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Lessons Learned in Space Systems: Achievements, Challenges, Best Practices, Standards. (5)

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SYSTEM ENGINEERING CHALLENGES INVOLVED IN CONFIGURING A SMALL SATELLITE BUS FOR ADVANCED TECHNOLOGY DEMONSTRATION

Abstract

Many experimental missions have been flown by ISRO to demonstrate new and emerging technologies. As part of these experimental missions, advanced technology demonstration missions including rendezvous docking, undocking, composite control, formation flying, etc., are being conceived by ISRO using small spacecrafts. Small spacecrafts are low cost alternative to large spacecraft and are considered as the best platform to demonstrate new technologies. The operational experience gained from these missions will be a forerunner for missions like on-orbit servicing, crew transfer in manned missions, building large modular spacecraft like space stations, which can serve as orbiting laboratories for a multitude of scientific and technological experiments and applications, international participation, etc. This paper explains the system engineering challenges and methodologies involved in configuring two small spacecrafts to demonstrate advanced technologies such as rendezvous, docking, composite control, power transfer scheme undocking. Docking refers to engaging and securing the two spacecraft together by a docking mechanism when the approaching spacecraft called the "Chaser" flies directly into another spacecraft called the "Target" in a controlled manner. The systems for docking experiment comprise mechanisms for docking, associated sensors and control elements. Various configuration studies and analysis related to mission, control dynamics, flight dynamics, design trade-off, structure, thermal, packages accommodation, mounting of sensors & antenna systems were carried out to meet the mission-specific requirements. The spacecraft configuration of Chaser and Target have been evolved considering the mission & subsystems requirements, constraints due to orbit and launch vehicle, critical budgets like mass, power & fuel. As no subsystem level hardware redundancy exists in the bus, the design of spacecraft is carried out in such a way that any functional failure in the rendezvous and docking specific subsystems will not jeopardize the mission. The configuration of Chaser and Target spacecrafts are almost identical and the roles are interchangeable before docking as it improves the overall mission redundancy. The application of system engineering techniques helped to overcome the challenges towards the design and configuration of Chaser and Target spacecrafts, defining the spacecraft architecture and its complete system level characteristics. It also helped to adopt and accommodate the advance/new design of major subsystems thereby improving the capability of the small satellite bus.

Index Terms— Challenges, Configuration, Small Satellite, System Engineering, Rendezvous, Docking