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ABSTRACT and CONTENTS

The attached document describes all the currently implemented MCALLs on the Sub-Process module of the Model I Basic System. It is intended to serve as a system programmer's manual for this part of the system. The portions of document PMTSPT/W-2 which deal with the Sub-Process System are rendered obsolete by the present document.

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I   Introduction

The Model I Basic System provides facilities with which a
user may include an arbitrarily constituted collection of
programs as "sub-processes" of his process, specify relations
which are to subsist among the sub-processes, and transfer
control from one sub-process to another. The Basic System
module which implements these facilities is called the Model
I Sub-Process System. Detailed descriptions of the MCALLs
through which the user accesses the Sub-Process System are
given below, following some explanatory material.

II   The Sub-Process Table

The sub-processes of a process are defined by entries in a large table, called the Sub-Process Table (SPT), which occupies a considerable portion of the process' Context Block. SPT can contain as many as eight entries. One or two of these will normally hold definitions of system sub-processes, leaving room for six or seven user-selected programs.

Figure 1 shows the format of an entry in the Sub-Process Table. Of the forty-two words, twenty-four are used to define the sub-process' address space, which may be as large as 128K words. The fields of the entry are given the following significance.

NAME:

This 9-bit field plays two roles. As an identifying mark for the sub-process, it is written into the lock fields of objects, such as ICT, OFT, and PMT entries, which belong to the sub-process. It also functions as a "control lock" on the SPT entry itself, protecting it from modification by other sub-processes which are not properly authorized. NAME always has exactly one bit set--in fact, its value is 2^n, where n is the index of the SPT entry.

CALL MASK:

This is another 9-bit field, whose function is to limit "access" to the sub-process, that is, to prevent it from being called by unauthorized sub-processes. The contents of CM bears no relation to the SPT index or to NAME. It may be any collection of bits.

KEY:

KEY is yet another 9-bit field. Its function is to unlock locks, such as the NAME and CALL MASK of SPT entries and the access and control locks of ICT, OFT, and PMT entries. A KEY fits a lock if the bit-wise AND of it with the lock is non-zero. If a sub-process' KEY fits the lock on some object, the sub-process is authorized to perform certain restricted operations on the object. In particular, if the KEY of a sub-process fits the NAME of an SPT entry, the sub-process is authorized to modify the entry. If its KEY fits the entry's CALL MASK it is authorized to call the sub-process defined by the entry.

FATHER:

When one sub-process creates another sub-process, the SPT index of the creating sub-process is put into the FATHER field of the new sub-process' SPT entry. The restrictions (described below) on subsequent modifications of the FATHER field guarantee that these fields define a tree in the Sub-Process Table. This "FATHER tree" establishes relations of responsibility among the sub-processes. If, for example, a sub-process causes a trap which it is not able to deal with, its FATHER is given a chance to handle it. If it declines, then its FATHER is called, and so on, until the "root" of the FATHER tree is reached. The root will normally be a system sub-process capable of handling any abnormal situations which may arise. The FATHER field of a root is always zero.

UTILITY SUB-PROCESS:

Sub-processes may run in the User Ring of the Model I address space or in the Utility Ring. Since these rings are disjoint and since the CPU provides hardware for communicating between the two rings, it is feasible and efficient to allow one sub-process to reside in the Utility Ring while another occupies the User Ring. It is intended that most programs be run as user-ring sub-processes and that the Utility Ring normally contain a standard system program (the Model I Utility System) with which the user-ring sub-processes can communicate through the hardware UCALL instruction.

The USP field of an SPT entry for a user-ring sub-process contains the SPT index of the sub-process which is to reside in the Utility Ring when the sub-process is active. For convenience, the USP field of a utility ring sub-process' SPT entry always contains the index of the entry itself.

RING:

This field indicates whether the SPT entry describes a user-ring sub-process or a utility-ring sub-process. A value of 0 means user-ring, 1 means utility-ring.

ENTRY POINT:

In order to be run as a sub-process a program must contain a specification of its entry points. This is expected to take the form of an array of pointers to function descriptors for the functions that are designed to be called by other sub-processes. The absolute address of the descriptor for this array is kept in the EP field of the sub-process' SPT entry.

The first two pointers in the array are assumed to point to a trap-handling function and an interrupt-handling function, respectively.

ENTRY G-REGISTER:

This field contains an 18-bit number which will be loaded into the CPU's G-register whenever control is transferred to the sub-process by any of the MCALL's described below.

STATUS BITS:

The bits in this field specify the privileges and certain operating characteristics of the sub-process. Details are given in Figure 2.

TRAP MASK:

The bits in TM arm/disarm the various traps which may be generated in the sub-process structure. Figure 3 gives details of this field.

STATUS CONTROL BITS:

This field has the same internal format as the STATUS BITS field (see Figure 2). A sub-process with bits set in SCB is authorized to set and reset the corresponding bits in SB.

TRAP CONTROL MASK:

TCM has the same relation to TM as SCB has to SB. A sub-process can set/reset bits in TM only if it has the corresponding bits set in TCM.

TEMPORARY ACCESS KEY:
USER NUMBER:
PERMANENT ACCESS KEY 1:
PERMANENT ACCESS KEY 2:

These four 48-bit fields are used to hold access keys for accessing objects through the Basic File System. Normally UNO will contain the User Number of the user to which the sub-process belongs and TAK will hold whatever key is being currently used by the sub-process. PAK1 and PAK2 are provided for saving arbitrary access keys.

USPUN:

This 48-bit field is intended to contain the File System's Unique Name for the file on which the sub-process' Utility Sub-Process resides. If the sub-process is a utility-ring sub-process, this field is the utility program's own Unique Name.

READ-ONLY BITS:

These 64 bits specify the read-only status of the 64 pages in the sub-process address space. They are copied, along with the corresponding PMT indices from the MAP, into the process' map when the sub-process is made active.

.PMT INDICES (MAP):

This string of 64 8-bit bytes specifies the sub-process' address space in terms of pointers to page names in the Process Memory Table. Only the first 32 bytes of the MAP (and the first 32 READ-ONLY BITS) have significance for utility-ring sub-processes.

III   The Sub-Process Call Stack

The Sub-Process System includes MCALLs by which one sub-process may call a function in another sub-process.   In order to allow the called function to return control (by another MCALL) to the sub-process which called it, the system must save some information about the state of the caller. This information consists primarily of the SPT index of the caller and the values to which the P, L, and G registers should be set on return.

