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The Environmental Protection Authority telemetry system

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Environmental Protection Authority
Perth, Western Australia
Technical Series 44
October 1991

The Environmental Protection Authority telemetry system

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ISSN 1030-0600
ISBN 0 7309 4784 X

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1. Introduction

The Environmental Protection Authority currently operates five monitoring sites from which measurements are returned twice-daily using telephone linkages. In preparation for possible use by participants in the monitoring programme required as part of the Kwinana Environmental Protection Policy, and due to a need to overcome several shortcomings of the previous system, the controlling software has now been upgraded.

This report covers the structure and operation of the new telemetry system, and is intended to form a user manual for any person who requires to use it. It discusses the reasons why certain choices have been taken, but does not cover in detail the minutiae of program operations, since these are fairly well documented by in-line comments, in the program source code.

2. Hardware

Data Logger: The central element of the Environmental Protection Authority's data recovery process is the Unidata logger. In broad outline, this is a microprocessor-based instrument which may be programmed to log data in the configuration required by the user, and stores measurements in up to 64 kilobytes of memory. Data may be read from the logger, and new logging instructions input through the serial interface provided.

While it is possible to connect the logger directly to a modem, so that interactions with a logger may be performed by a remote computer, the system used by the Environmental Protection Authority assigns the direct interfacing to a local IBM-compatible personal computer (subsequently termed "PC"). The result is an additional step in the data transfer process, but it means that any authorised user may contact the telemetry site using a modem, and obtain read-outs of logged data in normal measurement units.

Data logging by the Unidata instrument involves tasks handled by software both fixed in ROM and loaded into programmable memory. The ROM program manages the serial interface, system clock and other services, while the user program is called by the ROM program once each data-collection cycle, to process inputs from the connected sensors. After a selected number of logger cycles, data are written to logger memory, typically as averages of logged variables over the time since the last write to memory, but possibly also as a total (eg., for rainfall over the interval concerned).

The data collection cycle time is subsequently referred to in this report as the "cycle time". It is usually 0.25 seconds for Environmental Protection Authority loggers. The interval between the saving of data to logger memory is referred to as the "logging interval", and is normally 10 minutes in the Environmental Protection Authority's applications.

Depending on the logging interval, the number of parameters measured and the accuracy to which they are recorded, a logger's memory will fill in a period from several days to a month or more. The logger program can be configured so that, once memory is full, logging is suspended, or new data overwrite the data stored at the start of its memory. The latter is referred to a "circular memory" configuration. A location in logger memory stores bits which flag whether the logger's memory is circular or non-circular, and if the latter is the case, whether the memory has filled or not.

PC: the controlling system is a basic XT system with 640 kilobytes of memory, using two floppy diskette drives. A hard disk is not used, both for its slight cost benefit and for the higher reliability of diskettes in thermally-unstable conditions. For tasks requiring fast access, part of memory is configured as a RAM drive, but data stored here are routinely backed up to floppy disk.

A better option than the RAM drive would be a disk-caching program, ensuring the same fast access rate but preserving data in cases of system "crashes". Currently, however, we do not have multiple licenses for a suitable disk cache.

The computer possesses two serial ports, one ("COM1") being the means of access to the logger, the other ("COM2") being connected to a Hayes-compatible modem and providing access to the system by outside users.

3. Software

3.1 Original software and limitations

The initial software configuration included a "telemetry base station" program, TELBASE, which managed interfacing to the logger, and user interactions through a serial port connected to a modem. Other programs could be run by this master program, to transfer files to and from the telemetry site, contact other sites or update site calibration data. At the central computer site (or, alternately, on another PC) was another program, termed TELSIS, which provided the correct communication protocol to allow access to the remote TELBASE program.

In use, this system has shown many limitations, in particular:

- All communications between TELSIS and TELBASE are via line-by-line block transfers, using an error-checking protocol. For normal terminal-mode interactions, this is unnecessarily time consuming, since in full-duplex operation any transmission errors are seen as incorrectly-echoed characters.
- The simultaneous monitoring of input from the remote site and the user's own computer is done by alternate polling of the two sources. While acceptable on a single-user system (such as a PC), this approach is grossly wasteful on the MicroVAX, and results in degradation of the system's response to other users' tasks.
- The error-checking protocol requires four data transfers to send one packet of data, essentially an "are you ready" query, a "ready" response, the transmission of the data packet, and a confirmation of successful receipt. Since only one line of a file can be sent at a time, the result is a very slow transfer rate.
- The software as configured is strongly hardware-dependent, requiring availability of a PC or MicroVAX to any user, plus dedicated software of which only a small part can actually be used except by the Environmental Protection Authority. Even the MicroVAX version requires two forms, one for interactive use, the other for retrieval of data in a batch process.
- The quantity and quality of documentation of the system (both in the source code and as reports) was totally inadequate, and the source code was not constructed to a professional standard.

3.2 Objectives for a revised version

The result has been a major rewrite of all source code, with the objective of overcoming the above limitations, through:

- use of terminal-mode interactions for all except system-to-system file transfers. (With the presumption of ANSI terminal protocol, this has the side benefit of allowing normal users to access the telemetry system using many terminal emulation programs, such as Kermit on almost any computer, Crosstalk or SmartTerm on a PC, and Mac240 on a Macintosh);
- implementation of an interrupt-driven terminal routine on the MicroVAX, to eliminate waste of computer time in the polling of input lines;
- inclusion of a batch mode of operation for the TELSIS program, in which data retrievals only are performed; and
- introduction of a simpler and faster, two-transfer, protocol for file exchange.

- improving portability, through isolation of system-specific code into relatively small modules.
- expanding comments throughout the source code, implementation of a standard programming style over all modules, and preparation of this report.

In addition, a considerable reduction of the size of the telemetry system has been achieved, partly through improved coding and merging of all site programs into the TELBASE program, but also through use of the MS-DOS "packed file" format for the TELBASE executable file.

4. Program TELBASE

4.1 Outline of design principles

This program has the task of controlling both the logger, and interactions with users in contact through the modem line.

Logger Control: Logger access must be tightly managed, because when the logger serial interface is active, an additional current drain is imposed on the logger batteries. Fortunately, the line-driver routines provided in the function library used (the "NO-LIMIT" library) set controls on the RS-232 connection to activate the serial interface when the logger line is opened, and also reset them when it is closed (so de-activating the interface).

There is an additional reason for keeping the logger line closed, as the default state. The NO-LIMIT line drivers use an interrupt-driven interface, which means that whenever a character is received or sent, the normal operation of the computer is interrupted. The interrupt process ensures all received characters are stored in a 512-character input buffer, and that when output of any character is completed, any other character waiting for transmission from the 512-character output buffer follows immediately.

The only practical disadvantage of this highly desirable feature is that, should the program's operation be terminated while the logger or modem line is open for transmission (eg. by entry of a control-break at the keyboard), the interrupt process remains in effect. Further data received still results in transfer to the start address of the nominated interrupt handling routine. Should a subsequent user program overwrite this location, input data will result in a transfer to a spurious location, normally resulting in the "locking up" of the PC.

This means that, for safety, should the logger line remain active after a control-break abort of TELBASE, a full reset of the PC is necessary, including cancellation of serial line interrupts. A program COLDBOOT.COM containing commands to reset the serial lines, and a jump to cold-boot address F000:FFF0, has been created, and the recommended mode of use of TELBASE includes running it from the system startup batch file AUTOEXEC.BAT, including the two lines:

```
TELBASE
COLDBOOT
```

so that a reliable re-start can be ensured in most cases of failure of the program.

