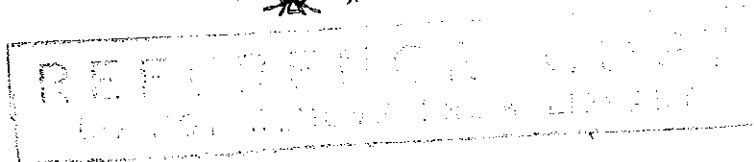


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AUSTRALIAN ATOMIC ENERGY COMMISSION
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LUCAS HEIGHTS RESEARCH LABORATORIES

AAEC COMPUTER NETWORK ACCESS
TO ACL-NOVA FACILITIES

by

P.L. SANGER

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ABSTRACT

A number of terminals supported by the NOVA computer-based DATERCOM system are given access to ACL-NOVA, the IBM3031 central computer and other resources of the AAEC computer network at Lucas Heights. Some of the other Dataway computers provide their own terminals with the same ACL and non-ACL mode support by communicating with DATERCOM, using a restricted set of Dataway sequences. Other more efficient Dataway computers provide their own non-ACL mode support and use only the restricted set of Dataway sequences to communicate with DATERCOM for ACL mode support. The extension to DATERCOM provides an even better use of Dataway resources by giving ACL mode support to terminals on Dataway computers that only provide non-ACL mode access to the resources of the computer network.

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CONTENTS

1. INTRODUCTION	1
2. THE DATERCOM SYSTEM	2
2.1 Early Versions	2
2.2 Current Version	2
2.3 Terminology for Modes of Terminal Access	3
2.4 ACL Mode	3
2.5 Non-ACL Mode	4
3. DATERCOM COMMUNICATION CONVENTIONS	5
3.1 Session Start	5
3.2 Dollar Command	5
3.3 Dataway Commands	6
3.4 Interruption Capability	7
3.5 Task Termination	8
3.6 Session Termination	8
4. NEW ACCESS TO ACL MODE FACILITIES	9
4.1 Establishing ACL Mode Access	9
4.2 Terminal Input Processing	10
4.3 Terminal Output Processing	11
4.4 Terminating ACL Mode Access	11
4.5 Performance	11
4.6 Problems Encountered	12
5. CONCLUSIONS	13
6. REFERENCES	13

1. INTRODUCTION

Terminals supported by the Dataway terminal communication system [DATERCOM : Sanger 1976, 1977] on the AAEC's NOVA computers at Lucas Heights are given access to ACL-NOVA, the IBM3031 central computer and other resources of the AAEC computer network.

Some of the other Dataway computers provide their own terminals with the same ACL and non-ACL mode support by communicating with DATERCOM by means of a restricted set of Dataway sequences [Sanger 1976]. This has been done for the DEC PDP11 RT11 operating system by staff in the former Engineering Research Division, now Nuclear Technology Division [R.W. Harris, AAEC unpublished report], and for one of the PDP11 monitor programs used by the Centrifuge Enrichment Project Division [J.M. Tobias, AAEC unpublished report].

Other more efficient Dataway computers provide their own non-ACL mode support and only use the restricted set of Dataway sequences to communicate with DATERCOM for ACL mode support. One example of this is the MICRONET system [Sanger 1980a] developed for the MICRONOVA computer to provide remote terminal access to the AAEC computer network.

The above systems give their terminals full access to network facilities, whereas another group of systems, including the PDP11 HASTE [G.D. Trimble and R.J. Cawley, AAEC unpublished report] and UNIX operating systems, limit their terminals to non-ACL mode access.

When there were a limited number of terminals attached to the PDP11 computers in areas already serviced by DATERCOM terminals, site users were not overly concerned by these differences in network access. However, with more computers making use of the PDP11 HASTE system, and more and more terminals being added to all of the Dataway computers, it seemed worthwhile to examine the possibility of extending DATERCOM to give non-ACL mode access to ACL mode facilities.

