MBSE for MSR-ERO: a use case

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September, 29th 2021

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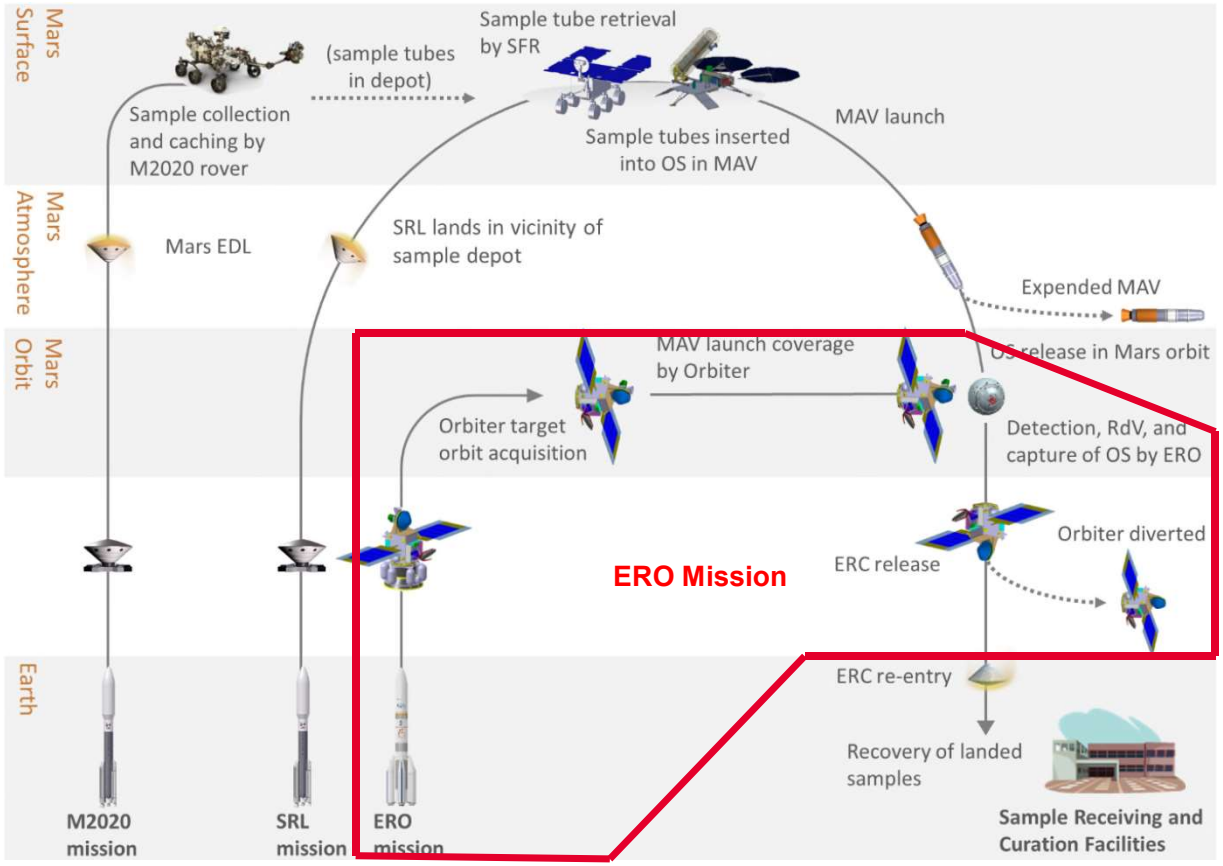
Agenda

- MSR-ERO mission : rationale for applying MBSE techniques
- MBSE on MSR-ERO in practice: MOFLT approach
  - Operational analysis
  - Functional architecture
  - Logical architecture
- Lessons learnt
- Next steps in ERO MBSE approach
- Q&A

MSR-ERO mission : rationale for applying MBSE techniques

- MBSE is a way to ensure the **robustness** in System Engineering practices required by the project constrains
  - **Mission complexity** from both technical and programmatic point of view, with many stakeholders and interfaces, numerous mission phases with dedicated constraints
  - **Large project** requiring a huge engineering team with several iterations design loop at different levels
  - **Challenging planning** for the mission: to be launched in 2026 (baseline) / 2027 (backup)
- Request from ESA to use MBSE techniques to **support exchange** with NASA

