

# Experienced gained on applied MBSE at Spaceship FR

## Author

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## Organizations

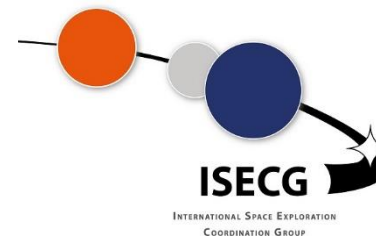
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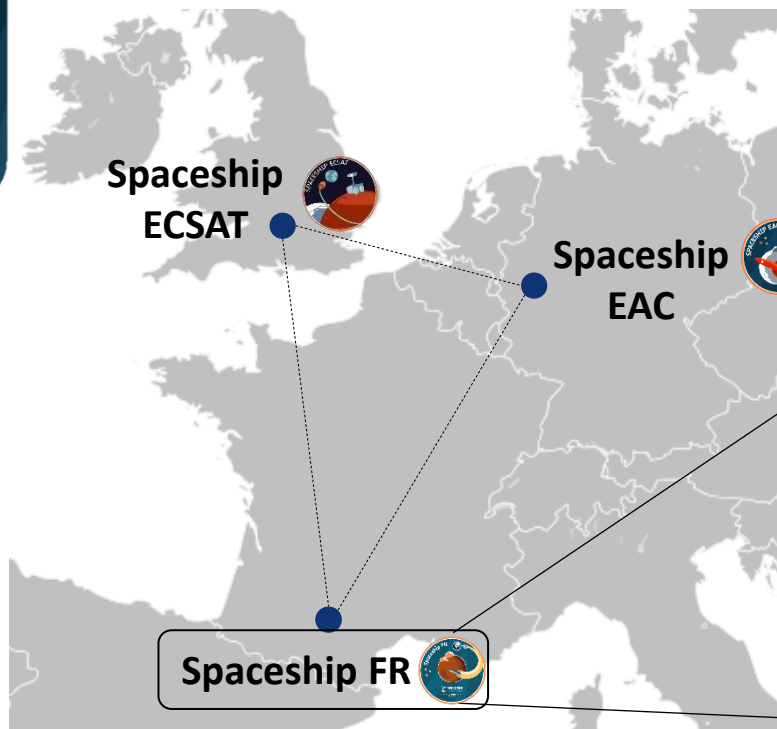


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## Inspire

Disseminate knowledge to the general public, support student projects, and attract talent for the development of French technological excellence.

## Federate

Develop synergies between space and non-space, network expertise to accelerate the development of innovative solutions.

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**ISECG** : International Space Exploration Coordination Group

**GER** : Global Exploration Roadmap

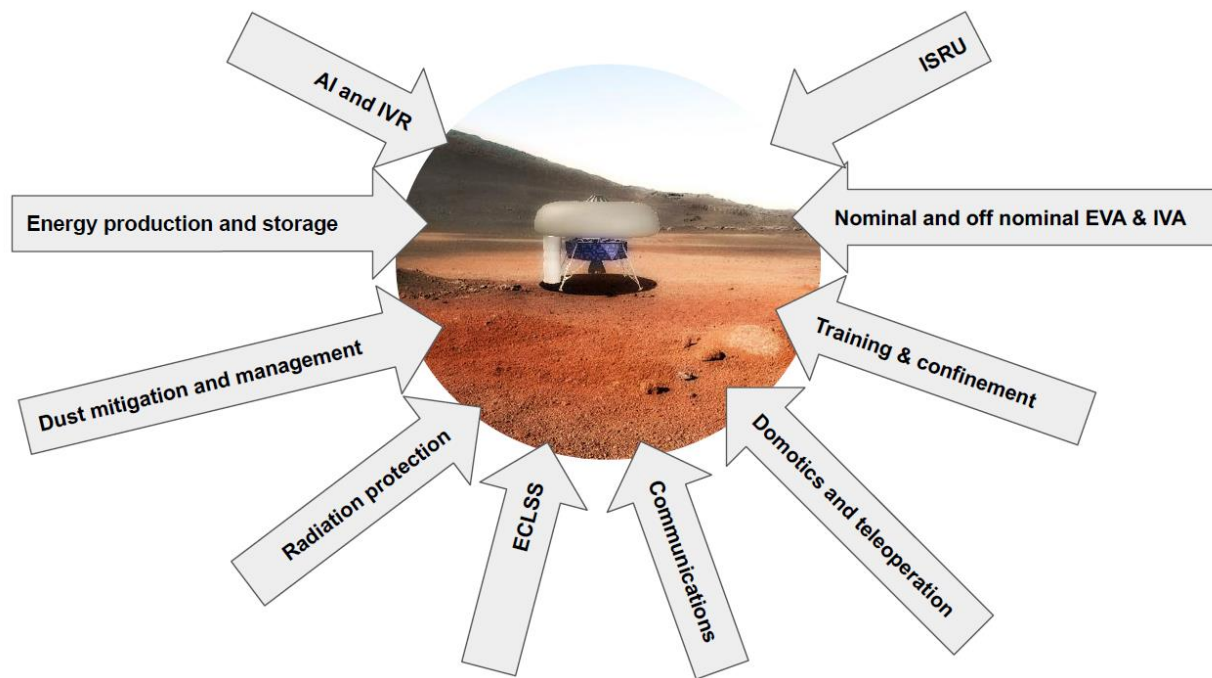
**ExPeRT** : Exploration Preparation Research and Technology

