D2OPS

Executive Summary

ENABLING CONTINUITY: FROM DESIGN TO OPERATIONS

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Release: 1.0

1 Summary

1.1 Purpose

The D2OPS activity started with the goal of applying MBSE practices to enable digital continuity between design and operations. This study involves the following main activities:

- ML with the context of MBSE: demonstrates the integration of MBSE to bridge the gap between the domain experts and the data scientists and applying ML for satellite mission operations.
- Demonstration of the planning application scenario using the Advanced Planning & Scheduling Initiative (APIS) framework. The planning app demonstrates the Onboard Autonomy Experiment that has been deployed on ESA's OPS-SAT mission scenario.
- Development of proof-of-concept tool for procedure generation and verification, the PoC is an OPEN-M based tool which allows users to insert, retrieve, update, and delete data from/to the MBSE hub (JanusGraph), generate procedures based on the data retrieved from the MBSE hub. The prototype also demonstrates the finite state machine approach for procedure verification.

This summary is an annex to the Final Report for the activity.

1.2 Approach

The ontologies that are used to represent the graph database are modeled using WebVWOL. The graph database which is part of the MBSE hub is created using JanusGraph, and the developed PoC generates the following CDM items:

- Activity
- Groovy script
- Activity & script mapper

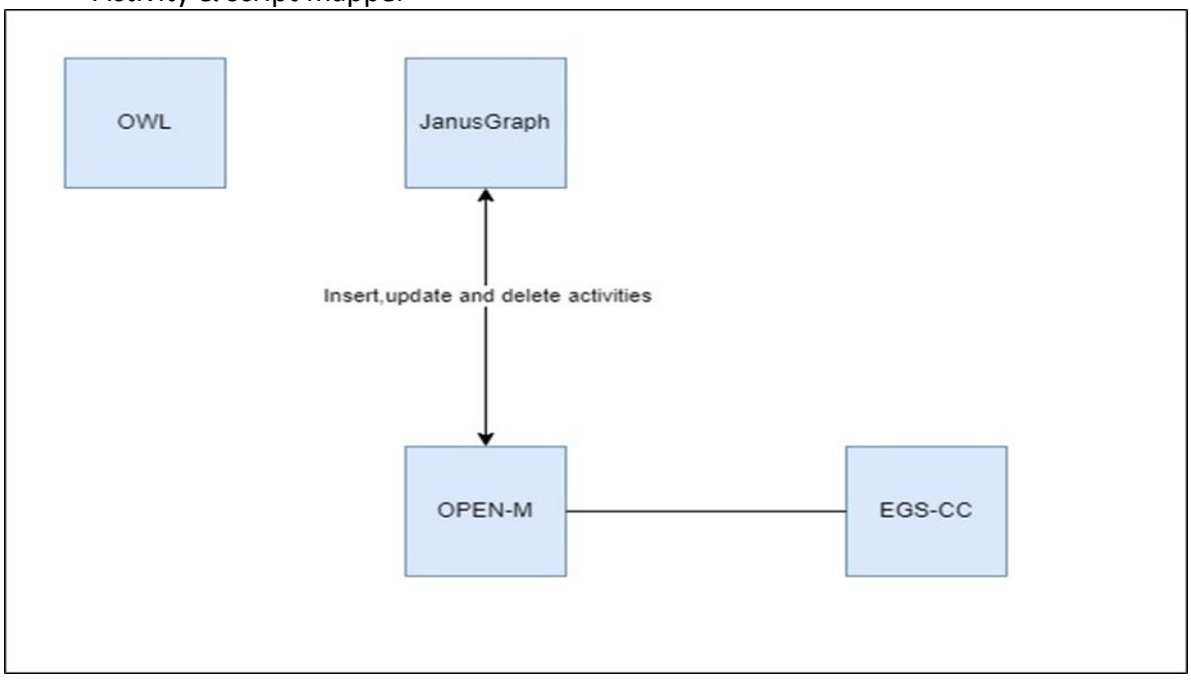

Figure 1 PoC approach

The solution allows a more autonomous process to support business understanding, design, verification, and validation of the ML models used in satellite operations by formalising the knowledge of Space Systems and ML domains in an MBSE model (OWL, RDF, SysML, between others), that then helps the data science experts to automate feature extraction for ML model building and deployment. The solution demonstrates a Pipeline developed using the MLFlow tool (Python).

