

# Incorporating Model Based Reviews into the life cycle of the Earth Return Orbiter

Lorenz Affentranger<sup>1\*</sup>, Jakob Huesing<sup>1</sup>, Eric Joffre<sup>1</sup>  
Jean-Baptiste Bernaudin<sup>2</sup>, Frederic Payot<sup>2</sup>

<sup>1</sup>MSR-ERO team, European Space Agency, Noordwijk, Netherlands

<sup>2</sup>Airbus Defence and Space

\*Lorenz.Affentranger@esa.int

## Introduction

The existing practices surrounding the reviews of design documentations in its current form (paper based) are well known and defined. However, the review of a digital model based upon Model Based System Engineering (MBSE) methodologies including yet unfamiliar techniques to display information which often crosses disciplinary, system, and subsystem boundaries has not yet been well defined. This is mainly due to the relatively recent introduction of MBSE as a whole. The Earth Return Orbiter (ERO) mission is an ESA project within the larger Mars Sample Return campaign. Together with its main industrial partner Airbus Defence and Space (ADS) it is applying a MBSE approach by creating a Digital Integrated System Model (DISM) to support effective coordination and information sharing between all disciplines involved. The DISM includes operational analysis, functional and logical architecture. The DISM also include allocation links between the functional and logical architecture, satisfy traces to requirements in the specification tree. In the scope of the ERO spacecraft Preliminary Design Review (PDR) a

Model Based Review (MBR) approach was introduced focusing on the aforementioned model content. This abstract will vehicle the lessons learned of the deployment of a DISM in a project's life cycle focusing on its review process.

## Technical context

The statement of work for the DISM was signed for phases B2/C/D. This resulted in a number of design choices being already on its way and the project's maturity level was already well beyond the point at which MBSE practises would usually be applied. SysML is the modelling language of choice while NoMagic/Cameo is the tool in which the model is implemented. The MOFL(T) methodology has been used by ADS to populate the model while the already existing design documentations from the phases A/B1 have served as a starting point of the modelling activities. While the delivery of the DISM was part of the overall spacecraft PDR, its review was a separate activity.

### Review process

The DISM was delivered as part of the PDR datapack together with a html version for users which do not have access to the necessary tools. The SysML standard profile was extended to incorporate review tools. This included SysML artefacts to capture reviewers' comments directly in the model as well as in external excel documents. The latter could then be imported into the model using the Cameo standard excel import functionalities. This profile was also used to exchange review comments between industry and ESA.

The overall review flow is described in Figure 1. The scope of the review was defined with a focus on consistency, completeness, and correctness. Before any actual review activities started, a general introduction to MBSE was held between ADS, the ERO team, and ESA reviewers. This included an overview to MBSE, SysML, Cameo, the MOFLT methodology and live demonstration of the ERO DISM. The review toolset allowed to directly comment any model artefact graphically during the model

