

# PLANS FOR MONITORING TPS CONTROL SYSTEM INFRASTRUCTURE USING SNMP AND EPICS

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## Abstract

The Taiwan Photon Source (TPS) control system is one of the crucial systems for the accelerators and beamlines. It is necessary to monitor the status of the control system components such as housekeeping parameters of cPCI EPICS IOC crates, network traffic, connections between computers, etc. The equipment room environment including electric power, temperature, fire alarm, and water leak will also need to be watched. Using Simple Network Management Protocol (SNMP), the behaviour of network-attached devices can be monitored for administrative attention. Since the TPS control system is based upon the EPICS framework, the monitoring system is planned to adopt the EPICS support with SNMP. This paper will describe the system architecture of this monitoring system.

## INTRODUCTION

Taiwan Photon Source (TPS) [1] will be the new 3 GeV synchrotron radiation facility to be built at National Synchrotron Radiation Research Center, featuring ultra-high photon brightness with extremely low emittance. The construction began in February 2010, and the commissioning is scheduled in 2013.

TPS control system will be implemented by using the Experimental Physics and Industrial Control System (EPICS) [2] framework. The various devices are integrated with EPICS based Input Output Controller (IOC) via control network connection. Figure 1 shows the architecture of TPS control system.

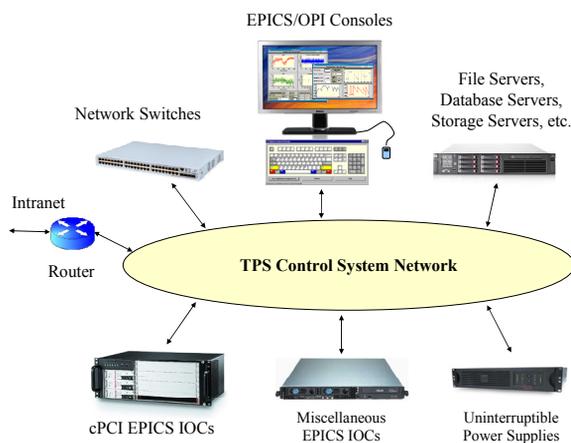


Figure 1: Possible SNMP-compatible devices in the TPS control system network

There are 24 Control Instrumentation Areas (CIA) which distributed along the inner zone just outside of the machine tunnel. Each CIA serves for one cell of the machine control and beamline interface. EPICS IOCs and major control devices connected to the control system are installed inside CIAs.

The TPS control system is designed for high availability. Its infrastructure must be reliable. Due to the long distance between control room and CIAs, an infrastructure monitoring system is planned to be implemented for gathering status of control system components such as CompactPCI (cPCI) IOC crates, network switches, servers, Uninterruptible Power Supplies (UPSs), etc. A dedicated EPICS IOC is planned to be used for housekeeping to monitor the health condition of these devices. When abnormal situations occur, e.g. crate temperature overheat, power supply breakdown, fan failure, or network disconnection, the monitoring system will automatically display the warning messages on the operator interface (OPI) screen and send out the alarm notification by voice call and E-mail. We can receive the early notification before a problem turns into a disaster. In addition to the warning messages, the monitoring system will also generate the warning reports or charts which can indicate the problems at the same time. Software tools such as MATLAB will be used to create these warning reports or charts automatically.

## SYSTEM ARCHITECTURE

Simple Network Management Protocol (SNMP) is an industry standard protocol for managing statistical data of the network-attached devices. It is based on the client-server architecture and consists of three components: managed device, agent, and Network Management System (NMS). A managed device is a network node that implements an SNMP interface that allows access to specific information. An agent is a software module that resides on a managed device which reports information via SNMP to the NMS. The NMS is an application which runs on the manager and regularly polls data from agents.

SNMP mechanism associates with the Management Information Bases (MIBs) which describe the structure of the management data of a device. MIB uses a hierarchical namespace containing object identifiers (OID). Each OID identifies a variable that can be read or set via SNMP.