Figure 4A shows the format of an entry in the table, called the Sub-Process Call Stack (SPCS), in which this sub-process return descriptor is saved.   A sub-process acquires an entry on SPCS (at "stack level -1") when it becomes active, that is, when it is called.   At this time, the sub-process' SPT index is put in the entry and certain other fields are initialized.   When the called sub-process itself calls another sub-process, its P, L, and G registers are saved in the entry (which becomes stack level $\emptyset$).

The fields of an SPCS entry hold the following information.

NIS:

This flag is set when the sub-process (in its incarnation at the stack level described by this entry) makes itself non-interruptable.   Non-interruptability is described in document IWS/W-11 on the "Interrupt and Wake-up System."

NIC:

This flag is set when the SPCS entry is acquired if the immediately preceding entry has either NIS or NIC set. It means that the sub-process being activated is non-interruptable as a result of being called from a non-interruptable sub-process.

SPNO:

The SPT index of the sub-process being called is recorded here at the time of the call.

CAKF:

If this flag is set in an SPCS entry, the called sub-process is allowed to copy the TEMPORARY ACCESS KEY of its caller into its own SPT entry. The calling sub-process specifies at call time the value to be given to CAKF.

CC:

The Basic System code which actually passes control to the sub-process being called may generate any of a number of traps without completing the transfer. In some cases it may be desirable to call another sub-process to handle the trap and then to try to pass control again when the trap-handling function returns. The Basic System could save its own P, L, and G registers in the SPCS entry and just resume execution at the point they define. This would probably lead to disaster, however, since there is no way to insure that the sub-process called to handle the trap will, for example, preserve the central registers. This problem is solved by saving in the stack entry enough information to

allow the entire function which transfers control to the
sub-process to be re-executed. This information is saved
in the fields EPNO, PAR1, and PAR2 shown in figure 4B.
The CC flag is reset when this information is saved and set
when the system detects that the call has been successfully
completed. (CC stands for "Call Completed.")

PC, LR, GR:

The P-counter and L and G registers of the sub-process are
saved here when it calls another sub-process.

NIET:

This 47-bit field holds the real time at which non-inter-
ruptability is to expire. It is loaded from the corres-
ponding field of the immediately preceding stack entry at
call time. If the sub-process is interruptable, NIET is
zero.

EPNO (Figure 4B):

When CC=∅, this field holds an index into the called sub-
process' sub-process entry point vector. It has no signi-
ficance when CC=1.

PAR1 (Figure 4B):

When CC=∅ and EPNO=∅ this holds the trap number of the trap
which the sub-process is being called on to handle. When
CC=∅ and EPNO=1 this field holds the interrupt number of
the interrupt which caused the sub-process to be called.
It has no meaning in any other cases.

PAR2 (Figure 4B):

This field only has meaning in the case $C=\emptyset$, EPNO=$\emptyset$. It then holds the parameter being passed to the called sub-process' trap-handling function.

IV   MCALLs on the Sub-Process System

The following pages describe each of the MCALLs on SPS by

giving

(1)   the SPL declaration for the function.

(2)   the values returned when the function succeeds,

(3)   the conditions under which the function will fail and
the error codes and error message numbers returned in
each case, and

(4)   a description of what the function does.

The function descriptions make reference to the following

parameters.

Name	Value	Significance
NSPTE	8	The number of elements in the Sub-Process Table (SPT) and therefore the maximum number of sub-processes which may co-exist in a process.
LSPTE	42	The number of words occupied by each SPT element.
NSPCSE	16	The number of entries in the Sub-Process Call Stack array and therefore the maximum depth to which sub-process calls may be stacked.
LSPCSE	5	The number of words in an SPCS entry.
USER'EP	8	The standard location of the sub-process entry point array descriptor for a user-ring sub-process.
USER'EG	$\emptyset$	The standard setting of the G register to be used when entering a user-ring sub-process.
MAXEPNO	1$\emptyset$23	The maximum acceptable index into a sub-process' entry point array. This allows for 1024 entry points, the first two of which are reserved for trap and interrupt functions.

NORMAL'SB   —   The value to which the STATUS BITS word of an SPT entry is initialized. The value is DPNIC + DCWSO + DDWSO + DPNOD. (See Figure 2.)

NORMAL'TM   Ø   The value to which the TRAP MASK word of an SPT entry is initialized. A sub-process is expected to arm those traps it wishes to handle.

NORMAL'SCB   —   The value to which the STATUS CONTROL BITS word of an SPT entry is initialized. The value is DPNIC + DCWSO + DDWSO + DPNOD. (See Figure 2.)

NORMAL'TCM   —   The value to which the TRAP CONTROL MASK of an SPT entry is initialized. The value is MACC + PRO + PNIM + PNIC + PI + TI + BLL + ILIM + PNOD + DWSO + CWSO + NEP + DMRD + NILE + SPCSO + PMTO. (See Figure 3.)

The descriptions also make reference to the variables CSP and SPCSL. The first of these is the SPT index of the currently active sub-process, which is imagined to have made the call to the function being discussed. The second is the SPCS index of the stack entry for the currently active sub-process.

Many of the functions take an SPT index as one of their arguments. In every such case, -1 is an acceptable value for this argument. With the single exception of CREATE'SP, -1 supplied as an SPT index is taken to mean CSP, the index of the entry for the current sub-process.

Every one of these MCALLs has at least one failure return. The failure returns uniformly return two integer quantities. The first is a character constant consisting of three 8-bit characters which are intended to be suggestive of the nature

of the error condition causing the failure. These error codes and the phrases they are intended to suggest are listed in Appendix B. The second argument is an index into an array of system error messages which provide a more complete description of the error. Appendix C lists the error message numbers which appear in the SPS MCALLs with tentative specifications of the strings to which they will correspond.

A few terms need definition:

An SPT entry is _free_ if its NAME field is $\emptyset$.

A sub-process is called a _utility sub-process_ if it is designed to run in the Utility Ring.

A sub-process is called a _user sub-process_ if it is designed to run in the User Ring.

The _ancestors_ of a sub-process are all the sub-processes which appear below it in its FATHER tree.

The _root_ of a FATHER tree is the (unique) sub-process in the tree which has no FATHER.

One sub-process _controls_ another if its KEY includes the other's NAME.

One sub-process _has access to_ another if the bit-wise AND of its KEY with the other's CALL MASK is non-zero.

Creating and Destroying Sub-Processes

A sub-process creates another one by making an entry in the
Sub-Process Table. The first step in making an SPT entry
is to call the function CREATE'SP. This function "acquires"
a free SPT entry and initializes it to certain standard
values. If these standard values are what are desired, it
only remains for the creating sub-process to specify the new
sub-process' address space (with SET'MAP). If necessary, the
standard sub-process definition may be modified, by the
use of SET'SPT'FIELD. It will be noticed that there is no
way to create a utility sub-process with the MCALLs described
in this document. This limitation will be removed shortly.

