INTRODUCTION OF EPICS IN VEC & SCC CONTROL SYSTEM

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Abstract

As a part of computerization of the VEC and SCC Control System, using a standard open-source software tool for designing distributed control system named as EPICS (Experimental Physics and Industrial Control System), several IOCs (Input Output Controller) are developed to control and monitor the Main Magnet Power Supply (MPS), Beam line MPS, Deflector Power Supply, Beam line instruments and LCW (Low Conductivity Water) system. The device layer of IOC, responsible for communication with MPS distributed over several multi-drop networks (RS485) ensures reliable and fast response while setting several MPS simultaneously. Process parameters e.g. water level, temperature and conductivity in different subsystems are measured using standard industrial sensors. An IOC is developed for acquiring process data form sensors using Modbus-TCP based distributed DAQ modules on Windows platform. An IOC is developed for affecting the necessary control for conditioning of the electrostatic deflector with facility for supervisory intervention. Application of EPICS in sub-systems will lead towards unified distributed control architecture for auto beam tuning of the machines.

INTRODUCTION

The subsystems like MPS, LCW, Cryogenic control, Beam line control, beam diagnostics etc for VEC/SCC are interdependent and most of the control subsystem often require handling of control/monitoring parameters from other subsystems. The control/monitoring parameters handling among the subsystems become difficult as different proprietary software solutions are used by each group responsible for designing and maintaining their subsystems. The unified open source accelerator control system s/w tools of EPICS provide rugged distributed architecture and implementation of it helps to overcome the control data sharing difficulties. Many developed open source drivers to control various devices are already available for EPICS and these drivers are extremely useful for the system designer to reuse by modifying and rebuilding as per the specific system requirements.

The portability of EPICS in different platform/processor [1] provides the advantage of distributing EPICS applications without changing existing OS/processor architecture. Several EPICS device drivers, OPIs (Operator Interface) and input output controllers are developed recently and integrated with the existing system. Input Output Controllers are also developed to run on arm based embedded systems and operator interface is developed for Windows and Linux on x-86 processor.

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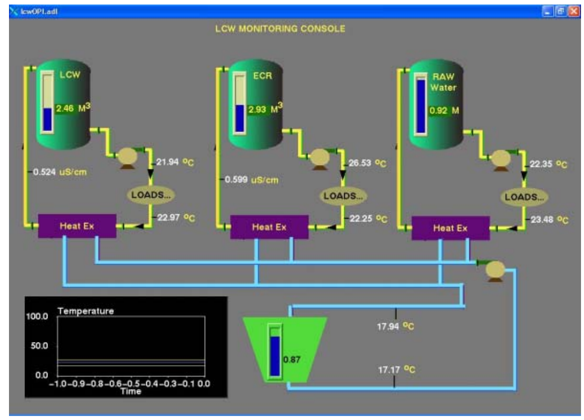

Figure 1: LCW OPI

CHANGE-OVER TO EPICS

Upgradation of LCW Monitoring for VEC

The web enabled modules with TCP connectivity are used for monitoring of plant parameters of Main LCW, ECR Cooling Water and Raw Water Systems. The gauge pressure type smart level transmitters are chosen to measure water levels in Raw-water storage tank, Main LCW Storage tank, ECR LCW Storage tank and Cooling-tower sump. The capacitance type level switches are also selected to provide HI & LOW level indications to initiate alarms. The temperatures at inlet and outlet headers of each subsystem by RTD and conductivities at different points are measured. EPICS asyn device support is used to develop the driver for DAQ modules having MODBUS-TCP connectivity.

The IOC uses the driver to communicate with the device and sends the channel data as Process Variables (PVs) to the client by Channel Access (CA) protocol. The LCW IOC loads the memory resident database which comprises of records contains several fields (variables). The bundled attributes of each record like scan rate, alarm limits etc. are defined according to the system requirements. The user interface as shown in Figure 1 is designed by MEDM (Motif Editor and Display Manager).Both the IOC and OPI is developed and running on win-x86 environment.

Upgradation of MPS system

The device driver for the commercially available magnet power supply (MPS) is developed using EPICS asyn device support routines. The device layer of IOC is responsible for communication with the Main Magnet and beam line power supplies having serial multidrop connectivity with ASCII protocol.

