THE GANIL COMPUTER CONTROL SYSTEM RENEWAL

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Abstract : Since 1982 the GANIL heavy ion accelerator has been under the control of 16-bit minicomputers MITRA, programmable logic controllers and microprocessorized Camac controllers, structured into a partially centralized system.

This control system has to be renewed to meet the increasing demands of the accelerator operation which aims to provide higher quality ion beams under more reliable conditions.

This paper gives a brief description of the existing control system and then discusses the main issues of the design and the implementation of the future control system : distributed powerful processors federated through Ethernet and flexible network-wide database access, VME standard and front-end microprocessors, enhanced color graphic tools and workstation based operator interface.

Introduction

In order to cope with the increasing capabilities of the GANIL facility, we envision the design and the implementation of a new generation computer control system.

Why renewing the control system ? : The objective currently assigned to the laboratory to increase the performances of the accelerator are leading us toward major improvements in the following domains :

- Beam setting up and tuning : control, simulation, optimization.
- Surveillance : display of pertinent pieces of information, error handling, alarms.
- Diagnostics : breakdown detection and repairing aids with more capabilities and flexibility when controlling the machine and more reliability.

All these goals imply powerful, sophisticated and open computer control system (CPU speed, memory, precision, networking...).

These characteristics are quite beyond the scope of the existing control system [1] which was designed twelve years ago to meet amply the requirements of the accelerator operation at that time. This control system which was built around 16bit minicomputers MITRA, programmable logic controllers and 8/16bit microprocessors linked by a large Camac system, is vulnerable because of its partially centralized architecture and limited 16bit minicomputers. Also a lot of pieces of software (hierarchical live database, graphic library...) had to be developed in close relation with the hardware following home standard. Shortly, the existing control system is not adequate for major improvements.

Which evolution ? : the present control system has to be renewed thoroughly. But this should be realized in a smooth fashion, the time schedule being spread over several years. And still, the needs of the GANIL operation stress us to start it right now.

During this advancement, the present control system will continue to operate in cooperation with the merging system. The settling up of the future control system will, by no means, impede the operator from controlling the accelerator.

The Camac installation will be kept up and integrated into the new system, whereas the minicomputers MITRA will be discarded as soon as possible.

It is important to make choice of industry "de facto" or international standards, for long term saving of human efforts and investments.

Taking benefit of the recent progress in networking technologies and standardization, we decided to adopt a flat distributed architecture. The GANIL facility will be sorted into geographic or functional regions (as examples : control room, injectors, experimental areas..). Every region will be under the control of appropriate processors. All the regions will be federated by a control local area network. Also, the regions can be autonomous and possess a great computational power.

It is highly expected that such a topology will facilitate extensions and allow us to cope with the future growth of the laboratory.

Because of their high added value (human effort and time to carry it out) and their longetivity, software products have to be selected, taking into consideration standard, price and support as well as the trends of the experimental physics control systems community. Also modern productivity tools have to be investigated and carefully chosen : graphics display (Windows. Icons. Menus. Pointers) and ergonomics, software design and programming methods (CASE).

The Future GANIL Control System

General Presentation[2]

The schematic layout of the future GANIL control system shown on figure 1 is built over an Ethernet network connecting mainly VAX computers running the VMS operating system. The control system is logically structured into three layers devoted to developments, real time control operations and front end processings.
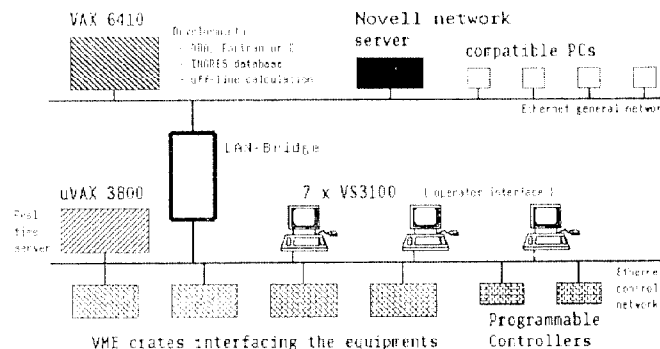

Fig 1 : Layout of the future GANIL control system

At the highest layer, developments are performed on the VAX 6000-410. The VAX 6000-410 is planned to meet all our development needs : software design, database management, calculation and simulation... On this computer are installed ADA, C, FORTRAN compilers and development tools.

The real time aspects are controlled, at the operator intermediate layer, by a dual-hosted μVAX 3800. This dual-hosting configuration provides a higher reliability when running the accelerator : two CPUs are sharing the peripherals so as to ease mutual back-up in case of CPU failure. The operator interface is based upon VS3100 workstations. At the lowest layer, equipments are under the control of front end VME processors and controllers.

