METOP-B ORBIT ACQUISITION OPERATIONS; PREPARATION AND EXECUTION

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ABSTRACT

The 23rd of May 2012 the second Metop satellite (Metop-B) was foreseen to be launched from the Baykonur cosmodrome by a Soyuz/Fregat launcher. After three days of LEOP (Launch and Early Operations Phase), performed by ESOC, the satellite should have been handed over to EUMETSAT, who should then have taken care of all satellite operations, starting from the SIOV (System in Orbit Validation) of the platform and of the instrument.

Metop constitutes the space segment of the EUMETSAT Polar System (EPS). The EPS is the European contribution to a joint European-US polar satellite system called the Initial Joint Polar System (IJPS). EUMETSAT has the operational responsibility for the morning orbit, where the Metop-A satellite is currently located since 2006 and where Metop-B will be operated, while its US counterpart, the National Oceanic and Atmospheric Administration (NOAA) is responsible the afternoon orbit, covered by the NOAA N and NP satellites.

In the frame of the EPS program an in-orbit phasing separation between the two Metop satellites of ±14/29 of an orbit is selected for the operational phase; that accounts for the given EPS system constraints (on data acquisition, processing and distribution) and requirements (identical ground-track), ensuring at the same time maximization of the data exploitation by the users.

Moreover, in order to be able to launch at any date with no collision risk between the two satellites, the injection orbit selected for Metop-B is 16 km lower than the final operational one, the same where Metop-A is currently flying.

This difference in altitude provides a large relative drift in in-orbit phasing between the two Metop satellites, which can be used to bring Metop-B into its target orbital location. As the orbital phase drift required to acquire the final in-orbit location is different for different launch dates, the duration of the drift phase depends on the launch date itself and of the injection error. An adjustment of the drift rate may therefore be required during LEOP to make sure that the target in-orbit location is reached in a date not conflicting with critical SIOV operations (instruments switch-on and decontamination); once the target is reached a drift stop maneuver is executed during the SIOV.

This strategy, even if apparently simple, presents however several difficulties that deserve to be carefully analyzed; we will just focus our analysis on the foreseen launch date, the 23rd of May and on the following 2 days (Soyuz can be launched on three consecutive dates once fuelled-up).

- If the Metop-B satellite is injected very close to its target, the drift adjustment manoeuvre required during LEOP is very large, as the residual drift to be implemented is extremely small. It is clear that even a little error in the large manoeuvre required for that correction is sufficient to create a relatively very large error in the achieved drift.
  This situation is observed for a launch on the 23rd of May; detailed analysis have been performed to characterise the expected performance of the platform assuming various error in the thruster alignment and in the centre of mass location in order to better predict the performance window of the propulsion system and adjust consequently the acquisition strategy.
  This analysis shows that the probability of having an underperformance when performing an orbital raise manoeuvre is much larger than the one of having an overperformance, which makes possible to consider strategies reducing the altitude offset with respect to the target orbit to a very small value with no risk of having the satellite stranded with an insufficient residual drift in case of overperformance.

- Whenever a large underperformance in altitude is observed at injection (8km of error are expected at 3-sigma confidence level) a coupled large error in eccentricity is to be expected (0.001 at 3-sigma). Due to limitations in the maximum thrust that can be delivered by the platform (around 6.4m/s) it may be impossible in this situation to adjust the drift toward the target location and at the same time to correct the eccentricity to bring it close to the frozen eccentricity value.
  This situation could happen for a launch on the 23rd of May; the acquisition strategy has therefore to be revised considering the execution of not one but two manoeuvres during SIOV to acquire in an optimal manner both the target location and the frozen eccentricity within the identified operational constraints; an important save of fuel can be obtained in comparison with the initial baseline strategy, based on a single manoeuvre in SIOV.

- As the two Metop satellites are identical, RF interferences can be observed whenever the two satellites are too close as observed from a ground station; these interferences make impossible to safely operate both satellites at the same time (TM jamming, TC conflict, ranging degradation); that problem is particularly severe if interferences are observed on the first day of the LEOP, while critical operations are carried out for Metop-B.
  This situation is expected for a launch on the 25th of May; special operations required to make sure that interferences are properly detected and that adequate countermeasures are put in place for Metop-A to minimize the impact on the LEOP of Metop-B.
  A dedicated tool was developed within the FD system to identify the risk periods and flight and ground procedures were developed to mute the on-board S-band transmitter of Metop-A and to suspend S-band operations from the prime EPS TTC station in Svalbard to avoid that any interference may affect Metop-B LEOP.

Currently the final launch date of Metop-B is still under discussion but launch should in any case take place before autumn 2012; new challenges will for sure appears on the new selected dates. This paper presents an overview of the Flight Dynamic operations performed during the LEOP and the SIOV of Metop-B to acquire its target orbital location, of the operational constraints affecting these operations and of the analysis performed to properly prepare them.