

A NEW DATA ACQUIRING AND QUERY SYSTEM WITH ORACLE AND EPICS IN THE BEPCII*

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Abstract

The old historical Oracle database in the BEPCII has been put into operation in 2006, there are some problems such as the program operation instability and EPICS PVs loss, a new data acquiring and query system with Oracle and EPICS has been developed with Eclipse and JCA. On one hand, the authors adopt the technology of the table-space and the table-partition to build a special database schema in Oracle. On another hand, based on RCP and Java, EPICS data acquiring system is developed successfully with a very friendly user interface. It's easy for users to check the status of each PV's connection, manage or maintain the system. Meanwhile, the authors also develop the system of data query, which provides many functions, including data query, data plotting, data exporting, data zooming, etc. This new system has been put into running for three years. It also can be applied to any EPICS control systems.

INTRODUCTION

BEPCII has successfully built its control system with EPICS^[1]. Besides using Archiver, a historical database^[2] with Oracle had developed for a long term storage. The data acquisition program developed by Python got the EPICS PVs from the EPICS IOCs. This program was scheduled by a back processing Cron. When it is scheduled timely, many CA were recreated and took too much times. As a consequence, the first schedule had been not finished, the next schedule had started. Many such data acquisition programs had been running in parallel so that the control network congestion caused EPICS PVs loss. Such kind of problem had happened many times since 2006. So, it is necessary to reconstruct a new historical database and data acquiring and query system with Oracle. Since EPICS has been widely applied to accelerator control systems, it's becoming a hot topic how to store EPICS PV data into a database for a long term storage. So, the purpose of this new system development is to be commonly used to EPICS control system.

THE OLD ORACLE SYSTEM

The old data acquiring and query system^[2] with Oracle consisted of three parts: data acquisition and Oracle database and data query (see Fig. 1).

The Old Data Acquisition Program

The data acquisition software programmed by Python

got the EPICS PVs from the EPICS IOCs.

It was scheduled by a Cron processing in Linux. It has the following disadvantages:

- Ineffective data acquisition sampling rate (once per minute). It took many times for the CA channels reconnection when it was executed.
- The program was repeatedly performed periodically. It means the next schedule has started when the first program had not been finished. Many same programs were running simultaneously so that the control network congestion caused PVs data loss.

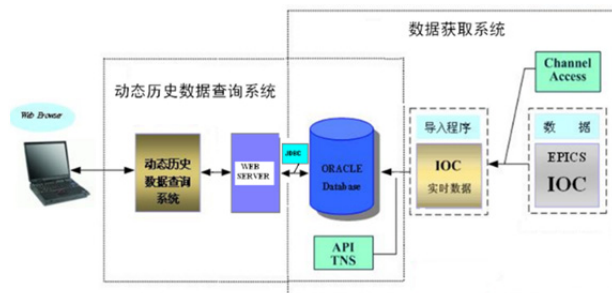


Figure 1: The old Oracle System^[2].



Figure 2: the Interface of the old Query System^[2]

The Old Query System

The old data query system was in B/S developed using Java. The query interface is shown in figure 2. It has the following disadvantages:

- It's impossible to implement the correlated subquery between the subsystems.
- The database tables are designed into one independent table for each subsystem (e.g. power supply control system table and vacuum control system table and so on).
- There is no any zoom in function and data without time stamp display in the interface.

