

uB DAQ and EPICS working together on Linux

Glenn Horton-Smith

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Overview

- “uB DAQ” running on Linux.
 - fake_seb, fake_assemblerMulti, run control display
 - Same performance with SEB and assembler on different hosts as when all on same host. (local GB/s ethernet)
 - shared memory for assembler-RC communication
- EPICS running on Linux
 - base: channels for readout and control; devices
 - extensions and modules: GUIs, sequencer, archivers
- Added device to EPICS base for uB DAQ RC "channels"
 - It wasn't actually that hard.
 - Proof of principle for EPICS-based run monitor, control, sequence, saved history.
- Next tasks and things to decide.

Mock uB DAQ running on Linux.

fake_assemblerMulti

10 fake_seb processes
also running on same host

shmMonitor

```
gahs@hep1:/user/gahs/MicroBooNE/DAQ/ubooneDAQ/code
fake_assemblerMulti: finished 620000 events. Wrote 63199958.
fake_assemblerMulti: finished 640000 events. Wrote 63399958.
fake_assemblerMulti: finished 650000 events. Wrote 63499958.
fake_assemblerMulti: finished 660000 events. Wrote 63599958.
fake_assemblerMulti: finished 670000 events. Wrote 63699958.
fake_assemblerMulti: finished 680000 events. Wrote 63799958.
fake_assemblerMulti: finished 690000 events. Wrote 63899958.
fake_assemblerMulti: finished 700000 events. Wrote 63999958.
fake_assemblerMulti: finished 710000 events. Wrote 64099958.
fake_assemblerMulti: finished 720000 events. Wrote 64199958.
fake_assemblerMulti: finished 730000 events. Wrote 64299958.
fake_assemblerMulti: finished 740000 events. Wrote 64399958.
fake_assemblerMulti: finished 750000 events. Wrote 64499958.
fake_assemblerMulti: finished 760000 events. Wrote 64599958.
fake_assemblerMulti: finished 770000 events. Wrote 64699958.
fake_assemblerMulti: finished 780000 events. Wrote 64799958.
fake_assemblerMulti: finished 790000 events. Wrote 64899958.
fake_assemblerMulti: finished 800000 events. Wrote 64999958.
fake_assemblerMulti: finished 810000 events. Wrote 65099958.
fake_assemblerMulti: finished 820000 events. Wrote 65199958.
fake_assemblerMulti: finished 830000 events. Wrote 65299958.
fake_assemblerMulti: finished 840000 events. Wrote 65399958.
fake_assemblerMulti: finished 850000 events. Wrote 65499958.
fake_assemblerMulti: finished 860000 events. Wrote 65599958.
fake_assemblerMulti: finished 870000 events. Wrote 65699958.
fake_assemblerMulti: finished 880000 events. Wrote 65799958.
fake_assemblerMulti: finished 890000 events. Wrote 65899958.
fake_assemblerMulti: finished 900000 events. Wrote 65999958.
fake_assemblerMulti: finished 910000 events. Wrote 66099958.
fake_assemblerMulti: finished 920000 events. Wrote 66199958.
fake_assemblerMulti: finished 930000 events. Wrote 66299958.
fake_assemblerMulti: finished 940000 events. Wrote 66399958.
fake_assemblerMulti: finished 950000 events. Wrote 66499958.
fake_assemblerMulti: finished 960000 events. Wrote 66599958.
fake_assemblerMulti: finished 970000 events. Wrote 66699958.
fake_assemblerMulti: finished 980000 events. Wrote 66799958.
fake_assemblerMulti: finished 990000 events. Wrote 66899958.
fake_assemblerMulti: finished 1000000 events. Wrote 66999958.
fake_assemblerMulti: finished 1010000 events. Wrote 67099958.
fake_assemblerMulti: finished 1020000 events. Wrote 67199958.

*****
Run number      = 0 (DATA MODE)
Event number    = 67166036, Latent = 0 (=0.0%)
Total Rate      = 0 Hz, Latent Ave = nan Hz
Instant Rate    = 410608.5 Hz, Latent Inst. = 0.00 Hz

Started Wed 31-Dec-1969 18:00:00 CST, 0 ms
Current Wed 31-Dec-1969 18:00:00 CST, 0 ms
Time Elapsed = 0.00 hr

-----Rate Info: instant(average), total count(latent)-----
Beam:  0.00(nan) Hz, 0(0)      Gamma-ZB: 0.00(nan) Hz, 0(0)      Gamma:
0.00(nan) Hz, 0(0)          Beta:  0.00(nan) Hz, 0(0)          Gamma':
Strobe: 0.00(nan) Hz, 0(0)    Gamma-ZB': 0.00(nan) Hz, 0(0)    Cube:
0.00(nan) Hz, 0(0)          Beta': 0.00(nan) Hz, 0(0)
Laser:  0.00(nan) Hz, 0(0)    Trk:  0.00(nan) Hz, 0(0)          Tank:
0.00(nan) Hz, 0(0)          Michel: 0.00(nan) Hz, 0(0)      SuperN: 0.00(nan) Hz, 0(0)
0.00(nan) Hz, 0(0)          Veto:  0.00(nan) Hz, 0(0)
BigNu:  0.00(nan) Hz, 0(0)    NuMI:  0.00(nan) Hz, 0(0)

Boards          = 0
Backlog         = 0
*****TRACKER*****
Total

*****
```

