F E R R A N T I L T D

F E R R A N T I A T L A S C O M P U T E R

THE ATLAS MONITOR PROGRAM

PROVISIONAL DESCRIPTION

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1. Introduction

The monitor program is a set of routines in fixed store and main store which deals in a general manner with the effect of detectable errors on the course of an object program. It is primarily designed to deal with faults caused by the object program (program faults), but it is also entered following the detection of computer failures or failures in on-line peripheral equipments, such as magnetic tapes, which affect the functioning of the program. The monitor program is common to all types of program faults, the different faults being distinguished on entry by a marker or counter in a B line. The program investigates whether the fault has been "trapped" by the program, and if so enters the trap; it is also possible for the program to request private monitor action, in which case the program is re-entered, either before or after the standard monitor printing. On conclusion of monitor printing, the "End Program" sequence is entered.

In this document a basic knowledge of the Atlas Supervisor and terminology, as described in the paper 'The Atlas Supervisor', is assumed.

2. Types of Faults

2.1 Program faults

a) Faults detected by hardware

These result in the setting of an interrupt flip-flop, line 1 of the central computer V store, and include exponent overflow, division overflow, use of an unassigned function, and sacred violation. A common interrupt routine deals with all these faults, extinguishing the appropriate flip-flop and setting a digit in B91 corresponding to the type of fault. It is assumed that the error has been caused directly by the current object program and not by the failure in supervisor routines. Multiple faults can be dealt with by setting appropriate digits in B91. One (common) SER is entered to the slow SER queue to continue the analysis.

b) Faults detected by SER's

Faulty use of store and peripherals are detected by SERs entered from extracode instructions in the object program. Only one such fault is detected at any one time. It is recorded in B91 as a counter without altering any fault already recorded of an interrupt type, and the same SER is entered as that initiated by interrupt faults. This SER forces the current object program controls to cause entry to a routine in extracode control when all currently active SER's are concluded.

Other faults may be detected when the program is halted for some reason and is not in control. One such fault is when the drum routines obey the extracode "Read to page P"; if page P is locked down when the instruction is obeyed at the top of the drum queue, the transfer cannot proceed. The block involved is unlocked, without completion of the transfer, and the usual SER monitor sequence is entered if the program involved is in control. If it is not in control the monitor sequence is not entered until the program is resumed. It is assumed that, when using this extracode, the programmer has made due allowance for this occurrence and is prepared to be interrupted at any succeeding time.

"Off line" faults may be detected in the use of on-line peripheral equipment e.g. the program may reach the end of a magnetic tape. This fault is not detected until the transfer is actually obeyed, which may be some time after the instruction was given by the program. To enable the programmer to deal with such a fault and resume the program, the contents of extracode working registers are specially preserved before the monitor sequence is entered, and only one such monitor reason is dealt with at once. The method used by the programmer to resume after such a fault is described below.

c) Faults detected by Extracode

Faults such as those in arguments of functions are detected directly by extracodes. Only one such fault is detected at once, and the extracodes set a suitable counter in B91 and jump directly to the monitor sequence. In the ways described above, all programs errors enter a common extracode sequence with B91 holding a record of all faults detected "in parallel".

2.2 Computer Faults

After a computer fault has been detected and dealt with, and it is desired to restart an object program, the monitor sequence is again entered to cause interruption to the present flow of control and to delete or restart the program. Again the monitor sequence is entered in extracode control with suitable fault records in B91. A similar course is followed after a failure in magnetic tapes which may cause the program to be abandoned. As in the case of program failures in use of tapes, only one such fault is monitored at any one time. In all cases of computer failure, current extracode working registers are preserved before entry to the monitor sequence.

3. Trapping of Faults

The programmer has the facility to "trap" individual errors and so cause immediate exit from the monitor sequence. The programmer provides a trapping vector, and informs the supervisor of its location by means of extracode instruction 1132. Full word n of this table contains trap information for an error of type n ($0 \leq n \leq 15$). Half word n holds the address to jump to main control; the previous value of main control is stored in the B register specified in digit 15-21 of half word n + 0.4 of the table. When the trap is entered B91 holds the fault information as described in Section 2, B92, 93, 121 are altered but all other registers are unaltered. Not all errors can be trapped; only those are included which the programmer might reasonably be expected to deal with before resuming the program, and the occurrence of which may be a useful means of avoiding extra checking in the program. For example, overflow of a local timer may prove a convenient end of an iterative loop. Faults which the programmer might be expected to avoid (such as sacred violation) cannot be trapped; faults arising from violation of the original job description, such as overall time exceeded, cannot be trapped.

Trapping may be avoided by specifying a negative address in extracode 1132; unless specified otherwise, the supervisor assumes no trapping. In order to trap some errors but not others, the programmer may fill any unwanted entry n in the trapping table with a negative jump address in half word 0.0n. Trapping of program errors is treated by the supervisor as a "normal" procedure and entry to a trap permits the program to continue normally. If multiple errors are detected (B91 contains a record of more than one error on entry to the extracode monitor sequence), trapping is ignored if a fault is not in the group for which trapping is allowed. If all faults can be trapped, the highest priority fault is inspected and exit is made to the trap or to continue monitoring according to the setting of the relevant entry in the trapping table. It is the programmer's responsibility to deal with multiple faults of which only one is trapped.

