MISSION ANALYSIS OF METOP-A END OF LIFE OPERATIONS

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ABSTRACT

Metop is the space segment of the EUMETSAT Polar System (EPS), Europe's first polar orbiting operational meteorological satellite system. EPS is the European contribution to a joint European-US polar satellite system called the Initial Joint Polar System (IJPS). On 19th October 2006, the first Metop satellite (Metop-A) was successfully launched from the Baykonur Cosmodrome by a Soyuz/Fregat launcher.

The Metop mission requires that a repeat orbit of 412 revolutions every 29 days is followed within 5 km around the nominal ground-track and that the local time of the descending node is kept within 2 minutes of 09:30. Regular maneuvers are then required to maintain the operational orbit.

This orbit maintenance requirement necessitates an on-board propulsion subsystem. By heritage of the Spot Family platform, Metop-A is carrying approximately 300kg of hydrazine. This amount of fuel is budgeted for orbit maintenance, for correction of orbit injection errors following separation from the launcher and to maintain the satellite in a safe attitude if a major anomaly at platform level occurs. During the development phase, no budget was included for end-of-life disposal and, in consequence no fuel has been allocated for de-orbiting the spacecraft at the end of its operational phase.

Thanks to a very accurate injection into the operational orbit and to a close to optimal orbit maintenance, together with the fact that no major anomaly at platform level has occurred, a large amount of fuel has been saved in comparison with the design case during the first six years of operations. This excess fuel can be allocated either to extend the satellite lifetime or to put the satellite in a faster-decaying orbit which will result in an earlier atmospheric re-entry (ideally within 25 years, as recommended by the international guidelines on space debris mitigation); or a combination of both.

Simulations and analysis have been performed by the EUMETSAT FD team to define possible end-of-life strategies that take into account on one side the limitations in the spacecraft design (not foreseen to be de-orbited) on another a proper balance between mission return (it is highly desirable to maintain Metop-A operational up to the end of commissioning of Metop-C, to ensure an hot redundancy of Metop-B and allow dual satellite operations) and compliance with the international guidelines on space debris mitigation.

In order to increase as much as possible the mission duration minimizing the fuel consumption, some mission extension strategies (such as overheating of the propellant tanks, uncontrolled drift of the local time, reduction of the semi-major axis) have been considered. On another hand, the impact of a potential major anomaly at platform level, leading to an important reduction of the available fuel, has been also analyzed, to assess the robustness of the proposed strategy to this kind of unforeseen events and to identify, when possible, mitigation options to limit their negative impact.

The paper presents an overview of the considered end-of-life options as well as the analysis performed to give a satisfactory answer to several questions that arose during the work, such as:

- Impact of the mission extension on the operations of the other two Metop satellites;
- Selection of the optimal perigee location and of the optimal final eccentricity, to achieve the desired re-entry time maintaining at the same time an acceptable operational risk);
- Selection of the optimal maneuvering strategy to achieve the target end-of-life orbit, to reduce the duration of the operations, and so their cost, but still keeping them properly under control;
- Interference and conjunction management during end-of-life operations;
- Fuel estimation approach on the different phases.

Author(s) statement for acceptance: this paper describes the mission analysis activities supporting the definition of the operational Metop-A end of life operations, foreseen to be performed in 2018, with emphasis on the trade-off between mission return and compliance with current guidelines on space debris mitigation. The concepts indicated are of general interest for future LEO mission.