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THE OPERATOR VIEW OF THE SUPERCONDUCTING CYCLOTRON AT LNS CATANIA

D.GIOVE, INFN MILAN
LASA - V. F.LLI CERVI 201
SEGRATE- ITALY
G. CUTTONE AND A. ROVELLI, INFN LNS
V.LE A.DORIA ANG. V. S. SOFIA
CATANIA-ITALY

Abstract

The upper level of a distributed control system designed for the Superconducting Cyclotron (SC), will be discussed. In particular, we will present a detailed description of the operator view of this accelerator along with the tools for I/O points management, data rappresentations, data archiving and retrieval. A dedicated program, developed by us, working under X-Window will be described as a starting point for a new man-machine interface approach in small laboratories opposed to the first industrial available packages.

I. INTRODUCTION

The SC developed at the Milan University, where was performed the first test on the magnetic field, has been moved to the final destination, at LNS in Catania. The work on the accelerator will start at the begin of the next year with the magnet excitation and the installation of the RF cavities. The extraction of the beam, injected in the booster by a 15 MV Tandem, is foreseen before the spring of 1993. The main features of this heavy ions accelerating facility are reported elsewhere [1] [2].

According to the experience gained in Milan on the control system during the first magnetic measurements, we planned improvements mainly on the upper level devoted to the man-machine interaction. The first console designed and realized in 1985-1987 [3], followed an old philosophy. Altough the main hardware and software choices had been proved satisfactory, it gave us a flexibility not so good as we expected.

Nowadays the availability of standard graphic software and the capability to create networks are the two features which make the workstation a pratical cost effective way to provide an universal environment for the development of the operator interface. It is possible to use powerful hardware and software standards which make straightforward the setting up of a network where hardware and software resources can be easily shared in a really efficient environment.

In the follow we will discuss the hardware and software architecture of the Superconducting Cyclotron operator console together with its performance measured during the test.

II. THE OPERATOR CONSOLE

In 1989, during the shut-down of the SC in Milan, we decided to review the structure of the console. Some general rules were fixed for the project.

- The architecure must be independent of the number of worksites in use: the insertion or the removal of a worksite must be invisible to the whole system, realizing in this way a real "easy expandible system".
- The architecture would allow to have the same graphical workstation conncted both in the main control room and in a remote place closed to the accelerator.
- The architecture of the console must be fully independent of the lower levels so that the choices made in process and plant levels don't influence the supervisor structure.
- The presentation level of the software must not require any practice in computer science and must be picture driven. The operator must be able to define its own working environment with few choices and the access to every information that he wants to deal with has to be guaranteed.
- The operations on an accelerator subsytem must be possible by each workstation but not at the same time. The display of all machine parameter must be possible on different workstations at the same time.
- The on line software configuration must be guaranteed by means dedicated programs taking advantage of a database.
- The allarms and malfunctioning logging task must be managed by a dedicated unit able to provide particular tools to help the operator in his trouble shooting job.
- The maintanance of the whole structure must be easy and centralized as much as possible on a single machine.

It was decided that the development of most of software would take not more than 3 man-years of work. The choice of the final solution was not easy and a lot of different considerations, like our experience with graphical workstations and their operating system, the estimated technical support avilable from vendors in our country, were taken into account. At last, we decided to implement our hardware architecture on a Local Area VaxCluster (LAVC) of 3100 Vaxstations with a µVax 3100 as boot member. A gateway was provided towards the lower levels. A µVax II was dedicated to this task along with the storage of the memory map of all sensors and actuators. Two 80386 PCs were dedicated to allarm logging and to manage the data necessary for the application tasks.

