SIGNAL ARCHIVING SYSTEM FOR RISP HEAVY-ION ACCELERATOR CONTROL SYSTEM

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Abstract

The Rare Isotope Science Project (RISP) of Institute for Basic Science (IBS) has developed heavy-ion accelerator. RISP control system uses the EPICS control system to control and monitor all accelerator software and hardware. Archiver appliance is the tool for signal archive and retrieval. RISP control group has conducted test of the archiver appliance, and customized signal archiver system. This paper will present the archiver appliance test that we have used.

INTRODUCTION

RISP control system uses the EPICS real-time distributed control system [1], which is software framework for stable operation of the accelerator. The output signal from all machines and devices must be archived by EPICS framework, and optimized signal archiver system is needed for each accelerator facility. Signal archiver method using the EPICS framework has three significant ways. First is the classic channel archiver using the file base method, and the second is the RDB archiver using the relational database. But classic channel archiver has a problem that the index file containing information of data block corresponding PV data mismatch with real data. Also, there is a problem in the performance of file I/O in RDB archiver. SLAC has developed archiver appliance utility to resolve these problems, and the usage of archiver appliance in EPICS community has gradually increased. RISP chose the archiver appliance to signal archiver solution. However, archiver appliance is not optimized for the RISP heavy-ion accelerator control system. Thus, we will develop the customized signal archiver system for RISP heavy-ion accelerator control system.

RISP SIGNAL ARCHIVING SYSTEM CONFIGURATION

Archiver Appliance has several characteristics. First, the index file structure has been removed. Second is the usage of RAM file system. This method is memory mapping to maximize I/O performance in local file system. Third is configuring Multiple Archive Appliance expansion of Single Archiver Appliance. This data store system enable users to design cluster type file system, and it shortens data retrieval time and helps load balancing through the parallel transaction [2].

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Design for Hierarchical Storage Area

Archiver appliance storage area consists of Short Term Storage (STS), Medium Term Storage (MTS) and Long Term Storage (LTS). STS region uses tmpfs that confirm the scope of the available memory as a memory mapping area and the file system area when the appliance is running. It is used to maximize the file I/O performance in the local area. MTS region is composed of SAS disk. LTS area was constructed by using a Storage Area Network (SAN).

Table 1: Design for Hierarchical Storage Area

Storage Area	Storage	File System
STS	RAM Disk	tmpfs
MTS	SATA Disk	ext4
LTS	SAN Storage	Lustre and GPFS

Multiple Archiver Appliance Configuration

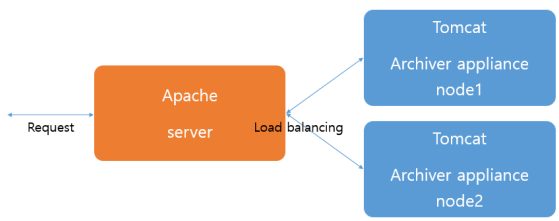

Figure 1: Apache load balancing

Multiple archiver appliance is a clustering of several single node archiver appliance. Each node in the cluster is independent, but can be controlled through load balancing. Load balancing is a service that distributes traffic properly by considering increase of server's load rate and speed deterioration when high traffic occurs in one service. Multiple archiver appliance node can be extended as required by the modified appliances.xml file.

Hardware Configuration

Network storage was configured to use the GPFS and Lustre for LTS area. SAN switch was used for communication between the SAN storage, SAN switch was also connected directly to the server and two parallel upper stage. The server performs two roles for the Object Storage Servers (OSS) that use the Lustre and GPFS role in archiver appliance LTS at the same time.

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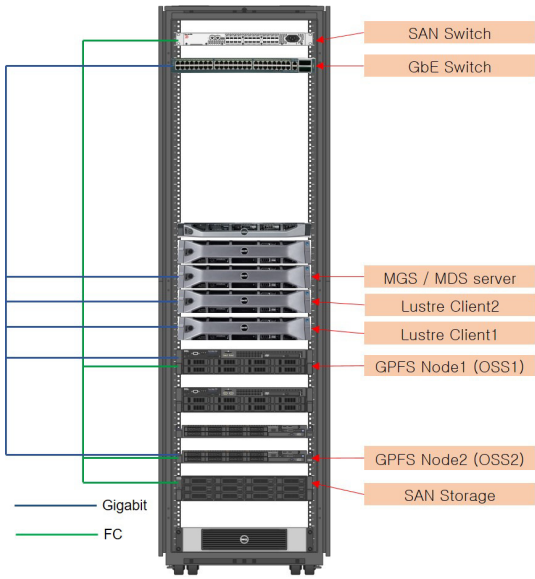

Figure 2: The configuration of signal archiving system rack

SINGLE NODE ARCHIVER APPLIANCE TEST

We can obtain the basic data for configuring multiple archiver appliance through the single node archiver appliance test. It was tested for scan mode and monitor mode. Scan mode of engine module assigns variables from IOC to slot. Thread sets and stores sampling period to each slot/variable. Monitor mode estimates the amount of storage needed by using the sampling period and fill it up.

