AAEC/E607

AUSTRALIAN ATOMIC ENERGY COMMISSION
RESEARCH ESTABLISHMENT

LUCAS HEIGHTS RESEARCH LABORATORIES

COMPUTER NETWORK ACCESS TO THE PYRAMID 90X COMPUTER AT LUCAS HEIGHTS

by

P.L. SANGER

JUNE 1985

ISBN 0 642 59807 X

AUSTRALIAN ATOMIC ENERGY COMMISSION
RESEARCH ESTABLISHMENT

LUCAS HEIGHTS RESEARCH LABORATORIES

COMPUTER NETWORK ACCESS TO THE PYRAMID 90X COMPUTER AT LUCAS HEIGHTS

by

P.L. SANGER

ABSTRACT

A new system, INTERNET, has been developed for the MicroEclipse computer. It provides computer network terminal access to the PYRAMID 90X computer, and hence to the Berkeley and AT&T UNIX facilities. INTERNET takes over the support for auto-answer modems, and includes a version of ACL-NOVA in the MicroEclipse computer.

National Library of Australia card number and ISBN 0 642 59807 X

CONTENTS

1. INTRODUCTION

The PYRAMID 90X computer was installed at Lucas Heights in June 1984 to provide access to the powerful Berkeley Version 4.2 and AT&T System V UNIX operating systems. Initial connections to the PYRAMID computer were to be provided through the UNIX-based PDP11/45 computer, but experiments showed that the serial lines between the PYRAMID and the PDP11/45 computer could not be operated at the required speed [G.W. Peady, AAEC unpublished work].

This focused attention on the MicroEclipse computer (Eclipse S/20 microcomputer) being set up to provide terminal access to CSIRONET. Software being developed for the MicroEclipse would take over the support for the existing four auto-answer modem lines and also provide terminal access to CSIRONET *via* four serial RS232 lines to the CSIRO Micronode installed at Lucas Heights.

However, if the four serial lines on the MicroEclipse computer were linked to the PYRAMID computer, then this could provide terminal access to the PYRAMID, and serial lines from the PYRAMID could provide access to the CSIRO Micronode. This approach led to the development at Lucas Heights of a new system called INTERNET.

2. REPLACING THE MICRONOVA COMPUTER

The 128 kilobyte MicroEclipse computer was purchased in April 1983 to provide terminal access to CSIRONET. The MicroEclipse initially replaced the technically obsolete MICRONOVA computer and took over its support for auto-answer modem access to the site computer network facilities. This was done by modifying the MICRONET software [Sanger 1980] to allow for the machine differences between the MICRONOVA and MicroEclipse computers*, and to support the more complex interface to be connected to the auto-answer modem lines.

The reserved locations in page zero were different, there were no automatic incrementing or decrementing locations, changes were made to operate the real time clock, and new stack instructions were included for the efficient handling of interrupts. Other changes related to the use of the more complex four-line asynchronous multiplexor (ASLM) interface board (the DGC 4336AS interface) to control the auto-answer modem lines instead of the four separate interfaces (DGC 4203 interfaces) used on the MICRONOVA computer. The resulting system, called ECLMODEM, was commissioned in December 1983 and provided the equivalent of the MICRONET system.

3. DATERCOM IN THE MICROECLIPSE

Changes were then made to the more complex DATERCOM software [Sanger 1976,1977] to allow it to execute in the MicroEclipse computer and support the auto-answer modem lines. These changes again related to machine differences, this time between the NOVA and the MicroEclipse computers as well as to the different MicroEclipse-Dataway interface [D.J. Reid, AAEC unpublished work].

The resulting system, ECNETCOM, was brought into service in May 1984. It provided an extra bonus by allowing users to log into ACL-NOVA [Sanger 1982] running in the MicroEclipse computer *via* the network access code '$8'. This version of ACL-NOVA has yet to be altered to take advantage of the MicroEclipse floating point instructions, yet it still runs at almost twice the speed of the NOVA 820 version.

3.1 Proposed Access to CSIRONET

Most importantly, the main purpose of ECNETCOM was to provide the framework needed to develop the support for computer network access to CSIRONET. Users could call up the MicroEclipse computer to log in to CSIRONET through one of four serial RS232 lines to be connected to the CSIRO Micronode in the main computer room.

