RENOVATION OF PC-BASED CONSOLE SYSTEM FOR J-PARC MAIN RING

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Abstract

Console system for J-PARC Main Ring (MR) was designed in 2007 and had been used for accelerator commissioning and operation since then. It was composed of 20 diskless thin clients and 10 blade servers. Both of them are PC-based computers running Scientific Linux (SL) 4 as their operating system. In 2013, migration to ordinary fat clients was triggered by update from SL4 to SL6. Intel NUC was selected based on result of preliminary investigation and use experiences of those thin clients. Its evaluation was carried successfully out during commissioning of MR. Thin clients were replaced by 22 NUCs that work as fat clients. Migration scenario and technique of managing console system are discussed.

INTRODUCTION

Performance improvement of computers and its price reduction are quite remarkable in recent years. The performance of a PC as small as palm-size surpass that of a server computer 5 years ago. In this paper, renovation of console computers for J-PARC MR which would withstand next 5 years is described.

The accelerator control system for MR was constructed in 2007 [1] using EPICS [2] and SL4 [3] as its control software framework and operating system, respectively. It has been operational since beam operation of MR started [4] in May 2008. GUI applications of the control system were designed and implemented using EDM and MEDM, which require X Window System. In order to achieve load balancing, the control system consists of thin clients which work as X terminals and blade serves to run those applications. HP Compaq t5720 and t5730 were introduced as thin client. They are diskless machines which boot from network using an image file common to all of them so that manageability would be advantageous. IBM BladeCenter HS20 and HS21 were introduced as blade server.

RENOVATION OF CONSOLE SYSTEM

Performance of MR has been steadily improving during 6 years of beam operation. At the same time, number of blade servers was increased [5] as functionality of applications for accelerator control became rich. However, the operation method was unchanged since 2007, which uses thin clients to display the GUI and blade server to the CPU.

Model Selection and Evaluation

In 2012 support for SL4 was ended. This triggered selection for new console computers that would withstand next 5 years. An Intel NUC DC54327HYE running 64-bit SL6 was evaluated in commissioning of MR from December 2013 to January 2014.

Figure 1: Photograph of HP Compaq t5730 (left), Intel NUC (right), and a D Battery for Size Comparison (center). T5720 is not shown but its appearence is almost same as t5730.

Following points are taken into account in the selection based on accelerator operational experience:

- Sufficient CPU power and amount of memory.
  Increase of demands to use heavy applications such as web browsers, PDF viewers, and office suites led to high load on blade servers. It is also foreseen that even more CPU power and memory are required in near future as GUI environment for EPICS will transfer from EDM and MEDM to Control System Studio (CSS) [6] which is becoming mainstream. Hence, it was considered that run applications locally on a console computer rather than remotely.
- Compatibility with SL6.
  Operating systems for blade servers have been migrated from SL4 to SL6 and EPICS I/O Controllers (IOCs) [7] underway. Using identical operating system for console will simplify its management and enables smooth transition.
- GPU support by the operating system.
  Matrox EpicA TC2 / TC4, which are graphics chips of previous thin clients, are not supported by SL. Proprietary device driver from the manufacture is available for SL4 and SL5, but update was stopped in 2009. No driver is available for SL6. Next model will be used for accelerator operation over next few years. Therefore a model was selected such that its GPU is supported by the operating system out of the box.

