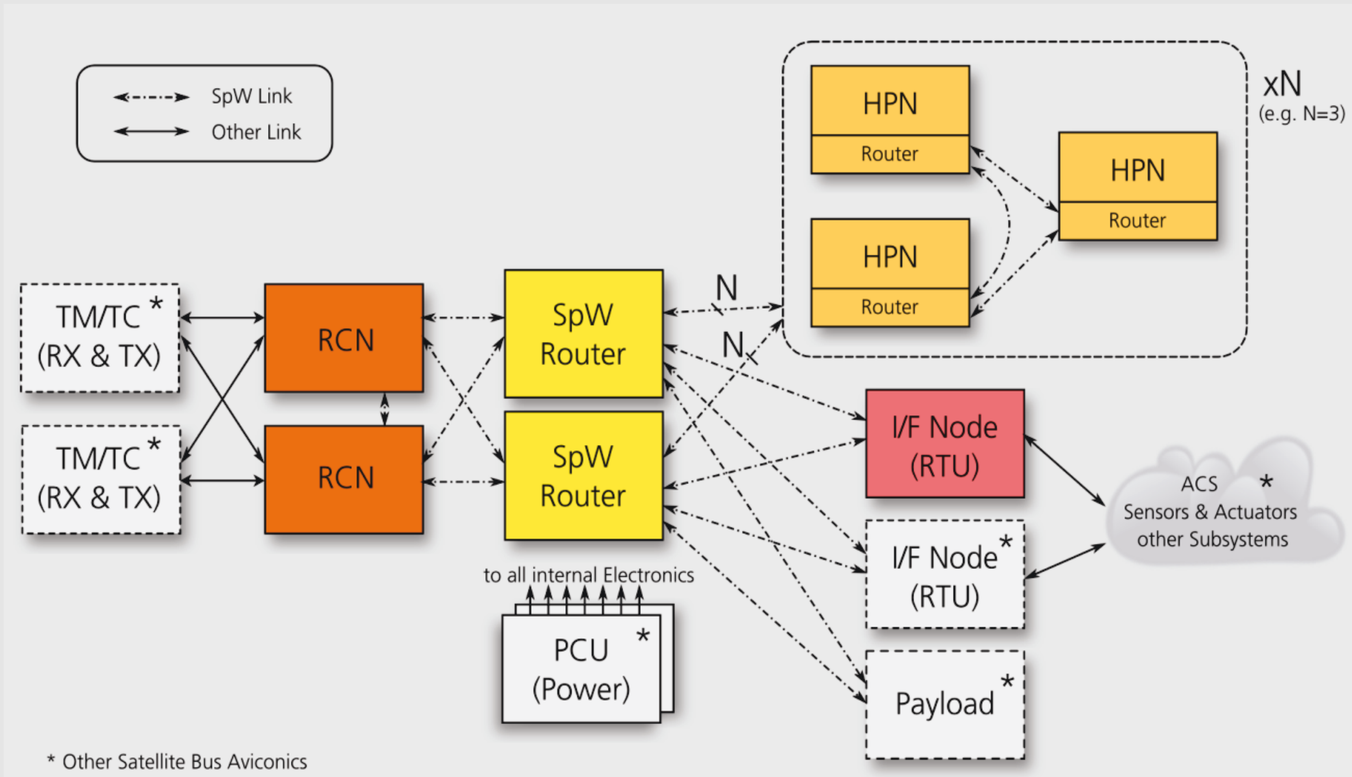
Scalable On-board Computing for Space Avionics (ScOSA)



ScOSA System Overview

System Recovery After Node Failure

Each node is assigned a role in order to ensure early detection of faults due to hardware malfunction, radiation effects or software errors. A timely reconfiguration for seamless operation is then initiated.
Each system has one active **Master Node** which requests regular heartbeat messages from all other nodes and acts as point of contact for all notifications on irregularities.
Each **Slave Node** continuously checks its own health status and informs the Master Node in case it detects a malfunction in itself or in the messages of another node.

Motivation

The ScOSA project at German Aerospace Center is aimed at creating a scalable on-board computer system based on the following goals:

Higher performance for processing large amounts of raw data onboard a spacecraft and for demanding real-time tasks.

Higher reliability of the overall system by combining radiation hardened and COTS parts into a reliable network.

Higher availability by automatically redistributing computation tasks in case a network node fails.

Scalability by exploiting the modular concept to tailor the computational resources to the mission's demands.

