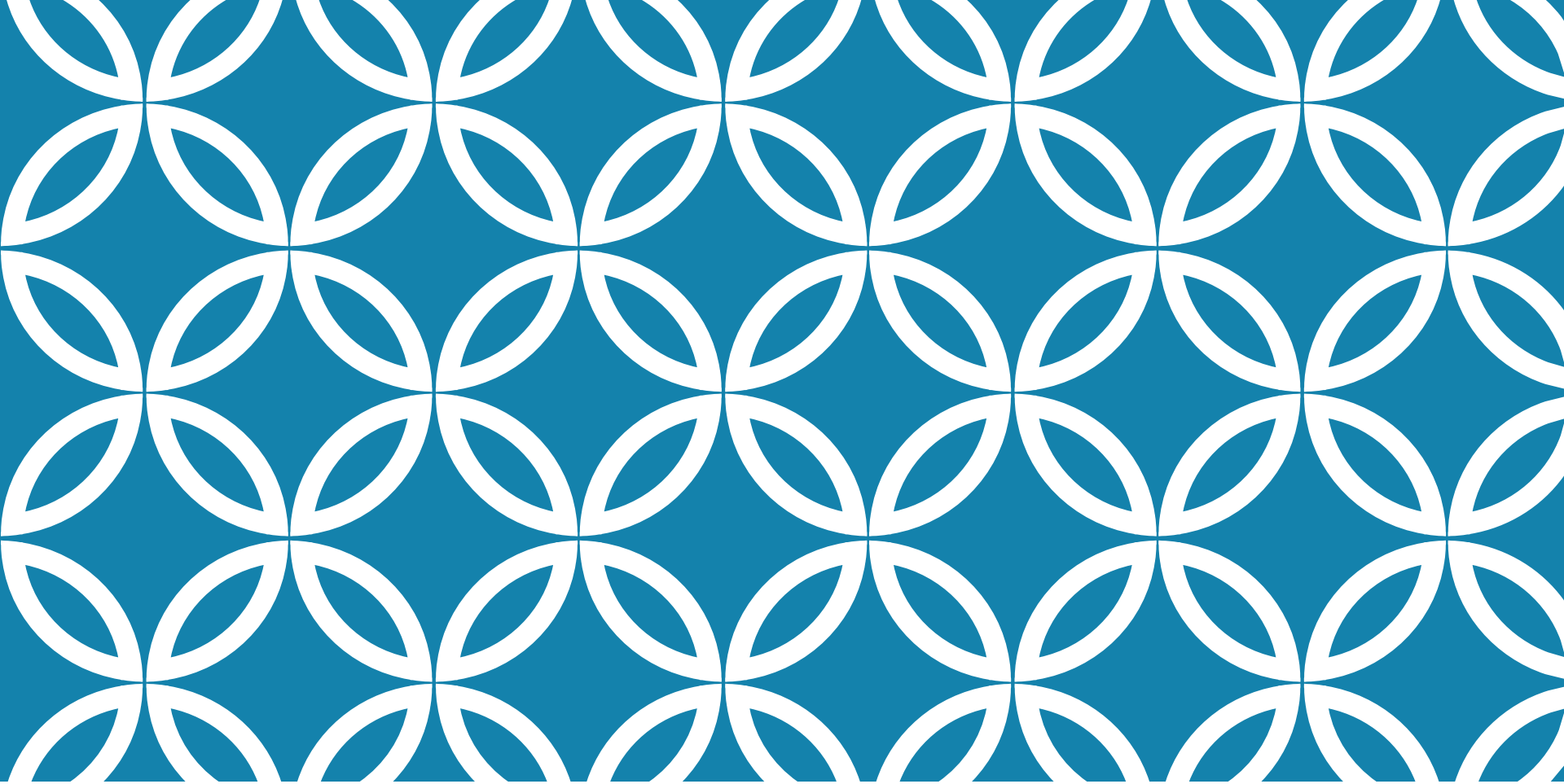


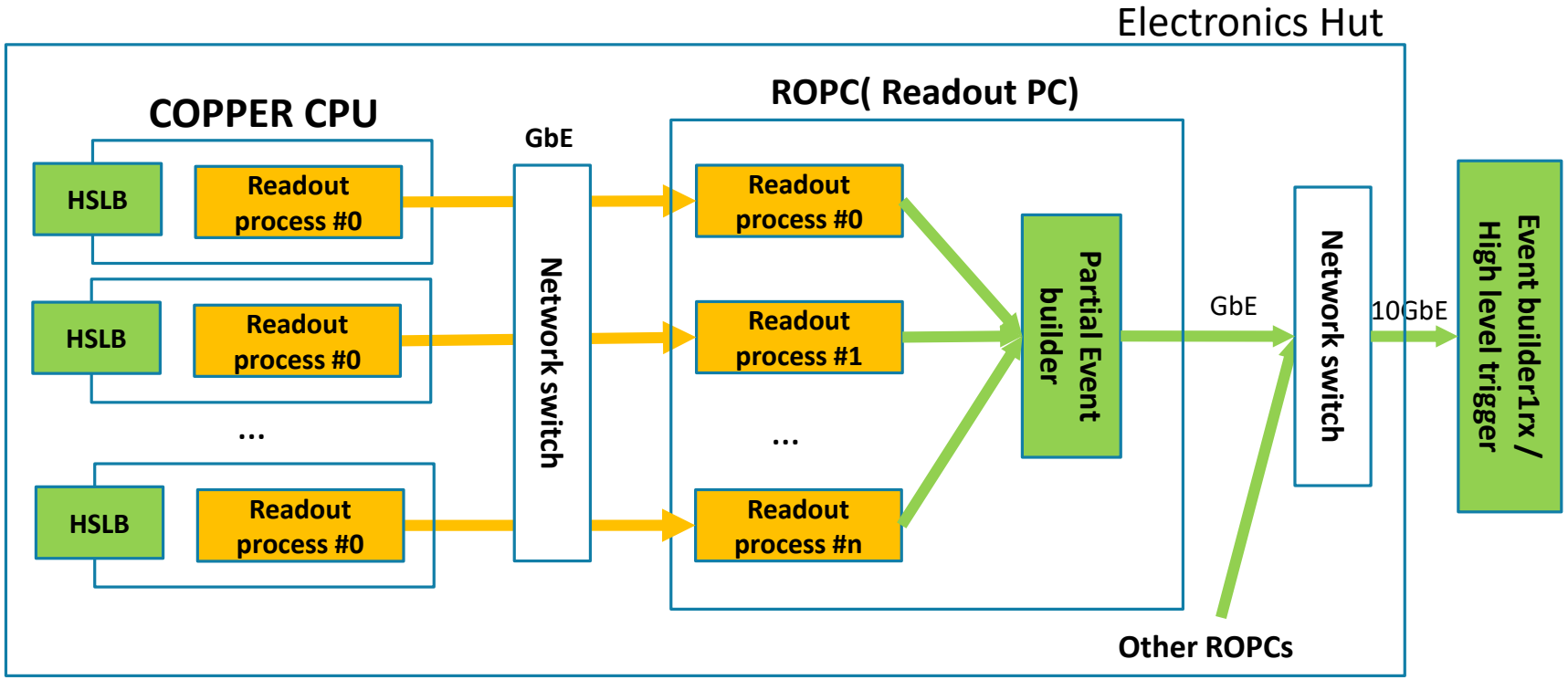
SOFTWARE DEVELOPEMENT

S. Yamada (KEK)

1. Readout software

CURRENT READOUT SYSTEM

I. data check by data-handler process
   I. Calculate CRC16 and compare CRC value attached by FEE
   II. XOR checksum calculated by software on COPPER
II. Data size reduction
   merging redundant header/trailer attached by b2link and COPPER)
   Reduction by 15MB/s/ROPC at 30kHz trigger rate(<- 5COPPERs/ROPC, 4HSLB/COPPER)
III. Collect data from several COPPERs and do partial event-building and send data to High level trigger unit.