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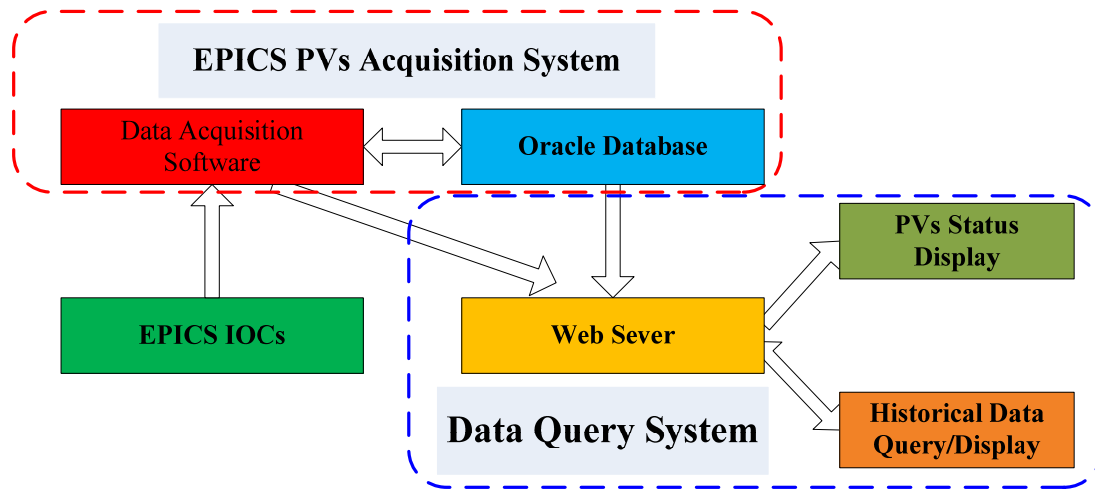


Figure 3: EPICS data access and query system architecture.

A NEW DATA ACQUIRING AND QUERY SYSTEM WITH ORACLE AND EPICS

The new system including data acquisition and query consists of three part: data acquisition and Oracle database and query (see Fig. 3).

The New Data Acquisition System

There are many interfaces to EPIC IOCs such as SCA、CA_Lab、MCA、CAP5、CaPython、JCA、CAJ and so on. JCA and CAJ are main interfaces to EPICS IOCs. After comparison on JCA and CAJ, we chose CAJ^[3] as the interface to EPICS IOCs and used a monitor method to get EPICS PVs, then send them to the Oracle database. This system is developed using JAVA on RCP platform. The data acquisition engine is shown in figure 4.

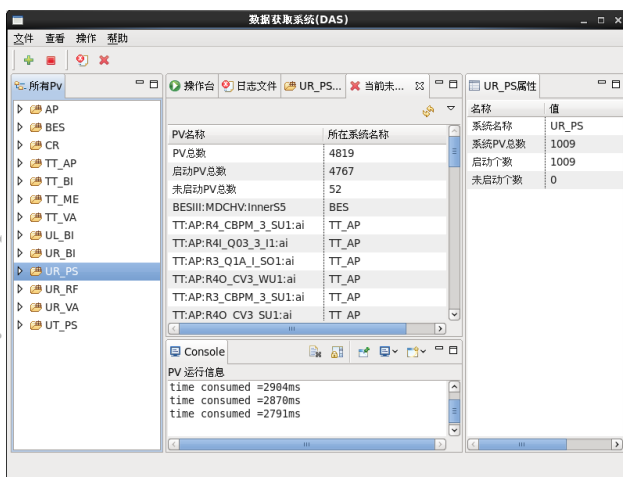


Figure 4: The data acquisition engine.

The data acquisition software using multithreading technology contains:

- Data acquisition thread.
- Data write thread.

- Data service thread.
- This system has the following function:
- Data acquisition of start and stop.
 - The recovery of PVs connection.
 - Log management.
 - PVs increases the wizard.
 - PVs status view.
 - Right control.

Oracle Database Model

There are about more than 5000 PVs to be stored in the Oracle database. These PVs are from EPICS IOCs of the different subsystems. There should be correlation between different data. So, we designed unique database tables: All_pv_list_tab and XX_tab. All_pv_list_tab mainly stored all PV static information, including name of PV, system name, alias, note, table, etc. XX_tab mainly stored PV concrete data, mainly including id, name of PV, PV date, PV value, including XX on behalf of the name of the system. All_pv_list_tab table structure as shown in table 1, XX_tab table structure as shown in table 2.

