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COMPUTER CONTROL SYSTEM OF THE ATF LINAC

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Abstract

The computer control system of the KEK ATF linac is based on an OpenVMS cluster, running the V-system software tools. The system comprises real-time databases that form a layer between the hardware and the user interface X-window screens. The databases reside on an AlphaServer 4/233. The CAMAC hardware is connected with an optical fiber link loops to VAXes. The access to the hardware on the VAXes is done using networked (TCP/IP) drivers. The overall system structure is presented.

Introduction

The ATF 1.54 GeV linac [1] was commissioned at the end of last year. The control system was built newly for most parts of the linac. The control system is based on real-time databases and graphical user interfaces on X-window displays. The databases form a layer between the hardware and the user interface screens.

While some parts of the control system already existed, the most part was built from scratch. Much of the development was done in parallel with the commissioning, adding new parts to the system as they became ready. Although there are still many improvements to be made the system, we succeeded in creating an control system in relatively short time and with limited manpower.

This article gives an overview of the system structure, its components and the principles of its construction.

CPU	#	Relative performance
AlphaServer 233	1	71.6
Vax 4000/106	1	17
Vax 4000/300	1	1.9
Vax 3500	1	1
VaxStation 4000	6	12.1

Table 1. The ATF control system hardware.

System Setup

The ATF control system is centered around a cluster of DEC Alpha and VAX computers running the OpenVMS V6.2 operating system. The computers are connected into one cluster using Ethernet LAN. The hardware is described in figure 1.

The actual accelerator hardware is controlled through CAMAC modules that are linked together with a serial highway using optical links. The serial highway driver modules (Kinetic) are connected to the VAX's. The VaxStations have large screens and are used as operator consoles and workstations for software development.

The Alpha has the highest CPU performance and is used to run most of the on-line control tasks. The VAXes perform the hardware accesses. A summary of the relative speeds of the cluster CPUs is shown table 1. The relative performance figure was obtained by running some commonly used benchmark programs on all the CPUs and normalizing the results so that the slowest CPU figure equals one.

In this configuration the Alpha does not have a direct access to the hardware. Our control tools (Vsystem) include a method to transparently access data on remote nodes. However, in our tests we found this method to be rather slow and instead developed a CAMAC remote server that transports the data over the network using TCP/IP protocol.

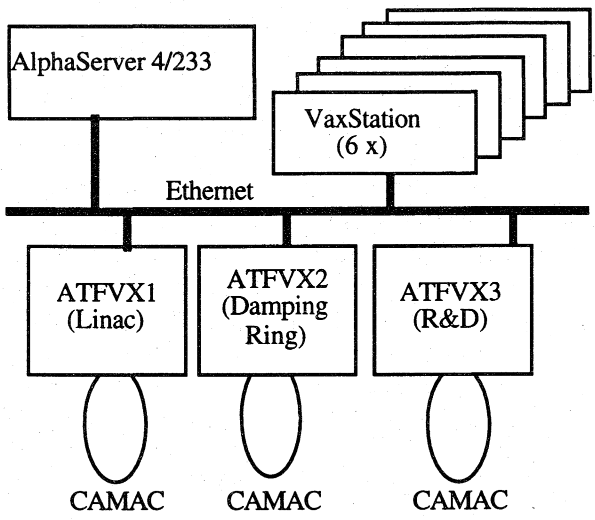

Figure 1. The hardware setup

Software Structure

The control system is (for most parts) built using the Vsystem control tools [2]. These tools include methods to access and control real-time databases (Vaccess), to generate user interface screens that can be used on a X-terminal display (Vdraw), methods for data logging (Vlogger) and analysis (Vtrend).

The control system is layered around the real-time databases in the following way: (see figure 2).

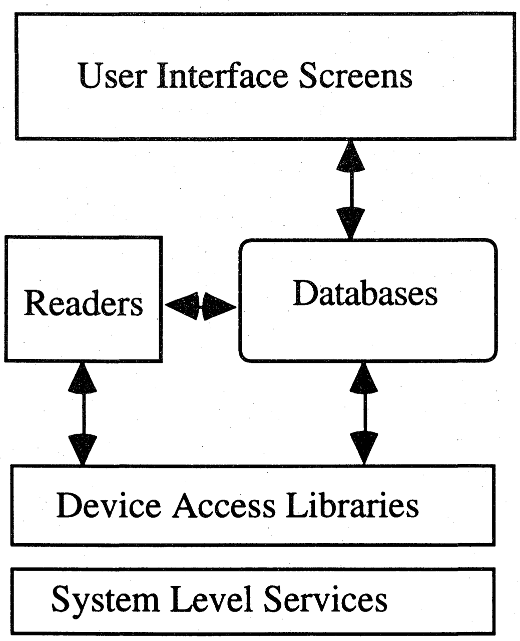

Figure 2. The software structure.

All the control data could be put into a single database. However, for reasons of efficiency and to make development easier, we decided to have multiple databases. Division of the data in separate databases is done on the basis of the device types: magnets, BPM:s, klystron modulators, etc.

