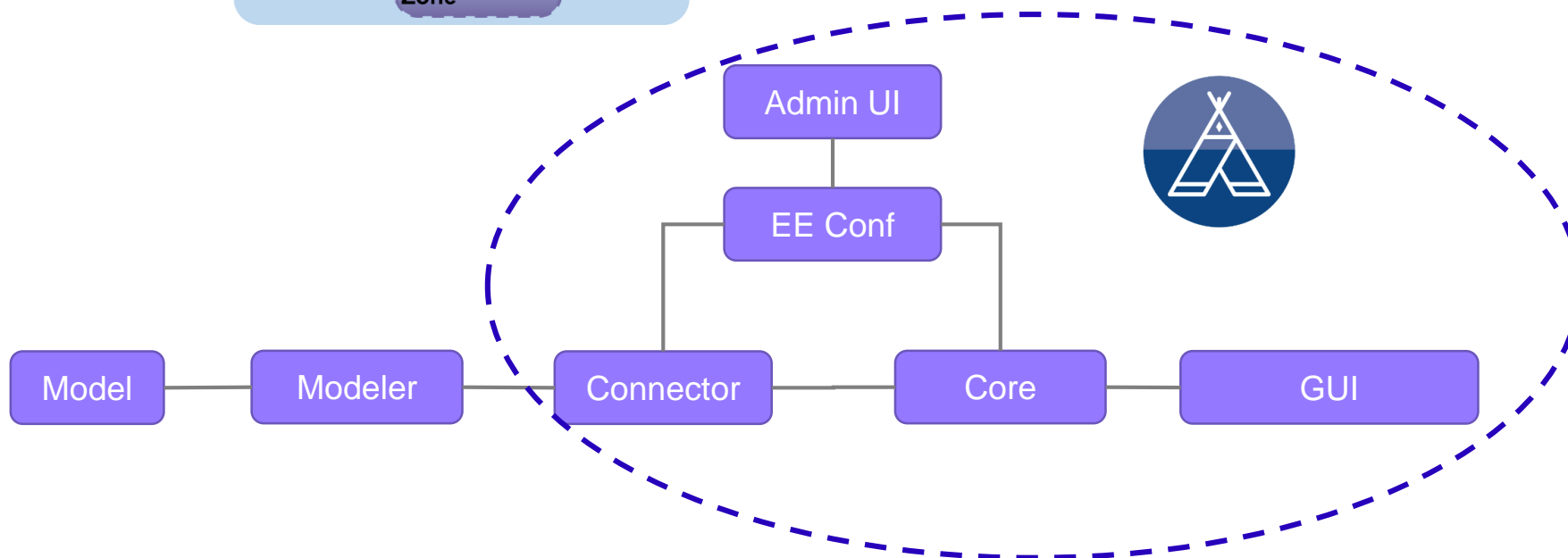
**TeePee value proposition** : to build the **digital continuity** for Systems Engineering artifacts within an **Extended Enterprise** for analysis purposes, by tackling **heterogeneity** of methods and tools, as well as **confidentiality** of data



# TeePee architecture



- Same architecture for each company in the EE
- Each part which is not an UI is seen as a « microservice » with its REST-like API
- The models storage is distributed : each stakeholder has the hand on his data, which he can choose to expose or not

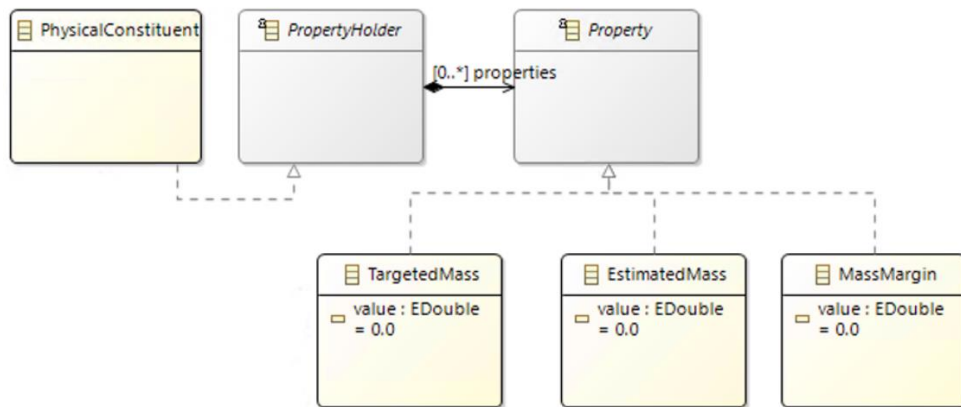


# Heterogeneity management – connectors and viewpoints

*How to manage the heterogeneity of methods and tools within the Extended Enterprise ?*