**EAC** : European Astronaut Centre

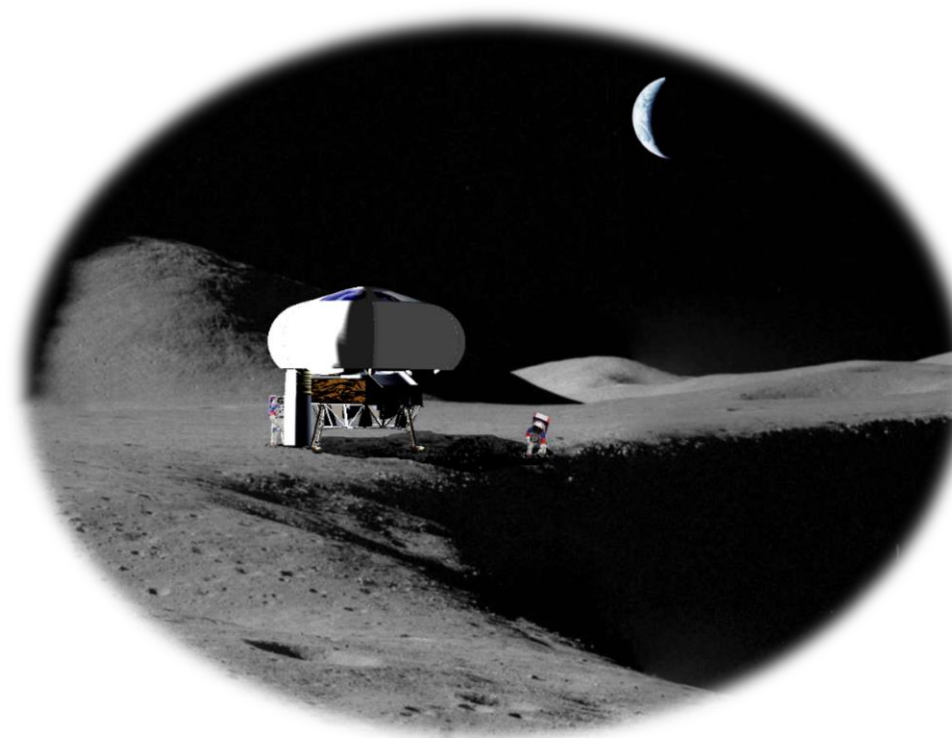
**ECSAT** : European Centre for Space Applications and Telecommunications







**Figure 1.** *Lunar Habitat in an Analogue Environment.*



**Figure 2.** *Lunar Habitat in the Lunar Environment*

The Spaceship FR Team worked with a start-up referred to as “the client”, who proposed a project based on a concept for an Inflatable Lunar Habitat which became the System of Interest (Sol).

**1**

**Created a documented basis on MBSE tools and methods to answer the questions and concerns of the client.**

**2**

**Used Capella and ARCADIA to perform the Operational Analysis based on the use cases provided by the client.**

**3**

**Evaluated the efficiency of both the tool and the method to respond to the needs of the Spaceship FR team and the client.**



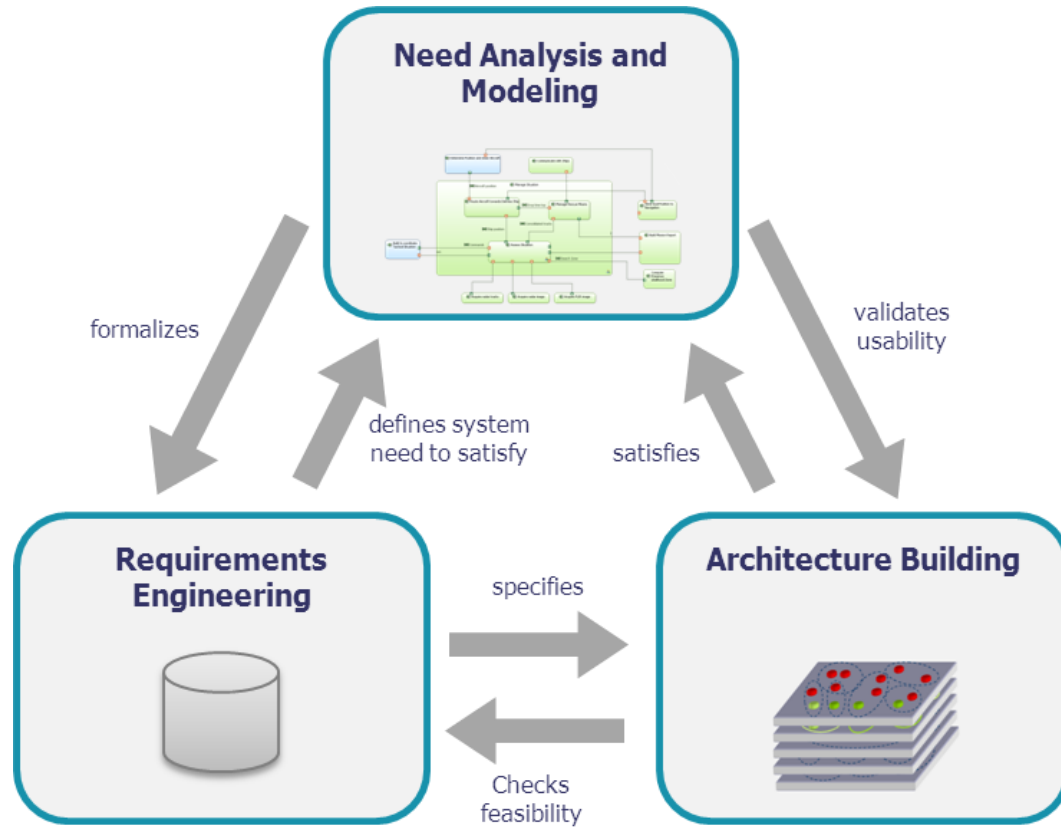
# Main differences between SysML and Capella/Arcadia



