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Author: Mr. Maximilian Henkel
Graz University of Technology (TU Graz), Austria, henkel@tugraz.at

SAFE IN-FLIGHT FPGA RECONFIGURATION ON OPS-SAT

Abstract

Space is the worst place for electronics. Because of the harsh environmental conditions, electronic components degrade faster in space. This degradation is commonly alleviated by careful testing and part selection together with thorough redundancy designs. However, these approaches are limited to predictable faults. For unpredictable faults, we propose to take the redundancy mechanism one level lower, to programmable logic gates. Field-programmable (logic) gate arrays (FPGA) are already used in the Space Industry but rarely reconfigured during flight, because of the associated risks. Here, we show a safe way to reconfigure a Cyclone V FPGA in-flight and demonstrate it on ESA's OPS-SAT mission in a real on-orbit scenario. In conclusion, strategies are provided to make FPGA reconfiguration in-flight safer and more feasible. The presented technology can mitigate potentially mission critical scenarios. Another significant benefit is modification or addition of features on an already launched mission, as it is required for the OPS-SAT mission. The gained hardware flexibility can substantially extend the overall satellite mission lifetime and enables adaptation to unforeseen scenarios and failures. In addition, it opens the door to further innovation.