Mars Sample Return Mission Concept



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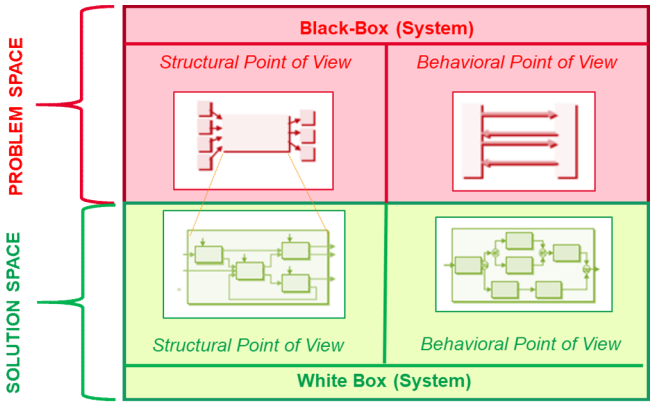
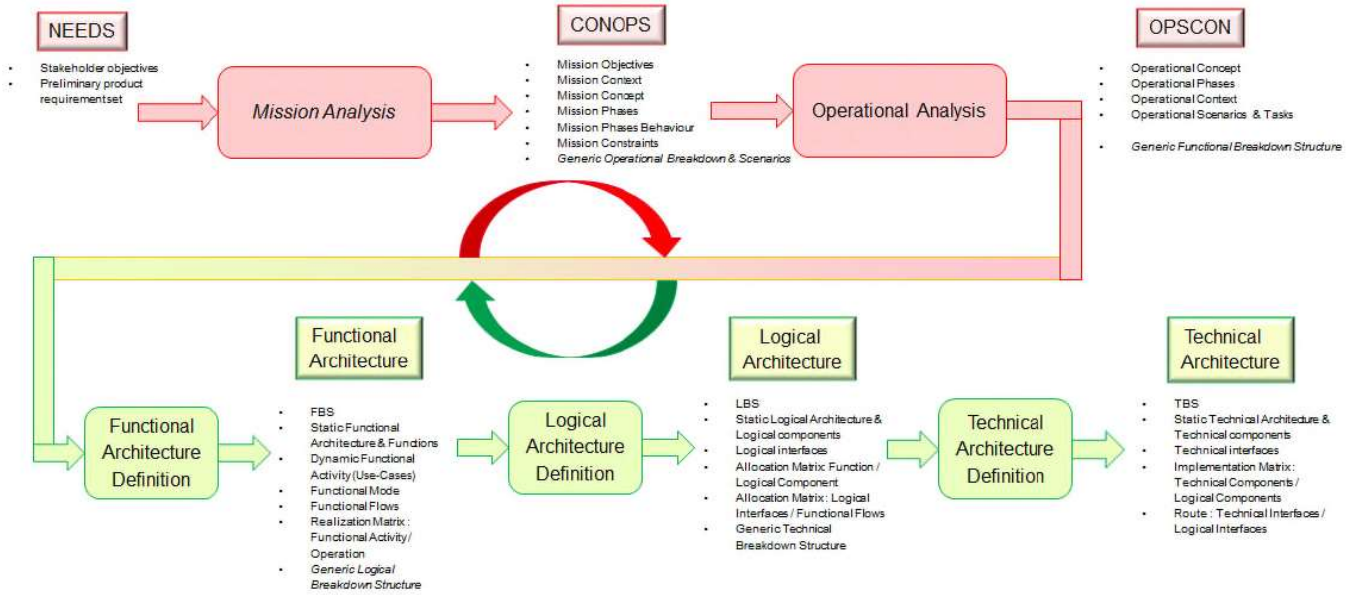
MBSE in practice: the Airbus MOFLT Architecture Framework

- **Generic and common MBSE framework** at Airbus Group level for architecting and developing in the right way (effective & efficient) products & industrial systems & services in transversal organizations
- Focusing on the **design of System of Interest through the Mission & Operational Analysis, Functional, Logical and Technical Architectures**
  - Method is tool and language agnostic and addresses both structural and behavioral point of views ensuring in a consistent manner
  - Implemented using SysML language and Cameo Systems Modeler ™ tool thanks to a profile
  - Compliant with ECSS





