INDUS-2 CONTROL SYSTEM

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Abstract

Indus–2 is a 2.5 GeV Synchrotron Radiation Source (SRS) being constructed at Centre For Advanced Technology (CAT), Indore, India. Electron beam at 700 MeV from booster synchrotron will be injected into this machine. Indus-2 will raise the beam energy to 2.5 GeV and store the same. The control system for this facility is being developed around a three-layer architecture. The distinct feature is the use of 'All-PC' user interface layer.

The paper presents the overall architecture of the control system.

1 INTRODUCTION

Indus-2 is a 2.5 GeV Synchrotron Radiation Source (SRS) being setup by Department of Atomic Energy at Centre for Advanced Technology, Indore. 20 MeV Microtron is used as injector to Booster, which boosts the electrons bunch energy up to 450 MeV for Indus-1 (450 MeV SRS) and up to 700 MeV for Indus-2. The Indus-2 ring is filled with electron bunches till a desirable current limit of 300 mA and then the electron beam is accelerated to 2.5 GeV at pre-defined rate.

Indus-2 control system is distributed over three layers of computers viz. user interface computer layer, supervisory computer layer and equipment interface computer layer. It can also be seen as distributed over two layers network architecture as shown in figure 1. The control system architecture is chosen to accommodate the present needs and future expansion possibilities. The distributed architecture with three computer layers interconnected by two network layers has been widely accepted because it allows convenient, functional separation of variety of hardware and software. This in turn results in better speed, performance together with easy maintenance and upgradation of the overall system.

The upper layer network (Ethernet) provides interconnection between user interface computers and supervisory computers. It is mainly governed by the requirements from the point of view user interface, market support and commercial availability. TCP/IP is the protocol of choice on this network, which is able to provide services like file transfer, remote file access, process to process communication, etc. Each of the control room computers can access any of the computer systems connected to the higher level network (supervisory).

Each middle layer supervisory computer system is networked to various lower layer Equipment Interface Units (EIU) using fieldbus network. The lower layer network (field bus) is governed by machine interface requirement, which is deterministic in nature. The physical medium is optical fiber to isolate each of the EIUs. The supervisory computers bridging across the higher level and lower level network are VME bus based systems. The main task of these system is of supervisory nature i.e. they continuously command and gather data from lower level EIUs and report to the user level as and when requested. All accelerator subsystems 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 equipments / units with one dedicated interface module for each.

2 HARDWARE

As per architecture, hardware is distributed mainly in three layers.

2.1 User Interface Layer:

Hardware at layer 1 comprises of latest, fastest IBM compatible PCs as operator consoles, network gateways, application/file servers and database servers. With rapid improvement in Intel processor technology high-end PCs are beginning to exceed workstation performance. PCs provide added advantage of cost-effective solution in terms of support for hardware and software. Win NT workstations will be used as operator consoles and network gateways, Win NT servers will be used as network domain controllers and database servers. This layer will also have few dedicated consoles for special (fast) application e.g. to access control room instruments like CROs, frame grabbers for beam position monitoring systems etc.

Network will be based on Ethernet working at 100 Mbps. It is hoped that ethernet at 100 Mbps will provide sufficiently good response.

2.2 Supervisory Interface Layer:

Ethernet connectivity is extended down from User interface computers to supervisory interface computers. These computer systems are VME bus based with Motorola 68040 CPU, running OS-9 (ROM based). All the hardware at this level is modular. These systems also comply with industry standard with higher MTBF rating for continuous operation. These systems are physically located near control room. Functional division at this layer results in one supervisory computer crate for each accelerator subsystem. Altogether, there would be about 15 such crates. These systems also provide network interface for lower level network using a separate controller board. Profibus is used as field bus for lower layer network. . Profibus protocol with it's token passing and command response mechanisms combined satisfies the deterministic response requirements.

Connectivity of 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 accelerator environment as there are many sources of noise around.

2.3 Equipment Interface Unit:

EIUs are directly interfaced to various accelerator subsystems like magnet power supplies, RF, vacuum, Timing, beam diagnostics, safety and interlocks, etc. These are also VME bus based computers running OS-9 with M 68000/68020 CPU. Each EIU consists of one CPU board, Profibus controller board, VME power supply and individual equipment interface module. 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 ring.

3 SOFTWARE

As hardware, software is also distributed at three layers. Client/Server architecture is followed at all the three layers. User interface layer software, which is also termed as GUI, handles user interaction and provides a means of communication between user and accelerator machine. The basic requirement of open system and friendly user interaction, should be the main reason for the selection of software environment. Availability of various development tools and development cost of different applications should also be considered.

Windows NT is chosen as the software platform for this layer. It provides powerful, built-in multi-protocol networking support, multithreading and structured exception handling besides serving as an excellent application service platform. It has Unix like features along with powerful graphical environment and simple network administration. Remote Procedure Call (RPC) which is well supported in Win NT is extensively used. VC++ and Labview are used most commonly as development tool for application development.

Machine side (equipment interface) mainly governs the software requirement for supervisory level. The main task at this level is to get data from EIU on regular time interval or on demand and provide a response to any request made by layer 1 software. OS-9, a real time multitasking operating system is chosen as the software platform for supervisory layer computers. OS-9 is one of the most widely used real time operating systems for VME bus and comes with good support for cross development tools. All the program development for supervisory level will be done at user interface layer computers in C++. After compilation, modules will be down loaded on VME crate over network.