Table 1: All_pv_list_tab Table Structure

Field name	Type	Description
PVNAME	VARCHA R2(50)	PV 英文名称
SYSTEMNAME	VARCHA R2(100)	系统英文名称
LASTTIME	DATE	该字段保留
LASTVALUE	NUMBER (10,3)	该字段保留
DESCRIPTION	VARCHA R2(100)	系统中英文名称
PVTABLENAME	VARCHA R2(20)	PV 所在表名
MACHINES	VARCHA R2(100)	PV 中文名称
TATUSNAME	VARCHA R2(100)	

Due to more than 5000 EPICS PVs to deposited in the database, in order to improve the query speed of data, optimize the database performance, the data table on the first of all in the name of the PV primary partitions, and then conducted on PV time partition. All PVs with a month of data is stored in a table space. It's convenient to remove historical data and the maintenance of the system.

Table 2: XX tab Table Structure

Field Name	Type	Description
ID	NUMBER(20)	主键
PVDATE	DATE	PV 时间
PVVALUE	NUMBER(20,3)	PV 值
PVNAME	VARCHA R2(50)	PV 英文名称

The Historical Data Query System

The historical data query system takes EPICS PVs out of the database in the form of curve display on the web. This system mainly includes the web server program and web service, as shown in figure 5.

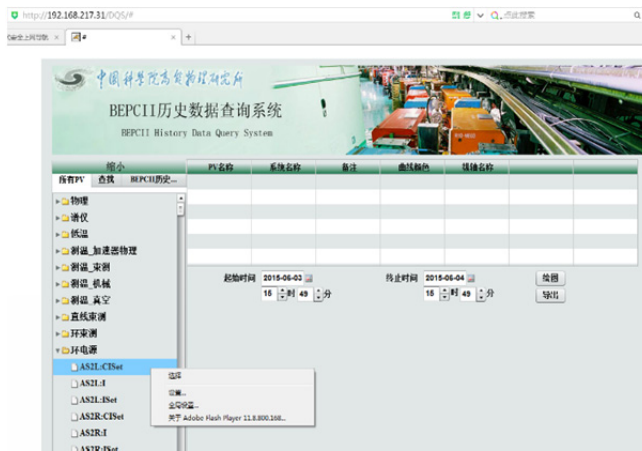


Figure 5: The interface of the historical data query system.

The web server programs are written in Java, database interaction using JDBC. The web page display service programs contain historical curve and the data acquisition engine status page. The web history curve display is developed using the Flex^[4], the main function is as follows:

- EPICS PV search.
- Query the date selection.
- Curve color choices.
- Longitudinal axis curve range of choice.
- Common longitudinal axis selection.
- Curve magnification.
- Curve with a little time message.

The historical data query interface as shown in Fig. 6, shows from 2013/01/16 to 2013/01/18, in collision mode within two days of the shape of the beam intensity and collisions brightness curve.

The data acquisition engine status page is shown in Fig. 7. It's convenient for the general users to view data acquisition engine PV operation state and running state diagnosis in data acquisition system.

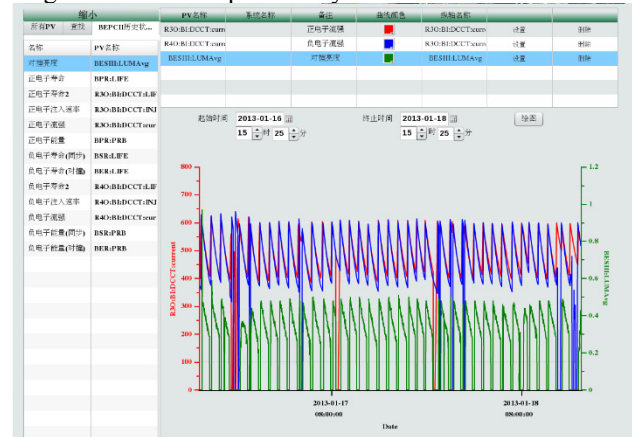


Figure 6: The historical data query interface and results.

