DEVELOPMENT OF AN ONLINE DIAGNOSTIC TOOLKIT FOR THE UPC CONTROL SYSTEM

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Abstract

Most IOC (Input Output Controller) platforms and servers at the TPS control system have been connected to uninterruptible power supplies (UPS) to prevent short downtime of the mains electricity. To accomplish higher availability, it is necessary to maintain batteries and circuits for the UPS system periodically. Thus, an online diagnostic toolkit had to be developed to monitor the status of the UPS system and to notify which abnormal components should be replaced. One dedicated EPICS IOC has been implemented to communicate with each UPS device via SNMP. The PV states of the UPS system are published and archived and specific graphical applications are designed to show the existing control environment via EPICS CA (Channel Access). This paper reports the development of an online diagnostic toolkit for the UPS System.

INTRODUCTION

The Taiwan photon source [1] (TPS) is a highly bright synchrotron light source constructed at the National Synchrotron Radiation Research Center (NSRRC). It consists of a 150-MeV electron linear accelerator, a booster synchrotron, a 3-GeV storage ring and experimental beam lines. The TPS control system [2] is based on the Experimental Physics and Industrial Control System (EPICS) [3] framework, which is a set of open source software tools, libraries and applications developed collaboratively and used to create distributed soft real-time control systems for scientific instruments. There are many devices in the TPS control system that are compatible with SNMP, such as: CompactPCI (cPCI) crates, network switches, UPSs etc.

Establishing a tool to automatically diagnose the device condition is desirable because the device number is large and they are distributed in different CIAs. We already developed diagnostic tools for Compact PCI creates. Next we chose to monitor the UPSs and create tools to diagnose their condition.

Most of the IOC platforms and servers at the TPS control system have been connected to the UPS system to prevent short downtime of mains electricity. The UPSs are installed inside the Control Instrumentation Areas (CIA) which are distributed along the outside wall of the machine tunnel.

To accomplish higher availability, it is necessary to maintain batteries and circuits for the UPS system. Thus, an online diagnostic toolkit had to be developed to monitor the status of the UPS system.

The EPCIS IOC can read the UPS status and use the diagnostic toolkit to monitor their condition. When abnormal conditions occur, such as a UPS working abnormally, overheating, too high output load in percent of rated capacity, battery working abnormal and UPS battery charge too low.

The diagnostic toolkit will show an alarm message on the GUI (Graphical User Interface) and send an alarm notification to the responsible personnel via E-mail.

SNMP DEVICE SUPPORT FOR EPICS

SNMP

The SNMP (Simple Network Management Protocol) is a component of the Internet Protocol Suite as defined by the Internet Engineering Task Force (IETF) and is a standard Internet protocol for managing and organizing information of Ethernet-based devices. It consists of the following three components, a managed device, an agent and a Network Management System (NMS). The NMS is a software installed on the management side to query the agent for information about the managed device, which is a node in the network and implements a SNMP interface to collect and store management information and make this information available to NMS using SNMP. The agent is the software installed on the managed device and allows it to collect management information from the managed device database and makes it available to the NMS.

EPICS SNMP Device Support Module

The devSNMP [4] uses the net-snmp library for access to SNMP-based devices. Net-snmp also includes a number of useful utilities such as snmpget and snmpset for reading and writing SNMP variables, and snmpwalk for listing which variables a host makes available. The devSNMP provides EPICS device support for hardware devices that communicate via SNMP. By using devSNMP, the EPICS IOC can query data from devices via SNMP, then store data in the EPICS database for PV channel access.

Figure 1 shows the system structure of an EPICS integrating an SNMP with a UPS in the TPS. The EPICS IOC retrieves information via SNMP from the UPS and the information will be stored in the EPICS database for PV channel access. The GUI can show UPS information via channel access and the diagnostic toolkit can use the data to diagnose the condition of the UPS.

DIAGNOSTIC TOOLKIT FOR UPS SYSTEM

The TPS UPS include a Network Management Card (NMC) that can receive the status information of the UPS and can send commands to control the UPS. The user can manage the UPS with the NMC via web browser or via a network management software which supports the SNMP protocol.
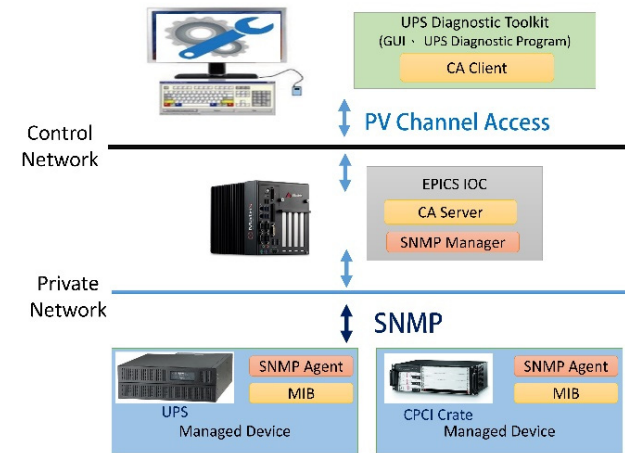
Figure 1: System structure for EPICS integrating an SNMP with a UPS.