Same or higher performance with (mock) SEBs on one host and assembler on the other

fake_assemblerMulti

shmMonitor

10 fake_seb processes running on different host

```
fake_assemblerMulti: finished 6140000 events. Wrote 57393799.
fake_assemblerMulti: finished 6150000 events. Wrote 57493799.
fake_assemblerMulti: finished 6160000 events. Wrote 57593799.
fake_assemblerMulti: finished 6170000 events. Wrote 57693799.
fake_assemblerMulti: finished 6180000 events. Wrote 57793799.
fake_assemblerMulti: finished 6190000 events. Wrote 57893799.
fake_assemblerMulti: finished 6200000 events. Wrote 57993799.
fake_assemblerMulti: finished 6210000 events. Wrote 58093799.
fake_assemblerMulti: finished 6220000 events. Wrote 58193799.
fake_assemblerMulti: finished 6230000 events. Wrote 58293799.
fake_assemblerMulti: finished 6240000 events. Wrote 58393799.
fake_assemblerMulti: finished 6250000 events. Wrote 58493799.
fake_assemblerMulti: finished 6260000 events. Wrote 58593799.
fake_assemblerMulti: finished 6270000 events. Wrote 58693799.
fake_assemblerMulti: finished 6280000 events. Wrote 58793799.
fake_assemblerMulti: finished 6290000 events. Wrote 58893799.
fake_assemblerMulti: finished 6300000 events. Wrote 58993799.
fake_assemblerMulti: finished 6310000 events. Wrote 59093799.
fake_assemblerMulti: finished 6320000 events. Wrote 59193799.
fake_assemblerMulti: finished 6330000 events. Wrote 59293799.
fake_assemblerMulti: finished 6340000 events. Wrote 59393799.
fake_assemblerMulti: finished 6350000 events. Wrote 59493799.
fake_assemblerMulti: finished 6360000 events. Wrote 59593799.
fake_assemblerMulti: finished 6370000 events. Wrote 59693799.
fake_assemblerMulti: finished 6380000 events. Wrote 59793799.
fake_assemblerMulti: finished 6390000 events. Wrote 59893799.
fake_assemblerMulti: finished 6400000 events. Wrote 59993799.
fake_assemblerMulti: finished 6000000 events. Wrote 60093799.
fake_assemblerMulti: finished 6010000 events. Wrote 60193799.
fake_assemblerMulti: finished 6020000 events. Wrote 60293799.
fake_assemblerMulti: finished 6030000 events. Wrote 60393799.
fake_assemblerMulti: finished 6040000 events. Wrote 60493799.
fake_assemblerMulti: finished 6050000 events. Wrote 60593799.
fake_assemblerMulti: finished 6060000 events. Wrote 60693799.
fake_assemblerMulti: finished 6070000 events. Wrote 60793799.
fake_assemblerMulti: finished 6080000 events. Wrote 60893799.