A sub-process which controls another may delete it (remove
its definition from SPT) by the use of the function
DESTROY'SP.

CREATE'SP - Acquire and Initialize an SPT Entry

Declaration:

   FUNCTION CREATE'SP(SPTX), FRETURN, MONITOR ← 9∅;

Success Return:

   RETURN SPTX;

Failure Returns:

   (1)   FRETURN('SPI', 138) unless

      (a) $1 \leq SPTX \leq NSPTE$, or

      (b)   SPTX = -1.

   (2)   FRETURN('SPF', 1∅3) if

      (a)   SPTX = -1 and there are no free SPT entries, or

      (b)   SPTX ≠ -1 and SPT[SPTX] is not free.

Action:

      If SPTX = -1, SPT is searched for a free entry and

   the index of the first one found is assigned to SPTX.

      SPT[SPTX] is cleared, and then initialized as follows.

   (1)   NAME ← 2↑SPTX

   (2)   CM ← NAME(CSP)

   (3)   KEY ← NAME

   (4)   FATHER ← CSP

   (5)   USP ← USP(CSP)

   (6)   RING ← ∅

   (7)   EP ← USER'EP

   (8)   EG ← USER'EG

   (9)   SB ← NORMAL'SB AND (SCB(CSP) AND SB(CSP))

   (1∅)   TM ← NORMAL'TM AND (TCM(CSP) AND TM(CSP))

CREATE'SP (continued)

(11)   SCB ← NORMAL'SCB AND SCB(CSP)

(12)   TCM ← NORMAL'TCM AND TCM(CSP)

(13)   UNO ← UNO(CSP)

(14)   USPUN ← USPUN(CSP)

SPT[SPTX] is incorporated into the sub-process control structure by merging its NAME into the KEYs of all its ancestors.

SPTX is returned as the value of this MCALL.

DESTROY'SP - Delete the Contents of an SPT Entry

Declaration:

FUNCTION DESTROY'SP(SPTX), FRETURN, MONITOR - 91;

Success Return:

RETURN, or

SP'RETURN in the case SPTX = CSP.

Failure Returns:

(1)   FRETURN('CSE', 162) if SPTX = CSP and the Sub-process
       Call Stack is empty.

(2)   FRETURN('SPI', 138) unless $1 \leq SPTX \leq NSPTE$.

(3)   FRETURN('SPC', 16Ø) unless SPT[SPTX] is controlled
       by CSP.

(4)   FRETURN('SPS', 161) if SPT[SPTX] appears on the
       Sub-Process Call Stack at any level except the very
       top.

Action:

If SPTX = -1, it is taken to refer to CSP.

NAME(SPTX) is removed from all CM, KEY, and USP
fields of SPT entries and from all Access Locks and
Control Locks in ICT, OFT, and PMT. Any entries in ICT,
OFT, and PMT whose Control Locks become zero as a result
of the removal of NAME(SPTX) are DELETEd.

Any SPT entry which has SPTX as its FATHER is given
FATHER(SPTX) instead.

SPT[SPTX] is cleared and the MCALL returns, either
in the normal manner, or through SP'RETURN, in the special
case where SPTX = CSP.

Passing Control Between Sub-Processes

This section describes the MCALLs by which one sub-process may pass control to another. The general procedure is for the current sub-process to call the Basic System and for the Basic System to then call a specially prepared function (designated as an SP'ENTRY) in the other sub-process. The MCALLs SP'CALL, SP'JUMP, and SP'BRANCH allow the calling sub-process to specify the sub-process to be called and the point at which it is to be entered. The sub-process called as a result of SP'TRAP or TRAP'RETURN is determined by the calling sub-process' FATHER tree and the TRAP MASKs therein and is not under control of the caller. There is one additional mechanism, the inter-process interrupt system, which causes control to be passed to a new sub-process. This mechanism is described in document IWS/W-11.

With the exception of SP'TRAP and its variant, TRAP'RETURN, the functions about to be described do not allow for the passing of arguments from one sub-process to another. A later version of the Sub-Process System will have this deficiency removed.

SP'CALL - Call a Sub-Process

Declaration:

FUNCTION SP'CALL(SPTX, ENTRYNO, FLAG), FRETURN,

MONITOR ← 111;

Success Return:

This MCALL does not return to its caller if it succeeds. Control will be returned to the caller when the called sub-process returns (with SP'RETURN).

Failure Returns:

(1) FRETURN('SPI', 138) unless $1 \leq SPTX \leq NSPTE$.

(2) FRETURN('EPN', 173) unless $2 \leq ENTRYNO \leq MAXEPNO$.

(3) FRETURN('SPA', 140) unless CSP either controls SPT[SPTX] or has access to it.

(4) FRETURN('RCS', 141) unless there is sufficient room on the Sub-Process Call Stack to record the call of SPTX and a subsequent series of calls on all the sub-processes which are ancestors of it. This is to insure that any software trap generated by SPTX can be handled in an orderly manner.

(5) FRETURN('ARG', 172) unless FLAG is $\emptyset$ or 1.

Action:

This MCALL transfers control to the sub-process defined by SPT[SPTX] by calling the $ENTRYNO^{th}$ function in that sub-process' SP'ENTRY transfer vector. If SPTX = -1, the sub-process called is the currently active one, CSP. No arguments are passed, but the central registers are preserved across the call. The final

SP'CALL (continued)

argument, FLAG, determines whether the called sub-process
will be allowed to execute the special function COPY'TAK.
If FLAG = 1 execution will be allowed; if it is $\emptyset$,
execution will be illegal.

The P, L, and G registers of the calling sub-process
are saved so that execution can be continued when the
called sub-process returns (with SP'RETURN or an
equivalent).

If the calling sub-process is non-interruptable with
a non-interruptability expiration time, NIET, the called
sub-process is made non-interruptable with the same
value for NIET.

SP'JUMP - Jump to a Sub-Process

Declaration:

FUNCTION SP'JUMP(SPTX, ENTRYNO, FLAG), FRETURN,

MONITOR ← 112;

Success Return:

This function does not return to its caller if it succeeds.

Failure Returns:

(1)   FRETURN('SPI', 138) unless $1 \leq$ SPTX $\leq$ NSPTE.

(2)   FRETURN('EPN', 173) unless $2 \leq$ ENTRYNO $\leq$ MAXEPNO.

(3)   FRETURN('SPA', 14Ø) unless CSP either controls SPT[SPTX] or has access to it.

(4)   FRETURN('RCS', 141) unless there are as many unused Sub-Process Call Stack entries as there are ancestors of SPTX.

