Discussion on the upgrade roadmap before PXD2020 installation (DAQ side)

R.Itoh, KEK
Upgrade plan in DAQ

- The major upgrade is the replacement of COPPER readout with new readout card.

- The decision of new readout card is supposed to be made by the end of October B2GM.

- After the decision, the production of cards will be started and they will be ready to be installed hopefully in the summer 2020.

- A pre-defined upgrade schedule is there proposed by the upgrade committee.

- Does it match with the Belle II global schedule?
Replacement timescale

- In the course of discussion and evaluation it became vital to clarify the timescale that is being considered.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Proposal deadline</td>
<td>Decision</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prototyping</td>
<td></td>
<td></td>
<td></td>
<td>Could be shortened depending on budgetary situation and integration results</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mass Production</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COPPER-replacement</td>
<td></td>
<td>repl. 1</td>
<td>spare</td>
<td>repl. 2</td>
<td>spare</td>
<td>repl. 3</td>
<td>spare</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comment</td>
<td>Multi candidates may be chosen?</td>
<td>test with pocket DAQ</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- COPPERs are replaced detector by detector during summer shutdown period in 2020, 2021, and 2022.
- Short winter shutdown might be utilized for additional work.

• Implies requirement for concurrent operation
- Current Belle II schedule in coming years is mostly determined by the installation schedule of PXD2020.

- The original plan was to have a long shutdown in 2020 summer, but because of the delay in the PXD production, it has been deferred to 2021 summer.
  -> We have a long shutdown in 2021 summer.

- How do we utilize 2020 and 2021 summer shutdown?

- In the proposed plan, the upgrade is supposed to be done subsystem by subsystem in consecutive 3 years.

- But the card production could be better to be done at one time to reduce the production cost.
  -> Possibility of one-time upgrade. Too dangerous?
Upgrade possibility of other subsystems

- The data flow and slow control software have to be updated to handle new readout card. where the number of optical links/card is increased from 4 to 48 (or so).

- Readout driver is now being designed to be compatible with that used for COPPERs, however, the slow control software may require a drastic change to manage the increased number of links (as suggested by Oskar).

- Backend:
  * Event builder 1 upgrade to handle new readout PCs.
  * HLT framework will be upgraded to ZMQ from fall run.
  * ERECO may follow by looking at the performance of ZMQHHLT.
  * Other upgrades? (Like ZMQ-based data flow / DQM histogram transfer / everywhere replacing Linux socket? ......)

- Slow control
  * Config. DB, ELK, MESOS/AURORA, ......
- It is nice to adopt up-to-date technology in our DAQ and young people (like Oskar) tend to run for such technology as fast as possible! The readout upgrade could be a good chance for such a drastic upgrade.

- But elder people (like me) think, it is dangerous to replace/upgrade all these components at one time. Gradual upgrade/improvement is more realistic.
  * From management side, we need to worry for the long term system maintenance, which includes the technology transfer, man power allocation, etc.

- The basics of DAQ management is “to leave untouched for well working components” (My opinion after 30 years experience).
  -> The Belle II DAQ has a modular structure and working elements should be kept untouched unless there is a strong reason to replace/upgrade (necessity-basis upgrade).
  -> Module based upgrade by keeping outside interface the same as before.

* Evaluation of “upgrade necessity” is essential before we go for the new technology.
## Example of Evaluation : HLT upgrade

Grading of components inside previous HLT framework (RFARM)

<table>
<thead>
<tr>
<th>Component</th>
<th>Current HLT (RFARM)</th>
<th>Grading in Phase 3</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data transport</td>
<td>RingBuffer+ socket</td>
<td>△</td>
<td>dead lock at ABORT</td>
</tr>
<tr>
<td>Processing basf2</td>
<td>the same offline basf2</td>
<td>△</td>
<td>Long initialization</td>
</tr>
<tr>
<td>Message logging</td>
<td>pipe + socket</td>
<td>○</td>
<td>working stably</td>
</tr>
<tr>
<td>System control</td>
<td>Own scheme + native NSM</td>
<td>○</td>
<td>working stably worry for long term maintenance</td>
</tr>
<tr>
<td>Configuration management</td>
<td>Own config file</td>
<td>○</td>
<td>working stably worry for long term maintenance</td>
</tr>
<tr>
<td>DQM</td>
<td>DQMHistoMangager +hserver/hrelay</td>
<td>○</td>
<td>working stably</td>
</tr>
<tr>
<td>RoI transport</td>
<td>Object embedded in data stream</td>
<td>△</td>
<td>missing events Trouble in RingBuffer</td>
</tr>
</tbody>
</table>
## Actual deployment of ZMQ HLT

