

VIRTUAL IO CONTROLLERS AT J-PARC MR USING XEN

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Abstract

The control system for J-PARC accelerator complex has been developed based on the EPICS toolkit. About 90 traditional ("real") VME-bus computers are used as EPICS IOC's in the control system for J-PARC MR (Main Ring).

In 2010-2011, we demonstrated a "virtual" IOC using Xen, an open-source virtual machine monitor. Scientific Linux with an EPICS IOC runs on a Xen virtual machine. EPICS records for oscilloscopes (network devices) are configured. Advantages of virtual IOC are discussed.

In addition, future directions are discussed. Plan view of virtual IOC's for MR operation will be given.

INTRODUCTION

The J-PARC Main Ring (hereafter MR) is a high-power proton synchrotron with beam-energy 30GeV. The beam commissioning of MR started May, 2008. Since then, various machine studies as well as beam deliveries to physics experiments have been carried out [1]. The control system for MR has been developed based on EPICS (Experimental Physics and Industrial Control System) [2], where EPICS is a toolkit for large accelerator controls developed and supported by an international community [3].

Table 1: Types of IOC used in J-PARC MR

Type	Number	Comment
VME-bus GE and Sanritz	~90	Traditional styles
Yokogaw PLC F3RP61-2L	~30	Embedded EPICS [4] with PLC I/O modules
Cosylab microIOC	3	Industrial PC [5] with serial lines (RS485)

In EPICS, signals are handled by an in-out controller (hereafter IOC). Traditional EPICS systems use a VME-bus computer as an IOC. In MR, we have about 90 VME-bus-type IOC's among 120 IOC's in total (Table 1). A snapshot of IOC status overview during operation is given in Fig. 1.

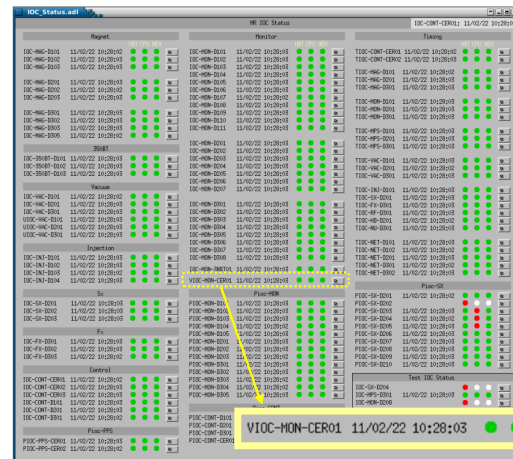


Figure 1: Overview for J-PARC MR IO-Controllers.

In J-PARC MR, 60 of 90 VME-bus-type IOC's do not use VME-bus. They are used for network-based devices: such as PLC with ladder sequences, intelligent measuring systems (WE7000 [6]), oscilloscopes, etc [7,2]. Typical topology found in MR is shown in Fig. 2.

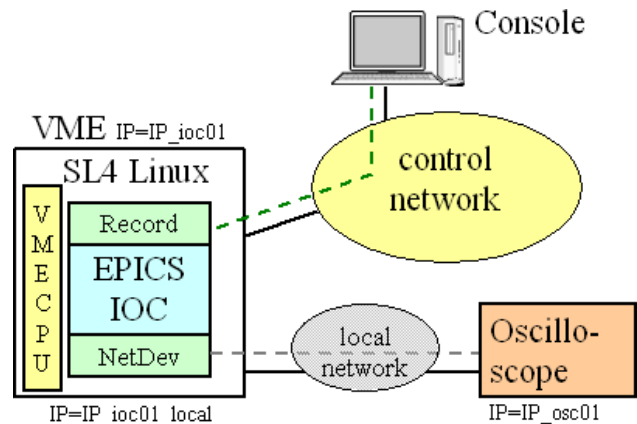


Figure 2: Typical topology with a network device.

STUDY OF VIRTUAL IOC

Idea of Virtual IOC

Recent IT technology has provided various types of virtualization of a computer: for example, Xen, VMware, VirtualBox, and KVM. Among them, we firstly interested in Xen [8], an open-source virtualization technology. The start procedures of a "vioc - virtual IOC" is given below (see also Fig. 3):

- (1) Prepare a host OS. In our case, it is a blade-type server running Scientific Linux 5 (SL5).

- (2) Run a guest OS using Xen. The guest OS is assigned 512MB memory, running SL5, with an independent IP address from the host.
- (3) Start an EPICS IOC on the guest OS. The EPICS IOC's in Fig. 2 and Fig. 3 are identical.

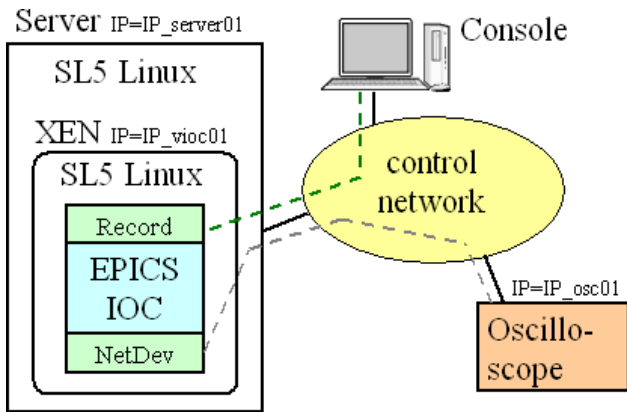


Figure 3: Topology with a virtual IOC.