(5)   FRETURN('ARG', 172) unless FLAG is Ø or 1.

Action:

Like SP'CALL, SP'JUMP transfers control to sub-process SPTX by calling the ENTRYNOth function in its array of SP'ENTRY functions. As usual, SPTX = -1 is taken to mean the current sub-process, CSP. The central registers are passed unchanged from the calling sub-process to the one being called, but no other arguments are transmitted.

SP'JUMP differs from SP'CALL in that no provision is made for the called sub-process to return to its caller. In fact, the calling sub-process completely

SP'JUMP (continued)

disappears from the Sub-Process Call Stack. It will look to the called sub-process as if it were called by the caller of CSP instead of CSP itself.

The called sub-process will be allowed to execute COPY'TAK iff the calling sub-process was authorized to do so and the value of FLAG is 1.

If the caller of the calling sub-process is non-interruptable with non-interruptability expiration time NIET, the called sub-process is made non-interruptable until the same time.

SP'TRAP - Generate a Soft-ware Trap

Declaration:

FUNCTION SP'TRAP(TRAPNO, PARAMETER, FLAG), FRETURN,

MONITOR ← 113;

Success Return:

This function doesn't return to its caller if it succeeds. Control will return to the caller when the sub-process which handles the trap executes an SP'RETURN.

Failure Returns:

(1) FRETURN('TNO', 139) unless $0 \leq$ TRAPNO ≤ 23.

(2) FRETURN('ARG', 172) unless FLAG is 0 or 1.

Action:

Starting with sub-process CSP and following its FATHER chain in SPT, we search for an SPT entry with bit TRAPNO set in its TRAP MASK (TM). Let SPTX be the SPT index of the first such entry, or the root of CSP's FATHER tree if there are none.

Control is transferred to sub-process SPTX by calling its SP'TRAP'ENTRY function, which is the 0th entry in its array of SP'ENTRY functions. TRAPNO and PARAMETER are passed by the call and the central registers are transmitted unchanged.

The P, L, and G registers of the calling sub-process are saved, so that execution can be resumed when the trap-handling function returns (with SP'RETURN).

If FLAG = 1, the sub-process which fields the trap

SP'TRAP (continued)

will be authorized to execute COPY'TAK. If FLAG = $\emptyset$, it will not.

The algorithm for finding the sub-process to which the trap is to be sent is in reality slightly more complicated than what was described above. In searching down the FATHER tree, we ignore SPT entries whose distance from the root of the tree is greater than the number of free Sub-Process Call Stack entries. In particular, this means that if there is only one free SPCS entry, we always call the root of the tree.

If the sub-process which generates the trap is non-interruptable with non-interruptability expiration time NIET, the sub-process which fields the trap is made non-interruptable until the same time.

When the Monitor wants to reflect a ring-independent hardware trap to a sub-process, it uses SP'TRAP. Primarily for this reason, bit TRAPNO in the TRAP MASK of the called sub-process is reset before the call is made.

TRAP'RETURN - Pop up the Sub-Process Call Stack and Generate

a Software Trap

Declaration:

FUNCTION TRAP'RETURN(TRAPNO, PARAMETER, FLAG), FRETURN,

MONITOR ← 114;

Success Return:

This MCALL doesn't return to its caller if it succeeds.

Failure Returns:

(1)   FRETURN('TNO', 139) unless $0 \leq$ TRAPNO $\leq$ 23.

(2)   FRETURN('ARG', 172) unless FLAG is 0 or 1.

(3)   FRETURN('CSE', 152) if the Sub-Process Call Stack
      is empty.

Action:

This MCALL is provided to allow a sub-process to
convert a call on itself into a software trap. The
system deletes all record of the call and proceeds as if
the sub-process which made the call had instead executed
an SP'TRAP. See the description of SP'TRAP for the
details of the action taken. There is one small anomaly.
The sub-process which gets called to handle the trap is
given authority to use COPY'TAK iff the current sub-
process has that privilege and FLAG is 1.

SP'BRANCH - Branch into a Sub-Process

Declaration:

FUNCTION SP'BRANCH(SPTX, PC, LREG, GREG, FLAG), FRETURN,

MONITOR ← 115;

Success Return:

This function doesn't return to its caller if it
succeeds, but the sub-process into which it branches
may return to the calling sub-process by executing an
SP'RETURN.

Failure Returns:

(1) FRETURN('SPI', 138) unless $1 \leq SPTX \leq NSPTE$.

(2) FRETURN('SPC', 142) unless CSP controls SPT[SPTX].

(3) FRETURN('RCS', 141) unless there is enough room on
SPCS to record calls to SPTX and all its ancestors.

(4) FRETURN('RNG', 173) unless PC, LREG, and GREG are addresse
in the ring specified by the RING field of SPT[SPTX].

(5) FRETURN('ARG', 172) unless FLAG is $\emptyset$ or 1.

Action:

Control passes to sub-process SPTX at location PC.
The L and G registers are set from LREG and GREG. The
central registers are passed unchanged. As usual,
SPTX = -1 is taken to refer to the current sub-process,
CSP.

With the one difference that the new sub-process
is simply entered at a specified location instead of
being called through one of its SP'ENTRY functions, this
MCALL is identical with SP'CALL.

SP'BRANCH (continued)

Whether the "called" sub-process will be allowed to
execute COPY'TAK is determined by the value of the final
argument, FLAG. · A value of 1 allows execution, a value
of Ø forbids it.

The calling sub-process' P, L, and G registers are
saved so that the called sub-process may return control
to it by executing an SP'RETURN.

The non-interruptability status of the calling sub-
process is carried over to the new sub-process. That is,
if the calling sub-process is non-interruptable until
a certain time, NIET, the new sub-process is made non-
interruptable until the same time.

SP'RETURN – Return to Calling Sub-Process

Declaration:

FUNCTION SP'RETURN( ), FRETURN, MONITOR ← 116;

Success Return:

This MCALL doesn't return to its caller if it succeeds.

Failure Returns:

(1) FRETURN('CSE', 152) if the Sub-Process Call Stack
is empty.

Action:

A sub-process which has been called as the result of
SP'CALL, SP'JUMP, SP'TRAP, TRAP'RETURN, or SP'BRANCH
can return to the sub-process which called it by
executing SP'RETURN. Control is returned to the old
sub-process with P, L, and G restored to the values
which were saved when the current sub-process was called.
The central registers are preserved over the return.

JUMP'RETURN - Return to a Specified Level in the Sub-Process
Call Stack

Declaration:

FUNCTION JUMP'RETURN(STKL), FRETURN, MONITOR ← 117;

Success Return:

None, unless STKL = -1. This rather strange case is
discussed below.

