A VIRTUALIZED BEAMLINE CONTROL AND DAQ ENVIRONMENT AT PAL

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I. Abstract

At least three different computers are used in the beamlines of PAL, first for EPICS IOC, second for device control and data acquisition (DAQ), and third for analyzing data for users. In the meantime, stable beamline control was possible by maintaining the policy of separating applications listed above from the hardware layer. As data volumes grow and the resulting data throughput increases, demands for replacement of highly efficient computers has increased. Advances in virtualization technology and robust computer configuration has enabled a policy shift from hardware-level isolation to software-level isolation without replacing all the computers. DAQ and analysis software using the Bluesky Data Collection Framework [1–5] have been implemented on this virtualized OS. In this presentation, we introduce the DAQ system implemented by this virtualization method.

II. Virtualization

Virtualization solutions can be classified into three major types depending on the hypervisors: KVM, Xen, and ESXi.

<table>
<thead>
<tr>
<th>Solutions</th>
<th>Hypervisor</th>
<th>Pricing</th>
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</thead>
<tbody>
<tr>
<td>Linux/kvm</td>
<td>KVM</td>
<td>Free</td>
</tr>
<tr>
<td>PROXMOX</td>
<td>KVM, LXC</td>
<td>Free</td>
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<td>Linux/Xen</td>
<td>Xen</td>
<td>Free</td>
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<td>XCP-ng</td>
<td>Xen</td>
<td>Free</td>
</tr>
<tr>
<td>Citrix XenServer</td>
<td>Xen</td>
<td>5763.01 / CPU</td>
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<tr>
<td>VMware</td>
<td>ESXi</td>
<td>Free (w/ limit)</td>
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Table 1: Virtualization Solutions for GPU Passthrough

The hypervisors listed above enable operating system virtualization and passthrough for free. Based on these hypervisors, there are commercial solutions that provide virtual machine (VM), network and storage management tools, and commercial support. Some examples are VMware vSphere (ESXi), Citrix XenServer (Xen), XCP-ng (Xen), and PROXMOX (KVM).

Virtualization Host using CentOS 7 / KVM as a Hypervisor

Hardware resources

- 32 Logical Cores
- 32 GB Memory
- 250 GB SSD
- Nvidia Quadro P400
- Radeon Pro Wx2100
- PCIe to USB Bridge
- 2x Keyboard
- 2x Mouse

 IOC (VM) DAQ (VM) ANALYSIS (VM)

8 Logical Cores
8 GB Memory
50 GB Storage
Quadro P400
Keyboard
Mouse
8 Logical Cores
8 GB Memory
100 GB Storage
Radeon Wx2100
PCIe to USB Bridge
Keyboard
Mouse

Figure 1: Multiple operating systems are running on one workstation. Headless: IOC VM (CentOS 6), Left: DAQ VM (CentOS 7), Middle: Analysis VM (Windows 7), Right: Workstation.

The procedures of setting up CentOS 7 as a hypervisor and GPU passthrough are summarized separately [8]

Figure 2: The workstation's resources have been allocated to the virtual machines.

III. Control & DAQ Environment with the Bluesky

Data Acquisition Framework

The EXAFS measurement software, previously developed in Labview, was rewritten with utilizing the Bluesky data collection framework to unify the fragmented development environment.

Fly Scan with FPGA based Scaler

A fly scan counter (see Fig. 4) with FPGA and ORODIID was designed. The direction of the motor is confirmed by two encoder signals having a 90 degree phase difference, and the operation (Inc. / Dec.) of the position counter is managed. When the position counter reaches the preset value, the detector’s counts is copied into the memory. At the end of the transfer, the measurement restarts and the data in memory is transferred to the EPICS IOC via serial communication. The data is stored in the waveform records allocated for each channel.

Figure 3: EXAFS data-acquisition software built with the Bluesky framework [1-5] and the silk scattering library [7].

IV. Conclusion

Virtualization is an interesting technology in terms of effectively utilizing the resources of multicore processor environment and facilitating the construction and operation of a multi-OS in a single workstation. The types of hypervisors and virtualization solutions were discussed, and KVM was used to convert the Linux kernel into a hypervisor to build various types of OS on it. EXAFS measurement software written in labview was rebuilt using the Bluesky data collection framework to unify the fragmented development environment. This confirmed the efficiency and versatility of the virtualization and the Bluesky framework. Therefore, these techniques will be applied to the multiple beamlines at PAL.

V. References

[2] https://github.com/bluesky/bluesky,
[3] https://github.com/bluesky/ophyd,
[4] https://github.com/bluesky/databroker,