Announcing Production Micronodes

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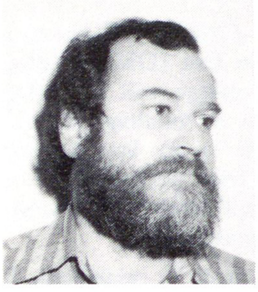
Packet Network Systems, DCR Canberra



Introduction

In late April 1983, Office Automation of Canberra delivered the first production micronode hardware to DCR. This delivery was a major milestone in the joint development project between this Australian company and the Packet Network and Hardware Sections of DCR. This project was initiated early in 1982 for the purpose of designing, developing and manufacturing node hardware for use on CSIRONET. Articles in the April 1981 and August 1982 issues of *CSIRONET News* have described some of the early progress toward this goal; this article describes the results of the project, after the arrival of the first production micronodes.

The micronode project resulted from the recognition of a number of deficiencies in the node hardware which had traditionally been used on CSIRONET. In particular it was realised that the new design would enable us to significantly reduce node hardware purchase and maintenance costs and, at the same time, provide a highly reliable flexible machine in which to run a variety of network software. In addition, it was thought that the new hardware would allow us to take a more cost effective approach to the design, development and maintenance of network software.

In-house testing of production micronodes is demonstrating that our expectations for this new concept in communications systems are being fulfilled.

Hardware Description

The micronode hardware is based on the Motorola 68000 CPU and the Motorola Versabus, and is comprised of the following major components:

- Power supply
- Card cage
- Main CPU board
- Serial co-processor board
- Front panel assembly
- Line distribution assembly
- Fan assembly (optional)

The system is assembled in a cabinet measuring 585mm x 480mm x 180mm, with a front-panel-lock key-switch, power switch, mains filter and a one metre power lead. The cabinet is designed to either mount in a standard 480mm rack or to stand alone on two stabilising feet. In the latter case the micronode stands on its edge; in this position convection cooling will be adequate in all but the harshest environments. The size of the micronode is a compromise which allows reasonable portability while allowing maximum space for expansion. The micronode is transported in a padded container which provides a degree of protection and an increase in portability. A brief description of the major components of the micronode follows.

Power Supply

The power supply requires input of either:

240 $\pm$20% volts, 47 - 62Hz AC at 1 amp or
120 $\pm$20% volts, 47 - 62Hz AC at 2 amps or
27 $\pm$8 volts DC at 4 amps.

Power supply output is:

5 volts at 12 amps and
12 volts at 5 amps and
-12 volts at 5 amps.

The 27-volt input option is provided to allow the machine to operate from two 12-volt lead-acid batteries in series. This option will not be supported at user sites initially.

Testing of prototype micronodes has demonstrated that the machines are extremely tolerant to mains disturbances. They have continued to operate at DCR through mains fluctuations which have caused many other machines to fail.

Card Cage

The card cage has provision for up to 6 circuit boards. The micronodes to be installed at users' sites initially will consist of a main CPU board and one serial co-processor board, leaving 4 slots for future expansion.

The card cage and its associated backplane conforms physically and electrically to the Motorola Versabus specification allowing the installation of Versa-modules from other sources.

The front edge of the boards are supported to increase the mechanical rigidity of the assembly.

Facing page. Top: Front and rear views of a production micronode. When installed vertically, as shown in the photo, a standard micronode does not require cooling fans. Below: Side view of the micronode with the cover removed.


