Slow Control for Belle / Belle II

Mikihiko Nakao (KEK-IPNS)

mikihiko.nakao@kek.jp

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Is everything other than clock / trigger / event timing related control is called "slow control"? More on run control for which I was working will be covered.

Belle Slow Control

- Run control start / stop runs, error handling, monitoring the data stream, including / excluding subsystems
- Implemented as "NSM" (network shared memory)
- HV control based on "Konoe", developed by Kyoto
- Environment monitor HP Hardware, read out by GPIB
- Temparature monitor based on LabVIEW (Windows)
- Alarm system temparature, humidity, voltages, etc
- Interface to KEKB data sharing, various interlocks
- Online database (logger) panther based
- GUI Run control is based on Gtk+, HV control within Konoe (Tcl/Tk)
- Infrastructure DAQ network and other sub-network segments, also many hardwired lines

DAQ and other networks in KEK

Services: file server (NFS), DNS, NTP, network booting (rarp, bootparam, tftp, bootp, limited mailing, no httpd



Network Shared Memory

- Used in run control and sharing many control data
- Linux, Solaris and VxWorks (porting to Unix-like OS is easy)
- No security (and attack) protection, otherwise error free (but breaking down by a DoS attack is possible)



Belle DAQ under NSM

- All data-taking systems are under NSM
- All the monitoring data are distributed over NSM



Belle Operation and Run States

ONLINE request

Make sure everything is ready to start, e.g., start a receiver process to accept connection from upstream

START request

Make the system ready to receive triggers, e.g., start the relevant process, make a connection to the receiver process

Doing more at START is easier and reliable, but has made the Belle startup procedure slower



Belle Master Run Control

- Run / error handling sequence is "almost" a state machine hardcoded in a C++ program
- Everything in one panel, all info availabe via NSM

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Log messages

Run start procedure

Detector Setup

Mostly localized within the subdetector

- Threshold and other parameter settings
- Not so many FPGA downloading (and firmware versions)
- Keeping track of the changes within the group
- Implementing the changes into the offline database (and sometimes hardcoded in the offline reconstruction program)
- Many things just happens at
 - Power on sequence
 - "ONLINE" request by the Master Run Control
 - "START" request by the Master Run Control (sometimes taking annoying time)
 - In a few cases, additional shell script for setup (e.g. ECL threshold setting through FASTBUS)

Interface to/from KEKB

Both fast and slow communication between KEKB and Belle were quite important for higher luminosity and safe Belle operation (and will be relevant for DEPFET at Belle II)

From KEKB, fast to slow

- RF clock (509 MHz), revolution signal (100 kHz)
- Injection kicker signal
- Permission to start the run (beam ready)
- KEKB status (current, injection, bunch, etc), EPICS to NSM
- From Belle to KEKB, fast to slow
 - Injection inhibit interlock, beam abort when high background
 - Oscilloscope video for background / trigger signals
 - Luminosity (ECL) and other Belle info, NSM to EPICS
 - Vertex position measured by RFARM (full reconstruction)

Lessons for Belle II

- Run control and HV control were on different framework, could have been unified
- Lot of information was available to monitor the current status, but tracing back the past events was not easy
 - Mostly because of missing "tools", and not because of missing information
 - Database and user interface should be designed these in mind

Detector readout setup at Belle II

Run control

- Faster run start no firmware or parameter downloading at "START" (need to change the word) but there will be something for slow (O(min)) setup
- Signals for frontend setup
 - Frontend FPGA programming through JTAG
 Distribution and collection of JTAG signals using FTSW, actual implementation not well thought out
 - Frontend parameter setting through optical link Need a path of DAQ file server \rightarrow readout PC \rightarrow COPPER PrPMC \rightarrow FINESSE \rightarrow frontend
 - Monitoring through timing link for redundancy and "fast" slow control

NSM at Belle II?

- NSM was reliable at Belle, why not using it at Belle II
 - I think NSM is easy to use
 - Other packages (e.g. EPICS) would require another learning process. KEKB had lots of EPICS troubles at the startup
 - Potential (solvable) problems
 - Extention over subnet already done in SVD, EFARM, RFARM, COPPER systems
 - No standard interface to GUI / histogramming / database / web / scripting languages
 - Cannot handle too large data on shared memory (e.g., putting histograms on the shared memory is not supported)

Summary

- We had many lessons from 10-year Belle operation, from when more people are active, to when very few people interested in stable operation
- If we follow Belle tradition, we can construct a minimal slow control system as was done in Belle (and was quite surprisingly working), with many improvements
- A structured "slow control group" would be also possible, but the reality will not be much changed unless human resources are provided