The status of the control system of the KEK accelerator test facility

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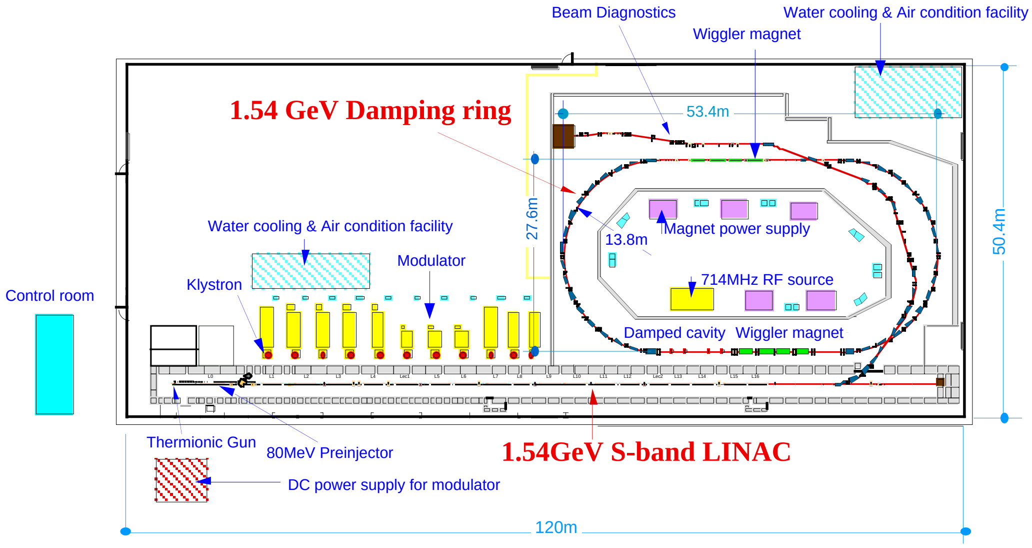

Fig. 1 Layout of the KEK accelerator Test Facility.

Abstract

Beam Commissioning for the damping ring of the KEK accelerator test facility (ATF) has been started since January 1997. Control system of the ATF accelerator is based on the CAMAC-enhanced byte-serial highways handled by the Open-VMS Cluster system. Control software is integrated by using a commercial database application for process control. In this paper we present the status of the ATF control system developed during the commissioning phase.

1 Introduction

The accelerator test facility (ATF) in KEK has a 1.54 GeV S-band linac and a 1.54 GeV damping ring [1,2]. Figure 1 shows the layout of ATF. Length of the linac is 70 meter and circumference of the ring is 138.6 meter. Aim of this facility is to study the low-emittance-beam phenomena and to develop technologies for a future linear collider [3]. Studies to understand the behavior of the hardware devices and that of the beam itself, have been performed since January 1997, the start of the beam commissioning of the damping ring.

The linac and the injection line to the ring have 16 S-band cavities for acceleration, two cavities for energy compensation, 112 magnets and 41 beam position monitors (BPMs). The damping ring and the extraction line have two damped cavities, 386 magnets (including eight wigglers), 112 BPMs, four current monitors, a kicker for injection and two kickers for ejection.

2 System Configurations

2.1 Hardware

Front-end devices for accelerator control are handled by the CAMAC networks consist of the enhanced serial highway driver (SHD, 2160-Z1F) [4] and many CAMAC crates (up to 64) located near the front-end devices. This highway has a capability of 5 Mbytes per second of data transmission. Main part of this network was connected with optical fibers to avoid an irregular noise from high power devices. There are two CAMAC networks in ATF.

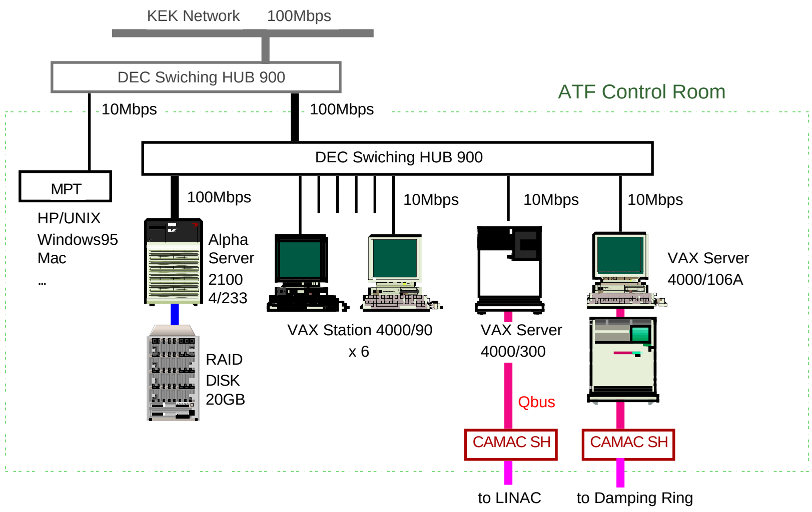

Fig. 2 Cluster configurations in the ATF control system.

One is for the linac and the beam transport line to the ring. The other is for the ring and the beam diagnostics line from the ring. Each SHD is inserted in the Q-bus slot of the VAX server 4000, therefore we use two VAX servers.

Configuration of the computer cluster system is shown in Figure 2. Most of the control tasks are running on the Alpha server 2100, because it has the highest performance. Six stations (VAX station 4000/90) are used as the user terminals for the accelerator control and for the software development. These machines are connected with a switching HUB (DEC VN900EF). The operating system is the Open-VMS V7.1.

2.2 Software

Overall structure of the control software is shown in Figure 3. The core part of the data handling is supported by Vsystem [5], a commercial database application for a process control, therefore we can concentrate to develop the hardware control routines and analysis routines. Vsystem supports the mechanism of distributing databases across the networks. User interface layer is supported by VDRAW that is one component of the Vsystem and a very convenient display-and-control tool based on the Motif.