Another program, PORTSOFF, is available to reset the serial lines only, without re-booting the system.

Modem Control: Unlike the logger line, which is always under the direct control of the PC program, modem interactions arise due to external demands. For this reason, the modem line must remain open at all times.

It has been found that the NO-LIMIT output function returns an inaccurate count of transmitted characters, when there is no room in the output buffer for all characters to be sent. In such circumstances, the program should wait until there is room before sending the remainder of the transmission string, and then send the remainder. As a result, this shortcoming has critical effect when large quantities of text are sent over a relatively slow line (eg. when sending menus to a remote user).

In order to overcome this problem, the PC function library includes a subsidiary output routine, OUTSTR, which sends a string and calculates when the next may be sent. On later calls, the routine waits until this time is attained before sending the next character string. The transmission rates assumed are 95 characters per second on the modem, and 9000 characters per second to the logger.

The routine does not differentiate between modem and logger line transfers, but there have been indications of conflicts arising when simultaneous transmission has been attempted. As a consequence, this feature has deliberately been left untouched.

User Access: Access to the program may be from either the keyboard or modem line. On a MicroVAX (where the initial modification work was performed) the modem line and the user's terminal line are functionally equivalent, but on the PC the driver protocols are entirely different, between the modem line and user console. This is reflected in the relatively large size of the PC versions of the relevant routines, INPTMO and OUTLIN, both of which reside in the system-specific module IBMSUB.FOR.

A user who accesses the system from the keyboard (a "local" user) is assigned privileged standing, permitting full access to all parts of the program, including such features as reprogramming of the logger and user account maintenance. This permission is based on the premise that once any user has gained physical access to the system, these items are directly accessible by other means, so that software protection is pointless.

Users gaining access via the modem line ("remote" users) must provide a user name and password. Associated with these in the user file USERS.DAT is a privilege code and a set of permitted access times. The privilege code currently indicates only whether or not the user has privileged standing, allowing access as for a local user. If not, the user may only check the logger status and read logged data in normal measurement units or volts.

Potentially, the privilege code could provide several levels of privilege, so that some users might be permitted to download data but not reprogram the logger or alter user information. This would require alteration of the logical ("T"/"F") entry in the file USERS.DAT to a numeric code (0 for no privileges up to some maximum for all, or representing a set of privilege bits).

The permitted access times are set to prevent use of the system during normal telemetry session periods, presently over time ranges 05:00 to 05:30, and 15:00 to 15:30. The exception is user TELSIS, who is only permitted to log in over these time ranges (plus an extra half-hour in case of problems). User name TELSIS is intended to be used by the remote telemetry system only.

User names, passwords, privileged status and access times may all be edited from within TELBASE, by any user with privileged standing. The user file includes a user "default", from which the default characteristics of any new user are copied. Since this user name is in lower case, and the input name is converted to upper case at log-in, no one may log under that name.

All program input, from logger, modem line or user console/terminal, is required to be through INPTMO. Without this precaution, events such as telephone line drop-outs and improper completion of work from the console could affect the program's services to future users, by locking it in an input-wait state. All routines which seek input unsuccessfully must return a failure status to the calling program, and all routines which receive the failure status must return the same status their caller. In this manner, if input times out, the program automatically returns to its default wait state, in which modem and console input is alternately polled (at one-second intervals).

Portability Issues: As far as possible, system-specific code has been isolated in specific files. On the PC, these are titled IBMSUB.FOR, IBMSESS.FOR and IBMDEFS.FOR. On the MicroVAX, the letters "IBM" in IBMSUB.FOR, IBMSESS.FOR and IBMDEFS.FOR are replaced by "VMS".

The IBMSUB and VMSSUB files contain most of those routines whose function is system-specific, such as line drivers and system date/time routines. Within these files, however, some routines are omitted due to their being supplied by the compiler library - eg. IDATE on the MicroVAX, and SYSTEM on the PC.

The interactive-session routine SESSION is different on the two systems because the PC version uses continuous polling, while the MicroVAX one responds to VMS event flags - ie. interrupts - in order to avoid waste of computer time. It is conceivable that, on some other stand-alone system, the routine in IBMSESS.FOR would suffice. This is why the routine resides separately from the other PC-specific code.

The files IBMDEFS.FOR and VMSDEFS.FOR contain system-specific names, such as that of the library directory ('USER:[PI.EXE]' on the MicroVAX, 'C:\UTIL' on the PC). This is an include file, which is used by subroutine COMMAN, located in file TELLIB.FOR.

There currently still reside a few other regions within the program where portability issues may arise, such as references to diskette drives A: and B: and the RAM drive, C:. On the MicroVAX these can be defined logical names so they have been left as they are for now. Such locations are identified in the program source files by a comment line including a double-percent ("%") pair.

4.2 Program operation

The original TELBASE program, when loaded, performed no detailed checks of its environment. There is potential for error in such an approach - eg. a disk drive latch left open, or a faulty logger not checked before it is left. The new version, on a PC, checks both floppy disk drives by issuing commands "DIR A: >NUL" and "DIR B: >NUL", which produce error messages on the console if the drives are not loaded and latched shut. It also tests the logger cycle time and configuration to ensure that no conflicts will subsequently arise when data are accessed, and the site number held in the logger.

If the logger does not respond properly, the user is provided the opportunity to reprogram it. If the user knows that the logger program resides on drive A:, this may be done immediately, otherwise the user should respond negatively (using a "N" response), and attempt to locate a disk containing the program by using the "DOS operations" menu item (see below).

After the checks, an informative message is displayed, much as is done by the first version, and the program enters a mode in which modem and console are polled at one-second intervals.

Once loaded, the program provides two modes of operation, via the PC console and keyboard, or using serial port COM2. The latter is connected to a modem, allowing access over a telephone line by a remote user.

A remote user, if non-privileged (see below) may use any communications program or terminal which supports ANSI screen commands (eg. a VTxxx terminal emulator - where "xxx" is 100 or greater). A companion program, TELSYS, will be required to use the file-transfer options provided to a privileged user.

4.3 Menu options

When a user indicates a requirement to access the program, by pressing any key on the PC keyboard, or on a terminal connected to a modem in communication with that of the PC, the response of the program will depend on whether it is in use through the alternate I/O channel. If it is already in use, a message to that effect will be displayed, and (as soon as possible) a corresponding warning will be transmitted to the current user.

When the system is available, a remote user will be prompted for user name and password. (These must be assigned by the system manager). Five tries at each of the user name and password will be permitted, after which the system will hang up the telephone.

On successful log-on, the user is presented a menu of options. While the original TELBASE program provided a main menu plus a privileged menu, some privileged operations were provided on the main menu (but internally password protected). The menu system has now been altered to provide a general and a system-management menu, with only part of the former available to non-privileged users.

