North American Response Center

# HP 3000 APPLICATION NOTE #34

## Process Handling

(Using COBOLII Examples)

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# RESPONSE CENTER APPLICATION NOTES

**HP 3000 APPLICATION NOTES** *are published by the North American Response Center twice a month and are distributed with the Software Status Bulletin. These notes address topics where the volume of calls received at the Center indicates a need for addition to or consolidation of information available through HP support services.*

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# PROCESS HANDLING

The purpose of this document is to give experienced programmers a guide to the use of process handling techniques. COBOLII is used in the examples since it is a common language of HP 3000 users.

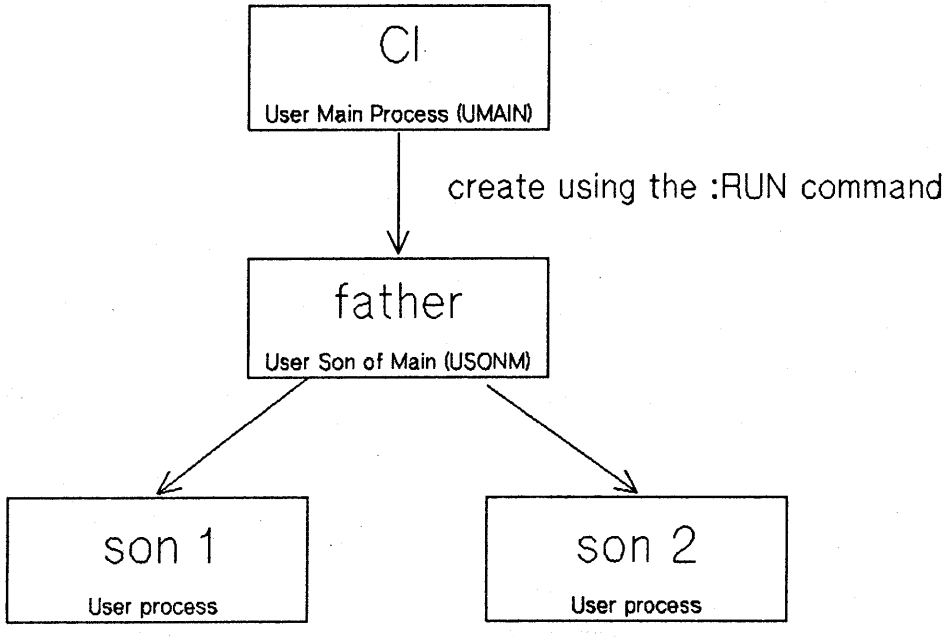
## Overview

Process Handling is a programming technique that allows a process to create descendant processes called sons or 'child processes'. In order for a process to use this technique it must possess the 'PH' (Process Handling) capability. This capability is granted to a program when it is PREPARED either by using the MPE PREP command or the SEGMENTER PREPARE command. The user who 'preps' the program must possess PH capability. The group and account in which the program resides must also possess PH. End users of the application *do not* require PH capability in order to run the programs possessing it.

## The PROCESS TREE Structure

Each job or session on MPE consists of at least a Command Interpreter process. This is referred to as the CI process or UMAIN (User Main process). Underneath this process, created via the :RUN Command, is the first user process or USONM (User Son of Main). Decendants of the USONM are referred to as USER processes. The structure that results is called a process tree which in its simplest form is made up of only a CI process and one program created using the MPE RUN command.

Following is an illustration of how a process tree structure is represented. This example contains two generations below the CI.




Process Tree (illustration 1)

The intrinsics used in a process handling environment are:

| | |
|---|---|
| ACTIVATE | Used to execute a created process and optionally, to suspend the calling process. |
| CREATE | Used to create the process. Its parameters are similar to those specified on a :RUN command. |
| CREATEPROCESS | Also used to create a process. This intrinsic allows $STDLIST and $STDIN to be redirected for the new process and passes an INFO string to it. |
| FATHER | Returns the PIN (Process Identification Number) of the father (or parent) of the calling process. |
| GETORIGIN | Determines the source of the calling process' last activation. |
| GETPRIORITY | Changes the priority of the calling process or that of its sons. |
| GETPROCID | Returns the PIN of a son process. |
| GETPROCINFO | Returns a double word containing information about the calling process. |
| KILL | Used to terminate a son process. |
| MAIL | Checks the status of the mailbox for incoming or out going mail. |
| RECEIVEMAIL | Transfers data contained in the mailbox to the calling process' stack. |
| SENDMAIL | Transfers data from the calling process' stack to the mailbox. |
| SUSPEND | Causes the calling process to give up the CPU or suspend pending a future reactivation by some other process. This intrinsic will also unlock a local RIN prior to suspending the caller. |

