EVENT-BASED SYSTEM TO MANAGE THE MAINTENANCE OF TAIWAN PHOTON SOURCE

C. W. Hsu, Z. D. Tsai, C. Y. Liu, C. S. Chen
National Synchrotron Radiation Research Center (NSRRC), Hsinchu 30076, Taiwan

Abstract

This paper describes a model of an event-based system to manage the maintenance in providing the conditions for commission of the utility facility. This system adopts cloud servers with a structured query language (SQL) database to treat all utility information about the facility. The system collects all event conditions, including scheduled maintenance, troubleshooting, alert information and equipment specifications. The user can readily access all facility information in mobile devices by scanning the quick response (QR) tag. This system can increase system reliability, decrease the cost of maintenance, minimize unprogrammed shutdowns and enhance the system performance. This system can also provide enough information to schedule maintenance, whether ordered by a user or preventive, and to optimize energy usage.

INTRODUCTION

Taiwan Photon Source (TPS) project, at present under construction at NSRRC, will provide a 3.0-GeV light source for users. In response to the extensive future maintenance work on the utility equipment, we have developed an event-based system to manage the maintenance of TPS. This system can improve the efficiency of maintenance work.

In previous work, the related systems for utility and alert design have been developed. The SMS system has been successfully used in a utility system of NSRRC. In case of a failure of critical components, a message is sent immediately to the maintenance personnel, and the relevant equipment will obtain the best attention [1]. A novel control and archive system for a utility facility was generated at NSRRC [2]. We had already finished the hardware design of utilities for TPS [3]. A novel system structure and control strategy had been proposed for TPS. The energy-saving issue has also been carefully considered [4]. Meanwhile, pending completion of the TPS construction project, this paper presents a system to manage the maintenance, to improve the efficiency of the maintenance work.

For utility systems having moving parts and rotating machinery, the scheduled maintenance must be fulfilled, as a fault situation of a machine produces a significant loss. To avoid a disaster happening, a predictive maintenance must be developed. To provide an easy, reliable and convenient method for maintenance to assist a technician to take care of the accelerator facility, especially the utility equipment, an event-based system to manage maintenance has been developed with a prototypical structure. This structure, based on the previous archive system, integrates a SQL database to implement the event recorder and QR code to provide an access tag for history view.

ARCHITECTURE OF MAINTENANCE MANAGEMENT SYSTEM

Based on the previous structure of an archive system, the system has four main levels: a remote-viewer level, a data service level, a data processing level and a controller level, as shown in Figure 1. In general, the controller level has hardware layers with various controllers; this level typically has a dedicated network protocol to transfer online data toward the exchange server. The exchange server confirms whether the status is at fault, to save the event recorder toward the SQL server located on the data service level. The SQL server possesses varied alert information, machine commission, fault status etc. Client software has been integrated into the previous archive system software to provide a query function of a fault record. The query function includes a time tag, data type and location to cover all possible situations. The maintenance personnel can access the information from the SQL server anytime and anywhere.

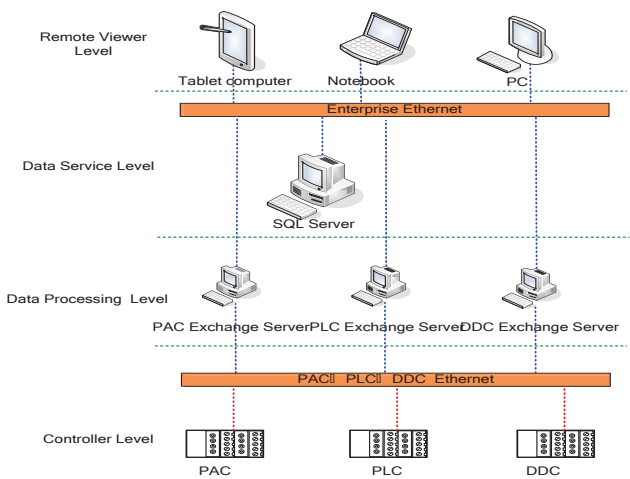

Figure 1: Network architecture of the SQL server.

MAINTENANCE MANAGEMENT SYSTEM WITH SQL DATABASE

For efficient searching and sorting event records and systematic integration to store useful information, the

management system adopts a SQL database. This database is a combination of many tables. A table is a combination of many fields. A field is a combination of many characters. A character is the smallest unit of the database. The scheme of the database is shown in Figure 2. SQL is a programming language to manage a relational database systematically. It is easy to comprehend for a beginner, because the SQL syntax resembles English semantics. For example, command SELECT retrieves data from one or more tables; the schema statements are shown in Figure 3. Command SELECT is the most complicated statement with keywords and clauses that include FROM, WHERE, ORDER BY etc. Statement FROM describes where the tables are. Statement WHERE describes the setting of the query condition. Statement ORDER BY can provide an ascending or descending sorting function for the query dataset. Using the excellent characteristics of the SQL database, we design thereby some Tables for our maintenance system, including SMS alert information, machine commission status, machine fault status, a monitor sensor crossing a threshold limit, trouble shooting and routine maintenance. The records can provide much information for maintenance to predict the machine burning in. In Figure 4 showing the SQL syntax based on Archive Viewer software, we built a new function 「Event」 for the system to manage utility maintenance. The event view uses a SQL database structure to provide operators with a display of historical events. In the event view, when the date and time period, machine region and event category are entered, the software will show the status of the event record immediately. In this way, the maintenance personnel can handle the past and current status of the equipment. All equipment has a comprehensive resume stored in the database, whereby the database provides an immediate and efficient status of the equipment for maintenance management.