- Definition of a **shared vocabulary**, formalized as a **pivot meta-model**, and **mapping** with the native modelling tools concepts

- Definition of **viewpoints** (FBS, functional dataflow, PBS, PBS+mass,...) **dedicated to a given analysis**, for which only the modeling artefacts required and agreed between the stakeholders are considered



Tool Method	Cameo by Teamwork Cloud NASA Mass Rollups	Capella Arcadia (Basic mass viewpoint)	COMET ECSS-TM-10-25
TeePee metamodel element			
Physical Constituent	SysML Block	Physical Component (both Node and Behavior) in Physical Architecture	ElementDefinition/ElementUsage
SubPhysicalConstituents (Has SubPhysicalConstituents)	Composition	Contained In	ContainedElement
Targeted Mass	allocatedBudget (Property)	Part Mass Max Value (Property)	Parameters, parameterOverride, ParameterValueSet, ParameterOverrideValueSet
Estimated Mass	realizedBudget (Property)	Part Mass Value (Property)	Not modeled
Mass Margin	designMargin (Property)	Not modeled (computed by TeePee)	Not modeled (computed by TeePee)
Views	SysML Block Definition Diagram	Physical Architecture diagram	Pbsmass spreadsheet

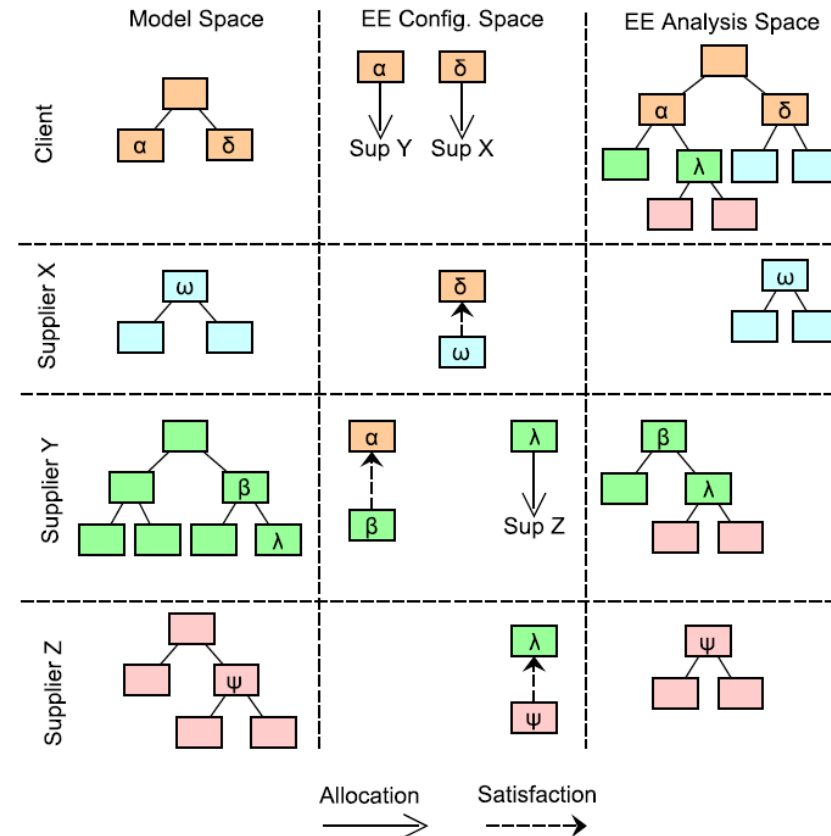
*Pivot meta-model and mapping with modelling tools concepts for the « **PBS + mass** » viewpoint*