It was important to preserve the appearance of the ACL mode facilities to the user and, in particular, to provide the character by character syntax analysis that is a fundamental part of the ACL-NOVA system [Bennett and Sanger 1973; Sanger and Hayes 1974].

The resultant DATERCOM extension or Dollar One (\$1) access, as it is called, also provided the opportunity to explore the 'active' and 'passive' roles of Dataway computers [Richardson and Sanger 1978] as it required the NOVA computers to take an active role in the Dataway communication.

2. THE DATERCOM SYSTEM

2.1 Early Versions

The DATERCOM system [Sanger 1976] was developed from the early ACL-NOVA system [Sanger 1971; Bennett and Sanger 1973] to provide terminal users with access to ACL-NOVA and to the resources of the AAEC computer network. It was set up to support a variety of terminals; the initial version in the 32K NOVA820 computer supported eighteen terminals consisting of nine SMUT [Ellis 1977] terminals, three RTIs,* five direct connections and one manual answer modem line. Two direct connections were supported by DATERCOM running in the 12K NOVA computer.

At that time, eight Dataway addresses (X'50' to X'57') were allocated to the NOVA820 computer and four addresses (X'58' to X'5B') were allocated to the original NOVA computer.

2.2 Current Version

DATERCOM usage has grown rapidly with more than eighty terminals supported by the system, mainly via SMUT connections to two NOVA computers.

Thirty-two Dataway addresses (X'CO' to X'DF') are used by the 32K NOVA820 computer, and sixteen addresses (X'70' to X'7F') are used by a 32K NOVA1220 computer.

A 4K MICRONOVA computer running the MICRONET system [Sanger 1980a] services four automatic answering modem lines and provides remote terminal access to the AAEC computing facilities.

* RTI - Remote Teleprinter Interface [Sanger, Jones and Ellis 1973].

2.3 Terminology for Modes of Terminal Access

No response is received at a DATERCOM terminal until either the CNTRL/G character, the SPACE character or the \$ character is pressed. When one of these characters is pressed, a 156-word control block is allocated to the terminal and either the ACL-NOVA message is printed out or the ID: prompt is echoed.

Entering a valid user account number in response to the ID: prompt results in the \$ character being printed on a new line. At this point, a \$command can be completed, or the CNTRL/G character entered to bring up the ACL-NOVA message response. When the CNTRL/G character is entered at a terminal and results in the ACL-NOVA message response, the terminal is in ACL mode and allows ACL-NOVA to be used in the normal way. A terminal is in non-ACL mode when an appropriate \$ command is entered at a terminal.

2.4 ACL Mode

ACL-NOVA usage is still an important network function. A few extensions to the features, discussed in detail by Sanger [1977], are as follows:

- (i) Eighty character input and output.
- (ii) A new function, UND(arith stmt or exprn), which takes the value zero if the argument contains an undefined variable (it takes the value minus one, otherwise).
- (iii) The CLEAR statement (with operands) which can now be used as a stored statement.
- (iv) The performance associated with using the colon character (:) in the TYPE statement for overprinting has been significantly improved. Those users wishing to overprint physically must now force the addition of CR,CR by using a different form of the TYPE statement, e.g.

```
110 TYPE *<20>, 'PRINT'
```

```
120 TYPE <16>, 'OVER'
```

(v) Equals sign (=) can now be used as an alternative to assignment arrow and knowledge of this can be saved with a stored program.

(vi) The WORK AREA EXPANDED message has been removed.

(vii) New forms of the LIST statement have been added, namely,

LIST *,arith stmt or exprn

LIST arith stmt or exprn,*.

(viii) Work area limit of 9K words.

2.5 Non-ACL Mode

Central computer access remains the dominant form of non-ACL mode usage of DATERCOM terminals, but access to the UNIX operating system (\$2 and \$3) has grown with the expansion of the Applied Mathematics and Computing (AMC) and Site Information Services (SIS) PDP11 systems.

