# Data Acquisition and Management in BEPC

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This paper describes the method of upgrading the BEPC control system, in which the dedicated adapter VAX-CAMAC-Channel (VCC) was replaced by a commercial adapter KSC2922/3922, Qbus CAMAC interface. All low level I/O driver routines have been changed without changing the whole CAMAC hardware system. The upgraded control system has a distributed architecture and several hierarchical databases are installed in the FEC computers, so the data flow should be controlled. Once raw data in any node have been refreshed, any changes will be transferred to the other nodes to maintain uniformity of data in those databases.

## 1. INTRODUCTION

The original BEPC control system has a centralized structure mainly composed of a console, a VAX750 computer, the intelligent channel VCC, the CAMAC system and hardware devices. The structure of the system is shown in figure 1. VCC is a dedicated product from SLAC, which is no longer produced and of which there is a shortage of spare parts. Now the VCC has been replaced by the commercial product KSC2922/3922, a Qbus-CAMAC adapter produced by Kinetic Systems Corporation, which serves as the data communication interface to the CAMAC hardware.

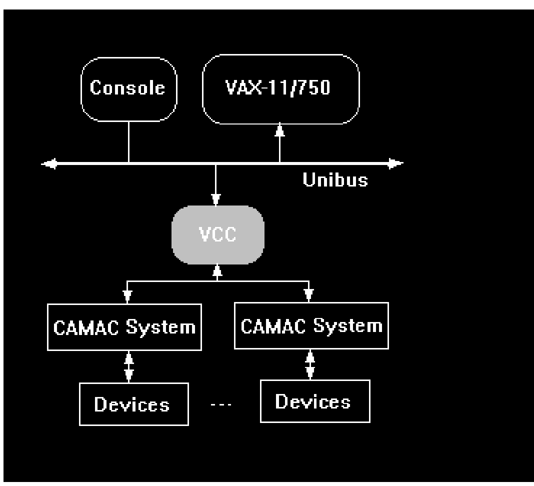


Figure 1 Original control system structure

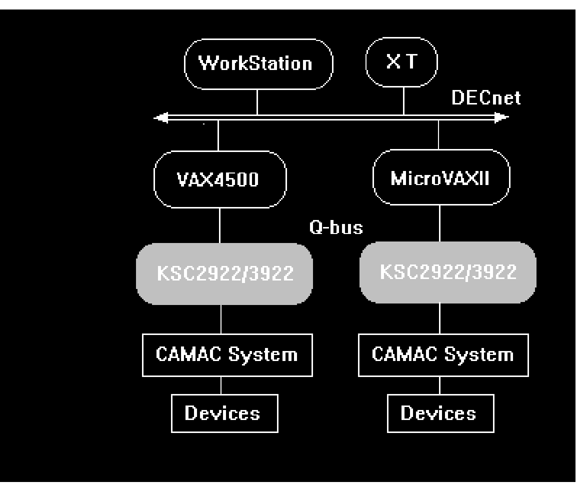


Figure 2 Upgraded BEPC control system

The upgraded control system has a distributed architecture based on Ethernet and has been operational since Oct. 1994 (Figure 2 ). Because of the short time available for upgrading, the low level CAMAC system was retained.

## 2. HARDWARE STRUCTURE

The VAX-11/750 used the VCC as a Unibus - CAMAC interface, but the VAX4500 and MicroVAXII computers in the improved system use the Q-bus. The KSC 2922 Computer Bus Adapter provides an interface between the DEC Q-Bus and up to eight 3922 dedicated crate controllers through a byte-wide parallel bus. The 2922/3922 combination provides four DMA modes and a programmed transfer mode. All modes of operation are capable of transferring 16- or 24-bit CAMAC data words. DMA data rates up to 0.77 MB/s can be achieved.

## 3. SYSTEM SOFTWARE

Data acquisition software consists of a packet creation program PBZ, a data I/O program XCAMAC, a device on/off program DCOUT, the digital voltage acquisition program of the main B and Q magnet power supplies SPRDVM and the beam position monitor program BPM.