3.2 Problems with Terminal Access to the PYRAMID

Work on this project was interrupted by the need to provide terminal access to the PYRAMID 90X computer. This computer was purchased to replace the aging UNIX-based PDP11/45 system with a faster, more reliable machine supporting more up-to-date versions of UNIX. Initial connections through the PDP11/45 computer were to have provided access to the PYRAMID *via* serial RS232 lines operating at 9600 baud. Unfortunately, experiments showed that these serial lines could only operate at 1200 baud because of

* Both computers are Data General products with similar, although not identical, instruction sets.

the overheads associated with interrupt handling in the PDP11/45 software.

Attention was then focused on the MicroEclipse computer to see if it could provide access to the PYRAMID. If four serial lines from the MicroEclipse were linked to the PYRAMID and could operate correctly at 9600 baud, this would provide the required access to the PYRAMID UNIX software, and serial lines from the PYRAMID could be used to access the CSIRO Micronode. A closer examination of the costs for CSIRO computing also indicated that terminal access *via* only one serial line from the PYRAMID would meet the anticipated demand.

3.3 Tests on the MicroEclipse to PYRAMID Link

Changes to the auto-answer modem software in the ECNETCOM system allowed tests to be carried out on access of the PYRAMID to the computer network *via* the serial RS232 lines. This was easily done in the MicroEclipse because of the mainly 'passive' role [Richardson & Sanger 1978] of the ECNETCOM Dataway communication. It allowed the PYRAMID console to be used as a standard computer network terminal from which to access such resources as the tasks running on the IBM 3033S central computer.

Interaction with tasks running on the central computer and listing output at the PYRAMID console was very successful, with the serial lines operating well, even at 9600 baud. This gave the impetus necessary to commit the MicroEclipse to providing access to the PYRAMID, and resulted in the development of a new system called INTERNET.

4. DEVELOPMENT OF THE INTERNET SYSTEM

Network access to the PYRAMID was not a simple task for the MicroEclipse. It required an extension of the 'active' support that was previously added to DATERCOM to provide computer network access to ACL-NOVA [Sanger 1982]. The problem was to balance the transfer of data between the MicroEclipse and the PYRAMID and, at the same time, synchronise the transfer of data between the computer network terminal and the MicroEclipse computer. Use of a separate passive control block to look after the serial line connections, coupled with some form of data flow control, provided the necessary buffering of data to and from the active terminal control block.

With ECNETCOM as the starting point, code was added to support this double control block structure to communicate over the serial lines to the PYRAMID. The simple XON/XOFF sequences were used initially for data flow control and the lines operated quite successfully at 9600 baud.

There were still difficulties in logging out from the PYRAMID owing to the complex DATERCOM task termination code, as well as to problems with '$5' access to the PYRAMID from the terminals connected *via* the auto-answer modem lines. Some of the PYRAMID tasks also suffered data loss which was thought to be related to data buffering in the MicroEclipse.

Full use of the input/output areas associated with the passive control block allowed 124 characters of data to be buffered in the MicroEclipse, and a new Dataway command X(0D) was introduced to enable the transfer of odd byte count data. This seemed to improve the situation, but the data loss problem was really caused by the fact that UNIX 'raw mode'* does not support the XON/XOFF data flow control.

Hardware 'handshaking', using the RTS (request to send) serial control line (see Appendix A for details) will presumably provide the solution to data loss, but at first there seemed to be no way of making use of it from the standard PYRAMID software. Various versions of INTERNET produced during August 1984 provided fixes for the above logout and modem terminal access problems, and gave reliable access to the PYRAMID computer.

In early October, PYRAMID routines were located to allow hardware handshaking over serial lines by making use of the the 'setcts' routine [F.P. Crawford, AAEC unpublished work]. The INTERNET software was altered to replace the XON/XOFF code by instructions that effectively toggled the CTS (clear to send) control line from the PYRAMID computer. This version of INTERNET worked well, even for UNIX raw mode communication, and it was brought into production in mid-October 1984.

Details of the computer network and serial line communication used to access the PYRAMID are discussed in the subsections that follow.

---

* In this mode, every character received by the PYRAMID is passed to the controlling UNIX task including XON/XOFF.