# Extended Enterprise definition

## How to manage the relationship between the stakeholders of an Extended Enterprise ?

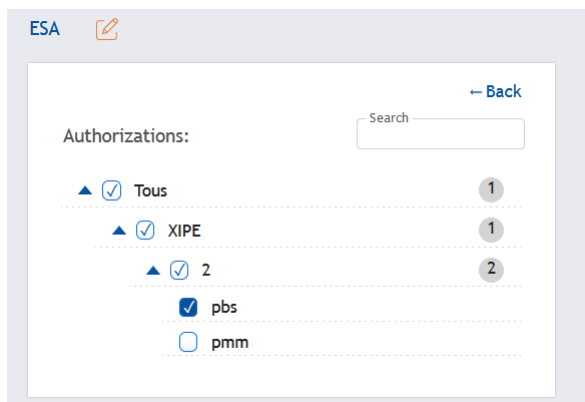
- Each customer defines its « **make or buy** » strategy, the decision is taken on the leaves of a given breakdown structure
- « Buy » leaves are **allocated to suppliers**
- The suppliers define the **satisfaction links** between the allocated components of the customer model and the associated components in their own model
- The suppliers may choose the « depth » of details they want to expose to the customer (« black box » or « white box »), depending on the contractual relationship



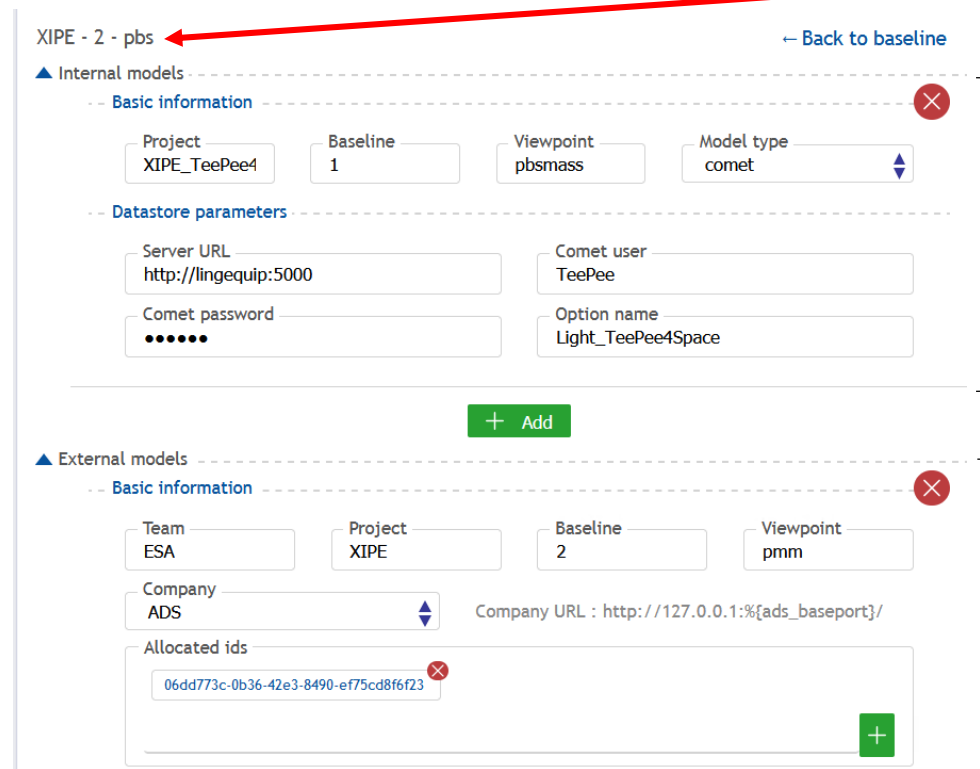
# Confidentiality and version management

## How to manage the confidentiality and version consistency of SE data ?

- **Version consistency** is managed by defining **projects** and **baselines** in each TeePee instance of the Extended entreprise.
- Allocation and satisfaction links are then defined for a combination of **Project/Baseline/Viewpoint (P/B/V)**
- Access rights to a P/B/V are managed by Teams



Access rights for team « ESA »



