THE STAR SLOW CONTROL SYSTEM - UPGRADE STATUS

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Abstract

The STAR (Solenoidal Tracker At RHIC) experiment located at Brookhaven National Laboratory has been studying relativistic heavy ion collisions since it began operation in the summer of 2000. An EPICS-based hardware controls system monitors the detector's 40,000 operating parameters. The system uses VME processors and PC's to communicate with sub-system based sensors over a variety of field busses. The system also includes interfaces to accelerator and magnet control systems, an archiver with CGI web-based interface and C++-based communication between STAR online system, run control and hardware controls and their associated databases. An upgrade project [1] underway. This involves the migration of 60% of the I/O control from the aging VME processors to PC's. The host system has been transferred from Sun OS to Scientific Linux and some VME boards were replaced with soft IOC applications. The experience gained with the current setup will be discussed, upgrade plans and progress will be outlined.

INTRODUCTION

STAR is a large detector at the Relativistic Heavy Ion Collider (RHIC) located at Brookhaven National Laboratory. RHIC provides Au+Au collisions at energies up to $\sqrt{s_{NN}}$=200 GeV. The STAR experiment was designed and constructed to investigate the behavior of strongly interacting matter at a high energy density [2].

This system is designed to cover a large solid angle and is currently composed of several sub-systems including a time projection chamber (TPC), an electromagnetic calorimeter, a data acquisition system (DAQ), the trigger and magnet.

The major part of the electronics is located on the detector in the high radiation area which is not accessible during RHIC operation. Therefore, the slow controls system [3] as well as the operation of STAR is designed and implemented to allow for both remote and continuous operation.

SLOW CONTROL SYSTEM

The STAR Slow Controls system sets, monitors and controls all sub-systems. In addition, Slow Controls can generate and display alarms and warnings for each subsystem [3]. A real-time VxWorks environment is utilized for this purpose and a controls software package Experimental Physics and Industrial Control System [4] (EPICS), is used to provide a common interface to all subsystems. Approximately 40,000 parameters are currently controlled and monitored. The communication of the STAR hardware controls is shown in Figure 1.

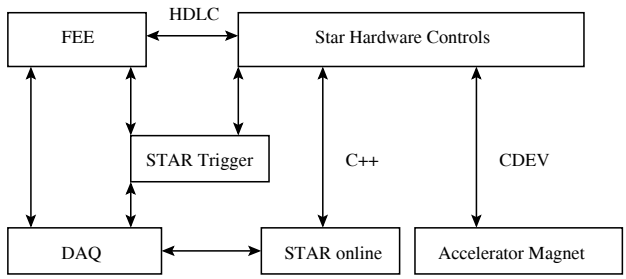

Figure 1: Communication between STAR real-time system.

Initially at STAR, EPICS was run on Sun workstation connected to VME processors running the VxWorks real-time operating system.

Motorola MVME147 and MVME167 single-board computers with 680x0 processors using the VxWorks version 5.2 were used. Over time MVME147 processors were replaced MVME162's. These cards handle the flow of data from the hardware to the network functioning as Input/Output controllers (IOC). IOC's are communicating with the host workstation via a serial and Ethernet connections. The host workstations serve also as operator interfaces (OPI) to the control system: they are used to control STAR detector subsystems, display warnings and alarms and archive status of the subsystems.

EPICS components used at STAR include MEDM (Motif Editor and Display Manager), the sequencer, the Alarm Handler and the Channel Archiver.

MOTIVATION

The STAR control system was designed more then ten years ago and implemented during the commissioning run for STAR in 1999. Design and development of the full system required more than twenty person-years. During last eight years the version of VxWorks and EPICS were frozen. The outdated version of the EPICS limited the support available from the EPICS collaboration regarding maintenance and adoption of new application tools. Upgrades more recent than EPICS version 3.13 require a newer version of VxWorks or RTEMS [5].

The VME boards are a decade old. Several of them have failed over the years and since the subsystems are constantly evolving, an extra load is added to existing processors. Additional VME crates with extra VME boards must be installed or another solution must be implemented.

Another concern was aging host workstations, one of the most crucial components of the existing control system.

Because of the reasons above, an upgrade of the STAR control system has been undertaken. In addition, the new subsystems require their fast integration into control framework and testing during the experimental operation. This can be achieved with the next generation of development software.

UPGRADE

The main goal which has to be addressed during the upgrade is the backward compatibility with the existing system. The new slow control system should allow the migration from the VME-based IOC's without major source code revision in a cost efficient manner.

While a number of subsystems must keep using VME boards as their IOC processors due to the system design or the need for high performance of real-time operating system, many subsystems do not require such kind of performance. This is particularly true as processor speed has increased by a factor of 100 since the system was first implemented. These subsystems are being replaced by Linux PC's which serve as host based IOC's (soft IOC's)

Another important step in the slow control system upgrade is the migration of the host system from Suns running Solaris to PC's running Scientific Linux 3 (SL). The work started in the fall 2005 and is approaching the final stage. The new host server has cross-compiling capabilities, which allow application development for the VxWorks 5.2 operation system under EPICS version 3.13.10. The performance of the cross compiler has been tested with MVME 162/167 applications and has proved to be reliable.

Also the new Linux server hosts a new archiving system [6] with an easy to use web-based configuration interface. Archived data can be later viewed with web-based and Java-based stand alone archive viewers [7]. The new archiving system has been continuously used during runs in 2006 and 2007.

The alarm handling system was moved to the new Linux server in 2005 and has proved to be reliable and robust during last data taking periods.

The new version of CDEV [8] has been successfully used for the magnet and primary interaction point monitoring on the new Linux host since the fall of 2006.

The final migration of the system will be completed during the upcoming run. This involves migration of all application to the Linux server and retirement of the Sun OS.

The monitors for the temperature and humidity were the first VME based IOC to be replaced by soft IOC's. A new soft IOC interface to the gas monitoring system has also been developed. In addition, a soft IOC has been implemented to monitor the electrical ground for the entire STAR detector.

Both old and new IOC's have been used during the last RHIC run. No operational problems have been found, the system proved to be reliable and allowed us to gain needed experience with Soft IOC development.

Another important step towards soft IOC migration is development of new software for various power supplies. The device support for the the LeCroy 1440 power supplies is currently under development.

Since the General Purpose Interface Bus (GPIB) interface is used be several subsystems at STAR several. Soft IOCs providing a GPIB interface and device support functions are under development at the moment and will be tested during the upcoming run.

We are planning to move approximately 60 % of the existing IOC applications to Linux soft IOC applications in the next year.

SUMMARY

STAR Hardware Controls maintains the system-wide control of the STAR detector using EPICS databases at the subsystem level. The STAR control system is currently being upgraded. With backward compatibility and continuity of operation as priorities, the initial upgrade systems have been installed and have been operated successfully in parallel with the original systems. This year's run should see the addition of more upgraded subsystems and the retiring of outdated processors.

ACKNOWLEDGMENTS

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[7] EPICS ArchiveViewer, http://ics-web1.sns.ornl.gov/archive/viewer/

[8] CDEV (Common DEVice) is a C++ and Java framework for developing portable control applications, http://www.jlab.org/cdev/