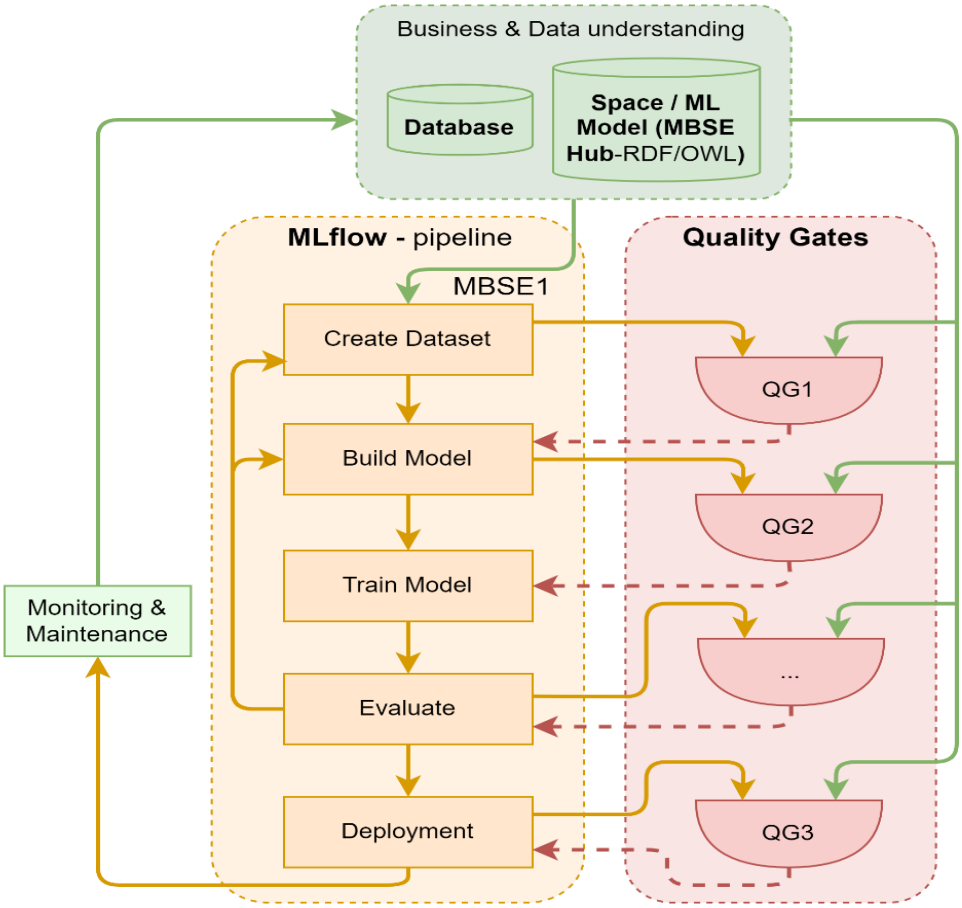

Figure 2. Machine Learning pipeline with Quality Gates

1.3 Conclusions and Future Work

While the results presented in this activity are just a proof-of-concept, there's a significant benefit to use MBSE to optimize the digital continuity between design and operations. As next steps and future work there are potential enhancements that can be made to the proof of concept tools so they offer additional features. The models can be extended to better represent the domain concepts in order to be more efficiently used in the ESOC operational environment. This will in turn aid future tool and infrastructure developments that will further become easier and more streamlined.