fake_assemblerMulti: finished 6090000 events. Wrote 60993799.
fake_assemblerMulti: finished 6100000 events. Wrote 61093799.
fake_assemblerMulti: finished 6110000 events. Wrote 61193799.
fake_assemblerMulti: finished 6120000 events. Wrote 61293799.
fake_assemblerMulti: finished 6130000 events. Wrote 61393799.
fake_assemblerMulti: finished 6140000 events. Wrote 61393799.

*****
Run number      = 0 ( FA MODE)
Event number    = 6092609, Latent = 0 (=0.0%)
Total Rate     = 0 Hz, Latent Ave = nan Hz
Instant Rate   = 448719.0 Hz, Latent Inst. = 0.00 Hz

Started Wed 31-Dec-1969 18:00:00 CST, 0 ms
Current Wed 31-Dec-1969 18:00:00 CST, 0 ms
Time Elapsed = 0.00 hr

-----Rate Info: instant(average), total count(latent)-----
Beam: 0.00(nan) Hz, 0(0)      Gamma-ZB: 0.00(nan) Hz, 0(0)      Gamma:
0.00(nan) Hz, 0(0)      Beta: 0.00(nan) Hz, 0(0)

Strobe: 0.00(nan) Hz, 0(0)
Laser: 0.00(nan) Hz, 0(0)
Michel: 0.00(nan) Hz, 0(0)
BigNu: 0.00(nan) Hz, 0(0)

Boards =
Backlog =
*****
Total =

*****

gahs@hep2:~
top - 14:56:16 up 255 days, 16 min, 7 users, load average: 0.90, 0.49, 0.19
Tasks: 293 total, 4 running, 289 sleeping, 0 stopped, 0 zombie
Cpu(s): 0.2%us, 7.6%sy, 0.0%ni, 91.5%id, 0.0%wa, 0.0%hi, 0.6%si, 0.0%st
Mem: 24545812k total, 23601340k used, 944472k free, 191144k buffers
Swap: 26738680k total, 77276k used, 26661404k free, 23028176k cached

PID USER PR NI VIRT RES SHR S %CPU %MEM TIME+ COMMAND
23159 gahs 15 0 13660 1128 984 S 14.0 0.0 0:18.66 fake_seb
23158 gahs 15 0 13660 1128 984 S 13.3 0.0 0:17.98 fake_seb
23162 gahs 15 0 13664 1132 984 S 13.3 0.0 0:19.30 fake_seb
23156 gahs 15 0 13664 1128 984 R 13.0 0.0 0:19.17 fake_seb
23154 gahs 15 0 13660 1124 984 S 12.6 0.0 0:18.25 fake_seb
23157 gahs 15 0 13664 1128 984 R 12.6 0.0 0:18.39 fake_seb
23161 gahs 15 0 13660 1128 984 R 12.6 0.0 0:19.14 fake_seb
23163 gahs 15 0 13664 1128 984 S 12.6 0.0 0:19.22 fake_seb
23155 gahs 15 0 13664 1128 984 S 12.3 0.0 0:18.32 fake_seb
23160 gahs 15 0 13656 1124 984 S 12.0 0.0 0:18.85 fake_seb
23216 gahs 15 0 22100 2284 1668 R 0.3 0.0 0:00.16 top
1 root 15 0 10356 200 168 S 0.0 0.0 0:02.94 init
2 root RT -5 0 0 0 S 0.0 0.0 0:01.47 migration/0
3 root 34 19 0 0 0 S 0.0 0.0 0:00.00 ksoftirqd/0
4 root RT -5 0 0 0 S 0.0 0.0 0:00.00 watchdog/0
5 root RT -5 0 0 0 S 0.0 0.0 0:01.25 migration/1
6 root 34 19 0 0 0 S 0.0 0.0 0:00.00 ksoftirqd/1
```