CSIRONET MICRONODE
CSIRONET
BY OFFICE AUTOMATION PTY LTD. CANBERRA
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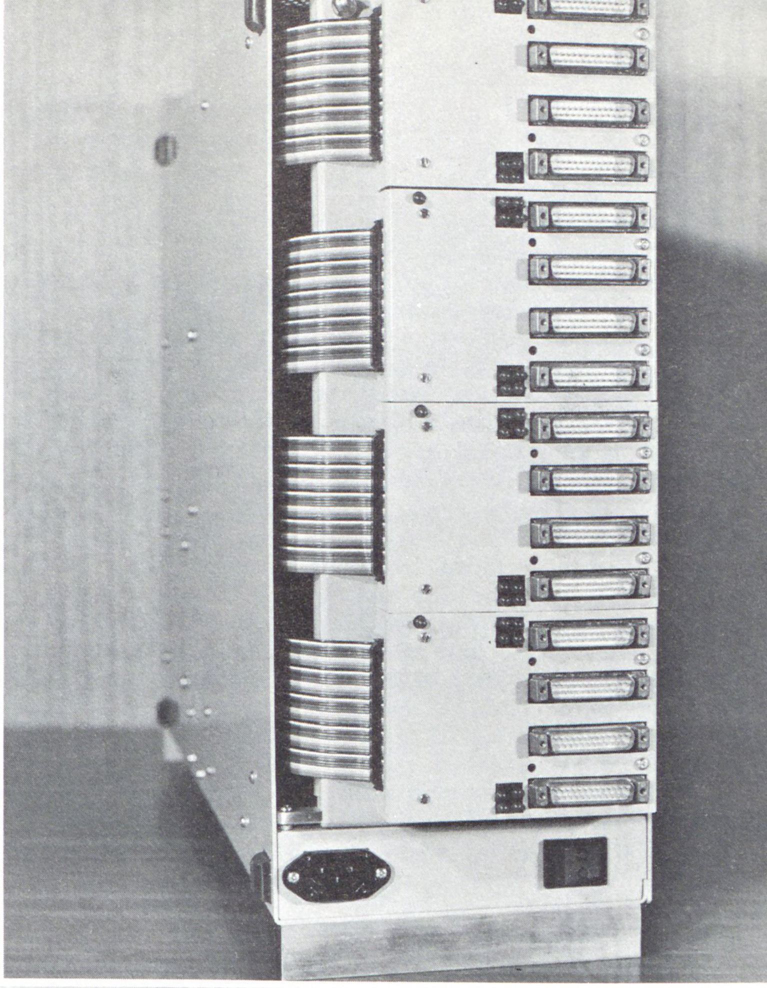
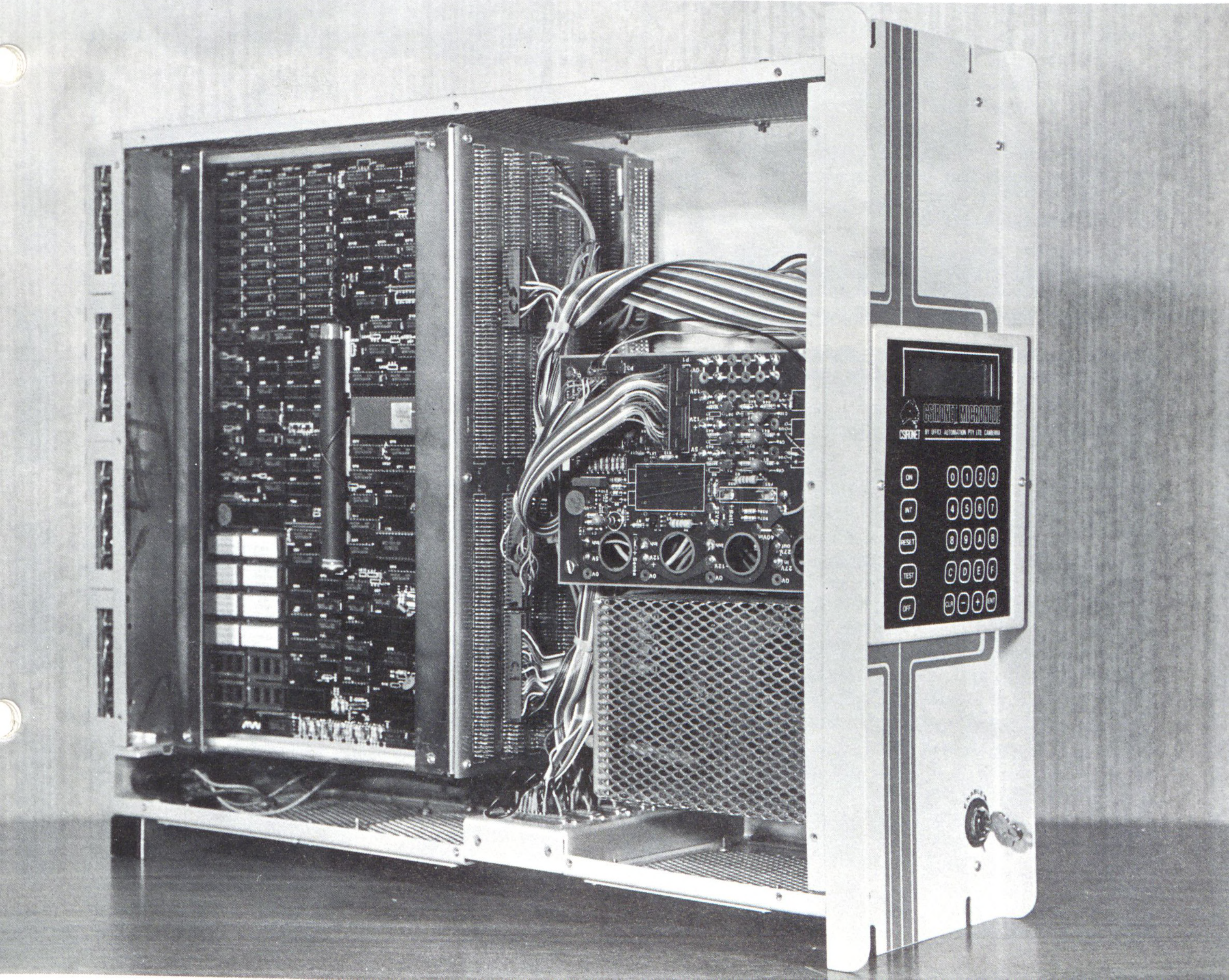
TEST
OFF
0 1 2 3
4 5 6 7
8 9 A B
C D E F
CLR − + ENT