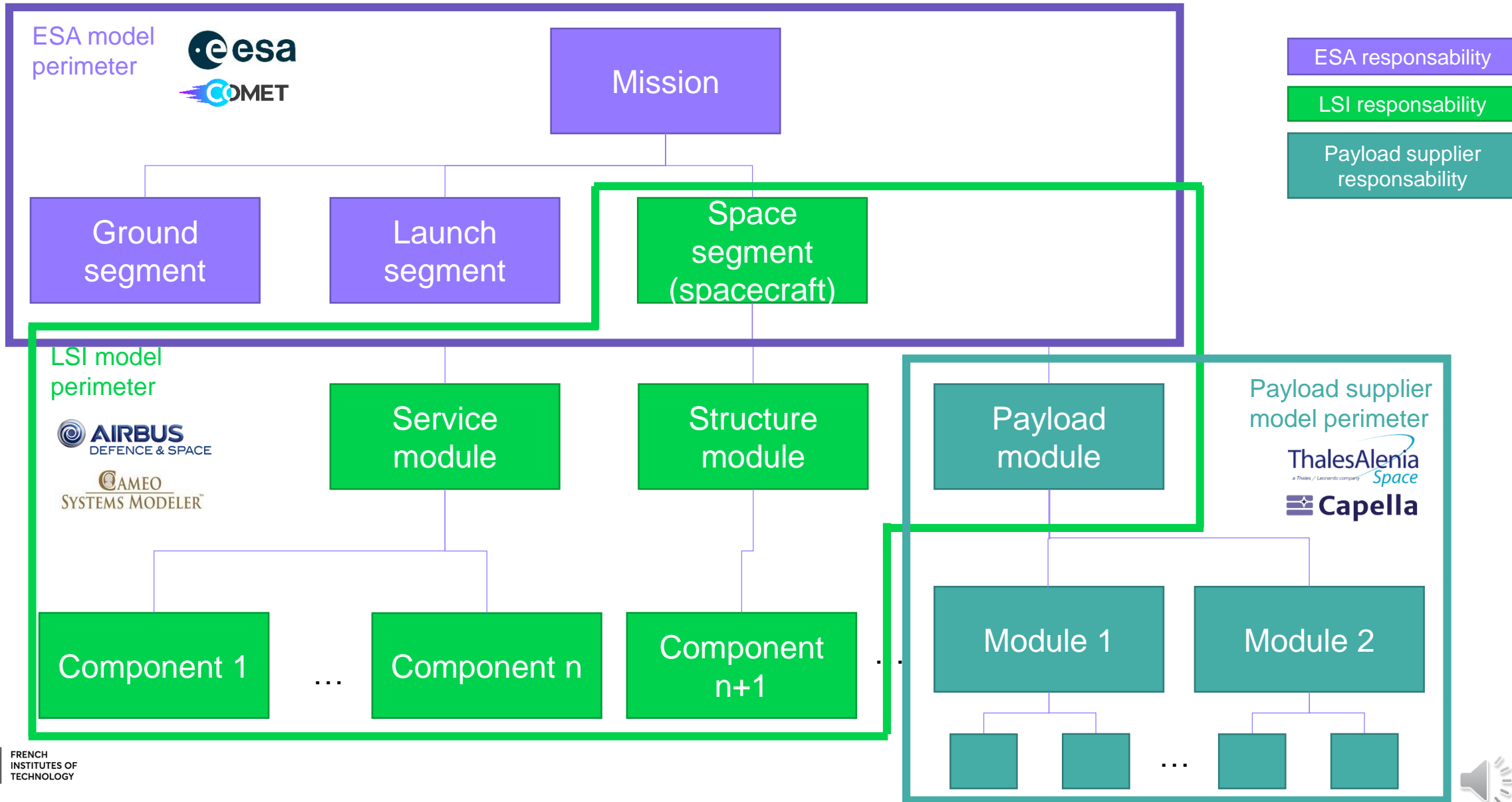
P/B/V

Internal model associated to the P/B/V

Supplier model associated to the P/B/V



# Space use case – PBS+mass