The format of the menu is shown below. Note that it is now left-justified: the existence of leading blanks in a centred menu would roughly double its transmission time.

```
[0] EXIT
[1] Inspect recorded data
[2] Check logger status
[3] Look at logger memory locations      (This line and those below
[4] Look at incoming voltages          are not shown to a non-privileged
[5] Dump hex file of logger data       user)
[6] System management options
[7] Connect to another site            (Only seen by a local user)
```

A non-privileged user sees (and can use) only options 0 to 2. A local privileged user sees all of options 0 to 7, while a remote privileged user sees 0 to 6. (Option 7 is meaningless for a remote user, since modem is already in use)

[0] EXIT

This option results in the updating of the file "USERS.LOG", showing log-off time, and reversion of the program to one-second polling of modem and console/terminal input. If the user is remote, the program will also initiate a hang-up sequence, presuming the attached modem to be Hayes-compatible. (See subroutine DISCON, in file TELBASE.FOR, for details of actions taken.)

[1] Inspect recorded data

This facility provides direct access to data recorded by the logger, up to the last logging interval available. Up to 11 parameters may be displayed at a time, and the displayed period is restricted only by the extent of data held in logger memory.

If more than 11 parameters are being logged (as is currently the case at Caversham and Kwinana), the user is provided a choice of parameters to display, with the following prompt:

```
UNIDATA DATA LOGGING INSPECTION
The PC screen restricts the display to 11 parameters.
There are more than 11 parameters being recorded at this site.
The parameters being recorded are:
(list of parameters and index numbers shown here)
Select parameters to display <1-11> :
```

The default range (1 to 11) shown above is the normal one, but is contained in the site calibration file, so may vary. Parameter index numbers may be entered as a list (eg. "1,2,4,5"), a range using a hyphen or a colon, or as a combination (eg. "1,2,3,6-8,11:14").

The user must then provide the time range of data to be displayed. This must be supplied as a four-digit start time and date, followed by an end time and date in the same format. The default is the immediate past three hours, which (with header lines and continuation/termination prompt, as below) closely fits a screen-full for a 10-minute logging interval:

```
Enter the start and end time and date (HHMM,DDMMYY,HHMM,DDMMYY), or press
RETURN for the last 3 hours <1340,120891,1630,120891>:
The data will then be read from the logger, and displayed:
Reading data logger...
```

after which the screen clears, showing a display of form:

```
STATION: Caversham A.Q.M.S.
DATE,TIME SPEED 10   SIGMA 10   DELTA T   AIRTMP18   NET RAD   NO2
          DIRECT10   AIRTMP10   RH 10     SOLAR     RAIN
120891,1340  2.40 184.5 12.7  4.60  0.02  63.2 -99.0 -999. -999. -99.0 -99.0
```

. (and further lines as requested, in similar format)

Finished processing selected period.

(N)ew period, (R)epet last period or (S)top <S>:

If the user does not elect to display data for a new period ("N") or to re-display the same period, the default ("S") returns the user to the program's main menu.

[2] Check logger status

The functionality of the logger, and several operating parameters, are checked using this option. In particular, it shows the availability of data, useful in cases when logging has been suspended due to full memory or failure of the logging interface. The format seen is typified by:

LOGGER STATE SUMMARY

```
The logger cycle time is measured as 0.25 seconds
The logging interval is 10 minutes
Number of records per day is 144
Site identification number is 7
The first time of available data is 11:13 on 12/08/91
The last time of available data is 16:23 on 12/08/91
Logging is currently in progress
Logger memory size is 65536 bytes (64K)
The logger's memory is non-circular
The logging memory pointer is presently at location 1952
The number of bytes per log is 29
```

Press any key to proceed ...

Of the items above, cycle time and logging interval were discussed earlier. The number of records per day is simply the number of minutes per day (1440) divided by the logging interval. Site identification is stored within the logger as a single byte, and normally ranges from 1 to 5 for the telemetry sites.

If logging is suspended, a message to that effect replaces the "in progress" line. Should logging be reported as suspended, whether or not full memory is responsible will be revealed by the location of the logging memory pointer. If it is within the number of bytes per log (29, above) of the full memory (65536, above), and logger memory is reported to be non-circular, then no more logging will be possible.

[3] Look at logger memory locations

This provides a brief "dump" of logger memory. The required location may be entered in decimal or hexadecimal, using any number of digits and upper or lower case (eg. location 192 may be entered as 192, C0h, c0H or 000C0H). Memory contents are written in both decimal and hexadecimal format, as shown in the example below:

```
UNIDATA LOCATION INSPECTION ROUTINE
Enter location (trailing H/h for hex): 192
LOCATION      1  1  1  1  1  1  1  1  2  2  2  2  2  2  2  2
            92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07
(DEC)       0  0  0  0 196 126 116  0 56 165 85  6 70 28  7  0
(HEX)       00 00 00 00 C4 7E 74 00 38 A5 55 06 46 1C 07 00
Another location? (Y/N) <N>:
```

[4] Look at incoming voltages

The voltage values used by the logger, as well as counter registers, are displayed repeatedly using this command. The specific connection between voltage values and data being logged is determined by the logger's internal program, and not covered here.

Sample output is provided below. The term "HI RES" refers to high-resolution inputs, while "PDL" indicates the logger's normal resolution.

UNIDATA VOLTAGE INSPECTION ROUTINE

HI RES VOLTAGES

0	1	2	3	4	5	6	7
0.000	0.000	0.000	0.000	2.500	0.000	0.000	0.000

PDL VOLTAGES

0	1	2	3	4	5	6	7
1.27	0.03	0.10	1.80	1.69	1.64	1.54	0.01

PDL COUNTERS

0	1
0	0

Press SPACE or ENTER to hold, any other to abort ...

[5] Dump hex file of logger data

This permits a privileged user to output, in hexadecimal form, data recorded by the logger over any specified period. For a local user the file is written to disk, while for a remote user the data are sent to the user's TELSIS program, which writes the input to a file.

The file name is now automatically defined by the program, and has format SSddmmyy.hhR, where:

SS is the 2-character station name (eg. "WT");

dd is the 2-digit day of the month;

mm is the 2-digit month number (1 for January, etc.);

yy is the 2-digit year (eg. 91);

hh is the hour of the day for the last time transferred (eg. if data up to 3:20 p.m. are sent, hh is 15); and

R denotes "raw", since the data are not converted to calibrated values before transfer.

In the previous approach the user was required to supply the file name and the date used (which normally corresponded to the day before that of the data transfer). The change has been implemented because there are now two transfers per day, so date alone is not a satisfactory indicator, and because the previous day is not representative when data transferred corresponds to a period within one day. It is also relevant that the time and date are readily to hand within the program, so that it is wasteful of the user's time for a string corresponding to the date and time to be requested.

[6] System management options

This menu item is only available to a privileged user. It covers those options by which elements of the site's configuration may be altered.

The menu presented is as below. The characters "6." in the menu are only used for referencing purposes, the option number which must be entered being the following digit only.

```
[6.0] EXIT
[6.1] Load a logger program
[6.2] Check/reset PC time
[6.3] Check/reset logger time sync.
[6.4] Update calibration file
[6.5] DOS operations
[6.6] Edit a file
[6.7] User access management
[6.8] Send a file from PC to user      (These last two are only seen
[6.9] Receive a file at PC from user  by a local user)
```

Details of each option are as follows:

[6.0] EXIT

This option returns the user to the program's main menu.

[6.1] Load a logger program

This option should normally only be used when the logger has been malfunctioning. Reprogramming deletes all logged data.

On selection of this option, the PC's system time is first checked, to ensure that the logger clock is initialised correctly. Then the user is shown the message:

```
UNIDATA DATA LOGGER PROGRAM LOADING
This routine loads a Unidata data logger with a program
that has been created by the FORTRAN program LOGPRO
NOTE: THIS WILL RESET THE LOGGER AND ALL EXISTING INFORMATION WILL BE LOST
Press RETURN when ready (or "S" to abort):
```

When the user confirms readiness, a menu of possible sites is shown. Not all will actually be available, though, since a file of the required name must reside on the PC's diskette drive A:.

