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High-throughput data distribution for CBM online computing

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The CBM experiment, currently being constructed at GSI/FAIR, aims to investigate QCD at high baryon densities. The CBM First-level Event Selector (FLES) serves as the central event selection system of the experiment. It functions as a high-performance computer cluster tasked with the online analysis of physics data, including full event reconstruction, at an incoming data rate which exceeds 1 TByte/s.

The CBM detector systems operate in a free-running and self-triggered manner, delivering time-stamped data streams. Without inherent event separation, timeslice building replaces global event building. The FLES HPC system integrates data from around 5000 input links into self-contained, overlapping processing intervals and distributes these to the compute nodes.

Using a combination of RDMA and zero-copy techniques, timeslices can be built efficiently over a high-throughput InfiniBand network and distributed to available online computing resources for a full online event reconstruction and analysis in a heterogeneous HPC cluster system. A new IPC online interface to timeslice data utilizes a Posix shared memory governed by a reference-counting item distributor. This design combines maximum performance and flexibility with minimum memory consumption. These new developments have already been successfully field-tested in production at the CBM predecessor experiment mCBM at the GSI/FAIR SIS18.

Primary author: DE CUVELAND, Jan (Goethe University Frankfurt (DE))

Co-authors: HUTTER, Dirk (Goethe University Frankfurt (DE)); LINDENSTRUTH, Volker (Goethe University Frankfurt (DE))

Presenter: DE CUVELAND, Jan (Goethe University Frankfurt (DE))

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