EPICS Collaboration Meeting Fall 2020

EPICS Archiver Appliance Update

Presented by Murali Shankar on behalf of multiple contributors from the EPICS collaboration





Goals



- Scale to 1-2 millions PV's
- Fast data retrieval
- Users add PV's to archiver
- Zero oversight
- Flexible configurations on a per PV basis

The EPICS Archiver Appliance is 10 years old

What's in an appliance?



Scale by clustering appliances



A few deployments

| Facility | PVs | Data rate (GB/day) | Cluster size |
|-----------------------|------|--------------------|--------------|
| LCLS (Electron) | 616K | 170.04 | 6 |
| LCLS (Photon) | 237K | 110.4 | 2 |
| SPEAR | 42K | 6.43 | 1 |
| BNL | 127K | 127 | 1 |
| BNL - Multiple | 323K | 157 | 25+ installs |
| LNLS | 127K | 86 | 1 |
| Keck1 | 1.5K | 27 | 1 |
| Keck2 | 1.3K | 20 | 1 |
| ANSTO | 103K | 6 | 1 |
| Diamond | N/A | | |
| PSI | N/A | | |
| FHI | 2.5K | 1.06 | 2 |
| Canadian Light Source | 26K | 2 | 1 |
| SESAME | 8.5K | 13.3 | 1 |
| Others | | | |

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Retrieval times



Retrieval time ranges and response

(mined from LCLS photon and electron web server logs)



Retrieval Mime Types



% of requests



Web based viewer

• Bundled with the appliance.

- Can be deployed separately as well
- Small feature set zoom/pan/log scales/link/export etc
- Full featured viewers Phoebus, PyDM, Grafana, Matlab, ArchiveViewer

Web based viewer

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Raw Data[0(s)]

Grafana



Create dashboards of multiple PV's for your most commonly viewed systems + alerting

- Couple of plugins
- Paul Richards (Keck) has an excellent plugin -<u>https://github.com/KeckObservatory/epics-grafana-datasource</u>
- Shinya Sasaki (KEK) has another excellent plugin -<u>https://github.com/sasaki77/archiverappliance-datasource</u>

KEK Grafana – 1 (courtesy of Paul Richards)

Temperature charting of one of the telescopes



KEK Grafana - 2

Azimuth/elevation of the telescope



LCLS Grafana (courtesy of Alex Wallace)

Create multiple panels to trend data







Easily search dashboards

| Sear | ch dashboards by name | | × |
|------|----------------------------|-----------------|---|
| | | 🕏 Filter by tag | |
| | Recent | | |
| | Facility Monitoring System | | |
| | | | |
| | EM1K0:GMD Vacuum | | |
| | K PMPS Events | KFE | |
| | K-Line LCLS Stats | | |
| | KFE beamline Vacuum | KFE VACUUM | |
| | KFE Mirror Stats | KFE OPTICS | |
| | SXR Gas Attenuator | GATT KFE | |
| | | | |
| | HXR Gas Energy Monitors | GEM LFE | |
| | L PMPS Events | | |
| | L-Line LCLS Stats | | |
| | LFE Beamline Vacuum | LFE | |
| | LFE Mirror Stats | LFE OPTICS | |
| | | | |
| | тмо | | |
| | | | |

LCLS Grafana

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Drop-down list of PVs that match your query

| ÷., | EPICS Archiver | Query options MD = auto = 1342 Interval = 15s | | Query inspector |
|-----|----------------|---|---------------|-----------------|
| | | | | |
| ~ / | | | | ↓↑₿⊚₫ |
| F | vv [| EVENT | Regex | |
| | perator | AMO:R15:EVR:18:2:EVENT1CTRL | | |
| A | lias | CXI:DG2:BMMON:EVR:EVENT12CTRL.ENAB | Alias pattern | |
| | unctions | CXI:DS1:EVR:01:EVENT10CTRL.ENM | | |
| | | CXI:EVR:SC1:INLINE:EVENT2CTRL.VME | | |
| + (| Query | CXI:EVR:SC1:INLINE:EVENT3CTRL | | |
| | | CXI:EVR:SC1:INLINE:EVENT8RATE | | |
| | | | | |
| | | | | |

