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GLOBAL INFORMATION MANAGEMENT SYSTEM FOR HEPS

C.H. Wang , P.Chu, Institute of High Energy Physics, Chinese Academy of Science, Beijing, China
H.H. Lv , Shanghai Institute of Applied Physics, Chinese Academy of Science, Beijing, China

Abstract

HEPS is a big complex science facility which consists of the accelerator, the beam lines and general facilities. The accelerator is made up of many subsystem and a large number of components such as magnets, power supply, high frequency and vacuum equipment, etc. Variety of components and equipment with cables are distributed installation with distance to each other. These components during the stage of the design and construction and commissioning will produce tens of thousands of data. The information collection and storage and management for so much data for a large scientific device is particularly important.

This paper describes the HEPS database design and application from the construction and installation and put into operations generated by the uniqueness of huge amounts of data, in order to fully improve the availability and stability of the accelerator, and experiment stations, and further improve the overall performance.

INTRODUCTION

High Energy Photon Source (HEPS) has constructed at suburban areas of Beijing in the end of June in this year. HEPS is a big complex science facility which consists of the accelerator, the beam lines and general facilities. The accelerator is made up of many subsystem and a large number of components such as magnets, power supply, high frequency and vacuum equipment, etc. Variety of components and equipment with cables are distributed installation with distance to each other. These components during the stage of the design and construction and commissioning will produce tens of thousands of data. The information collection and storage and management for so much data for a large scientific device is particularly important.

Database system will provide global database for lighting project and application services, including accelerator, beam line, HEPS project management, application software and database, thus ensuring HEPS whole big science device from construction, installation and put into operations generated by the uniqueness of huge amounts of data, in order to fully improve the availability and stability of the accelerator, and experiment stations, and further improve the overall performance.

This system designs the related database according to the comprehensive requirements of physics and management, and develops the Application Programming Interface (API) and some database Application software. After passing the test stage and initial operation, the database and application software will be deployed to the computer room of the computing and network communication system, and professional database managers will be responsible for daily operation management and performance optimization.

All database design and application source code will be stored in AcceleratorDatabase software set of GitHub server under modern software management specifications for domestic and international cooperation, and stored in HEPS internal Git server to ensure software security.

DATABASE DESIGN

The database and its related application software architecture also follow the overall architecture of the upper software in the accelerator control. The whole HEPS database covers a large range, and it is difficult to complete the design and construction in one time with limited human resources. Therefore, the database can be functionally broken up and modularized into several smaller databases to be developed separately and done in collaboration with other labs. Each module is connected by simple modification of Primary key and Foreign key, data acquisition API or software service.

The overall architecture of the accelerator and beam line (non-experimental data) database set was based on IRMIS[1] (Integrated Relational Model of Installed System) v3, and was designed based on the collaborative work of the former DISCS[2] international accelerator database. This part of the database will be open source database such as MySQL. Most of the databases related to project management are based on MS SharePoint, so most of them are stored in MS SQL database built in SharePoint in the form of document whole and content decomposition data.

For the mysql-based accelerator and beam line database, MySQL Workbench or other visual schema editing tools as shown in the Fig. 1 are used to design the database schema according to user requirements. After the schema preliminary design is completed, it is deployed to the MySQL server under test.

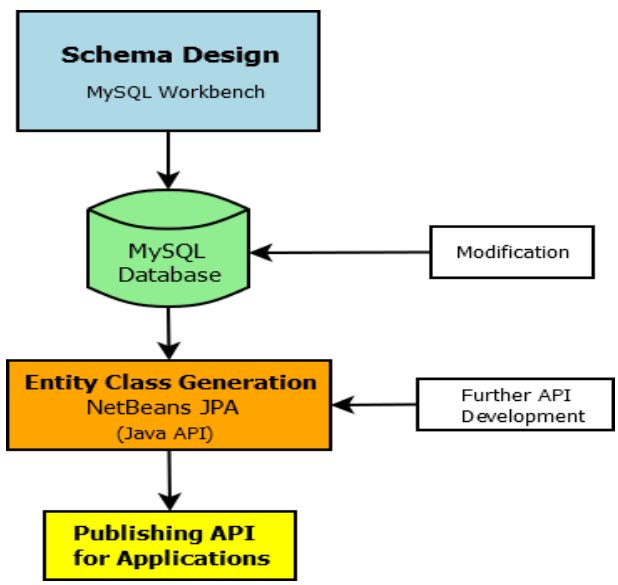

Figure 1: Typical relational database development.