The devSNMP [3] is the EPICS device support with SNMP that allows us to access management data from any network device in the same manner as we are used to for the EPICS PVs. Current devSNMP supports only

snmp-read commands and works with SNMPv2c.

A dedicated EPICS IOC will be used to retrieve information from the SNMP-compatible devices. The system structure is shown in Figure 2. The IOC can query the management data from managed devices via SNMP protocol. Then the data will be stored in the EPICS database for PVs channel access. The Extensible Display Manager (EDM) will be used as the operator interface (OPI) to show the monitored information via the Channel Access (CA) protocol.

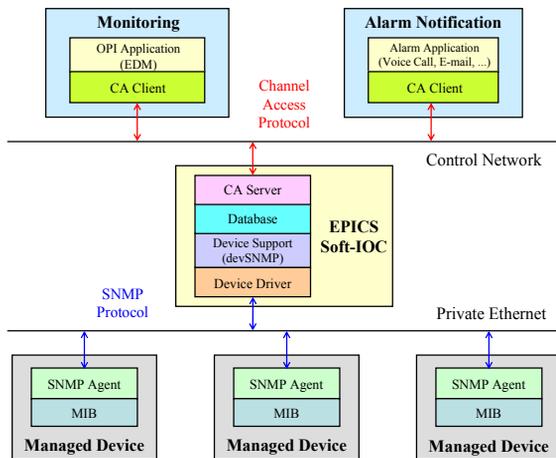


Figure 2: System block diagram of building EPICS support for SNMP-compatible devices

### MONITORING OF SNMP-COMPATIBLE DEVICES

In the future, the TPS control system is expected to setup more than 100 IOC crates, more than 50 network switches, and more than 50 UPSs. Due to these large amounts of devices, it is hard to pinpoint which device has a breakdown. Fault-finding and troubleshooting become a critical issue we have to face. So, it is necessary to build a warning mechanism using the SNMP-compatible devices that can show the status of device information on the Graphical User Interface (GUI). Besides the monitoring screen, it can also send the warning message by voice call and E-mail. In order to speed up the troubleshooting, the warning message should indicate the location and status of the fault devices. The detail will be described in the following paragraphs.

#### cPCI Crates

The cPCI crate is chosen as the standard EPICS IOC platform for the TPS control system. Monitoring the health of the crate is essential. Each cPCI crate has an alarm board with SNMP support. The alarm board can provide the parameters of the crate status. These parameters stand for the status of the following entries, including voltage, temperature, fan speed, and status of power supply unit.

The monitoring system will poll the data from the cPCI crates located at 24 CIAs every 10 seconds. A prototype

has been developed to collect the real parameters from cPCI crates for testing. Figure 3 shows the EDM display page for monitoring the cPCI IOC crate status. Each column represents one cPCI IOC crate which will be installed in certain CIA. If the parameters exceed normal range, the display value will turn into red for warning the operator.

