WEB-BASED REAL-TIME DATABASE ACCESS FOR BEPC II

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Abstract

All information on the dynamic web pages of the web site must be read from databases on the server. The web pages of the web-based BEPCII (Beijing Electron Positron Collider II) real-time information system access the databases at regular intervals automatically. When many clients visit the web site synchronously or the database size is getting to become more and more large, it increase the server much load severely, the response of the entire server system will be influenced directly. In the information system, we adopt the design strategy of the new databases which are resided in the server machine, it basically carry out the fast responses accessed the real-time databases.

BACKGROUND

The main status and operating parameters of the accelerator can be monitored by the web-based real-time information system for BEPC II during commissioning, these parameters include the beam currents, energy, life time and luminosity for BES III (Beijing Electron Spectrum III) etc.. The historical data of the accelerator equipments can be analyzed through the browser.

The original real-time information system only consists of one server computer. This server used HP Proliant ML350, it includes the dual core processors, 2GB memory, 140GB disk and so on. The web server system adopts the dynamic web site design, and it uses the different kinds of web pages to visit the single database table at the beginning of BEPC II commissioning. The obvious problem is that the system loads always are very heavy when the more clients visit same database of this web site especially, the responses from the system are very slower, Indeed, it give the clients to bring a great many distress.

We analyzed the reason caused this kind of the affliction. The design of the system and databases theoretically didn't exist the problem, and the server system also doesn't appear abnormity when it is visited by a little of clients and the database size is not too large, the system operation is normal. Along with the system running continuously, if the capacity of each database are increasing about 9,000 records (if 1 record/10s) at least every day, the size of database would be expanded fleetly; Even the multi-clients want to request the different database of other subsystem (such as RF superconducting cavity, safety interlock and accelerator commissioning, see Figure 1.) because of all these databases are resided in one server machine, here the load of the entire computer system is extreme heavy similarly, and the client's database requests would be delayed, resulting in the system send out continually the time-out of SQL requests, in this way, easily produced the database dead-lock and stopped some system services and so on.

In the beginning，we try to use 'Select top xxx / xx Percent' to limit the returned rows (records) from the database, or use 'SET ROWCOUNT' to limit the rows for avoiding more table scan, our intention is to reduce the amount of records read from the database, thus it may decrease the hardware spending on CPU time, memory space, I/O resource and others. In this way, we had obtained some effects, but when multi-clients focus on accessing one database at same time, the system response still is very slow-acting. After this, we also try to create the SQL index for retrieving the datum, thus dispensing with making to scan whole table can find out the datum needed quickly. The brought problem is that using index needs to occupy extra space of physical memory beyond the database table. On the other hand, because of the index will be rebuilt constantly when the real-time database table is updated ceaselessly, so creating and maintaining the index still costs certain time. Thus it would lower the speed of the data access. Similarly, when the multi-clients visit the web site and access same database, the efficiency of the system seems not to be very ameliorative.

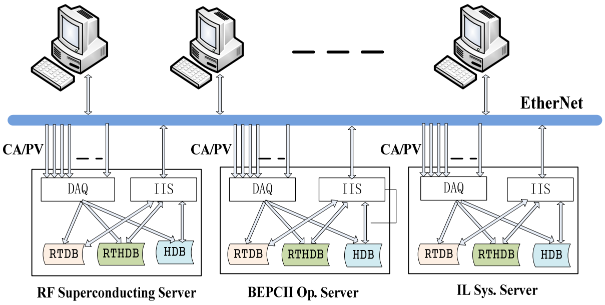


Figure 1: The structure of BEPCII real-time information system.

To solve these existent problems, we decided to add other two server machines into the real-time information system for enhancing the system ability. One of three servers is dedicated to the commissioning server, second is the server for RF superconducting cavity and third for the safety interlock (next will be added for the power supply subsystem later). Even running under the new system structure, when the database size is more than 100,000 records, the system responses for the clients still be getting slower again. In general, we know that one table holds 100,000 records is not too much, however along with the commissioning continuously, the physical size of the database of each system would be more and more huge, and the problems are still more and more serious.

THE REAL-TIME DATABASE ACCESS

As each server in the BEPCII real-time information system, they all are one node on the Ethernet. The DAQ

(Data Acquisition) programs can acquire dynamically the raw data from each subsystem of the accelerator through the PV variables of EPICS CA（Channel Access）, then the DAQ program stores them into the different database according to the different time intervals quickly (see Figure 1.).

In the information system of BEPCII, the display of the web pages for real-time status is different with the normal dynamic and/or static web pages. It demands that the current web page can be refreshed at regular intervals continuously. When the web page is refreshed each time automatically, the related database would be accessed once. Especially when some clients want to make the statistic analysis and/or to display the historical curves, it need to read and traverse the entire database, at this rate, this is very time-consuming operation apparently.

To solve the response problem, we performed the optimized design for the web site system, that is, adopted the storage strategy divided the real-time data processing and display from the data analysis. The method used one database table to design multi-database can make that the different web page access the different database. It can obtain the better results for guaranteeing the real-time requests to the system.