CSIRONET MICRONODE
CSIRONET
BY OFFICE AUTOMATION PTY LTD. CANBERRA
ON
INT
RESET
TEST
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Main CPU Board

The main CPU board consists of:

- An 8 Megahertz 68000 16-bit CPU.
- 256k bytes of parity checked memory with automatic retry on error.
- 2 Zilog 8030 serial input/output chips with associated level conversion circuitry to provide 4 RS232C serial I/O ports. These ports are reserved for diagnostic and testing purposes when the hardware is being used as a CSIRONET micronode.
- 24k bytes of Read Only Memory.
- A calendar/clock chip to maintain date and time. Batteries are included on the board to keep this chip operating when the mains power is disconnected. The chip also includes 52 bytes of battery backed up Random Access Memory (RAM) which is used to store information about system failures.
- A timer chip to provide timing interrupts for the micronode's executive program and a watchdog timer to restart the micronode after a hardware or software failure.
- An analogue to digital converter which allows the micronode software to monitor its own operating environment including power supply voltages and system temperatures.

Serial Co-processor Board

All input and output to user's devices connected to the micronode are performed by this co-processor. It consists of:

- A Motorola 68000 8-Megahertz CPU
- 128k bytes of Random Access Memory (RAM)
- 48k bytes of Read Only Memory (ROM)
- 8 Zilog I/O chips providing 16 serial I/O ports
- A Western Digital WD2000 encryption chip to allow encryption and decryption of users' data.

Front Panel Assembly

Operator control of the micronode is via a front panel assembly which consists of a touch sensitive keypad of 25 keys and a liquid crystal display capable of displaying 2 lines of 20 characters of text.

The assembly can be attached to the cabinet oriented for either vertical (stand-alone) or horizontal (rack) mounting.

Line Distribution Assembly

The line distribution assembly consists of four line distribution circuit boards which perform the TTL to RS232C level conversions for the 16 serial I/O ports on the I/O board.

The line distribution boards are connected to the serial co-processor by ribbon cables at TTL levels and to the users' equipment at RS232C levels by 25-pin D type connectors with locking blocks. This subsystem has been designed so that the line distribution boards can be plugged and unplugged 'live', thereby removing the necessity to shut down the whole micronode to replace a single board.

Later systems will allow remote (up to 4 metres) mounting of the line distribution assembly.

One feature of the I/O system design is that signalling levels other than RS232C will be able to be provided at a later date. This can be achieved by designing alternative line distribution boards rather than modifying the serial co-processor board.

