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RAMS ANALYSES INTERDEPENDENCIES WITH FDIR AND SYSTEM ENGINEERING

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. As a consequence, planning ahead and target 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. In this paper, a detailed description of the RAMS analyses used for FDIR will be provided through the "RAMS Map". The "RAMS Map" aims to show the intended use of RAMS analyses within space missions and to clarify their interdependencies between them and with other fields of expertise by pointing out what outputs/inputs are required in order to keep consistency between RAMS and design activities during the development. The focus of this paper will be strictly on the interdependencies of RAMS with FDIR where a rather generic view based on standards, expert judgment and overall experience acquired from a variety of past and on-going space missions will be provided. It is to be mentioned that the "RAMS Map", though versatile, in its current form, refers to spacecraft missions only.

The paper will provide a general introduction to RAMS and FDIR, a thorough description on the scope and use of RAMS analyses in space missions followed by a detailed depiction of the RAMS analyses (part of the "RAMS Map") and their interdependencies with FDIR both at system and subsystem level.

The paper will also discuss and conclude over the importance of RAMS for FDIR Engineering and will highlight the common shortcomings in RAMS-FDIR interactions.