

Remote Direct Memory Access in heterogeneous computing, enabling on-the-fly MRI reconstruction

Bachelor/Master Thesis

Research field

Over the past two decades, as scaling technology neared its physical limits, new architectures such as many-core processors, GPUs, TPUs, and domain-specific accelerators have emerged. These heterogeneous systems extend Moore's Law and meet growing computational demands in cloud and edge environments, especially for real-time tasks like MRI reconstruction. However, the main challenge has shifted from computation to the data memory access and movement between accelerators and memories involved in the system. To face this problem different Existing Remote Direct Memory Access (RDMA) solutions have been proposed like RoCE and InfiniBand, which are GPU-centric and not efficient for on-the-fly data transfer between FPGAs and other accelerators. This limitation is critical in real-time applications such as Ultra-High Field MRI where 3 Gs/s of data per channel must be collected using FPGA-based data acquisition systems, and then immediately send to GPUs or TPUs for the data processing, as the only suitable near-sensor solution to achieve real-time requirements.

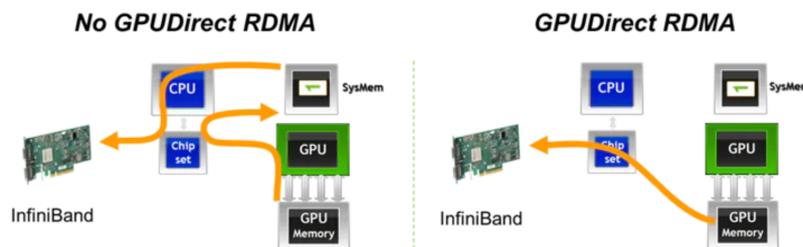


Figure 1: Example of no-RDMA and RDMA

Research topic and working hypothesis

In this thesis the student will get a MRI reconstruction algorithm to run on GPU, where data are supposed to be stream from FPGA over PCI-Express without using RDMA. Starting from this set-up, he will study existing RDMA solution for GPU and FPGA and propose his own solution, to be implemented on FPGA and than integrated with GPU to enhance the data communication between these accelerator running on the same workstation. Finally, the student has to validate and evaluated the performance of the proposed solution in comparison with the starting implementation without RDMA and other solution in the state of the art that exploit RDMA for real-time applications.

Skills

Required:

- Knowledge in Verilog or VHDL
- Knowledge in C++ and CUDA

Desired:

- Basic knowledge of Vivado
- Knowledge of coherency and bus communication

Contact



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