We can define multiple databases individually on local and remote node in the cluster. The identification of each database is done by the logical names based on the VMS service. The definition for local database and remote one is different. For local database, we define the logical name as the file name of the database object. For remote database, logical name should be defined with the node name as ‘node_name::”task=vserver”’. Vserver is one of the Vsystem process to access a remote database using the DECNET objects. The database logical name is transparent in the cluster so that the style to access the database is identical both in local and remote node.

A basic element of a database is called “channel” and it should be defined one of the various data types; integer, real, binary, strings and arrays. Channel has an automatic mechanism to execute some user-written function when the channel access has occurred. This function is called “handler”. For example, a read access to a channel that shows a hardware status executes the CAMAC read action of the target hardware.

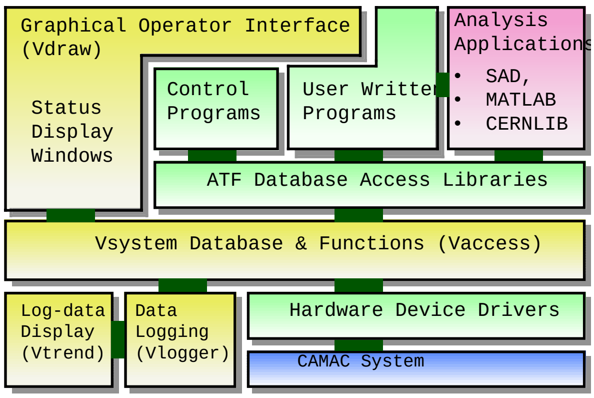

Fig. 3 Software configurations. Vdraw, Vaccess, Vtrend and Vlogger are Vsystem components.

3 ATF Database

In the cluster system, we use a lot of logicals to identify databases. We set a prefix to the database logicals as DB_ for that on the Alpha server, DB1_ for that on the linac server and DB2_ for that on the ring server. Channels are named with a hardware-device name like ‘device_name: generic_type’, where the generic type describes the data element of the hardware.

3.1 Device Access

There are two ways for writing and reading the CAMAC on a remote server from a local machine. One is a direct call of a network CAMAC function that we prepared and the other is a Vserver method in the Vsystem.

3.1.1 CAMAC network functions

At the first commissioning of the linac in October 1995, we needed to move software from slower VAX server to faster Alpha server. Since the Alpha server had no hardware CAMAC networks, we prepared the network-CAMAC processes between Alpha and VAX servers by using VMS services [6]. To keep the compatibility of codes, the format of CAMAC functions is unified as that of the IEEE CAMAC standard [7]. Identification of the target CAMAC network is done by changing the CAMAC branch number. Device libraries for the linac were successfully installed into the Alpha server. This is quite simple and convenient, but leads to a heavy CAMAC traffic on the cluster network.

An average time to execute a CAMAC single action from Alpha to VAX server 4000/300 (for linac) is 5 ms. For VAX server 4000/106A (for ring), it is 1 ms. The CAMAC access speed in the VAX is 2 ms and 0.5 ms for linac and ring, respectively. The performance of a CAMAC access is limited by the network overhead. Therefore, we prepared a function that executes many single actions in a network call.

3.1.2 Handler method

Another method is a remote channel by using the Vserver mechanism as described before. Databases and handlers are exist in the remote computers. In addition, Vsystem has the 'list' channel access to the remote database. This accesses multiple channels in a function call from user routines. Performances of the list-mode were measured between an Alpha server and a VAX server under the CPU load in the beam experiments. Table 1 shows the results with and without the CAMAC access in the handler.

In ATF, there are many magnet power supplies that have different interfaces due to the difference of the manufacturer. Handler method is convenient to keep the channel structure for all magnets by changing the access routine in the handler level.

Table 1
Performance of remote database access from Alpha server to VAX server (channels/second).

	mode	no CAMAC	with CAMAC
VAX(linac)	normal	60	50
	list	1000	344
VAX(ring)	normal	198	196
	list	5520	1428

3.2 Standalone process

Some channels have no "automatic" handler options to avoid a heavy concentration of hardware accesses. Only the background readers enable the "automatic" option in themselves and then update the channel values. Other processes get a channel value without executing the handler. We made some readers to update the hardware status and the BPM data.

The orbit handling such as the correction of the closed orbit distortion, local orbit bumps and the optics changing, is done by changing the magnet settings calculated by the model. We use a computer program complex for the accelerator design named "SAD". All ATF lattices are designed by using this code. SAD is running on the other cluster in the KEK network. We prepare the automatic communication procedure submitted from the operator window.

3.3 Present status

At present, we use 28 databases for the accelerator control. They have 12667 channels in total; 4639 integer and 5454 real and other are binary and strings. Largest database is for magnets and it has 7520 channels. Channels that have an automatic handler option are only 384, therefore we are adding this option into more channels to improve the overall performance.

Background processes are updating the channel data with specified time intervals. For ring's BPMs, data are refreshing by every beam injection (0.75 Hz). Graphical plots on the window are updating similar rate. Even if the beam injection rate reaches maximum rate (25 Hz), we could update the data in the database.

We plan to install many monitors to measure the behavior of the extracted beam and plan to develop the on-line analysis tools. Although the data handling in the system will become more complicated one, we will be able to optimize the control system by using our database system.

4 Summary

The control system for the ATF accelerators has been developed by using the process-control-database system, Vsystem. We succeeded in creating the system in a limited time and staff by combining our device driver software and this database application. Now we are changing the database structure to use the distributed-database feature more effectively. This will improves the overall performance of our system.

5 Acknowledgments

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6 References

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