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The Main Technical Parameters

The main technical parameters and indexes of database system design are as follows:

- 1-2 million static parameters storage and query
- 1-2 million EPICS PV to acquire storage
- Fast data retrieval
- Users (not administrators) can add static parameters and EPICS PV
- A storage strategy based on a single PV
- Zero predictable maintenance Support
- Supports multiple data storage (short, medium and long term), and automatically transfers data between different data storage
- Provide a good management interface, users can add parameters and PV through the browser, view various parameters
- Support EPICS alias

Critical Database

The overall HEPS database covers a large range. At present, we have planned 17 working modules based on relational database according to functions, which are detailed as follows:

- Parameter List
- Naming Convention
- Magnet
- Lattice/Model
- Device/Configuration
- Physics/Save/Restore
- Logbook/Issue Tracking
- Operation/Maintenance
- Inventory
- Survey/Alignment
- Work Flow Control/Traveler
- Tech Notes/Documentation
- Cable
- Authentication and authorization
- Machine Protection System/ Interlock
- Alarm
- MPS Postmortem Analysis

In this paper, we will mainly describe the following database: Parameter List and authentication database and Inventory database.

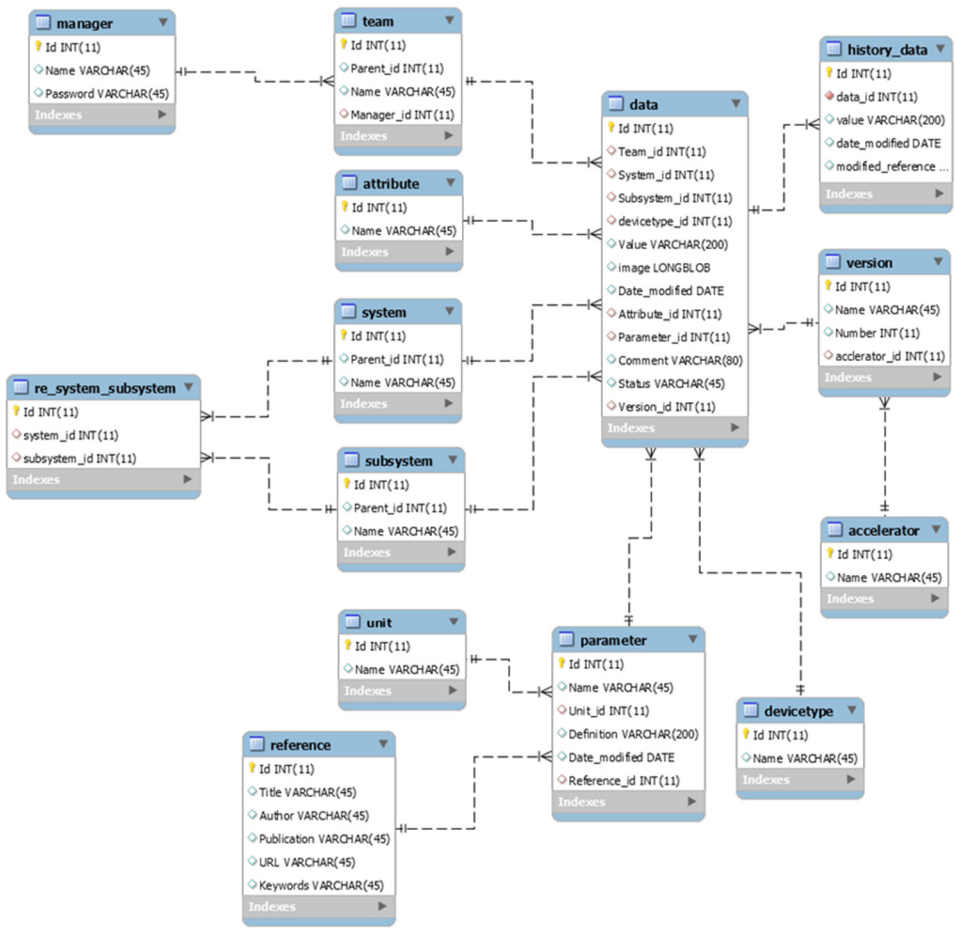

Figure 2: Parameter table database design.

