Indus-2 Control System

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1 Introduction

Indus-2 is a 2 GeV Synchrotron Radiation Source (SRS) being constructed by the Department of Atomic Energy at the Center for Advanced Technology, Indore. A 20 MeV Microtron is used as an injector to a Booster, the booster raises the electron bunch energy up to 450 MeV for Indus-1 and up to 700 MeV for Indus-2. The storage ring is filled with electron bunches untill a smaximum current of 300 mA is reached. It then accelerates them to 2 GeV at pre-defined rate.

This paper describes the control system of Indus-2. The control system architecture has been chosen to accommodate present needs and future expansion in terms of functionality and capability. The system should also address the upward trend in technology. Following are some of the guidelines used in the design of the control system and its architecture:

-The architecture of the control system should be modular and distributed at all levels.
-Standard tools should be used for development.
-Commercially available hardware should be used to ease in replacement and maintenance.
-Networking of subsystems should be maximized.
-There should be provision to accommodate various instrument supplied by different agencies.
- The control system should be expandable and be able to accommodate new technologies.
-Fail safe operation.

2 Architecture

Indus-2 control system is distributed over three layers of computers : user interface layer, supervisory layer and equipment interface layer. It can also be seen as distributed over two network layers as shown in the figure.

The upper layer network provides interconnection between the user interface and the supervisory computers. Selection of the upper layer network is mainly governed by the requirement from user interface, market support and commercial availability. The higher layer network has to be 'open' in the sense that different kinds of computers from different suppliers and running different operating systems will be connected to it. This leads to use of sophisticated and standard protocols, such as TCP/IP, running over a Local Area Network and able to provide services like file transfer, remote file access, process to process communication. In the control room, consoles are provided for operator interface and software development. Dedicated servers are also connected to the network. Each of the control room computers can access any of the computer systems connected to the higher level network(supervisory).

The lower layer network (field bus) is governed by machine interface requirements, which is deterministic in nature. It connects supervisory computers to equipment interface unit via a field bus. Optical fiber is used to isolate each of the EIUs. The supervisory computer bridging across the higher level and lower level networks are VME bus based systems. The main task of these system is of a supervisory nature i.e. they continuously command and gather data from lower level EIUs and report to the user level as and when requested. Any equipment with a standard interface (GPIB, Serial etc.) can be connected to the network via VME modules or PC interface boards. All equipment in the field are interfaced to microprocessor controlled systems (EIU). These EIUs are also VME bus based crates. Each EIU performs predetermined tasks either on request or on regular basis. One EIU can be interfaced to many devices with one dedicated interface module.

3 Hardware

Hardware is distributed in three layers.

3.1 User interface hardware

Hardware at layer 1 are servers, operator consoles and consoles for software development. Powerful workstations and PC's from different vendors are good choices at this level. The gap between workstations and PCs is narrowing down with improvement in technology. A PC provides cost a effective solution in terms of support for hardware and software. Availability of software and hardware is also in favour of PCs. For Indus-2 high performance PCs for both servers and operator consoles is being considered. At this time two servers are considered to be sufficient for file services, database services and also to provide redundancy with auto switching capability. Services are also required to provide autobackup, controlled access and a warning feature for hard disk, network failure . Operator consoles should provide an excellent graphic environment for Graphical User Interface (GUI) development. 64 bit PCI bus based graphics accelerator cards with high resolution monitors well satisfy this requirement. Hardware support for multimedia may be considered for user interface software development. Multi-homing interconnection via a switch can be implemented for expansion and higher transmission rate requirements. The accelerator control network (AcCNET) is based on Ethernet (IEEE 802.3 standard) running at 10 Mbps. Ethernet is not deterministic at higher loads but when the load is low, 30% to 40% of the total capacity, it is almost deterministic. Also, ethernet is widely accepted in industry and variety of applications are designed around it. Some of the dedicated systems at

control room may be as follows.

-High performances servers.
-Operator console with GUI.
-Dedicated consoles for program development.
-General purpose consoles.
-Dedicated fast CROs, Synthesiser, PA system etc.
-Display monitors and terminals as per user requirements.

