A FUNCTIONAL MICROCOMPUTER NETWORK

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Abstract

Bishop's, like many other small universities and colleges, is constantly striving to supply state of the art computing facilities to students, faculty, and the administration from very limited funds. The very advantageous cost/performance ratio of this network has allowed the university to obtain such facilities while remaining within budget constraints.

The paper describes the computer network of microcomputers installed at Bishop's in the summer of 1981. The experience of the first academic year of actual operation will be outlined. The equipment will be used as the major computing facility on campus.

Briefly, the network consists of two nodes, with internode communication capability; 20 independent work stations (soon to be increased), two 80 MB Winchester disk drives, two floppy disk units, two high speed printers and a "Diablo-like" printer for word processing applications, and a digital plotter. There is also a communication link to the minicomputer being replaced by the new network.

Some of the features of the network include: automatic spooling of output to all printers, individual accounting controls (i.e. assignment of passwords, control of disk space including write protection of volumes, control of lines printed per job and per academic term), support of multiple operating systems, and support of multiple processors.

The paper will describe our very positive experience with the system, and our future plans.

Introduction

Bishop's University is a small university offering degree programs in business, the humanities, science, and the social sciences. The Cole Computer Centre is responsible for supporting these areas with the necessary computer facilities.

In the spring of 1980 it was decided to replace the existing computer. At this time the decision was taken to move from the existing batch environment to an on-line system. A study of possible replacement equipment commenced.

The traditional on-line environment at that time was a time-shared computer. It was determined that a sixteen(16) terminal system with high level languages had to be available - mainly PASCAL - as well as an assembler language.

Becterm Inc., a Quebec-based computer manufacturer and distributor, did not propose a time-shared system. They offered a network of computers. This was the eventual system selected.

The present paper describes the hardware and software of the network and provides an evaluation of the installation after one academic year of use.

Hardware

The installation (see figure 1) consists of a double star network with a number of support subsystems. The subsystems are of two types; coprocessor master symbionts, and end user work station support units. These are connected to the nodes using high speed delta communication channels which access the network communication controller on each node. The delta communication channels offer a 500K baud transfer rate. The nodes communicate with each other using a special node communication controller based on DMA technology.

The function of the master symbiont is to control, automatically, the spooling of printer output to any one of a number of printers (currently three), the plotter, and/or floppy disk units. This ensures that these devices will be utilized efficiently and not reduce performance on either the node or any user work station. In our environment, a master symbiont will also handle synchronous communication to the Xerox 530 on campus for the transfer of files and use of its peripherals.

Each end user work station support unit (see figure 2a) controls up to eight(8) single-board processors with on-board memory and asynchronous communication controllers. The units at Bishop's have 64K bytes of memory and a 6502 CPU. On order, we have six(6) units which will have 256K bytes of memory and a 68000 CPU. One of the asynchronous controllers is used for connecting a terminal (usually a CRT at 9600 baud) or an auto-answer modem (for remote dial-up access); the other can be used for a local printer (most useful in word processing applications) or any other devices that can be supported using the RS-232 standard. A very useful feature of the terminal controller is the ability to reset the work station by turning the CRT off or by

disconnecting the dial-up call. This ensures, that in the event of a program loop or jam, the user can restart the station without the necessity of physically being on site. The software performs an automatic log-off at this time as well, helping to ensure the integrity of the system.

The network, as of this writing, is supporting twenty(20) individual work stations, two(2) Centronics 704-9 dot matrix printers, a Diablo 1620 daisy wheel printer, a Miplot intelligent flatbed plotter, two floppydisk units and each node has an eighty(80)M byte winchester type hard disk. With an average seek time of 38 milliseconds and a transfer rate of 7.97 megabits/sec, the hard disks offer very satisfactory file access and storage capacity.

Software

BMOS (Becterm Multi-user Operating System) is used to control the network. The initial version of this software was developed as a joint project between Becterm and Bishop's with the later releases coming from Becterm.

One of the main concerns, initially, was the development of a method to take advantage of the large storage capacities available on the hard disks using sixteen(16) bit address ranges. To overcome this, the disk was divided into a number of virtual disks with each of these divided into blocks of 512 bytes. BMOS keeps a table of offsets to each virtual disk in memory, then adds the appropriate offset to any address passed to the node for a file access. This method imposes the restriction that any single file must not exceed 16M bytes. However, for many applications this is adequate.

The design also considered the fact that more than one operating system would be supported along with a mix of 8 and 16 bit CPUs. This required that we make the file access method independent. The two(2) operating systems now available on the system (the UCSD p-system(tm) and OS-65U) have unique file requirements which are being served. The UCSD system expects 512 bytes of data at a time, while OS-65U uses 3584 bytes at a time. UNIX(tm) appears to be one of the popular operating systems that will be running on the 68000 CPU, once again with its own requirements.