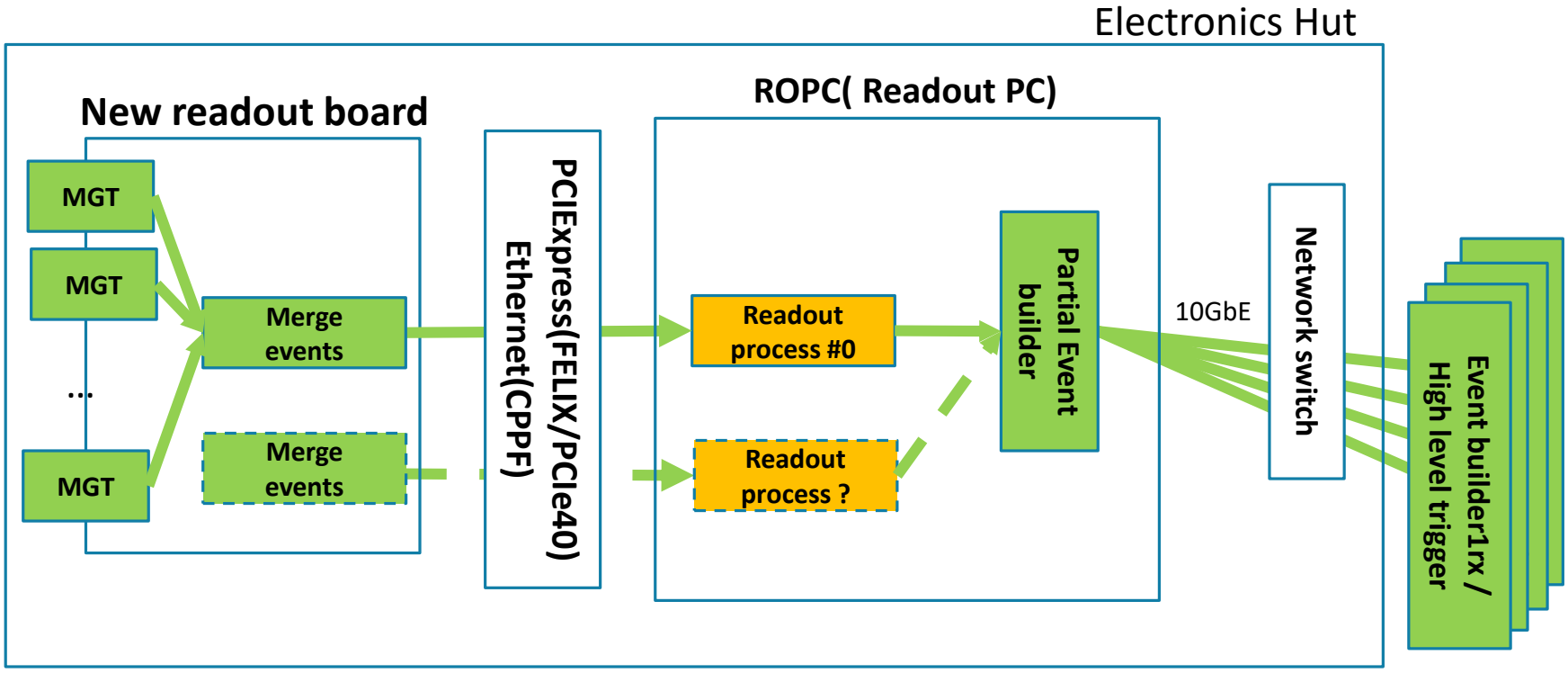


NEW READOUT SYSTEM

I. data check by data-handler process
   - ~~I. Calculate CRC16 and compare CRC value attached by FEE~~
   - II. XOR checksum calculated by firmware on new readout hardware

II. Data size reduction
   - ~~merging redundant header/trailer attached by b2link and COPPER)~~
   - ~~Reduction by 15MB/s/ROPC at 30kHz trigger rate(<- 5COPPERs/ROPC, 4HSLB/COPPER)~~

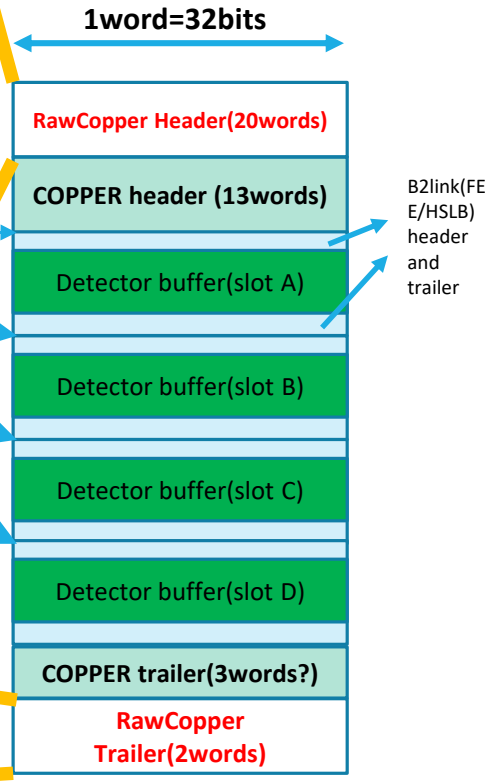
III. (~~Collect data from several COPPERs and do partial event-building and~~ send data to High level trigger unit.



Current format of RawCOPPER hdr/trl

Use this version number to distinguish Different data format.
Ver.0 : to 2014. June(including DESY test)
ver.1 : from June.2014
Ver.2 : from Apr. 2015 (rev.17269)
Ver. 3: For new readout data

1 Number of total words
2 0x7f7f | Format ver.(8bit) | Number of words in this block (8bit)
3 exp no. (10bit=1024), run no.(22bit=4194304 including subrun)
4 event number(32bit)
5 From B2link FEE header 2 (TT-ctime | Trig-type)
6 From B2link FEE header 2 (TT-utime)
7 Node ID
8 b2link CRC error bit (4) | |truncation mask (truncated or not) / type of data (compressed,calibration, …)
9 offset to 1st block of user's data(FEE data)
10 offset to 2nd block of user's data(FEE data)
11 offset to 3rd block of user's data(FEE data)
12 offset to 4th block of user's data(FEE data)



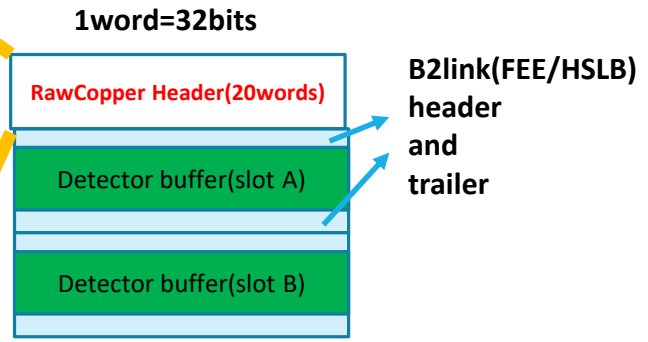
1 reserved (maybe used for checksum)
2 termination word of this block = 0x7fff0006

https://stash.desy.de/projects/B2/repos/software/browse/daq/copper/doc/SetupPocketDAQ_4p1_RawCOPPERDataFormat.pdf