Test Environment

- Intel(R) Xeon(R) CPU E5-2650 v2 2.6GHz(16-cores)
- STS : tmpfs (RAM disk)
  MTS : ext4 (SAS disk)
  LTS : GPFS (SAN storage)
- Test IOC
  We created testIOC for testing single node archiver appliance. Also, we created 9 IOC having 5000 PV operated at 10Hz to minimize IOC's load. PV data created from multiple IOC are sin wave form and double type.

Scan Mode Test

We tested the archiving of 45000 PV operated at 10Hz. Sampling period is 0.1 sec, policy default (STS : 1 hours, MTS : 1 day, LTS : 1 year).

In Figure 3, as the number of PV gradually increases, the time for counting PV increases. This phenomenon occurs because the number of PV, which should be proceeded, increases write thread. It is a disadvantage of scan mode. Scan mode is not suitable for storing a large amounts of PV.

Figure 4 shows that the data do not increase constantly. it is because the data loss was caused from impact of the buffer. The highest data rate is 3767794.09 byte/sec(3.5932 MB/sec), 303.18 GB/day, 110660.82 GB/year at 36000 PV.

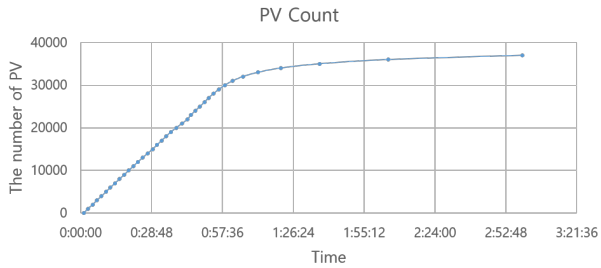

Figure 3: PV change with time

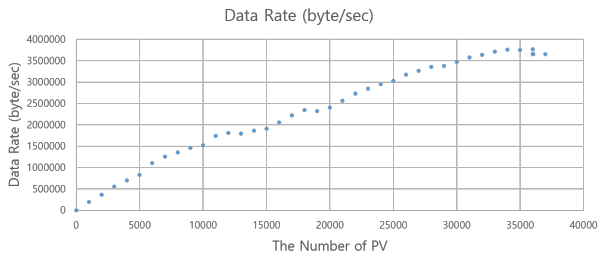

Figure 4: Data rate change vs. the PV change

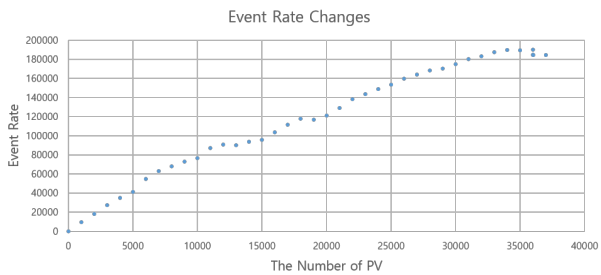

Figure 5: Event rate change vs. the PV change

Although archiver appliance is supposed to have the event rate of 37000, but it has event rate of approximately 19000 from the result. In Figure 6, data loss showed up at regular intervals, so we tested this if it was affected by buffer or problem of the archiver appliance algorithm.

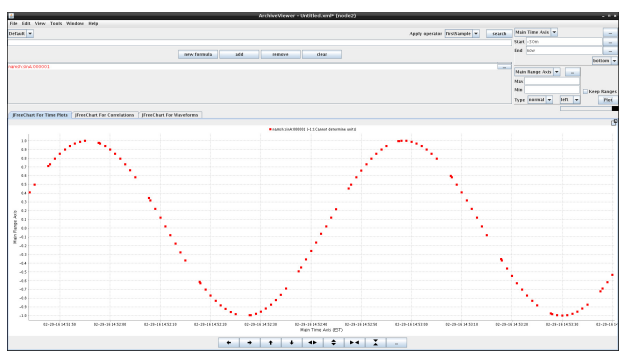

Figure 6: 10000Hz(1Hz,10000PV) retrieval data

We have conducted several tests with the same event rate.