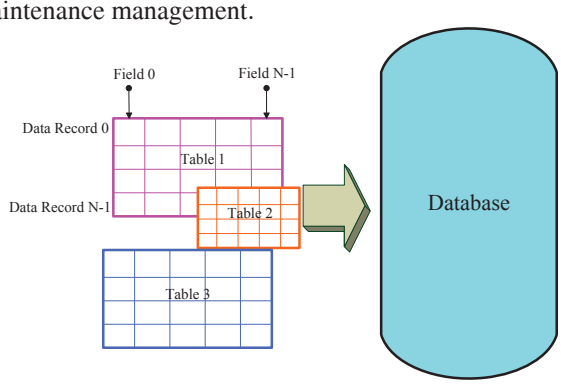

Figure 2: Scheme of the database.

```
SELECT    Field 1、Field 2、...
FROM      Table 1、Table 2、...
WHERE     Conditions...
ORDER     Field 1、Field 2、...
```

Figure 3: Schema statements of SQL.

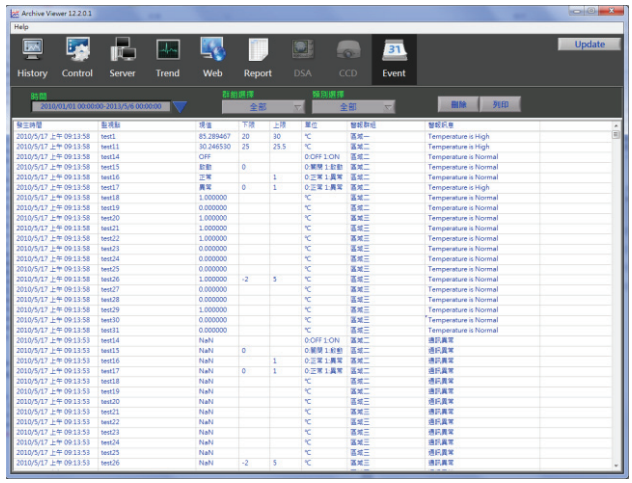

Figure 4: Event display of archive data.

MAINTENANCE MANAGEMENT SYSTEM WITH QR CODE

The Quick Response Code (QR) is a two-dimensional bar code, because the inventors expect that its information can be quickly decoded. The QR code rendered in a square, composed mainly of black and white, has the ability to allow errors. If the QR code pattern is broken, the QR code is still readable for the content. The QR code is static information and stores no dynamic information. We use QR code as an accessible entry of the machine or to monitor sensor identification. Once the QR code is decoded, the identification can elicit history information from the archive database and an event record from the SQL database.

We designed also some criteria for tag names to identify a machine or monitor sensor in a dedicated manner. The tag name comprises four fields, including system, location, facility/subfacility and sensor. The system field covers all the utility system, including Cu deionized water, RF deionized water, Al deionized water, chilled water, cooling water, hot water, ventilation etc. The location field is defined by the coordinates, including building, floor and region, as shown in the top view of T building in Figure 5. For a sensor located in building T, 33 column, CIA room and the second floor, the location field of the tag name is named 33CT2. The facility/subfacility field describes the main and attached equipment, such as a fan, damper, heat exchanger, pump, air handling unit et cetera. The last field describes sensors of various types, such as for temperature, pressure, flow meter etc.

After finishing the tag name, we applied the function to search for history information from the archive database and an event record from the SQL database. Based on the previous Archive Viewer software, the operator can obtain the equipment information on mobile devices on scanning the QR code. For example, the history view is accessible via QR code to observe offline data as shown in Figure 6.

ISBN 978-3-95450-122-9

Figure 5: T building top view.

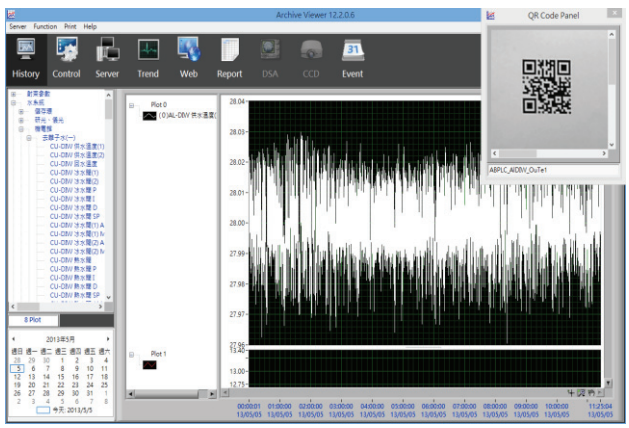

Figure 6: Status of the utility facility.

CONCLUSION

In this latest design of a system to manage the maintenance of TPS, the database has been finished in a SQL server. Some utility schemes of the TLS have also been adopted. In this paper, the main purpose of the event record is to facilitate maintenance personnel in a short period of time to know the fault of the equipment. These methods have much increased our work efficiency.

ACKNOWLEDGMENT

We thank our colleagues of the utility group of NSRRC for their assistance.

REFERENCES

[1] T. S. Uen et al., “SMS Alert System at NSRRC,” Particle Accelerator Conference 07, New Mexico USA, 2007 June.

[2] Z. D. Tsai et al., “Integrated Control and Archive System for Utility Facility,” ICALEPCS2009, Kobe Japan, 2009 October.

[3] J.C. Chang et al., “Utility Design for the 3-GeV TPS Electron Storage Ring,” EPAC’08, Magazzini del cotone, Genoa, Italy, 2008 June.

[4] Z. D. Tsai et al., “Utility Cooling System Design for the Taiwan Photon Source ,” IPAC’10, Kyoto, Japan, 2010 May.