In the control system, there are nearly 7,000 signals which can be classed into 7 types. (see Table 1)

Table 1. The signals table

| | | |
|---|---|---|
| Input signals | DM ( digital monitor ) | 1 bit digital input |
| | AM ( analog monitor ) | analog input |
| | D I ( digital input ) | 16 bits digital input |
| | DV ( digital voltage ) | R*4 analog input |
| Output signals | DC ( digital control ) | 1 bit digital output |
| | AC ( analog control ) | analog output |
| | DO ( digital output ) | 16 bits digital output |

For acquisition of the signals mentioned above, the following programs were rewritten:

The VCC packets are made by subroutine PBZ. PBZ takes the CAMAC I/O address of each signal from the database and assembles it to the control word and VCC packet. Then the control words and VCC packets are sent to the database to be used by XCAMAC and other processes. The sequence of the VCC packets in the database is: DMAMDI packets, AC_OUT pockets, AC_IN packets, DCDO packets, IPSC packets and SAM packets. The BEPC system has about 1350 VCC packets.

The data acquisition process XCAMAC refreshes the database at a rate of twice a second and acquires about 4000 signals each time. The process also carries out the ramp operation of the magnet power supplies during particle acceleration in BEPC.

The subroutine SPRDVM acquires the digital voltage signals (DV) so that operators can monitor the present current status of the magnet power supplies. DVM3456A is connected to the VAX computer via a 3388 GPIB interface.

## 4. IMPROVEMENT

There was a hierarchical database in the original control system which had a static area and a dynamic area. In the static area, there was information about the CAMAC interface and machine parameters. The original data from the accelerator equipment was stored in the dynamic area which was refreshed at 2 HZ. For the distributed architecture of the new system, the original database had to be modified. First of all, we installed a database in each FEC computer with same data structure and created a 3922 packet area in the dynamic area of the databases. To keep the uniformity of the data records in these databases, a network communication program was developed to exchange the data between those databases and several new sections were inserted the dynamic area of each database to hold the raw data from other nodes which are refreshed once per second through the network. As shown in figure 3, when the database on node 1 receives the raw data from its input/output port, the network communication manager is notified by a event flag to fetch the data and send them to the database in node 2. In order to prevent alteration of the high level application program, the 3922 data area in the dynamic area is mapped onto the original VCC data area and the local index of the database is replaced by a new global index in each database at control system startup, so that the raw data from all of the accelerator devices can be read in each node.

The format of the data and command packets differs from that for the VCC; therefore the main work was in changing the packet chains from VCC format to 3922 format. Another difference is the data bit format. The VCC requires the 16 high bits to be valid, but the 2922 needs the 16 low bits.

A new packeting organization program QPBZ acquires the CAMAC I/O address of every signal from the database, assembles them to CAMAC control words by calling the 3922 driver subroutines such as Cainit, Caopen, Caclos, Canaf, Cainaf, Cablk, Cahalt, Caexew and Camsg, etc. Since block transfer operation is need for acquiring the analog signals by the SAM modules, we wrote a new program for the organization of SAM packets.

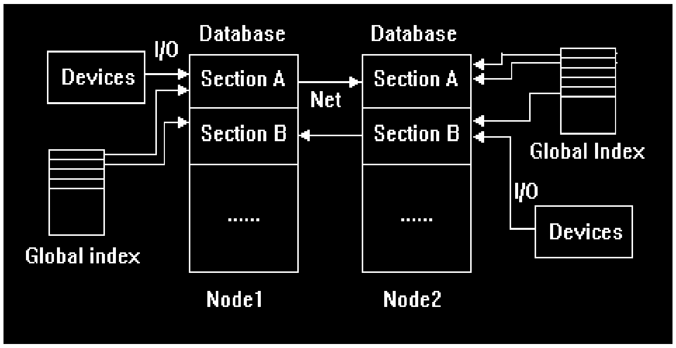


Figure 3 The upgraded database

In tests, we found that the I/O speed of the KSC2922/3922 is lower than that of the VCC. To transfer the same number of data when 30 main power supplies are ramping, the minimum interval between two QIOs is 30 ms for the VCC and 44 ms for the 3922. The reason is that the VCC is an intelligent module which can assemble F17 command transfers to CAMAC modules, while the 3922 is a dumb module. The F17 command has to be sent by the VAX computer, so the length of the 3922 packet chain is 1.5 times as long as that of the VCC. As it takes more time to transfer the data, we don't acquire the device status information during the ramping of the main PS to enhance speed. In accordance with the 3922 packet rules, the output data are placed in the packet chains and the readback is mapped onto the old VCC area.

## 5. CONCLUSION

The upgraded BEPC control system was completed in October 1994. The dedicated adapter VCC has been replaced by a commercial product successfully and the real-time response speed and the reliability of the system are improved. In the near future, we will upgrade the DVM acquisition with an analog scanning module.


## ACKNOWLEDGMENT

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