MBSE Pillars	SysML	ARCADIA/Capella
Language	SysML is a general modeling language for system modeling and an extension of the Unified Modeling Language (UML).	The modeling language used by Capella is exclusive to ARCADIA. However, the ARCADIA concepts can have full or partial equivalencies in UML/SysML.
Methodology	There are multiple methodologies based on SysML. <ul style="list-style-type: none"><li>• SYSMOD (General)</li><li>• OOSEM (General)</li><li>• MagicGrid (Catia Magic)</li><li>• IBM Rational (IBM Rhapsody)</li></ul>	The ARCADIA Method consists of 4 layers: <ul style="list-style-type: none"><li>• Operational Analysis</li><li>• System Analysis</li><li>• Logical Architecture</li><li>• Physical Architecture</li></ul>
Tool	There are many SysML-based tools available. <ul style="list-style-type: none"><li>• Cameo Systems Modeler</li><li>• Genesys</li><li>• Enterprise Architect</li></ul>	Capella offers a digital solution to support the design of systems architectures. This tool aims to provide an easier learning curve, facilitating the transition to MBSE and allowing everyone to interact with the model.

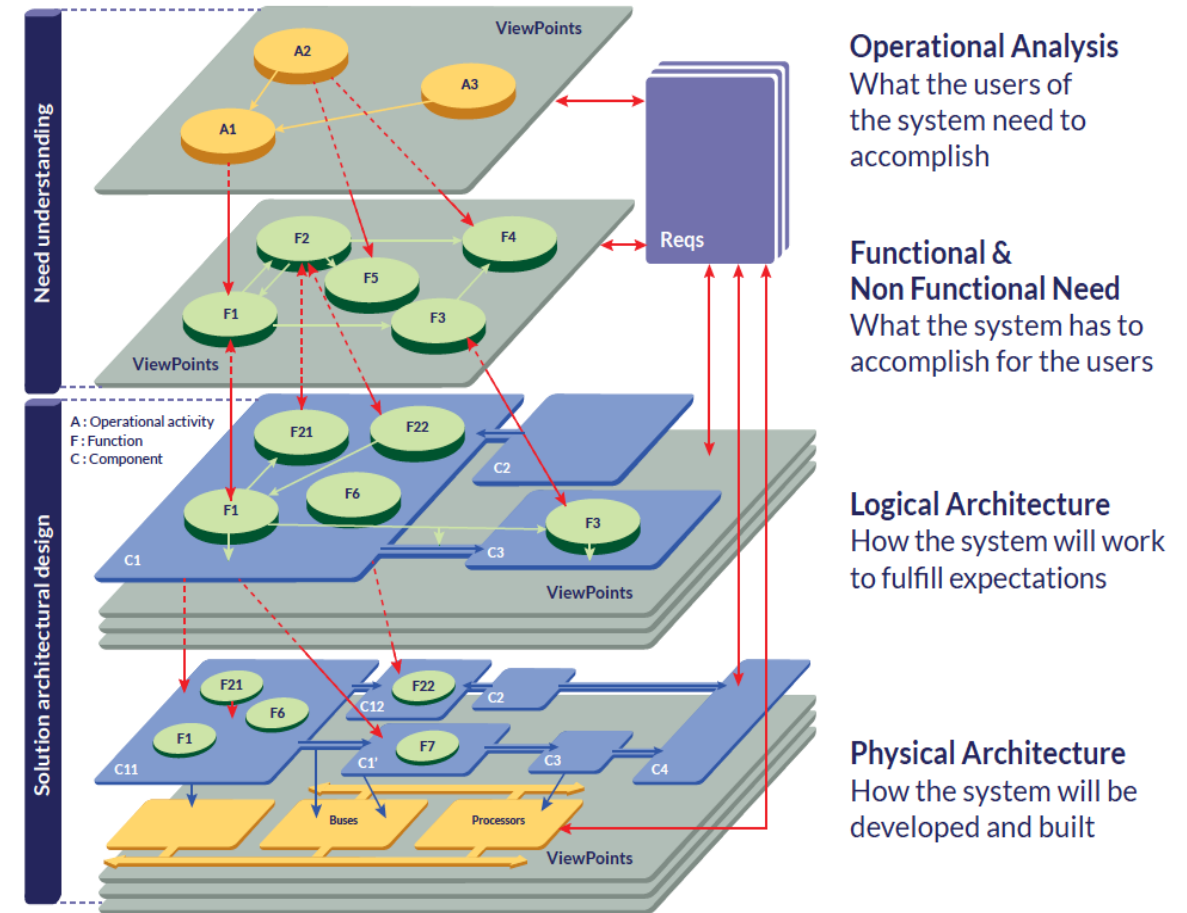






**Figure 3.** Main purposes of the ARCADIA Method.

**Credits:** Eclipse [1]



**Figure 4.** Layers within the ARCADIA Method.

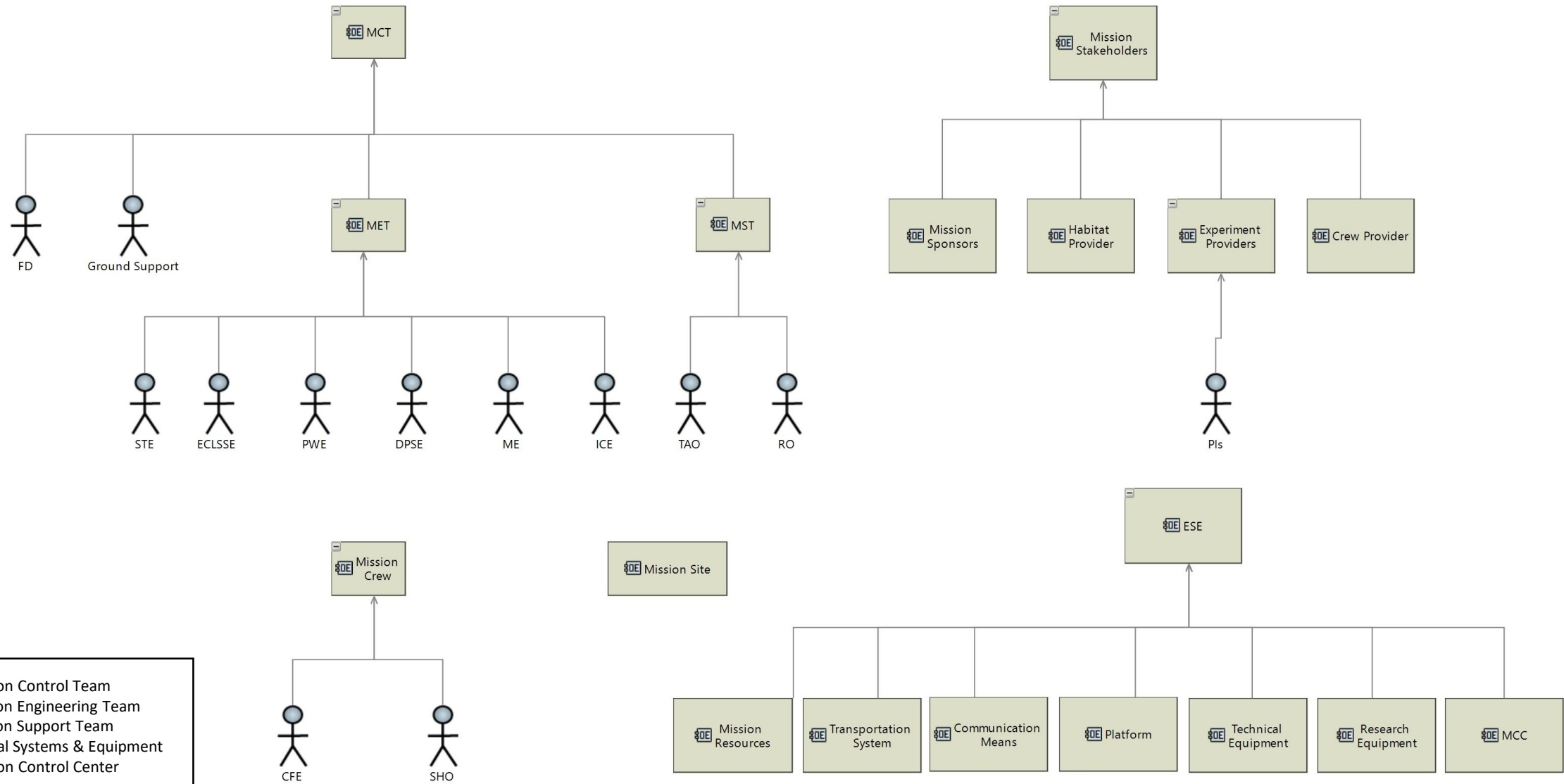
**Credits:** Eclipse [2]

