IoT APPLICATION IN THE CONTROL SYSTEM OF THE BEPCII POWER SUPPLIES*

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Abstract

In recent years with the development of Internet technology, the Internet of things (IoT) has begun to apply to each domain. The paper introduces the idea how to apply IoT to the accelerator control system and take the existing control system of the BEPCII power supplies as an example for IoT application. It not only introduce the status of the control system of the BEPCII power supplies, but also present a solution how to apply IoT to the existing control system. The purpose is to make the control system more intelligent and automatically identify what and where the problem is when the alarm of the control system of the power supplies occurs. That means that IoT can help to automatically identify which chassis and which module inserted in the chassis and the connection cables. It is great convenient for the maintainer to use a mobile phone to diagnose faults and create the electronic maintenance record.

INTRODUCTION

In general, a modern accelerator is a complex facility which consists of many systems and a large amount of equipment such as magnets, power supplies, RF and vacuum devices, and so on. Various equipment and cables are placed dispersedly with a long distance. During the construction and installation as well as running of an accelerator, a huge number of data and information related to the equipment are created. So, it's very important for a large accelerator to collect, save and manage such large data. With the benefit of the Internet of things, these problem can be solved nicely. The idea of IOT application in the accelerator is that every object is connected, and people and objects are also linked together; there should be setup model of two-sided direct interconnecting and interworking networks. It's possible to use RFID[1] in the accelerator to construct a sensing layer as shown in Figure 1.
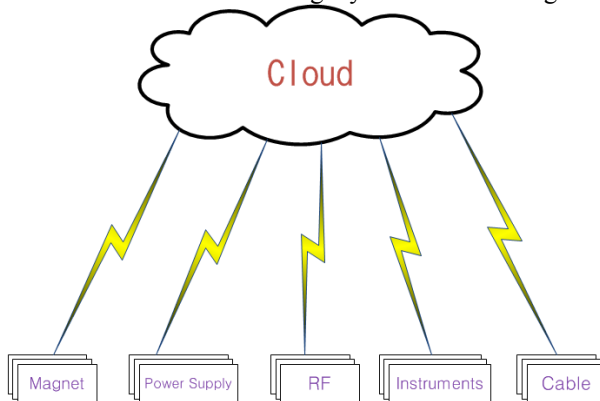

Figure 1: IOT with RFID in the accelerator.

The goal is to automatically track the information of the accelerator equipment and devices as well as the cables with RFID. So, we will take a mature system as an example of IoT like the BEPCII power supply control system.

POWER SUPPLY CONTTROL SYSTEM IN THE BEPCII

The control system of the BEPCII[2] power supplies follows the "three-layer" standard model [3] of a distributed architecture as shown in Figure 2. The front-ends consist of VME-64x crates, Motorola PowerPC750 CPU boards (MVME5100s as IOCs) and PSC/PSI modules as shown as in the figure 2. A workstation/Linux and a PC/Linux are used for the EPICS development. There are 17 IOCs (10000 points) implementing the controls and monitors for more than 400 magnet power supplies in the two rings and the transport line. The control system of the BEPCII power supplies has run well for ten years since it was put into operation and running in September of 2006.
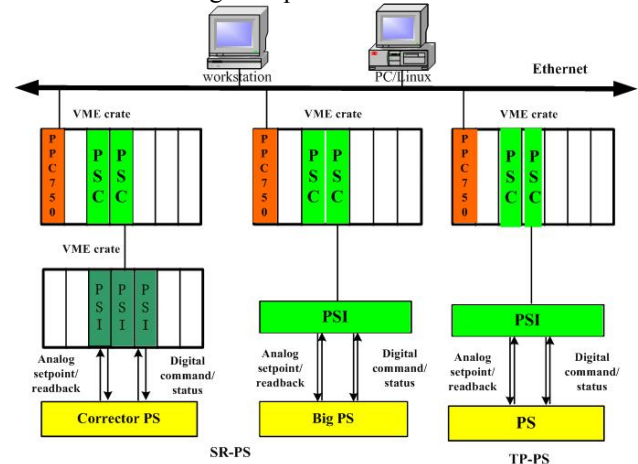

Figure 2: BEPCII PS Control System Architecture.

During the maintenance of the BEPCII control system, there are many different kinds of control devices and various, thousands of cables, it's not so easy for the engineers to maintain, even there are labels on the control crates and control modules as well as the cables; it's easy to forget after a while. Therefore, it is very important for the electronic information with RFID of all equipment (cabinets, chassis, plug-ins, cables, etc.) to be automatically identified. This will greatly improve the control system intelligence, operation maintenance convenience, fault location identification and automatic maintenance logging.

