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Quality and Safety, always a beginning! (1)

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INTRODUCING AND INCREASING RAMS FOR DEEP-SPACE CUBESATS

Abstract

The constant maturing of technology for spacecraft components naturally inspires more complex and difficult to achieve, ambitious missions. Cost is always one of the main driving factors in designing a mission. This justifies the recent popularity of spacecraft miniaturization and standardization, with the very well-known example of CubeSats.

CubeSats have been flourishing in the past 15 years, allowing for dramatic reductions of the costs of missions in Low Earth Orbit. Recently, the space community has started to express a strong interest in using such platforms also for interplanetary missions. The need of implementing RAMS (Reliability Availability Maintainability and Safety) tools is becoming critical for CubeSat developers, especially considering that nowadays CubeSats are also developed for such untraditional missions in deep-space environment, where longer life and durability to long travels is required to the on-board COTS components.

In accordance with ISO 19683:2017, it is important to achieve reliability against infant mortality, especially for CubeSats developed under untraditional processes. ESA, NASA and industrial players are targeting the use of CubeSats for performing particular short-duration missions in the Moon Mars environment or around asteroids (e.g. LUMIO, MarCO, Hera). However, this implies shorter operational period (1 year) compared to larger spacecraft, with potentially long-duration travels until ejection and activation of the CubeSat. These platforms are expected to operate in harsh environments and avoid infant mortality despite the time spent in space from launch to operation. Increase of reliability is therefore becoming a more and more stringent need for CubeSats, especially for these interplanetary missions given their much higher costs compared to LEO launch and operation. However, this reliability increase is associated in CubeSats to several shortcomings, such as the high proportion of use of COTS, the lack of redundancy and multitude of single points of failure and the strict mass, volume and power budgets that do not allow for complex designs. Due to these aspects, RAMS becomes important and can potentially contribute to life extension and accomplishment of mission goals.

This paper presents an overview of the manners in which RAMS can be integrated and adopted by the CubeSat community, analysing in particular how to implement adequate redundancies, design variety and maintainability in flight, as well as proper FDIR to allow for mission availability. Based on this analysis, recommendations will be provided on how to increase the reliability of CubeSats despite the shortcomings these platforms experience for the aforementioned types of missions.