Operational Flight Dynamics System for PROBA-3 Formation Flying Mission

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PROBA-3 is the fourth ESA mission of the Project for Onboard Autonomy (PROBA), aimed at the demonstration of European on-board technology. Planned for launch in 2019, it is intended to validate in-orbit formation flying techniques and technologies with the scientific aim of observing the Sun's corona during a mission lifetime of 2 years. The mission is composed by two spacecrafts (coronagraph and occulter) on a high-elliptic orbit building a virtual telescope during scientific operations near the orbit apogee. This requires very precise formation flying of the two objects distant 150m from each other around the apogee.

As it can be inferred, such a mission has very demanding performances for the on-board Guidance Navigation and Control (GNC) system, in charge of the automatic science operations near the apogee. Additionally, the mission will count on an on-ground Flight Dynamics System (FDS) in charge of the following main activities:

- Orbit determination: based on GPS during the perigee pass and data from the metrology instruments and inter-satellite link during the apogee. Phase and pseudo-range double differences shall be used to achieve a higher accuracy of the relative orbit determination, which is critical for the mission. Considering the high autonomy of the spacecrafts, the manoeuvre data has to be retrieved after each apogee to account for the automatic on board manoeuvres performed during the formation flying.
- Manoeuvre optimisation: whereas routine formation flying and collision avoidance manoeuvres (CAM) between both spacecrafts are automatically computed on-board, FDS shall compute the manoeuvres for the initial formation acquisition, recovery after CAM and resizing the formation. All in all, FDS is responsible for the manoeuvres for formation acquisition prior to the start of automatic scientific operations driven on board.
- Calibration of the on-board Flight Formation Software (FFS), in particular for the computation of the perigee pass and the automatic formation acquisition manoeuvres. Flight Formation performances based on the reconstructed orbit and attitude will be also analysed by the Flight Dynamics System.
- Collision risk evaluation: as part of the manoeuvre computation, the collision risk between both spacecrafts has to be evaluated in case of misperformance or failure to execute any manoeuvre in a commanded batch.

This paper will describe the main challenges of the Flight Dynamics System for the PROBA-3 formation flying mission, due to the high level automation required on the ground segment and the interaction with the on-board system. The operational approach of the flight dynamics system will be also described in the paper.