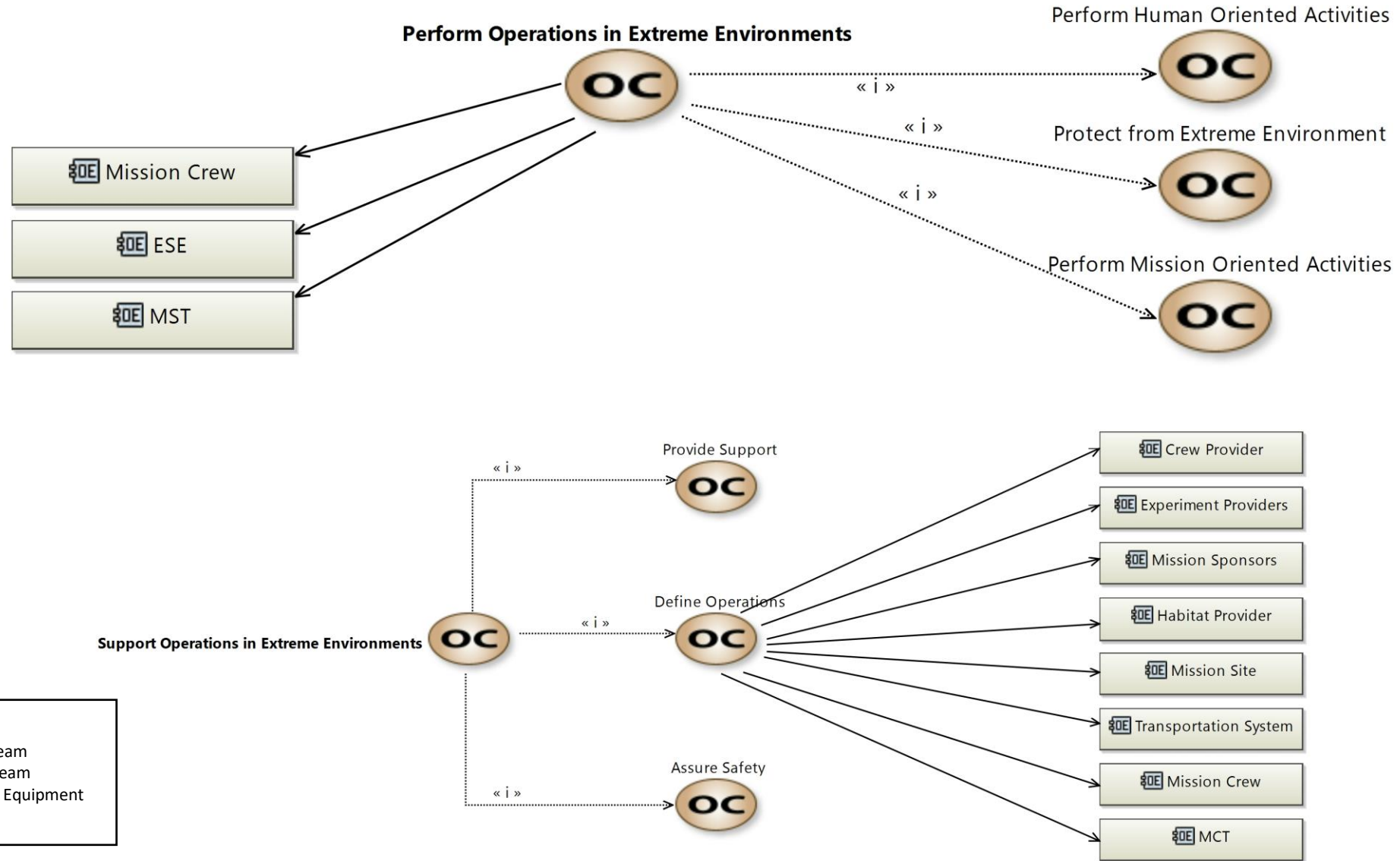


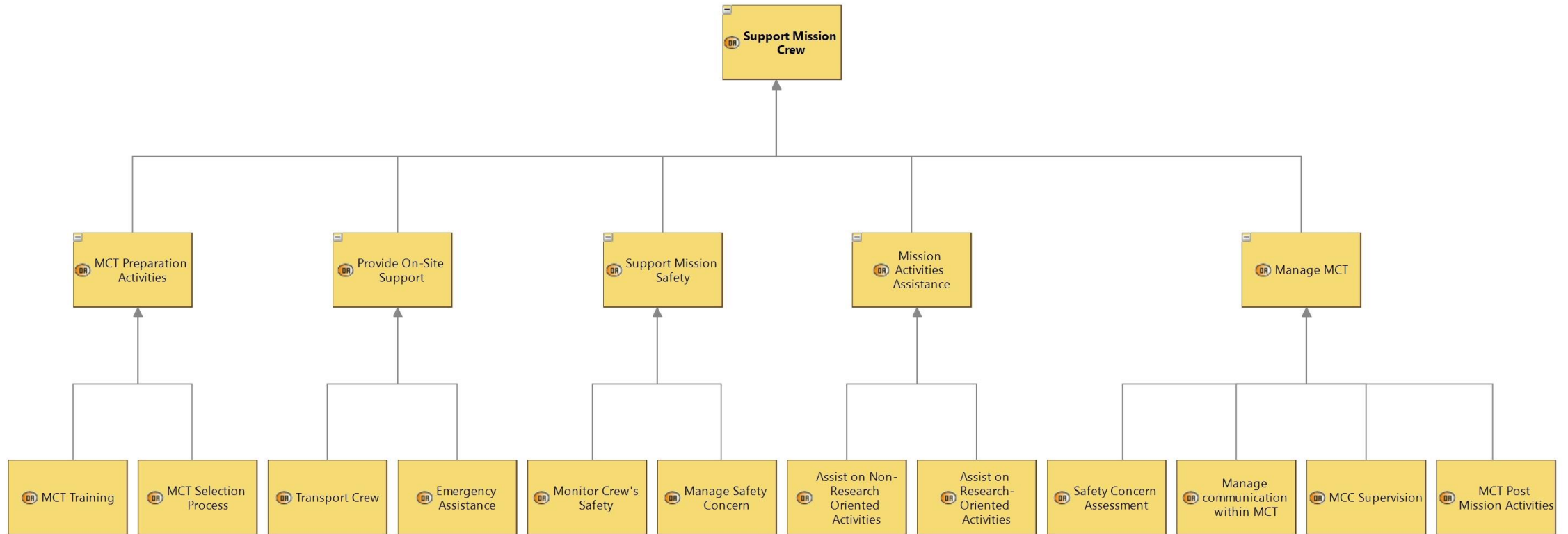
## Operational Analysis

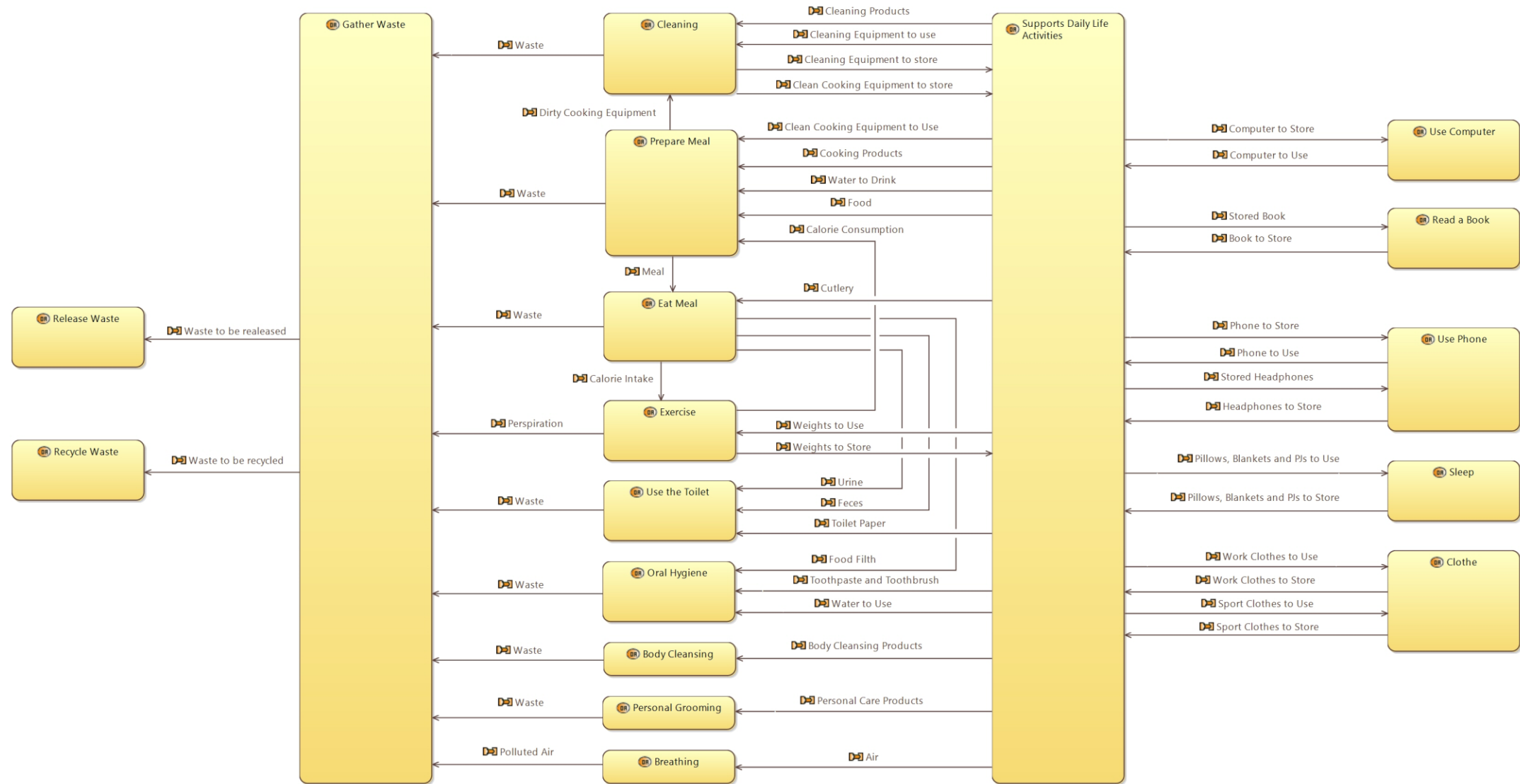
1. Define the Operational Entities and Capabilities.
2. Define Operational Activities and describe Interactions.
3. Allocate Operational Activities to Operational Actors, Entities or Roles.



