SPACE SYSTEMS SYMPOSIUM (D1)
Lessons Learned in Space Systems (5)

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AUTONOMY AND FAILURE DETECTION ISOLATION AND RECOVERY FOR A FORMATION FLYING MISSION: LESSONS LEARNED OF THE PRISMA MISSION

Abstract

Autonomy, and Guidance, Navigation and Control are the focus of the PRISMA formation flying mission that was launched on the 15th of June 2010 and which has since been operated successfully. PRISMA is a two-satellite formation for experiments in autonomous formation flying and rendezvous. To provide autonomy the common Failure Detection Isolation and Recovery (FDIR) on satellite level has to be enhanced by an FDIR function on formation level which is tasked to autonomously maintain the operational timeline of the formation. This requires control of all the functions needed for the control of the relative position of the satellites to avoid collision or evaporation of the formation while keeping a close watch on the propellant spent. The design basis were a Failure Mode Effects Analysis (FMEA) of the complete system together with the treatment of so-called "feared events" such as loss of navigation, low power and high propellant consumption. With a tremendous amount of sensor readings and control function auxiliary data the challenge was to arrive at a simple and robust distributed FDIR system, while at the same time maximizing autonomy. Sufficient autonomy to maintain a fully packed operational timeline and to give the operations team two weeks of for summer vacations. SSC's SMART-1 design was the starting point for the PRISMA FDIR system. Most additional functions could be handled in onboard software but some required additional hardware functions in the satellites' power systems which have the highest authority on board. The paper presents the design and testing process and the lessons learned after 8 months of operations. The lessons learned concern both the logical failures and successes of the design, the advantages and disadvantages of the design and testing process, and concludes with guidelines for autonomy and FDIR systems for formation flying missions yet to come such as ESA's PROBA 3 mission.