- Sampling period=10Hz, 1000 PV (total 10000 event rate)
- Sampling period=5Hz, 2000 PV (total 10000 event rate)
- Sampling period=1Hz, 10000 PV (total 10000 event rate)
- In all tests, the actual event rate is about 9800

The reason for the periodic data loss caused by this is not an internal algorithm matter of the archiver appliance. The reason of data loss was caused by a buffer overflow. Data loss due to the buffer overflow could be improved with the addition of a system memory. A key of the signal archiving system is to design the system memory.

Monitor Mode Test

We tested the archiving of 45000 PV operated at 10Hz. Sampling period is 0.1 sec, policy default (STS : 1 hours, MTS : 1 day, LTS : 1 year).

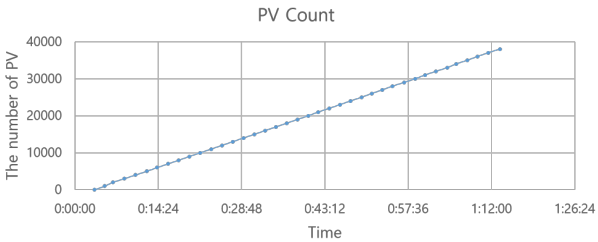

Figure 7: PV change with time

The time taken for counting PV is almost constant at about 2 minutes. This is can be explained due to pre-calculation of capacity of the buffer in the monitor mode, regardless of the engine thread (See Figure 7).

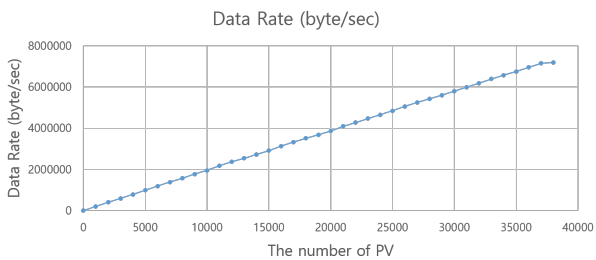

Figure 8: Data rate change vs. the PV change

The data is increased almost constantly as PV increased. This means that the loss of data is small to store a large amount of PV. The highest data rate appeared to 7199415.52 byte / sec (6.8658 MB / sec), 579.31 GB / day, 211448.19 GB / year (206.4923TB / year) at 38000 PV. PV in excess of 38,000 could not be confirmed because of insufficient memory in the server. More PV event can be stored if we increase server's memory (See Figure 8).

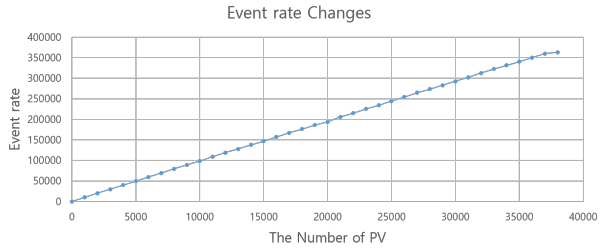

Figure 9: Event rate change vs. the PV change

Event rate of monitor mode was superior to that of scan mode as 363405.53 when 38000 PV are counted. Event rate is expected to be much higher if the system has sufficient memory. When the archiving of 38,000 PV event rate was confirmed in 363495.53, it means that data loss 16504.47 per second. (See Figure 9.)

Event drop due to a buffer overflow was occurred much less than the scan mode. Because monitor mode is used with pre-calculation of buffer capacity, the data loss can be solved if the buffer capacity is high. One can increase buffer capacity by shortening sampling period. Archiver appliance can be set as minimum sampling period 0.1 and maximum sampling period 86400. To prevent the data loss, archiver appliance can be set to shorten sampling period of under 0.1 at archiver appliance home. Another way to solve the data loss is to increase the engine sample buffer size, for example, such as FRIB / PSI. Although sampleBufferCapacityAdjustment = 1 is set as default, if you change the sampleBufferCapacityAdjustment = 1.5 by increasing the buffer size upto 150%, data loss can be prevented. [3]

CONCLUSION

Monitor mode has better performance than scan mode, and it is suitable for the storage of large amounts of data. However, the monitor mode has also node down due to insufficient system memory, therefore it is necessary to design the node memory and use multiple archiver appliance.

ACKNOWLEDGEMENT

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