The 'passive device' function of the DATERCOM non-ACL mode support has been very successful and allowed any required interaction to be built into the remote computer software.

Extensive interactive software has been developed for the IBM3031 computer including the powerful \$ UNED text editor [R.J. Cawley, AAEC unpublished report], job output viewing facilities (\$V) [R.P. Backstrom, AAEC unpublished report], job status viewing facilities (\$Q) [C.B. Mason, AAEC unpublished report] and plotter output viewing support (\$PLOT) [R.P. Backstrom, AAEC unpublished report]. More recently, access to the IBM TSO system (\$TSO) [Backstrom and Sanger, AAEC unpublished report] has been provided using an IBM ACF/VTAM secondary application program [Sanger 1980b].

A number of Dataway commands have been added to the DATERCOM communication conventions reported by Sanger [1976] including, for example, the X'0A' and X'09' commands used to read and clear the single character look-ahead buffer. These and the other 'passive' DATERCOM Dataway commands are discussed in detail in Section 3 to set the framework for the description of the commands that were used to implement the 'active' \$1 ACL mode support.

3. DATERCOM COMMUNICATION CONVENTIONS

3.1 Session Start

Entering a user account number in response to the ID: prompt results in a special 24 byte primary write (attention) X'05' sequence, with the first two bytes X'5A00', being sent to the central computer to establish a terminal session. The Dataway return address used to send the attention request specifies the communication address to be used for the invoked network task activity.

After validating the account number, the central computer responds to the attention sequence by issuing the following commands:

- (i) a rewind command X'07' to acknowledge the primary write sequence;
- (ii) a write X'01' command containing the user's encrypted account number plus an authorisation word; and
- (iii) a rewind/unload X'0F' command to complete the session start task activity.

DATERCOM responds to the session start task termination command X'0F' by printing the \$ character on a new line.

3.2 Dollar Command

Entering a \$ command at the terminal results in an appropriate 24-byte primary write sequence, usually with the first two bytes as X'7000' being sent to the specified remote computer. The first digit following the \$ character is currently taken to be the 'dial' character with the following meanings:

- (i) zero or no digit specifies the PDP9L computer for central computer access;
- (ii) one specifies the other NOVA computer for the special ACL mode access (see Section 4);
- (iii) two specifies the AMC Division's PDP11/45 computer for UNIX service;

- (iv) three specifies the Site Information Services PDP11/34 computer for UNIX access; and
- (v) four to nine default currently to one of the NOVA computers.

The remote computer task activated by the attention sequence responds initially with a rewind X'07' command and results in the DATERCOM system setting a default attention capability for the terminal with the two attention bytes set as X'8000'.

3.3 Dataway Commands

The remote computer task can use four write commands, with codes X'01', X'05', X'09' and X'41' to send information to the DATERCOM terminals.

For the first two commands, X'01' and X'05', up to 132 characters of data can be sent and stored in a control block output buffer. Using the X'05' command results in the automatic addition of carriage return (CR), line feed (LF). DATERCOM gives channel end (CE), device end (DE) status after a data transfer if the output buffer is available. Immediate BUSY status is given if the buffer is not available followed later by an 'NOP control' X'03' sequence to present asynchronous DE status when the buffer is available.

The command X'09' is used to clear one character from the look-ahead input buffer and to restart terminal input. When combined with the X'0A' command discussed below, this command gives the remote computer the opportunity to process the input data without the data first going through the syntax analyser of the DATERCOM system supporting that terminal. This facility is used in the 'raw mode' of the UNIX operating system and is also a vital part of the \$1 access (Section 4).

The X'41' command is used to write up to 18 bytes of control block information to DATERCOM, to set the required attention capability (if the default bytes of X'8000' are not suitable), and to set appropriate terminal tabular (TAB) settings (in binary code in up to nine consecutive words).

