

GSI

Data Acquisition Backbone Core DABC

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The new Facility for Antiproton and Ion Research at GSI

First sketch of the data acquisition concept for CBM (2004)
H.G. Esel, FutureDAQ for CBM, Online event selection,
IEEE TNS Vol.53, No.3, June 2006, pp 877-881

Frontend hardware example

The left Figure shows hardware components the DABC has to deal with. The hardware components include:

Front-end board sampling ADCs (x4), clock distribution to FE

Data combiner boards, clock distribution to FE

FE Front-end board

PC Data combiner board

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Motivation for developing DABC

Use cases

- Detector tests
- FE equipment tests
- High speed data transport
- Time distribution
- Switched event building
- Software evaluation
- MBS* event builder

Requirements

- build events over fast networks
- handle **triggered or self-triggered** front-ends
- process **time stamped** data streams
- provide data flow control (to front-ends)
- connect (nearly) any front-ends
- provide interfaces to plug in application codes
- connect MBS readout or collector nodes
- be controllable by several controls frameworks

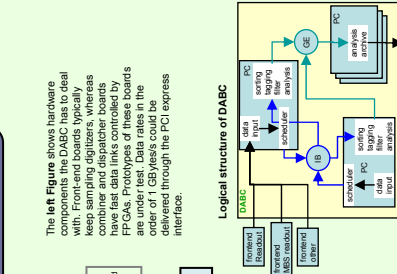
General purpose DAQ

- Event building network with standard components like InfiniBand
- Scheduled data transfer with ~10µs accuracy
- Thread synchronization with determined latency
- Needs **realtime patches of standard Linux kernel 2.6.19**:
- RT priorities, nanosleep and pthread condition
- PREEMPT_RT (Ingo Mohr), high resolution timer (Thomas Gleixner)

Using the real time features of Linux

- Linux kernel 2.6.19 with RT patches high resolution timer now in 2.6.21
- With two threads doing condition ping-pong and one "worker"-thread one turn is 3.2 µs
- With high resolution timer and hardware priority a sleeping thread gets control after 10 µs
- Synchronized transfer with microsleep achieves 8.00 MBS/sec

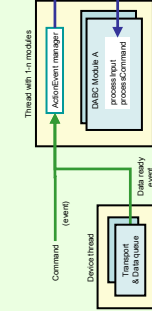
* Multi Branch System; current standard DAQ at GSI



Logically such a setup looks like sketched in right Figure. Depending on the performance requirements (data rates of the front-end channels) one may connect one or more front-ends to one DABC node. From a minimum of one front-end to a maximum of 23 front-ends, all kind of configurations are possible. One may separate input and processing nodes or combine both tasks on each machine using bi-directional links depending on CPU requirements.

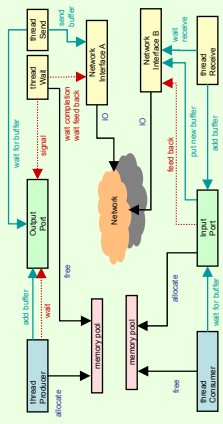
DABC as data flow engine

The right Figure shows the components of DABC data flow mechanism. Basic object is a module which gets access to data buffer and outputs them to output ports. The data queues on each node are controlled by a Memory management which allows processing buffers without copy by modules. The data flow is managed by Transport components in this case. If a port is connected to a remote port, the Transport and Device components do the transfer.



Module components can either run in separate threads to utilize multiple CPUs, or in one thread which is faster because no module synchronization is required. Data processing functions of the module are called by an Action event manager. The data flow is controlled by buffer resources (queues) handled through the transports. Once a queue buffer is processed, the module calls the ActionEvent manager, which in turn calls the processing function of the module associated through a port. This function has access to the data buffers through the port (Fig. above). Similarly, the module calls the ActionEvent manager, which calls the associated module function processCommand.

Data flow control of DABC



If the receiver nodes are busy with other calculations like event building, it is necessary to hold the senders. This is achieved by the back pressure mechanism shown in Figure above. The senders inform the receivers about their queue status after a collection of buffers. The senders only send when the receivers signaled sufficient resources. The back pressure works smoothly.

Performance measurements InfiniBand