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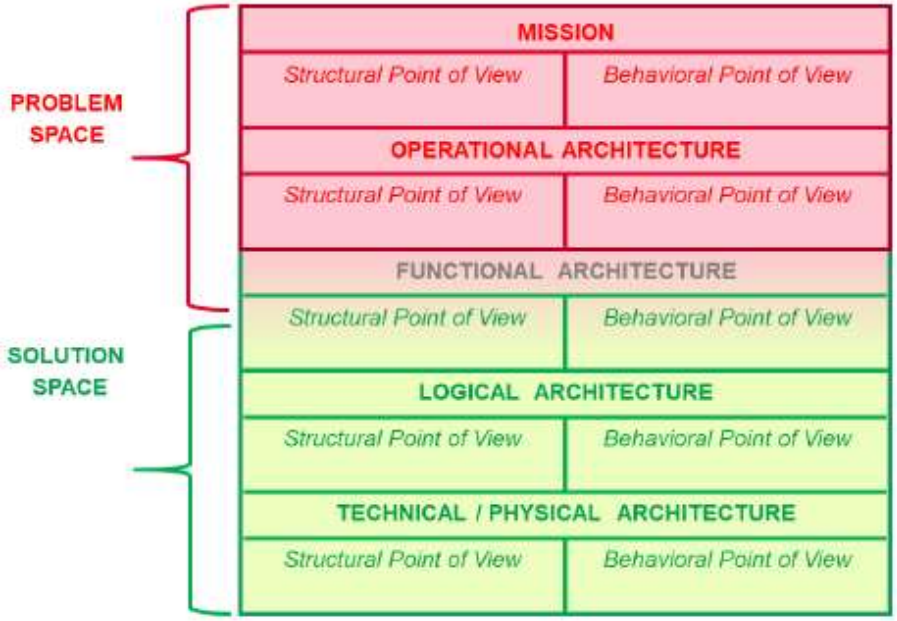
MOFL modeling logic

Mission analysis: WHAT is the problem that we need to solve, and WHAT are the potential ways of solving it?

- Definition of SoS Mission : Objectives / Effects
- Determine and characterize potential ways of realizing a Mission (Mission Concept)



Operational Analysis : WHAT the System of Interest will do to contribute to the mission ? What is the context of the SOI ?

- **Definition of Operational Concept focusing on an Entity : Context / Constraint / System of Interest**
- **Definition of Operational Scenarios consistent with Mission Concept**

Functional Architecture : HOW the System of Interest will work to meet expectations ?

- **Definition of execution sequence between functions to realize operations**
- **Definition of structural arrangement of functions & interfaces**

Logical Architecture : HOW the System of Interest is organized ? (Abstract Component)

- **Definition of logical components** + logical interfaces
- **Allocation of functions to logical components**

Technical (Physical) Architecture : HOW the System of Interest will be implemented ?

- Definition of technical (Physical) components + technical (Physical) interfaces
- Realization of logical Components / Interfaces by technical Components / Interfaces
- Derived technical components (due to implementation constraints)