Failure Returns:

(1) FRETURN('CSL', 153) unless $-1 \leq STKL \leq SPCSL -1$.

(2) FRETURN('SPC', 154) unless the calling sub-process,
CSP, controls all the sub-processes which are
entered in the Sub-Process Call Stack at levels -1
through STKL.

Action:

This function pops the Sub-Process Call Stack up to
level STKL and returns control to the sub-process
whose SP'RETURN descriptor (P, L, and G) was stacked
at that level. The central registers are preserved by
this function. If STKL = -1, the function just returns
to its caller. Note that the function can fail even
in this case if the calling sub-process doesn't control
its own SPT entry.

MARK'CALL - Record a Function Call on the Sub-Process Call
Stack

Declaration:

FUNCTION MARK'CALL(PC, LREG, GREG), FRETURN,

MONITOR ← 118;

Success Return:

RETURN;

Failure Returns:

(1) FRETURN('RCS', 141) unless there is at least one
more free Sub-Process Call Stack entry than there
are ancestors of CSP.

(2) FRETURN('RNG', 155) unless PC, LREG, and GREG are
all addresses in a ring accessible from the ring
from which the MCALL was made.

Action:

This function is provided primarily to allow utility-
ring functions which have been entered by a UCALL to
record the call on the Sub-Process Call Stack as if they
had been entered with SP'CALL.

READ'SPT - Read an SPT Entry

Declaration:

FUNCTION READ'SPT(SPTX, Array SPTE, Scalar NW), FRETURN,

MONITOR ← 95;

Success Return:

RETURN;

Failure Returns:

(1) FRETURN('SPI', 138) unless $1 \leq SPTX \leq NSPTE$.

Action:

If SPTX = -1, CSP is used in its place.

The first M words of SPT[SPTX] are copied into the

caller's array, SPTE, where M is the minimum of LSPTE

and NW.

READ'SPCS - Read an SPCS Entry

Declaration:

FUNCTION READ'SPCS(STKL, Array SPCSE), FRETURN,

MONITOR ← 96;

Success Return:

RETURN;

Failure Returns:

(1) FRETURN('CSL', 153) unless $-1 \leq STKL \leq SPCSL -1$.

Action:

STKL is interpreted as a stack level number, not as an SPCS index. Stack level -1 refers to the SPCS entry for the current sub-process, stack level $\emptyset$ to the entry for the sub-process which called it, stack level 1 to that for _its_ caller, and so on. The LSPCSE words of the SPCS entry selected by STKL are copied into the caller's array, SPCSE. The CC field of the entry returned determines which of figures 4A and 4B should be used to interpret it. CC = $\emptyset$ refers to figure 4B, CC = 1 to figure 4A.

READ'SPT'FIELD - Read Selected Field of an SPT Entry

Declaration:

FUNCTION READ'SPT'FIELD(SPTX, FLDNO), FRETURN, MONITOR ← 97;

Success Return:

RETURN FLD; where FLD is the contents of the field speci-
fied by SPTX and FLDNO.

Failure Returns:

(1) FRETURN('SPI', 138) unless $1 \leq$ SPTX $\leq$ NSPTE.

(2) FRETURN('ARG', 165) if FLDNO is not an acceptable field
specification (see below).

Action:

SPTX is used to select an SPT entry. If SPTX = -1, the
entry selected is the one which describes the currently
active sub-process, CSP.

FLDNO selects one of 12 fields within SPT[SPTX], in ac-
cordance with the following table.

FLDNO	Field Selected
Ø or 'NAM'	NAME
1 or 'CM'	CALL MASK (CM)
2 or 'KEY'	KEY
3 or 'FTH'	FATHER
4 or 'USP'	UTILITY SUB-PROCESS (USP)
5 or 'RNG'	RING
6 or 'EP'	ENTRY POINT (EP)
7 or 'EG'	ENTRY G-REGISTER (EG)
8 or 'SB'	STATUS BITS (SB)
9 or 'TM'	TRAP MASK (TM)

READ'SPT'FIELD (continued)

       10 or 'SCB'   STATUS CONTROL BITS (SCB)

       11 or 'TCM'   TRAP CONTROL MASK (TCM)

    READ'SPT'FIELD returns the contents of the selected field as its value.

SET'SPT'FIELD - Set the Value of a Specified Field of an SPT

Entry

Declaration:

FUNCTION SET'SPT'FIELD(SPTX,FLDNO,DATA), FRETURN,

MONITOR ← 98;

Success Return:

RETURN;

Failure Returns:

(1) FRETURN('SPI', 138) unless $1 \leq SPTX \leq NSPTE$.

(2) FRETURN('SPC', 143) unless SPT[SPTX] is controlled by

the current sub-process, CSP.

(3) FRETURN('ARG', 167) if FLDNO is not an acceptable

field specification. See the description of

READ'SPT'FIELD for a list of acceptable values of

FLDNO and the SPT fields they select.

(4) In addition to the three general errors just described,

there are others having to do with the validity of

DATA as a new value for the field selected by FLDNO.

We list these for each of the 12 fields which FLDNO

may select.

(a) NAME -

(1) FRETURN('MNM', 168) unless DATA is identical

with the current NAME field of SPT[SPTX].

(b) CALL MASK (CM) -

Any value of DATA is acceptable.

(c) KEY -

(1) FRETURN('SPC', 148) if DATA contains any bits

which are in neither the KEY of SPTX nor the

SET'SPT'FIELD (continued)

KEY of CSP (i.e., if CSP is trying to give
SPTX control of SPT entries which it does not
itself control).

(d) FATHER –

(1) FRETURN('SPI', 138) unless $1 \leq$ DATA $\leq$ NSPTE.

(2) FRETURN('SPC', 149) unless SPT[DATA] is con-
trolled by CSP.

(3) FRETURN('FHL', 150) if

(a) DATA = SPTX, or

(b) SPTX is an ancestor of DATA.

(4) FRETURN('RCS', 151) if SPTX appears on the
Sub-Process Call Stack at a level, CSL, such
that the number of ancestors of DATA is greater
than NSPCSE – (CSL + 3).

(e) UTILITY SUB-PROCESS (USP) –

(1) FRETURN('MUS', 170) unless DATA is identical
with the current USP field of SPT[SPTX].

(f) RING –

(1) FRETURN('MRG', 171) unless DATA is identical
with the current RING field of SPT[SPTX].

(g) ENTRY POINT (EP) –

(1) FRETURN('RNG', 157) unless DATA is an address
in the ring specified by the RING field of
SPT[SPTX].