	3.3 V	5 V	12 V	-12 V	T1 (C)	T2 (C)	Fan1 (rpm)	Fan2 (rpm)	Fan3 (rpm)	Fan4 (rpm)	Fan5 (rpm)	Fan6 (rpm)	PSU
QIACS-EPIC011	3.3	5.0	12.2	-12.3	27	25	4340	4420	4420	4300	3070	4960	OK
QIACS-EPIC012	3.3	5.0	12.2	-12.3	25	24	4500	4510	4370	4410	3040	4900	OK
QIACS-EPIC013	3.3	5.0	12.1	-12.3	23	22	4310	4370	4350	4290	3010	4840	OK
QIACS-EPIC014	3.3	5.0	12.2	-12.3	22	21	4370	4450	4350	4440	3040	4830	OK
QIACS-EPIC015	3.3	5.0	12.2	-12.2	20	21	4430	4570	4450	4490	3070	4860	OK
QIACS-EPIC016	3.3	5.0	12.3	-12.3	18	17	4310	4350	4340	4250	3020	4840	OK
QIACS-EPIC017	3.3	5.0	12.1	-12.3	25	24	4370	4300	4350	4300	3060	4850	OK
QIACS-EPIC018	3.3	5.0	12.2	-12.3	27	25	4430	4420	4480	4430	4930	3030	OK
QIACS-EPIC019	3.3	5.0	12.1	-12.3	25	23	4280	4320	4320	4250	3020	4810	OK
QIACS-EPIC010	3.3	5.0	12.2	-12.3	22	21	4250	4350	4300	4300	3060	4860	OK
QIACS-EPIC011	3.3	5.0	12.1	-12.3	20	20	4210	4250	4280	4230	3060	4800	Fail
QIACS-EPIC012	3.3	5.0	12.3	-12.3	18	18	4260	4320	4320	4310	3030	4800	OK
QIACS-EPIC013	3.3	5.0	12.0	-12.2	27	24	4310	4450	4340	4320	2980	4820	OK
QIACS-EPIC014	3.3	5.0	12.1	-12.3	24	24	4360	4420	4410	4420	3020	4800	OK
QIACS-EPIC015	3.3	5.0	12.1	-12.2	23	22	4300	4420	4400	4300	3070	4820	Fail
QIACS-EPIC016	3.3	5.0	12.2	-12.3	23	21	4330	4350	4360	4280	3050	4850	OK
QIACS-EPIC017	3.3	5.0	12.2	-12.3	22	19	4280	4340	4340	4300	3040	4470	OK
QIACS-EPIC018	3.3	5.0	12.2	-12.2	20	19	4300	4360	4340	4310	3100	4810	OK
QIACS-EPIC019	3.3	5.0	12.0	-12.3	24	23	4290	4320	4310	4310	3030	4840	OK
QIACS-EPIC020	3.3	5.0	12.0	-12.3	23	22	4260	4270	4350	4240	2990	4470	OK
QIACS-EPIC021	3.3	5.0	12.1	-12.3	21	21	4360	4310	4340	4350	3020	4820	OK
QIACS-EPIC022	3.3	5.0	12.2	-12.3	21	20	4330	4420	4350	4390	3030	4810	OK
QIACS-EPIC023	3.3	5.0	12.2	-12.3	21	19	4310	4370	4310	4270	3160	4880	OK
QIACS-EPIC024	3.3	5.0	12.1	-12.3	21	18	4240	4340	4240	4280	3020	4450	OK

Figure 3: EDM display page for monitoring cPCI IOC crate status

The original devSNMP module should be extended the "Regular Expression" for non-standard output data string. There are two ways to solve the problem: One is to rewrite the device support of devSNMP module, the other is to insert the a new definition field of module support. However the second method could solve the problem much more directly so that the definition "scalcout" from CALC [4] module is inserted to main database definition file. Afterwards, it only need to add the "scalcout" field in the DB file which would translate the output string from the device.

#### Network Switches

Network Switches only support SNMP, however, they do not support with EPICS framework. We can use off-the-shelf network management tools or dedicated EPICS IOC to obtain the SNMP data of switches.

The application tools for network management (e.g. MRTG, RRDTools, Ganglia, etc) usually have many complicated functions for certain purposes. These tools are suitable for webmaster or network manager who needs to monitor the detail information of network equipments.

In general, most of the users or maintainers only wants to know some ordinary entries such as heartbeat, bandwidth and hot-spot warning. Thus assembling the housekeeping parameters is also needed to make into consideration for monitoring these switches.

In contrast with switching among different kinds of graphical user interfaces, it is more convenient and efficient to centralize variety of data into EPICS IOC so that we can manage and present the received data via a customized control interface which could integrate into the TPS control system.

In Figure 4, it shows that both EPICS IOC with devSNMP module and network management tools are used to monitor the status of switches.