Layout of the Power Supply Control Station

There are four local stations for the power supply control in the BEPCII. There are many cabinets, chassis, plug-ins,
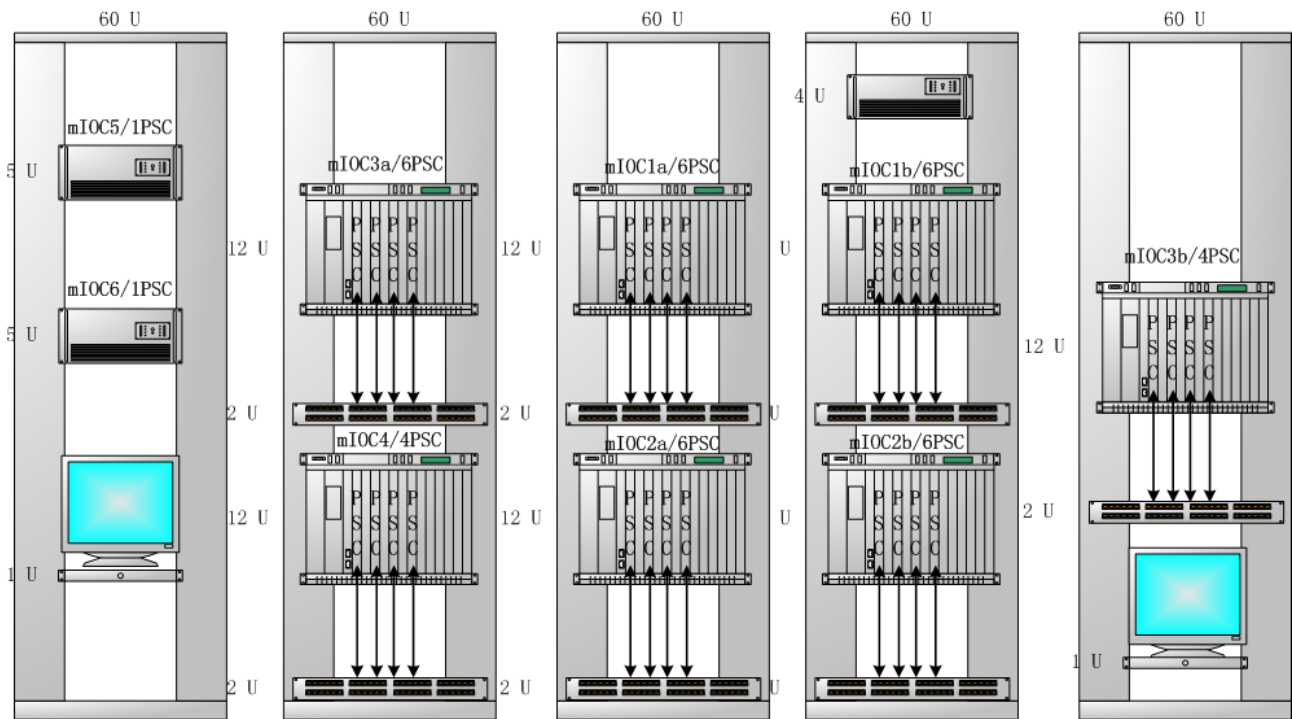
Figure 3: Layout of the big power supply control station in the BEPCII.

cables, etc.in each local station. Figure 3 shows a layout of the big power supply control station for BEPCII. It's not so easy for engineers to maintain so many cabinets, chassis, plug-ins, cables, etc. When a fault occurs with the power supplies and the control system, it will take a long time to recognize what and where the problem happened. In order to improve the control system intelligence, we will use RFID to construct a sensing layer in each power supply control station. The goal is to make the operation maintenance convenient, easy to recognize the fault location, and automatically recording maintenance and generating electronic maintenance log.

IOT APPLICATION IN THE CONTROL SYSTEM OF THE POWER SUPPLIES

The architecture of the IoT application is shown in Figure 4. It consists of the RFID and the cabinets, the chassis, the plug-ins, the cables as well as the control system. The information of the cabinets, chassis, plug-ins, cables in the control system of the power supplies will be stored in a MySQL database. The status of the control system of the power supplies like ON/OFF, Local/Remote, Normal/Alarm will send directly to IoT server via a data interface services (DIS) to the control system of the power supplies. The IoT application server will monitor the status of the cabinets, the chassis, the plug-ins, the cables and the status of the control system of the power supplies. When a fault occurs in the control system of the power supplies, the IoT application will inform the engineers to maintain the control system on-site. The engineers scan the QR cord in the local station of the power supply control and get the permission to repair; they can then recognize what and where the problem happened according to the alarm colour, , and perform the repair. When the maintenance work is