viewpoint





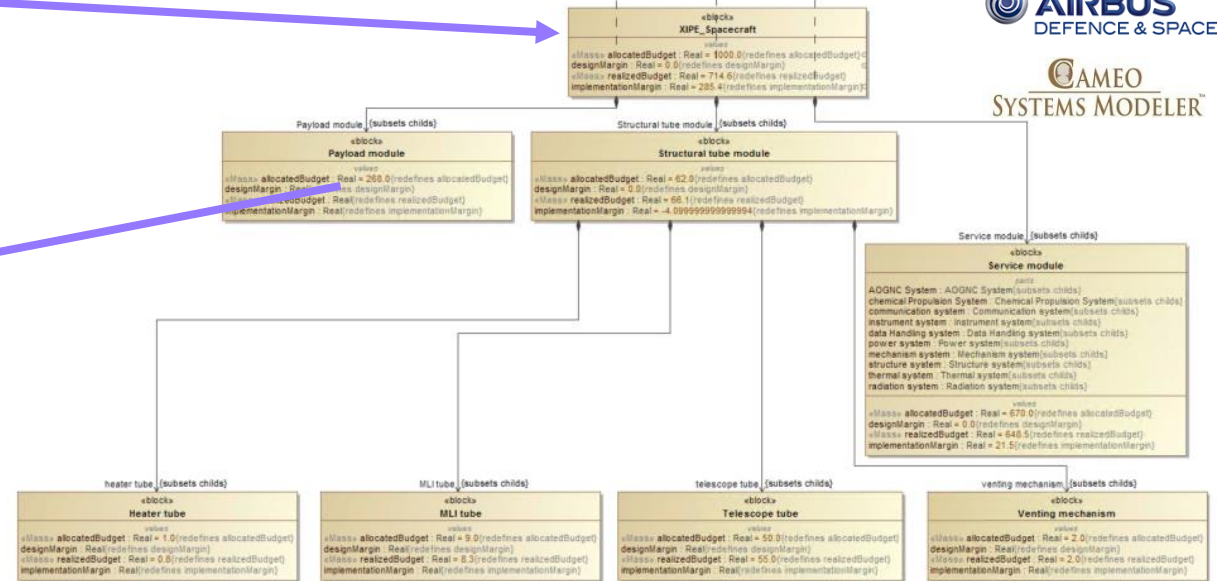
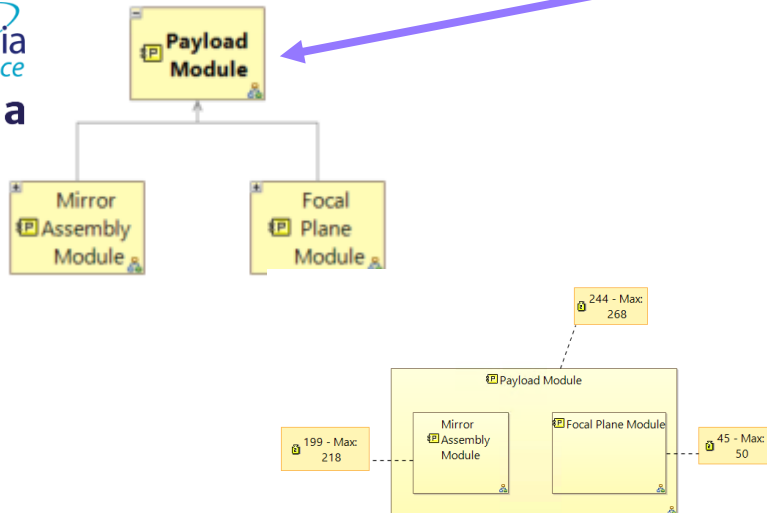
# Experimentation – models in their native tools



