MBSE at ESA: State of MBSE in ESA Missions and Activities

Paper proposal for MBSE2021 Conference

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In their 2018 paper to AIAA, J.L. Alvarez et al. issued a paper entitled "*Towards a definition of best practices for Model Based Systems Engineering in European Space Agency Projects*". The authors presented the state MBSE adoption in ESA, giving a contextualised account of the technologies and methodologies enabling MBSE in the Agency, discussing in detail MBSE deployment in missions across the lifecycle, and highlighting research and development activities addressing the application of MBSE in the ESA environment.

Since their 2018 paper, the European Space Agency and the European Space Industry have experienced a significant increase in the acceptance of model-based approaches to systems engineering. Consequently, ESA has experienced an order of magnitude increase in MBSE deployment in ESA missions and in MBSE-related R&D activities, as well as significant progress in establishing collaborative efforts across the European Space Industry (in particular, the MB4SE Advisory Group). However, the deployment of MBSE across the Agency has not been homogenous, and many different varieties of approaches and technical solutions have been taken.

To update the European Space Industry and wider MBSE community on the state of MBSE adoption in ESA, and the various approaches undertaken, the proposed paper will present a structured overview of all known MBSE deployments in ESA missions, giving detail on:

1. The mission context and current lifecycle phase;
2. The primary goals of the MBSE efforts and contractual structure;
3. The key technical challenges and adopted MBSE solution, including justification and motivation for the chosen solution;
4. The key results to date and open points for future development.

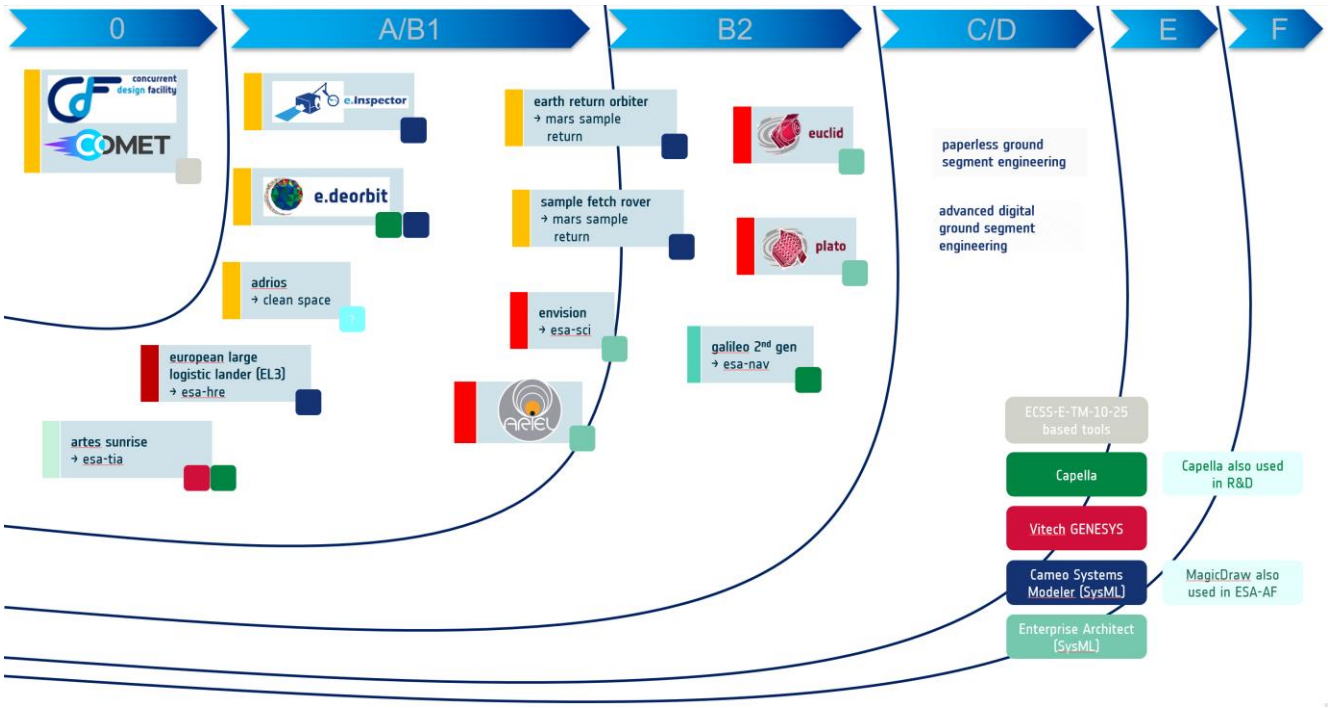

Figure 1 – Proposed Overview of MBSE in ESA Projects

Due to the breadth and variety of tasks encompassed by Systems Engineering, and the different decisions on which tasks are addressed by the MBSE approach per project, a common decomposition of SE tasks such as Figure 2 will be presented. The areas supported by a model-based approach will be identified, allowing for an easier digestion for the participants of each projects approach and how they compare. Accompanying these decompositions will be a graphical representation of the technical architecture established to meet their stated MBSE goals.