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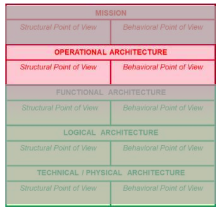
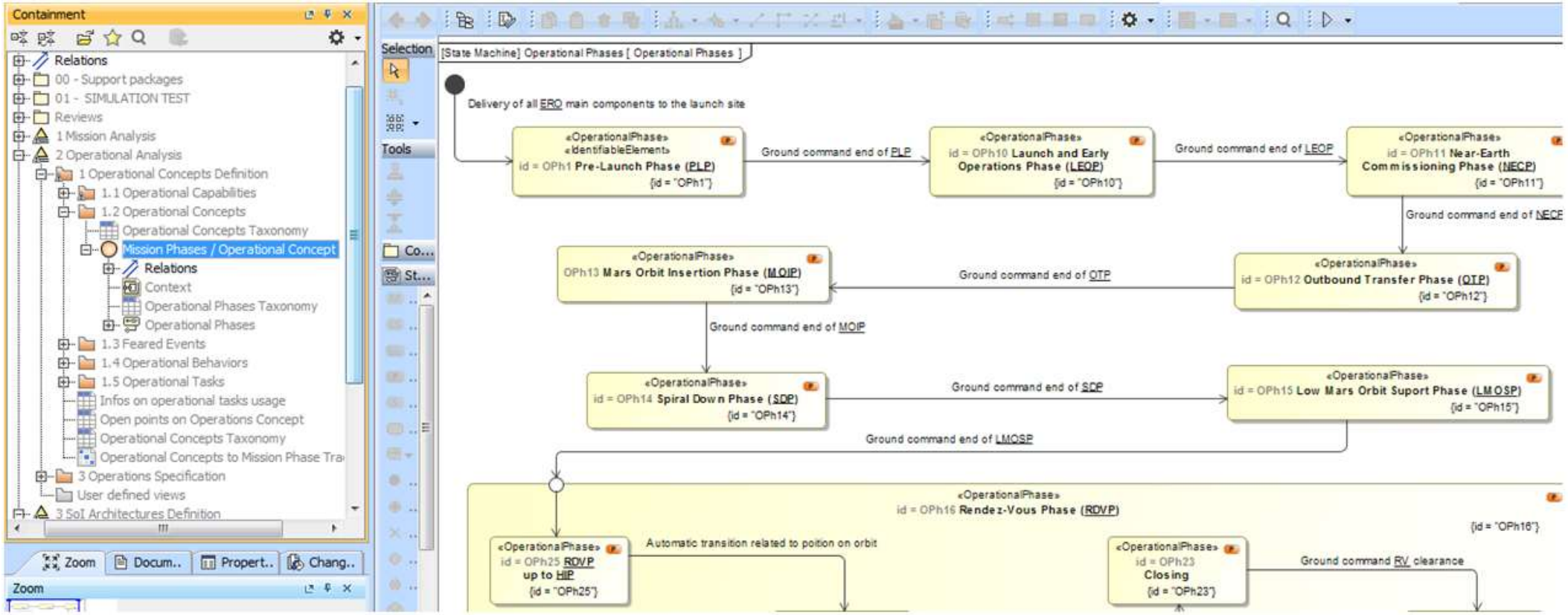


MBSE in practice: MOFL(T) approach – operational analysis

- Mission phases implemented as state machines



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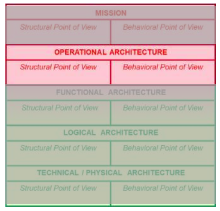
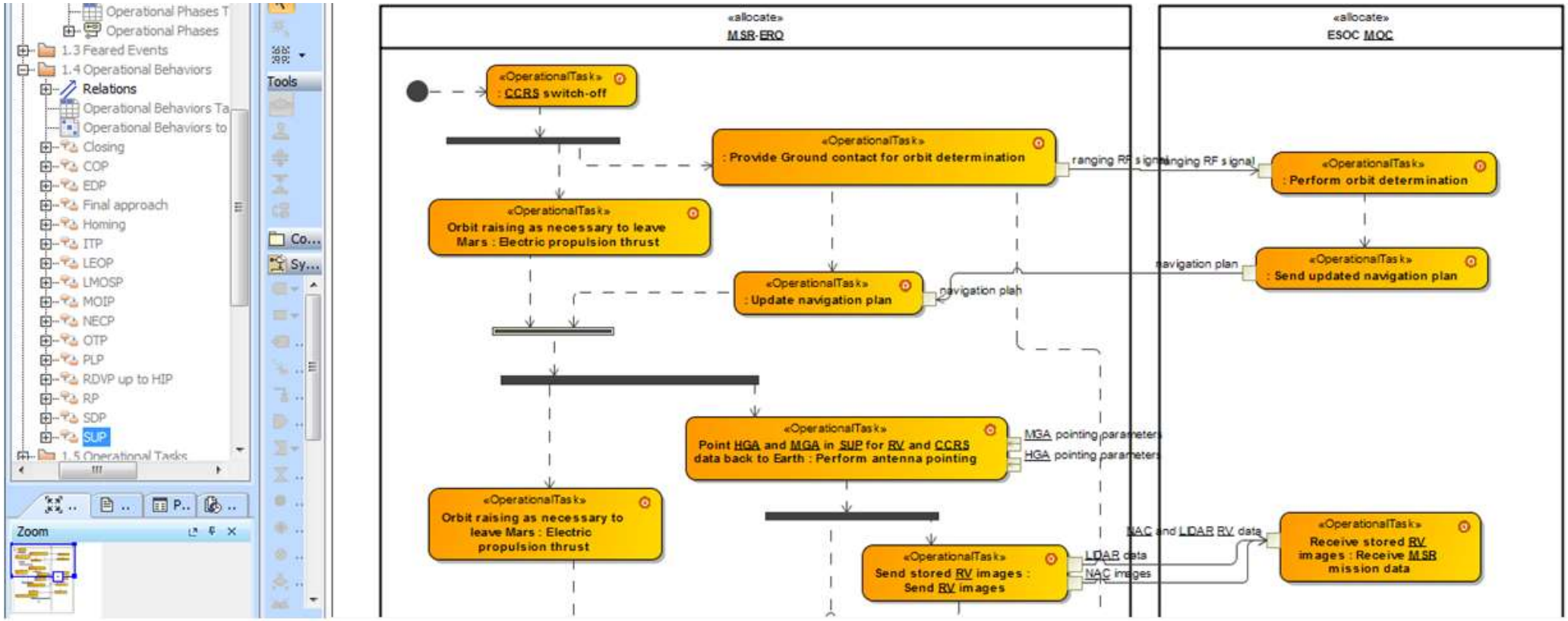