Regular expression support for quickly getting a whole slew of PVs

| Query 1 Cf Transform 0 Q Alert 0 | | | | | | | | | |
|----------------------------------|--|-------|-----------------------------|--|--|--|--|--|--|
| •. EPICS Archive | • EPICS Archiver • O > Query options MD = auto = 1342 Interval = 15s Query inspector | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| PV | .*MMS:0[0-9].*.RBV | Rege | | | | | | | |
| Operator | AMO:EXP:MMS:04.ERBV | | | | | | | | |
| Alias | AMO:LMP:MMS:09.ERBV | Alias | pattern Alias regex pattern | | | | | | |
| | AMO:PPL:MMS:06.DRBV | | | | | | | | |
| Functions | AT2L0:XTES:MMS:00:01:MOVE_OK_RBV | | | | | | | | |
| | AT2L0:XTES:MMS:00:02:VALID_RBV | | | | | | | | |
| + Query | AT2L0:XTES:MMS:00:05:MOVE_OK_RBV | | | | | | | | |
| | AT2L0:XTES:MMS:00:06:DELTA_RBV | | | | | | | | |
| | | | | | | | | | |

LCLS Grafana



Whole system dashboards with status indicators – energy detector vacuum system



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LCLS Grafana

Area access and PPS status display without EPICS

| 侣 PPS Ove | erview 🏠 📽 | | | | | | | | | | |
|-----------|---|------|-----------|----|---------------------------------|-----------------------|------------------------------|---|------|--|---------------|
| FE | E Access | XI | RT Access | | | | | | | | |
| No / | Access | No . | Acce | SS | | | | | | | |
| | | | | | | BTM | Pressures | | | | |
| 30psi ——— | | | | | | | | | | - BTM:FEE0:10:PPSPRSSR | curr 12.88 |
| | | | | | | | | | | BTM:FEE0:11:PPSPRSSR BTM:EFE0:12:PDSSDSSR | 13.83 |
| 25psi | | | | | | | | | | BTM:FEE0:13:PPSPRSSR | 12.28 |
| | | | | | | | | | | - BTM:FEE0:14:PPSPRSSR | 14.54 |
| | | | | | | | | | | BTM:FEE0:15:PPSPRSSR | 51.2 |
| Opsi | | | | | | | | | | BIM:FEEU:16:PPSPRSSR BIM:FEEU:16:PPSPRSSR | 51.2 |
| | | | | | | | | | | - BTM:FFF0:18:PPSPRSSR | 14.6 |
| | | | | | | | | | | BTM:FEE0:19:PPSPRSSR | 14.73 |
| | | | | | | | | | | - BTM:FEE0:1:PPSPRSSR | 14.8 |
| 5psi | | | | | | and the second second | interpretation in a superior | | | - BTM:FEE0:20:PPSPRSSR | 14.10 |
| | A CONTRACTOR OF THE OWNER OWNER OF THE OWNER | | | | An owner the state of the state | | | And the second se | | BTM:FEE0:21:PPSPRSSR | 14.78 |
| | | | | | | | | | | - BTM:FEE0:22:PPSPRSSR | 14.84 |
| 0.nei | | | | | | | | | | - BTM:FEE0:23:PPSPRSSR | 12.5 |
| upsi | | | | | | 1 | ļ | | | - BTM:FEE0:24:PPSPRSSR | 14.8 |
| | 7 | | | | | | | | | - BTM:FEE0:25:PPSPRSSR | 14.1 |
| | | | | | | | | | | BTM:FEE0:26:PPSPRSSR | 14.1 |
| 5osi | | | | | | | | | | BTM:FEE0:27:PPSPRSSR | 14.6 |
| | | | | | | | | | | BTM:FEE0:28:PPSPRSSR | 14.46 |
| | | | | | | | | | | BTM:FEE0:29:PPSPRSSR | 14.7 |
| | | | | | | | | | | BTM:FEE0:2:PPSPRSSR | 14.2 |
| Onoi | | | | | | | | | | BTM:FEE0:30:PPSPRSSR | 14.2 |

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Python logs

-- Grafana --

😂 -- Mixed --

-- Dashboard --



Annotate PV trends with caPutLog (any log) information, or display logs as a panel – data sources galore

LCLS Grafana





LCLS Beam Statistics for current status and longer term trends, auto-refresh rates bring dashboards alive





LCLS Grafana

Grafana Renders Nicely On Mobile Devices



PVAccess support



- NTScalars and NTScalarArrays are stored as their channel access counterparts
 - Existing viewers should work with these types
- Other PVData structures are stored as a bunch of bytes.
 - Add any V4 type to the archiver
 - V4 service to get archiver data over PVAccess
 - Also, over JSON
- Lots of teething issues
 - Checking for a PVA PV's liveness using CA will not work

Retrieval for complex types



/retrieval/data/getData.json?pv=VRGA:GUNB:100:BARDATA"

| "timeStamp": { |
|---------------------------------|
| "nanoseconds": 699300096, |
| "secondsPastEpoch": 1586199005, |
| "userTag": 0 |
| }, |
| "value": { |
| "Mass": [|
| 0.0, |
| 0.0, |
| 0.0 |
| 7, |
| "Pressure": [|
| 1.935e-15, |
| 7.5035e-14, |
| -2.365e-14, |
| 1.05887e-13, |

Save/Restore API



- Get the value of several PV's as of a point in time
- Primarily aimed at save/restore applications SCORE/MASAR
 - Archiver data is often used as quality control
- Performance.
 - At least one IOP per PV.