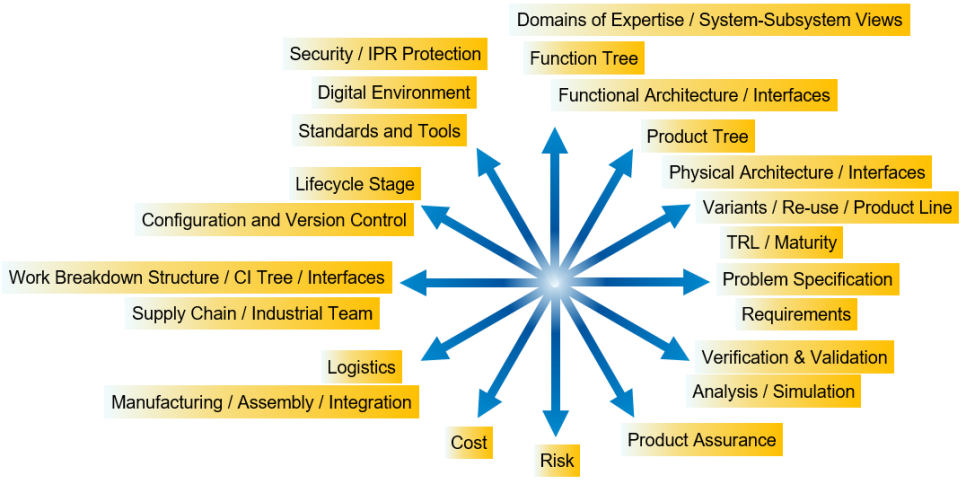

Figure 2 – Proposed Decomposition of SE Tasks

For instance, the PLATO mission in ESA will be presented with a decomposition such as Figure 3. Alongside this will be presented the overall technical architecture of the PLATO MBSE Infrastructure such as Figure 4.

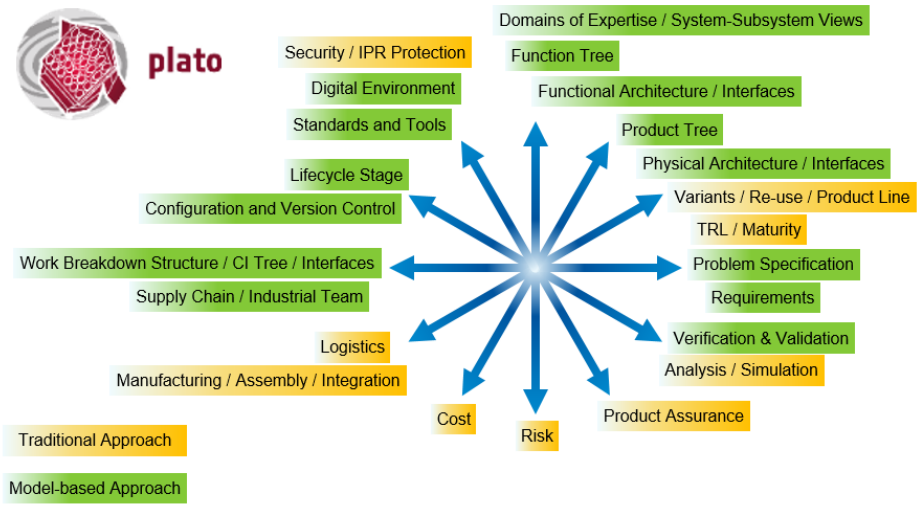

Figure 3 – Example Decomposition of SE Tasks for PLATO

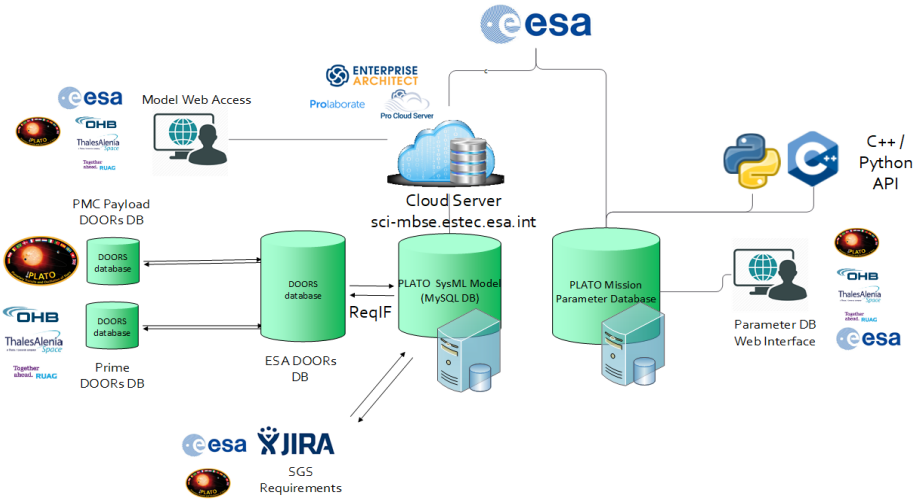

Figure 4 – Example Infrastructure Diagram for PLATO

The proposed paper will also present an updated overview of MBSE-related R&D activities, either completed or underway. The paper will primarily discuss activities spawned from ESA-internal research channels as part of the harmonised MBSE Roadmap. Particular emphasis will be given to ambitious activities such as *TASTE*, *Digital Engineering Hub Pathfinder*, *Overall Semantic Modelling for Systems Engineering (OSMoSE), SAVOIR Electronic Data Sheets (SEDS)* and *MBSE Engineering Hub*. The paper will also present additional information on ESA-funded activities originating from Industry via new channels such as Open Space Innovation Platform (OSIP).

Finally, we will present wider Agency initiatives which have been established with the aim to further improve MBSE adoption and work towards a common MBSE approach with future missions. We present initiatives such as the Digital Spacecraft, MB4SE, and MBSE Space, giving detail on their efforts to date and future plans to support MBSE in ESA missions. These initiatives have played a significant role in expanding and improving the MBSE adoption in ESA over the last 3 years.

The authors believe this paper fits primarily into the stated MBSE2021 topic of interest of “approaches to adopt model-based techniques successfully in practice and at scale” as part of the primary track. The paper will introduce MBSE2021 participants to current MBSE approaches adopted in real ESA missions, implemented at different scales, and using different

technical solutions, as well as presenting downstream outputs from activities to inform their future efforts.

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with inputs from ESA Project and Activity representatives.