SCADA FUNCTIONALITY FOR CONTROL OPERATIONS OF INDUS-2

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ABSTRACT

The user interface layer and machine applications for Indus-2 [1] control system runs on commercial Supervisory Control And Data Acquisition (SCADA) and virtual instrumentation packages, to cater with the diversified requirements of different systems involved.

On the basis of evaluations performed at CERN [2], it was decided to make use of PVSS-2 (Process Visualization and Supervising System) [3]. This package is based on the concepts of object oriented design, flexible data points, notification, authorization, redundancy, scalability with the use of various managers as per requirements, this package provides the functionality to develop graphical user interfaces (GUI), interface to hardware, data logging, Alarm/event handling, data exchange features etc.

We are also using LabView® for slow processes like Low Conductivity Water (LCW) plant controls and have provided SCADA like features in it e.g. Alarm/Event handling, Data logging and plotting, configurable control actions, and layering concept to provide zooming.

This paper describes the use of commercial SCADA package for the control systems, status of developments and problems faced.

INTRODUCTION

Indus-2, a 2.5 GeV Synchrotron Radiation Source (SRS) under commissioning at CAT is having three-layer control system architecture [1]. Layer-1 is User Interface Layer (UI) has PC workstations for GUI. Layer-2 is Supervisory Control Layer (SC) has VME stations for supervisory control and Layer-3 is Equipment controller Layer (EC) has VME stations that house various I/O boards. Communication between SC and EC Layers uses Profi field-bus protocol [4]. Each SC station is assigned to one subsystem like power-supply, vacuum, LCW etc. SCs receive commands over TCP/IP from the operator consoles at layer-1. SCADA based application program will run at the layer-1 to supervise all the system activities.

PVSS-II [3] is to be used for different subsystems like Magnet Power Supply (MPS), Vacuum, Radio Frequency (RF), beam diagnostics (BDS) Radiation Safety System (RSS) and Timing Control System (TCS). The total numbers of I/O points in the system are 10,000 approximately with a refresh rate of 1 per second at present. It is planned to increase the refresh rate to 4 per second. Connectivity of PVSS to the SC layer is with Application Programming Interface (API) manager, which gets and sets data at periodic interval and applies smoothing and filtering. Commercial database is used for history database and connectivity between PVSS and SQL Server is under development. API manager and Driver manager concepts of PVSS are used extensively to interface different types of instruments, equipments and application software to PVSS over industrial standards like OLE for Process Control (OPC), Modbus and Profi bus.

LABVIEW is used in LCW plant control which is having ~1200 I/O points with a refresh rate of 1 sec. This package implements closed loop feedback system to control parameters of the plant, startup condition check and device interlocking and interdependency. Personal computer (PC) failure redundancy is provided in this package with a timeout. When the first system fails control is automatically transferred to the second machine after the timeout. This package is totally modular, configurable and is based on different services which can be run independently send inter service communication is achieved through Global files.

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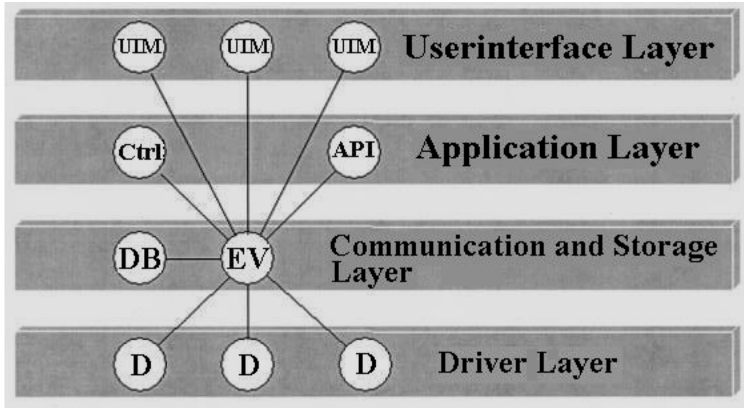