SET'SPT'FIELD (continued)

   (h) ENTRY G-REGISTER (EG) -

       (1) FRETURN('RNG', 157) unless DATA is an address

           in the ring specified by the RING field of

           SPT[SPTX].

   (i) STATUS BITS (SB) -

       (1) FRETURN('MSB', 144) if the exclusive or of

           DATA with the SB field of SPT[SPTX] is not a

           subset of the SCB field of SPT[CSP]. This

           means that CSP cannot set or reset a status

           bit which it doesn't control.

   (j) TRAP MASK (TM) -

       (1) FRETURN('MTM', 147) if the exclusive or of

           DATA with the TM field of SPT[SPTX] is not a

           subset of the TCM field of SPT[CSP]. This

           means that CSP cannot set or reset a trap bit

           which it doesn't control.

   (k) STATUS CONTROL BITS (SCB) -

       (1) FRETURN('MSC', 145) if the exclusive or of

           DATA with the SCB field of SPT[SPTX] is not a

           subset of the SCB field of SPT[CSP]. This

           prevents CSP from modifying status control

           bits it doesn't control.

   (l) TRAP CONTROL MASK (TCM) -

       (1) FRETURN('MTC', 146) if the exclusive or of

           DATA with the TCM field of SPT[SPTX] is not a

SET'SPT'FIELD (continued)

subset of the TCM field of SPT[CSP]. The ef-
fect of this is to prohibit CSP modifying
trap control bits it doesn't control.

Action:

SPTX is used to select an entry in SPT. As with most
of the MCALLs which take an SPT index as an argument,
SPTX = -1 is taken to refer to the SPT entry which defines
the currently active sub-process, CSP. The second argu-
ment, FLDNO, specifies a field within SPT[SPTX] in exactly
the same way as is detailed in the description of
READ'SPT'FIELD. The third argument, DATA, is copied into
the selected field of SPT[SPTX], if the relevant validity
checks succeed.

READ'MAP - Read the Map of an SPT Entry

Declaration:

FUNCTION READ'MAP(SPTX, String MAP), FRETURN, MONITOR ← 99;

Success Return:

RETURN;

Failure Returns:

(1) FRETURN('SPI', 138) unless $1 \leq SPTX \leq NSPTE$.

Action:

If SPTX = -1, this MCALL reads the MAP of CSP.

Let ML = 32 if SPTX is a utility sub-process or 64 if it is a user sub-process, and let M be the minimum of ML and LENGTH(MAP). This function writes the first M bytes of MAP from the first M PMT indices in SPT[SPTX] and its first M READ ONLY BITS. Twelve bit quantities are written into each byte. The last 8 bits are a PMT index and the first bit a READ ONLY BIT.

SET'MAP - Set the Map of an SPT Entry

Declaration:

FUNCTION SET'MAP(SPTX, String MAP), FRETURN, MONITOR ← 1ØØ;

Success Return:

RETURN;

Failure Returns:

(1) FRETURN('SPI', 138) unless $1 \leq$ SPTX $\leq$ NSPTE.

(2) FRETURN('SPC', 137) unless SPT[SPTX] is controlled by CSP.

(3) FRETURN('SPM', 1ØØ) unless

   (a) BYTESIZE(MAP) is 12 or 24, and

   (b) $\emptyset \leq$ LENGTH(MAP) $\leq$ LM, where LM = 32 if SPTX is a utility sub-process or 64 if it is a user sub-process.

(4) FRETURN('SPM', 1Ø1) unless the PMT index field, PMTX, of every byte in MAP satisfies at least one of the following conditions.

   (a) PMTX = $\emptyset$.

   (b) PMTX is identical with the PMT index currently in the corresponding byte of MAP(SPTX).

   (c) $1 \leq$ PMTX $\leq$ NPMTE and CSP has access to PMT[PMTX].

Action:

If SPTX = -1, the map referred to is that of CSP.

The bytes of MAP are used to set the first LENGTH(MAP) PMT indices of SPT[SPTX] and the corresponding READ ONLY BITS. The remaining PMT indices and READ ONLY BITS are cleared. Each byte of MAP is expected

SET'MAP (continued)

to contain a PMT index, PMTX, and a read only bit, RO.

   If BYTESIZE(MAP) is 12, RO is taken from bit $\emptyset$ of the bytes and PMTX is taken from bits 4-11. If BYTESIZE(MAP) is 24, RO is taken from bit 12 and PMTX from bits 16-23.

   If SPTX is the current sub-process in either the User or Utility ring, the Process Map is updated to correspond to the new MAP(SPTX) and the Physical Map is cleared.

READ'MAP'BYTE - Read a Byte in the Map of an SPT Entry

Declaration:

FUNCTION READ'MAP'BYTE(SPTX, BYTENO), FRETURN, MONITOR $\leftarrow$ 1Ø1;

Success Return:

RETURN BYTE; where BYTE contains in bits 16-23 the $BYTENO^{th}$

PMT index from the MAP of SPT[SPTX], and in

bit 12 the corresponding READ ONLY BIT.

Failure Returns:

(1) FRETURN('SPI', 138) unless $1 \leq SPTX \leq NSPTE$.

(2) FRETURN('MBN', 163) unless

$\emptyset \leq BYTENO \leq LM$, where LM = 31 if SPTX is a utility

sub-process or 63 if it is a user sub-process.

Action:

SPTX is used to select an entry in SPT (-1 selects

CSP's entry) and BYTENO to choose a PMT index from the

entry's map. The value of the MCALL is a word with this

PMT index in bits 16-23 and the corresponding READ ONLY

BIT in bit 12.

SET'MAP'BYTE - Set a Byte in the Map of an SPT Entry

Declaration:

FUNCTION SET'MAP'BYTE(SPTX, BYTENO, BYTE), FRETURN,

MONITOR ← 1Ø2;

Success Return:

RETURN;

Failure Returns:

(1) FRETURN('SPI', 138) unless $1 \leq SPTX \leq NSPTE$.

(2) FRETURN('SPC', 137) unless SPT[SPTX] is controlled by CSP.

(3) FRETURN('MBN', 163) unless

$\emptyset \leq BYTENO \leq LM$, where LM = 31 if SPTX is a utility sub-process or 63 if it is a user sub-process.

(4) FRETURN('SPM', 1Ø1) unless the PMT index, PMTX, in BYTE satisfies at least one of the following conditions

(a) PMTX = $\emptyset$.

(b) PMTX is identical with the PMT index currently in the byte of MAP(SPTX) selected by BYTENO.

(c) $1 \leq PMTX \leq NPMTE$ and CSP has access to PMT[PMTX].