We designed three kinds of the databases. According to each kind of the database table, we called respectively them as: Real-time (parameter) database, Real-time historical database and Historical database. The different database is served for the web page of the different function. If the web page only requires to display some real-time parameters (no curves) of the commissioning for the accelerator, then it accesses simply the real-time database to get the latest parameters at the minimum interval 500ms and dispense with accessing the historical database held the huge data records. This real-time database always keeps one record, it is like a computer register, and it stores merely the latest raw data and status of the accelerator and depresses the system spending. Utilizing this design of the database, the database link programming in the language as .asp, .jsp, .php and etc. for the web page can be simplified, and the web-based program structure can be optimized too.

The real-time historical database only stores the recent historical datum in 24 hours(one day) at minimum interval 10s normally, of course, the time range can be chosen arbitrarily and changed according to actual need, such as, two or three days. So this type of database is called the real-time historical database stored the limited datum. This database always maintained the up-to-date and fixed amount of the records. Design this kind database, its purpose also is to avoid the access to the database which stored the huge amounts of data records, causes that the web page may display quickly the latest parameter and the curves. The different web page visit the corresponding database, and that the database size can be determined by the designer according to the chosen time.

Third type of the database is called the historical database. It is used to store all the historical data records at the minimum interval 120s since the accelerator commissioning. Their amounts of data are very large, and there is no limitation to the size of the database. These historical data can be used to the statistic and analysis, and also for the data sources of the data warehouse and data mining. In general, the clients visited the historical database only are few, even the amount of datum retrieved is very large, its influence to the system responses is transitory.

Because of the dynamic web page visits the server ceaselessly，and the data acquiring programs refresh the database at respectively regular intervals continually, and sometimes other web pages also want to query the database and/or make the data statistics and analysis etc., however, these operations may be focused on particular and/or a few databases tables. And at times, although the related data queries for statistics and analysis retrieve the data are not frequent, but yet it still traverse the database table held huge capacity data, this is a very time-consuming operation, thus it will cause the client request delay and the conflicts between the web page's visit, easily results in the system dead lock or stops the system service.

After optimizing the design, separated the display for real-time data and current curves from data query and statistics analysis, enhanced the performance of data processing. It is very useful that this kind divided storage strategy conduces to improve the real-time processing for the huge data on the web-based information system.

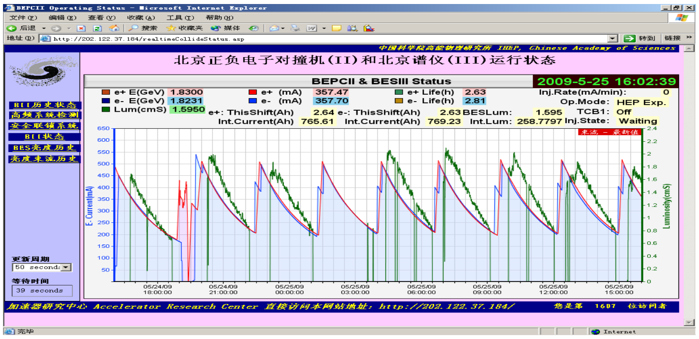
Under the special circumstance, for example, if some renewal web pages only need to display real-time operating parameters for the accelerator frequently instead of the historical curves, it would be great that it merely access the real-time database, thus its response taken these parameters from real-time database will be faster than from big database, the performance of system processing will heighten several times or much more times.

This design strategy of the databases separates the loads of the big database, and reduces the system time-out or dead lock when accessing the huge database, increased the reliability of the whole system.

As an example, when the dynamic web page gets all the data from the real-time historical database held about 9,000 records (at interval 10s, one day) to display the operation parameters and some curves automatically, the access of the web page only traverse these maximum 9,000 records, and dispense with the accesses to read that table owned already more than 100,000 records (Usually more this quantity in capacity), the whole system response obviously is faster than before. Through the testing, before the optimization design of the system, one access process of the dynamic page needs more than 30 seconds absolutely (when the capacity of database are more records); After the optimization design, this process only needs about 4 seconds at same mount of the data, its ratio is about 7:1.

CONCLUSION

It is common problem how to process quickly the accesses to the huge databases based on web applications. BEPCII real-time information system adopted this database design strategy, the data refreshing and the response are quickened obviously, and given that the system had a steady operation, even more clients synchronously visited web-based information system without serious delayed sense (see Figure. 2).



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北京正负电子对撞机(II)和北京谱仪(III)运行状态

BEPCII & BESIII Status 2009-5-25 16:02:39

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e- E(GeV) 1.8231 e- (mA) 357.70 e- Life(h) 2.81 Op.Mode: HEP Exp.
Lum(cmS) 1.5950 e+: ThisShift(Ah) 2.64 e-: ThisShift(Ah) 2.63 BESLum: 1.595 TCB1: Off
Int.Current(Ah) 765.61 Int.Current(Ah) 769.23 Int.Lum: 258.7797 Inj.State: Waiting

更新周期 50 seconds
等待时间 39 seconds

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Figure 2: The dynamic web page of accelerator commissioning.

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