Experience has shown that one of the most common failures of communications equipment is due to high voltage spikes on cables damaging the line driving chips on the serial board. By putting this circuitry on an external assembly on the micronodes, DCR believes that repair will be greatly simplified.

All peripherals will be connected to micronodes by identical RS232C serial line interfaces. By enforcing this common electrical connection it has been possible to define a single hardware configuration which can be used in a wide range of applications. This approach eliminates problems associated with configuring machines for particular applications and maintaining back-up systems. The function of each port is determined by the module of software which is used to control it.

Fan Assembly

This optional assembly will normally only be used with horizontally (rack) mounted systems or systems which have close to a full complement of circuit boards (6). The fans operate on direct current and use ball bearings for high reliability. The fan assembly is designed so that it would be possible to change the assembly without disrupting the normal operation of the micronode.

Environmental Requirements

Micronodes are designed to operate in normal office and laboratory environments mounted vertically for convection cooling. The machine should be installed out of direct sunlight and with the cooling vents free of any obstruction.

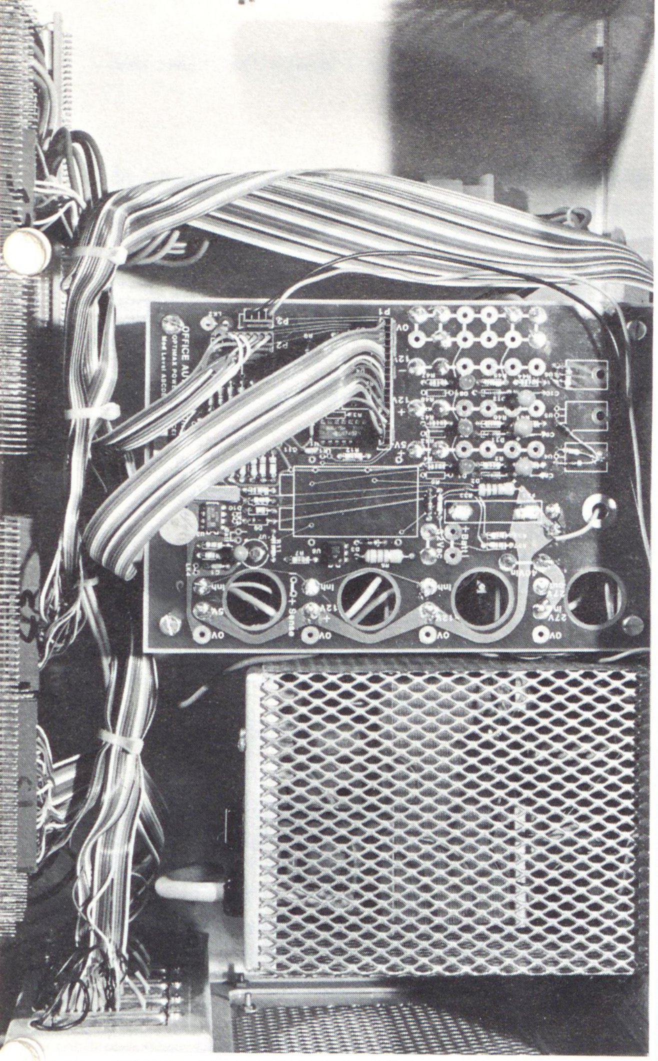
Micronodes weigh about 19 kilograms and are powered from normal general power outlets drawing about one amp.