Figure 1: PVSS-II structure

DESCRIPTION OF PVSS SCADA

PVSS-II is an industry independent process control system for the visualization, monitoring and control of technical workflows. It is designed as a distributed system. It can be used in multi-user mode. It is multilingual, has a fully GUI and allows window technology with a multi platform support (WindowsNT/XP/2000/Linux). It provides flexible data-point (DP) concept where DP is a representation of an object. A number of DPs can be generated against any data-point structure. The functions of PVSS-II (Figure 1) are distributed into different managers, which are program modules. These managers communicate with the Event Manager, which is the central part of PVSS-II. The EV and the Database Manager (DB) are required to be run on a single machine while other managers e.g. User Interface Manager (UIM), Control Manager (CTRL), Application Programming Manager (API) and Driver Manager (D) can be run to different machines according to client/server techniques. It has also Redundancy manager to provide machine and system level redundancy and distribution manager to integrate multiple PVSS systems permitting large number of data points to be handled in a distributed manner. API manager of PVSS-II offers a number of functions allowing addition of special managers to the process control system. The DDE manager responds as expected under Windows. The OPC client can be connected to 20 local/remote OPC servers simultaneously. Drivers can establish connection to peripheral devices like Profi bus, SSI etc. The communication is through TCP/IP, V24. The ADO interface has been used for accessing OLE-DB or ODBC-compatible databases. The HTTP Server integrates Internet technologies in PVSS-II. Suitable alerts are generated in the system by the alert handling protocol. The operator can acknowledge alerts. It also supports event management. PVSS-II provides all the functions required for managing simple recipes. It offers scalability and the facility of authorization reduces the errors. On the basis of the above features, PVSS-II has been selected for Indus-2 machine.

IMPLEMENTAION DETAILS OF PVSS SCADA APPLICATIONS FOR INDUS-2

Definite data structure, called data-point type (DPT), has been generated against each device for all subsystems of Indus-2. A number of data-points (DP), the objects of DPT, are created for multiple identical devices for each system. This concept of object based data points is very useful for expansion and maintenance. Configurations settings for Range, Alert, smoothing, lock and authorization configs are assigned to each DP element.

To interface to the SC layer to the PVSS system API managers are developed. These API Manages use the ASCII manager to install a list of DPTs and interacts with the Event Manager (EV) to get a complete list of DPs. There is one API manager per SC and these API managers polls the SCs periodically to get the data. When ever any application program or user change any parameter value one message is generated by the EV which is captured by the API manager and corresponding value is send to SC which in turn will send it to Equipment Interface Unit (EC) (Figure 2). PVSS system can handle typically 700-800 DP changes per second; this limitation is a big hurdle for system, which is going to monitor 10,000 DPs approximately. To cater with this API managers are running on different

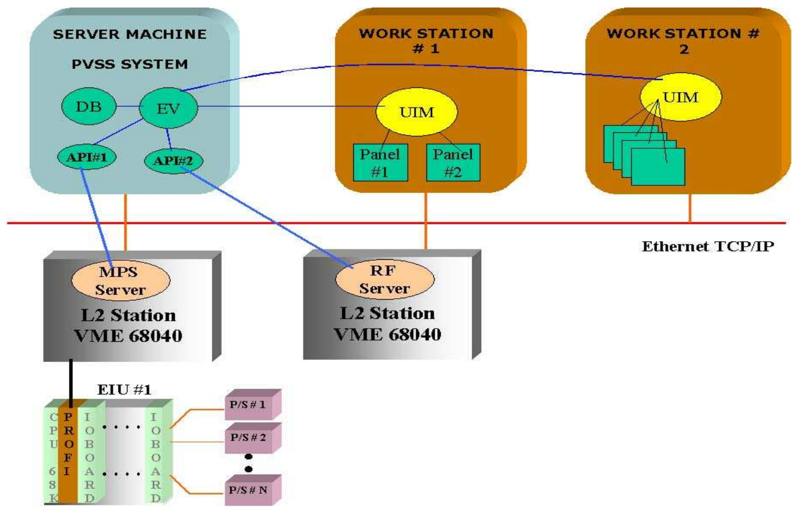

Figure 2: Control System Architecture

machines and has smoothing and filtering thus reducing number of DP change and in turn events generated per second.

Front panels of all the subsystems have been developed. Trends, bar charts, panel-meters are used in front panels for regular monitoring of analog parameters. Change of color is used to indicate the status