数据获取软件PV状态

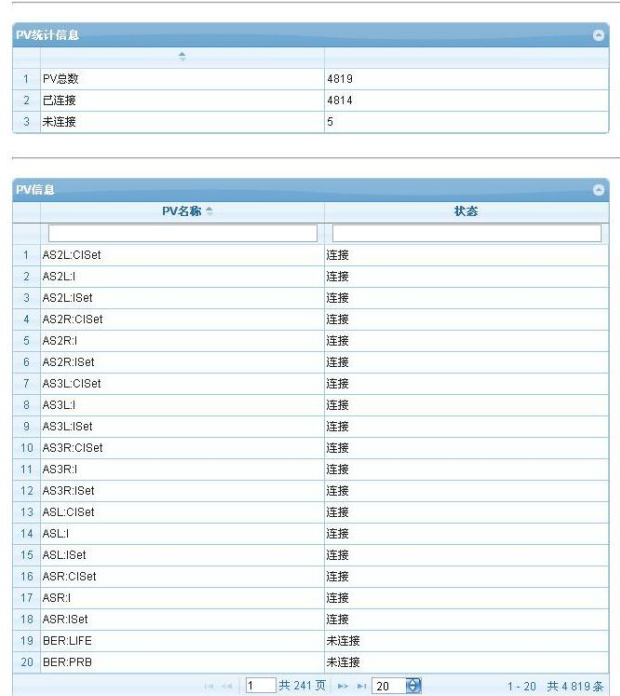


Figure 7: PV data acquisition engine running state.

SYSTEM PERFORMANCE TESTING

We mainly use Jconsole for the system performance test. The Jconsole provides memory, threads, such as CPU performance monitoring. It can easily find memory leaks and thread deadlock. The Jconsole testing interface as shown in Fig. 8. The new EPICS data acquisition system and the data query system has been put into operation since July 2012.

The new data acquisition system test results are as follows:

- Data acquisition software runs stable.
- The minimum sampling time 2s.
- The biggest footprint of about 250 m.
- Data storage consumption time 1.5s (48 tables and 200 data into one table).
- No memory leaks.
- No thread deadlock.
- No thread deadlock.

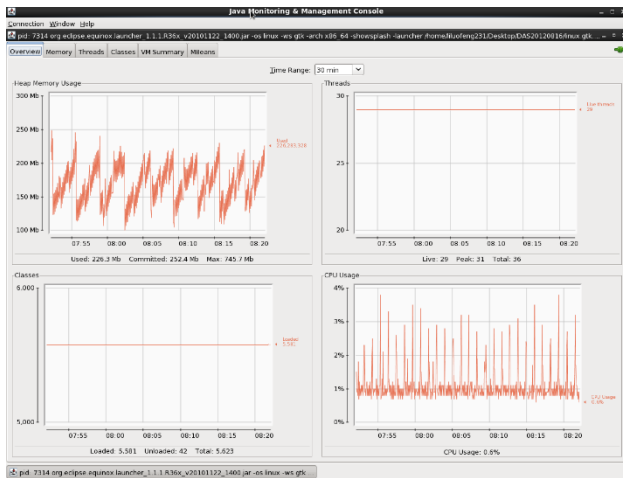


Figure 8: Jconsole test interface.

At the same time, data query system test results show that:

- Access concurrency > 50.
- Page 4s drawing time (1 day, 3 PVs), 15s (15 days, 3 PVs).
- Web services work duration > 190 days.

According to the above test results, for the long time storage, we uses the minimum sampling interval time 1 minute feed into the database. So, 5000 PVs estimate 24 hours and need about 300 MB to 500 MB of storage space, including data storage and index files are stored.

From monitoring system, without any increase in the signals under the condition of invariable and access frequency, storage for one year is about 100 GB of data storage space. Compared with the old system 300 GB per year, it's significantly reduced and saved storage space.

CONCLUSION

Compared with the old dynamic historical data acquisition and the historical data query system, the new system mainly solves the following problems:

- Data acquisition program operation instability.
- EPICS PVs connection interface.
- EPICS PVs connection stability.
- EPICS PVs access loss.
- No friendly man-machine interface.
- Slow data query speed.
- Unrelated query data query.
- Data without time stamp prompt.
- Without magnification.

The new data acquisition and historical data query system with Oracle have been trouble-free operation more than three years since July 2012. The new system is stable and reliable, and can completely replace the old ones. It can not only meet the needs of physical beams personnel, but also greatly convenient equipment operation maintenance personnel equipment fault analysis and diagnosis.

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