BASED ON CHANNEL ARCHIVER OF EPICS TO REALIZE SSC-LINAC SYSTEM EFFICIENTLY BEAM TUNING

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Abstract

In order to improve running efficiency of accelerator, shorten the time of changing accelerator beam is key link and it should be considered how to accelerate the ion to specific energy quickly and accurately. We will discuss how to use years of heavy ion accelerator operation data to generate a set of virtual accelerator equipment data for specific ion and energy, load to all the accelerator equipment fast. EPICS provide Channel Archive tools that can achieve and store data from the IOC equipment operation information. In this study, we use Archive Engine tool and Oracle to combine data acquisition function and data management function. Firstly store the Archive Engine acquisition data in Oracle database, and then according to the data to create accelerator system operation snapshot as the basis for beam tuning. The snapshot data includes all equipment state and parameters at special time in accelerator running. When the ion is to be changed, related snapshot in Oracle database will be retrieved and loaded to all the equipment and to realize efficiently beam tuning.

BACKGROUND

As a major research facility, Heavy Ion Research Facility in Lanzhou (HIRFL) accelerator provides tens of thousands of hours of beam time to researchers at home and abroad each year. Some important achievements have been obtained in the HIRFL accelerator in recent years. Especially after the completion of CSR(Cooling Storage Ring), Institute of Modern Physics takes international and domestic issues of atomic and nuclear quality assessment. However, the provided beam time cannot meet the experimental requirement of research institute and some universities. Therefore, our institute is now building SSC-LINAC linear accelerator to improve ability of providing beam.

At present, the HIRFL control system has not established beam archive log. If we want to change beam or energy, we should look up the history of record and check every parameter of controlled experimental equipment and set the historic parameters for equipment. However, these parameters are not necessarily appropriate. So we will use Faraday tube, fluorescent target and beam diagnostic equipment to determine the beam state and adjust individual parameters until the beam state meet the requirement of experiment. It can be seen from above that the whole process is time-consuming and laborious. In fact, the process can be realized as automation which can greatly save the time of tuning beams and improve efficiency of providing beam. So, in SSC- LINAC control system construction, we must establish data archiving system to fundamentally change the beam tuning method and improve the efficiency of accelerator control system beam tuning.

INTRODUCTION

The Channel Archiver is a Toolset [1] for archiving any Channel Access data. The ArchiveEngine is an EPICS Channel Access client. It collects data from a given list of PV(Process Variables), and stored in binary index, data files or database. The configuration and operation of the ArchiveEngine will obviously require some planning, as only data that was sampled and stored will be available for future retrieval and analysis. The ArchiveEngine is configured with an XML file that lists what channels to archive and how. Each given channel can have a different periodic scan rate or be archived in monitor mode. The ArchiveConfigTool can export existing archive engine configurations from the database into an XML file format or import such XML files into the database. The XML file format is compatible with the one used by the Channel Archiver, allowing the import of existing archive engine configurations.

Currently several Relational Database are supported, MySQL, Oracle and PostgreSQL. We use Oracle lies in the support for partitioning. While the sample table appears as one table, it can be spread over several table partitions based on the sample time and channel name. Spreading by channel name might improve performance because several channels can be written in parallel to different disk locations. Partitioning by time allows quick removal of older samples.

ARCHIVE ENGINE APPLIES IN SSC-LINAC CONTROL SYSTEM

Building Archive Engine

First of all, we download the CSS(Control System Studio) java sources from the SNS CSS web page [2]. Then we set up the eclipse development environment, including Java Development Kit (JDK), Eclipse for RCP and RAP Developers. In this environment, ArchiveEngine and ArchiveConfigTool headless applications are compiled. Establish archive configuration file for each subsystem according to the system of classification and then use ArchiveConfigTool to import archive configuration file to Oracle database. During establishment of the archive configuration file, we should consider the relationship between the scan period, write_period and buffer_reserve.

The Archive server running interface is shown in Figure 1.

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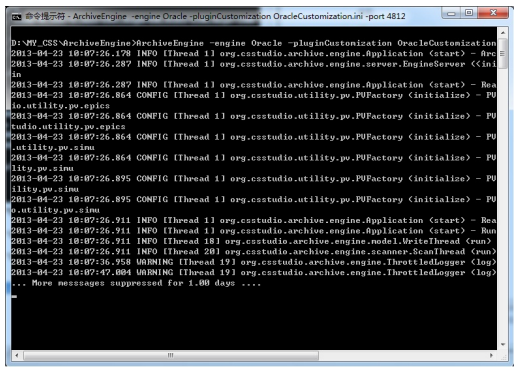

Figure 1: Archive Engine running interface.

Building Database Table Structure

For the CSS Data Browser or other tools, a read-only account is sufficient. But for the Archive system, we provide a database account that has write access to the archive tables. Each system has its equipment archive information data structure, including: basic information, operation information and real-time status data. These data information can provide strong support for unified monitoring and display interface. The whole system can be divided into several subsystems to be archived respectively, including psArchive for the power system, vcumArchive for the vacuum system, mgntArchive for magnet systems, etc. According to the equipment property each system set scan/monitor interval in Archive Configuration file and using one or more ArchiveEngine to archive data indexed by time. Figure 2 shows Archive server structure in SSC-LINAC control system. There will be other subsystem added. Each subsystem has its own ArchiveEngine.