In an academic environment security is very important. The network tends to make it easier to implement reasonable measures to help safeguard critical files. In this instance, the virtual disks mean that academic and administrative applications can be kept isolated. Each virtual disk can have read only or read/write access specified under the accounting system. The network expects requests for file access to be in a particular form and once logged on, a work station can only access its own virtual disks. Any invalid requests can be intercepted by BMOS with appropiate error messages being returned to the work station. The table of offsets is kept in the memory of the node which cannot be accessed by any work station, work stations being only allowed to make requests to read or write to the disk or peripherals connected to the master symbiont coprocessor.

BMOS supports programs running on the master symbiont coprocessor to control the spooling of files to be printed on any of the printers or other devices connected to the coprocessor. This software allows print jobs to select a free printer or, under program control, select a particular printer or other device such as the plotter. Jobs may be suspended or canceled. When print queues are empty, extra form feeds are sent to the printer to allow removal of listings. Each listing has a header indicating the name and account number of the user that originated the job, date and time of printing, and size of print task. Accounting information is updated and if print limits are exceeded no further jobs will be printed for that account.

The log-on procedure is controlled by the network. During log-on, basic user information is verified such as account number, password, expiry date for account, time limits, disk space limits, etc. Once a valid user has been identified, the user is asked to inform the system if the password is to be changed, what type of terminal is to be used (hard copy or various CRTs), and what operating system is to be used (UCSD or OS-65U). Any mail available for the user is then transmitted to the work station. At this point the appropriate virtual disk offsets are retrieved and placed in the memory of the node to which the work station is attached. Note: it does not matter on which of the two hard disks your virtual disks actually are; BMOS will retrieve them and pass the information to your work station even if that work station is attached to the other node. Now the work station memory is cleared and the requested operating system is downloaded. This typically takes about eight(8) seconds.

If at any time the terminal is turned off, or the line drops on the modem, the network software closes all files associated with that work station, logs off the user, and reintializes the logon procedure.

Under these operating systems PASCAL, FORTRAN 77, BASIC and an assembler language are currently available. A Number of text formatter programs, a database management system, a financial modeling system, and a statistical package are some of the application programs that we have on the network.

Conclusions

The network has been in production use since September 1981. In the last academic term there were approximately 400 user accounts on the system. All computer science courses are using the network, as well as a number of business, biology, geography, psychology, and mathematics courses. A trade accounts receivable program is run on the system for the business office, and all functions of the records office will be on line by the fall of 1982. The number of work stations will be increased to 32 by the end of the summer.

Recently, I had occasion to visit a number of other universities. An observation made, more than once, was that students in introductory computer science courses were not allowed to use the screen-oriented editors available on

their time-shared computer facilities. They had to use line-oriented editors so as not to degrade the response time of the system. This is one type of problem that has not arisen with the use of the network.

The decision to use coprocessors for the handling of I/O to slower devices has allowed the nodes to perform their file serving functions effectively. The use of the double star has ensured not only good response times, but also built-in hardware backup.

As with all computer systems there have been problems - delays in delivery and a shortage of good system documentation are familiar to everyone. However, there have been no major problems with either the hardware or the software.

In summary, we feel that this network has given a very cost-effective computer facility to our user community. It will allow us to acquire and be able to adapt versatile and effective state-of-the-art equipment as it becomes available. It is our opinion that this is a solution that other universities or colleges would like to consider, in this era of increasing demand for services to be supplied from decreasing amounts of available funding.

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UNIX is a trademark of Bell Telephone laboratories.
UCSD is a trademark of the Regents of the University of California.
OS-65U is a product of Ohio Scientific Incorporated.