The following System Intrinsics do not require PH capability but are applicable in a process handling environment:

| | |
|---|---|
| PROCINFO | Uses ITEMNUM/ITEM pairs to return information about the caller or other processes in the tree. It duplicates the fuctionality of other process handling intrinsics. |
| PROCTIME | Returns the number of milliseconds of CPU usage of the caller. |
| QUIT | Allows a process to abort itself and all of its descendants. Causes the PROGRAM ERROR #18 message to be displayed. |
| QUITPROG | Similar to QUIT, it aborts *all* processes below the 'CI' process and issues the PROGRAM ERROR #19 message. |

## Application of Process Handling

Process Handling can be used in many diverse applications. One common use is in menu driven systems. This design allows a main 'driver' program to manage seperate processes for the various functions of the applications. The benefit of this design is that is simplifies maintenance since an individual program can be modified without the need to recompile other parts of the system not affected.

### Using the Process Handling Intrinsics

Note that the CREATE and ACTIVATE intrinsics are used in this discussion. For information on the use of the CREATEPROCESS Intrinsic, refer to *Application Note #31, Calling the CREATEPROCESS Intrinsic.*

Following are the Working-Storage definitions that are referred to in this discussion:

```
01  PROCESS-HANDLING-DATA.
     05  PROG-NAME              PIC X(36) VALUE SPACES.
     05  ENTRY-NAME             PIC X(8)  VALUE SPACES.
     05  PIN                    PIC S9(4) COMP VALUE 0.
     05  PARM                   PIC S9(4) COMP VALUE 0.
     05  FLAGS                  PIC S9(4) COMP VALUE 0.
     05  INFO                   PIC X(80) VALUE SPACES.
     05  INFO-LEN               PIC S9(4) COMP VALUE 0.
     05  GETINFOERR             PIC S9(4) COMP VALUE 0.
     05  STACK-SIZE             PIC S9(4) COMP VALUE 0.
     05  DL-SIZE                PIC S9(4) COMP VALUE 0.
     05  MAXDATA                PIC S9(4) COMP VALUE 0.
     05  PRIORITY-CLASS         PIC X(2)  VALUE SPACES.
     05  RANK                   PIC S9(4) COMP VALUE 0.
     05  SUSP                   PIC S9(4) COMP VALUE 0.
     05  ACTIVATE-SOURCE        PIC S9(4) COMP VALUE 0.

 01  PROCINFO-DATA.
     05  ERROR-1                PIC S9(4) COMP VALUE 0.
     05  ERROR-2                PIC S9(4) COMP VALUE 0.
     05  ITEM-NUMBERS.
         10  ITEM-NUM-1         PIC S9(4) COMP VALUE 1.
         10  ITEM-NUM-2         PIC S9(4) COMP VALUE 2.
         10  ITEM-NUM-3         PIC S9(4) COMP VALUE 3.
         10  ITEM-NUM-4         PIC S9(4) COMP VALUE 4.
         10  ITEM-NUM-5         PIC S9(4) COMP VALUE 5.
         10  ITEM-NUM-6         PIC S9(4) COMP VALUE 6.
         10  ITEM-NUM-7         PIC S9(4) COMP VALUE 7.
         10  ITEM-NUM-8         PIC S9(4) COMP VALUE 8.
         10  ITEM-NUM-9         PIC S9(4) COMP VALUE 9.
         10  ITEM-NUM-10        PIC S9(4) COMP VALUE 10.
     05  ITEM-NUM REDEFINES ITEM-NUMBERS
                                PIC S9(4) COMP OCCURS 10 TIMES.
     05  ITEM-VALUES.
         10  MY-PIN             PIC S9(4) COMP VALUE 0.
         10  FATHER-PIN         PIC S9(4) COMP VALUE 0.
         10  SONS-CREATED       PIC S9(4) COMP VALUE 0.
         10  NUM-SONS           PIC S9(4) COMP VALUE 0.
         10  NUM-DESCENDANTS     PIC S9(4) COMP VALUE 0.
```

```
        10  NUM-GENERATIONS    PIC S9(4) COMP VALUE 0.
        10  SONS-PIN-ARRAY.
            20  SONS-PIN      PIC S9(4) COMP OCCURS 10 TIMES.
        10  ALL-DECENDANTS.
            20  PINS-OF-TREE  PIC S9(4) COMP OCCURS 20 TIMES.
        10  PINS-PRIORITY     PIC X(2)  VALUE SPACES.
        10  ACTIVATE-STATE    PIC S9(4) COMP VALUE 0.
        10  PROGRAMS-NAME     PIC X(28) VALUE SPACES.

01  MISCELLANEOUS-DATA.
    05  LOCK-CONDITION        PIC S9(4) COMP VALUE 0.
    05  STATINFO              PIC S9(9) COMP VALUE 0.
    05  STATINFO-ARRAY REDEFINES STATINFO.
        10  STAT-WORD1        PIC S9(4) COMP.
        10  STAT-WORD2        PIC S9(4) COMP.
    05 MODULO-VAR             PIC S9(4) COMP VALUE 0.
    05  CPU-USAGE             PIC S9(9) COMP VALUE 0.
    05  CPU-MASK              PIC ZZ,ZZ9.999.
    05  DEASSEMBLE-PROG-NAME.
        10  DPN-PROGRAM-NAME  PIC X(9)  VALUE SPACES.
        10  DPN-GROUP-NAME    PIC X(9)  VALUE SPACES.
        10  DPN-ACCOUNT-NAME  PIC X(9)  VALUE SPACES.

01  MAIL-DATA.
    05  MAIL-STATUS           PIC S9(4) COMP VALUE 0.
    05  MAIL-MESSAGE          PIC X(80) VALUE SPACES.
    05  MAIL-WAIT-FLAG        PIC S9(4) COMP VALUE 0.
    05  MAIL-LENGTH           PIC S9(4) COMP VALUE 0.
```