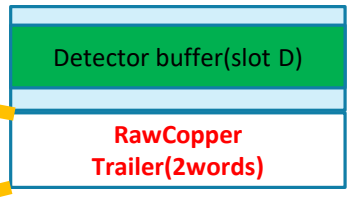
New data format for RawCOPPER hdr. and trl. (ver. alpha-190306)

- Remove COPPER header/trailer (which is currently removed on a readout PC.)
- Position in header will be removed to reduce header size.
- Error information in trailer (which link, what kind of error)
- XOR checksum (less CPU power to re-calculate on host servers or HLT)

1 Number of total words
2 0x7f7f | Format ver.(8bit) | Number of words in this block (8bit)
3 exp no. (10bit=1024), run no.(22bit=4194304 including subrun)
4 event number(32bit)
5 From B2link FEE header 2 (TT-ctime | Trig-type)
6 From B2link FEE header 2 (TT-utime)
7 Node ID
8 b2link CRC error bit (4) | |truncation mask (truncated or not) / type of data (compressed,calibration, …)



1 Error bit
2 Error slots
3 XOR checksum
4 termination word of this block = 0x7fff0006



Current format of HSLB/B2L hdr/trl

- FEE sends “B2L hdr + FEE data + B2L trl”.
- hslb_receiver.vhd adds HSLB hdr and trl.
- Some header entries (blue broken lins) are copied in RawCOPPER header and removed on ROPCs.

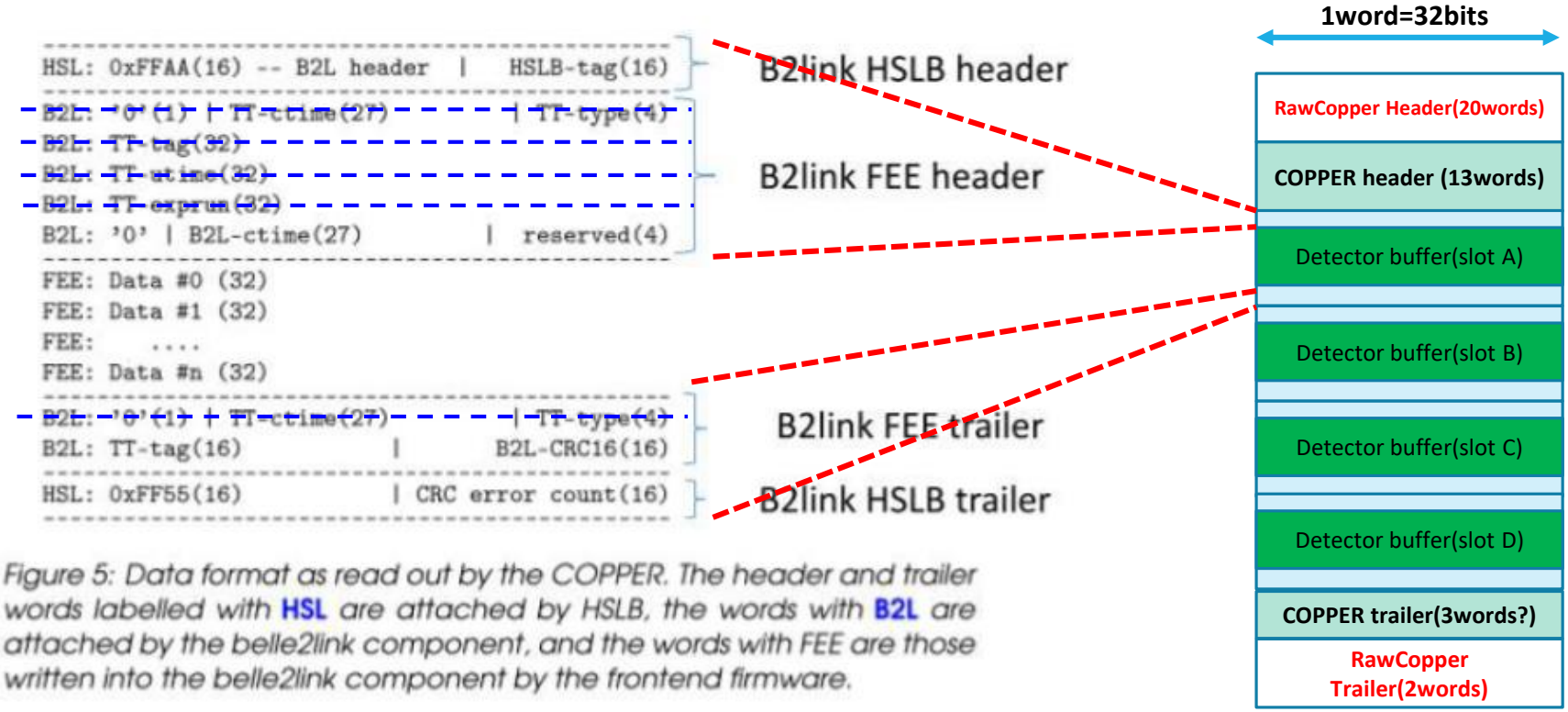


*Figure 5: Data format as read out by the COPPER. The header and trailer words labelled with **HSL** are attached by HSLB, the words with **B2L** are attached by the belle2link component, and the words with FEE are those written into the belle2link component by the frontend firmware.*