3.2 *Supervisory layer hardware*

Ethernet connectivity is provided at the supervisory level computers. These computer systems are VME bus based with a Motorola 68040 CPU. All the hardware at this level is modular. These systems are industry standard with a high MTBF rating. These systems also provide network interface for the lower level network using a separate controller board. Profibus is used as a field bus for the lower layer network. Profibus is token passing and satisfies the deterministic requirement for equipment interfaces. These system are physically located near the control room.

Connectivity of the fieldbus will be implemented by RS485 to fiber converter and vice versa. Thus providing isolation and noise immunity to different systems. This isolation is must for an accelerator environment as there are many sources of noise.

3.3 Equipment interface unit

EIUs are interfaced to various accelerator subsystems power supplies, vacuum, RF systems, safety and interlocks. It is also designed around VME bus structure. It consists of one CPU card, Profibus controller board, VME power supply and individual equipment interface modules. One such module is needed for each equipment. It consists of ADC, DAC and digital I/O. It also provides optical isolation to the actual equipment being interfaced. There may be nearly 100 EIUs all around the Indus-2 machine.

4 Software

As with the hardware, software is also distributed at three layers. Upper layer software (GUI) handles user interaction and provides a means of communication between user and accelerator machine. There is no defacto standard for this purpose, because of fast development and new emerging technologies. The basic requirement of open system and friendly user interaction, should be the main reason for the selection of a software environment. Also the availability of tools and development cost of different applications should be considered.

Unix is being used by many control system designers for software development. We have deviated from Unix to WinNT which provides almost Unix like features along with powerful graphical environment. VC++ will be used for application development. It provides the MDI environment needed for the control and data acquisition system. Layer 1 software mainly deals with user requirements and should respond to each of the user action. Since the application software may be running with a non real time operating system, the response to user interaction should be within human acceptable limits 500 msec. to 1 sec. Similarly database updating may be at a rate of 1 sec. to 1 hr. or more as the requirements.

Software requirement for supervisory level is mainly governed by the machine side. The main task at this level is to get data from EIU on regular time intervals or on demand .A real-time operating system is required at this level. In the field of real time system software there are mainly three options for consideration i.e. VxWorks, pSOS & OS9. OS9 along with cross development tools was chosen. OS9 is one of the most widely used real time operating systems for VME bus. All the program development for supervisory level will be done in C++. After compilation, modules will be down loaded to the VME CPUcrate over the network.

EIU software is dedicated to a particular task and confined to a group of equipments. Its basic function is to log equipment parameters and report equipment status to the supervisor layer when demanded. It also controls the equipment as per user interaction and commands. It also has to manage many diagnostic tasks related to hardware and report accordingly (like ADC, DAC calibration, channel testing with reference source provided on board etc.).

5 Database

Indus-2 has a distributed data base architecture. Configuration of the database will be done at a single point to avoid conflicts. In a distributed system some data may be held in different forms in different parts of the system. Indus-2 control system will have a dedicated database server on the network. A general purpose commercial database will be used to store parameters and equipment data for the whole machine. Data for the machine is stored in a unified way and accessed by various processes running on consoles in the client server manner.
On line and off line applications distributed in several systems can store and retrieve the data from the database over the network. On line applications have a higher priority than off line applications. The database manages three categories of databases , consistent, on-line and historical database. The consistent database stores stable data of equipment like calibration constants , and physical dimensions . The on line database stores the current status of accelerator parameters. The software for this purpose should be fast enough to cope with the number of channels required to be updated per second. The data ,which is needed for off line analysis, is extracted from the on line database and stored in the historical data base with a time stamp. The historical data base is an archive of data which includes ambient temperature, LCW temperature, alarm status, beam current etc. SQL support is a requirement for data retrieve from the database.

6 Conclusion

The commissioning of the proposed control system will be done after completion of the civil work. This may take nearly 18 months or more. Till that time there may be many advancements in technology and easier availability

of components in the market. *I*f the load on the network increase,the main network may need to be changed to FDDI. User consoles or networks will also be connected to the main network when the machine gets commissioned.

References

[1]Tutorial on standard field buses - Application in physics laboratories - Raymond Rauch.-ICALEPCS 93, Berlin.