EPICS: components and status of my testing on Linux for MicroBooNE

Component	Source	Functionality	
Base (R3.14.12)	ANL	Process Variable, channel access backbone	I tested
Sncseq (2.0.12)	BESSY	State sequencer	I tested
Alarm Handler (1.2.26)	ANL	Alarm reporter and manager	I will test
Display and control panels: multiple options (just three shown below)			
EDM	ORNL	Motif-based, old	-
MEDM	APS	Motif-based, supported	I tested
CAML	ORNL	Browser-based, new	I will test
History / archiving: multiple options (just two shown)			
ChannelArchiver	was ORNL	file-based solution	-
RDBChannelArchiver	ORNL	SQL-based, new	I will test
Other: multiple Python and LabView interface options,			-

With a trivial MEDM display

EPICS
IOC

Trivial "GUI"
updates continuously

The screenshot shows a terminal window with several overlapping windows. The main terminal window displays the following text:

```
gahs@hep1:~/user/gahs/MicroBooNE/DAQ/uboonedaq/EPICS/apps/rc-fiocBoot/
iocInit
Starting iocInit
#####
## EPICS R3.14.12 $Date:
## EPICS Base built Jan
#####
devAiRunControlSHM (init
devAiRunControlSHM (init
devAiRunControlSHM (init
devAiRunControlSHM (init
cas warning: Configured
cas warning: Using dynam
cas warning: but now two
cas warning: Depending o
cas warning: reachable w
iocRun: All initializati
## Start any sequence pr
#seq snxxxx,"user=gahsHo
epics> exgahs@he
bash: exit: comma
gahs@hep1:iocRun
gahs@hep1:iocRun
gahs@hep1:iocRun
[1] Running
ud: /user/gahs
Running
q-2.0...est/de
[3]- Stopped
onedaq/code/host
[6] Running
ySimple/iocBoot/
[7] Running
s/MicroBooNE/DAQ
[8]+ Stopped
gahs@hep1:iocRun
../bin/linux-
epics> dbl
RUN:DAQ:1:EVENT
RUN:DAQ:1:RATE
epics> 
```

Overlaid windows include:

- event_number.adl (edited)**:

```
Hello, World! Run Monitor with event number.
74192576
```
- medm**: A window with a menu (File, Edit, View, Palettes, Help) and buttons for Mode, Edit, and Execute.
- ser/gahs/MicroBooNE/DAQ/uboonedaq/code**:

```
connect to daqLogd: Connection refused
... 20919... reset file position to beginning for 500th time
clock1
```
- gahs@hep1:~/user/gahs/MicroBooNE/my_testing/medm-tests**:

```
fake_assemblerMulti: finished 7220000 events. Wrote 72198635.
fake_assemblerMulti: finished 7230000 events. Wrote 72298635.
fake_assemblerMulti: finished 7240000 events. Wrote 72398635.
fake_assemblerMulti: finished 7250000 events. Wrote 72498635.
fake_assemblerMulti: finished 7260000 events. Wrote 72598635.
fake_assemblerMulti: finished 7270000 events. Wrote 72698635.
fake_assemblerMulti: finished 7280000 events. Wrote 72798635.
fake_assemblerMulti: finished 7290000 events. Wrote 72898635.
fake_assemblerMulti: finished 7300000 events. Wrote 72998635.
fake_assemblerMulti: finished 7310000 events. Wrote 73098635.
fake_assemblerMulti: finished 7320000 events. Wrote 73198635.
fake_assemblerMulti: finished 7330000 events. Wrote 73298634.
fake_assemblerMulti: finished 7340000 events. Wrote 73398634.
fake_assemblerMulti: finished 7350000 events. Wrote 73498634.
fake_assemblerMulti: finished 7360000 events. Wrote 73598634.
fake_assemblerMulti: finished 7370000 events. Wrote 73698634.
fake_assemblerMulti: finished 7380000 events. Wrote 73798634.
fake_assemblerMulti: finished 7390000 events. Wrote 73898634.
fake_assemblerMulti: finished 7400000 events. Wrote 73998634.
fake_assemblerMulti: finished 7410000 events. Wrote 74098634.
fake_assemblerMulti: finished 7420000 events. Wrote 74198634.
fake_assemblerMulti: finished 7430000 events. Wrote 74298634.
fake_assemblerMulti: finished 7440000 events. Wrote 74398634.
07
07
07
```
- clock1**:

```
0 S 1.0 0.0 12:26.32 kjournald
2016 S 0.3 0.0 0:00.23 xterm
0.3 0.0 0:00.02 top
0.3 0.0 6:56.65 nfsd
0.3 0.1 12:43.02 Xvnc
0.3 0.0 1:11.28 scp
0.3 0.0 0:18.66 sshd
0.0 0.0 16:25.88 init
0.0 0.0 0:02.04 migration/0
0.0 0.0 0:00.12 ksoftirqd/0
0.0 0.0 0:00.00 watchdog/0
0.0 0.0 0:00.31 migration/1
0.0 0.0 0:00.18 ksoftirqd/1
0.0 0.0 0:00.00 watchdog/1
0.0 0.0 0:00.21 migration/2
```
- gahs@hep1:~/clock1\$ caget RUN:DAQ:1:EVENT**:

```
RUN:DAQ:1:EVENT
6.41497e+07
gahs@hep1:~/clock1$ 
```

assembler

Next things to try

- RDBChannelArchiver
- AlarmHandler
- Some more useful monitoring devices
 - I've written an IOC for monitoring a Linux host's state: CPU load, uptime, free memory, CPU temperature.
 - Would be neat to track history of this on uboonedaq01.
 - For CPU temperature, someone needs to configure the right sensors on uboonedaq01.fnal.gov.
- CAML display and control panels

Some things to decide

- Which EPICS components to choose for gui, history recording (“archiving”).
- What naming convention to adopt for EPICS channels.

EPICS user interfaces

- **Motif Editor and Display Manager (APS)** is well-known, easy. One display per window.
- **Channel Access Markup Language (ORNL)** is “web browser based” using plug-ins installed in browser, allowing navigation between pages.
- Other options include **edm**, **StripTool**, **DM2K**, and coding a gui ourselves (*e.g.*, in Python).
- I intend to look at CAML when I get a chance.

EPICS record naming conventions

- Geoff mentioned last meeting the desirability of having a convention from the start.

- For the “Run Control” example, I used a convention that could be summarized as

SPECIES : AREA : UNIT : PROPERTY

- Examples:

RUN:DAQ:1:EVENT, RUN:DAQ:1:RATE,
HVPS:TPC:1:VOLT, HVPS:TPC:1:CURR,
HVPS:PMT:1:VOLT, *etc.*

Elaborating on SPECIES:AREA:UNIT:PROPERTY

- SPECIES is “an alphanumeric primary name describing a general device class.”
 - “Examples are BPMO for beam position monitor, QUAD for quadrupole... and so forth.”
 - This is not the same as the EPICS type such as “analog input”.
- AREA indicates a region or subsystem.
- UNIT is a decimal digit number.
- PROPERTY is “an alphanumeric secondary name representing some attribute of the device.”

Some of the text above is taken from Chapter 1 of the
[SLC Control System Principles of Operation](#) (March 21, 1994).

Better conventions might be devised, but ...

- whatever convention we adopt, it should be
 - easy to interpret for humans,
 - easy to remember (both the convention and the names used in the convention),
 - systematic enough that we can imagine writing tools to do things like scan the values of all records of a certain “species”, etc.
- The SPEC:AREA:UNIT:PROP convention seems to fit the bill, something like it has worked before.