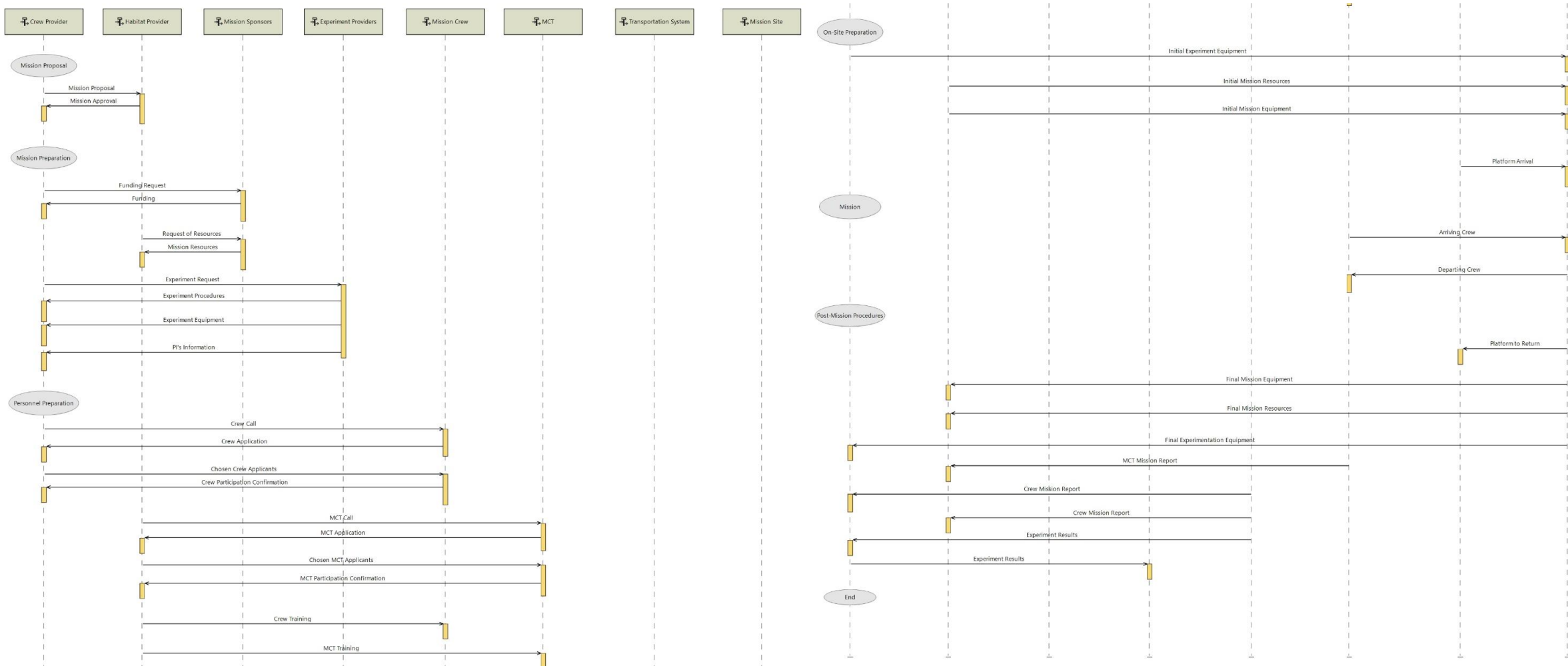


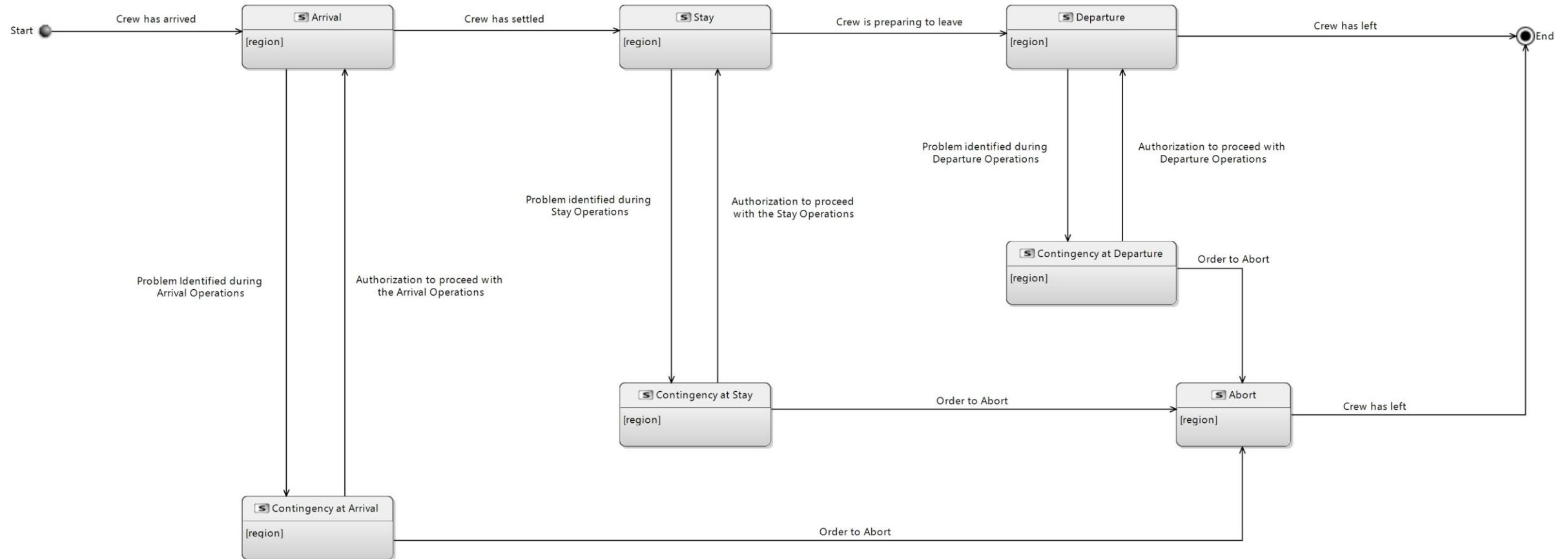


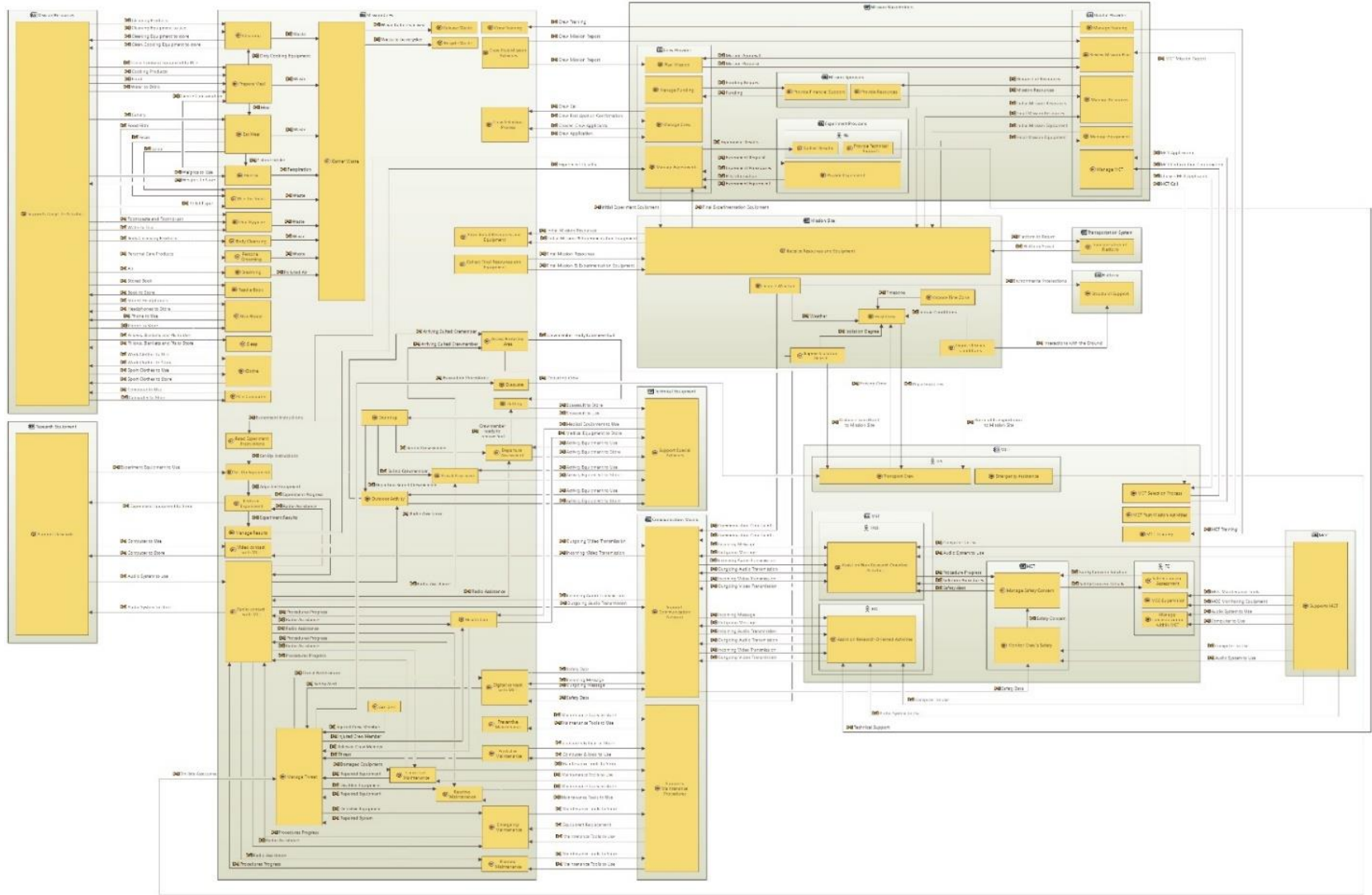














**Lesson N°1** - Explaining the benefits of MBSE to the client.

**Lesson N°2** - Guiding the client in choosing an MBSE tool.

**Lesson N°3** - Clarifying the relationship between MBSE and Concurrent Engineering.





### Myths

Open-Source Tools provide free access to MBSE.

Documents are not necessary.

A methodology is enough to be able to perform MBSE properly.

### Truths

Any MBSE tool will have a cost in deployment and maintenance.

From our point of view, formal written documents were still useful to share information with our client, especially our approach and decision rationales.

While most MBSE methodologies explain each process well, sometimes they don't mention aspects that beginner modelers often aren't aware of. An example would be configuration management.

## Benefits of using Capella

- The tool is easy to learn and easy to install.
- A big community uses the software.
- The tool is updated constantly.
- Creating plug-ins and add-ons for Capella is relatively easy.
- The validation feature of Capella is quite simple, allowing the modeler to identify and correct errors easily.

## Areas of Improvement for the Tool

- The added value of some add-ons and plug-ins is not enough based on the amount of effort that needs to be put in using it.
- Not being able to model collaboratively without extensions like teams for Capella is frustrating.

## Benefits of using ARCADIA

- The method is straightforward, and its documentation is of good quality.
- The operational analysis is quite helpful, particularly when there is not much information about how and where the Sol will operate.