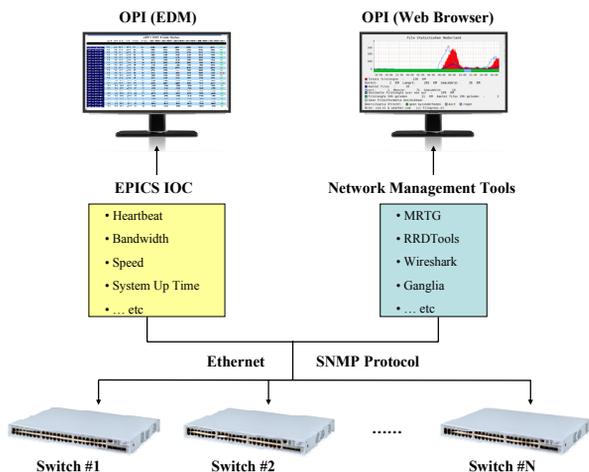


Figure 4: EPICS IOC vs. Network Management Tools

*Servers*

There are two strategies to monitor the servers, one is used for the servers without running EPICS IOC but support SNMP, the other is for the servers with running EPICS IOC. Figure 5 shows the difference between them.

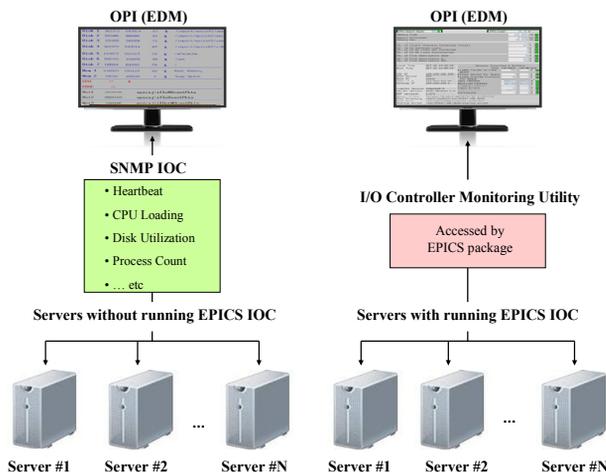


Figure 5: Monitoring schema for servers

For servers without running EPICS IOC, such as file servers and database servers, we can start the SNMP daemon to allow the dedicated EPICS IOC to gather host information. The host information includes heartbeat, CPU load, disk usage, number of processes, network traffic, etc. The housekeeping information such as status of power supply, fan, and temperature can also be obtained via the MIBs provided by vendors.

For servers with running EPICS IOC, there is the IOC monitoring utility similar to IOC MON [5] that can run at IOC and monitor the available resources. The OPI can get data directly through the utility without involving SNMP

and other dedicated EPICS IOC. It can reports the IOC resources information including CPU heart beat, CPU usage, number of file descriptors used, memory allocated, boot parameters, number of CA clients, number of CA database links, and network interface statistics, etc.

*Others*

Other SNMP-compatible devices such as UPSs are planned to be added into the monitoring system. The UPS status information such as current, load rate and battery will be monitored.

The equipment room environment parameters including electric power, temperature, fire alarm, and water leak are also our concerns. Instead of using the inefficient SNMP, detection devices supported by EPICS will be used to collect the environment parameters which can be integrated to the control system.

In order to maintain and classify each device in effective way, EPICS framework supports the template file for management. In particular, "dbLoadTemplate" loads the definition file which contains macros and other substitutions. It is not only reducing the line numbers of the script but also flexible to extend the parameters for each device.

**SUMMARY**

Maintaining high reliability of the TPS control system is important to the operations of accelerators and beamlines. Since there are many control system components distributed at numerous locations in the TPS buildings, it is necessary to have an infrastructure monitoring system to supervise the status of these components. Most of these components such as IOC crates, network switches, and servers support SNMP which is the industry standard protocol for managing statistical data of the network-attached devices. To be consistent with TPS control system which is based on EPICS framework, the monitoring system is developed by using the EPICS device support with SNMP. This system not only can display warning messages on the OPIs but also send alarm notifications to responsible personnel by voice call and E-mail. The alarm message should contain the location and status information for easily targeting the failed device. A prototype has been developed to gather the real status information from cPCI crates. Implementation for other SNMP-compatible devices is still in progress.

**REFERENCES**

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