Computer failure can be trapped; the monitor routine arranges to queue these up, allowing one to be trapped at once, and an extracode 1114 "Exit from trap" must be used, after entry to such a routine. Similarly when off line program errors (e.g. tapes) are trapped. If this extracode is not used, no further information will be given on computer or tape faults. Extracode 1114 can specify the following actions, according to the address S (= N + Bm) as follows:-

S	Action required
-ve	Monitor, printing "Monitor entered"
0	Restart
+ve, odd	Resume at S
+ve, even	Recover working registers and resume at current extracode, after setting B127 to S.

If the program is not in trap, all values of S cause exit to monitor; similarly if the program is in monitor. Restart is only permissible after a computer failure, not after an off line program fault. If any other similar faults are awaiting attention, they are dealt with before resumption.

4. Standard and Private Monitor Printing

4.1 Entry to private monitor

If a fault is not trapped, the monitor program regards the program as effectively terminated and proceeds to diagnostic printing. This consists of

a) one line describing the fault.

b) standard post mortem printing.

The programmer may supply a private monitor sequence, using extracode 1112 to specify the starting address, and this is entered in main control before (a), after (a), or after (b), according to digits 22, 23, of the starting address.

Digits 22, 23 = 0 1 Enter before (a)

0 0 Enter after (a) (the normal case)

1 0 Enter after

When entered before (a), B91 contains the record of faults, B92 contains the current value of main control, and B93, 121 only are altered. In certain cases such as "page locked down", where a page number is to be specified, this is found in B119 on entry. When entered after (a) or (b), the contents of B96, 97 are also atered.

Once private monitor has been entered, it will never be re-entered for any subsequent fault; any subsequent fault may be trapped, but if not trapped will cause standard monitor printing. This is necessary in order to avoid endless loops of errors in the event of faults in the private monitor sequence itself. Examples of the application of this rule are when overall computing time, execution time, or output time are exceeded; the monitor routines add standard amounts to the check values to allow for monitor action, and if these exceeded by a private monitor routine, they are incremented again, but cause entry to standard monitor printing.

4.2 Standard Monitor

The standard monitor printing routines are in main store, and are called from the drum and copied to form a part of the object program when required; for this and other purposes, one spare block is always retained with each program. The routine operator under main control, but the "process switch" is set before entry, permitting exit to extracode when required.

A description of each fault is printed on a separate line, using output stream 0 of the program. The messages are stored as packed characters and are of variable length; only characters common to all output equipments are used. Before any such printing, program branching is terminated if it was in use.

If no private monitor printing has been requested, a standard post mortem is printed. This consists of the following information:

Line 1: Heading ORDER followed by value of main control less than 2. If this value is in private store, the description UNALLOCATED is printed. If the store location has not been defined, this desciption is also printed. Otherwise, the contents of the specified store are printed as

Function, Ba Bm, N

The function is printed in octal form; Ba, Bm as decimal integers to three figures; the "full word" part of N as a decimal integer, signed, followed by a "point" and the last octal digit, unless this is zero, when it is omitted. Following this, the contents of Ba, Bm are printed as signed decimal integers followed by the last octal digit; this print is omitted if the B line is B0.

Line 2 : Repeat of line 1 for main control less 1.

Line 3 : Repeat of line 1 for main control.
These three lines describe the instructions most likely to have caused faults. Extracode faults are caused by order M-1; block addressing faults may have been caused by order M, resulting in non-equivalence. Other faults may have been caused by order M-1 or M-2.

Lines 4, 5, 6....
Value of B lines 1 to 80. These are printed 4 to a line in the form

B 3 = signed decimal (. octal digit)

the octal digit being omitted if zero.

Next line:
Heading "ACCUMULATOR" followed by single length accumulator, unstandardised, as a signed fraction. This followed by "/" and the octal exponent. If exponent overflow has occurred, the overflow digit is ignored, but the sign digit is preserved for printing.

Next lines:
If magnetic tapes are in use, their positions are listed on separate lines as

TAPE n AT (block number)/(word number)

the word number being omitted if variable tape operations are not in use.

This concludes the standard monitor printing; private monitor printing is then entered if called for, otherwise the printing is augmented by the "End Program" sequence. This prints the number of instructions obeyed, and the accumulated time of use of magnetic tapes. The quantity of output on each stream is printed at the end of each stream; the quantity and location of input is printed at the start of the program, again on output stream 0.

5. Table of Faults and Numbering

Fault	Detected by*	Mark of count in B91	Trap number if any
Local time	S	Dig. 5	0
DO	I	Dig. 6	1
EO	I	Dig. 14	2
Page locked down	S	Dig. 1	3
No. of blocks	S	2.0	4
Square root	E	2.4	5
Log	E	3.0	6
Trig function	E	3.4	7
Inverse function	E	4.0	8
Input ended	S	4.4	9
End of tape	S	5.0	10
Variable string error	E	5.4	11
Unassigned function	I	Dig. 4	
SVI	I	Dig. 8	
SVO	I	Dig. 10	
Illegal block number	S	9.6	
Band not reserved	S	10.2	
Computing time	S	Dig. 2	
Execution time	S	Dig. 3	
Input not defined	S	11.6	
Output not defined	S	12.2	
Output exceeded	S	12.6	
Tape not defined	S	13.2	
Illegal search	S	13.6	
No selected tape	S	14.2	
No mode defined	S	14.6	
Mark in read mode	E	15.2	
Tape failures	S	6.0	12
Computer failures	S	6.4	13

*I = Interrupt

E = Extracode

S = S.E.R.

Note: The above ordering is provisional and subject to amendment if more faults are to be trapped.

BMMH/RP

19th December, 1962.