New data format for B2L/HSLB hdr. and trl. (ver. alpha-190306)

- Basically unchanged
- Add length and ID (link number = 0, 1,2,… 47)

"ID(0-47) : 8bits" + "# of words : 24bits"

```
HSL: 0xFFAA(16) -- B2L header  |   HSLB-tag(16)
B2L: '0'(1) | TT-ctime(27)          | TT-type(4)
B2L: TT-tag(32)
B2L: TT-utime(32)
B2L: TT-exprun(32)
B2L: '0' | B2L-ctime(27)           |  reserved(4)
FEE: Data #0 (32)
FEE: Data #1 (32)
FEE:    ....
FEE: Data #n (32)
B2L: '0'(1) | TT-ctime(27)          | TT-type(4)
B2L: TT-tag(16)            |       B2L-CRC16(16)
HSL: 0xFF55(16)            | CRC error count(16)
```

B2link HSLB header

B2link FEE header

B2link FEE trailer

B2link HSLB trailer

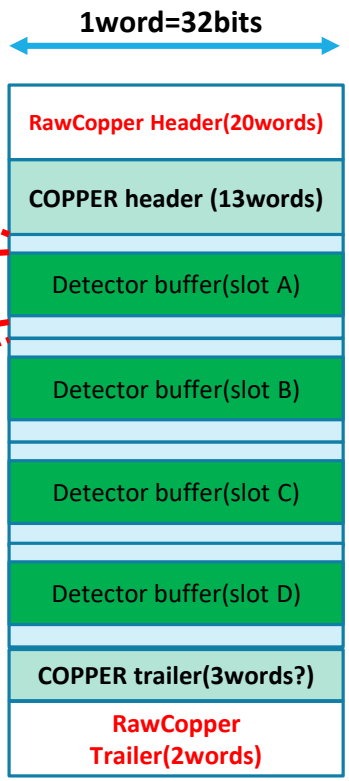


Figure 5: Data format as read out by the COPPER. The header and trailer words labelled with **HSL** *are attached by HSLB, the words with* **B2L** *are attached by the belle2link component, and the words with FEE are those written into the belle2link component by the frontend firmware.*

DEVELOPMENT STATUS

Branch : feature/for-DAQ-readout-upgrade
URL :
https://stash.desy.de/projects/B2/repos/software/browse?at=refs%2Fheads%2Ffeature%2Ffor-DAQ-readout-upgrade

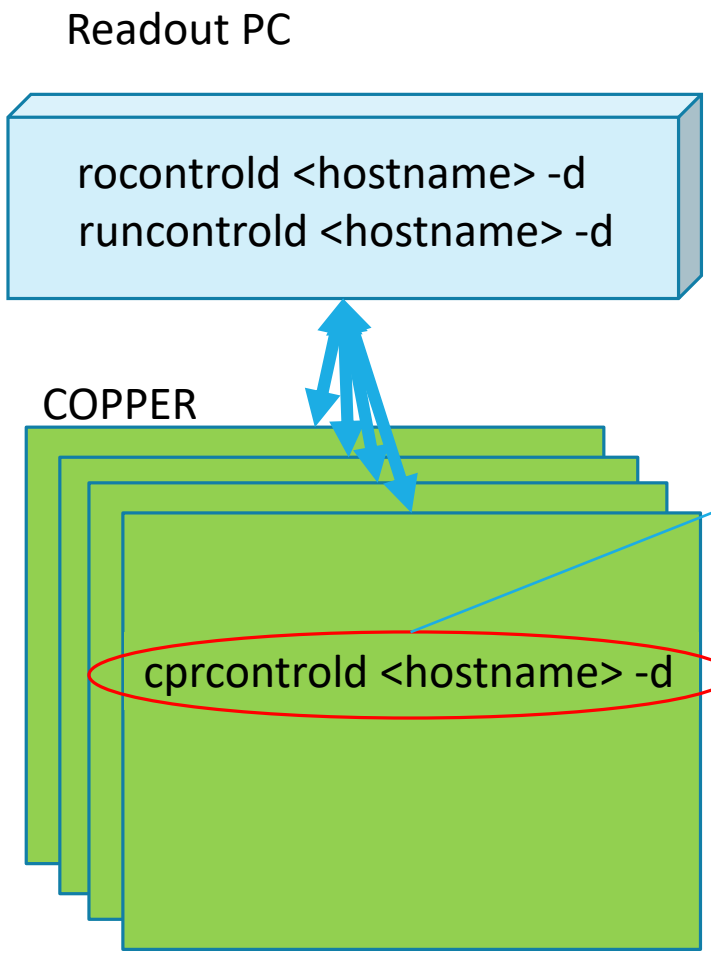
Todo

- Test with dummy data source
- Replace the current recv() function which receives data from COPPER with another function which is specific for new readout hardware.
- Packer module for offline software test. (not urgent)