The NMC can get UPS work information from UPS status, work temperature, input voltage and frequency, output voltage, output current, output load in percent of rated capacity, battery charge status and battery voltage.

In the TPS control system, we have 24 UPSs distributed in different CIAs. We cannot monitor the UPS status all the time. If an UPS is working abnormal, the device connected to the power supply will lose power thus affecting accelerator operation. Therefore, the diagnostic toolkit is used to monitor automatically the UPS status all the time and create a GUI to display device information [5]. The diagnostic tool will constantly confirm the UPS status and if an abnormal condition occurs, an alarm will be issued. The alarm information shows the location, time and status of the failed device to speed up troubleshooting. The EPICS IOC will poll the data from the UPS and use them on the PyDM display page and diagnostic toolkit.

EPCIS Archiver Appliance

The EPICS Archiver can store UPS component values such as output voltage and battery capacity from the EPICS IOC to provide historical data for analysis of the UPS conditions. The recorded characteristic parameters which are stored in the database and can be retrieved for easy examination of its stability by the specific toolkits, such as CS-Studio, Python, MATLAB, etc. Figure 2 shows the CS-Studio Archive data browsing page.

GUI for Diagnostic Toolkit of UPS

The GUI is created by Python Display Manager [6] (PyDM) which is based on the PyQt framework to build a user interface for control systems. The PyDM supports EPCIS CA which can read from and write to EPCIS PV.

We integrate GUI into the Diagnostic tool for Compact PCI crates and the show system in Fig. 3. The green light indicates proper functioning of the corresponding UPS. If the UPS is working abnormal, the red light is displayed. If any are not working normally, a message will show up at the bottom of the page. The abnormal message contains position of the UPS and the time and cause of the abnormal

state. Clicking the history log button, the history of the abnormal message will be displayed. The button next to the light showing the UPS status can open another page that shows a more detailed status of the UPS.
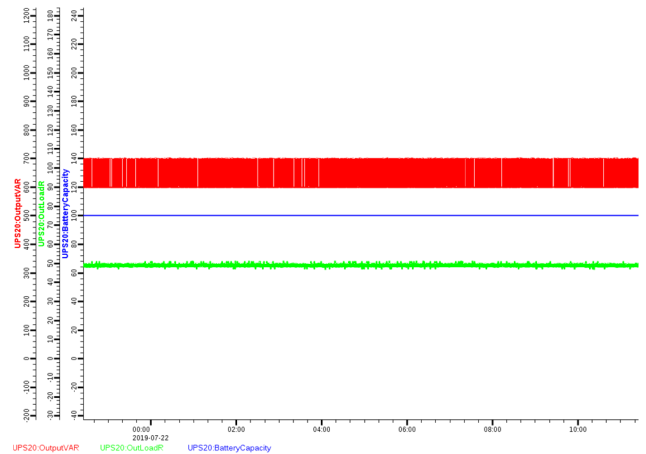

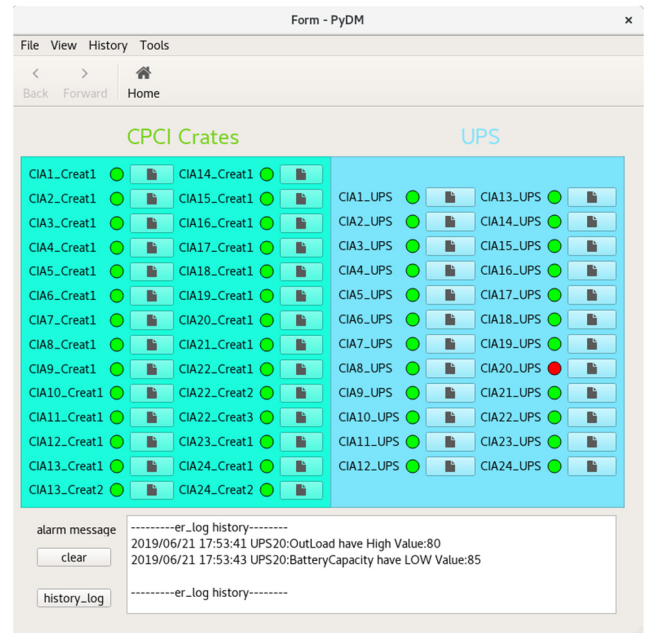Figure 2: CS-Studio Archive data browsing page for the UPS.