- The number of ways to describe the interactions between operational activities and entities is complete.

## Areas of Improvement for the Methodology (ARCADIA)

- Some of the Arcadia concepts can lead to confusion about how to build the model correctly.
- The documentation on Arcadia could benefit from discussing MBSE fundamentals that allow the modeler to learn how to make the best out of it.

## Main Conclusions

- The client was satisfied with the work done is continuing its collaboration with Spaceship FR.
- This experience became the cornerstone for much work on applied MBSE at Spaceship FR.
- The Operational Analysis allowed the Spaceship FR Team to represent all the relevant Mission Elements that would be interacting with the system.

## Subsequent Work

- The Spaceship FR Team has now various models that reach the logical architecture of this specific system.
- The Spaceship FR Team started working on an MBSE Methodology that can serve as an equivalent to ARCADIA but for SysML-Based Modeling.







Thank You for your  
Attention!



- [1] Capella MBSE Tool - Arcadia. (2021). <https://www.eclipse.org/capella/arcadia.html>
- [2] Roques, P. (2017). Systems Architecture Modeling with the Arcadia Method: A Practical Guide to Capella (Implementation of Model-Based System Engineering) (1st ed.). ISTE Press - Elsevier.
- [3] Voirin, J. (2017). Model-based System and Architecture Engineering with the Arcadia Method (Implementation of Model-Based System Engineering) (1st ed.). ISTE Press - Elsevier.
- [4] Successful MBSE landing on a CNES operational use-case. *Jonathan Lasalle, ARTAL Technologies at MBSE 2020.*
- [5] Modelling Avionics Interfaces and Generating ICDs for the Propulsion Subsystem of the MPCV-ESM. *Delia Cellarier, European Space Agency at MBSE 2020.*

