Web based visualization tools for EPICS embedded systems: an application to Belle2

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The proposed data publishing architecture is based on a common pattern of data collection. Each produced data fragment (PV) is collected by any EPICS node and sent by network to a central server that gathers all data and store them in a database. A web application runs on the central server and displays collected data.

A Tornado web application has been developed enabling some security enhancements like HTTP+SSL for communication encryption and client side (Collectd) authentication. Data gathered from Tornado web application are stored on a local database.

The data collection task is performed by Collectd an open-source software. A specialized input plugin for Collectd has been developed in order to read EPICS PVs. This plugin uses Python API of Collectd and PCASpy library for EPICS Channel Access.

InfluxDB has been selected as preferred Time Series Database implementation for this data publishing architecture. Its main features include: native support for time-centric functions in SQL-like query language, data tagging to allow flexible data querying, native downsampling for historical time series with continuous queries, retention policies to efficiently auto-expire stale data.

The data gathering from Tornado web application are stored on a local database and then the data are transferred to InfluxDB. Grafana dashboard framework has been selected as web visualization tool. It allow users to create, using web application on a common Internet browser, their own control dashboards defining plots that fetching data from InfluxDB data store. Grafana also provides a rapid deployment due to embedded web server and it allows different user roles with the definition of custom authentication and authorization policies.

EPICS plugin Example query for InfluxDB

```
select mean(value), percentile(90, value) as percentile_90
from /^stats/.*
group by time(10m)
into 10m:series_name
```

Calculate the mean and 90% percentile of all time series starting with stats (first two lines), down-sample them (through group by) and finally fan them out into a respective number of time series (e.g. 10m.stats_a, 10m.stats_b, ...)

Belle2 Experiment use case

The BelleII detector is currently under construction at the SuperKEKB electron-positron collider at the KEK Laboratory (Tsukuba, Japan). As a major upgrade of the forerunner Belle experiment at the KEKB collider, the BelleII detector has been improved to make measurements of CP-violating asymmetries in rare B meson decays, to achieve precision determination of CKM parameters, and to perform sensitive searches for lepton flavor violation and lepton number violation in rare and forbidden B and D decays.

Temperature and relative humidity in the two BelleII ECL endcaps are monitored by a uSOP-based network. uSOP is a Single Board Computer (SBC) based on ARM processor and Linux operating system [16] that makes it possible to develop and deploy easily various control system frameworks (EPICS, Tango) supporting a variety of different buses (I2C, SPI, UART, JTAG), ADC, General Purpose and specialized digital IO.

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Architecture

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