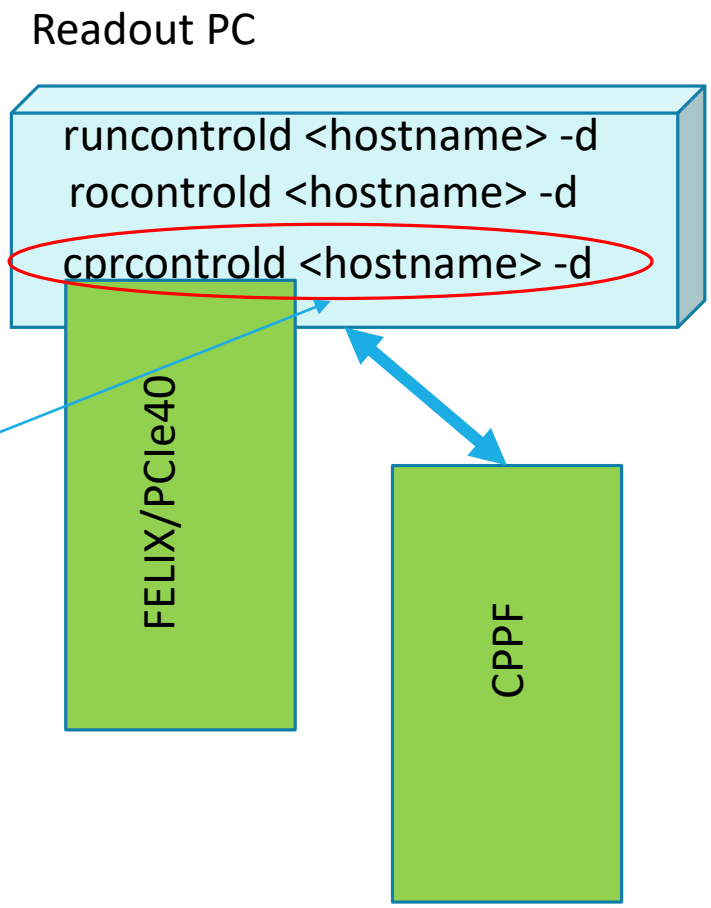
2. Slow control software

Slow control daemon processes on the new setup

Current setup

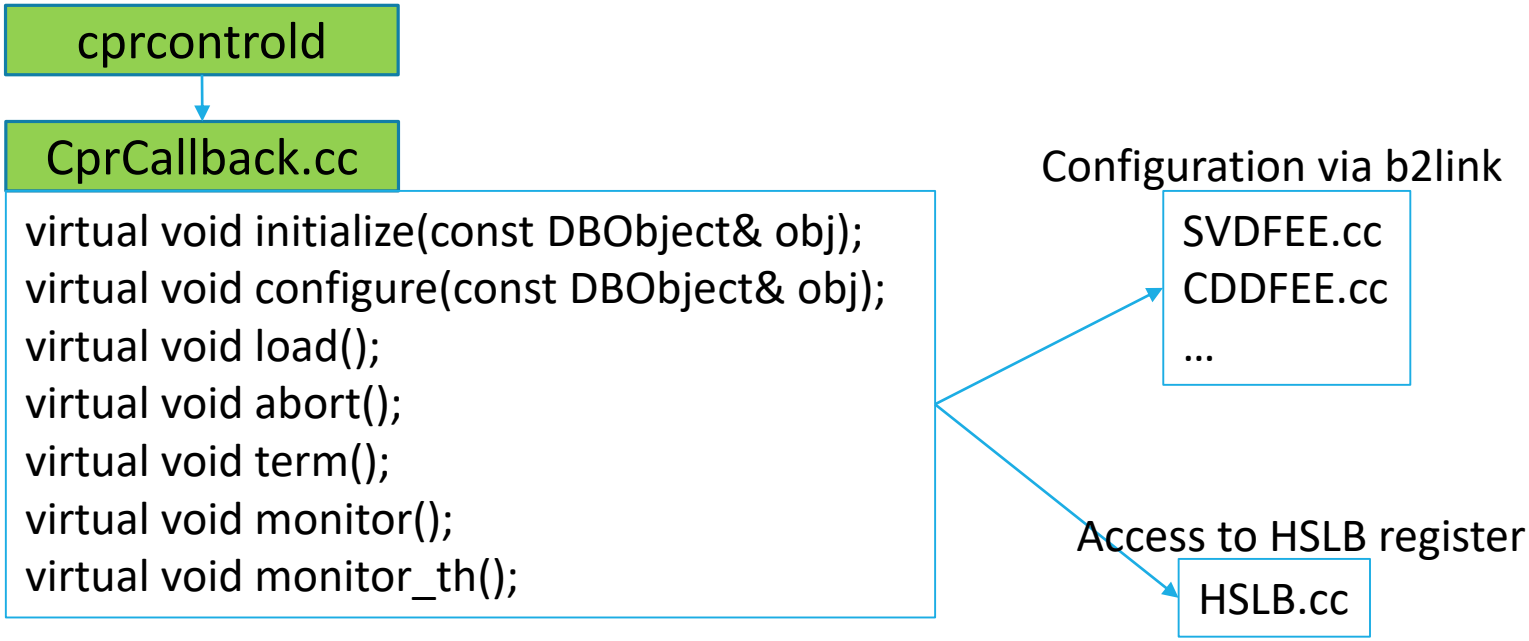


New setup

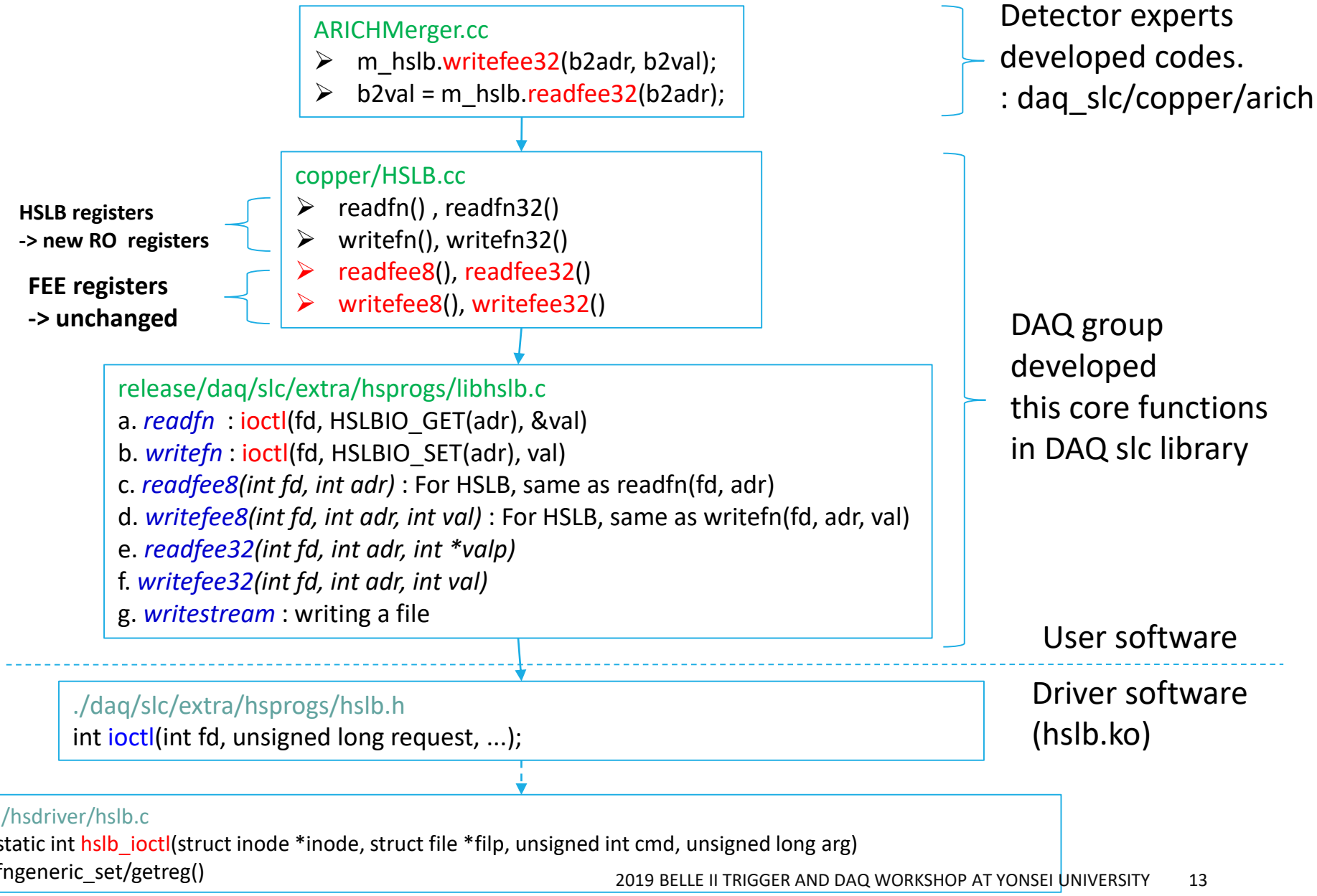


cprcontrold

- It is a daemon process which communicates with the run-control system and readout hardware (= COPPER(+HSLB(+FEE))) .



Slow control on COPPER and HSLB



New SLC software (in the PCIe40 case)

- Replacing read/write function in the current SLC software
  - Daq_slc repository : branch : feature/slc_wo_COPPER_for_DAQupgrade
  - https://stash.desy.de/projects/B2DAQ/repos/daq_slc/browse/extra/hsprogs?at=refs%2Fheads%2Ffeature%2Fslc_wo_COPPER_for_DAQupgrade

Copying Patrick-san's PCIe40 library in daq_slc/extra/hsprogs/PCIe40

```
int
writefee8(int fd, int adr, int val)
{
#ifdef USE_PCIE40
  return pcie40_writefee8( fd, adr, val );
#else
  if (devtype == FIN_HSLB) {
    if (adr <= 0 || adr > 0x7f) return -1;
    if (ioctl(fd, HSLBFEE8_SET(adr), val) < 0) {
      sprintf(errmsg, "cannot write %s: %s\n",
              DEVICE, strerror(errno));
      return -1;
    }
    return 0;

  } else {
    int ret = 0;
    ret |= writefn(fd, HSREG_CSR, 0x05); /* reset read fifo */
    ret |= writefn(fd, adr, val & 0xff);
    ret |= writefn(fd, HSREG_CSR, 0x0a); /* parameter write */
    return ret;
  }
#endif
```

PCIe40

HSLB

- Compiling (make sl6) was successful after replacing read/write/open/close function.
- To be modified
  - HSLB register access part
  - Increase the max number of link per readout board
    (currently 4/COPPER
    -> 48 /new RO, for example)

➢ Same strategy (replacing just read/write functions in SLC repository) can be used for other proposals.

