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SATELLITE FDIR PRACTICES USING TIMED FAILURE PROPAGATION GRAPHS

Abstract

FDIR functionalities are investigated since the very beginning of a space mission and play a relevant role in the definition of its autonomy, reliability and availability objectives. An attentive FDIR analysis is necessary since it impacts the overall mission specification, design and operation. Currently, the lack of a strong analytical methodology supporting RAMS activities, system-level FDIR conception down to its implementation causes serious discontinuities throughout all the project phases and hampers the process of a stable and consistent FDIR design.

In this paper, an analytical methodology derived from the Timed Failure Propagation Graph (TFPG) is proposed. TPFG is a causal model that captures the temporal aspects of failure propagation in a wide variety of engineering systems. It has been extended so as to incorporate the recovery actions as well as to accommodate the dependencies on the mission phase and spacecraft operational mode in the related graphs. An algorithm to compute the sustainability of a failure has been developed as well, which can be used as a measure to determine the system reliability at any given time.

The robustness of the TFPG model with respect to the settings in the related graphs has also been investigated. Faults, actions and observations are represented by the TPFG network nodes and associated weights. The path leading to the fault recovery can be modified by tuning the network parameter values. The proposed methodology has proved to be very useful in the context of the trouble identification shooting of complex system, such a satellite.

As demonstrative example, a prototype supporting the satellite FDIR analysis, specification, design, implementation and verification has been developed. Use case scenarios and functional requirements of this tool have been laid down. In particular, it has been shown how to represent and reproduce diagnostics scenarios of a specific satellite sub-system, how to tune them by updating the TPFG network and how to integrate via a top-down approach FDIR dynamics involving different sub-systems. Thanks to its high level of configurability, this tool can be regarded as a valuable means to counteract the late availability of concrete FDIR system-level input data.