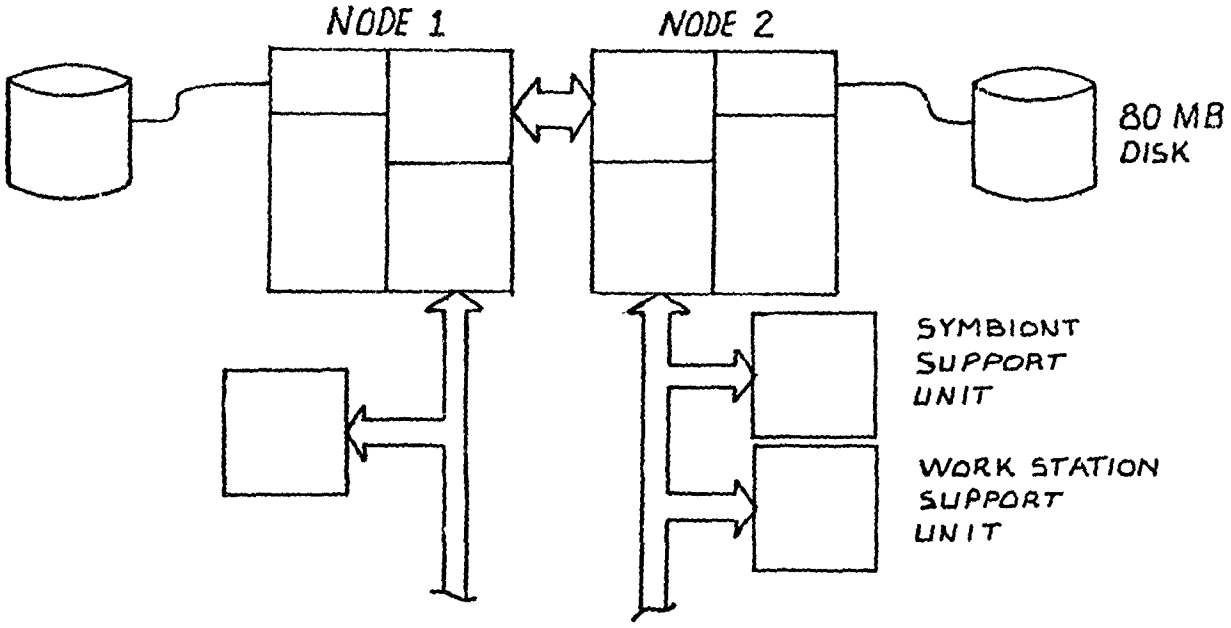
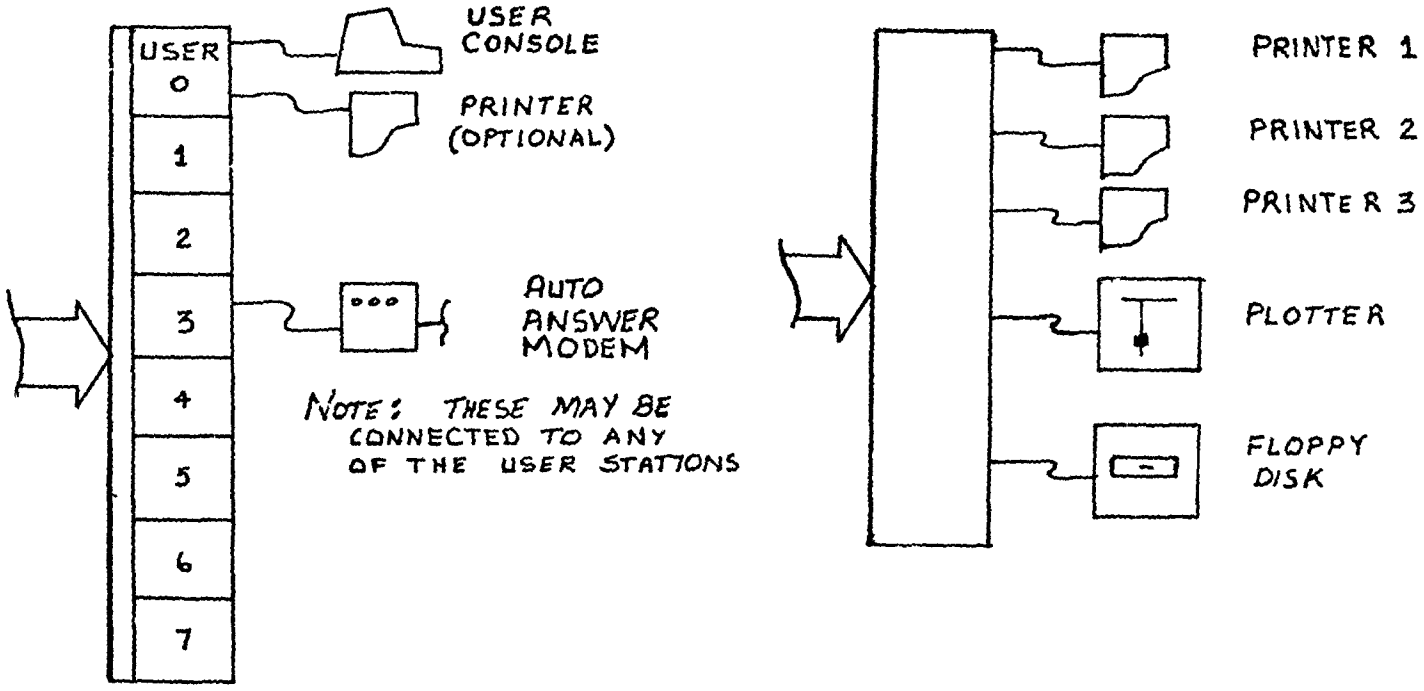


FIGURE 1



WORKSTATION SUPPORT UNIT
(a)

SYMBIONT SUPPORT UNIT
(b)

FIGURE 2