PLATO Mission Parameter Database

Abstract for MBSE2022

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Workshop Objectives: O-1/O-2/O-3/O-4/O-5

Abstract

1. Introduction

The PLAnetary Transits and Oscillations of stars (PLATO) mission is the third medium-class mission in ESA's Cosmic Vision programme. Its objective is to find and study a large number of extrasolar planetary systems, with emphasis on the properties of terrestrial planets in the habitable zone around solar-like stars. [1]

The PLATO Mission Parameter Database (MPDB) is a single reference repository for the PLATO Mission System. It represents, at any time, the official representation of the system consistent with the reference payload and spacecraft models. The MPDB provides a centralized, version controlled distribution system of parameters required by ESA Project, Science Ground Segment, the PLATO Mission Consortium (PMC) members, and Industry contractors. It contains launcher, ground segment, spacecraft and payload parameters, as well as ground test data directly relevant for current best estimates or data processing. In addition, it includes a selection of relevant mathematical, physical, and astronomical constants when consistent usage of their values is critical. Development of the PLATO MPDB occurred over 2020-2022, with initial data population and release to end-users in July 2022.

COMET is the RHEA Group Concurrent Design Solution that allows a team of engineers to perform Concurrent Design. COMET is used to collaboratively create a design that is shared

by means of a central repository that is the single-source-of-truth. [2] [3] Since the start of 2022, COMET is used daily in the ESA Concurrent Design Facility to support feasibility studies. [4]

2. Development of the PLATO MPDB

To meet the objectives of the PLATO MPDB, a number of key functionalities were required from any potential solution:

- Storage and management of PLATO mission system parameters in a single common location
- Version control, management of baselines and tracking parameter evolution
- Ensuring consistency in parameter data (unit/scale/format/etc.) and metadata (i.e. references)
- Controlled usage of parameter data in analyses and simulations
    - Standard data model and interfaces
    - Reproducible use of parameter data from authoritative, verifiable source – i.e. no copy/paste or duplication
- Distribution and access to end-users via on- and off-line interfaces

While some of these functions were satisfied by heritage solutions from Gaia and Euclid [5], key deficiencies and gaps remained. This led the PLATO team to search more broadly for a solution.

Drawing on the experience of the ESA Concurrent Design Facility [6] and their knowledge of Concurrent Engineering (CE) tools, many commonalities between the goals of the PLATO MPDB and CE were identified. With CE tools such as COMET, which allow for storage and exchange of parameter data as part of a collaborative model, evolved through successive iterations, organised by domains, and providing access controlled interfaces governed by open standards such as ECSS-E-TM-10-25 [7], a robust solution was readily available along with a depth of knowledge from the CDF System Engineering (SE) teams.

The PLATO MPDB now includes a configured COMET deployment with modelling guides for different parameter types, a large file storage system, a simplified Angular web viewer for

general navigation and browsing, and a Python-based programming language client for use in simulations, performance analysis and verification tasks.

3. Operational Deployment of the PLATO MPDB

The PLATO MPDB was deployed to end users in July 2022. To manage the parameter data stored in the PLATO MPDB and control its evolution, a data governance process was defined involving the establishment of a Change Control Board (CCB). The CCB is composed of representatives from the PLATO engineering teams, and provides regularly scheduled releases of parameter data. This process enables shared exchange of and responsibility for engineering data across domains, across the customer/supplier chain and across the life-cycle, through the use of a centralised system model.

Work is ongoing to integrate the PLATO MPDB into downstream applications in support of mission performance analysis and verification tasks. Specifically, PLATO MPDB parameter data will be integrated into the PLATO Noise-to-Signal Ratio Calculator and PLATOSim instrument simulator.

Many of the components of the PLATO MPDB are also targeted for reuse in other ESA Science projects and as input to the ongoing development of COMET.

4. Conclusion

This paper presents a practical and successful application of MBSE in space mission development in the form of the PLATO MPDB. It describes the path to selection of COMET, the customisations/extensions made to COMET to better fit the PLATO MPDB use cases, and additional development activities. This paper also reports lessons learned from the deployment and operational use of the PLATO MPDB, detailing its integration into downstream applications to support mission performance analysis and verification. This paper demonstrates alternative uses of COMET to support a wider variety of space project activities, bolstering the case for investment in COMET as an early-phase design tool as part of the Digital Engineering Hub Pathfinder activity, and beyond. This contributes towards ESA's Digitalisation objectives as part of Agenda 2025. [8]

NOTE TO PROGRAMME COMMITTEE

A similar abstract on this topic has been submitted to SECESA 2022 ("*PLATO Mission Parameter Database: Concurrent Engineering Tools for Projects*"), which discusses reuse of Concurrent Engineering tools for later-phase activities and its impact on SE&CE tool development roadmaps, while this paper shall present a more detailed technical exposé on development and implementation aspects of the PLATO MPDB, as well as feedback from its operational use.

References

[1] https://sci.esa.int/web/plato

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[4] ESA - COMET upgrade for ESA's mission design centre

[5] https://www.cosmos.esa.int/documents/966608/1172235/Vavrek_MDB.pdf/4e65ce2d-20c9-476a-9922-4c116b1e3864?version=1.0

[6] ESA - Concurrent Design Facility

[7] ECSS-E-TM-10-25A – Engineering design model data exchange – CDF (20 October 2010) | European Cooperation for Space Standardization

[8] https://www.esa.int/About_Us/ESA_Publications/Agenda_2025