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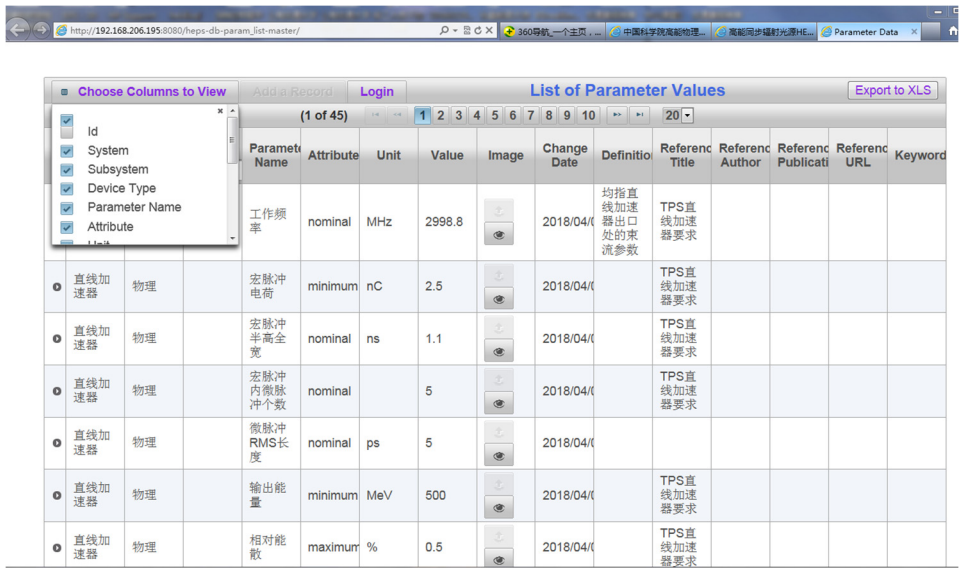

Figure 3: Parameter table database web application.

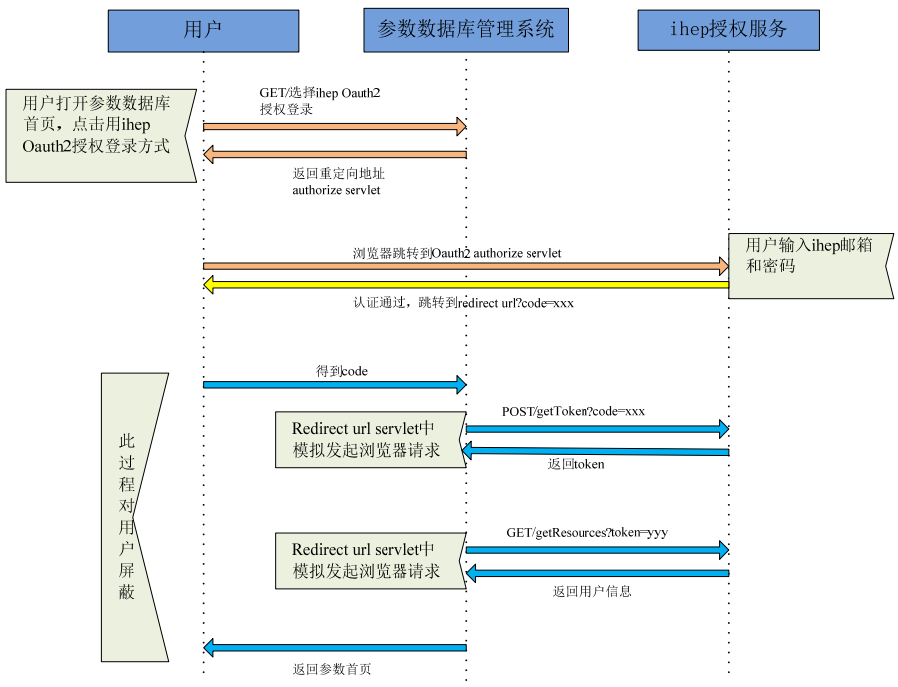

Figure 4: Authentication process.