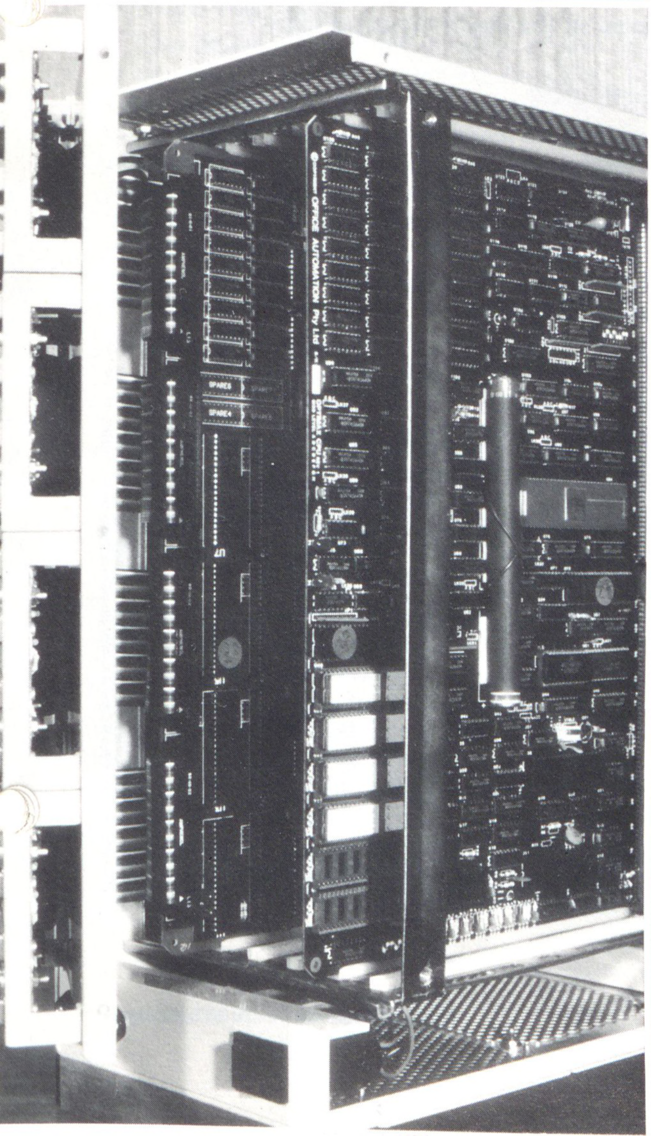
While the micronode could be installed on the floor, it may be desirable to install it on a table or bench to reduce the risk of physical damage and to provide easier access to the front panel.

