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Upgrading the BEPC Control System

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Abstract

The BEPC control system has been put into operation and operated normally since the end of 1987. Three years's experience shows this system can satisfy basically the operation requirements, also exhibits some disadvantages araised from the original centralized system architecture based on the VAX-VCC-CAMAC, such as slow response, bottle neck of VCC, less CPU power for control etc.. This paper describes the method and procedure for upgrading the BEPC control system which will be based on DECnet and DEC-WS, and thus intend to upgrade the control system architecture from the centralized to the distributed and improve the integral system performance.

1. The system status and its milestone

The project of BEPC control system was determined to adopt basically from the SPEAR control system in january of 1985. The prototype control system was constructed during half year begun from september of 1985 at SLAC. In the end of 1987, the control system realized the on-line control and monitoring for the most equipments of BEPC Storage Ring (SR) and its Transport Line (TL), and was put into precommissioning at this time. The beam orbit correction has been brought into commissioning in june of 1989. The RF on-line control (including its ramp) was completed in march of 1990. Thus all the equipments of SR and TL were controlled by the computer, and the VAX-11/750 computer (the central control computer) becames a member of DECnet of IHEP at the same time.

From the operation experiences in the past several years, it seems that the philosophy and criterion for constructing the BEPC control system are available, which resulted that this system can be completed just on time schedule and have a high reliability of system operation.

2. Several problems in system

The BEPC control system architecture follows the old centralized control model of the SPEAR, we had done incessantly some improving work on system level in the past years, but still there are several problems which can't be solved. These problems are as follow:

1. The unique VAX-11/750 computer is used for the central control computer, its poor CPU power (only the 60 percent performance of VAX-11/780) limits the processing speed of whole control system; Many batch jobs (about 16 control processes) always reside in the memory, morever which heavily increases the load of VAX-11/750 computer system. These causes slow the response and processing speed of the entire system.

2. Due to we adopt the VAX-VCC-CAMAC (VCC, that is, VAX CAMAC Channel) hardware system architecture, one VAX QIO in CXCAMAC program takes 20 ms at least, so the VCC forms the bottle-neck of the control system communication. Especially it is obvious during the power supply ramping, the other jobs can not be serviced quickly.

3. The current human-machine interface is supported by two graphic colour monitors (resolution 512 × 512), two touch-screen with several computerized knobs. Now one monitor is occupied by one picture once a time, if we want to see several pictures of the different requirements of accelerator commissioning simultaneously, it needs to add more graphic display.

4. A fatal failure of the VAX-11/750 computer in the night (no on call service for computer) will break down the collider's operation. So a backup computer is needed to be considered.

3. System upgrade

After we analyzed the present conditions, we decided to reform the control system from the current centralized system to the distributed system and intend to solve those problems for improving the whole system performace.

a. The distributed control system architecture

In order to reduce the heavy load of VAX-11/750 and increase the speed of whole system responses, we divide the current control jobs on VAX-11/750 to several parts and load them into different computer nodes. the upgrade system will be based on the DECnet, its system architec-

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ture is shown in figure 1. The new added VAX-II computer is used as a intelligent node dedicated to the power supply control. The current VAX-11/750 also is a intelligent node which mainly is used for other subsystems, such as BPM, RF, VACuum. In the first phase, we will still use the current human-machine interface as the system console. In the second phase, we will add another DEC-WS as upgrade system console which can utilise fully the rich DECwindow's software functions and make the multi-display for improving the environment of human-machine interface. Some of the jobs involved a lot of calculation will be moved to the DEC-WS. These three nodes will be networked into a individual local network which is linked to current IHEP DECnet via a network bridge.

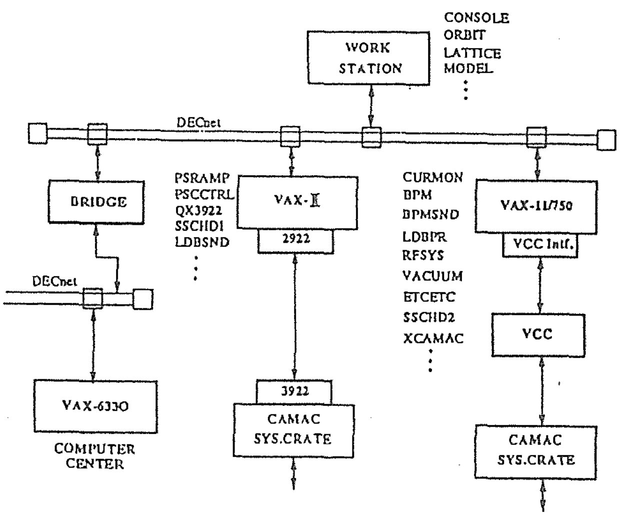

Figure 1. The upgrade of BEPC control system

b. Adopting Q-bus CAMAC adaptor

In the current system, all the datum are passing through the VCC, one QIO of VMS for VCC need about 20 ms at least and obviously reduce the processing speed of whole system. Beside the VCC adaptor is an old SLAC dedicated product, not a commercial module. Therefore, we adopt the Kinetic Systems Corporation's KSC 2922 and 3922 commercial modules as the VAX-II CAMAC adaptor. Under the support of KSC's, a VAX QIO operation only takes 3 ms in 1,000 words under the VMS, it would overcome the bottle-neck of the VCC and also increase the system reliability.

c. The compatiblity on new and old system

For keeping the compatiblity of CAMAC system, we are not going to do any modification on the hardware below the CAMAC system crates as far as possible. Thus after the upgrade is completed, the current control system on the VAX-11/750 can become the backup on Micro VAX-II. Conversely, if VAX-11/750 computer is out of work, the collider operation can keep continuously due to the power supply still be controlled by the VAX-II machine.