finished, the engineers are responsible for writing a record and submitting the record to the IoT server. In addition, the engineers may monitor the status of the cabinets, chassis, plug-ins, cables and the control system of the power supplies by IoT APP.
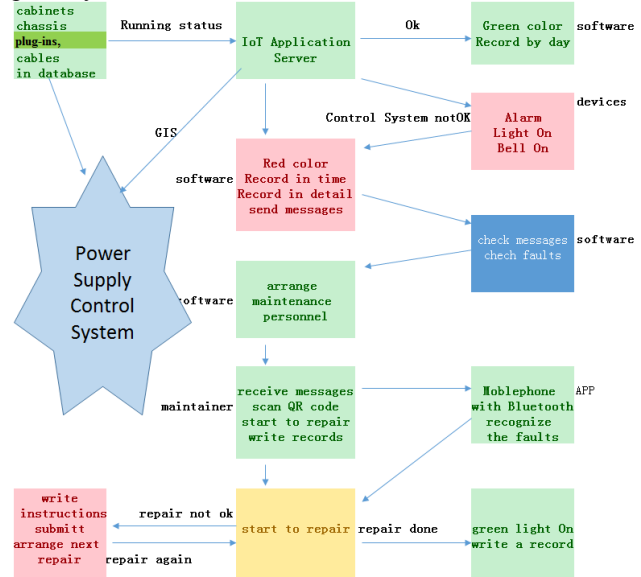

Figure 4: The architecture of the IoT application.

VISUALIZATION OF THE CONTROL DEVICES OF THE POWER SUPPLIES

In order to intuitively view the layout of the control devices of the power supplies, according to the map of the local control station of the power supplies and distribution graph of the cabinets, the chassis, the plug-ins, the cables

there, we make them visual as shown in Figure 5 and Figure 6. Figure 5 shows the visualization of the VME chassis, the PSC modules and the optical fiber cables between PSC and PSI modules. The middle panel in Figure 5 shows the layout of the VME chassis with the PSC modules. The right panel in Figure 5 shows the detail information of the each VME chassis including the name of the power supply and the related VME chassis number, the PSC number and the PSI number as well as the status of the connection between the PSC and the PSI, and the status of the power supply. The green colour in the VME chassis means the PSC module is running ok, while the red colour means the PSC module is not running ok. From the middle panel in Figure 6, we can recognize which power supply and the correlated PSI number is having problem with the fault messages in the red colour line.
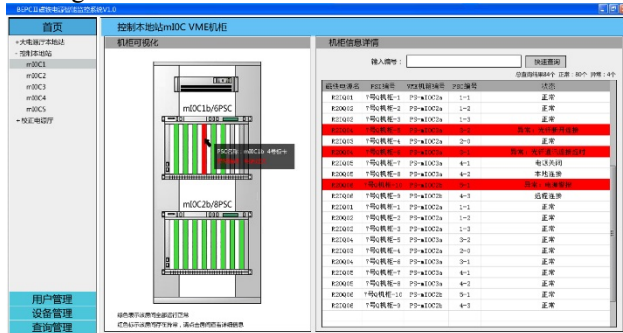

Figure 5: Visualization of the VME chassis, the PSC modules and the optic fibers between the PSC modules and the PSI modules.

In the same way, Figure 6 shows the visualization of the cabinets of the power supplies and the PSI chassis sitting in the cabinets. The right panel in Figure 6 shows the detail information of each VME chassis including the name of the power supply and the related VME chassis number, the PSC number and the PSI number as well as the status of the connection between the PSC and the PSI, and the status of the power supply. From Figures 5 and 6, the problem with which power supply and the related PSC/PSI can be recognized easily.

Figure 6: Visualization of the cabinets of the power supplies and the PSI chassis sitting in the cabinets.

CONCLUSION

The work of the IoT application is still in development. The expected result that the engineers can scan QR code in the local control station of the power supplies by a mobile phone to get access permission using the IoT APP. The IoT APP supports both IOS and Andriod operating systems. On one hand, the engineers may check the status of the cabinets, the chassis, the plug-ins, the cables and the status of the control system of the power supplies by the IoT APP. On the other hand, it's easy for the engineers to recognize the fault location, to automatically record maintenance and to generate electronic maintenance log.

ACKNOWLEDGEMENT

REFERENCES

[1] http://www.rfidworld.com.cn/

[2] BEPCII Construction report.

[3] http://www.aps.anl.gov/epics/