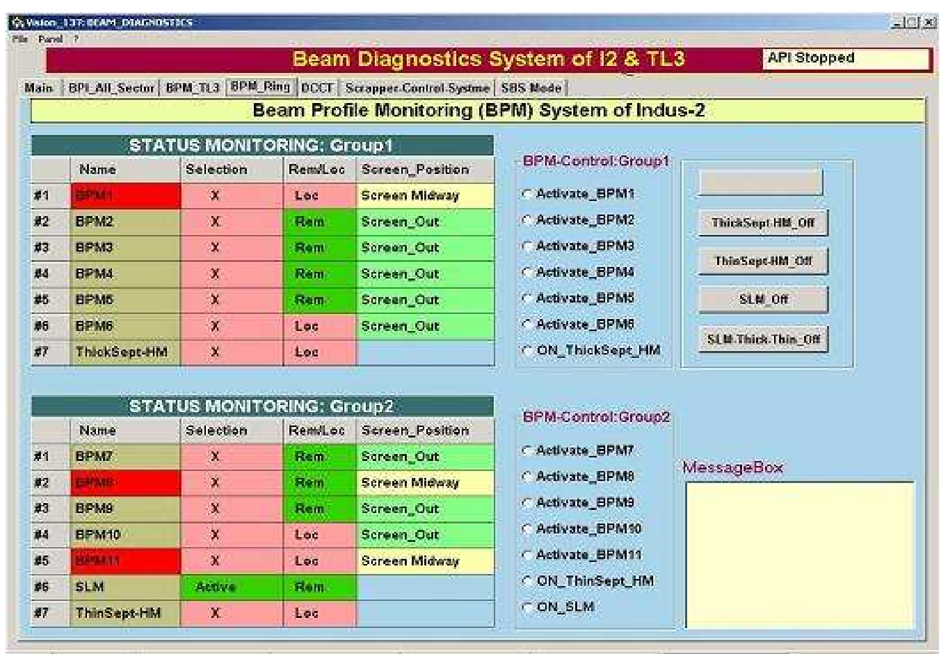

Figure 3: Panel for Beam Diagnostics System

of digital signals. Command buttons are used for control actions. Operator will be intimated at the instant of change of system status or fault. A panel for beam Diagnostics System is shown in Figure 3. Advanced scripting capability of PVSS-II helps to generate the required functionality against any graphics object linking to the Data-Points (DPs) of any subsystem. PVSS maintains data in its own form in the DB manager and it can be achieved at user needs. Interface to the commercial Database SQL server is under development with ODBC connectivity.

ALARM HANDLING

PVSS II provides Alert DP config to handle the alarms generated by various devices. Indus-2 has various devices generating different types of alarms based on the status change or value change. Alert

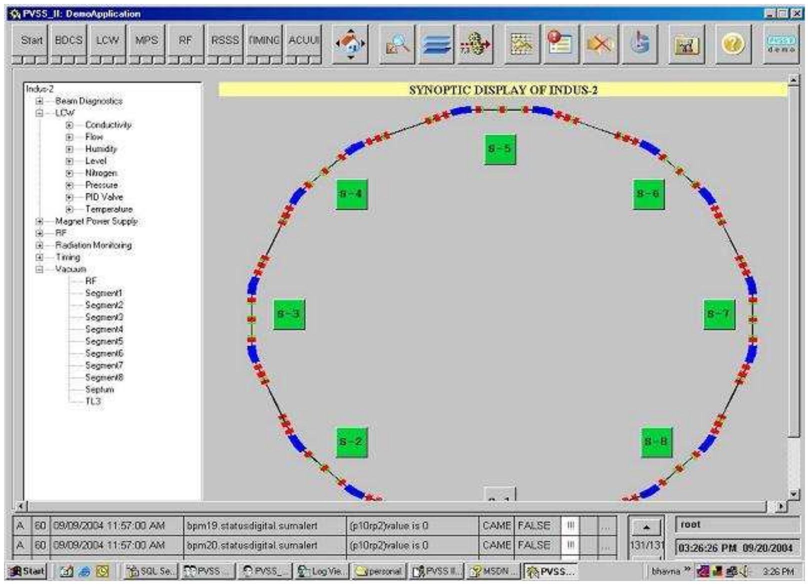

Figure 4: Alarm Panel for Indus-2

configs are defined for various DPs and the alerts coming are displayed in a panel with synoptic view of Indus-2 ring (Figure 4). This GUI panel is also providing a tree structure display and any devices generating alarm is highlighted and corresponding area on the synoptic zoomed with a blinking display of the device. Group alarms (sum alert) are also configured to cater alarms based on conditions multiple devices.

DESCRIPTION OF LCW CONTROL SOFTWARE

LABVIEW® is a graphical programming language which supports multi-tasking, having interfaces to industrial standard protocols (TCP/IP, DDE, GPIB, serial communication and OPC, ActiveX, COM/DCOM). LCW control software is designed to provide facility for selection, generation, logging, setting limits for alarms & control events. Provides data on LAN for viewing, logging & plotting of data on any PC on LAN. It facilitates the user to change the control action associated with events, addition or removal of any device, change the startup procedure and test the functioning of individual devices. Provides context sensitive and user-friendly help for both operator & control person. Password protected logon facility is provided to ensures security of the over all system. It maintains a self-record of modifications and repair works done. It presents a graphical mimic of complete Plant with zooming facility.