Action:

If SPTX = -1, it is taken to refer to CSP.

The byte of MAP(SPTX) selected by BYTENO is set from bits 16-23 of BYTE and the corresponding READ ONLY BIT is set from bit 12.

If SPTX is the current sub-process in either the User or Utility ring, the Process Map is updated to correspond to the new MAP(SPTX) and the Physical Map is cleared.

READ'ACCESS'KEY - Read an Access Key from an SPT Entry

Declaration:

LONG FUNCTION READ'ACCESS'KEY(SPTX, KEYNO), FRETURN,

MONITOR ← 1Ø3;

Success Return:

RETURN AKY; where AKY is the value of the access key se-

lected by SPTX and KEYNO.

Failure Returns:

(1) FRETURN('SPI', 138) unless $1 \leq$ SPTX $\leq$ NSPTE;

(2) FRETURN('ARG', 166) if KEYNO is not an acceptable Ac-

cess Key specification (see below).

Action:

SPTX is used as an index to select an entry in SPT.

SPTX = -1 selects the entry corresponding to the current

sub-process. KEYNO selects one of the four access keys

in SPT[SPTX] according to the following.

KEYNO	Access Key Selected
Ø or 'TAK'	TEMPORARY ACCESS KEY (TAK)
1 or 'UNO'	USER NUMBER (UNO)
2 or 'PK1'	PERMANENT ACCESS KEY 1 (PAK1)
3 or 'PK2'	PERMANENT ACCESS KEY 2 (PAK2)

The (48-bit) access key is returned as the value of

the MCALL.

COPY'ACCESS'KEY - Copy an Access Key from one SPT Entry to Another

Declaration:

FUNCTION COPY'ACCESS'KEY(SPTX1, SPTX2, KEY1, KEY2),

FRETURN, MONITOR ← 1∅4;

Success Return:

RETURN;

Failure Returns:

(1) FRETURN('SPI', 138) unless SPTX1 and SPTX2 are in the interval [1, NSPTE].

(2) FRETURN('SPC', 143) unless the calling sub-process, CSP, controls both SPT[SPTX1] and SPT[SPTX2].

(3) FRETURN('ARG', 166) unless KEY1 and KEY2 are acceptable access key selectors. See the description of READ'ACCESS'KEY for an explanation of how these arguments are interpreted.

Action:

This MCALL sets the access key selected by SPTX2 and KEY2 from the one selected by SPTX1 and KEY1. SPTX1 and SPTX2 are used as SPT indices, with the usual convention that when -1 is offered as an SPT index, it refers to the SPT entry for the current sub-process. KEY1 and KEY2 select one of the four access keys in SPT[SPTX1] and SPT[SPTX2] in exactly the same way that KEYNO selects an access key in the function READ'ACCESS'KEY.

COPY'TAK - Copy TEMPORARY ACCESS KEY

Declaration:

    FUNCTION COPY'TAK( ), FRETURN, MONITOR ← 1Ø5;

Success Return:

    RETURN;

Failure Returns:

    (1) FRETURN('CNA', 174) unless the CAKF flag is set in the
        SPCS entry at stack level -1.

Action:

        This MCALL copies the TEMPORARY ACCESS KEY of the sub-
    process which called the current sub-process into the
    TEMPORARY ACCESS KEY field of the current sub-process.

Format of an Entry in SPT

0	0 ╳ 23 NAME 11 12 ╳ 14 15 CALL MASK (CM) 23	
1	0 ╳ 23 KEY 11 12 ╳ 15 16 FATHER 19 20 USP 23	
2	0 RING 12 ╳ 56 ENTRY POINT (EP) 23	
3	0 ╳ 56 ENTRY G-REGISTER (EG) 23	
4	0 STATUS BITS (SB) 23	
5	0 TRAP MASK (TM) 23	
6	0 STATUS CONTROL BITS (SCB) 23	
7	0 TRAP CONTROL MASK (TCM) 23	
8	0 23	
9	0 TEMPORARY ACCESS KEY (TAK) 23	
10	0 23	
11	0 USER NUMBER (UNO) 23	
12	0 23	
13	0 PERMANENT ACCESS KEY 1 (PAK1) 23	
14	0 23	
15	0 PERMANENT ACCESS KEY 2 (PAK2) 23	
16	0 23	
17	0 UNIQUE NAME OF UTILITY SUB-PROCESS (USPUN) 23	
18	0 23	
19	0 READ ONLY BITS 23	
20	0 15 16 PMT INDEX 0 23	
21	0 PMT INDEX 1 7 8 PMT INDEX 2 15 16 PMT INDEX 3 23	
	. . .	
41	0 PMT INDEX 61 7 8 PMT INDEX 62 15 16 PMT INDEX 63 23	

Figure 1

Format of SB and SCB Fields in SPT

0	1	2	3	4	5	6	7	8	9	10	11	12 23
PRP	SYS		940M	DPNIC	DPNIM	WFI	DCWSO	DDWSO	DPNOD	MSP	SD	⨯

PRP   - Sub-process is a proprietary program

SYS   - Sub-process has system privileges

940M   - Sub-process runs in 940 Mode

DPNIC - The system is to automatically put referenced

          pages into the Core Working Set

DPNIM - The system is to create new pages when the

          sub-process refers to pages not in its map

WFI   - The sub-process is allowed to open files for

          output in certain cases where this is not

          normally allowed

DCWSO - The system is to automatically correct Core

          Working Set Overflow

DDWSO - The system is to automatically correct Drum

          Working Set Overflow

DPNOD - The system is to automatically put referenced

          pages into the Drum Working Set

MSP   - The sub-process has Master Sub-Process

          privileges

SD   - The sub-process has System Diagnostic

          privileges

Figure 2

Format of TM and TCM Fields in SPT

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16 ——— 23
MACC	PRO	PNIM	PNIC	PI	TI	BLL	ILIM	PNOD	DWSO	CWSO	NEP	DMRD	NILE	SPCSO	PMTO	✕

MACC - Memory Access Trap

PRO   - Page Read Only Trap

PNIM - Page Not in Map Trap

PNIC - Page Not in Core Trap

PI   - Privileged Instruction Trap

TI   - Trapped Instruction Trap

BLL   - BLL error

ILIM - Indirection Limit Exceeded

PNOD - Page Not on Drum Trap

DWSO - Drum Working Set Overflow

CWSO - Core Working Set Overflow

NEP   - Non-Existent Page

DMRD - Drum Read Error

NILE - Non-interruptability Limit Exceeded

SPCSO - Sub-Process Call Stack Overflow

PMTO - Process Memory Table Overflow

Figure 3

Normal Format of an SPCS Entry

0	NIS / NIC	SPNO		SAVED P-COUNTER (PC)
1	CAKF / CC			SAVED L-REGISTER (LR)
2				SAVED G-REGISTER (GR)
3				NON-INTERRUPTABILITY
4				EXPIRATION TIME (NIET)