Five read commands, with codes X'02', X'06', X'0A', X'42' and X'4A', can be used to read information from the terminals. In response to the commands X'02', X'06' and X'4A', up to 80 characters of information can be read by the remote computer. Immediate BUSY status is initially given to these read

requests as there is no input available from the control block input buffer. When the input is entered at the terminal (signified by receipt of a CR character that is not transmitted to the remote computer), an NOP control X'03' sequence is issued by DATERCOM to present asynchronous DE status to reactivate the original read request. The command X'02' is a 'read with echo', X'06' is a 'read without echo' and X'4A' is a 'read with asterisk echo'. In practice, the X'06' silent read command is used to read small amounts of synchronous input, such as screen coordinates, from graphics devices, whereas the X'4A' command is required to ensure that lengthier sensitive data are accepted from SMUT terminals under fast poll conditions [Ellis 1977].

Two words are read by the X'0A' command; the low byte of the first word contains one character from the look-ahead input buffer (interrupting question mark appears as X'8000'), and the second contains the DATERCOM terminal device code. Input data read via the X'0A' command do not pass through the syntax analyser of the DATERCOM system supporting that terminal and, as stated above, this gives the remote computer task the opportunity of carrying out its own syntax analysis of the terminal input. In this case, the X'09' command must be used in conjunction with the X'0A' command to keep data flowing through the look-ahead buffer, whereas separate write X'01' sequences to the DATERCOM system supporting the terminal are required to echo the terminal input.

The command X'42' is used to read eighteen bytes of information from a terminal control block to determine the current TAB settings.

A system broadcast message may be sent to the DATERCOM system via the command X'71' (with 80 bytes of data being accepted), while system details relating to DATERCOM control block usage and SMUT performance statistics can be read by using the X'46' command (with 568 bytes of data being transferred).

3.4 Interruption Capability

Tasks with attention capability (the default) send a 24-byte attention sequence X'05' to the remote computer if an input character is entered when input is not expected and if BUSY status is not stored for that current task. The data sent include the attention bytes (default being X'8000') followed by the input character in the low byte of the next word (or X'8000' for the question mark character). If BUSY status is stored, then UE status is presented to the next write X'01' or X'05' sequence sent by the remote

computer. It is up to the remote computer task to act upon these interruption conditions, but this type of interruption capability is essential to the correct handling of tasks that could become processor (CPU) bound in the remote computer, or I/O bound in sending output to DATERCOM terminals.

For tasks without attention capability, entering the question mark character when input is not expected causes UE status to be sent to the next write X'01' or X'05' command. This is sufficient to allow remote computer tasks to handle the terminal I/O bound condition, but does not allow for the handling of CPU bound tasks. For this reason, tasks are given a default attention capability in response to the initial rewind X'07' command and would have to clear the attention bytes deliberately via the command X'41' if this was not required.

3.5 Task Termination

The rewind/unload X'0F' command is normally used to terminate task activity and results in the freeing of the Dataway address used for the task communication and the printing of the END-TASK message at the DATERCOM terminal, followed by the \$ prompt on a new line.

Abnormal task termination occurs if the CNTRL/P(DLE) character is entered at a terminal; it causes a 24-byte attention sequence and the first two bytes as X'8FFF' to be sent to the remote computer. The Dataway address used for the task communication is immediately freed, and the END-TASK and \$ prompt are printed at the terminal. It is up to the remote computer task to complete its own abnormal termination processing upon receipt of this special termination attention sequence.

3.6 Session Termination

Entering immediate CR in response to the \$ prompt indicates that the current terminal session is to be terminated. A special 24-byte attention sequence with the first two bytes X'4A00' is sent to the central computer, the END-SESSION message is printed at the terminal and the terminal control block is returned to the DATERCOM system.

4. NEW ACCESS TO ACL MODE FACILITIES

Close examination of the existing DATERCOM Dataway support indicated that the system could be extended to provide a new means of accessing ACL mode facilities.