Figure 3: PyDM page for the status of all cPCI crates and UPS.

Figure 4 shows the UPS working information which contains the UPS working status, working temperature, input voltage and frequency, output voltage, output current, output power, output load in percent of rated capacity, battery status, battery voltage and battery charge state in percent of capacity.
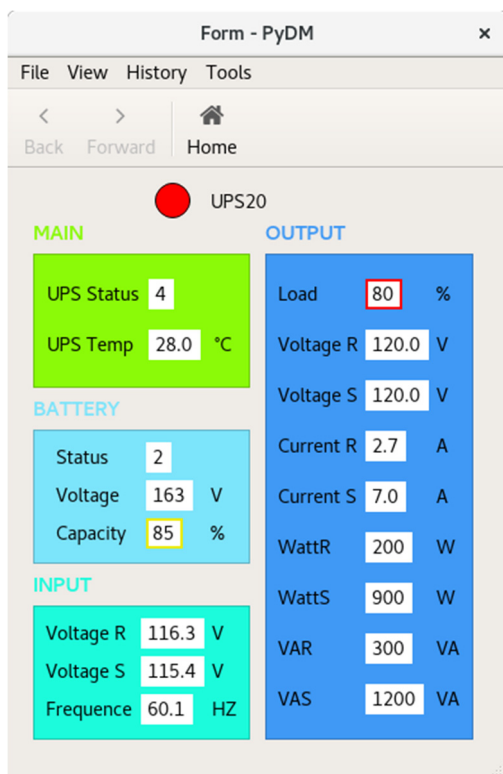
Figure 4: PyDM page with information for UPS.

If UPS component value is not between the upper and lower limits, a yellow frame or red frame will appear. Exceed the HIGH or below the LOW that the yellow frame is displayed. Exceeding the HIHI or the LOLO the red frame is displayed. The limit value is set in the EPICS record database. If any abnormal state occurs, the top light will be displayed in red and the corresponding light on the main page will also be changed to red.

UPS Diagnostic Program

The UPS diagnostic program is built by using python. By using the PyEpics package [7], we can interact with the EPICS Channel Access(CA), which can read from and write to Epics Process Variables (PVs) via the CA protocol. This program will constantly confirm the status of the UPS. If the UPS status or UPS battery status is in error or the UPS Input/output voltage value, temperature etc. is not between limits, this program will let the UPS component status show a red light on the GUI and send an alarm via E-mail. The abnormal message will be stored and can be shown on the GUI as a historical message [8].

Figure 5 shows the UPS diagnostics program flow chart. A program was developed to check the UPS working status and if its working abnormal with a component value not between upper and lower limit, the program will send an alarm message to the responsible personnel by E-mail and activates the corresponding UPS status red light on GUI. The alarm message is stored in a database as history and shown on the GUI.
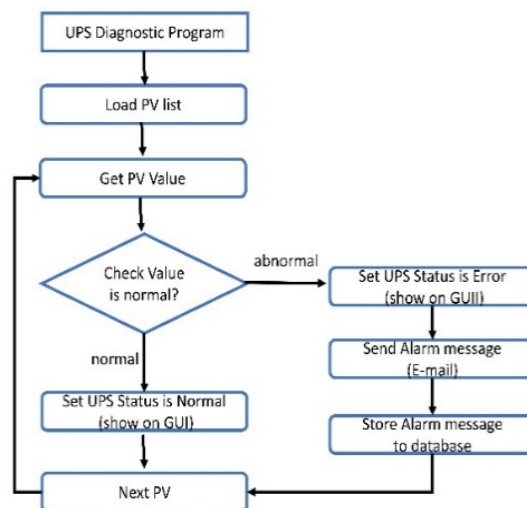

Figure 5: UPS diagnostics program flow chart.

CONCLUSIONS

Maintaining high reliability of the TPS control system is important for the operation of the accelerator. In the TPS control system the hardware platforms are distributed in different CIAs. Since we cannot check the device states all the time it is necessary to have an automatic infrastructure monitoring system for these devices.

When the UPS is working abnormally and the power cannot be provided normally or the emergency power supply cannot be provided during a main power outage, the equipment connected to the UPS will go off-line, which will affect the operation of the accelerator. This toolkit will send an alarm notification to the responsible personnel by E-mail and it can be displayed on the GUI for early maintenance or replacement.

We have developed a cPCI diagnostic tools and UPS diagnostic toolkit, but there are many devices in the TPS control system hardware that are support by SNMP. We will continue to develop device diagnostics and integrate them together.

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