NIS — Non-interruptability set

NIC — Non-interruptability copied from calling

     sub-process

SPNO — Index of SPT entry which defines this

     sub-process

CAKF — Copy caller's Temporary Access Key

CC — Call Completed

NIET — Real time at which non-interruptability

     status will expire

Figure 4A

Alternative Format of an SPCS Entry

NIS - Non-interruptability set

NIC - Non-interruptability copied from calling
       sub-process

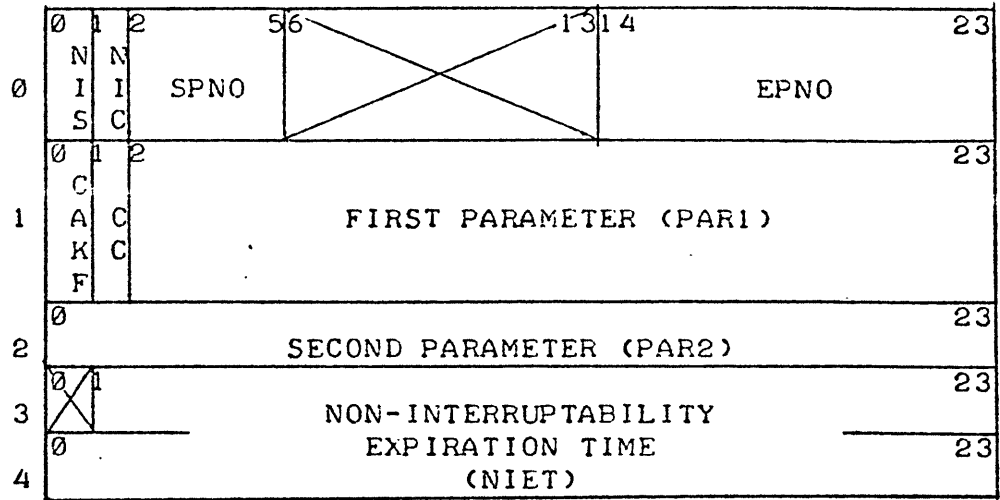SPNO - Index of SPT entry which defines this
       sub-process

EPNO - Entry Point Number

CAKF - Copy Caller's Temporary Access Key

CC   - Call Completed

PAR1 - Interrupt or trap number

PAR2 - Trap parameter

NIET - Real time at which non-interruptability
       status will expire

Figure 4B

Appendix A:

SPS MCALLs in Numeric Order

Number		Name	Page
9Ø	-	CREATE'SP	17
91	-	DESTROY'SP	19
92	-		
93	-		
94	-		
95	-	READ'SPT	34
96	-	READ'SPCS	35
97	-	READ'SPT'FIELD	36
98	-	SET'SPT'FIELD	38
99	-	READ'MAP	42
1ØØ	-	SET'MAP	43
1Ø1	-	READ'MAP'BYTE	45
1Ø2	-	SET'MAP'BYTE	46
1Ø3	-	READ'ACCESS'KEY	47
1Ø4	-	COPY'ACCESS'KEY	48
1Ø5	-	COPY'TAK	49
1Ø6	-		
1Ø7	-		
1Ø8	-		
1Ø9	-		
11Ø	-		
111	-	SP'CALL	21
112	-	SP'JUMP	23
113	-	SP'TRAP	25

Appendix A: (continued)

Appendix B:

Error Codes Returned by SPS MCALLs

'ARG' — Argument value unacceptable

'CNA' — Call not allowed

'CSE' — Call stack (SPCS) empty

'CSL' — Call stack (SPCS) level out of bounds

'EPN' — Entry point number illegal

'FHL' — Fatherhood loop in SPT

'MBN' — Map byte number out of bounds

'MNM' — Modify sub-process NAME

'MRG' — Modify sub-process RING

'MSB' — Modify STATUS BITS

'MSC' — Modify STATUS CONTROL BITS

'MTC' — Modify TCM

'MTM' — Modify TM

'MUS' — Modify sub-process USP

'RCS' — Room on SPCS

'RNG' — Ring error

'SPA' — Sub-process access needed

'SPC' — Sub-process control needed

'SPF' — SPT (or SPT entry) full

'SPI' — SPT index out of bounds

'SPM' — Sub-process map

'SPS' — Sub-process on call stack

'TNO' — Trap number out of bounds

Appendix C:

Error Message Numbers Returned by SPS MCALLs

100 - byte size or length of string descriptor to SET'MAP

101 - value of byte offered to SET'MAP unacceptable

103 - attempt to acquire occupied SPT entry

137 - attempt to set map of uncontrolled sp

138 - SPT index out of bounds

139 - trap number out of bounds

140 - attempt to call inaccessible sp

141 - not enough room on SPCS for SP'CALL or MARK'CALL

142 - attempted SP'BRANCH on uncontrolled sp

143 - attempt to set uncontrolled SPT entry

144 - attempt to modify uncontrolled STATUS BITS

145 - attempt to modify uncontrolled SCB bits

146 - attempt to modify uncontrolled TCM bits

147 - attempt to modify uncontrolled TM bits

148 - attempt to set uncontrolled bits in sp KEY

149 - attempt to set FATHER to uncontrolled sp

150 - attempt to create FATHERhood loop in SPT

151 - lack of room on SPCS forbids setting FATHER

152 - attempted SP'RETURN from empty stack

153 - call stack level for JUMP'RETURN or READ'SPCS out of
       bounds

154 - attempt to JUMP'RETURN over un-controlled sub-process

155 - offered P,L,G for MARK'CALL violate ring restrictions

157 - offered EP or EG violates ring restriction

160 - attempt to delete un-controlled SPT entry

Appendix C (continued)

161 - attempt to delete SPT entry which appears on SPCS

162 - attempt to commit suicide when SPCS empty

163 - map byte number out of bounds

165 - unacceptable parameter code offered to READ'SPT'FIELD

166 - unacceptable access key code (READ/COPY'ACCESS'KEY)

167 - unacceptable parameter code offered to SET'SPT'FIELD

168 - attempt to modify the NAME of a sub-process

170 - attempt to modify the USP of a sub-process

171 - attempt to modify the RING of a sub-process

172 - offered value for CAKF is neither $\emptyset$ nor 1

173 - illegal entry point number (SP'CALL or SP'JUMP)

174 - un-authorized call on COPY'TAK