Initial tests allowed terminals on the NOVA820 computer to access ACL-NOVA in a modified version of DATERCOM running in the NOVA1220 computer. A final test permitted terminals on the NOVA820 computer to access ACL-NOVA in the NOVA1220 computer while NOVA1220 terminals accessed ACL-NOVA in the NOVA820 computer. Details of the new \$1 access to ACL-NOVA facilities are discussed in the following sections.

4.1 Establishing ACL Mode Access

A \$1 request at a DATERCOM terminal on one NOVA computer (that will take a passive role in the Dataway communication), designated NP, results in a 24-byte attention sequence, with the first two bytes X'7000' being sent to the other NOVA computer (that will take the active role in the Dataway communication), designated NA.

NA generates a special device code word from the NA base address (X'CO' or X'70') and the specified NP return address (X'71' to X'7F' or X'C1' to X'DF') and checks if there is a corresponding control block (a special device code word control block). If not, then NA:

- issues a rewind X'07' command to NP to acknowledge the attention sequence and to establish the default attention capability in NP (with bytes X'8000');
- allocates an ACL control block and associated work area;
- sends the ACL-NOVA message to NP using a multi-character (block) write X'01' sequence;
- sends the NA system message (if any) to NP using a block write X'01' sequence; and
- issues a write X'09' sequence to NP (after flushing a null character through the control block look-ahead buffer and the NA syntax

analyser) to restart input at the NP DATERCOM terminal.

If there is a control block corresponding to this special device code (due to some abnormal termination condition), the ACL control block and work area in NA will be re-initialised as though CNTRL/G had been entered during an existing ACL session.

4.2 Terminal Input Processing

Characters entered at the NP DATERCOM terminal are stored in the NP look-ahead buffer and, as a result of the default attention capability, are normally sent to the NA computer in 24-byte attention sequences with the first four bytes as X'800000XX', where XX is the ASCII character that generated the attention sequence. The only exception to this is the question mark character, which causes the first four bytes X'80008000' to be sent.

The input character is stored in the NA control block look-ahead buffer and subsequently processed through the NA syntax analyser. The character is echoed at the NP DATERCOM terminal, by NA issuing a single character write X'01' sequence to NP after syntax checking, followed by a write X'09' sequence to flush the character out of the NP control block look-ahead buffer and restart NP DATERCOM terminal input.

If a character is entered at the NP DATERCOM terminal while output is in progress, the next write X'01' sequence from NA would be given unit exception (UE) status. NA responds by issuing a read X'0A' command to read the character from the NP look-ahead buffer and stores it in the NA look-ahead buffer for later processing (unless it is the question mark character data) and re-issues the write X'01' sequence to NP. The question mark character input must be handled immediately in case it is used to interrupt ACL statement processing.

Some input characters cause more than one character to be echoed at the DATERCOM terminal; for the special device code word control blocks, this is achieved by NA sending the first character to be echoed as a single character write X'01' sequence, and then sending all of the remaining characters as a block write X'01' sequence.

4.3 Terminal Output Processing

Output from ACL statement processing is sent to NP via block write X'01' sequences. This gives the user full access to the printing facilities of the ACL language including both forms of the TYPE statement used for overprinting.

If NP is already processing output when the next write X'01' sequence is received, then it responds with BUSY status. NA notes the BUSY condition and stacks the write X'01' sequences until the condition is cleared by NP sending an NOP control X'03' sequence to NA. Receipt of the X'03' sequence causes NA to reissue the write X'01' sequence to NP to continue terminal output.

The question mark character can be used in the normal way to interrupt terminal output and results in the suspension of ACL statement processing.