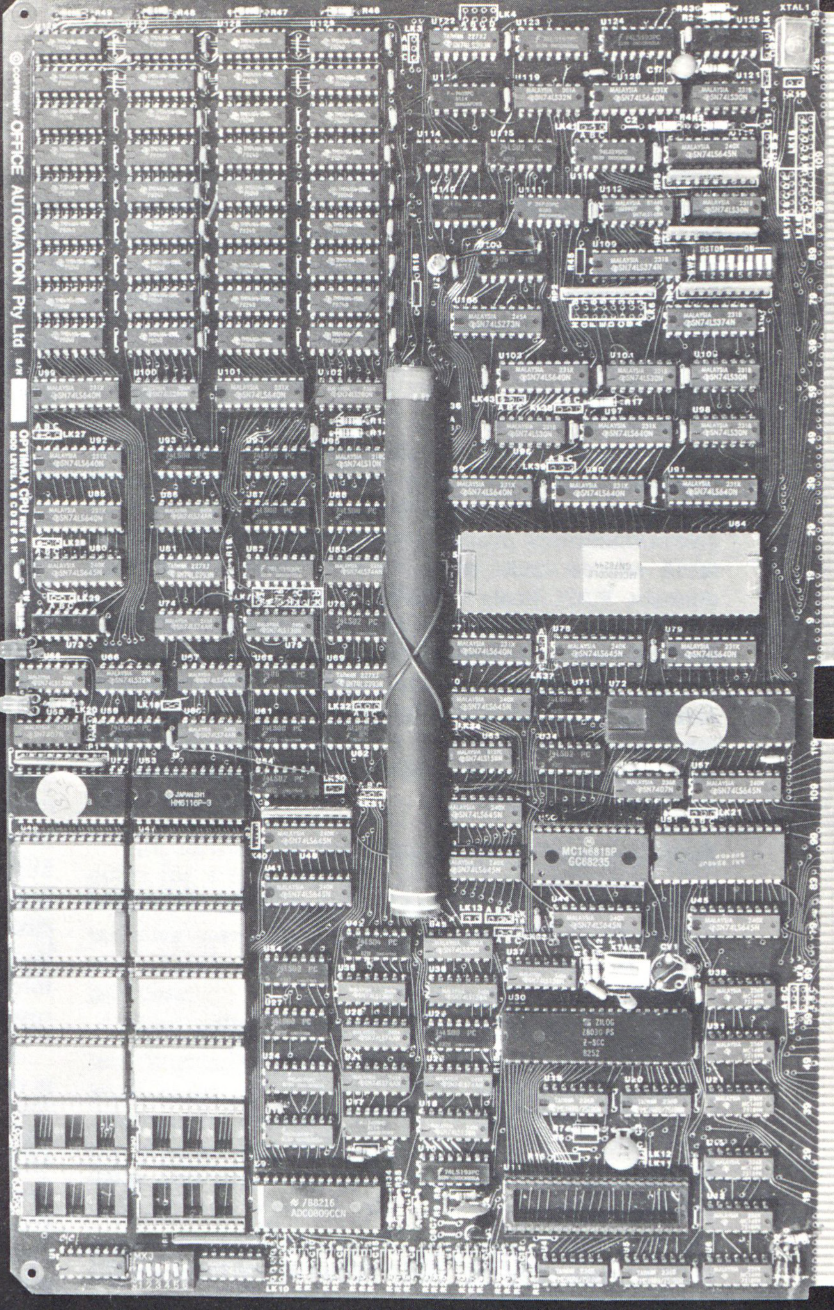
Software Philosophy

DCR has recognised for some considerable time that the decrease in hardware cost and the requirement for increased functionality by users has resulted in the cost of node software becoming an ever increasing proportion of the cost of the communication service to the users. DCR is attacking this problem in two major ways.

Facing page. Top left: Power supply. Right: Main CPU board. Bottom left: A rear view of the micronode with the cover removed and the rear door, which holds the distribution assembly, partly open. Right: Front panel assembly.






OFFICE AUTOMATION Pty Ltd
OPTIMAX CPU


CSIRONET MICRONODE
CSIRONET
BY: OFFICE AUTOMATION PTY LTD, CANBERRA
ON
INT
RESET
TEST
OFF
0 1 2 3
4 5 6 7
8 9 A B
C D E F
CLR – + ENT

Wherever possible node software is written in a high level language, in this case Pascal. This results in significant savings in programming time when compared with the Assembly language software used in the original PDP-11 nodes. In addition, Pascal reduces the probability of errors occurring in the software while reducing the time to fix any errors or add new features.

Secondly, we have used 'single source software' as far as possible. This is software which is held on a common library and used in a range of often quite different environments. For example, the CNIO communications program used in micronodes is the same source code as the CNIO program used to connect VAX hosts to CSIRONET. In each case a small machine dependent group of routines with well defined interfaces is used to adapt the common code to the particular computer system. This approach assists greatly in keeping programs in a range of machines compatible and ensures that modifications and corrections are added in the same way to software in all machines.

Software Components

Micronode software consists of the following major components:

- The micronode executive
- The input/output system
- CNIO - CSIRONET access program
- CNIA - interactive terminal control
- CNOP - output peripheral control
- CNIP - input peripheral control
- CONTROL - operator control

A short description of each of these software components follows.

The Micronode Executive. This executive program is used to time-slice the main 68000 CPU between the tasks running in that CPU and to provide a small set of executive functions for tasks running in the machine. It also manages the analog to digital conversion system which allows monitoring of the micronode's operating environment.

The Input-Output System. This system runs in the co-processor CPU and manages all input and output for the main CPU. A range of different external protocols are supported, and the significant load associated with managing I/O is kept from the main CPU by use of this approach.

CNIO. This program controls all data transmission between the micronode and CSIRONET. It is the same program as is used to provide these functions in VAX, Hewlett Packard and other systems. A small amount of machine dependent code is used to interface the Pascal CNIO code to the specific environment of the micronode.

CNIA. Interactive access to CSIRONET for terminals connected to the micronode is controlled by the program CNIA. At present the functionality of CNIA provides a terminal service similar to that provided by PDP-11 nodes. In the longer term, modifications to this program and the addition of more terminal controlling programs will allow different terminal functionality and the support of a new range of terminals.

CNOP. The support of the serial output peripherals is managed by this program. The software consists of a common part and a series of peripheral-specific procedures to allow formatting for a range of peripheral types.

CNIP. Input peripherals are controlled by this program. Like CNOP, CNIP has procedures to cope with a range of input peripherals.