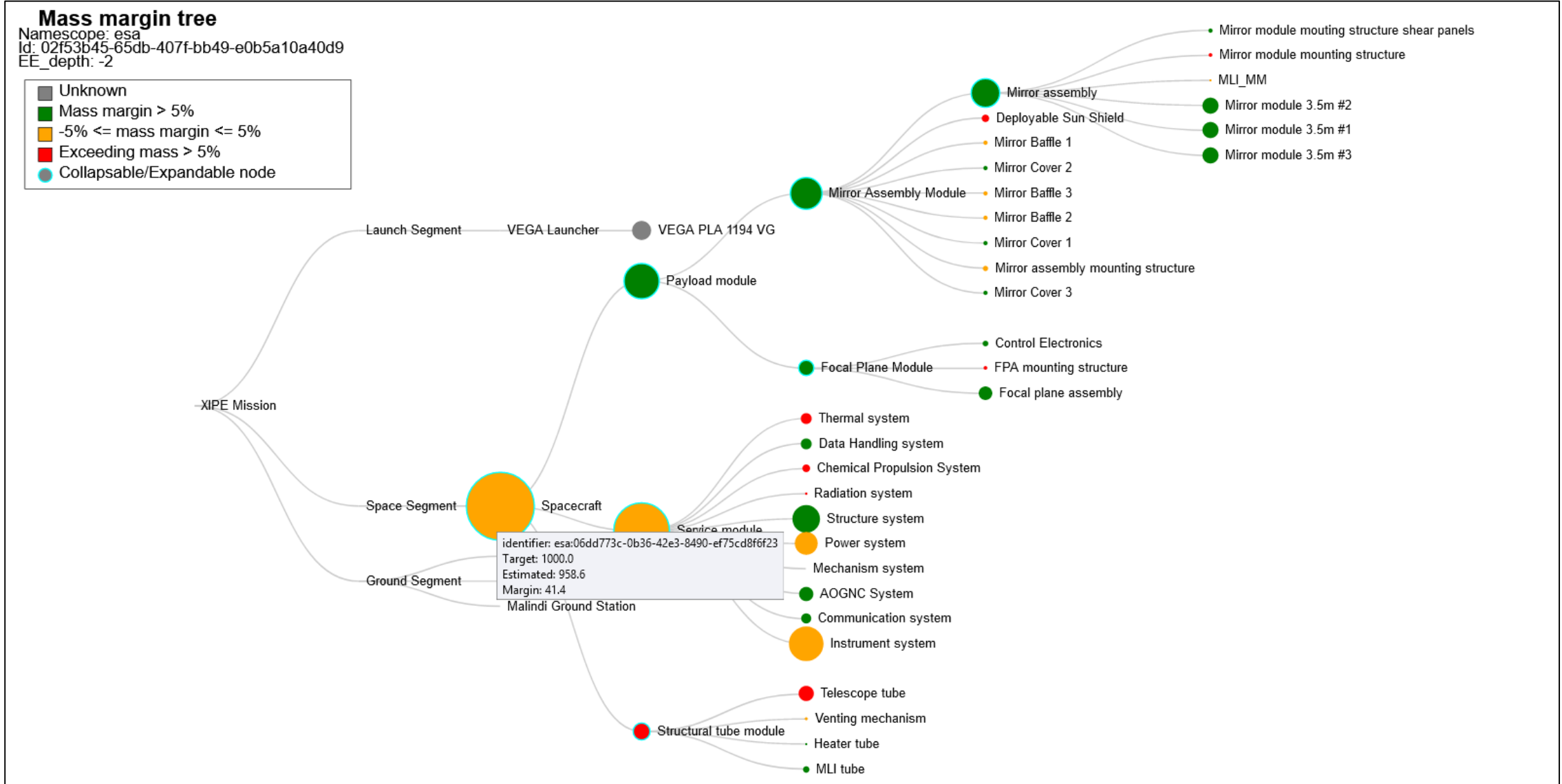
Product Tree, Light\_TeePee4Space x

Model: XIPE\_TeePee4Space Data-Source: http://lingequip:5000/ Iteration: 1 Person: Romaric Demachy Option: Light\_TeePee4Space Domain Of Expertise: System Engineering [SYE]