4.4 Terminating ACL Mode Access

The ACL END statement can be used in the normal way to terminate ACL mode access from the NP DATERCOM terminal. NA processes the END statement and after echoing CR, LF at the NP terminal via write X'01' sequences, issues a rewind/unload X'0F' command to NP to terminate the non-ACL mode access to NA, and then frees the NA ACL control block and work areas. NP responds to the rewind/unload command by freeing the Dataway address used in the \$1 task communication and printing the \$ prompt at the NP DATERCOM terminal ready for the next user non-ACL mode request.

Abnormal termination of the ACL mode access occurs if the CNTRL/P (DLE) character is entered at the NP DATERCOM terminal. This results in a 24-byte attention sequence with the first two bytes X'8FFF' being sent to NA. NP then immediately frees the Dataway address used to communicate with NA, and the END-TASK message is printed at the NP terminal followed by the \$ prompt on a new line. NA processes the terminating attention sequence as though the special device code control block had just timed out due to terminal inactivity and frees the NA ACL control block and work areas.

4.5 Performance

The initial tests of the modified DATERCOM system soon dispelled early doubts about the possible inefficiencies of using the single character X'09', X'0A' commands or the 24-byte attention sequences to handle terminal input.

The small volume of input relative to terminal output sequences and the slow rate at which user data are entered at a terminal far outweigh the effects of these short Dataway sequences. Similar comments apply to the use of single character write X'01' sequences, sometimes coupled with a block write X'01' command, to echo terminal input.

It is more important to use blocked Dataway transfers when sending output to the terminals; consequently block write X'01' sequences are used to send full lines of output to the NP DATERCOM terminal.

The combination of Dataway commands used in the \$1 implementation thus makes quite efficient use of the Dataway and, at the same time, provides the character by character syntax checking that is a fundamental part of the ACL mode access.

4.6 Problems Encountered

Handling BUSY conditions caused some problems in the initial tests of the system. A stall condition occurred when a write X'09' sequence following a stacked echo write X'01' sequence caused the BUSY status to be overwritten in NP so that NA never received a later NOP control X'03' sequence to resume terminal output. This was the result of DATERCOM allowing a new sequence (X'09') to be issued after BUSY had been received - something that is not allowed by the operating system environments of the central computer or UNIX. The problem was overcome by DATERCOM processing the X'09' sequence through a dummy control block (also used to process other special sequences) so that the BUSY status condition would not be lost.

A more subtle stall condition occurred when the AREA FULL message was printed after an ACL load or save request. This resulted from a conflict caused by using one status word for two separate Dataway task activities - namely, the ACL load or save request to the central computer coupled with the support for the NP DATERCOM terminal. Sending the AREA FULL message to the NP terminal caused the ACL load or save BUSY condition to be overwritten in NA. Since few messages are printed at DATERCOM terminals during ACL load or save statement processing, the problem was solved by resetting the status word to the BUSY state after any write X'01' sequence issued to NP during ACL load or save processing.

This simple fix causes a few extraneous asynchronous device end status presentations to the central computer ACL load or save request task; but, to date, this has had no adverse effect on the performance of the central computer operating system.

5. CONCLUSIONS

Extending the DATERCOM system to provide non-ACL mode access to ACL mode support has significantly expanded the facilities available to the AAEC computer network. The new support is already being used by terminals on the PDP11 HASTE system, and tests of UNIX access to the facilities are under way.

Implementation of the \$1 access makes use of the character processing commands of DATERCOM to allow the called computer to carry out its own syntax analysis of terminal input data. This has preserved the interactive appearance of ACL to the terminal user and, in particular, the character by character syntax checking of terminal input. Combining the character Dataway commands with block output write sequences has resulted in an efficient balanced use of Dataway resources and good terminal response.

The new DATERCOM is the second example (after UNIX) of a system taking both an 'active' and a 'passive' role in Dataway communication. Its new facilities open up the possibility of having smaller microprocessor-based terminal support systems on the Dataway with minimal software to support the non-ACL mode protocols to gain full access to AAEC computer network facilities.

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