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ISBN 978-3-95450-146-5

Table 1: Specifications of Console Computers

Manufacture	Intel	HP Compaq	HP Compaq
Model	NUC DC53427HYE	t5730	t5720
CPU	Intel Core i5-3427U	AMD Sempron 2100+	AMD Geode NX 1500
CPU Frequency	1.8 - 2.8 GHz	1 GHz	1 GHz
Number of Cores	2 (4threads)	1	1
Amount of Memory	8 GB	512 MB	512 MB
GPU	Intel HD Graphics 4000	Matrox EpicA TC2 / TC4	Matrox EpicA TC2 / TC4
Maximum Number of Monitors	3	2 or 4	2 or 4
Boot Media	SSD	Network (PXE)	Network (PXE)

- Network booting and/or diskess not anymore mandatory.
  Diskless SL6 needs more than twice as much RAM as the size of boot image when booting from Live-CD ISO file [8]. Another choice for diskless system is NFS-mounted root filesystem, but operation of a console running SL6 becomes extremely slow under high load condition with NFS root.
- Space-saving and multi-monitor output.
  Configuration of previous consoles were dual display or quad display so that space in central control room is used effectively. At least two monitor outputs are required to the next generation console computer.
- Hang up problem.
  There was a difficulty in thin clients that hangs up at a rate of one unit per month. This problem occurred as frequent as interfering accelerator operation. On the other hand it was as rare as unable to determine the cause.

Since both NUC and blade server use SL6 as their operating system and X Window System which is network transparent, there was no difference in operation whether an accelerator control application is running locally on NUC or remotely on a blade server. No hang up happened during evaluation.

The result of evaluation was satisfying and Intel NUC was selected as successor mode. Table 1 shows specifications of previous and next generation console computers. Figure 1 shows their appearance.

Migration to New Console

Replacing all the thin clients all at once would require careful preparation period. This method also may face unexpected problem which was not forceseen in the evaluation, and may interfere accelerator operation. Therefore console computers were replaced on the fly during accelerator operation. One or two units per week were replaced so that number of troubles to solve would be suppressed.

Replacement was started in January 2014 and 19 thin clients out of 20 were successfully replaced until summer shutdown of MR July 2014. Finally 20 thin clients were replaced by 22 NUCs. Number of console was increased in order to deal with shortage of consoles during accelerator commissioning. Figure 2 shows a screenshot of NUC in operation during MR commissioning. No major problem such as hang up happened so far during operation of MR from January 2014 to June 2014.

Role of blade servers is changing. They had been platform for running applications. Importance of blade server is increasing as a host computer of virtual machines (VM) in which IOCs are running [9, 10]. More than 30 IOCs running on VMs are used for MR operation, and its number is increasing.

Installation of Operating System

Operating system are installed to new consoles by replicating disk image from master copy. An image of entire disk is occasionally extracted from a reference console and stored on disk server. When a brand-new console is booted from a USB flash drive, disk image is fetched from the server and restored into its SSD.

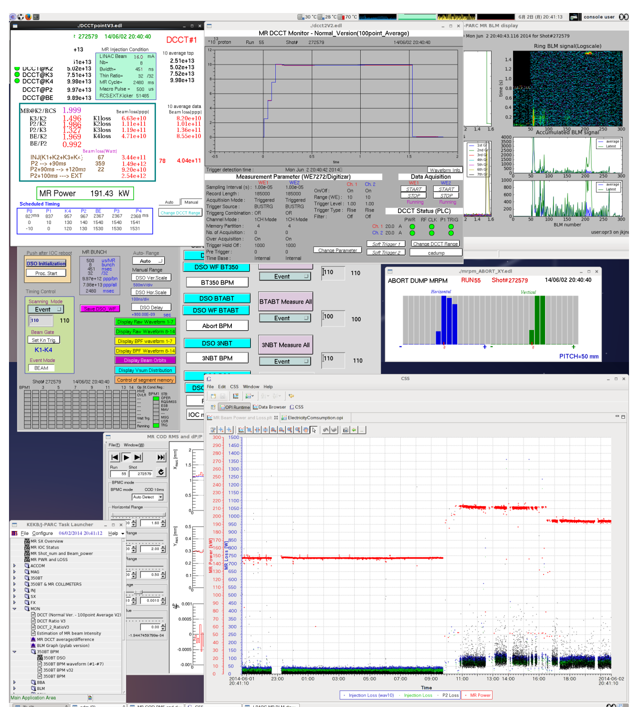

Figure 2: A Screenshot of Intel NUC During Commissioning of MR.

