MANEUVERS DESIGN HIGH REACTIVITY IN ATV MISSIONS

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ABSTRACT

The European cargo, the Automated Transfer Vehicle (ATV), has reached its maturity at the completion of its 4th mission supplying the International Space Station (ISS). The last vehicle of its kind, the so-called ATV-5 "Georges Lemaitre", will be launched in June 2015, ending the saga and letting other vehicles fulfill this duty in the future use of the International Station. For the time being, the ATV has become the heaviest spacecraft ever launched by a European launcher, the Ariane 5 ES rocket, and, after the Space Shuttle, the ISS logistics spacecraft carrying the highest quantity of dry cargo, liquid cargo and maneuver capacity to raise the Station orbit.

From the Flight Dynamics point of view, one of the most important characteristics of the ATV is its high flexibility in terms of launch and docking scheduling. This flexibility leads to a complete disconnection between launch and docking dates scheduling, thanks to the following facts:

- Orbital maneuvers until ISS vicinity computed on-ground
- Phasing strategy covering any phasing angle with respect to the ISS
- Generic phasing strategy conceived to target any ISS altitude imaginable for docking
- Possibility to perform a parking phase as long as needed

Concerning the undocking and de-orbitation phase, an equivalent flexibility is achieved by the ATV vehicle, easing the reentry operations scheduling and the ISS traffic planning with partners.

Nevertheless, the experience of the four first missions of the ATV shows that no real recurrence existed between each of the ATV manoeuver strategies. In-flight demonstrations, new imagery experiences, changes due to contingencies prevention… all of them resulted into short-term demands of revision and re-building of the generic phasing strategy (or reviewing the de-orbitation strategy) being followed of modifications at the different levels of the operational products all along the FDS team: from extremely fast and targeted complementary mission analysis, to new operator procedures, new specific templates, software modifications and extra validation tests.

ATV-CC team is able to solve all these problems at maneuvers design level thanks to an organization and a set of FDS techniques leading to a high reactivity of the FDS team, capable of re-computing, re-demonstrating strategies and renewing the optimum quantity of operational

products in days or weeks of delay. A proof of this high reactivity can be found in the recent operations of ATV-4 “Albert Einstein” mission, for which, as major modifications into the maneuvers strategy, the phasing phase was preceded by a free flight at injection altitude and the reentry trajectory had to be performed in phase with the ISS.

The future ATV-5 “Georges Lemaitre” mission will also carry important modifications on both phasing and de-orbitation strategies. In the case of phasing, ATV-5 will perform a new IR/Visible experience during a free-flight underneath the ISS, then a return to the interface point using a drift orbit over the ISS before proceeding with the RDV. For reentry phase, ATV-5 will target a low flight path angle trajectory, in order to get the maximum data as possible for future ISS reentry trajectory models. This “shallow” ATV vehicle reentry will be phased with the ISS and observed by the crew.

ATV-CC: Automated Transfer Vehicle Control Center
RDV: Rendezvous
IR: Infrared