## Creating A Process

In its simplest form process handling means that a process creates and activates another process. After this, the creating or father process suspends and is reactivated when the son process terminates. The following is an example of a user written process to create an EDITOR process:

**NOTE**

In these examples double backslashes '\\' are used to indicate parameters that are not being passed to the intrinsic. Since the call specifies INTRINSIC these are not required to act as place holders and are used simply to add to the clarity of the code.

```
CREATE-EDITOR.
    MOVE "EDITOR.PUB.SYS " TO PROG-NAME.
    MOVE 1 TO FLAGS.
    CALL INTRINSIC "CREATE" USING PROG-NAME, \\, PIN, \\,
                                  FLAGS, \\, \\, \\, \\, \\.
    IF C-C NOT = 0 THEN
        PERFORM INTRINSIC-ERROR-ROUTINE
        CALL INTRINSIC "QUIT" USING 1.
    MOVE 2 TO SUSP.
    CALL INTRINSIC "ACTIVATE" USING PIN, SUSP.
    IF C-C NOT = 0 THEN
        PERFORM INTRINSIC-ERROR-ROUTINE
        CALL INTRINSIC "QUIT" USING 2.
```

In this example a value of '1' is moved to the item FLAGS. This sets bit 15 (the right most bit) on to tell MPE that when the newly created process terminates, the calling process is reactivated. Reference the *MPE System Intrinsics Manual* for further information. Your program can be reactivated by MPE when EDITOR ends (when the user enters EXIT). If this bit is not set, MPE assumes that you intend to handle reactivation which, in this case, would be impossible.

FLAGS can be used for several other purposes by moving the appropriate values to it. These options require bits to be set on or off. If you want more information on how to do this using COBOLII, please refer to *APPLICATION NOTE #21, COBOLII and MPE Intrinsics.*

After the process is CREATEd it must be ACTIVATEd. You can use the ACTIVATE intrinsic to both activate the new process and (optionally) suspend the caller. In the example a value of '2' is moved to SUSP. This indicates that the calling process will be suspended while the SON is running *and* the calling process expects to be ACTIVATED by the SON. Since EDITOR is being run this will actually never occur. That is, the EDITOR program will not explicitly call the ACTIVATE intrinsic to wake up the program that created it. This action will be carried out by MPE based on the value in FLAGS when the EDITOR process terminates.

The value of SUSP passed to ACTIVATE is used primarily in more complex process handling environments. In simple examples like the one presented, it serves only to ensure the calling process suspends during the active life of its son. Remember, if bit 15 of FLAGS is not equal to '1' then MPE does not activate the caller when the son process ends! (This would not, however, create a program hang situation since BREAK and ABORT can still be used.)

## Creating Several Processes in One Generation

Any process tree structure may contain at most 255 processes. This is not a configurable value. Since a generation is a layer of processes that share a common father or parent process, the maximum number of generations possible is also 255 (assuming that each generation consists of a single process.)