When a site is selected, the program will determine its short identifier code (eg. "WT" for Wattleup), then attempt to open a file with name comprising these characters followed by "PROG.DAT". If successful, information will be read from the file, and presented to the user for confirmation, in typical format:

```
Logger cycle time: 0.25 seconds
Logger averaging time: 10 minutes
Continue with reprogramming? (Y/N <Y>):
```

Given a "Y" response, the program will proceed with the loading process. Once this is completed, the user will be prompted for the memory configuration, as follows:

```
Enter the logger memory size in Kbytes <64>:
Do you want circular memory in this logger (Y/N <N>):
```

Normal answers are the defaults.

At the Hope Valley site, the large quantity of data means that two loggers have to be used. The two loggers must be synchronised, which means that both must be reprogrammed. The program for the second logger is held in a file of the same name as that for the first, but with an extension "DAB".

In the Environmental Protection Authority's normal usage, the second logger is connected through an electronic switch to the same port as the first. The switch is controlled by the "RTS" line in the RS-232 connection. The arrangement, design by Vlado Raich of the Environmental Protection Authority, is termed by the program the "Raich box". Therefore, the user sees the message:

```
The second logger needs to be programmed now.
Is this connected through the RAICH box? (Y/N <Y>):
If the answer is "Y" (or simply a press of the "return" key), the program will use the RTS
control line to address the second logger. Otherwise, the user will be asked to connect the
second logger manually before proceeding, in form:
```

```
Connect second logger and press RETURN ...
```

The reprogramming of the second logger will then, in either case, proceed as for the first logger.

[6.2] Check/reset PC time

The system clock on the site PC may change slowly due to inaccuracies, and it is crucial that it is kept accurate within a minute or so, to ensure that data inconsistencies are minimised. If the user alters the time or date in response to the prompt, both the clock maintained by MS-DOS and the CMOS clock are updated. (The latter, using program TIMER.COM on drive A:).

[6.3] Check/reset logger time sync.

The logger does not maintain its own clock, but logs data at specific intervals (normally 10 minutes). The logging times should be such that each whole hour of actual time corresponds to the end of one logging interval. This correspondence can be maintained as long as the logger time is not permitted to drift far from "synchronisation".

The program reads, from the logger, the time from the end of the last log interval, and compares it to that from what should have been the last log interval (eg. for a 10-minute interval, and time 11:37, the time from the last interval should be 7 minutes). If the difference is greater than 15 seconds, it is then shown to the user, and may be set to zero if desired.

```
UNIDATA DATA LOGGER SYNC CHECKING PROGRAM
The logger is 259 seconds fast
Do you want to reset it? (Y/N <Y>): y
Resetting logger time...
```

[6.4] Update calibration file

This item on the menu allows a local or remote user to alter the relationship between the recorded bytes of data in logger memory and the values to which they correspond. It is normally used when instruments are routinely calibrated.

The relationship is presumed linear, so that each calibration is characterised by a y-axis intercept and slope of a linear equation. Since a user may interrogate a logger for a time preceding the most recent calibration, it is necessary for multiple calibration values to be held at the monitoring site. (The correct intercept and slope in these cases is determined by linear interpolation between adjacent calibrations, so the time and date of each calibration must also be entered)

The screen display shows all parameters available for modification, after which the user may elect to add new calibration information, delete old information, or simply view the existing calibrations:

```
MODCAL - MODIFIES A CALIBRATION FILE
Parameters being measured at this station are:
```

- (1) SPEED 10
- (2) DIRECT10
- (3) SIGMA 10
- (4) AIRTMP10
- (5) DELTA T
- (6) RH 10
- (7) AIRTMP18
- (8) SOLAR
- (9) NET RAD
- (10) RAIN
- (11) NO2
- (12) NO
- (13) O3
- (14) VISIBILI

```
Select parameter number or (Q)uit: 1
(A)dd, (D)elete, (V)iew data for SPEED 10 or (Q)uit <V>: v
```

In this case, the user has elected to view calibration information for "SPEED 10". The program shows only one calibration in this case:

```
DATE TIME STATUS SLOPE OFFSET
311290 2400 GOOD 9.3980 0.2230
(A)dd, (D)elete, (V)iew data for SPEED 10 or (Q)uit <V>: a
```

The user now has decided to enter a new calibration set; firstly, the current state is again shown, and after confirmation of a the user's intent, the date, time, slope and intercept of the new calibration are entered. (The default date and time are the current values.)

```
Current calibration information for SPEED 10:
DATE TIME STATUS SLOPE OFFSET
311290 2400 GOOD 9.3980 0.2230
Enter more calibration information for SPEED 10? (Y/N/Q) <N>: y
Enter "Q" to quit at any time...
Date of calibration? (DDMMYY) <120891>:
Time of calibration? (HHMM) <1632> :
Was prior data for this parameter GOOD ? (Y/N) <Y>:
Slope? : 9.2
Intercept? : 0.1
```

The "STATUS" shown above, and subject to enquiry, determines whether the previous calibration is discarded or retained. After entry, the new values are shown to the user, and after confirmation of their correctness, the total set of calibrations for this parameters are re-displayed:

```
Calibration point added is:
DATE TIME STATUS SLOPE OFFSET
120891 1632 GOOD 9.2000 0.1000
Confirm data correct? (Y/N) <Y>: y
Current calibration information for SPEED 10:
DATE TIME STATUS SLOPE OFFSET
311290 2400 GOOD 9.3980 0.2230
120891 1632 GOOD 9.2000 0.1000
Enter more calibration information for SPEED 10? (Y/N/Q) <N>:
```

The user may also delete a calibration, specifying its time. Finally, by entering "Q" at the above prompt, the user returns to the parameter menu. If no further calibrations are required, the user enters "Q" again, and the calibration file is updated.

[6.5] DOS operations

The telemetry program provides a subset of DOS commands to a privileged user, allowing basic system maintenance. Commands supported are CLS, TIME, DATE, EXIT, PATH, DIR, CD, MD, RD, TYPE, DEL, COPY, REN and ATTRIB. In addition (provided CHKDSK.COM is available on the DOS "PATH") the CHKDSK command may also be used.

CLS, TIME, DATE, EXIT and PATH permit no arguments, with TIME, DATE and PATH only reporting system parameters. EXIT returns the user to the main menu.

DIR requires one, or no arguments. CD, MD, RD, TYPE and DEL require a single argument. COPY and REN require two arguments. (DIR and COPY use COMMAND.COM to perform their function, all other commands accessing MS-DOS directly. Both DIR and COPY allow "*" and "?" wildcard specifiers.)

ATTRIB requires one or two arguments. If one is specified, it is presumed to be a file name, and attributes are shown. Otherwise, the first is presumed to be a combination of "+", "-", "R", "S", "H" and "A", in the standard DOS convention, and attributes for the second argument (presumed to be a file specifier) are set. The "*" and "?" wildcards are supported.

Copying to or from a DOS port (CON, COM1, COM2, PRN, LPT1, LPT2, or AUX) is prohibited on the grounds that the port might not be functional, so that the command may lock up the system.