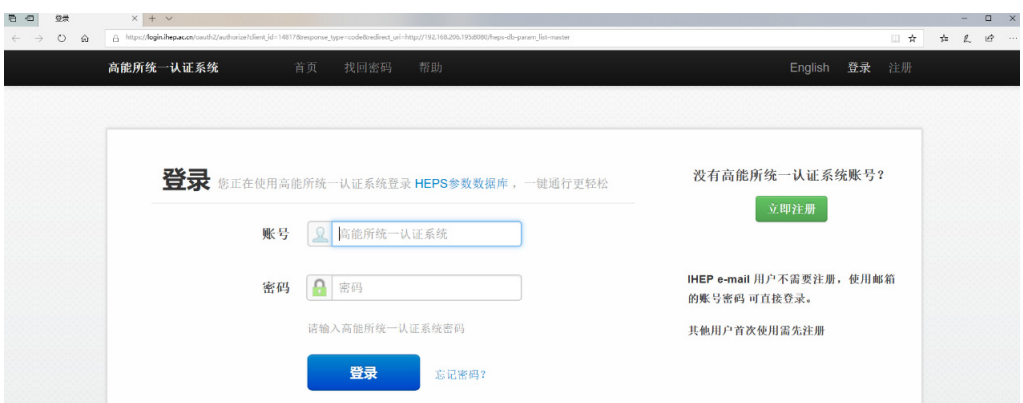

Figure 5: Authorization database login interface.

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PARAMETER LIST

During the design and construction of the light source, the design parameters and acceptance indexes of the accelerator and the beam line must be strictly controlled and kept in a unique database. According to the current construction experience of major scientific devices (such as BEPCII and CSNS), parameters can be determined by mail or paper work contact sheet between each system. Due to the large number of parameters, it is easy to make mistakes, and a large amount of time needs to be spent on cross-checking between the persons in charge of each system for many times, resulting in low efficiency. This traditional working mode is not suitable for the management of modern advanced light source. Therefore, we refer to the original design of ESS and modify it into a parameter table database suitable for HEPS. The design of parameter table database is shown in Fig. 2, including 14 tables, including system, subsystem, equipment class, parameters and data, and reference files of this parameter. Among them, the parameter database adopts the universal name/value matching design and can be compatible with image data. Therefore, this parameter table database can be applied.

The parametric table database also has a web-based user interface application, as shown in Fig. 3, which currently has the following functions: select, sort, modify, upload, and delete. There is also batch import via Excel. The remaining functions to be completed are exporting selected parameters to Excel sheets, generating printable reports on parameter tables, generating layout diagrams for mechanical parameters based on component layout positions, and so on.

AUTHORIZATION DATABASE

This system adopts Oauth2.0 resource authorization protocol for user authorization authentication. Specifically, it USES the oauth package for Java provided by Apache to realize resource authorization access. There are four authorization modes of Oauth2. The system adopts authorization_code, and the authentication process is shown Fig. 4. This authority authentication database can be used uniformly for login interfaces of various databases (Fig. 5).

INTELLIGENT MANAGEMENT SYSTEM FOR HEPS DEVICES

Objective is to solve the information management of the HEPS equipment from construction, installation and operation, so as to reduce the tedious manual labor. From the beginning of the construction of HEPS, each system needs to report the expenditure budget of equipment, and fill in Excel forms of various budgets. The filling of forms is carried out from each system to the overall summary, which costs a lot of labor, and often fills in various forms according to the needs. We will set up a complete relational database from the naming rules of the device. On this basis, all kinds of customized tables are automatically exported out. People can use mobile phone to scan QR code to track the whole process of the equipment (budget, purchase, warehousing, receiving and other information), and quickly browse. The data access scheme is shown in the Fig. 6. It consists of six parts: uniform equipment coding, data extraction of each system, data analysis and uniform device coding, server, data formatting, data storage. The data storage is divided into structural data, unstructured data and operating data. The structural data is saved into the relational database. The unstructured data is saved into files. The operating data is saved into time series database.