CONTROL. Operator control at the micronode and from remote sites is provided by this program. One of its most important functions is to monitor the power supply voltages and the machine's temperatures so that local and remote staff can be alerted to any marginal conditions.

System Initialisation

The micronode system includes sufficient software in read-only memories to allow the machine to be automatically down-line loaded at power up, operator request or following a failure. In the latter case the reason for the failure is stored in battery backed up RAM to be transmitted to a network information file in Canberra when communication is restored.

Information about the initialisation of the system is displayed in the liquid crystal display.

Maintenance

All micronode maintenance will be performed in the Canberra workshops of Office Automation and/or DCR. Both Office Automation and DCR place a great deal of importance on the need to fully analyse any faults so that permanent repairs can be effected and any design deficiencies can be rectified in subsequent machines.

Following maintenance, machines will be returned to service at DCR premises providing a service to DCR staff. To ensure that replacement machines can be delivered to users' sites in the shortest possible time, 'spare' machines will be held on 'hot standby' at major DCR sites. These machines will normally be sent to users' sites by courier where they can be installed by simply transferring the peripheral cables from the old to the replacement machine.

There will be no routine maintenance on micronodes, but the analogue to digital system will be used to continually monitor the power supply voltages and temperatures of all machines and Canberra operations staff will be notified if any of these parameters are outside predetermined thresholds. A scheduled replacement will be made of any micronode which is not operating within the predefined limits. In most cases it is expected that this replacement will occur before the users notice any impact on the service.

Peripheral Types

Micronodes are designed to have all peripherals connected via RS232C interfaces. By restricting the type of connection, it has been possible to obtain complete flexibility in how each port is used. At system load time a 'file' is loaded which specifies how each serial port is to be used. It is relatively easy to change this file and thereby change the use to which any port is put.

Unfortunately some of the batch peripherals used with PDP-11 nodes are incompatible with the serial ports on micronodes. To overcome this problem, DCR has designed an external conversion box to match PDP-11 parallel line printers, cardreaders and the old style Calcomp 500 plotters to the serial ports. All new peripherals purchased for micronodes should use RS232C interfaces.

Current Status

At the time of writing, mid-May, one micronode was in regular use at DCR Canberra although no micronodes had been formally accepted. A number of minor problems were still to be overcome before the machines would be considered completely satisfactory by DCR. Indications were that these problems should be resolved and full testing should be complete in about three weeks if no further problems were revealed.

In Retrospect

The design and implementation of the micronode is one of the most complex projects that DCR has been involved in. Traditionally, with the exception of a few specialised interfaces, DCR has chosen off-the-shelf hardware rather than participating in significant design and development. In this case it was considered that the advantages of designing hardware to our own requirements were so overwhelming that the option could not be ignored. After public tender, it was obvious that Office Automation were following a similar line of development and were the most suitable tenderers for the contract. Their tender included an offer of a joint project, which DCR accepted. DCR and Office Automation then combined their efforts to produce the micronode.

The performance and cooperation of Office Automation throughout the project has been very good. The same cannot be said of some of their subcontractors and suppliers. Deadlines for the completion or delivery of various components often slipped and in some cases the work was unsatisfactory and had to be corrected. A number of instances were detected where it became obvious that subcontractors had been less than candid about their stage of progress. Discussions with others who have been involved in similar projects have suggested that our problems were not unique. Indifferent performance seems to be fairly widespread in Australian industry. This lack of professionalism and foresight must be corrected if Australia is to achieve the desired growth in high technology industries.

The Future

The micronode hardware is a very good starting point for a large number of projects associated with communications and in other areas. The cabinet includes space for a disc of at least 40 megabytes, so the system has possibilities as a stand alone processor.

DCR is already using the hardware to provide test interfaces to a number of host systems for a wide range of purposes. Work by DCR and Office Automation should result in further enhancement of the product and its application to an ever increasing range of uses. Office Automation is planning to develop the product for use in non-CSIRONET applications. These could include general purpose UNIX systems and data entry systems.

In spite of all this, by programming in a portable way in high level languages, DCR is keeping its options open to change to different hardware if this becomes desirable. ■

Below: Micronode block diagram.