The CHKDSK command may have only one argument, which should be the name of the drive required. A "/F" qualifier is automatically appended, and input is taken from a temporary file containing "N" only. This means that, if any lost clusters are found on the drive, they are automatically deleted.

[6.6] Edit a file

A simple editor is incorporated, in order to allow a privileged user to alter system parameters remotely.

When the user selects this item, a prompt for the file name is presented. If the requested file does not exist, this fact is noted by a "new file" message, otherwise the lines of the file are read in. (Only files of 100 lines or less may be edited)

The screen is cleared, and a "*" prompt is shown. The user may then use a set of commands to alter the file. Commands permitted are:

- I number insert lines of text before the specified line number;
- R range remove the specified range of lines, and replace them with the entered text;
- D range delete the specified range of lines;
- T range type the specified range (default is 12 lines from the present line);
- Q quit editing without making changes; and
- E exit and save changes, renaming the old file to have a "BAK" extension.

The "number" is the line number in the file, ranging from 1 upward. When lines are inserted, replaced or deleted, the line numbers change for all lines after the edit point. A "range" may include a list of numbers (eg., "1,2,6,7"), and set between limits (eg. "1-5" or "7:12"), or a combination (eg. "1,2,4:6,9").

For the "R" (replace) command, the range must be contiguous - eg. "1,2,3" and "8:16" are allowed, "1,2,5,6" is not.

[6.7] User access management

A privileged user may alter the system password file using this option. On selection, the full user set is shown, in the following form:

USER	PASSWORD	PRIV	BARRED	TIMES	...	1	1	1	1	1	1	1	1	1	2	2	2	2
			0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5
default		no		*														*
PIB	xxxxxxx	yes		*														*
MON	xxxxxxx	yes		*														*
KWIN	xxxxxxx	no		*														*
BP	xxxxxxx	no		*														*
CSBP	xxxxxxx	no		*														*
TELSYS	xxxxxxx	yes	*****	*	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
RYE	xxxxxxx	no		*														*

Passwords are shown above as "xxxxxxx". In practical use, these strings show the actual passwords of the users concerned.

Observe that user "TELSYS" is permitted to log-in only between 5am and 6am and 3pm and 4pm. This is the telemetry retrieval system's own user name. No other user may access the telemetry sites during telemetry times (except for the second half, when data transfer will normally have finished).

The user names include "default", which is the default user, whose privileged status and log-in times may be altered, but who may not be deleted. The privileged status and log-in times of the default user are copied to those of any newly-added user, when the name is added.

Users can be added, deleted, or their password, privileged status and log-in times may be altered. The normal syntax is the command letter (eg. A for add), followed by the name of the user concerned. (But for the "quit" option) A sample session is shown below:

```
(A)dd, (D)elete, (P)assword, (C)hange priv, (T)imes, (Q)uit
<Q> [X USER]: A DEMO
```



```
Enter password for user DEMO: PASSWO
After this addition, the screen display shows the additional line:
DEMO  PASSWO  no          *          *
```

A request for deletion of a user proceeds as follows. Note that the privileged operator must provide a confirmation, since all details of the user will be removed from the record.

```
(A)dd, (D)elete, (P)assword, (C)hange priv, (T)imes, (Q)uit
<Q> [X USER]: D DEMO
Confirm deletion of user DEMO? (Y/N) <N>: Y
```

Log-in times are entered as shown - as 48 spaces or asterisks corresponding to half-hour periods through the day. The previous barred-time line is shown, to assist entry of data in the correct columns - for example:

```
(A)dd, (D)elete, (P)assword, (C)hange priv, (T)imes, (Q)uit
<Q> [X USER]: T PIB
Enter new barred times using *'s:
                1 1 1 1 1 1 1 1 1 1 2 2 2 2
  0.1.2.3.4.5.6.7.8.9.0.1.2.3.4.5.6.7.8.9.0.1.2.3.
Old:                *          *
New:                ***
```

On entry of "Q", the operator is prompted as shown below. Changes to the user file are not saved until the operator quits, and enters a "Y" response to the prompt.

```
Save changes? (Y/N) <Y>: N
```

[6.8] Send a file from PC to user

[6.9] Receive a file at PC from user

These menu items are only provided to remote users.

Text files may be transferred between the PC controlling the logger, and the user's computer, using an error-checking protocol. On selection of either of these options, a prompt from the remote computer will request the filename, and a command will be sent to the user's computer program to receive or send the file.

While the "PC" and "user" terms are unambiguous, there is potential for confusion of source and destination in these commands. Care is recommended.

[7] Connect to another site

This menu item is only provided to a local user.

It invokes a full equivalent of the TELSYS program, including file transfer, downloading of logger data and so on.

After a site has been selected, the number dialled and connection established, the user will be in communication with a remote TELBASE program from a local TELBASE program. There is considerable opportunity for confusion here, with nearly identical menus from each program, so care must be taken - although in the event of errors, the program's time-out handling will ultimately rectify their consequences.

5. Program TELSYS

This program is the normal means of access to the telemetry sites. It may also be used as a terminal emulator, for simple terminal access to systems such as the Environmental Protection Authority's MicroVAX. (It supports only the screen-clear and backspace functions of an ANSI

terminal, but should not in any case be used for operations such as screen-mode editing, because of the slow speed of the 1200 baud modem line)

It presumes the attached modem supports the Hayes modem protocol. The modem commands discussed below are Hayes commands.

At commencement the program reads a file "SITENAME". On the MicroVAX this may be a defined logical name, but if not, it translates the normal site-name file, "SITENAME.DAT". Site information is read from this file, and the opening screen shows the available options, for example:

W.A. EPA TELEMETRY STATION ACCESS

- [0] EXIT
- [1] Connect to Wattleup A.Q.M.S.
- [2] Connect to Hope Valley A.Q.M.S.
- [3] Connect to Rockingham A.Q.M.S.
- [4] Connect to Queen's Buildings A.Q.M.S.
- [5] Connect to Caversham A.Q.M.S.
- [6] Direct connect to modem line

Select option <0>:

When any of options 1-5 (above) are selected, the program will issue modem command "ATDnnnnnnn", where "nnnnnnn" is the telephone number (also read from file SITENAME). The screen will clear, with message "Dialling ..." shown.

As the modem dials the number, the digits will be echoed. These are shown on screen, confirming the dial-up process. If digits are not echoed, the program will quickly detect a time-out, and enter an error-recovery process (See below).

When the telephone call is answered, the local modem will attempt to detect a compatible carrier tone from the remote modem. If the phone is not answered or no carrier is detected, the message "NO CARRIER" will be sent from the modem to the program, and a corresponding message will then be sent to the user.

On occurrence of this error state, or failure to receive the dialled number, the program will attempt to correct the error. To do this, it will exercise the modem in test mode, using command "AT&T1", exit using the escape command "+++", cancel test mode using command "AT&T0", followed by the hang-up command "ATH". The dial-up process will then be repeated; if it fails again, the connection attempt will be aborted, and the program will return to its main menu.

After completion of the dial-up process, the user will be placed into the program's "terminal" mode, with the program providing a very basic VT100 terminal emulation. For non-privileged users, the terminal function will be all that is needed, but TELSIS also supports the file transfer functions accessible to privileged TELBASE users.