<table>
<thead>
<tr>
<th>Component</th>
<th>Current HLT</th>
<th>Original ZMQ HLT</th>
<th>Deployment in B2 HLT</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data transport</td>
<td>RingBuffer+socket</td>
<td>ZeroMQ</td>
<td>Yes</td>
<td>Should be stable Maintenance free</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Load Balancing?</td>
</tr>
<tr>
<td>Processing basf2</td>
<td>the same offline basf2</td>
<td>variant of basf2 specialized</td>
<td>Yes</td>
<td>Fast startup</td>
</tr>
<tr>
<td></td>
<td></td>
<td>for HLT</td>
<td></td>
<td>Compatibility with offline basf2 is kept</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>at module level only?</td>
</tr>
<tr>
<td>Message logging</td>
<td>pipe + socket</td>
<td>pipe+socket</td>
<td>Yes</td>
<td>Compatible with daq_slc</td>
</tr>
<tr>
<td>System control</td>
<td>Own scheme + native NSM</td>
<td>daq_slc</td>
<td>Yes</td>
<td>Consistent maintenance</td>
</tr>
<tr>
<td>Configuration management</td>
<td>Own config file</td>
<td>daq_slc</td>
<td>Yes</td>
<td>Consistent maintenance</td>
</tr>
<tr>
<td>DQM</td>
<td>DQMHIstoManager +hserver/hrelay</td>
<td>ZeroMQ+TMemFile</td>
<td>internally yes</td>
<td>Compatibility with external I/F is kept</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>externally with</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>hrelay/hserver</td>
<td></td>
</tr>
<tr>
<td>RoI transport</td>
<td>Object embedded in data stream</td>
<td>RoI binary embedded in ZMQ</td>
<td>Yes</td>
<td>proven to work stably</td>
</tr>
<tr>
<td></td>
<td></td>
<td>message</td>
<td></td>
<td>no event lost</td>
</tr>
</tbody>
</table>
Belle II backend data flow in fall run

- PXD → Onsen → Event Builder 2 → STORE → Express Reco

- RoIPC → RoI merger

- Event Builder
  - Current HLT framework (hlt01-05+06/07)
  - New ZMQ HLT framework (hlt08+09+06/07)

- hserver → hrelay

- Online Storage

- DQM master → event display (basf2)

- DQM server

- event data

- histograms

- Unchanged

- New development
Timeline of ZMQ-HLT deployment

- **July**
  - Gemba HRT/CRT
  - cvmfs on HLT
  - Integration of hlt06-09
  - ZMQ HLT test with hlt03 in HRT

- **Aug**
  - DAQ stop
  - Test of mixed HLT operation (RFARM+ZMQ)
  - ZMQ HLT on hlt06-09

- **Sep**
  - Gemba HRT/CRT
  - Full Dress Rehearsal

- **Oct**
  - Fall Beam Run

- **Nov**
  - Fall Beam Run

- **Dec**
  - Fall Beam Run

---

* Start operation with RFARM only (hlt01-05) until beam run is stabilized.
* Add ZMQ-HLT (hlt08+09) after the operation becomes stable -> Mixed operation of RFARM and ZMQ
* If confirmed stable operation of ZMQ-HLT, operate hlt06-09 (4 units) with it.
* Validation of ZMQ-HLT output by comparing with that from RFARM
* After the validation try to operate ZMQ-HLT on all units.
- ELK and MESOS/AURORA
  * Elastic logging system could be useful for the fast debugging of troubles.
  * MESOS/AURORA could be useful for the system recovery after power outage, for example.

- Can we allocate enough man power skilled in such advanced technology? (Nils is leaving now.....)

- Need to revisit the evaluation of necessity and maintenance resource before we decide.