MBSE in practice: MOFL(T) approach – operational analysis

- Description of the ERO System Of Interest behavior: described in each phase by a sequence of operational tasks and operational exchanges with external entities



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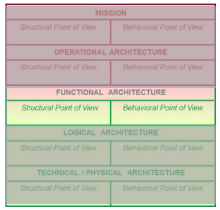
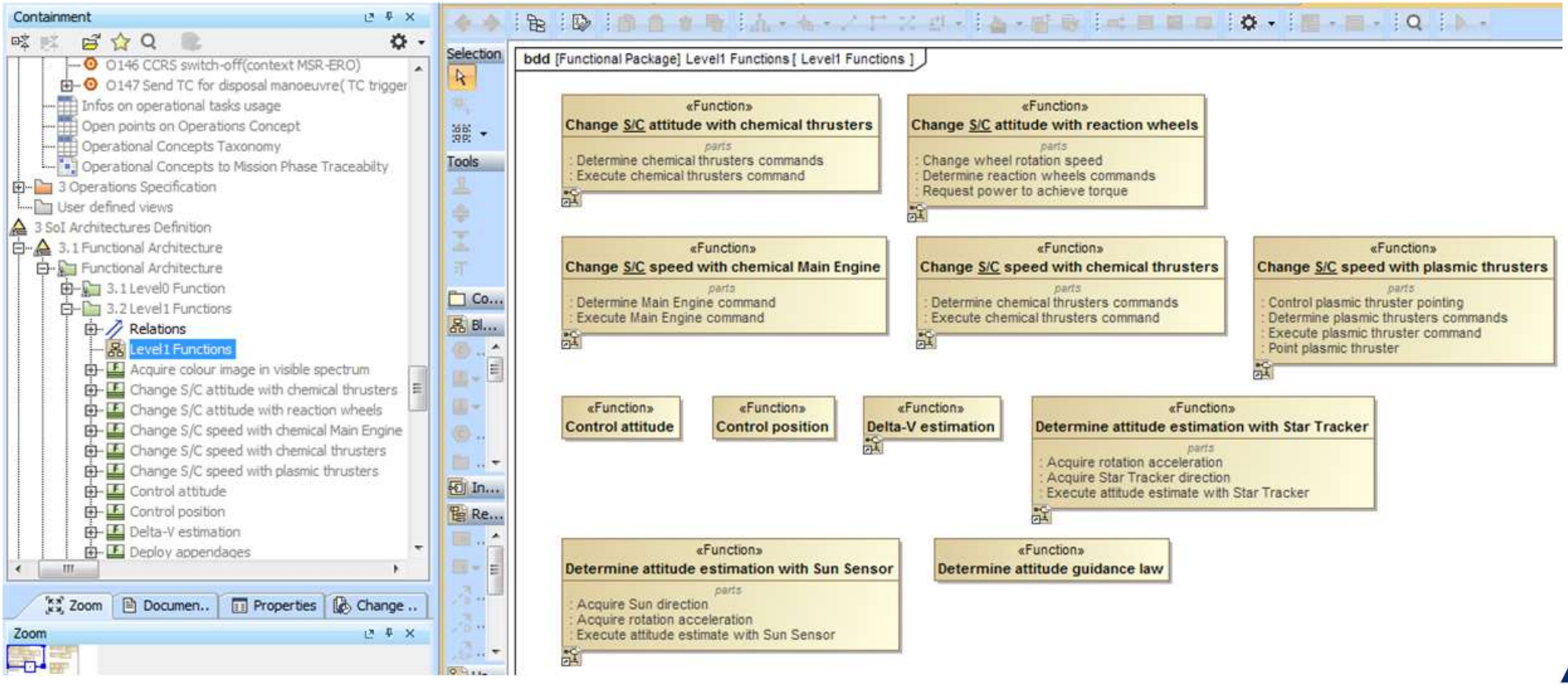


