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Mars 2020 Model Based Systems Engineering Pilot

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Abstract

The pilot study is led by the Integration Engineering group in NASA's Launch Services Program (LSP). The Integration Engineering (IE) group is responsible for managing the interfaces between the spacecraft and launch vehicle. This pilot investigates the utility of Model-Based Systems Engineering (MBSE) with respect to managing and verifying interface requirements. The main objectives of the pilot are to model several key aspects of the Mars 2020 integrated operations and interface requirements based on the design and verification artifacts from Mars Science Laboratory (MSL) and to demonstrate how MBSE could be used by LSP to gain further insight on the interface between the spacecraft and launch vehicle as well as to enhance how LSP manages the launch service.

The method used to accomplish this pilot started through familiarization of SysML, MagicDraw, and the Mars 2020 and MSL systems through books, tutorials, and NASA documentation. MSL was chosen as the focus of the model since its processes and verifications translate easily to the Mars 2020 mission. The study was further focused by modeling specialized systems and processes within MSL in order to demonstrate the utility of MBSE for the rest of the mission. The systems chosen were the In-Flight Disconnect (IFD) system and the Mass Properties process. The IFD was chosen as a system of focus since it is an interface between the spacecraft and launch vehicle which can demonstrate the usefulness of MBSE from a system perspective. The Mass Properties process was chosen as a process of focus since the verifications for mass properties occur throughout the lifecycle and can demonstrate the usefulness of MBSE from a multi-discipline perspective. Several iterations of both perspectives have been modeled and evaluated.

While the pilot study will continue for another 2 weeks, pros and cons of using MBSE for LSP IE have been identified. A pro of using MBSE includes an integrated view of the disciplines, requirements, and verifications leading up to launch. The model allows IE to understand the relationships between disciplines throughout test activities and verifications. Additionally, the relationships between disciplines and integration tasks are generally consistent. The model allows for the generic relationships and tasks to be captured and used throughout multiple mission models should LSP further pursue MBSE. A con of MBSE is the amount of time it takes upfront to understand MBSE and create a useful model. The upfront time it takes to create a useful model is heavily discussed in MBSE literature and is a consistent con throughout the known applications of MBSE. The need to understand SysML and the software chosen also poses the possibility of a "bottleneck" or one person being the sole MBSE user for the working group. The utility of MBSE will continue to be evaluated through the remainder of the study.

In conclusion, the original objectives of the pilot study were to use artifacts from MSL to model key aspects of Mars 2020 and demonstrate how MBSE could be used by LSP to gain insight into the spacecraft and launch vehicle interfaces. Progress has been made in modeling and identifying the utility of MBSE to LSP IE and will continue to be made until the pilot study's conclusion in mid-August. The results of this study will produce initial models, modeling instructions and examples, and a summary of MBSE's utility for future use by LSP.