CNESOC FLIGHT DYNAMICS MONITORING AND COMMAND OPERATIONS DURING GALILEO FOC1 LEOP AND RECOVERY

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Abstract: *This paper presents the highlights of the CNESOC attitude monitoring and command generation Flight Dynamics (FD) team operations during Galileo Full Operational Capability (FOC) 1 LEOP and the following recovery phase.*

In the context of Galileo FOC, the CNESOC team is a result of collaboration between CNES and ESOC centres with members from both establishments. Within this collaboration, the flight dynamics monitoring and command generation team is responsible for monitoring the spacecraft attitude dynamics and generating commands related to the AOCS subsystem. In addition, at ESOC a test and validation team performs parallel monitoring and validation of all the FD operational products, using independent tools, in order to assure the safety and quality of operations.

The first two Galileo FOC satellites were launched on August 22nd 2014. Unfortunately, due to a launcher anomaly, they were injected in a severely non-nominal eccentric orbit.

The latter was so far off from target that the nominal operational orbit could not be reached, with the fuel loaded on-board. Too low temperatures in the solar array (SA) deployment mechanism initially also prevented the deployment of one SA wing for each of the two spacecraft, leading to a series of contingency operations to achieve as soon as possible their successful deployment. The failed SA deployment could be observed by FD based on the estimated vs expected spacecraft inertia matrix.

After the deployment was accomplished, both spacecraft were kept in a safe Sun-pointing attitude for an extended period, while a new achievable target orbit was defined.

In the recovery phase, a series of orbit control manoeuvres (OCM) were performed in order to increase the perigee altitude such that the Earth sensor could operate normally, targeting at the same time an orbit somehow suitable for the Galileo constellation in terms of resonance and ground coverage. Before that, a series of analyses were done to ensure the spacecraft operability in an orbit far from the design specification, especially in terms of the on-board orbit propagator, conceived for orbits with very low eccentricity. The consumption of a very significant part of the available propellant to achieve the new target orbit gave FD the chance to observe the spacecraft propulsion system during most of its life cycle, close to end-of life *conditions. The mass consumption predictions had to be refined in order to ensure the overall feasibility of the manoeuvre strategy, taking into account in particular the thruster off-modulation observed during manoeuvres. Comparisons between the fuel book keeping respectively based on pulse counting and PVT methods showed increasing discrepancies as the propellant was being consumed. This lead into an analysis showing the effect of initial pressurant mass errors in the PVT method predictions. Also further investigations were performed concerning observed discrepancies in the Earth sensor blinding predictions between on-board telemetry data and the ones based on on-ground models.*

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