Summary

- For new readout hardware,
  - DAQ process
  - SLC process

  need to be updated.
- DAQ program
  - Remove DAQ process on COPPER
  - New unpacker for new format
- SLC program
  - Cprcontrold will be moved to ROPC
  - Try to minimize the modification (especially sub-detector dependent part.)
    - Basic idea is replacing read/write functions for new hardware.

- Git branches are made.
  - Development is ongoing.
  - These software is necessary for TOP B4 demo by proponents.

Slow control on COPPER and HSLB (2)

./hsdriver/hslb.c
static int **hslb_ioctl**(struct inode *inode, struct file *filp, unsigned int cmd, unsigned long arg)
_IOC_TYPE(cmd) are defined in hsprogs/hslb.h.
#define **HSLB**_MAGIC 0xe3
#define HSLB_**FEE8**_MAGIC 0xe4
#define HSLB_**FEE32**_MAGIC 0xe5
#define HSLB_**FEESTREAM**_MAGIC 0xe6
The functions below are called depending on above values.
- fee8_getreg(), fee8_setreg()
- fee32_getreg(), fee32_setreg()
- hslb_setreg(), hslb_getreg() : // streaming

./hsdriver/hslb.c
**** fee8**
- getreg : fee8_getreg(slot, offset, *valp);

```
  ret = fngeneric_setreg(slot, HSLBADDR_CSR,    0x05); /* reset read fifo */
  ret = fngeneric_setreg(slot, offset,          0x0c); /* dummy value */
  ret = fngeneric_setreg(slot, HSLBADDR_CSR,    0x07); /* 8-bit read */
```

Waiting until the return value becomes **0x11,**

```
    ret = fngeneric_getreg(slot, HSLBADDR_STAT, &stat);
    if (ret != 0) return ret;
    if (stat == 0x11) break;
```

Then start getting a value

```
  ret = fngeneric_getreg(slot, HSLBADDR_D32D, valp);
```

- setreg

```
  ret = fngeneric_setreg(slot, HSLBADDR_CSR,    0x05); /* reset read fifo */
  ret = fngeneric_setreg(slot, offset,          val & 0xff);
  ret = fngeneric_setreg(slot, HSLBADDR_CSR,    0x0a); /* 8-bit write */
```

hslb_feecontrol.vhd

```
FD32R       <= '1' when LeControl = '1' and LDsync = x"0c" else '0';
```

Slow control on COPPER and HSLB (3)

./hsdriver/hslb.c

**** fee32**

- getreg

```
  ret = fngeneric_setreg(slot, HSLBADDR_CSR,    0x05); /* reset read fifo */
  ret = fngeneric_setreg(slot, HSLBADDR_CSR,    0x0c); /* 32-bit read */
  ret = fngeneric_setreg(slot, HSLBADDR_SERIAL, (offset >>  8) & 0xff);
  ret = fngeneric_setreg(slot, HSLBADDR_SERIAL, (offset >>  0) & 0xff);
  ret = fngeneric_setreg(slot, HSLBADDR_CSR,    0x08); /* end of stream */
```

Waiting until the return value becomes **0x11,**

```
    ret = fngeneric_getreg(slot, HSLBADDR_STAT, &stat);
    if (ret != 0) return ret;
    if (stat == 0x11) break;
```

Then start getting a value

```
  ret = fngeneric_getreg(slot, HSLBADDR_D32D, &bytes[3]);
  ret = fngeneric_getreg(slot, HSLBADDR_D32C, &bytes[2]);
  ret = fngeneric_getreg(slot, HSLBADDR_D32B, &bytes[1]);
  ret = fngeneric_getreg(slot, HSLBADDR_D32A, &bytes[0]);
```

- setreg

```
  ret = fngeneric_setreg(slot, HSLBADDR_CSR,    0x05); /* reset read fifo */
  ret = fngeneric_setreg(slot, HSLBADDR_CSR,    0x0b); /* 32-bit write */
  ret = fngeneric_setreg(slot, HSLBADDR_SERIAL, (offset >>  8) & 0xff);
  ret = fngeneric_setreg(slot, HSLBADDR_SERIAL, (offset >>  0) & 0xff);
  ret = fngeneric_setreg(slot, HSLBADDR_SERIAL, (val >> 24) & 0xff);
  ret = fngeneric_setreg(slot, HSLBADDR_SERIAL, (val >> 16) & 0xff);
  ret = fngeneric_setreg(slot, HSLBADDR_SERIAL, (val >>  8) & 0xff);
  ret = fngeneric_setreg(slot, HSLBADDR_SERIAL, (val >>  0) & 0xff);
  ret = fngeneric_setreg(slot, HSLBADDR_CSR,    0x08); /* end of stream */
```