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babyIOC - CONTROL SYSTEM IN A BOX SMALL FACTOR SOLUTION*

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Abstract

In the world of increasing complexity and integration, experiments often stretch over multiple beamlines or several facilities. Users may come with their own sample environments and detectors. It is always a challenge to integrate user end-station equipment into the hosting facility controls. Recognizing this trend, NSLS2 has developed babyIOC Control System in a Box, portable small-form-factor IOC solution.

The selected hardware is from innovative hardware designer UDOO. This SBC has microSD card storage, 64-bit Intel architecture, 4-core 2.56 GHz, 8 GB of RAM, x3 1 Gbit interfaces (including dual port daughter card). The cost of board and extensions is ~$400 US. We've configured it so the system boots and runs from microSD card. Building another system comes to copying the image to another microSD card. We believe this board with the easy downloadable image can be used at any facility and/or experimental stations. Given a growing interest to areaDetector software from the Tango community, babyIOC could serve as evaluation starting point.

MOTIVATION

Back in March 2018 we faced the need to support mobile experiments at NSLS2. It was clear that the controls system solution would need to travel with the experiment, thus, it should be small factor and powerful enough for the job. It would need to blend seamlessly with the NSLS2 control system, be low maintenance, and easily upgradable to support evolving needs of the experiment. In addition, we were looking for an inexpensive, small factor solution for quick prototyping and testing in the real production environment.

HARDWARE SELECTION

From analyzing areaDetector [1] performance on older hardware, we determined that 2GB memory and 8 core 1GHz CPU should be enough to run areaDetector IOC, the most resource demanding application. We also needed at least two ethernet interfaces.

We have looked at single board computers offered by Beagleboard, Raspberry Pi, Nvidia, PINE64, UDOO, Boundary Devices, Hardkernel, PC Engines, and others. We stopped on the UDOO Ultra [2] board originally funded on Kickstarter in 2016. This board offered Intel architecture 4-core 2.56 GHz, 8 GB of RAM. NSLS2 computing hardware is standardized on Intel architecture and all system's installation is provisioned using Foreman, and configuration managed (orchestrated) with Puppet. Because of the matching architecture, installing our standard operating system on UDOO Ultra was simple. UDOO Ultra also has three 1 Gbit Ethernet interfaces: one on the board plus two provided by a daughter card. It also comes with a microSD slot, HDMI, miniDP++, USB 3.0, UART and other interfaces. It should be noted that the board boots and runs from microSD card. It also has a possibility to add a hard drive via an onboard SATA connector. We did not use this option opting instead for mircoSD because it is small, low-power, low-heat, solid state, and easy to swap. Another advantage of using microSD card for storage is that one can create a master image with all necessary software deployed and configured, which could then be copied on a new microSD card. Additional systems can be created by simply acquiring the hardware and copying the system image onto a microSD card. Figure 1 shows the arrived hardware and Figure 2 the assembled board.

Figure 1: Unassembled hardware: UDOO Ultra board, two 1Gb Ethernet daughter card, metal case, cooling fan.

Figure 2: Assembled babyIOC.

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We would like to note that hardware is evolving so fast that one year later, in 2019, better hardware can be found. For example, UDOO is coming out with a new board UDOO Bolt with 4-core AMD Ryzen 4, 8-threads, 3.6 GHz CPU, funded by Kickstarter campaign in 2018 and available for preorder [3].

The first babyIOC image, released in October 2018 can be found on [4]. It was a Debian 8 system with NSLS2 EPICS deployment via packages [5], areaDetector [1] 3.3.1 with several example IOCs deployed.

The second image, released October 2019, is CentOS 7 with areaDetector 3.6. and deployed IOC examples for ADSimDetector, ADPintGrey, ADPrisilica. At the moment of release the following modules are build: base R7.0.2.2, ipac 2,15, seq-2.2.6, asyn R4-35, autosave R5-9, busy R1-7, sscan R2-11-2, calc R3-7-1, iocStats R-3.1.15, areaDetector 3.6, as well as EPICS driver for a gamepad controllers [6], which could serve as a fun enhancement of any user experience. The gamepad EPIC driver [6] was tested on Logitech F710 wireless unit. CentOS babyIOC will be used to test the new OS environment at NSLS2 beamlines.

babyIOC DEPLOYMENT RESULTS

babyIOC was used for quick new software deployment at XFP 17BM and CHX 11ID beamlines, for areaDetector delivery tests, for testing/development of the ophyd layer with new areaDetector software for bluesky data collection software [7], and for R&D of new software. babyIOC is found to be very useful in quick prototyping, development, and deployment tests as well as the at the beamlines. We would like to report that one system with 128 GB microSD card and the highest rating, 1, required frequent disc checks. Other cards with the same or lower ratings from the same vendor worked without any issues.

CONCLUSION

babyIOC[xx] is an inexpensive, $400 US solution with deployed EPICS control system, areaDetector and several IOC examples. It can be used or quick prototyping, deployment and software evaluation.

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