The relational data base management system INGRES was selected to handle the 3000 equipments of the accelerator as well as the beam parameters. All these topics will be emphasized thereafter.

Networking Aspects [3]

The GANIL laboratory is equipped with a general Ethernet network linking many kinds of computers (VAX, SUN, personal computers attached to NOVELL servers...). This network answers various needs such as office automation, electronic and mechanical computer aided design, off-line calculations and software engineering...

To monitor the network traffic at the real time level, we have installed a separate Ethernet control network devoted to our control processors : the μVAX 3800, the VS3100 workstations, the VME crates and the programmable controllers.

A LAN-BRIDGE links the general network to the control network. It checks the data flow between the two networks and filters the communications flowing to the real time level processors.

The main network protocols in use are DECNET (VAX to VAX communications), LAVC (the VS3100 workstations belong to a local area VAX cluster served by the μVAX 3800 boot node), CSI (interconnection with the programmable controllers) and TCP/IP (link with the today's control computer).

The ADA Language

The strong need for a high level language which provides program reliability and quality maintenance, as well as efficiency and security features, leads us to select ADA as the main language. ADA will be mixable with FORTRAN and C for some applications. As the ticklish aspects of this language will be hidden to most programmers, the use of ADA shouldn't appear as a heavy constraint and offers many checkings when programming.

As we wish full homogeneity between the VAX computer and the VME processors, the basic programming language on the VME CPUs will be ADA, too, using cross development tools. In both cases, the development tools include the compiler and linker, a library manager and a source level debugger.

The VME Level

The VME processors are in charge of the critical real time aspects of the system, they contain most of the hardware which interfaces the equipments of the accelerator.

As aforesaid, they are programmed in ADA using cross-development tools installed on the host VAX 6000-410 computer : programs are compiled, linked and then downloaded into the VME CPU boards through the Ethernet network and the LAN-BRIDGE. Debug sessions can be invoked on the VAX using a remote source level debugger over the network.

The Database Management

A detailed investigation convinced us that a relational database management system could provide powerful tools to control the accelerator and save time when writing the basic control software. Therefore the INGRES database management system was chosen.

Since a database management system does not fit well with the real time environment of a process control, the INGRES RDBM will be used at a background level, when response times are not critical. Files or memory pools derived from the database will be used at the lowest level.

The general database will be updated, maintained and examined on the development 6000-410 Vax using SQL queries either with INGRES tools or included in the INGRES ABF fourth generation language. Then, extractions from the database will be transferred to the real time level on the VAX3800 control computer and the VME crates. Programs running on this control computer or on the workstations will be able to examine these databases by means of SQL queries embedded in ADA or FORTRAN. The kinds of applications using database are mentionned here after :

- We have first to manage the 3000 equipment database (name, hardware address, scaling factors, thresholds, alarms...). In order to be autonomous, each VME crate will have an extraction of the basic database containing all the informations required to handle the equipments under its control,

- The beam parameters management will fully use the possibilities of the database management system. Each ion species accelerated by the GANIL facility is associated with the beam parameter collection constituted by the settings of the equipments of the machine. It is desirable to be able to perform off-line and on-line accesses and processings on these beam parameters.

- Other applications are related to pieces of information about hardware installation, the handling of alarm messages...

The Operator Interface

This topic is very sensitive because it concerns the way the system will be perceived by the operation group. This interface will be based upon the VAX/VMS VS3100 workstations operating under the DECwindows windowing system based on the X-window standard. Discussions with the operators induced us to the following conclusions [4] :

- Hardware potentiometers must be kept up, in addition to software sliders on screens. So we plan to join to each station a VME crate able to answer specific needs. This console VME crate will allow to handle up to 8 shaft encoders with an associated display.

- Too heavily loaded screens by overlapping windows may decrease readability and operation efficiency. This will be overcome by adding peripheral screens to the stations, either X-window terminals or common TV monitors or touch-panels connected to the station or to the console VME crate.

At the present time, thorough investigations have been carried out aiming to profile a prototype of the future operator interface. We also wonder about integrating the supervision software inside our console design.

Supervision at GANIL

The Supervision Basic Software

Last year, a new supervision system was added to the Control System. This supervision system widely described elsewhere [5] consists of pieces of software provided by the french company SFERCA and running on VAX/VMS workstations. Their graphic capabilities are based on the GKS IIc standard.

The supervision basic software consists of three families of products : "IMAGIN" is devoted to all the graphic developments, "PROLINK" provides the link with the programmable controllers whereas "PRODIGE" deals with the alarm logging and reporting, the data archiving, the real time process commands...