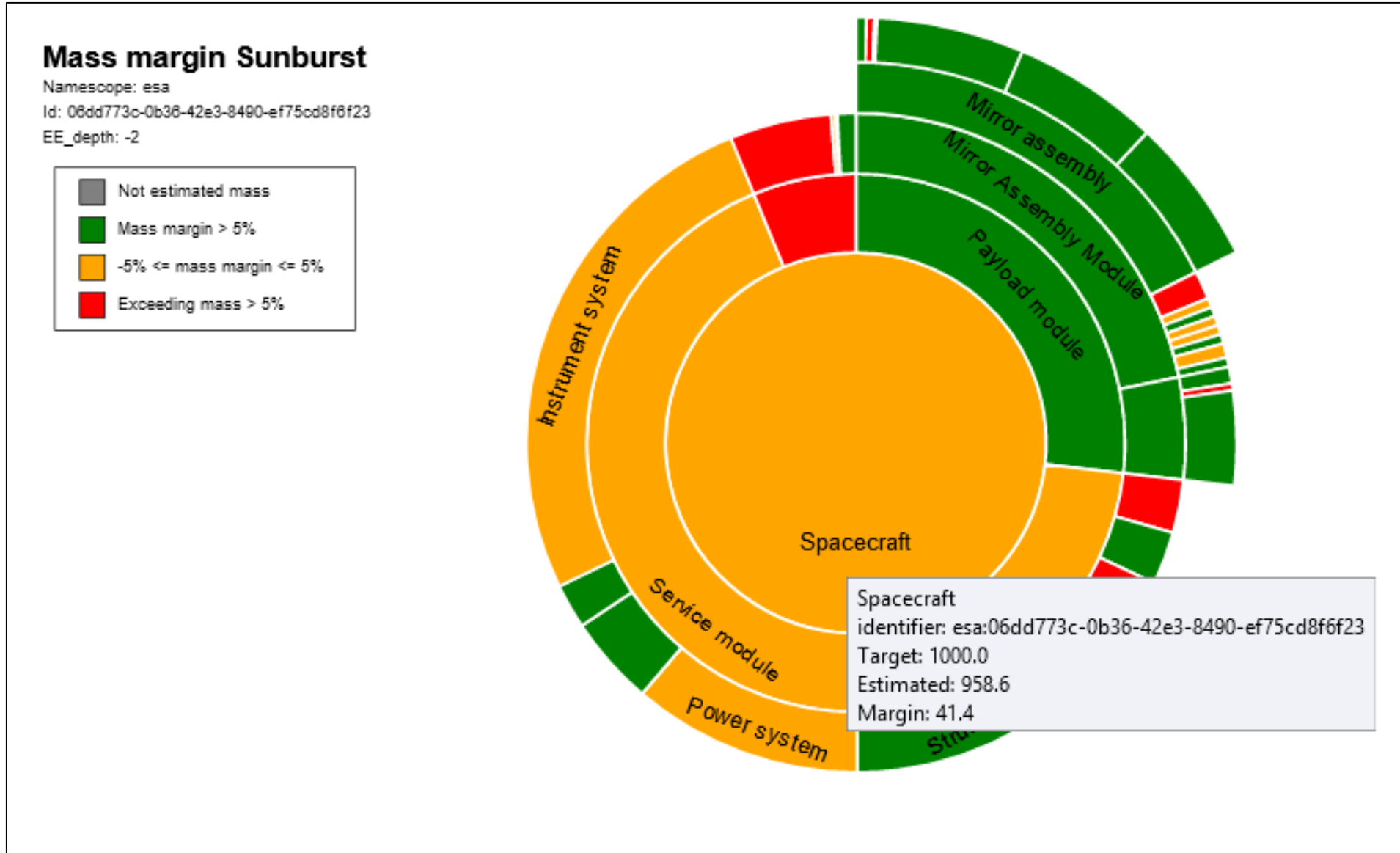
Name	Value	Owner	Switch	Description	Model Code	Row Type
XIPE Mission		SYE			XIPE	Element Definition
Ground Segment : Ground...		SYE			XIPE.Ground_Seg	Element Usage
Launch Segment : Launch...		SYE			XIPE.Launch_Seg	Element Usage
Space Segment : Space Se...		SYE			XIPE.Space_Seg	Element Usage
Spacecraft : Spacecraft		SYE			Space_Seg.SC	Element Usage
dry mass	- [kg]	SYE	MANUAL		SC.mass_dry	Parameter
mass	1000 [kg]	SYE	REFERENCE		SC.m	Parameter
wet mass	- [kg]	SYE	MANUAL		SC.mass_wet	Parameter



# Experimentation – PBS+mass viewpoint results



# Experimentation – PBS+mass viewpoint results



# Conclusion

- Preliminary results :
    - Development of a COMET connector for the PBS and PBS+mass viewpoints
    - Validation on a use case representative of an Extended Enterprise in the space industry
  - Teepee4Space future work :
    - Development of a Power Consumption analyse viewpoint
- The project runs until the end of 2021**
- Long-term perspectives :
    - Take advantages of more complete ontology definition (like the OSMOSE initiative for the space industry), which may be used as pivot meta-models in Teepee
    - Integration of TeePee with EasyMOD to enable the review of unified aggregated models
    - Improve the maturity and « industry-readiness » of TeePee, by developing partnerships with tool vendors





**Thank you  
for your attention**

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**[julien.baclet@irt-saintexupery.com](mailto:julien.baclet@irt-saintexupery.com)**