4.1 Logging into the PYRAMID

A network terminal user specifying the access code '$5' causes a primary write X(05) Dataway sequence to be sent to the MicroEclipse computer with the attention bytes X(7100). An active control block is allocated to synchronise the Dataway communication, and the rewind X(07) Dataway sequence is sent to acknowledge the initiating primary write sequence.

A dollar character ($) is generated for processing through the MicroEclipse syntax analyser, and this results in the allocation of one of the four serial lines to the PYRAMID plus a passive control block to look after the serial line communication. The active and passive blocks are cross-linked to control the transfer of data between the computer network terminal and the PYRAMID computer.

In the MicroEclipse, the ASLM is initialised for communication over the required serial line, with DTR (data terminal ready) and RTS set, and the receiver enabled. This raising of DTR in the ASLM causes the DSR (data set ready) signal to be received by the ITP (intelligent terminal processor) in the PYRAMID computer, and results in the normal UNIX login messages being sent to the MicroEclipse computer. The UNIX login messages received by the MicroEclipse *via* the ASLM are initially buffered in the passive control block, before being transferred to the corresponding active control block for transmission over the Dataway to the required computer network terminal.

4.2 Processing Output from the PYRAMID

In more detail, a character received from the PYRAMID when no active output is in progress is immediately stored in the active control block for transmission to the computer network terminal *via* the write X(0D) Dataway sequence.

Characters received while active output is in progress are buffered up to a limit of 124 characters in the passive control block. On completion of the current active output, the buffered data are transferred from the passive to the active block and then transmitted to the computer network terminal *via* the appropriate write X(01) or X(0D) Dataway sequences.

This type of output processing worked well for computer network terminals that could operate at the same 9600 baud rate as the serial line to the PYRAMID computer. However, most of the network terminals operate at much slower rates, particularly those that are connected *via* the SMUT system [Ellis 1977; Sanger 1976], so it was important to implement some form of data flow control that would avoid the problems of data loss.

At first, the simple XON/XOFF protocol was used to control the flow of data; this was quite successful except for UNIX raw mode tasks in the PYRAMID. The protocol was implemented by transmitting the XOFF (control S) character to the ITP to suspend PYRAMID output once 115 characters had been buffered* in the passive control block. PYRAMID output is restarted once the XON (control Q) character is transmitted to the ITP when the active output is completed and the 115 buffered characters are transferred to the active control block.

Later implementation of a hardware handshaking protocol overcame the problems associated with the UNIX raw mode tasks. This was done by effectively toggling the CTS line from the ITP instead of transmitting the XOFF/XON characters. Normally, the ASLM RTS line would be toggled to control the CTS line from the ITP, but the ASLM required the RTS line to be set for transmitter operations. This meant that, for the MicroEclipse computer, the ASLM RTS line was left high and linked to the DSR line of the ITP, and the ASLM DTR line was linked to the ITP CTS line and toggled to control the data flow. Whenever XOFF would previously have been sent, the ASLM DTR line was dropped to cause the ITP CTS line to drop, effectively suspending PYRAMID output; and whenever XON would have been sent, the ASLM DTR line was re-asserted to raise the ITP CTS line and restart output from the PYRAMID.

4.3 Sending Data to the PYRAMID

Computer network terminal data for the PYRAMID are normally sent over the Dataway to the MicroEclipse computer using the Dataway sequences that provide network terminal access to ACL-NOVA [Sanger 1982]. The input character normally arrives as part of a primary write X(05) Dataway sequence and, if passive output is not in progress, the character is stored in the passive block ready for immediate

* 115 characters out of 124 were selected to allow additional data to arrive from the PYRAMID before the XOFF character was processed by the ITP.

transmission to the PYRAMID computer. A write X(09) Dataway sequence is issued from the MicroEclipse to acknowledge receipt of the character and to restart network terminal input.

When passive output is in progress, the input character is buffered in the active block up to a limit of 124 characters. On completion of the passive output, the buffered data are transferred from the active to the passive block ready for transmission to the PYRAMID.

Data flow control was not used when transmitting data to the PYRAMID as the 9600 baud line could operate much faster than data could be received from the computer network terminals.