When the dial-up connection to a PC is made, the user may be informed that the system is in use locally. Should this be the case, the connection should be aborted, and the number tried again later. (The local user will be informed of the access attempt, as soon as possible)

On successful connection to a PC, the user will enter the main-menu stage of program TELBASE. On completion of operations, option 0 of this menu should be selected, to log-out formally from the PC system, then the escape key (or, on the MicroVAX, the control and left bracket keys) must be pressed twice, to return to the main TELSIS menu.

The connection may be aborted at any time using the double-escape. The remote telemetry system will automatically log off the user if input times out (the time-out interval being one minute).

The "direct connect" option (numbered 6 above, but varying according to the number of sites available on the menu) allows operation over a direct serial line without modems, and also

permits a user to interact directly with the modem using the Hayes command set. This might be of value if modem responses seem faulty, and the user desires to check out its functional state.

Users should note that the program, in combination with the TELBASE program at the remote site, is particularly strict in requiring that active use be made of itself. A 60-second limit on input delays is invoked by the TELBASE program at all input stages, and TELSIS maintains a 50-second limit on terminal mode operation, as well as a 60-second limit at the initial menu stage. This means that if a user runs TELSIS and leaves the terminal unattended, the program will exit automatically after 50 seconds on terminal mode, plus 60 seconds at the main menu stage.

The slightly shorter time-out in interactive mode is assigned to ensure that TELSIS times out before TELBASE. Otherwise, the TELBASE timed log-out message would reset the interactive session timer. Total program timeout would then require the 60-second TELBASE interval, a 60-second interactive-session interval, then the 60-second main menu interval.

5.1 Batch operation

The first implementation of TELSIS included a specific batch version, which allowed hands-off retrieval of data in automatic telemetry operation. The batch-mode specifics are now handled within the input and output routines (INPTMO and OUTLIN), so only one program is needed.

Currently, the PC version of the batch-mode detection routine (function BATCH, in IBMSUB.FOR) always returns .FALSE.. If needed, it could be modified to return a logical value depending on the program's operating environment - eg. if a file "BATCH" existed, or a command parameter "BATCH" was included when the program was initiated).

The VAX version uses a system call to detect automatically whether it is running from a terminal or from a batch file. (It currently identifies an operation from a command file as an interactive mode, but this feature may be changed at a future date). In batch mode, the program obtains "terminal" input from file TELSIS.INP, and writes "terminal" output to file TELSIS.OUT.

It is intended that in batch operation, the program's usage would involve a sequence of VMS commands such as:

```
$ COPY WATTLEUP.INP TELSIS.INP
$ RUN TELSIS
$ RENAME TELSIS.OUT WATTLEUP.OUT
$ PURGE WATTLEUP.OUT
$ DELETE TELSIS.INP;*
$ REN WT*.*%R ..whatever..
```

with this sequence being repeated for each site involved. The Wattleup input file should be of form

```
2
TELSIS
password
5
S
0
<ESC><ESC>
0
```

where:

"2" is the station number on the menu,

TELSIS is the telemetry user name (with access limited to 05:00-06:00 and 15:00-16:00 each day, but exclusive access from 05:00-05:30 and 15:00 to 15:30),

"5" is the menu option to retrieve logger data,

the blank accepts the default dump time range,

"S" stops the data telemetry routine, and returns TELBASE to its main-menu stage,
"O" logs off the remote site's computer,
"<ESC><ESC>" (two escape characters) command TELSYS to return to the site-menu stage,
and
"0" is the menu option which terminates TELSYS.

The returned file is renamed to one of the user's preference on the final VMS COMMAND line. The file returned has name as detailed under "[5] dump hex file of logger data", above, so for Wattleup, the file specification shown will cover all possible Wattleup raw data files.

NOTE: using the EDT editor on the MicroVAX, an escape character is produced using the 4-key sequence GOLD, 2, 7, SPECINS. If they are ever needed on a PC, they can be generated by holding down key ALT, pressing keys 2 and 7, and then releasing the ALT key. This works in many word processors, but failing that works also while copying text from the user console (CON) to a file - eg. command "COPY CON ESCAPE".

6. The logger simulator

The telemetry system described above is highly portable, and runs both on the PC and MicroVAX. Due to the greater sophistication of the MicroVAX programming environment, much early modification was conducted on this machine, and a simulated logger was developed to allow operation without tying up a Unidata logger.

The logger simulator code resides in file LOGSIM.FOR. The functions in this file respond to "put" ("Pxxxxxx...") and "get" ("Gxxxxxx") commands from the program as would a normal logger.

To permit this, at initialisation, a file containing a full copy of a functioning logger's memory is read in. Then, when a put-logger command ("Pxxxxxx") is received (relayed from the VMS version of the output function OUTLIN), the memory buffer holding the memory copy is updated. In response to a get-logger command, an output buffer is filled, firstly with a one logger prompt sequence (NULL, NULL, CR, *) for each logger cycle since the last access, then with data requested, and a checksum in the normal Unidata format.

When input is requested from the logger, data from the output buffer is returned, either up to the end of the receive string, or until a terminator character (CR, normally) is found.

The result is a simulation of a "frozen" logger, in which neither logged data nor clock registers are updated. While this was found to limit the effectiveness with which the telemetry system's time functions could be validated, these were very simple items within the program, and did not require debugging.

The program used to download a full copy of a logger's memory, resides in file DMPLOG.FOR. It can copy the full memory of any 64K logger to a disk file on the PC in a few minutes.

The TELBASE program can, in principle, run on a MicroVAX using a real logger. Direct access to a Unidata logger from the MicroVAX would be possible, provided the connection set the RS-232 protocol lines so that the logger's serial interface was activated. (Our normal serial lines do not do this.)

7. Maintaining the Telemetry Program System

The telemetry system comprises two programs, TELBASE and TELSYS, which employ a large set of common routines (TELSYS now forming a subset of TELBASE).

The files which are compiled to create the TELSIS program are as follows:

TELSIS	The main program for the interrogating end of the telemetry system.
TELLIB	General telemetry subroutines which send and receive data packets, calculate checksums, make and break telephone connection presuming Hayes modem protocol, and display a timed user message.
SENREC	Routines to send and receive ASCII files
IBMSUB or VMSSUB	System-specific subroutines performing functions such as character input and output from the console/terminal and modem, and system time measurement.
IBMSESS or VMSSESS	Terminal-session routines, which provide two-way routing of characters between user terminal/console and modem line, while watching for remote commands (to run file send/receive routines), activity time-out and the user abort (double-escape) sequence.
LOGDUM	(VAX version only) dummy routines implementing the logger simulator calls, but empty since the logger channel is not used in TELSIS.

On the PC, compilation is achieved using command MAKETS, which compiles TELSIS, SENREC, IBMSUB and IBMSESS, and links it with the library file obtained from TELLIB. On the MicroVAX, a command of form "EX TELSIS, SENREC, VMSSUB, VMSSESS" performs the same task, the library file from TELLIB being invoked automatically by the library specifier defined at log-in time. In both cases, a batch file is activated which scans the files nominated and compiles only if necessary. (In the MicroVAX case, this is defined to be when there is no object file, or the source file post-dates the object file; in the PC case, this is defined to be when there is no object file, or there exists a backup file from the Norton editor or from PC-WRITE (extension "~FO"), or from other editors using a "BAK" extension.

