Epics Based Beamline Front-End Monitoring and Control System

Ishita Bhatia, Bhavna N. Merh, Sanjeev R. Kane, Dr. Pragya Shukla

P.G.Student, Institute of Engineering and Techn,ology, Devi Ahilya Vishwavidyalaya, Indore,, India
Accelerator Control Section, Raja Ramanna Centre for Advanced Technology, Indore, India
Indus Synchrotron Utilization Division, Raja Ramanna Centre for Advanced Technology, Indore, India
Professor, Institute of Engineering and Technology, Devi Ahilya Vishwavidyalaya, Indore, India

ABSTRACT:A beamline front-end acts as an interface between synchrotron source (Ring) and experimental workstations i.e. Beamline We have developed software for monitoring and control Indus-2 front-end. The EPICS framework is chosen as the standard development tool for front-end control system. The developed software is designed for monitoring temperature, pressure and to control vacuum gauges, fast shutter, water cooled shutter, safety shutter, pneumatic gate valves, other safety parameters associated with front-end. The front-end control system is VME based. One VME crate serves as a cluster of 2 front-ends. The communication between the VME stations and server PC is over RS485 link.

KEYWORDS:EPICS; Front-end; Beamline; VME

I. INTRODUCTION

Indus-2 is a 2.5Gev Synchrotron Radiation Source at Raja Ramanna Centre for Advanced Technology, Indore (India). Front-end consists of various mechanical components such as pneumatic Gate-Valves, Collimater, Water Cooling Shutter (WCS), Fast Closing Shutter (FCS), Beam Position Monitors (BPM), & Delay-Line with associated control cables.   Front-ends   at   Indus-2 beamlines aim at protecting synchrotron ring in case of vacuum failure from beamline side and protecting beamline user from radiation when beam is not in use. The front-end is ~15 m long and is in ultra high vacuum. Front-end components are located behind a permanent shielding wall of storage ring and not easily accessible. It is therefore important that control system should be capable of operating front-end components in a safe and reliable manner. To do that the developed software shows status of various mechanical components as well as parameters of front-end in a user-friendly manner.

The Software is developed using Experimental Physics and Industrial Control System (EPICS) over Linux operating system. EPICS has become a popular open source software framework in scientific industry, used for developing software for distributed control systems and scientific experiments. It is a collection of software tools which provide reliability, scalability and flexibility to the system. It provides various libraries and driver support to create a soft real time distributed system.

A control system using EPICS [1] will contain one or more IOCs(Input Output Controllers).An IOC is a database which in turn is a collection of records of various types. EPICS records are created by Visual Database Configuration Tool (VDCT) to make a .db file. VDCT [2] is a database configuration tool for EPICS which is a completely Java based graphical tool. It creates database file (.db) which contains detail of various records and this file is interfaced with database definition (dbd) file which provides specification for records. It performs conceptual modeling for applications in the form of hierarchy of records. The record support in visual database configuration tool (VDCT) is used for acquiring the data to/from devices.

The developed software serves as a client/server application for operation of front-end where the server displays status of all the 18 beamline front-end components and GUI developed for client can be accessed over web. Using this client GUI beamline users can seamlessly access data of their respective beamline from anywhere at any time via a web-browser-equipped device such as a PC, laptop.