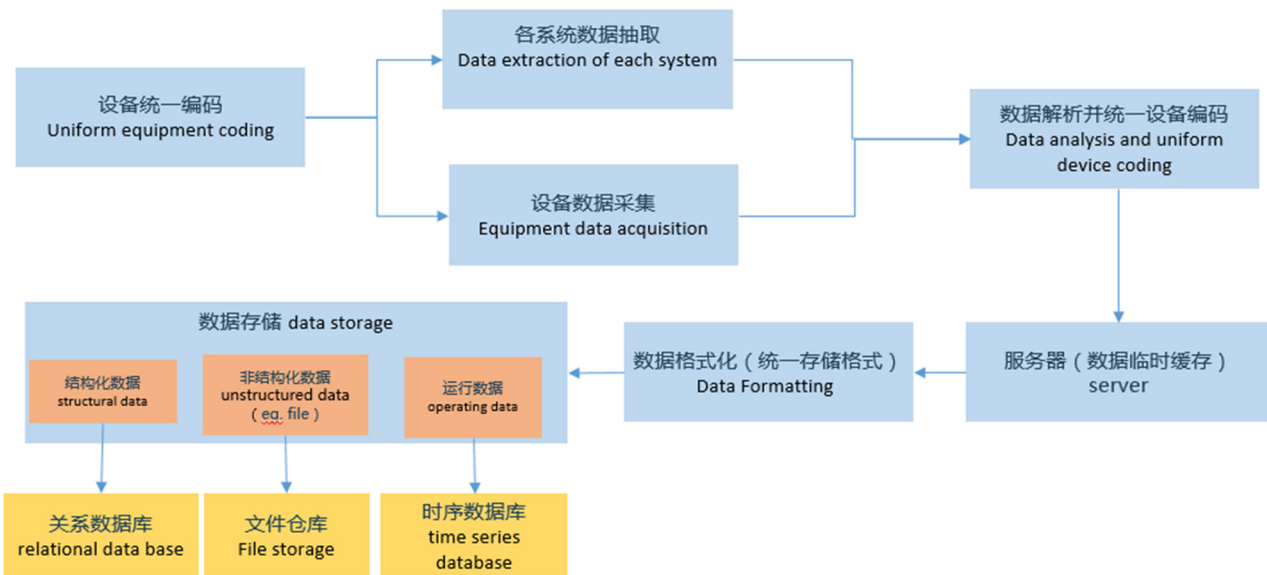

Figure 6: Data access scheme.

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This system provide the following functions:

- Equipment from "life" (start to use) to "death" (scrap) full information management including equipment file management, equipment distribution management, equipment allocation management, equipment scrap management, equipment classification management and equipment manufacturer management.
- Automatic generation of equipment inspection, automatic distribution of tasks, linkage maintenance business.
- Mobile terminal equipment repair, receive maintenance application, maintenance registration, acceptance and maintenance work. Inquire maintenance record, statistic equipment failure rate, generate maintenance account.
- Automatic generation of equipment maintenance, automatic distribution of tasks, linkage maintenance business.
- Conduct periodic inventory of equipment assets using equipment ledger and RFID tags.
- Fast and efficient, automatic production of inventory records and ledger.
- Make spare parts plan and budget.
- Generate all kinds of required business statistical reports, standard desk accounts.
- Export EXCEL/PDF format, query authority can be assigned and controlled.
- Through big data analysis of various state data of the equipment, we can provide the problems that may occur in the equipment, and take the initiative to repair and maintain the equipment in advance, so as to avoid modification after failure.
- Equipment maintenance "foresight, nip in the bud", keep the equipment in good condition for a long time, reduce the failure rate.

The ultimate goal is to be based on the massive data stored, the application of big data based on accelerator and beam line can be developed by using data mining technology and machine learning algorithm, so as to provide decision-making analysis and early warning mechanism for the operating efficiency of the light source, so as to improve the operating reliability of the light source and the maximum utilization value of experimental data.

SUMMARY

So far, the HEPS has just started to construct in June of this year. The whole HEPS database covers a large range, and it is difficult to complete the design and construction in one time with limited human resources. So, we will collobrate with other institutes. Databases can be functionally broken up and modularized into smaller databases to be developed separately and done in collaboration with other institutes.

REFERENCES

[1] http://irmis.sourceforge.net/

[2] http://discs.openepics.org/