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GPU for triggering in HEP esperiments

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The aim of the GAP project is the deployment of Graphic Processing Units (GPU) in real-time applications, ranging from high-energy physics online event selection (trigger) to medical imaging reconstruction. The final goal of the project is to demonstrate that GPUs can have a positive impact in sectors different for rate, bandwidth, and computational intensity.
General-purpose computing on GPUs is emerging as a new paradigm in several fields of science, although so far applications have been tailored to the specific strengths of such devices as accelerator in offline computation. With the steady reduction of GPU latencies, and the increase in link and memory throughputs, the use of such devices for real-time applications in high-energy physics data acquisition and trigger systems is becoming ripe. We will discuss the use of online parallel computing on GPU for synchronous low level trigger, focusing on tests performed on CERN NA62 experiment trigger system. GPUs typically show deterministic behaviour in terms of processing latency, but assessment of real-time features of a standard GPGPU system takes a careful characterization of all subsystems. The networking subsystem results the most critical one in terms of latency fluctuations. Our envisioned solution to this issue is NaNet, an FPGA-based PCIe Network Interface Card (NIC) to enable GPUDirect connection. Results obtained parassitically with respect to the NA62 trigger system, during standard data taking, will be shown.
The use of GPU in higher trigger system is also considered. In particular we discuss how specific trigger algorithms can be parallelized and thus benefit from the implementation on the GPU architecture, in terms of the increased execution speed and more favourable dependency on the complexity of the analyzed events. Such improvements are particularly relevant for the foreseen LHC luminosity upgrade where highly selective algorithms will be crucial to maintain a sustainable trigger rates with very high pileup. We will give details on how these devices can be integrated in a typical LHC trigger system and benchmarking their performances. As a study case, we will consider the Atlas experimental environment and propose a GPU implementation for a typical muon selection in a high-level trigger system.

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