LCW SOFTWARE ARCHITECTURE

LCW control software architecture is fully modular and is divided into services as shown in Fig. 5. This modularity allows component reuse, easy maintenance and up-gradation. Multitasking facility of LABVIEW is exploited here to run multiple services simultaneously such as alarm handling, taking control action, data logging and monitoring. A service is grouping of tasks related with the implementation of some well-defined goals. Services are independent of each other. Inter-service data flow and communication uses global data file.

VME service

Functions of VME Service are to acquire data from SC layer [3] through Ethernet, by using Clint-Server based architecture, to pass control commands (issued from control services) to SC layer and to ensure the command action. It also parses the different types of data (Digital IN, Analog IN), extracts status signals & attaches tag names, scales & maps different analog data to corresponding devices, updates the global data file and configures remote port No, local port no, TCP address & data refresh time.

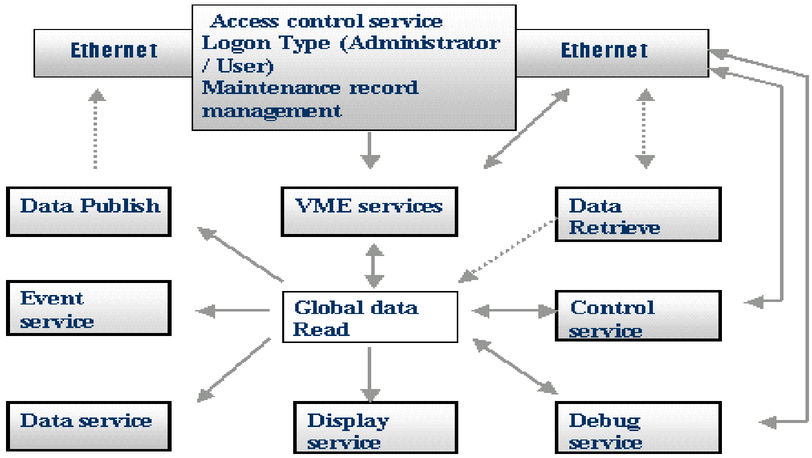

Figure 5: LCW software architecture

Event service

This is responsible for generating control and alarm evens. Its functions are to select parameters for event logging, to enable & disable events, set limits for events, identify the occurrence of events,

generate alarms, handle alarms, record events in event log file, handle event log file generation and viewing & printing of event log file.

Data service

Functions of Data Service are selecting data for logging, configuring log-rate, plotting of data (stored and on-line), handling data log file generation and viewing & printing of log file.

Control service

This is for implementing a closed loop feedback system to control the Inlet/outlet temperature, flow-rate, conductivity, quantity and pressure head of the circulating low conductivity water. Its functions are implementing the control action, start up checking, generating & editing of start-up configuration file (responsible for sequencing the start up procedure), handling the pre-start-up failure alarms, starting & stopping of plant, generating & editing of start & stop configuration files, control configuration file (responsible for implementing event control action, selecting event limiting values, comparing logic, action array, delay array, feedback device array) and handling the feed back device failure alarms.

Debug service

This is for testing the functioning of individual devices at the time of commissioning & fault diagnosing. Its functions are reading /writing on the selected device, adding/removing of devices from device table, setting the alarm values and scaling values for different devices.

Access control service

Provides password protected logging in two modes, as “Administrator” with full control and as “User” with limited controls. It provides and maintains the record of the maintenance work done in software.

Display service & Help service

These services comprises of interactive Plant mimic as shown in Fig. 4, facility for zooming on parts, providing help for User, Administrator and control persons. (FAQs, problems & remedy, starting & stopping of plant, Device tables).

Data Publish and Data Retrieve service

These services are used for communication over TCP/IP to publish data so that the data can be monitored on other machines on the Local Area Network. Other machines on the network need to run the Data Retrieve service and other services as per the requirements e.g. for monitoring the data Display service and Data Retrieve services are required.

PROBLEMS WITH PVSS SCADA

PVSS II SCADA package do not provide device modeling in terms of operation. The API library is not fully object oriented and properly documented. To the best of our understanding we have found PVSS II API library is single threaded and integration with Windows MFC application is not straightforward. Commercial SCADA packages in general do not provide GUI features normally required for the scientific applications e.g. log scale for trends. Specifically PVSS II do not have good GUI ActiveX® Controls for many objects e.g. table control.

CONCLUSION

Control System development for various sub-systems of Indus-2 using commercial SCADA packages makes it a very flexible and adaptable system. The development is very fast and follows the industrial standards allowing easy integration with the off the shelf hardware. During initial beam injection the operation of the system is found satisfactory. The scattered nature of the PVSS SCADA with centralized data and event management is found very beneficial.

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