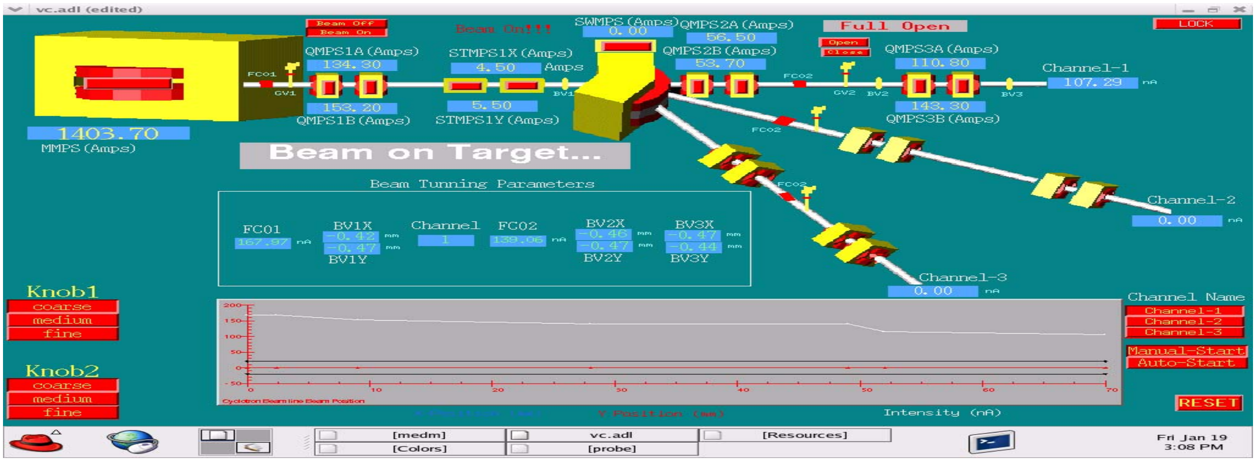

Figure 2: Virtual beam line control OPI

Asyn octet and asyn Int32 methods are mainly used in the driver source. Epics threads and mutex functions are used to ensure pseudo parallelism of the application. The scan rates of the channel are suitably chosen, so that the commands to the MPS do not repeat during single


Figure 3: IOC running on arm based embedded system

SET/READ action of a particular PV. The IOCs/drivers (compiled in both linux-x86 and Linux-arm environment) are tested with a virtual device simulates the field conditions.

Development of Deflector System

Conditioning of the electrostatic deflectors for the machine is done by modulating the voltage applied across the deflectors to reduce the *dark current*. The distributed client/server architecture is adopted for this control as the operation is performed from control console located far away from the actual devices. EPICS IOC communicates with two deflector power supplies and one gas flow meter having RS 485 connectivity. Deflector voltage and dark current are measured using 16-bit serial ADC. A heterogeneous protocol driver routine is responsible for communication with two different devices from the single IOC. An embedded arm processor based controller as shown in Figure 3 is used as an input/output controller and is housed inside the deflector power supply. The operator interface communicates with IOC via channel access protocol developed using EDM (Extensible Display Manager).

Simulation of Beam line Control

A virtual beam line control is designed to validate the auto tuning of the beam line with the help of EPICS tools. Here all beam line objects are soft device and virtual device configuration routines are developed for such objects. The designed IOC can dynamically load the virtual object of interest during run time. All objects are presently considered as an ideal one which is to be replaced with suitable mathematical model to simulate the real one. The OPI shown in Figure 2 gives the facility of choosing Auto/Manual mode of operation. The operators set the parameters using encoder based soft-knob during manual mode of control. The integration of two soft-knobs for simultaneous control of two power supply parameters is done.

CONCLUSION

The change-over of LCW and MPS systems of VEC from existing control mechanism, development of Deflector conditioning system for SCC and simulation of accelerator beam line using EPICS are completed. EPICS R3.14.8 which does not support linux-arm architecture is used for these applications. A separate 'patch' file is used for needed cross compilation. Several other subsystems control for SCC and VEC which are partially developed or in final stage of development, are yet to be upgraded to EPICS. EPICS are also used as a SCADA (Supervisory Control & Data Acquisition) in PLC based systems where instead of channel archiver, Oracle DB integration is being incorporated for historical storage.

REFERENCES

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