4.4 Logging Out from the PYRAMID

A user normally logs out from UNIX by entering the EOT (Control D) character; this causes the ITP DTR line on the PYRAMID to drop. The ITP DTR line is linked to the ASLM DSR line and, when it drops, it can be interpreted as task termination in the MicroEclipse computer. Any output still buffered in the passive control block must be sent to the network terminal, followed by the 'END-TASK' message and then terminated by the rewind/unload X(0F) Dataway sequence. The ASLM RTS line is dropped to cause the ITP DSR line to drop, the active and passive control blocks are freed and the ASLM line is marked as being available for subsequent access by some other network terminal.

There were initial problems in handling the PYRAMID logout owing to timing conflicts in the DATERCOM task termination software, but these were eventually overcome with changes to the INTERNET coding.

4.5 Access from Auto-answer Modem Terminals

The main thrust of the work on PYRAMID access was to provide support for computer network terminals, these being the principal terminals used at Lucas Heights. However, it was also desirable to provide support for terminals gaining access to the site *via* the auto-answer modems, as well as support for the MicroEclipse monitor terminal.

In this case, the difference was that the terminal control block had nothing to do with active Dataway communication. Fortunately, the code used for communication between the active and passive blocks was sufficiently general to be extended in a fairly simple way to provide the required support.

Again, there were initial problems with logging out from the PYRAMID in that the 'END-TASK' state of the '$5' access from the auto-answer modem was treated as if it were 'END-SESSION' for the modem access. This problem was resolved by making further changes to the INTERNET task termination software and was part of the production version that has since given efficient and reliable access to the PYRAMID computer.

5. CONCLUSIONS

Development of the INTERNET software for the MicroEclipse computer has provided computer network terminal access to the PYRAMID 90X computer. It allows on-site users to log in to the Berkeley and AT&T UNIX operating systems to make use of such features as the 'vi' full screen editor and the comprehensive nroff text processing software. Logging into the PYRAMID also provides the path for access to CSIRONET, thus indirectly satisfying the original objectives of the MicroEclipse software development.

The INTERNET software has taken over the support for the auto-answer modems and also gives computer network access to a faster version of ACL-NOVA that runs in the MicroEclipse computer. The new software to provide data transfers between active terminal control blocks and passive serial line control blocks, coupled with hardware handshaking for data flow control, allows the link to the PYRAMID computer to operate successfully at 9600 baud, even under UNIX raw mode conditions.

A pleasing feature of the double control block structure of the PYRAMID access is that it applies equally to locally attached MicroEclipse terminals as well as to the computer network terminals for which it was originally designed. This technique should prove to be useful for future computer network software development.

6. REFERENCES

Ellis, P.J. [1977] - SMUT - Serial Multiple-user Terminals System. AAEC/E433

Richardson, D.J. and Sanger, P.L. [1978] - Inter-computer Communication within a Multi-nodal Computer Network. Proc. 8th Aust. Computer Conference, 4:1591-1611.

Sanger, P.L. [1976] - The AAEC Dataway Terminal Communication System. Proc. 7th Aust. Computer Conference, 2:610-622.

Sanger, P.L. [1977] - Terminal Facilities Provided by the DATERCOM System. AAEC/E409.

Sanger, P.L. [1980] - Remote Terminal Access to AAEC Computer Network Facilities. AAEC/E497.

Sanger, P.L. [1982] - AAEC Computer Network Access to ACL-NOVA Facilities. AAEC/E533.

APPENDIX A
HARDWARE SIGNALLING TO CONTROL DATA FLOW

There is no accepted standard for using RS232 lines to control data flow over a serial link between two computers. However, the most common technique for synchronising the flow of data is to have the RTS control line from one computer control the CTS control line in the other. This approach is based on the fact that the CTS control line is normally checked before data are sent over a serial line. For most applications, CTS is permanently high and this allows for immediate transmission of data. Dropping CTS causes the temporary suspension of data transmission and provides the required data flow control.

One computer can thus avoid overrunning its input buffers if it can control the CTS line in the transmitting computer. By linking the RTS line from the first computer to the CTS line in the second, the first computer can control the transmission of data from the second computer by raising or lowering ('toggling') the RTS line.

In a similar way, the second computer's RTS line can be linked to the first computer's CTS line to control the transmission of data from the first computer. This symmetric use of the RS232 lines is called hardware handshaking and provides an effective means of controlling the transfer of data over a serial link between two computers.