4. The upgrade of BEPC control software system

The upgrade work of the control system is mainly focused on the software side, the block diagram of system software upgrade is shown in figure 2, which can be divided into the following three parts:

1. Creating new control software system for power supply control on the VAX-II.
2. Remoulding the current control software on the VAX-11/750.
3. Coordinating the relations between VAX-II, VAX-11/750 and DEC-WS for integrating whole distributed control system.

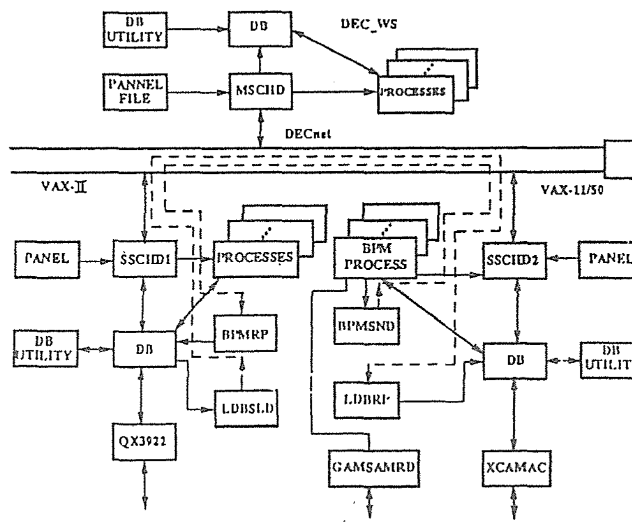

Figure 2. The upgrade of BEPC control software system

a. Upgrading procedures

First, we copy and modify a second set of BEPC control software system and its VMS operating environment on the VAX-II machine, and also modify and create the real time database (DB) on the VAX-II and DEC-WS as like as on VAX-11/750. Under such arrangement, we can reuse same panel files and all of the current application programs, reduce the software work to minimum and keep all the operator procedure as before.

We need to develope some communication programs for exchanging the necessary messages between three nodes on

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the DECnet. These programs are: a.) The schedule communicating program —— used for transferring the schedule control and processing message (as position coordinate of touch panel or cursor on DEC-WS later, knob datum etc.) of console node (either VAX-11/750 or the DEC-WS later) to other process nodes. b.) The power supply DB refreshing program —— the real time DB of power supply is resided on VAX-II, this program is used to send and receive all of the power supply DB parameters form VAX-II to the console computer for refreshing the DB on the console node continuously in 1 time/second rate. c.) Other communicating programs —— used for transferring the control and the relative information of BPM, RF and VAC subsystem between VAX-11/750 to VAX-II and DEC-WS.

We prepare to use the DEC GKS graphic packets or the UGS graphic system of SLAC to upgrade the current graphic programs. In order to remain and keep the current operating environment for operator and reuse all of the application programs, we want to save all the previous subroutine names and only change the contents from old graphic program to new upgrading graphic program.

According to our current upgrading police, we still want to keep and save all the current programs on each node. Therefore, we introduce a "Pseudo-Subroutine Method" (PSM) in the programs, i.e., if one process is needed to be activated, only the process resided on the active node is functioned, the same process on other nodes keep quiet without any activity. This PSM can reduce the upgrade work amount and short the upgrading time. Of course, it will introduce some disadvantages, such as, occupy some memory resource etc, which will be considered to improve it at later.

During the second step, when the DEC-WS will be used as the system console, we will transfer some application programs used for modelling-based control, such as Lattice, Modelling and Orbit correction processes to the DEC-WS later. Thus we can construct our minimum distributed system architecture under our tight budget condition and establish a basic distributed system environment for later development.

b. Some progresses at present

So far, we have got some progresses in the upgrade of software on the VAX-II during this summer shutdown of BEPC. In order to run the BEPC control software on the VAX-II, we have modified and changed some parameters and commands procedures concerned with BEPC application system resulting to optimize the environment of the upgrading control software; We have created the real time database and have debugged all of the DB utilities on VAX-II; Now, the process and subtask can be submitted and activated by the schedule (SSCHD1) process through calling the panel files which is same as on the VAX-11/750 while we touch the current touch-screen; When the BPM process on the VAX-11/750 is once activated, the BPM buttons datum can be acquired individully by CAMSAMRD program instead of the XCAMAC. The BPM process also calls BPMSND program to active the remote process BPMRP on VAX-II and send the latest BPM datum to it via the DECnet, thus the BPMRP refreshs the BPM area of DB; The status and parameters communicating process of power supply and the graphic program substitution which is based on the work station also got some progresses.

Acknowledgements

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