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# SCOSA - SCALABLE ON-BOARD COMPUTING FOR SPACE AVIONICS

**Abstract**

Computational demands on spacecraft have continuously increased for years whereby available space

qualified hardware is not capable of satisfying these requirements completely. This paper introduces a way to overcome this problem by combining highly reliable space qualified hardware with highly performant commercial off-the-shelf (COTS) components. This combination of hardware enabled us to develop a new type of on-board computing (OBC) system, called ScOSA (Scalable On-Board Computing for Space Avionics).

A ScOSA system uses a distributed approach whereas it consists of multiple nodes. They are classified as reliable or high performance nodes. The reliable nodes are based on radiation-hardened Leon3 processors, the high-performance nodes on COTS Xilinx Zynq (CPU and FPGA). All nodes are connected by a SpaceWire network with a meshed topology that provides redundant data paths to establish fault tolerance. A large number of existing systems can be connected to our system given that SpaceWire is widely used within the space domain.

ScOSA has additional capabilities during operation that set it apart from traditional on-board computing systems. During runtime a dynamic reconfiguration of the whole system can be performed. By this, faulty nodes can be removed or recovered nodes can be reintegrated into the system. Additionally, computation tasks can be started, stopped or shifted between all active nodes. Also, connected FPGAs can be reprogrammed. As a consequence, these reconfiguration capabilities can be used to fulfill changing requirements without exchanging the underlying hardware. This can also be used to handle different spacecraft modes or mission phases.

The contribution of this paper is to explain the details of the ScOSA architecture, implementation and its functionality. Additionally, we will show the results of running representative applications from the space robotics, earth-observation and satellite avionics domains. These applications were selected for evaluating the system capabilities and include, among others, autonomous navigation and capture operations, stereo image processing and optical ship detection. Testing and demonstration will be done in Hardware-in-the-Loop simulators or on robotic testbeds (namely DLR's EPOS and OOS-Sim).