II. SYSTEM ARCHITECTURE

A computer is configured to act as the server. Two such servers are developed one for BL-01 to Bl-12 and another for BL-13 to BL-22. Two servers ease the problem and are easy to handle, if any problem arises. The server communicates with all the installed VME stations at Indus-2 Beamlines. Each VME station serves a cluster of 2 front-ends. Total 9 VME stations are installed for 18 beamlines. These VME stations communicate with EPICS based server over serial communication (RS-485). Vacuum is monitored by cold cathode gauges. 18 gauges are installed for 18 beamline front-end. Serial interface with daisy chaining is used to get vacuum information of all installed gauges. Beamline users can get data of their respective beamline from the server. The architecture of the system is shown in Figure 1:
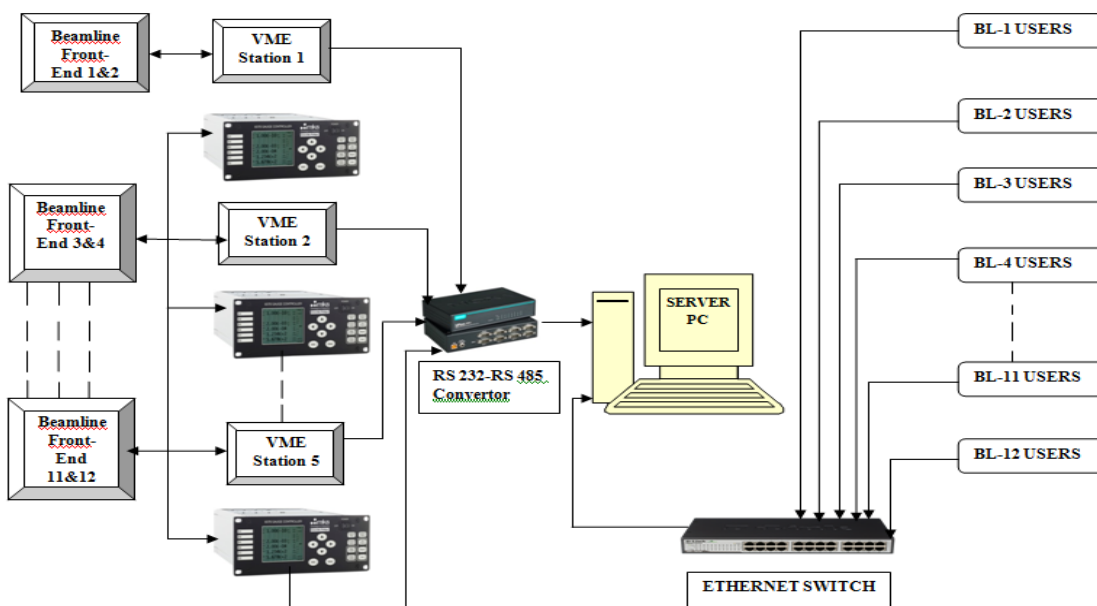

Figure1: System Architecture of EPICS Based Front-End Control System

III. SOFTWARE ARCHITECTURE

To implement the software for front-end control system as the EPICS IOC (Input/Output Controller), EPICS (version R3.14.12.5) is compiled and installed on Linux platform. Asyn driver (version 4-26) is appended to the EPICS installation for serial communication between VME stations and EPICS based server . EPICS records are created by VDCT to make a .db file. Inside the IOC, these records are processed according to the control algorithm. Various device supports are created in C language to read and write data from/to EPICS records in VDCT and perform required logic on data which can't be accomplished in VDCT. The graphical user interface is developed using EPICS CA client CSS-BOY. This user interface can be accessed over web using WebOPI. The schematic is shown as Fig. 2
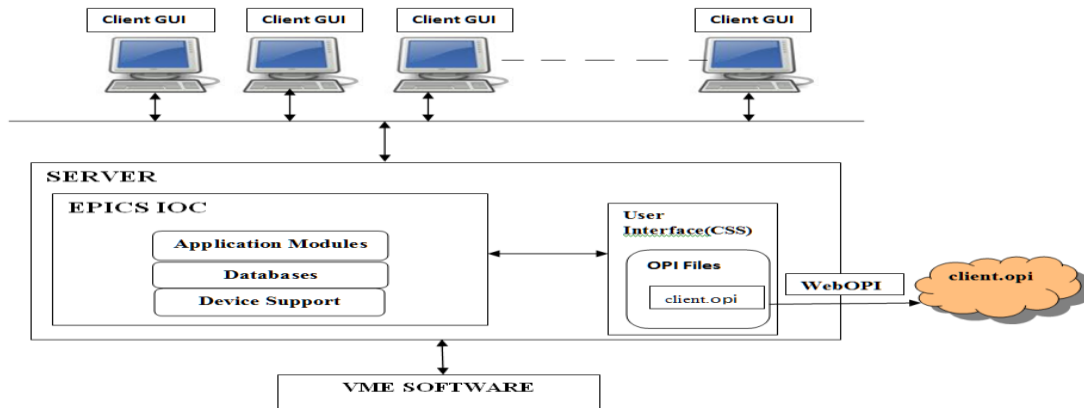
Figure 2: Software architecture of EPICS based beamline monitoring system