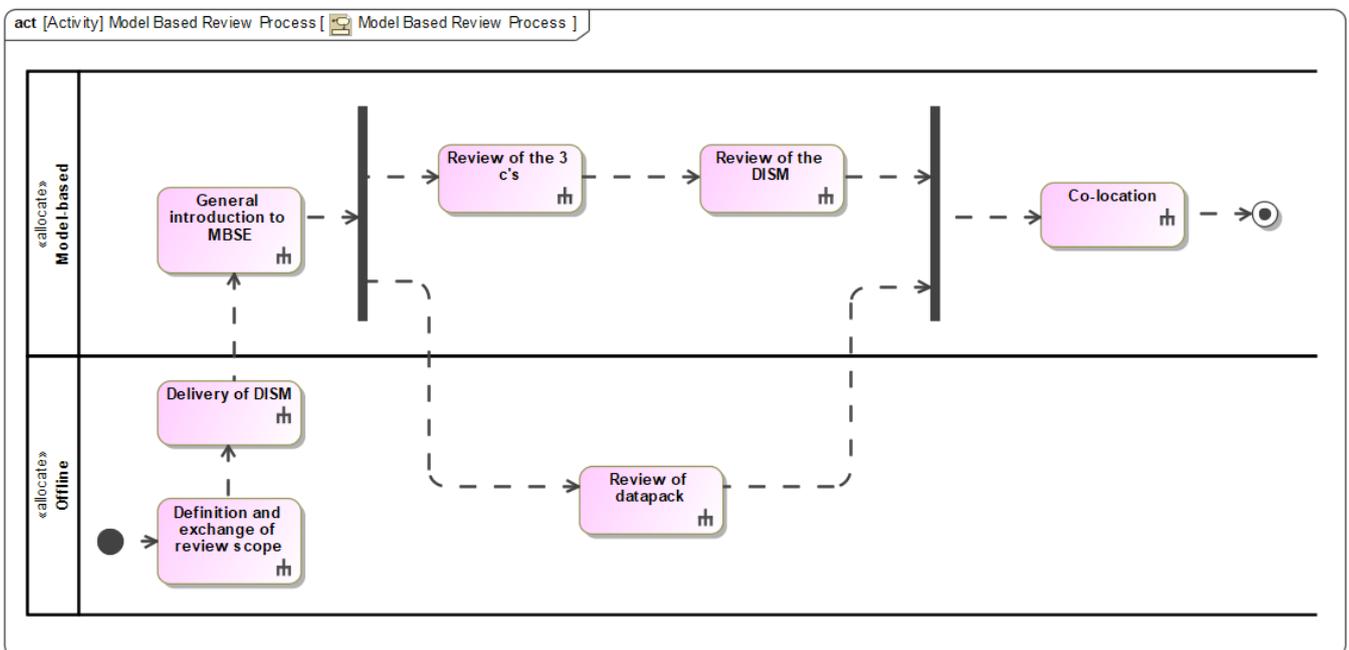


Figure 1: Model Based Review Process

The review of the DISM was split in two main parallel components. The first consisted in defining the scope of the review, receiving the datapack (i.e. the DISM) as well as reviewing the model offline. The second was a set of model based review steps. A general introduction regarding MBSE, the tool used and its context in ERO was given to all the reviewers. This was followed by a review of the 3 c's (consistency, completeness, correctness). As part of the review of the DISM, specific visual SysML diagrams (activity diagrams, block definition diagrams, ..) were mapped to relevant experts and reviewed in the model. Lastly, co-location type sessions were held to discuss review comments, which emerged during the offline review.

