VME-COMPUTER NETWORK(MAP) FOR THE KEK PROTON SYNCHROTRON

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Abstracts

A VME-computer based system is used for controlling KEK proton synchrotron to replace old minicomputer based system[1]. More than 20 node computers are connected with each other through a broadband token-bus network called MAP(Manufacturing Automation Protocol). The nodes are categorized into four types; a network management node(NM), a software development node(SW), operator's console nodes(OP's) and equipment control nodes(HW) that control accelerator equipments. System and application programs of any node except the SW and the NM are down-loaded from the NM and/or the SW. The MAP version 2.1 with File Transfer Access and Management(FTAM) and Common Application Service Element(CASE) is supported at present. A performance test of the network has been done and the results are reported here.

Introduction

The control computer system for the KEK proton synchrotron has been working for more than 14 years[1]. It was decided to replace the system with a new microcomputer based system[2],[3].

A standard bus(VME-bus) and a standard network(broadband MAP) are adopted in the new system to minimize time, cost and labor.

A MAP network with 13 VME-computers was installed in March, 1988. 8 VME-computers has been added to the network until now. Sixteen VME-computers are working for controlling KEK PS as shown in Fig.1, and four more are now being added to the MAP network and tested.

The installation of the VME-computers has been done first for controlling newly installed equipments of accelerators such as the 40MeV beam transport line(BT), H^- charge exchange injection system for the booster synchrotron, and dynamic steering magnet power supplies of the main ring.

Old minicomputer system will be removed in summer of 1989 and more VME-computers will be introduced.

Computers

VME-Computers

The VME-computer in our system basically has an MVME-132 32-bit computer module(a product of Motorola Company with a 16MHz 68020 microprocessor unit, 68881 floating-point coprocessor unit and 68851 paged memory management unit). At least 2M bytes of Dynamic Random Access Memory(DRAM) are used as the main memory, and 500k bytes of Static RAM(SRAM) or at maximum 16M bytes of DRAM are used as RAM disk. An MVME-372 MAP interface module(MAPIM) and an MVME-371 broadband MODEM module are installed for communication. Other interface modules are installed depending on the purpose of the computer.

We have started with single processor configuration, but in the case that more computational power is needed we can add extra processor in the same VME-computer sub-rack later.

The VME-computer for program development has hard-disks and flexible disk drives for storage of programs or data. On the other hand, the HW's which