Requirements

The following main requirements were identified for ScOSA to be fulfilled in order to compete with existing onboard computing systems:

- Reliable in high radiation environments
- Execute avionic, command and data handling, payload control and on-board data processing software
- Support distributed systems and communication services as well as parallelized applications
- Support hard real-time applications and computationally intense on-board processing applications

System Setup

The overall system consists of a set of functional computing nodes connected via a SpaceWire network. There are essentially 3 types of nodes:

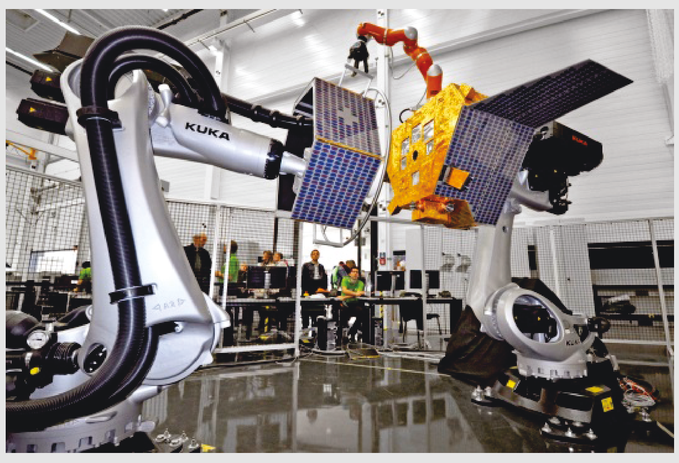
Reliable Computing Node (RCN):
Built with radiation hardened hardware (e.g. Leon), it is responsible for mission critical services like ensuring a working TM/TC system is available at all times.

High Performance Node (HPN):
Computing nodes made of standard COTS parts (e.g. Xilinx Zynq) for computationally demanding tasks.

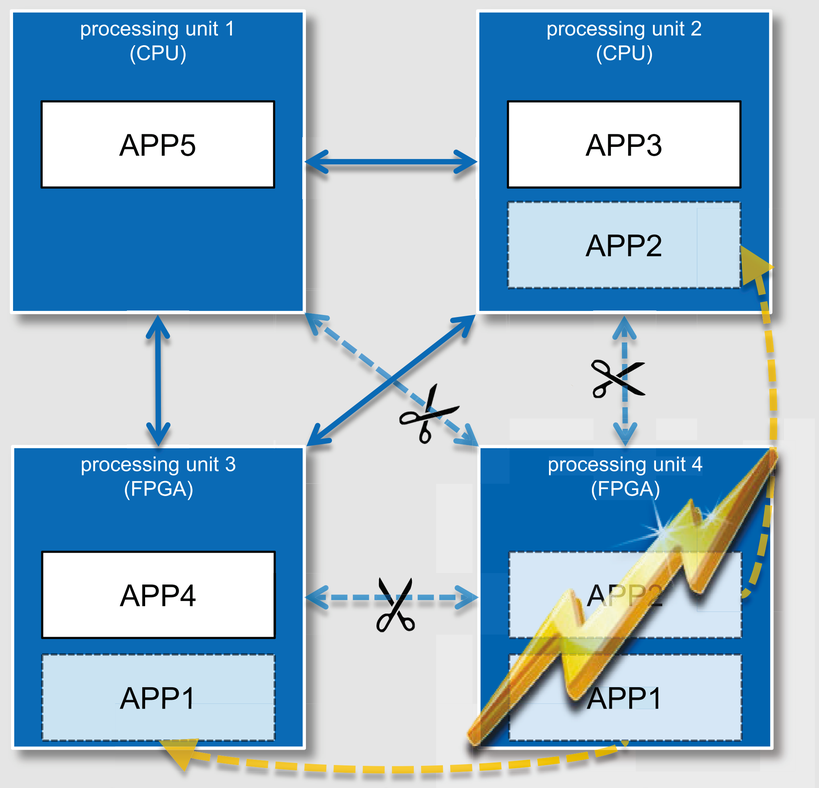
Interface Node (I/F):
Communicates with low-level hardware devices. It forwards the generated data to any subscribed processing node and commands to the hardware devices.

Applications

- On-Orbit Servicing
- Rendezvous Navigation
- Ship detection



On-orbit Servicing
(DLR Institute of Robotics and Mechatronics)



Reconfiguration in case of a detected node failure

In case that a node's failure is detected, a reconfiguration event is issued by the Master Node. The failed node is isolated from the network and its processing tasks are redistributed among the remaining nodes in the network.
The tasks are then resumed from the last available checkpoint.
As a result the overall mission objective can still be continued with the possibility of some performance degradation. Later, ground control might command the system to reconfigure back into a fully operational state after the cause of the failure has been handled.

ScOSA Team

- Institute of Robotic and mechatronics
- Institute of Optical Sensor Systems
- Institute of Robotic and Mechatronics
- Simulation and Software Technology

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