Evaluation of the Multi-Core Technology for Demanding Space Applications

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In space technology, as well as in all application areas of computer systems, the trend towards ever-increasing demand for computing power is evident. On-the-fly processing of the high-volume data streams generated by innovative space instruments, either to deal with the limited downlink capacity or even to utilize the data in real time directly for autonomous complex mission control operations can hardly ever be performed by existing space qualified processors.

To roughly satisfy the performance requirements of data-and compute-intensive space applications, complex and highly specialized FPGA-or DSP-based solutions have to be developed. However, such an approach is limited to low functional complexity and in addition it results in extensive loss of flexibility.

The current architectural trends in the field of multi-core processors provide an enormous increase in processing power by exploitation of the available parallelism in many applications. The moderate clock rates together with new energy-efficient semiconductor technologies and highly efficient power management functions provide an extremely favourable ratio of effective computing power to energy consumption. In the area of server and desktop systems multi-core processors are already in place and also in the field of embedded systems, this technology is increasingly used. In particular, because of their high energy efficiency, it is very desirable that multi-core processor-based systems will also be used in future space missions. In complex compute-intensive space applications, highly integrated embedded multi-core-processors offer advantages over a specially configured FPGA platform due to their much greater flexibility, since the required functionality can be easily defined and in addition, dynamically changed by the software.

To evaluate the capabilities of the multi-core processor technology for future satellite missions the German Space Agency (DLR) initiated a research activity by funding the MUSE project (MUSE = evaluation of a MUlti-core architecture for tracking SEnsor in space). The objective of MUSE is to design and implement a high performance processing system based on newest multi-core processor technology. To demonstrate the advantages of the multi-core approach and in particular the performance of the prototype system, a complex tracking sensor application will be implemented. The input generated by multiple high resolution camera systems will be processed in real time by different algorithmic solutions and different parallelization strategies to examine how multi-core processors can be used optimally for typical compute-intensive aerospace applications. The redundant resources of multi-core architecture will be employed not only to increase the processing power, but in particular to achieve fault tolerance by implementing effective FDIR strategies.

On the workshop we will introduce the fault tolerant architecture of the MUSE High Performance Processing Node (HPPN). Especially we will present the highly effective FDIR concept implemented on the different hardware and software levels of the system and will give first performance figures achieved in real application on the eight core embedded processor P4080, the most powerful version of the "QorIQ" family from Freescale .