The IMAGIN Software

"IMAGIN" is the set of tools designed for all the graphic aspects. It allows to build synoptics which are organized into trees of views. The design of a synoptic requires using three components :
- The *graphic editor* permits creation of backplane views and symbols.
- The *configurer* then allows to create the synoptics by defining the animations which are constructed over the backplane views. Animations can be bargraphs, appearance of texts and symbols according to digital or analog data (thresholds), displacement of moving symbols...
- Finally, the *animator module* fulfils the animation of the synoptics. By means of mailboxes and a shared global section, this module communicates and is synchronized with an user process performing the data acquisition.

Implementation

As shown in figure 2 three VS2000 workstations were installed to meet the supervision needs, and arranged as a local area VAX cluster on Ethernet.
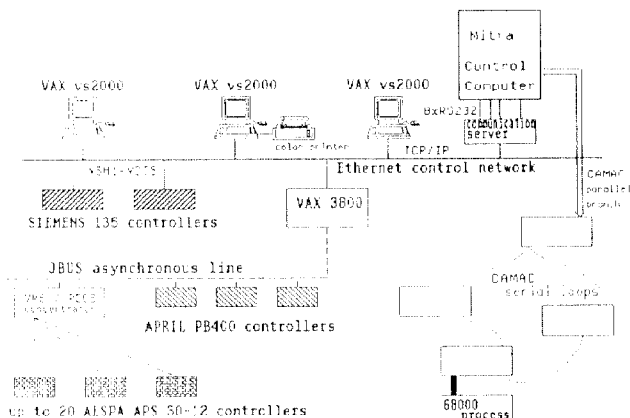
Fig 2 : The supervision system

Programmable controllers APRIL PB400 are seen through an asynchronous line network named "JBUS" based on a master/slave relationship. To connect our older ALSPA APS 30-12 programmable controllers, a VME gateway was developed at GANIL last year.

The future control computer VAX3800 is planned to be used as a server node for the JBUS programmable controller network. This server capability will be soon achieved by using the "PROLINK+" software from SFERCA.

To increase the capabilities of the supervision, a link with the today's control system has been implemented by means of a TCP/IP communication server and a dedicated sofware running on the MITRA computer.

By the end of next summer, we expect to connect SIEMENS controllers directly to Ethernet. This will rely upon the OSI model, using the VOTS (Vax Osi Transport Services) sofware from DIGITAL ; at an upper level, VSH1 sofware from DIGITAL will be used, integrated into the PROLINK+ sofware.

Up to now, more than 100 views have been designed ; as an example, figure 3 shows the septum magnet main view where data are collected from the interlock PB400 programmable controller and the MITRA control computer.
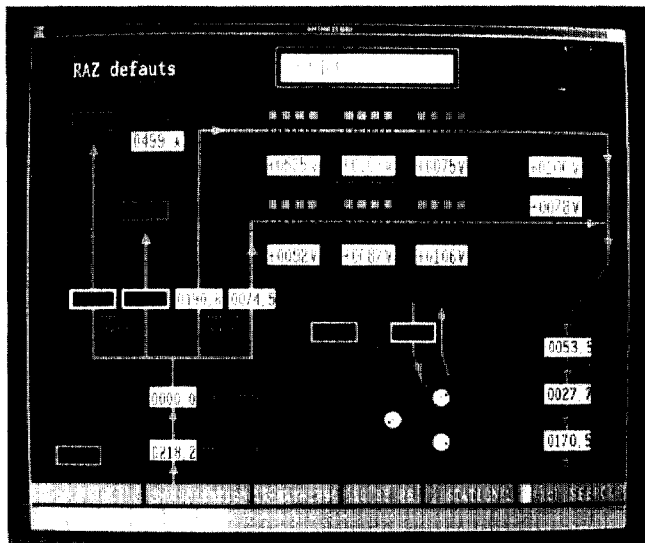
Fig 3 : Septum magnet control display

Conclusion

The hardware architecture is in progress. The upper layer is now completed including the VAX 6000-410 with its peripherals, links to the PC network, the acquisition system and the CAD system through the general purpose Ethernet network. Some offline codes (e.g. to compute the beam parameters) are now running on the development VAX.

Installation of the real time control layer comprising the dual-host VAX3800 and 3 additional VAX stations VS3100 is under way.

The control network is now bridged to the general Ethernet network and is currently managing the workstations devoted to the accelerator control.

The front end system (software and hardware) will be selected this year and the installation of a prototype will be undertaken thereafter.

We are aiming to fulfil the major functionalities of the new control system by the end of 1992, taking into account that more than half of our effort is actually locked in supporting the existing control system.

References

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