IV. SOFTWARE DESIGN

For a cluster of 2 front-ends a 21 slot VME crate is used with different I/O cards such as 32 channels relay out card, 32 channels integrating type ADC card, 32 channels OPTO in card and 68000 based CPU. Opening and closing operations of pneumatic valves, water cooled shutter, and a safety shutter are through relay cards and their status information is obtained through OPTO in cards. Analog values such as voltage and temperature values of front-end components are obtained through ADC cards.

The data refresh rate is 100ms at each EPICS server .The fetched data has been converted by using device support that is created in c language and deployed in EPICS to get the digital information of installed components in front-end [3] and PSIs [4]. For the analog data similar device support is created .To operate the pneumatic gate-valves, a VME-based Relay card is used. Momentarily ON Relay command is sent to Relay channels by pressing action buttons at GUI corresponding to 32 Relay channels. For the vacuum information, a serial interface is used with daisy chaining which gives vacuum information of all the installed gauges.

V. GRAPHICAL USER INTERFACE

The Graphical User Interface (GUI) is designed in Control System Studio-Best OPI, Yet (CSS-BOY). It is operator interface (OPI) development and runtime environment toolkit of EPICS. An OPI is a general GUI but with extra facilities to connect to your live data directly. Also the developed GUI can be accessed over web using WebOPI [5]. For running the GUI, EPICS IOC (input output controller) should be in running stage.
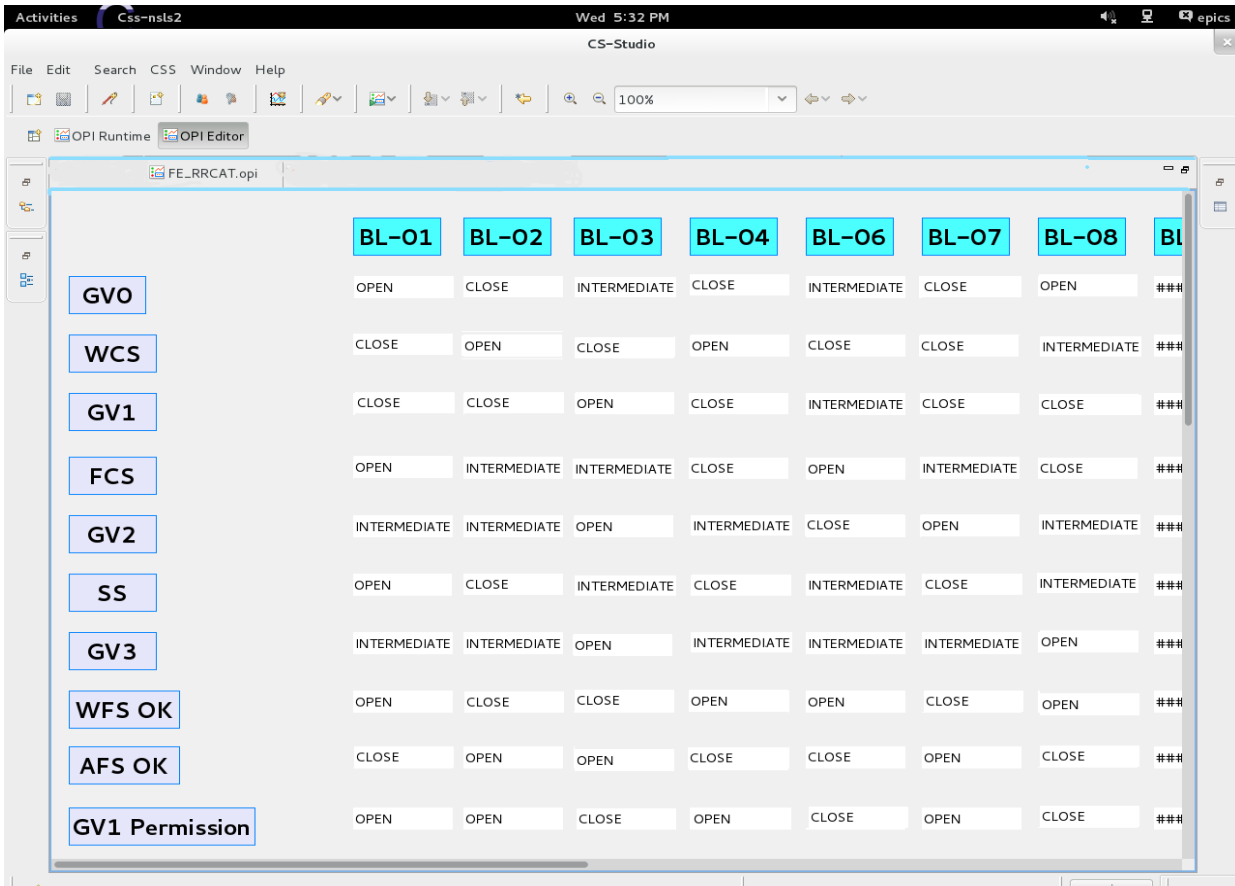
Figure 3: GUI OF EPICS BASED FRONT-END CONTROL SYSTEM