Save/Restore API - performance



EPICS archiver data for anomaly detection (Anwesha Das)

- Beam loss, RF trips, DC magnet faults etc
- Analyze 1000s of PV trends together over diverse space-time and conduct statistical multi-variate time-series analysis with comparative ease.
 - Irregular sparse time-series, thus anomaly identification non-trivial
- Assimilate all the PV data at one location (skip the server).

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EPICS archiver data for anomaly detection (Anwesha Das)

Fan Fault: For a beam failure caused by SCR temperature fault, SCR_FAN_TEMP_FLT PV shows clear indications of anomaly during the day shift (i.e., 8 am to 4 pm) and beyond. Recovery in this case was replacement of the FAN assembly unit.



Deployment



- Migrated to JDK 1.12+/Tomcat 9
 - Upgrade is relatively straightforward; a few labs have already done this.
 - But this is a migration; simply replacing the WAR's may not work.
 - Other versions of Tomcat should be fine.

Gateways (Jingchen Zhou/Bruce Hill)



- LCLS uses gateways to protect the IOC's from the archiver.
 - Accumulation of dead PV's.
 - Lots of CA search requests.
- LCLS Photon folks use a gateway per hutch (approx).
- The LCLS accelerator folks use 6 gateways (all running on the same machine)
 - Gateway 0 is the default gateway # allow everything, deny patterns
 EVALUATION ORDER ALLOW, DENY
 .* ALLOW
 ^[A-Za-z0-9]+:UND1:.* DENY

•••

 Others match on PV name patterns – LINAC sectors EVALUATION ORDER DENY, ALLOW
 .* DENY
 ^[A-Za-z0-9]+:UND1:.* ALLOW

Administration/monitoring (Bruce Hill)



- <u>https://github.com/slaclab/epicsarchiver_automation</u>
- Archive request files as part of the IOC build
- Auto pause/auto resume
- Liveness of disconnected PV's.
 - If using gateways, bypass these for this check.

Multi-step BPL

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- Changes in naming conventions
 - Append old PV data to new PV
 - Delete old PV
 - Add old PV name as an alias
- Can do this outside from within Python
- Frequent usecase, we moved this inside the archiver
 - /appendAndAliasPV

PBEditor (Anthony Carriveau, FRIB)

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Post processing PB files for storage reclamation

- GATE: post process delete records based on controlling PV
 - optional minimum record or time-frame before and after
 - Keeps records with field changes
- DEDUP: delete identical records
 - Value
 - Timestamp
 - both
- ADEL: delete records based on a new ADEL value
- MERGE: merge two PB files from separate archivers
- DECIMATE: delete records according to normal decimation rules

Requested Features

- Failover
- Simple authorization
- Event building
- Compression/Reduce number of files
- Fast Archiving
- Puppet based installation
- Timestamps in the logger/better logging
- Better self-diagnosis

Gallery of bugs

- Reconnect bugs
- "No data" display bugs
- Very slow "Delete PV"

Quickstart/evaluate

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Google "EPICS archiver appliance"

Download archiver appliance and tomcat

Run using

• ./quickstart.sh apache-tomcat-9.0.20.tar.gz

| quickstart_test]\$ ls -l |
|---|
| otal 312440 |
| -rw-rr 1 mshankar cd 11358 Sep 9 16:03 Apache_2.0_License.txt |
| -rw-rr 1 mshankar cd 10851264 Nov 13 08:08 apache-tomcat-9.0.20.tar.gz |
| -rw-rr 1 mshankar cd 154003400 Nov 13 08:08 archappl_v0.0.1_SNAPSH0T_12-November-2019T21-10-12.tar.gz |

| | INF0 | config.org.epics.archiverappliance.config.DefaultConfigService - Start complete for webapp ENGINE |
|------|-------------|--|
| ••• | INFO | config.org.epics.archiverappliance.config.DefaultConfigService - Start complete for webapp ETL |
| ••• | INFO | config.org.epics.archiverappliance.config.DefaultConfigService - Start complete for webapp RETRIEVAL |
| ••• | INFO | config.org.epics.archiverappliance.mgmt.MgmtRuntimeState - All components in this appliance have started up. We should be read |
| y to | star | t accepting UI requests |
| | | |

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Thanks for listening