On-line testing and healing permanent radiation effects reconfigurable systems

Run-time reconfigurable systems are more and more employed in many application fields, including aerospace. SRAM-based FPGAs represent an extremely interesting hardware platform for this kind of systems, because they offer flexibility as well as processing power. The scope of this project is to develop a software flow, named **OLT(RE)²** (***O***n-***L***ine ***T***esting and Healing Permanent ***R***adiation ***E***ffects in **Re**configurable Systems), for testing and diagnosing, during the life-time of a space mission system, permanent faults due to radiation in SRAM-based FPGAs. Once faults have been detected and diagnosed, the flow should allow patching the discovered faulty resources, allowing faulty regions of the FPGA to be available for further use.

Within the context of the ITI A project, the work verifies that the presented OLT(RE)² diagnosing and detection flow of permanent faults is applicable on partially dynamically reconfigurable FPGAs utilized in space application. OLT(RE)² proves that the routing resources of an FPGA are free of Stuck-at-1 and Stuck-at-0 permanent faults (e.g. caused by TID). It is important to verify that the FPGA is free of this kind of permanent faults, since they may cause Stuck-at-0, Stuck-at-1, bridge, conflicts or antenna effects in a specific design. The effectiveness of the tool OLT(RE)² is proved on the DRPM (**D**ynamically **R**econfigurable **P**rocessing **M**odule) demonstrator, which allows validating the concept in a space application scenario. Stuck-at-1 and Stuck-at-0 permanent faults are emulated on the DRPM in order to prove the error fault detection capability of the tool. The hardware tests are performed on a Xilinx Virtex-4 FX100 FPGA of the DRPM. More precisely, one clock region with 111,179 testable wires is diagnosed for permanent faults in around 26 seconds. Thereby, 100 % of injected faults are detected by the developed coarse-grained testing circuits.

The OLT(RE)^2 flow is suitable for a wide number of Xilinx FPGAs: Virtex-4,-5,-6,-7, Spartan-6, Kintex-7, Artix-7 and Zynq.