ISBN 978-3-95450-146-5

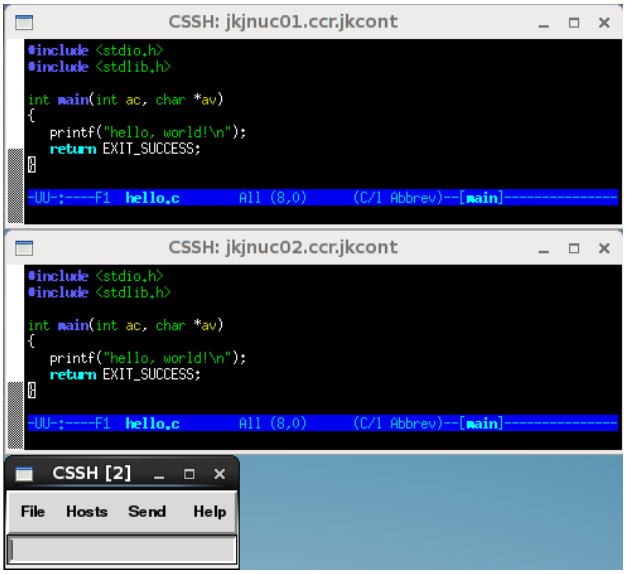

Figure 3: Screenshot of cssh. Two hosts are under control via ssh.

Management of New Consoles

New consoles are not managed collectively anymore, since they boot from their own SSD. Two distributed command execution programs are employed to manage new consoles.

One is Cluster SSH (cssh) [11], which runs interactive commands on multiple hosts over ssh. Cssh opens a control window and a xterm per each specified hosts. In each xterm user is automatically logged into specified host via ssh. Any keyboard input to the control window is replicated to all xterms. Thus inputs to all the xterms under control are kept in sync. Figure 3 shows screenshot of cssh controlling two hosts.

The other is Parallel SSH (pssh) [12], which runs the same command via ssh in parallel on number of hosts. Exit status of the command is shown in the terminal. Standard output and standard error of the command can be displayed in the terminal as each host completes, or they can be saved into a file for each host. Figure 4 shows screenshot of pssh running in a terminal.

SUMMARY

Console computers for J-PARC MR operation were renovated. Intel NUC was selected and its evaluation was carried successfully out during commissioning of MR. 20 thin clients were replaced by 22 NUCs on the fly during accelerator operation. New operation method was introduced so that applications run locally run on console rather than on

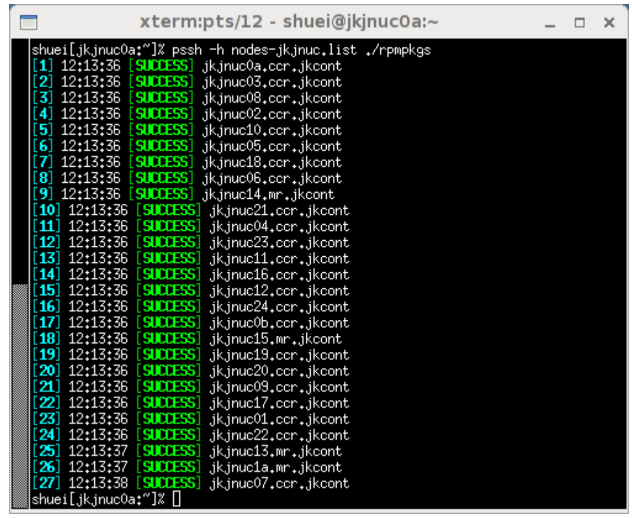

Figure 4: Screenshot of pssh. Exit status of the command is shown in the terminal.

blade servers. No major problem such as hang up happened so far during operation of MR from January to June 2014.

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ISBN 978-3-95450-146-5