MBSE in practice: MOFL(T) approach – functional analysis

- Functions structured in several levels of decomposition
- Static representation (block diagram) showing subfunctions and the functional flows between them



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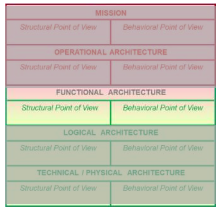
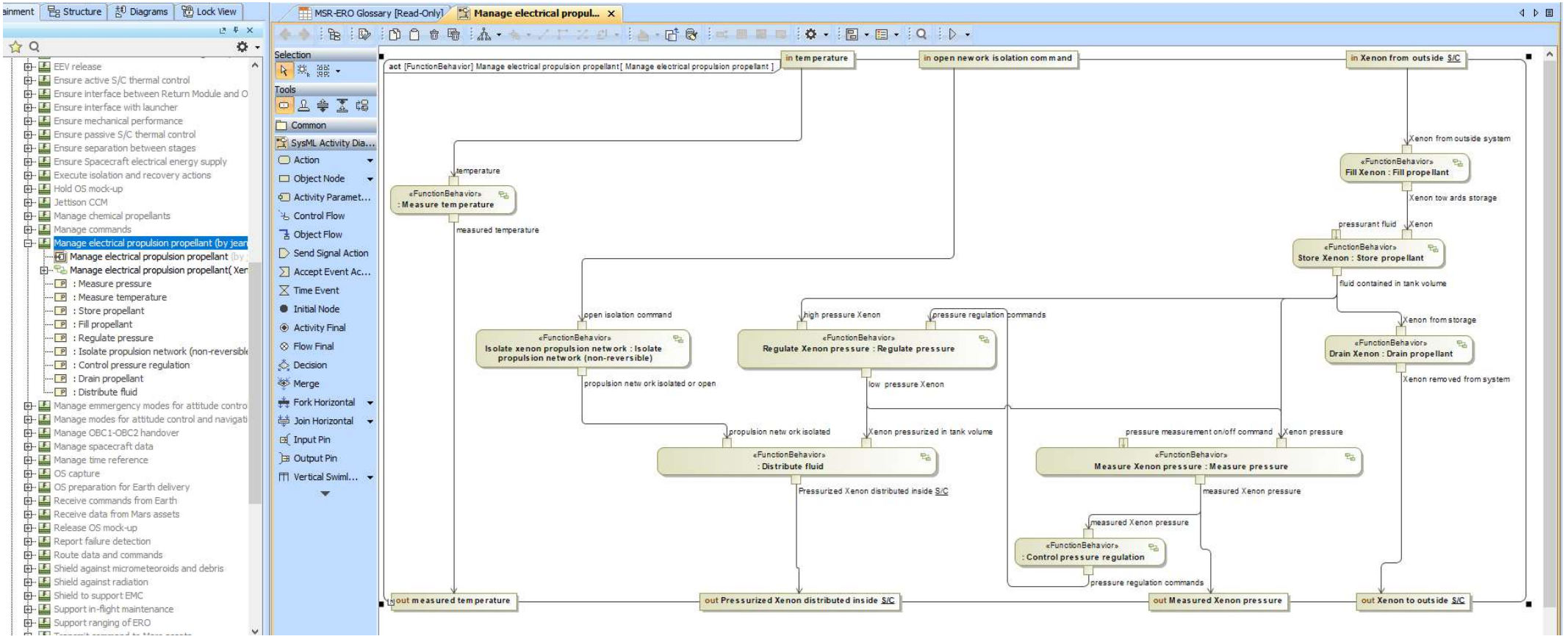


MBSE in practice: MOFL(T) approach – functional analysis

❖ Behavioural representation (activity diagram) associated to each function



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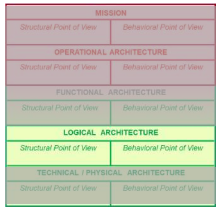

MBSE in practice: MOFL(T) approach – logical architecture

- Logical components structured in several levels of composition
- Allocation of the leaf functions to the different logical components