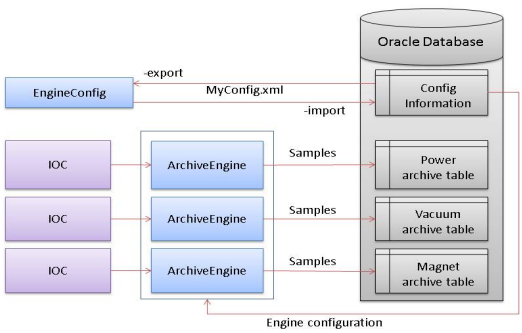

Figure 2: Archive server structure.

The Main Features of This Application

A complete accelerator archiving system application was established. It can provide the following functions.

1. We can use CSS Data Browser[3] to retrieve data from Oracle database for browsing, analysis and processing. If there is new application requirement we can create new database table or view for analysis and processing. Figure 3 shows a CSS Data Browser example.

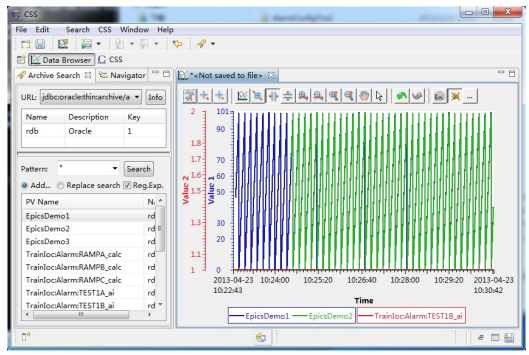

Figure 3: CSS Data Browser example.

2. A virtual accelerator can be achieved by taking snapshots indexed by time of the current beam state. Through this beam snapshots, we can reproduce any historic accelerate beam state. When a similar beam needed, by recall the historic data and run the virtual accelerate, all beam tuning parameters can be reloaded.

3. This application provides data comparison function. Accelerator operation status, historic snapshots and the theoretic data are shown in one table for comparison(see Fig. 4). The comparison form provides beam tuning staff intuitive reference to analyze the problem they met. Thus, the efficiency of the accelerator beam tuning can be improved.

Figure 4: Data comparison.

4. Equipment operating safety auditing function was also realized in this application to record all the operating information during the beam tuning period. The equipment status before and after this operation will also be recorded.

It is necessary to explain some tag in XML configuration file. The configuration file is show in following. In the file, there are several important tags[4], write_period, buffer_reserve, max_repeat_count, period tag, scan and monitor.

```
<?xml version="1.0" encoding="UTF-8" standalone="no" ?>
<!DOCTYPE engineconfig SYSTEM " engineconfig.dtd ">
<engineconfig>
<write_period>30</write_period>
<ignored_future>1.0</ignored_future>
<buffer_reserve>3</buffer_reserve>
<max_repeat_count>120</max_repeat_count>
  <group>
    <name>Power</name>
    <channel>
    <name>ssc_linac:ps_q01.VAL</name>
    <period>3</period><scan/>
    </channel>
    <channel>
    <name>ssc_linac:ps_ms02.VAL</name>
    <period>10</period><monitor/>
    </channel>
  </group>
  ......
</engineconfig>
```

- write_period

This is a global option that needs to precede any group and channel definitions. It configures the write_period of the Archive Engine in seconds. The default value of 30 seconds means that the engine will write to Storage every 30 seconds.

- buffer_reserve

To buffer the samples between writes to the storage, the engine keeps a memory buffer for each channel. The size of this buffer is reserve×buffer_reserve/scan_period.

- max_repeat_count

It forces the engine to write a sample even if the channel has not change after the given number of repeats. The default is 120, meaning that a channel that is scanned every 30 seconds will be written once an hour even if it had not changed.

- period

This illustrates the period of scan. For example, the channel "X" is once configured for periodic sampling every 30 seconds and once as a monitor with an estimated period or one second, the channel will in fact be monitored with an estimated period of 1 second.

- scan

Either "monitor" or "scan" need to be provided as part of a channel configuration to select the sampling method. True to its name, "scan" selects scanned operation. As an example, scanned operation with a period of 60 means: the engine will write the most recent value of the channel to the archive every 60 seconds.

- monitor

As an alternative to the "scan" tag, "monitor" can be used, requesting monitored operation.

SUMMARY

Based on the Channel Archiver toolset of EPICS, it is very convenient for us to archive the PV through simple, flexible configuration. The archive efficiency is improved by using Oracle as the archive database because of its partitioning advantage. We can establish the accelerator state snapshot using the archived data, through this method; beam history state can be quickly loaded to improve the efficiency of beam tuning. Meanwhile, this system can exchange and share data with the HIRFL control system database. This method provides us a possible way and some useful technique to use EPICS architecture to update the HIRFL control system architecture.

REFERENCES

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