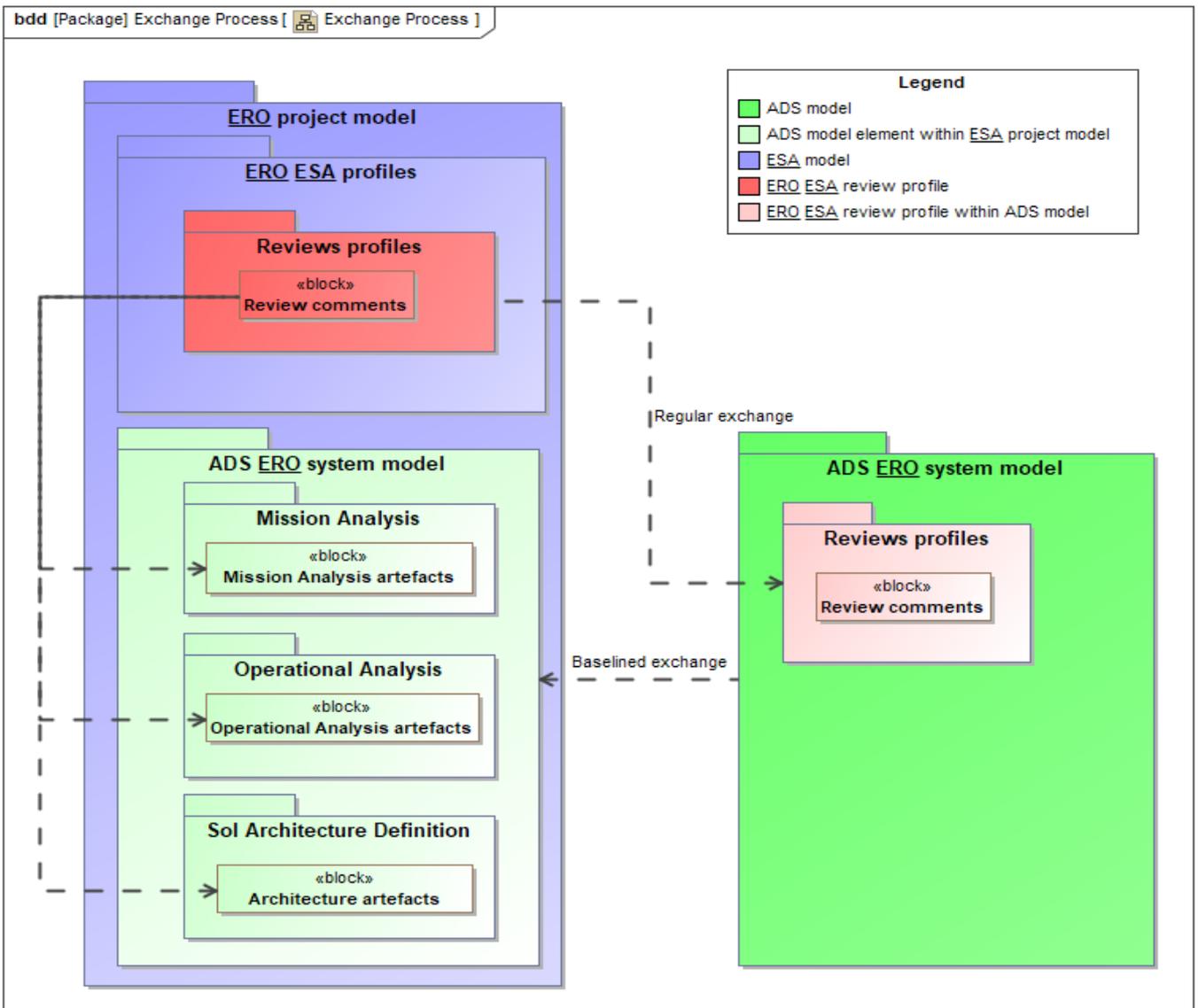


Figure 2: Review Comments Exchange Process

The ADS system model is integrated within the ESA project model, which forms the ERO DISM. Its exchange is based on baselines. Review comments are an extension of the SysML standard profile and are used to annotate specific model artefacts during the review. The exchange of these review comments are excel based, simplifying the entire process and allowing more flexibility in the exchange rate. The Cameo native tables ensure changes and development in the comments are properly tracked.

based review sessions. The exchange process is explained in Figure 2. Any follow-up discussion and response could then be iterated and tracked using Cameo’s native tables, allowing both parties (e.g. ESA and ADS) to work on their own model version. To conclude the

MBR, co-location sessions were held to close-out the comments which have arisen from the offline datapack review.

### Conclusion

A first iteration to incorporate a model based review into a project’s life cycle was

accomplished. This included the definition of a review process and the extension of the SysML standards profile to accommodate the creation of digital RID's directly in a model based environment – insuring consistent tracking throughout its resolution. The concurrent aspect of the review allowed for cross-disciplinary experts to be at the same table viewing information from different sub-systems.

While the participation and interest was positive overall, an important take away and feedback from the reviewers was the lack of focus on specific use cases. This mainly stemmed from the fact that the model as such is not a design document. However, having relevant experts work in the model during the review allowed the ERO MBSE team to make a first assessment of these needs. At the time of writing this abstract this aspect is further being addressed as part of future development. An earlier implementation of these use cases would allow its reviewers to be more familiar working with the DISM and MBSE methodologies as a whole, ultimately further benefiting the MBR process.