Legend

↗ Allocated To Logical Component

	1.2 Level 1	Battery	CCRS	CSW	DST	FSS	Heaters and thermistor	HGA Assembly	IMU	LGA	LIDAR	MAMSW	MGA Assembly	MLI	Monitoring Cameras	NAC	OBC	OIM	OIM Separation System	OS mock-up System	PCDU	Plasmic Thruster Assem	PPS Fluidic components	PPU	RIU	RM 2ary and 3ary struc	RM Central Tube	RM CPS	RM harness
Command safe mode	1			↗																									
Condition electrical power	1																				↗								
Configure OBC1	1			↗																									
Configure OBC2	1											↗																	
Constrain OS																													
Control attitude	2			↗								↗																	
Control battery charging	1																				↗								
Control battery discharge	1																				↗								
Control plasmic thruster pointing	1																												
Control plasmic thruster thrust	1																							↗					
Control position	1			↗																									
Control pressure regulation	1																												
Control Solar Array pointing																													
Create initial relative velocity	2		↗																↗										
Decide actions wrt. failure typology	2			↗								↗																	
Delta-V estimation	2			↗								↗																	

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Lessons learnt

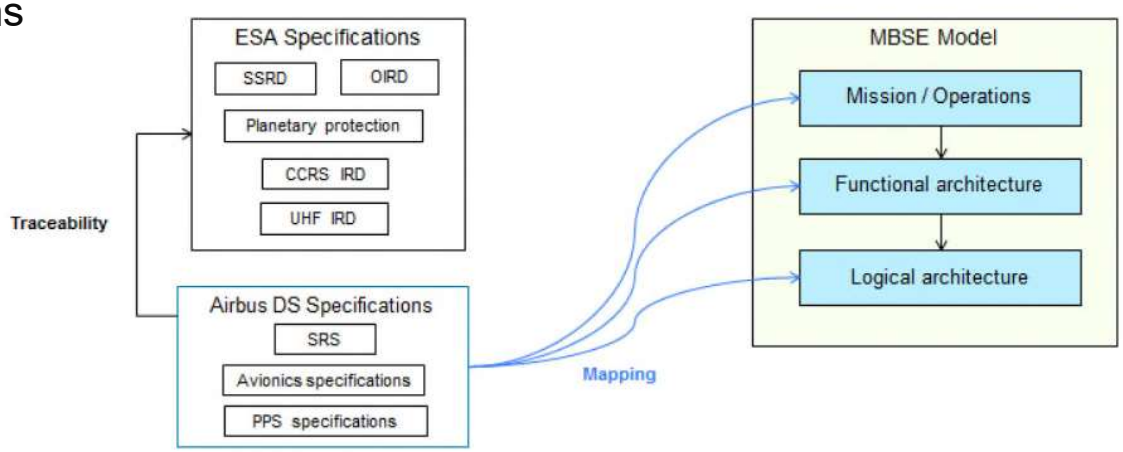
- Unambiguous single source of truth based on a common language
- Model centric information management (continuous evolution) rather than document based approach (update for review)
- Ensure consistency and exhaustiveness of architectures thanks to the formalism brought by the model

- Single source of truth effective if all people use the model and if models are well integrated with downstream engineering process
  ⇒ ***Need for change management at process and people level***
- Sharing the model internally and externally
  ⇒ ***Deploy means to share the model with people not used to MBSE approach***
- Too late start in B2 phase
  ⇒ ***Start at last in B1 phase to get full benefits***

Next steps

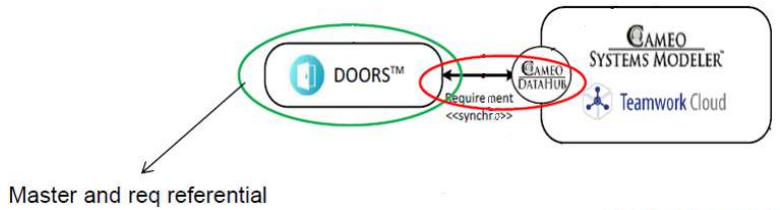
❖ Requirements mapping on the model in order to

- Ensure consistency of the specification and the system design
- Bring an additional check of the specification (adequacy, completeness, consistency)
- Allow an easier assessment of the impact of any modifications from need (mission / operation) and solution (functional logical) domains



❖ How ?

- Method to define the mapping rules under development
- Use of Cameo DataHub plug-in allowing a bi-directional synchronization between Doors and Cameo



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Any questions ?