Demonstration of VIOC at J-PARC MR

In order to demonstrate a vioc at J-PARC MR, we selected an extinction-monitor setup [9]. It consisted of oscilloscopes, and not EPICS-based. Thus, we developed an EPICS-based system using vioc in October, 2010. The system controls Tektronix DPO4054 and TDS3054 oscilloscopes. Setting parameters as well as waveform signals (four input and 1 output) are configured as EPICS records. Typical waveform is 10,000 elements, 10 us with 1G/s sampling rate.

The vioc for extinction monitor setup started operation since November, 2010. It was used in machine studies very successfully. Moreover, the vioc was included in our IOC surveillance monitor with the name “VIOC-MON-CER01” (Fig. 1). It had been stable over a few months. It is worth noting that nobody can find it a “virtual”, not a “real” VME-bus-type, unless using it remotely (Fig. 4).

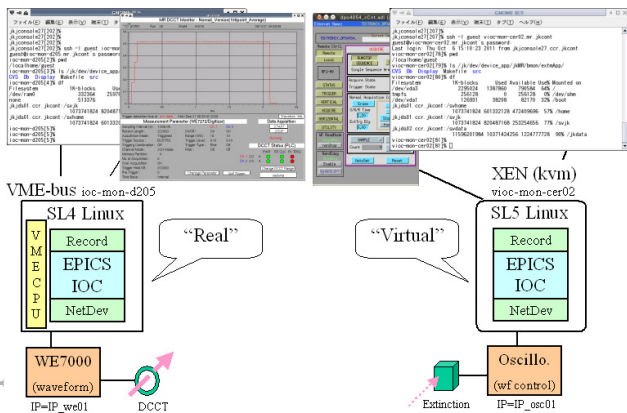


Figure 4: virtual IOC (right) and real IOC (left).

Discussion

Based on our successful experience, a scheme that running multiple vioc's (guest OS's) on limited number of servers (host OS's) seems promising. It is efficient and flexible: (a) adding new vioc is easy, (b) customization for

each vioc (i.e. small memory size for small function) is possible. When a server has a trouble, one can move vioc's to another server.

However, we must pay attention to network traffic. Unless network amount is small, vioc scheme works well. When waveform signals are handled at a considerable high repetition rate, “real” scheme has an advantage. More studies are needed.

FUTURE DIRECTIONS

Xen to KVM

We have demonstrated a vioc using Xen. However, recent trend of virtualization technology suggests KVM. KVM functions were merged into Linux kernel after 2.6.20. Now Scientific Linux 6 (SL6) has native supports for KVM.

When we run multiple vioc's on servers, it is apparent that we need a management tool. In the early phase, we looked for a tool for Xen, but could not find an appropriate one. For KVM, a default “virt-manager” is available with SL6. We have checked that it is good and stable enough for our purposes.

Toward mass introduction of vioc's in the future, we decided to use KVM instead of Xen. A plan view of vioc's, using KVM and SL6, is shown in Fig. 5. We will start operation with the new scheme after December, 2011.

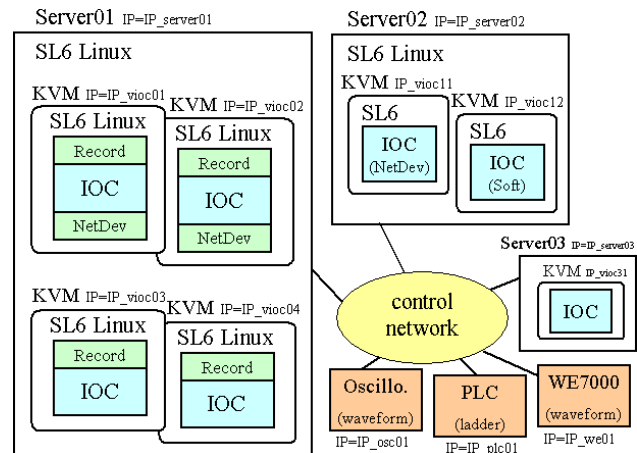


Figure 5: Plan view of vioc's for future MR operation.

Virtual Terminal

We also studied a possibility to use virtual desktop infrastructure (VDI) under KVM environment. The idea of “vterm - virtual terminal” is similar to vioc. Instead of an EPICS IOC, we run a SPICE server on a virtual machine. SPICE is a remote-desktop protocol supported by recent Linux kernels [10]. On a SPICE server, we run GUI applications developed in our EPICS-based control system.

We have an operator's console system using commercial thin-client terminals [11]. We expect higher reliability when we run a SPICE client on a thin-client terminal, since system load (CPU and memory) is always constant. Number of GUI applications does not affect to

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stability of a thin-client terminal. Studies are under progress.

CONCLUSION

We have demonstrated a virtual IOC (vioc) on a Xen virtual machine. A vioc was configured for parameter settings of oscilloscopes. It has been used very successfully in studies of extinction monitors. In addition, it was stable over a few months.

Recently we decided to use KVM virtualization technology instead of Xen. After December, 2011, we will start to run multiple vioc's in our operation.

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