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SIRIUS PRODUCT LINE: RETROSPECTIVE AND FEEDBACK ON THE DEVELOPMENT OF FLIGHT DYNAMICS SYSTEMS

Abstract

The SIRIUS product line defines the new generation of Flight Dynamics Systems (FDS) for the present and upcoming CNES missions such as SWOT, MicroCarb and MERLIN for example. As a part of the Control Ground Segment, the operational FDS are critical systems dedicated to orbit determination and prediction, maneuvers calculation (post-launch, station keeping, deorbiting), guidance and programming, mass and inertia calibration, events calculation, etc.

The development of the FDS from the SIRIUS product line is based on a customized model-driven approach and is carried out through three layers:

- PATRIUS: base level flight dynamics library for studies, mission analysis and operational products

- Flight Dynamics (FD) Algorithms: for each thematic domain (orbitography, maneuvers, programming...), definition of the Flight Dynamics functionalities and the associated datamodel

- FDS: operational system defined for a given mission through:
    - FD Algorithms assembling,
    - FD Applications with Graphical User Interfaces based on reused data widgets,
    - Operational sequences for ground segment automation

This paper focuses on the reusability, one of the main objectives of the SIRIUS product line. A feedback study on a decade of FDS development and operations by CNES drove to the conclusion that the next generation of FDS software should be implemented with increased reusability and modularity, maximizing the assembly of well-defined and validated services from one mission to another. In order to increase reusability and improve the production process of an integrated and validated operational FDS, the SIRIUS product line has implemented different products:

- the FDS Toolkit to provide to every FDS the infrastructure in terms of support functions (data persistence, communication, automation capabilities, ...) and to ensure the harmonization of the operability between different missions.

- the Standard FDS, an off-the-shelf FDS that consists of a set of Flight Dynamics Applications considered to be common to every mission and that can be directly used for basic missions (for example, nanosatellites) or extended to respond to the specific needs of a mission.

Following the first use of an FDS from the SIRIUS product line within an operational Control Ground Segment for LEOP and station keeping since the end of 2018, this paper aims to expose a retrospective on the complete development process of an FDS and to present an early feedback and some of the lessons learned. The first reusability metrics for the upcoming missions are also presented in this paper.