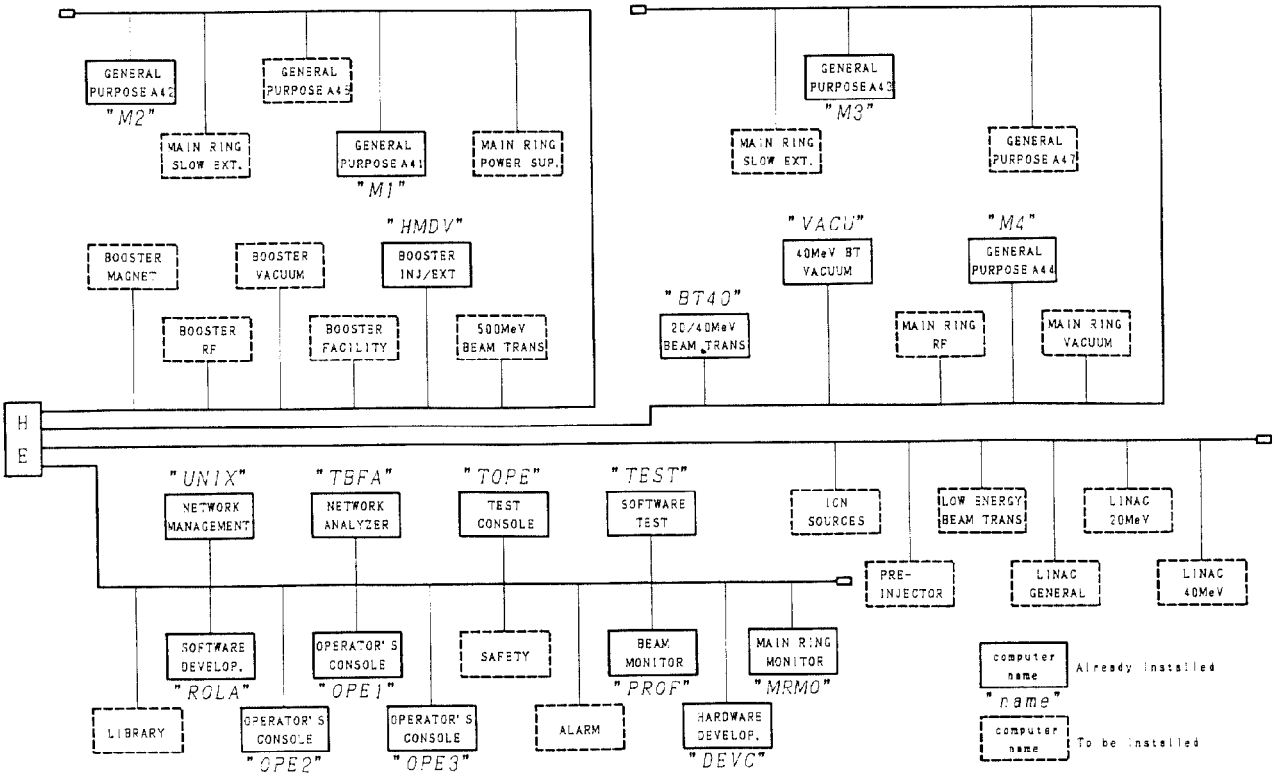

Fig. 1. Configuration of the MAP network for KEK proton synchrotron facilities.

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interface directly to the accelerator components can have no peripheral device because of the severe environment such as high temperature or dusty air.

Network Management Computer: The NM works under the UNIX System V/68K operating system and manages the network and keeps the network log in the disk file for later analyses. It also responds to the IPL requests from the satellite computers including the OP's and the HW's.

Software Development Computer: The SW has a large volume of memory and disk storage for software development as shown in Fig.2. This computer starts up by loading programs from the disk of itself. Programmers can develop programs by using one of ten terminals connected to SW under VERSAdos. The developed programs are stored in the disk files of the SW for downloading into the OP's and the HW's.

Operator's Console Computers: The OP handles man-machine interfaces, and it gets operator's commands input, passes them to HW's, receives responses from HW's and then displays the result on the graphic displays. There are three OP's and another one for test. There will be more OP's in the future. One OP has two 13-inch touch-panel color displays, two 21-inch color graphic displays with 816*640 resolution in 16 colors and a keyboard for communication with the operators. It has also a fairly large capacity of RAM disk for application programs and data.

Equipment Control Computers: The HW has only small memory space and no peripheral equipment like hard-disk or printer as shown in Fig.3. It has only process input/output interface modules such as digital I/O, A/D, and D/A for data acquisition and control.

Software

The operating system of the VME-computers except the NM is VERSAdos(Motorola) and its real-time kernel RMS/68K is used on the disk-less VME-computers. The minimum system programs for diskless-systems are made on the development computer by using TSS terminals and linked together with the RMS/68K kernel and saved in the disk drives of the SW and down-loaded to the object computer at the system start-up time. The application programs for the disk-less computers are made in the same manner but down-loaded later on request. Therefore, it makes the development of the application programs easy. The application programs are coded usually in Objective Pascal(OBJP) or FORTRAN-77 languages. The OBJP is an extended PASCAL preprocessor which includes network functions and it generates PASCAL language source codes to be compiled by Motorola PASCAL compiler.

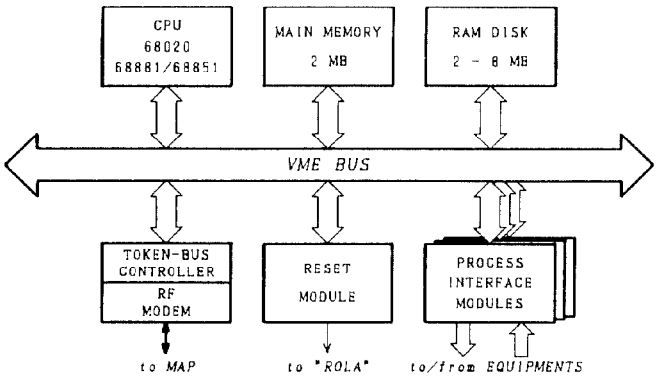


Fig. 3. Configuration of the equipment control computer.

