

**> How did you trace M&C data such as TM definitions to the system model? Did you follow any standards compliant approach for this e.g. ECSS E70-31?**

No - we actually used the definitions for telemetry in our Operations PostgreSQL database to define the TM values.

Since the detailed model was developed after the spacecraft development was finished this information was already available and also the only definition of TM relevant for the operations team.

Also, while not keeping with a standard that includes best practices and lessons learned from past missions, this made sure we keep to the paradigm keep it simple and stupid.

Technically, on the platform, traces will be built in a semi-automated way, based on an algorithmic similarity approach as well as the possibility to add manual traces. The potential for an ML based approach to determine traces has been identified, but is out-of-scope for the current activity.

**>Do you feel this approach is feasible also on bigger systems than cubesat ?**

On the condition that you provide a modelling guideline and profile beforehand, we do not see limits to the applicability per se.

The problem we see with larger systems is the question whether you are able to keep them up to date on an at least weekly basis.

From our point of view, a model is only as good as it is trustworthy and hence always has to be up to date.

**>Did you find any open source ML/AI specific tool/library particularly useful or easy to use?**

At this time we are using Python libraries such as Numpy, Tensorflow and Scikit-Learn implementing LSTM based anomaly detection.

**>Do you think this tech can be applied to CIP / MBSE Hub?**

We see the DataLake primarily as an analytics platform with its semantics grounded in a defined Ontology, at this time derived from the CIP DataModel. Part of the demonstration scenario is an import/mapping for the MOVE-II MagciDraw SysML model and telemetry database.

An importer for CIP and/or MBEH models/data could certainly be implemented and added.

**>Did you/the students define the meta-model and profiles in advance (especially for the detailed modelling) or did they start from a blank page and extended it on the way?**

The profiles and meta-model were made up on the way.

This meant we had to refactor the model multiple times as the development progressed.

However, it also meant that we were able to deliver the first usable version very early on, which was an advantage in training operators for the next mission.

**> Was it hard to get the students to follow the MBSE model? Were students still asking randomly around and following conventional methods to get information, instead of using the SysML model?**

Actually, it was not that difficult. The key is to keep them on-board at any time.

I.e. we developed key diagrams together with the respective subsystem teams and always encouraged people to come to the systems engineering team with any questions.

Thereby

a) they did not holdup other people from their work

b) we always knew what the model was eventually lacking.

I.e. either we were able to find it in the model together with them, or we knew that the information is lacking in the model and made sure to retrieve it for the questioning student and to then also include it in the model.