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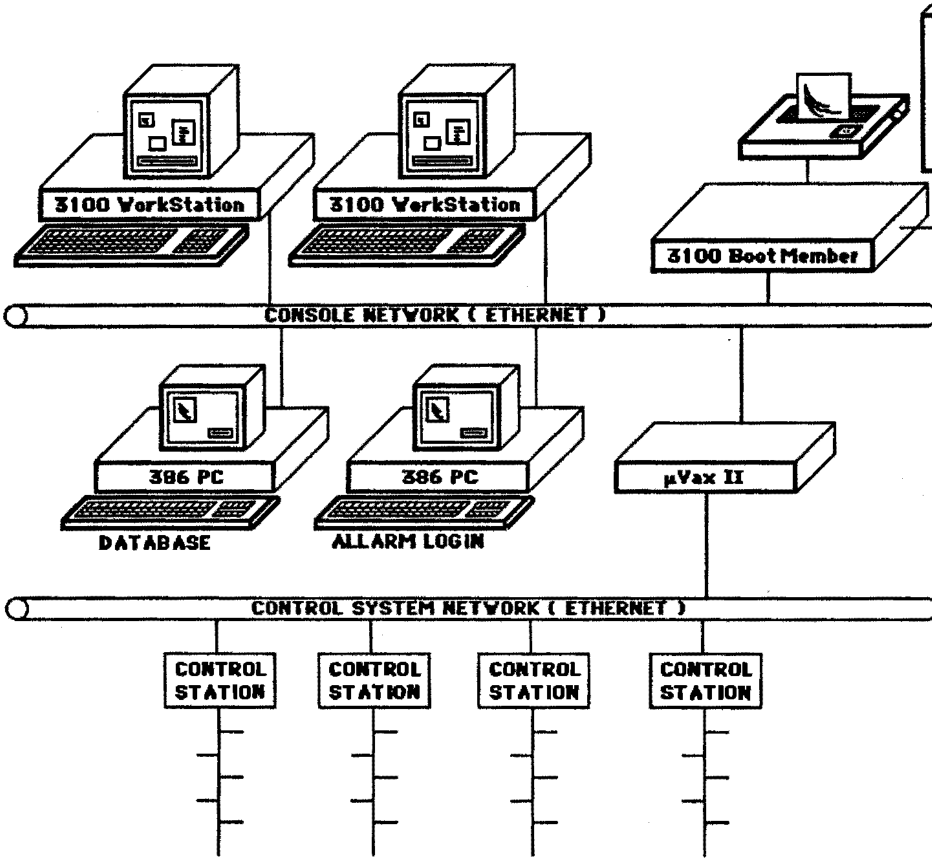

Fig. 1 The hardware architecture of the control system.

III. HARDWARE ARCHITECTURE

The main console has been designed as an Ethernet segment with a distributed software running on the resources which are connected to it. The Ethernet segment is physically the same which interconnects the process stations but we have superimposed on it the LAVC. This software is quite reliable and is well tested in a lot of installations all around the world. The structure resulting is easy to mantain as it recalls centralized architectures but it is really flexible and able to suit growing requirements. The intrinsic problem to have a central machine which will paralize the whole system in case of failure has been considered but our experience gained in similar architecture used for computer rooms reports a very low failure rate.

The boot member is dedicated to the management of Cluster operations and of print and tape resources. Historical logging of all the accelerator parameters acquired or calculated by the control system is provided by the µVax II, which is a satellite in the LAVC. Powerfull 3100 VaxStations with 16" Trinitron colour monitor have been chosen as the hardware platform for the operator interaction tools. All the workstations, whose number is completely unrelated to the architecture of the console, share the same programs and are able to work on every acces point to the coaxial Ethernet cable. This is the true sense of statement that: "the console is a network". A workstation will be dedicated to the beam dynamic simulation either in accelerator or in the beam transport lines. This machine, working on a complete accelerator or beam lines setting, will calculate the necessary corrections for the beam optimization.

Two particular nodes on the control room Ethernet are two 80386 based PCs, chosen because of their high performance, low cost, easy programming and full integration in the Digital network architecture (DECNET). The first is dedicated to run a database application (INFORMIX) used for the storage of all relevant parameters of each sensor and actuator of the cyclotron, like its name and software position in the control system, the different alarm thresholds and the range of possible setting value. Data are organized according to different query schemes to provide an interactive tool for everyone needs a particular information. A particular use of this application is the console itself. Infact, the data section of the applicative programs refers to this database and each variation is immediately available to the operator workstations taking advantage by the possibility in a DECNET environment to share disk between DOS and VMS

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machines. The second PC provides a lot of tools to help the operator during alarm handling and troubleshooting operations. This computer was conceived like an hypermedia machine, with enhanced graphic capabilities for the display of pictures or drawings related to particular event and with the possibility to play back defined speeches as an auxiliary tools. Fig. 1 showes the hardware architecture of the control room Ethernet so far described.

