STARDUST - RAMS AND FDIR FOR CUBESATS - KEYNOTE

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ABSTRACT

Nowadays spacecraft are built with a large range of objectives and with the clear aim of fulfilling complex functions that can bring the desired return depending on the field and scope of operations such as science, earth observation, telecommunications, navigation, in-orbit demonstration, planetary protection, etc. The cost of these missions can range from several million to billions, and hence most of these systems do not allow access for on-board maintenance. When it comes to CubeSats, the constant advancement of technology for spacecraft components naturally inspires more complex and ambitious missions. This clearly justifies the recent popularity of spacecraft miniaturization, with the very well-known example of CubeSats. Recently, the space community has started to express a strong interest in using such platforms also for interplanetary missions.

The need to achieve high reliability and avoid infant mortality, especially for CubeSats developed following non-traditional processes is critical. Targeting the use of CubeSats for performing particular short-duration missions to the Moon and Mars or around asteroids implies shorter operational periods (~1 year) compared to larger spacecraft, with potentially long-duration piggyback transfers in dormant mode until separation 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 (and overall RAMS) is therefore becoming more and more stringent for CubeSats, especially for these interplanetary missions given their much higher costs compared to low Earth orbit missions. As a consequence, planning ahead and targeting high reliability and survivability is critical. Reliability Availability Maintainability and Safety (RAMS) analyses are methods used during design and development in order to support that the right decisions are made through optimisation of the different constraints such as design and cost, while ensuring safety, survivability and planetary protection. Fault Detection Isolation and Recovery (FDIR) System represents a core satellite system engineering activity that shall start from the beginning of the mission and shall end at decommissioning, while covering for the parts in which the system does not behave as expected. While RAMS has to be part of all missions in order to ensure mission success, FDIR shall be developed also in all satellite missions, however the complexity may depend. One particular case in which complexity is significantly increased is for those missions, or parts of missions, that aim at achieving a certain amount of on-board autonomy. This results in a critical need to develop exceptionally robust and deterministic systems in order to cover the moments in which ground intervention is not possible, either due to coverage or due to the need of an immediate reaction.

RAMS should be regarded as the bridge that makes the connection between System Engineering and FDIR, contributing mainly to the design and process development of the FDIR system. This keynote will provide a general introduction to RAMS and FDIR, a thorough description on the scope and use of RAMS analyses in CubeSat missions (both conventional and deep-space) and will tackle what ought to be performed in terms of RAMS and FDIR for deep-space missions Cubesats. The keynote will highlight, how these inputs should be used and how to contribute to a more reliable missions success for a potential deep-space CubeSat mission.