Network

Mid-split CATV media are used for MAP network. The main cables are extended in four routes and the total length of the main route is about 2500 meters. The number of bi-directional amplifiers is 5 and only the longest route has two cascaded amplifiers. Electric power for the amplifiers are supplied from the power unit at the head-end.

One of three 12MHz channel pairs is used at first, and others are left for later use.

Network Management

The MAP network is managed by the NM called "UNIX". It manages network configuration such as node-name, node address, boot files and etc. It displays network status every 5 seconds and logs them in the logging file.

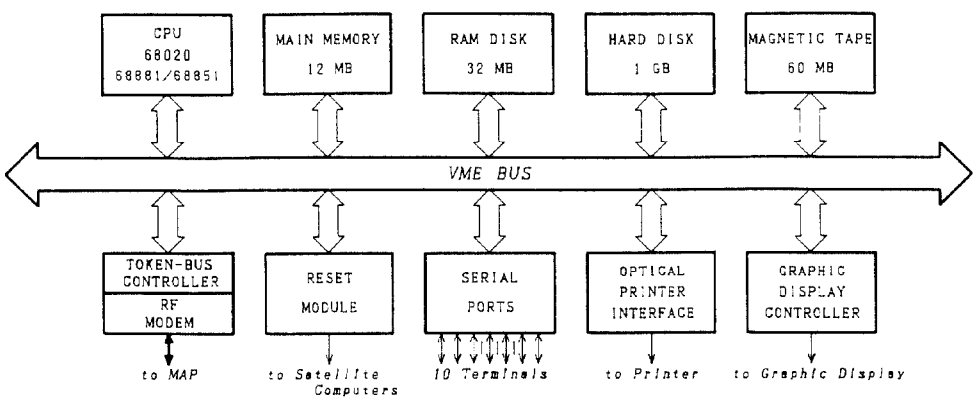
There is a passive MAP frame monitor "TBFA" connected to the network and it usually takes the network statistics. In the analyzer mode, we can take frame data to make analyses about the frames.

Network Software

The software on the MAPIM is based on the micro-MAP software supplied by Motorola. It conforms to the seven-layer model of Open Systems Interconnection(OSI) of the International Standard Organization(ISO). Therefore, an application program can easily communicate with a task on another computer in the network by passing data to the micro-MAP software using buffered pipe protocol. As the application layer softwares, FTAM and CASE are implemented in this system.

Fig. 2.

Configuration of the software development computer.



As micro-MAP was supplied to run on UNIX, we had to revise them to suit our operating systems, e.g. VERSAdos and OS-9. OS-9 is used for making ROMmed start-up programs in the system.

PASCAL, FORTRAN and C language callable libraries for three operating systems are prepared for the user to make application programs easier. By using them, one can easily write programs to communicate with other computers or to control equipments connected to them.

Program Down-loading

As the VME-computers at the building around the accelerators have no auxiliary storage device, all the software of them should be down-loaded from the SW via the network.

When the electric power of a disk-less VME-computer is activated, the bootstrap program in the EPROM on the VME-computer runs and requests to get boot information on the NM through the minimum program on the MAPIM. The boot information includes the name of the OS file, the name of the MAPIM program file, the name of the node directory table and the name of the IPL program file. In the node directory table, information about the MAP nodes(node address, node name, etc.) is listed. By scanning boot information, the node starts to get contents of the files and develop them on its main memory. Then it down-loads the MAPIM program to the MAPIM and it makes all of the MAP facilities ready for use. Now the control is transfered to the IPL program and it moves the OS to the proper memory area and starts the OS. The OS initializes tables and RAM disk and get application programs from the SW and runs them on request.