IV. SOFTWARE ARCHITECTURE

The most relevant challenge in the development of a new, flexible and portable console is in the software design. The whole hardware architecture described in the previous section would be meaningless if it would not be provided an adequate software support.

The main choice in the software architecture has been to use X-Window as basic development environment. Taking as a reference the software model proposed by X-Window, a modular object oriented code has been developed: GIULIA (Graphical Interactive Unit Level for Improved Automation). It is based on DEC-Windows, an extension of X-Window developed by DEC, which permits to use a powerfull toolkit and a User Interface Language (UIL) able to define the structure of the graphical interface. The Object description is stored in a separate file where the methods to which the objects will respond are outlined. The necessary code for the implementation of every method described in the UIL file is contained in a second file. Such a structure enhances the seperation between form and content of an application. The possibility to use low level Xlib functions together with DEC calls in the same code is guaranteed. We chosed to work under VMS and to use the "C" language to develop our code.

GIULIA is composed by two main parts running on at least two different computers: the first provides man-machine interaction tools while the second is dedicated to the management of the accelerator data received from the control stations and guarantees the operations on an accelerator subsytem by only a workstation at a time. GIULIA creates a remote task on the µVAX II devoted to the data exchange with the control system, in order to realize a trasparent task to task communication scheme. Data exchange has been optimized to reduce the traffic on the network and to semplify the handling of the shared memory. For each control station devoted to a particular accelerator subsystem according to a functional scheme of intelligence distribution, we have on the µVAX II two different VMS global sections where are written respectively the accelerator data received and the command to be sent. The access to these sections is controlled by means of flags. Tasks running on remote workstations look and actuate on the control hardware in an indirect way by means of this sections, making the software really device independent. Full operations on each accelerator subsystem are possible by each workstation asking to the µVAX II the allocation of this resource. At the end the operator must deallocate the resource to permit the operation by an other machine. The bandwidth measured on the network channel is of nearly 1.1 Mbit/sec for 2.5 Kbytes packets quite in agreement with the performance of other control networks. In this way we can send by a workstation up to 35 commands for second, receiving any time by the control station all the data acquired at that moment.

The interaction tools in GIULIA are based on the defintion of three different classes: rappresentation, interaction and BPM. Main attributes of these classes are "true" resizing and iconic interface. Rappresentation has three subclasses (table, bar chart and graphic) that identify the different ways to display every parameter of the cyclotron. Interaction has three subclasses (button, slider and knob) that identify the different ways to operate on each parameter of the cyclotron. A particular class is BPM which is realized to display the reconstructed beam shape acquired by the beam diagnostic devices, with a low frequency. The environment provided to the operator for its job is like that one of a writing desk: foils, particular rappresentations, are distributed on the screen and the parameters to be displayed or actuated have been chosen during a short navigation inside the program by the operator itself according to its preference. Foils may be opened, iconified, deleted and reconfigured. Graphic attributes of the subclasses may be easily changed by interactive setup utilities or modifing the UIL description file.

A process in GIULIA checks all variables for allarms or safety limits, and when a threshold is exceeded all the related informations are transferred to the second PC for further dedicated analysis. GIULIA provides an extensive on-line context sensitive help explaining how it works and all the details concerning the objects classes which it implements. Some choices, which may be dangerous as the modification of an allarm limit by the operator, are always recorded in the display of the workstation and are effective only for that related display.

V. CONCLUSION

The goal to develop the software so far discussed has been reached. Preliminary test has been carried out in order to verify the overall architecture and its performance that seems to be quite in agreement with the accelerator requirements.

In order to implement a real time picture of the beam a dedicated system is under development based on a CCD camera and a VME frame grabber board. A dedicated monitor will display the images so acquired at a high rate (about 30 Hz) with the possibilty to show up to 4 different images at the same time.

VI. REFERENCES

[1] E.Acerbi et al. "Progress Report on the Heavy Ion Facility at LNS" in EPAC Proceedings, Nice, France, June 1990, pp. 425-427.

[2] L.Calabretta et al. " The Tandem Injector for the Superconducting Cyclotron at LNS" in EPAC Proceedings, Nice, France, June 1990, pp. 497-499

[3] F. Aghion et al. "The Operator Interface in the Control System for the Milan Superconducting Cyclotron" in 11th Int. Conf. on Cylotrons and their Appl. Proceedings, Tokyo, Japan, 1987, pp. 432-435