[2]The Elettra control system - methodology, architecture and technology - D.Bulfone, M.Mignacco, R.Mazzurco.

[3]Control system of Spring 8 storage ring - K.Tanaka and others.

[4]20 MeV Microtron control system - J.S.Adhikari, B.J.Vaidya, Y.Seth - ICALEPCS 95, Chicago.

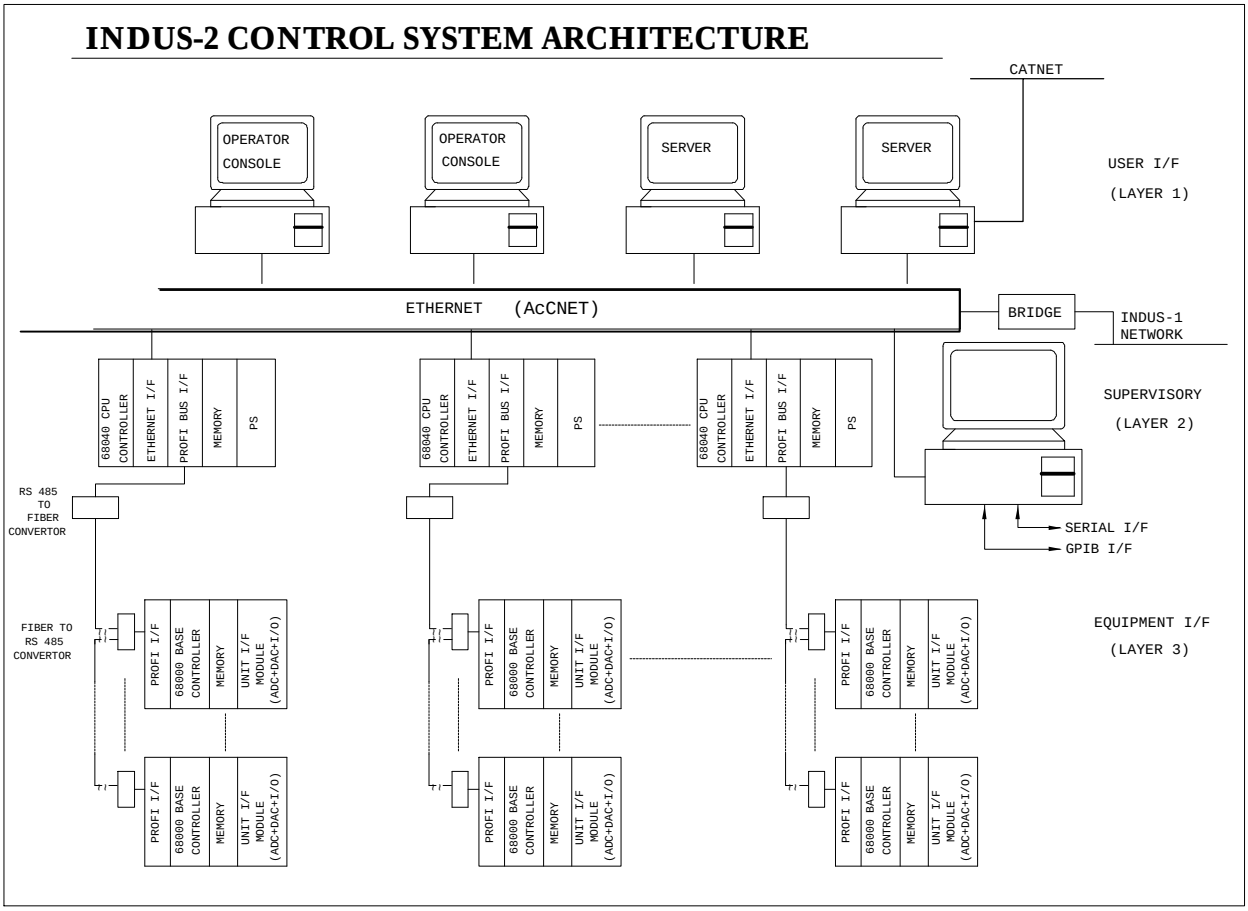

Fig. Indus-2 Control System Architecture.