GUI shows status of various parameters of system such as Open, close or intermediate status of Gate Valve 0 (GV0), Water cooled shutter (WCS), GV1, GV2, Safety Shutter (SS), GV3, Water Flow Switch Ok (WFS Ok), Air Flow Switch OK (AFS Ok) and status of various safety parameters of Front-end such as GV1 Permission, SS permission, Front-end Maintenance, Beamline (BL) Fan On, BL Hutch Door Close, BL Radion In Range, BL Water Flow Ok, Front-end Ok.

GUI also displays temperature of collimator, Fix-Mask, Water-Outlet and vacuum information at different locations. It consists of action buttons to operate various pneumatic gate-valves like WCS, GV1, FCS, GV2, SS.

Client GUI

A client GUI is basically a operator interface file named client.opi that has been developed in CSS-BOY and deployed over web using WebOPI. Beamline users can access it over web from anywhere at any time via a web-browser-equipped device such as a PC, laptop. To get the status information of the respective beamline, a beamline user has to enter the beamline number and password to get authenticated. Once the user gets authenticated, data of respective beamline is fetched from server and displayed as shown in Fig. 4. Using this window, user can also operate various pneumatic gate-valves of their respective beamline.
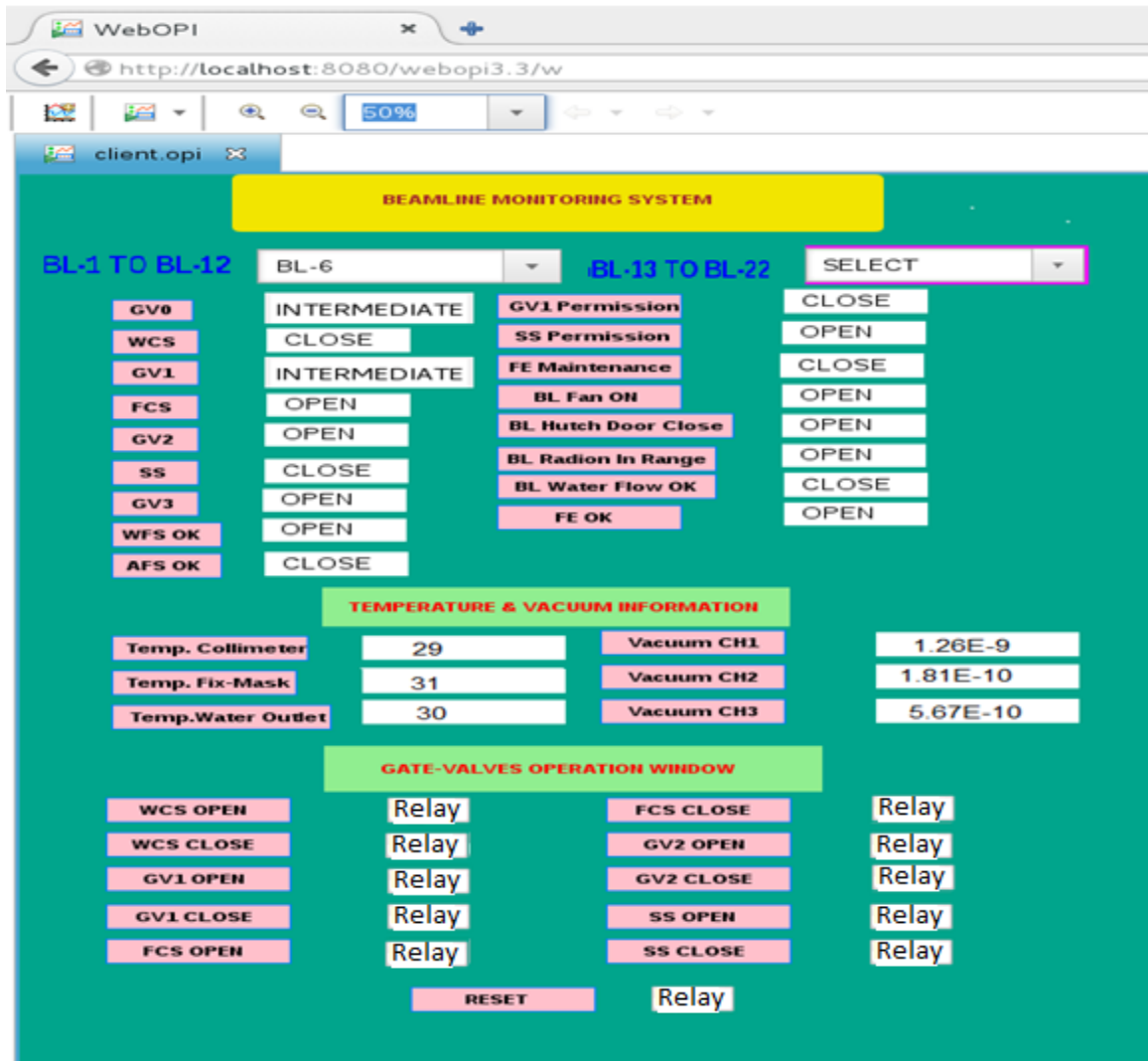
Figure 4: WebOPI based Beamline monitoring system GUI window

VI. CONCLUSION

This paper shows that the EPICS based software for front-end control system is a soft real time software system. The status of data displayed is refreshed every 100 ms. The software ensures fail safe opening of pneumatic gate valves as per the predefined sequence. It also shows status of various mechanical components and parameters of front-end in a user-friendly manner. EPICS provide facility to easily upgrade the software in the near future. Thus the software provides flexibility to the users.

REFERENCES

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

[2] M.Sekoranja, S. Hunt and A. Luedeke, "Visual EPICS Database Configuration Tool", THAP029 (2001)

[3] S.R. Kane et al. "Indus-2 Beamline Personnel Safety Interlock System" CARS2011; conference on accelerator radiation safety; Mumbai (India); 16-18 Nov. 2011.

[4] S.R. Kane et al. "Control and Interlocking system for bending magnet front-end at Indus-2" AIP Conf. Proc., 2007, Volume 879, pp.635-638(2007).

[5] github website:https://github.com/ControlSystemStudio/cs-studio/wiki/webopi