Compiling the TELBASE program involves several of the above files, plus others performing site management functions, as follows:

TELBASE	The main site program, which provides and enacts the operating menu, plus some minor site-related routines.
VOLTAG	display A/D values stored in specific memory locations, as their analogue equivalents
GETLOC	permits the user to examine logger memory
PASSOK	check a user password
LOGINS	inspect logged data in S.I. units or as analogue voltages
LOGLIB	library of functions used in accessing the data logger
LOGSET	allowing the user to set the logger clock in synchronisation with the site PC's clock
LOGLOAD	routine to load a logger program into the logger
LOGDMP	means of extracting logged data in raw (hexadecimal) form, and writing to a file or sending over modem line.
MODCAL	allows the user to alter the site calibration file
SENREC	<i>common with TELSIS</i>
TELLIB	<i>common with TELSIS</i>
TIMSET	permits the user to alter the system time, including the CMOS clock on an XT using program TIMER.COM.
DOSSHL	DOS operations routine

IBMSUB and

VMSSUB *common with TELSYS*

LOGSTA summarises logger's operational status

ACCESS allows privileged user to control user passwords and access controls.

DIALOUT performs functions of TELSYS, allowing one site to connect to another, or to the MicroVAX

IBMSESS and

VMSESS *common with TELSYS*

LOGSIM (VAX version only) logger simulator

The large number of routines listed forces use of specific batch files on both the MicroVAX and PC. These are TB.COM and MAKE.BAT, respectively, so that compilation is achieved using the respective commands "@TB" and "MAKE".

8. The Telemetry Processing System

The overall telemetry processing system is illustrated in the figure below. Programs are shown in shaded boxes, while files are shown in unshaded, rounded boxes. The characters "SS" correspond to 2-character station codes (eg. "HV" for Hope Valley).

Components of the Telemetry System:

TELBASE and TELSYS: Currently, transfer of data using the TELSYS program occurs twice daily, at 5:00-5:30 a.m. and 3:00-3:30 p.m. This uses command file TS.COM, which requires a 2-digit hour of the day as a command argument ("05" or "15" at the moment), and runs TELSYS in batch mode.

In this mode, TELSYS takes user input from file TELSYS.INP. This file is copied from SS.INP (shown above) before TELSYS is run. While running in batch mode, the program sends user output to file TELSYS.OUT, which is later renamed to SS.OUT.

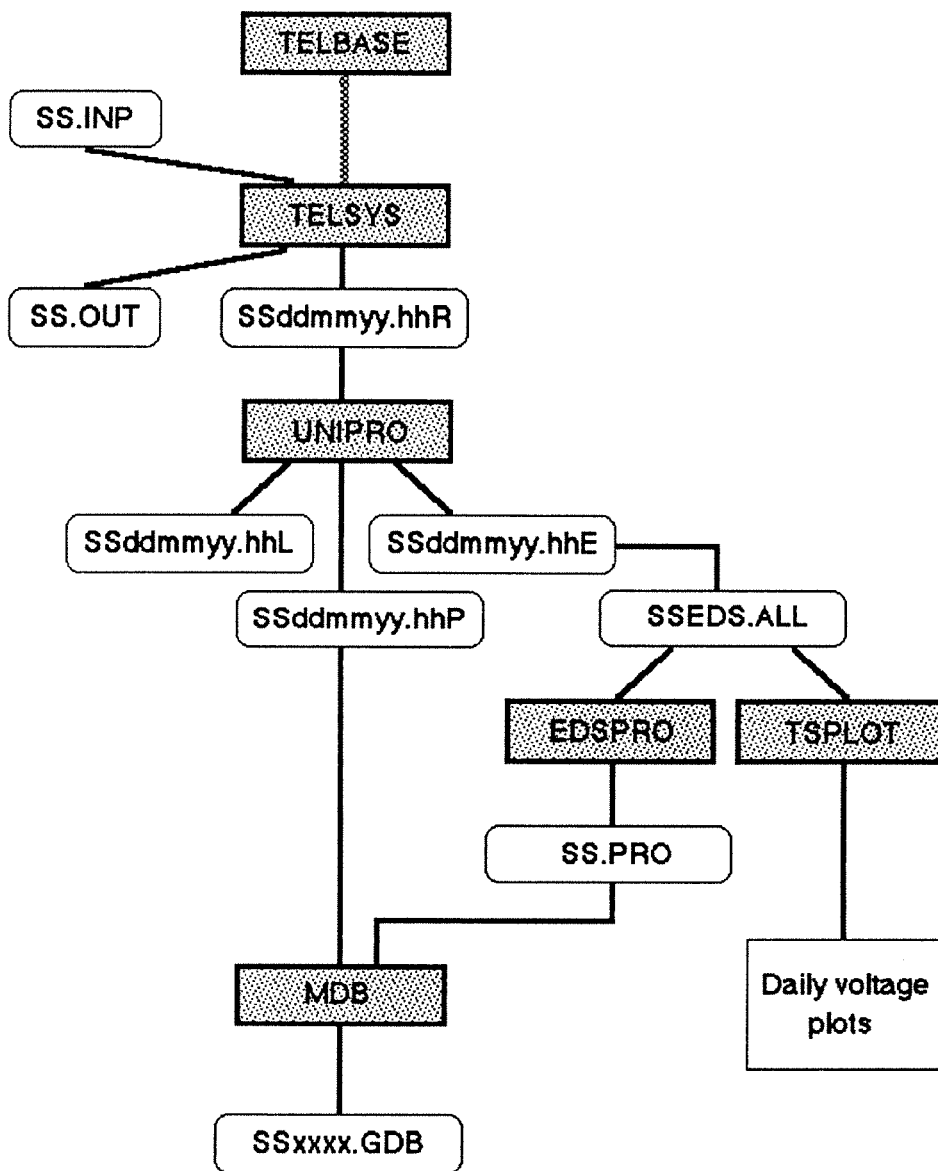
The commands in SS.INP command the TELBASE program to download all data recorded since the last download time, producing file SSddmmyy.hhR, where "ddmmyy" is the current date (in day, month, year sequence), and "hh" is the hour of the day. This is a "raw" file, holding a header of site and time information, and hexadecimal data corresponding the values recorded by the Unidata logger.

UNIPRO: The data in file SSddmmyy.hhR are processed by the UNIPRO ("UNIdata-to-PROcessed") program, which converts the file's hexadecimal data to ASCII format, one line per logging interval with date and time leading. Output in S.I. units is written to file SSddmmyy.hhP, and as volts to file SSddmmyy.hhE. A summary file SSddmmyy.hhL provides a log of the program's transactions. UNIPRO uses information from calibration files SSUNID.CAL to perform the voltage-to-S.I. conversion.

The program can take "wildcard" names so that, for example, it can process all telemetry files using input file specification "*.R". This file specification is all that is required as input, with output file names generated by replacement of the trailing "R" with an "E", "P" and an "L".

MDB: After UNIPRO is run, the processed file is converted to the Environmental Protection Authority's data base format by program MDB, with output to a data base of name SSxxxx.GDB (where "xxxx" varies from site to site).

In its batch mode, program MDB reads the required data base name, input format and input file name from file SPECIF.MDB, and processes the data directly. The file to be used as SPECIF.MDB is copied from a file of name SS-hh.MDB (where "hh" is normally 05 or 15), and deleted afterward.



Disposition of Telemetry Files: File SSddmmyy.hhE is appended to a monthly voltage file, normally of name SSEDs.ALL (where "EDS" has historical origins, referring to the Environmental Protection Authority's original use of EDAS loggers, and "ALL" reflects the retention of all of a month's data in the file). Then, both this and file SSddmmyy.hhP are moved to another directory, to be deleted at the end of the month. Files SS.OUT and SSddmmyy.hhL are deleted after a day's retention. Temporary files, of name TELSYS.INP and SPECIF.MDB are deleted at the end of the telemetry session.