At equipment interface layer, software is almost dedicated to a particular task and confined to a group of equipments. OS-9 is used at this layer also though with limited capability. Its basic function is to log equipment parameters and report its status to supervisory computer 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. Device/equipment servers running at this layer update the latest machine status in the local database and send replies to the client requests from higher layer.

4 DATABASE

Indus-2 has distributed computer architecture, based on client/server model and so is the database of Indus-2 machine. Microsoft SQL Server has been chosen as the commercial database platform. Being another Microsoft product, it integrates well with Win NT platform and VC++ as a development tool and front end. It supports the distributed client/server architecture quite well. It provides powerful tools for enterprise-wide administration, data replication, parallel DBMS performance, and scalability to very large databases. SQL Server also provides tight integration with OLE object technology.

Data for the machine are stored in unified way and accessed by various application processes (clients) running on consoles in the client server manner. There are four categories of databases viz. configuration database, on-line and historic database. Configuration database stores static data of equipment like calibration constants, physical dimensions, I/O channel assignments etc. On line database stores the current status of accelerator subsystem parameters. The data, which are needed for off line analysis, are extracted from on line database and stored in the historic database with time-stamp. Alarm database manages the detailed record of alarm events occurring at various levels.

5 CONCLUSION

Presently, software at various levels is under development. Till the commissioning starts (at least 18 months from now), there would be much advancement in technology and easier availability of components in the market. While implementing we may have to take this into account to provide a good control system to user. The network and operator console hardware is more likely to be affected.

5. REFERENCES

1. Indus-2 Control System - J.S.Adhikari, B.J.Vaidya - ICALEPCS 97, Beijing.

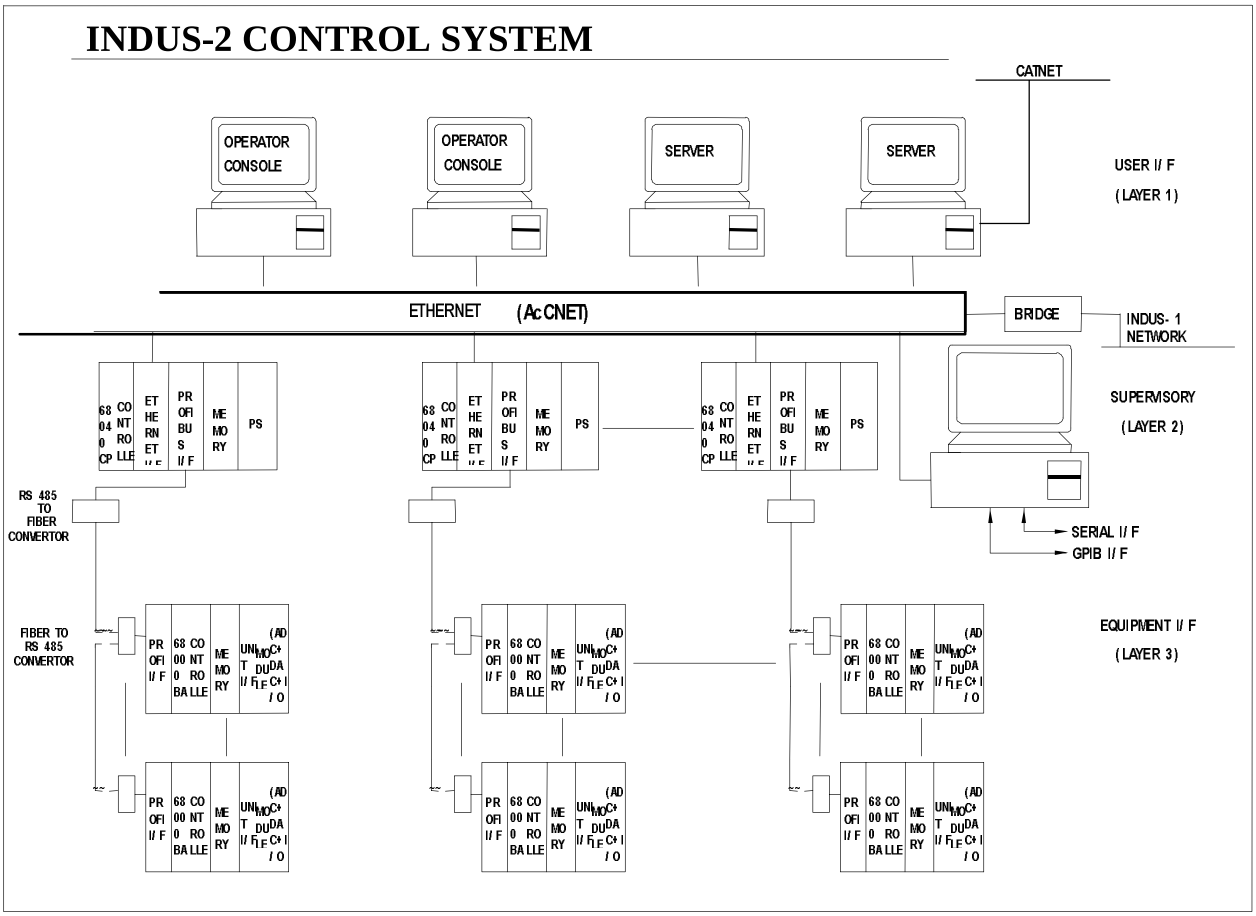

Figure1 Indus-2 Control System Architecture.