Network Performance

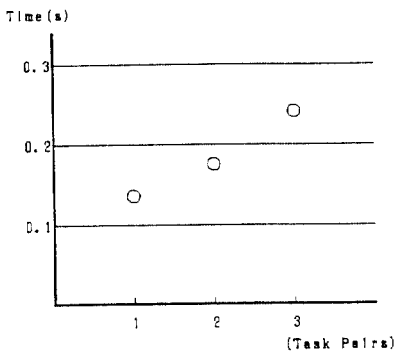
The performance of the network were measured by using two or three node computers under the normal operating conditions. The number of network nodes in the network is 18 and the proton synchrotron was running as usual. The SW node called "ROLA" and other test nodes "TEST", "OPE3", "TOPE", "MRMO" and "DEVC" were used. Other nodes were used for controlling 12 GeV proton synchrotron.

Message Transfer

We measured message loop-back times to know the response time for a short message transfers. The results of short message transfers between two tasks are shown in Fig.4, and it shows that 140ms is the minimum response time from a task on a computer to a task on another computer.

Fig. 4.

Message transfer response time of the MAP network.



File Transfer

We also measured the block transfer capacity of the network by file transfer using CASE software not by FTAM. The file data were transfered from "ROLA" to other 5 computers. The data was read from the RAM disk file and the read-out speed is estimated to be 300kB/s. The throughput of the file transfer is shown in Fig.5 and it shows the total throughput of the file transfer from a node is limited to about 22kB/s. The data in the file were read in 8kB blocks and sent in 1kB blocks.

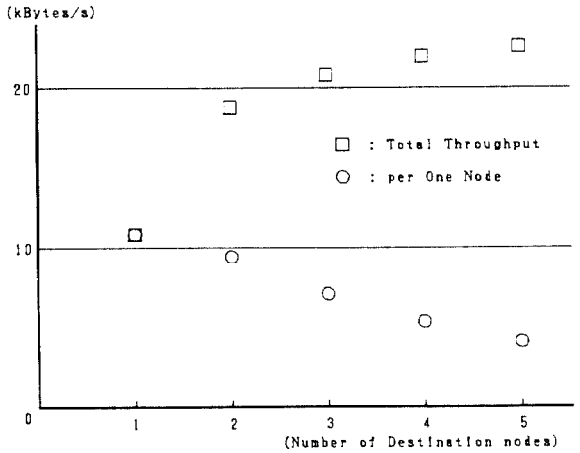


Fig. 5. File transfer throughput of the MAP network.

Program Down-loading

In the start-up sequence, it takes 10 to 20 seconds to initialize the MAP network interface, 60 to 90 seconds for file down-loading depending on the total size of the files, 20 to 30 seconds for initialization of OS and another 1 to 3 minutes to get application programs. The total start-up time needed is between 4 and 6 minutes.

Conclusion

The performance of the network is not fully satisfactory but it seemed to be acceptable at present. It is quite desirable to make the file transfer rate higher. There are many parameters to be tuned up to raise the network performance. The total data transfer throughput of the network is estimated to be about 300kB/s.

Acknowledgements

We wish to thank Professor M. Kihara and other members of the accelerator department for their support during the work.

References

[1] T. Katoh, K. Uchino, T. Kamei, M. Tejima, T. Takashima, K. Ishii, S. Ninomiya and E. Kadokura, "Control Computer System for KEK Proton Synchrotron", IEEE Trans. on Nucl. Sci., Vol. NS-24, No. 3, pp. 1789-1791, June 1977.

[2] H. Nakagawa, T. Katoh, E. Kadokura and K. Ishii, "Design of New Control System for the KEK Proton Synchrotron", IEEE Trans. on Nucl. Sci., Vol. NS-32, No.5, pp. 2074-2076, October 1985.

[3] T. Katoh, "VME-Computer based Control System for the KEK Proton Synchrotron", Presented at the Europhysics Conference on Control Systems for Experimental Physics, Villars-sur-Ollon, Switzerland, Sept. 28 - Oct. 2, 1987.