The control screens are used to operate the accelerator. The screens (see figure 3) are composed of control objects like buttons, graphs, meters and so on. These control objects are connected to the on-line database. Whenever for example a button on the screen is clicked, the attached channel is notified. If the channel is associated with hardware, a hardware access is performed to update the hardware status.

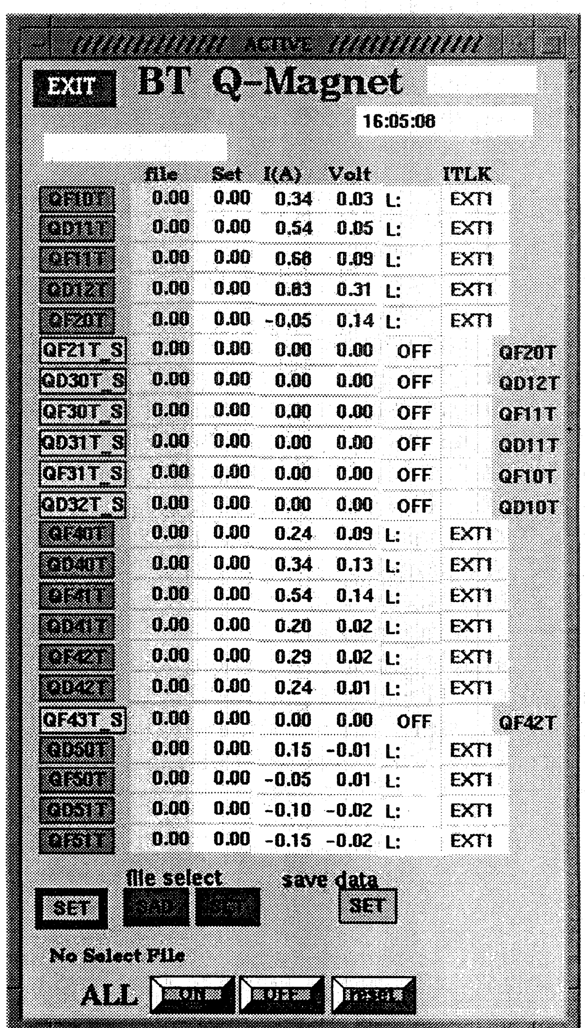

Figure 3. A sample control screen.

The reader processes are also essential

components of the system. These processes perform hardware accesses at regular intervals to keep the database updated with the hardware status.

Below these levels are the device libraries. These routines define how the actual hardware access is performed. System level utilities include services like the CAMAC server that gives processes running on the Alpha a transparent access to the CAMAC hardware.

Subsystems

The device control is done using the above mentioned control tools. There are subsystems for controlling the magnets, klystron modulators, the electron gun, beam position monitors and so on.

There are however a few cases when a slightly different approach is necessary. For example, the connection to beam simulation software (SAD) had to be implemented differently, although it now can be used under the same interface. The magnet setting data is interchanged between the ATF control cluster and the SAD computer cluster by sending and receiving files using ftp (File Transfer Protocol). A button click on the control screen spawns a job to perform the file transfer.

Another example is the alarm system. The default alarm handling scheme provided by Vsystem was not very suitable for our purposes due to the interlock handling method in our hardware. The hardware interlocks are represented as bits in CAMAC registers. Having a channel for each control bit was out of question, so we had to implement our own alarm handling method. However, even this system uses Vsystem databases to keep track of the alarms. The alarm system also includes an alarm viewer, implemented by a small extension of Tcl/Tk toolset to access Vsystem databases from Tcl/Tk scripts.

Future Plans

While the system is basically working, there are still several improvements that we are looking to implement. One of the intended improvements is to improve the on-line data analysis properties by introducing a spreadsheet program (Xess). This software has a possibility to directly connect to the Vsystem database. Data from the databases can be directly imported to the spreadsheet. Xess has powerful data analysis functions that enable tasks like on-line statistical analysis, curve fitting, data transformations etc. The data can be instantly visualized by using the graphing capability. The graphs can be made to change in real time.

The data can be transferred in both directions. This could be utilized to create simplified interfaces for bookkeeping of the hardware for example. Whenever a CAMAC address is changed, changing its value on the spreadsheet could be immediately transferred to the database.

Also, we are in process of improving the user interfaces. We intend to make them more intuitive by incorporating a graphical representation of the accelerator.

Conclusions

The selection of Vsystem as our basic toolset has enabled us to reasonably rapidly build a working control system. While there are still numerous improvements to be made, the experience in building the linac control has given us a basis to extend the system to the damping ring control, and to further improve the operability of the ATF.

Acknowledgments

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References

1. ATF Design and Study Report. KEK Report 1995-4. Ed. by F.Hinode, S. Kawabata, H. Matsumoto, H. Oide, K. Takata, Seishi Takeda and J. Urakawa

2. Vsystem is a product of Vista Control Systems, Inc., NM, USA.