TSPLOT: Daily check plots are generated using the monthly file, and program TSPLOT. TSPLOT can be operated using data from any of the Environmental Protection Authority's data bases, from ASCII voltage files in the old EDAS logger format, or the current format from UNIPRO.

EDSPRO: After the end of a month, all monitoring equipment is recalibrated, and the data base updated. For this, the updated calibration files and program EDSPRO ("EDAS-to-PROcessed"), which converts the voltage file to one in S.I. format, are used, then program MDB is run again using the S.I. output file. Program EDSPRO can accept both new and old (EDAS-format) data, as for TSPLOT.

9. MicroVAX organisation

The telemetry system presently operates within a set of subdirectories on the Environmental Protection Authority MicroVAX. These have arisen from "ad hoc" decisions, and do not always represent the ideal arrangement. They may therefore be altered shortly.

All executable program ("EXE") files are held in the normal executable-file directory, USER:[PI.EXE].

Batch-mode telemetry operations are carried with a default directory USER:[PI.SCRATCH.NEW]. The "INP" and "MDB" files reside in this area, and the "OUT" and "hhL" log files are stored here until they are deleted.

Files with extensions "hhP" and "hhE" are initially written to this area also, but are later moved to directory USER:[PI.SCRATCH.TELE]. The previous month's files should be deleted from this area as a matter of routine.

The monthly "SSEDS.ALL" files are stored in area USER:[PMS.RAICH.PRO]. Calibration files are held in USER:[PI.AQMCAL], and data bases in USER:[PI.AQMDATA].

The locations of the calibration files and data base files are logical and user-independent. The use of subdirectories of the SCRATCH area is less logical, since "scratch" implies temporary (usually files with no requirement for day-to-day retention). In addition, files of across-branch importance should not be held in an individual's directory area (eg., the monthly files).

Any revision must also recognise that the "ownership" of the data itself also changes. Day-to-day software maintenance and processing are the responsibility of Pollution Investigations staff, while monthly calibration is the task of Pollution Monitoring staff. Suitable equivalent directories for the telemetry operations would therefore be

Telemetry default area: USER:[PI.TEL]

Telemetry daily file: USER:[PI.TEL.DAILY]

Telemetry monthly files: USER:[PMS.MONTHLY]

10. Future developments

A number of additional features are still to be added to the system, particularly:

- enlarging the size of transmitted packets, sending multiple lines in one packet. This will improve transmission rates, particularly when only a few parameters are logged at a site. The transmission protocol already permits multi-line packets, but the code in the send and receive routines has not been modified to take advantage of this capability;
- support for the Unidata Macro logger. The program already includes nominal support for this device, but it is expected that additional requirements will arise when the functionality of this support is tested; and
- support for the Airtrak monitor. Discussions with the manufacturers, MCI, are now in progress to ensure a user routine can be incorporated in the instrument's controlling software. This would be used to communicate with a PC at the measurement site, allowing downloading of data and subsequent telemetry.

Appendix 1

Troubleshooting the telemetry system

Problems in connecting to a remote site, and in operating the TELBASE program, can arise from several causes. Below is a list of several problems, their confirmatory symptoms, and suggested solutions

1. Failure to connect to remote site

If the telephone number was not echoed after "Dialling ..." message was shown on screen:

In the process of telephoning the remote site, the numbers echoed by the modem are transmitted to the user's screen. The absence of these numbers indicates the modem is either not physically connected to the modem line, that it is in the incorrect state, or that its settings have been corrupted.

On the MicroVAX, check that the local name MODEM corresponds to the physical modem line, TXA2:, using command "SHOW LOGICAL MODEM". If not correct, use command "ASSIGN TXA2: MODEM".

On the PC, confirm that the switch in the line from port COM2 is set to MODEM rather than UVAX.

If the above is correct, select the TELSIS option "Direct connect to modem line", in which state you can directly interrogate and command the modem. Firstly, enter three plus characters; the "+++" command will break any communication state, returning to command mode. If the response is "OK", you will have identified the probable error, and cleared it.

If not, enter command "ATS*". This should produce a sequence of lines of output, whose content is not of great value here, but may confirm the modem's operational status. If not produced, the modem must be in a corrupted state - the best option is to turn the modem off for a few seconds, and on again.

Next, enter command "ATZ". This will return the modem to saved settings. You should receive the "OK" response again.

Now return to the TELSIS main menu using a double-escape key sequence, and try redialling. If this fails again, return to the direct-connect menu option, and now enter "AT&F", which will reset the modem to factory settings (normally the same as saved settings).

If all the above fail, the modem probably needs repairs.

If the full telephone number is echoed within a couple of seconds:

Number echoing reflects the rate of dialling, which in the correct pulse mode takes a second or two per digit. If the rate is faster than this, it indicates that the modem has switched to tone dialling mode, which the telephone line does not support.

When the program has returned to the main menu state, select option "Direct connect to modem line". Enter command "ATZ", which will return the modem to its saved settings. You should receive an "OK" response, after which you may return to the TELSIS main menu using the double escape character sequence, and try dialling again.

2. Carrier from remote modem detected, but no log-in prompt.

Firstly, try pressing the RETURN (or ENTER) key a few times. The TELBASE program awaits three RETURN characters before providing the log-in prompt, and the TELSIS program will send then prior to entering its terminal mode. If there is any problem in initiating transmission, however, these may be corrupted.

Otherwise, the lack of response indicates the remote system is in use, or a problem with the program on the remote PC, which may only be corrected by visiting the monitoring site.

3. Log-in process successful, but you are logged off by the program

If you receive a message of form:

```
Your use of this system is barred for now
Please try again after hh:mm.
```

where "hh:mm" is a time, this indicates that you have tried to use the system during a normal telemetry data transfer time - currently 5:00am to 5:30am, and 3:00pm to 3:30pm. The program allocates these times exclusively to the automatic telemetry system.

4. You receive an error message of form "Logger Access Failure ..."

This suggests a problem with the logger. Retry the menu option which produced the error, and if it recurs, note the error message details and report the error to Pollution Investigations staff.

5. The program indicates that data requested from the logger is not available.

Use TELBASE menu item 2 to check the status of the logger. If its state is reported as "suspended", this indicates that logging has stopped for some reason - this may be a failure of the analogue interface, or due to filling of memory of a logger configured for non-circular memory.

Check the reported range of data available, and request only data within that range. Also, ensure the problem is reported, since it should not occur for a logger on the telemetry system.

6. Problems in DOS operations.

Wildcard characters do not work: The permitted commands normally use internal routines and accept only specific file names as arguments (ie. no "*" or "?" characters). The exceptions are ATTRIB, DIR and COPY.

DIR or COPY commands generate a disk-full message: these commands are run using the DOS shell "COMMAND.COM", with output directed to a file (entitled "PSEUDOS.TMP") on drive C:, subsequently typed to the user's screen, and deleted. If this drive becomes full, these commands will fail.

Characters are lost from a large quantity of screen output: the port-driver routines in the PC do not respond properly to a buffer-full state. While an attempt has been made to limit the output rate from the program to prevent the buffer-full state occurring, a sufficiently low rate has not yet been identified. This problem should disappear in time.