

IAF SPACE SYSTEMS SYMPOSIUM (D1)  
Technologies to Enable Space Systems (3)

Author: Ms. Adilson Barbosa

National Institute for Space Research - INPE , Brazil, eng.adilsonlb@gmail.com

Dr. Geilson Loureiro

National Institute for Space Research - INPE , Brazil, geilson@lit.inpe.br

Dr. Silvio Manea

National Institute for Space Research - INPE , Brazil, silvio.manea@inpe.br

Dr. José Duarte

National Institute for Space Research - INPE , Brazil, jose.duarte@inpe.br

Dr. Giuliani Garbi

National Institute for Space Research - INPE , Brazil, giuliani.garbi@gmail.com

## SEQUENTIAL FRAMEWORK BY METRICS RELATED TO FPGA COTS

**Abstract**

This paper presents a sequential framework with the objective of assisting the component engineer in a process of choosing fault mitigation techniques in electronic integrated circuits of the type COTS-FPGA (Commercial Off-the-shelf - Field Programmable Gate Array). The failures considered occur due to the effect of spatial radiation and can lead to several types of errors, including those due to TID (Total Ionizing Dose). In the literature on frameworks, it is generally found that they are sequential, but do not have selection metrics. In a current article, we found a framework that considers metrics, but it is not sequential, making it difficult to understand the flow of information. It also has the disadvantage of considering only four types of mitigation techniques. In the spatial context, mainly of nanosatellites, the efficiency must be high and meet certain critical parameters like high processing rate, low energy consumption and low cost. The "hardening" process is used to make the component more radiation tolerant, with less cost. It should be noted that COTS were not manufactured for the hostile environment of space, mainly related to the effects of radiation. With the choice and implementation of these techniques, FPGAs COTS should achieve spatial qualification, observing some requirements such as maximum power usage, maximum failure rate and minimum required life time. With the successful implementation it is possible to achieve significant savings in the purchase of COTS components, as they are about 20 times cheaper than those manufactured with radiation tolerance. Another important advantage is to avoid the possibility of commercial embargo of these devices, because the market is restricted. In addition to these advantages, this proposed article covers approximately twice the mitigation techniques for analysis, extracted from a literature study (period of seventeen years). The metrics used for this selection should cover at least the parameters: power, reliability and lifetime. Thus, one can double the number of techniques indicated and follow a flow of sequential information, helping in the measurement of the metrics and in the best process of selection of the techniques. With the adoption of this improvement, the component engineer can use this tool to design projects in the area of COTS FPGA, with the mitigation of radiation effects according to the objectives of the mission and sequentially. Keywords: COTS-FPGA, fault mitigation techniques, sequential framework, selection metrics