STATUS MONITORING OF THE EPICS CONTROL SYSTEM AT THE CANADIAN LIGHT SOURCE

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Abstract

The Canadian Light Source (CLS) uses the EPICS Distributed Control System (DCS) for control and feedback of a linear accelerator, booster ring, electron storage ring, and numerous x-ray beamlines. The number of host computers running EPICS IOC applications has grown to over 200, and the number of IOC applications exceeds 700. The first part of this paper will present the challenges and current efforts to monitor and report the status of the control system itself by monitoring the EPICS network traffic. This approach does not require any configuration or application modification to report the currently active applications, and then provide notification of any changes. The second part will cover the plans to use the information collected dynamically to improve upon the information gathered by process variable crawlers for an IRMIS database, with the goal to eventually replace the process variable crawlers.

BACKGROUND

The Canadian Light Source is Canada's national centre for synchrotron research and a global centre of excellence in synchrotron science and its applications. Located at the University of Saskatchewan in Saskatoon, the CLS is a world-class, state-of-the-art facility that is advancing Canadian science, enhancing the competitiveness of Canadian industry and contributing to the quality of life of people around the world.

EPICS is used at the CLS to monitor and control the electronic devices for both electron beam components and photon beam components. While there are many tools that monitor individual Process Variables (PVs) for conditions that indicate problems with individual devices, there are no tools that give an overall picture of the health of the control system itself. Early attempts at the CLS to reflect the status of the control system using an alarm handler meant that the control system was attempting to report on its own health – not an easy feat to accomplish.

Since the CLS first began operation, the monitoring of the control system health was provided by the machine operators in the control room. This was not done as a specific task, but rather occurred when a particular system was unavailable or unresponsive. The natural challenge was not all systems are being used by the operators at all times. A system failure could go unnoticed if it was not in use or directly connected to the PV alarm system. There was a strong need to improve the control system monitoring.

AVAILABLE DATA

It is important to emphasize that the information being collected does not depend on a database of running applications or available PVs. Rather, the purpose of this exercise is to provide maximum status information without having to preconfigure anything.

EPICS uses broadcast packets to indicate the continued running of server processes and when establishing communication between processes. Although the CLS uses individual Virtual Local Area Networks (VLANs) to partition the network, there are currently two systems used for EPICS gateway communication that use 802.1Q packets directly and establish numerous virtual Network Interface Cards (NICs). These two systems can then see all the broadcast packets off of all the configured networks.

The first of the two types of broadcast packets provides the following information:

- Server IP
- Server unique port number
- Packet sequence number

This information is collected to provide a summary as follows:

- The identity of each host running an EPICS server
- The number of EPICS server applications running on any host
- An estimate of how long each server application has been running
- Notification when the number of unique server applications changes
- The timestamp of when the latest packet from a server application had been processed

These packets are sent at regular intervals. These intervals can be configured differently at different sites, but the default is 30 second intervals (more frequent on start-up). Because they are UDP packets, there is a risk that the operating system will drop a packet on a congested network. A single missed packet can't be taken as a problem, but continued missed packets are an alert that something could be wrong.

The second type of broadcast packets come from EPICS client applications, and provides the following information:

- Client IP
- Client Unique TCP port number
- Requested PV name

Collecting this information provides the following summaries:

- Number of times a PV has been requested
- List of clients requesting a PV
- All PV names that have been requested

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The third type of monitored broadcast packet is the CA_PROTO_SEARCH responses from the EPICS server. These packets contain the following information:

- The server IP address
- The TCP port number of the serving application

By itself, this isn't a lot of information. By combining this with PV search requests and responses from the monitoring application itself, it can be determined which (if any) server application may have responded to the request. This now extends the information available:

- Unserved PVs
- PVs served by multiple applications

INFORMATION DISPLAY

The information collected is available at the CLS through an internal web page. A single page gives a list of all hosts known to have run or be running as a server.

INFORMATION PERSISTENCE

Currently, the information is stored at regular intervals as JSON strings.

PROGRAMMING

The system is programmed in Python. A python module (bottle.py) is used to generate the web pages.

FUTURE WORK

There is still a lot more information that is missing. The current work only finds the PVs that are used outside of an application on a regular basis. The exact identity of a client or server is not known. Performance issues with older hardware can cause the UDP beacons to not appear. Combining what is currently known with other information leads to exciting possibilities.

It is possible to run a query on a Linux host and obtain a list of EPICS clients and servers, along with their related TCP and UDP port numbers, running directories, boot time, whether they're using the ProcServ application, and the port number for connecting to the application console through ProcServ. Making this information available for simple query would allow collecting a full PV listing for any server application, and also allow tracking what client applications are referencing different PVs. This is useful when a major revision to a system changes a PV name.

The main intention of this system is as an aid to the on-call Controls staff at the CLS. While still in the early stages, this shows a great deal of promise to provide a quick diagnostic tool for determining when the control system itself has failed.

The secondary objective of this system is to eventually be able to populate an IRMIS or PV finder database. If it is simple to track when an application restarts, and what application has restarted, it follows that this would be the best time to compare the currently used server database against what is stored in a persistent database, and to note any updates. Further, having a unique identity for all running server applications and client applications would allow tracking the PV connections that are made, simplifying finding affected applications when there is a change to an EPICS record name or record type.

CONCLUSION

The information gathered by a relatively simple process has proved valuable to see the overall status of the control system. It is expected that further effort will allow this approach to provide timely information to speed system recovery from major outages, and to help identify the source of problems relating to the overall system operation.

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