The following example demonstrates how several processes, in this case 5 copies of a program called SONPROG, are created. It also demonstrates how a local RIN is used to syncronize the operation of these 5 processes. Note that the first process created cannot begin execution until the last son has started running. The father process first acquires and locks one local RIN. When execution begins each son attempts the same lock. As each son is created it receives a PARM value equal to the order in which it was created. For example, the first son created receives a '1' as PARM. This is equivalent to the ;PARM parameter that can be used on a RUN statement.

```
CREATE-SONS.
    CALL INTRINSIC "CREATE" USING PROG-NAME, \\, PIN, PARM,
                                  FLAGS, \\, \\, \\, \\ \\.
    IF C-C NOT = 0 THEN
        PERFORM INTRINSIC-ERROR-ROUTINE
        CALL INTRINSIC "QUIT" USING PARM.
    CALL INTRINSIC "ACTIVATE" USING PIN, SUSP.
    IF C-C NOT = 0 THEN
        PERFORM INTRINSIC-ERROR-ROUTINE
        CALL INTRINSIC "QUIT" USING PARM.
SONS-CREATED.
    EXIT.
```

The main body of the program sets up the necessary values and performs CREATE-SONS, for example:

```
    CALL INTRINSIC "GETLOCRIN" USING 1.
    MOVE 1 TO LOCK-CONDITION.
    CALL INTRINSIC "LOCKLOCRIN" USING 1, LOCK-CONDITION.
    IF C-C NOT = 0 THEN
        PERFORM INTRINSIC-ERROR-ROUTINE
        CALL INTRINSIC "QUIT" USING %1001.
    MOVE 0 TO FLAGS, SUSP.
    MOVE "SONPROG " TO PROG-NAME.
    PERFORM CREATE-SONS VARYING PARM FROM 1 BY 1
                        UNTIL PARM > 5.
    MOVE 2 TO SUSP.
    CALL INTRINSIC "SUSPEND" USING SUSP, 1.
    IF C-C NOT = 0 THEN
        PERFORM INTRINSIC-ERROR-ROUTINE
        CALL INTRINSIC "QUIT" USING %1000.
ALIVE-AGAIN.
    DISPLAY "All done! ".
    STOP RUN.
```

Note that both SUSP and FLAGS are zero for the five iterations of CREATE-SONS. This allows the calling program to remain active. Also notice that the call to SUSPEND includes the local RIN this process has locked. The SUSPEND intrinsic can unlock a local RIN prior to suspending the calling process. The following is an example of a SONPROG:

```
WORKING-STORAGE SECTION.

01  DISPLAY-DATA.
    05 MESSAGE-TO-DISPLAY.
       10  MSG-1              PIC X(40) VALUE
           "Shift to the left..."
       10  MSG-2              PIC X(40) VALUE
           "Shift to the right...".
       10  MSG-3              PIC X(40) VALUE
           "Pop up! ".
       10  MSG-4              PIC X(40) VALUE
           "Push down! ".
       10  MSG-5              PIC X(40) VALUE
           "Byte, byte, byte!!".
    05  DISPLAY-MSG REDEFINES MESSAGE-TO-DISPLAY
                               PIC X(40) OCCURS 5 TIMES.

01  PARM                      PIC S9(4) COMP VALUE 0.
01  DUMMY                     PIC S9(4) COMP VALUE 0.
01  LOCK-CONDITION            PIC S9(4) COMP VALUE 1.
01  SON-MASK                  PIC Z9.

PROCEDURE DIVISION.
GET-PARM.
    CALL INTRINSIC "GETINFO" USING \\, \\, PARM
        GIVING GETINFOERR.
    IF PARM = 0 THEN
        CALL INTRINSIC "QUITPROG" USING 900.
LOCK-LOCAL-RIN.
    CALL INTRINSIC "LOCKLOCRIN" USING 1, LOCK-CONDITION.
    IF C-C NOT = 0 THEN
        CALL INTRINSIC "QUITPROG" USING 901.
PRINT-MESSAGE.
    MOVE PARM TO SON-MASK.
    DISPLAY DISPLAY-MSG (PARM), "(From SON #", SON-MASK, ")".
UNLOCK-LOCAL-RIN.
    CALL INTRINSIC "UNLOCKLOCRIN" USING 1.
    IF C-C NOT = 0 THEN
        CALL INTRINSIC "QUITPROG" USING 902.
FINISH-UP.
    IF PARM = 5 THEN
        CALL INTRINSIC "ACTIVATE" USING 0, 0
        IF C-C NOT = 0 THEN
            CALL INTRINSIC "QUITPROG" USING 903.
    STOP RUN.
```

In this example the paragraph named FINISH-UP determines whether or not the father process should be activated based on the value of PARM. If this is the last process to run, then it wakes up the father before it terminates. The call specifies zero for BOTH parameters so the calling process is not SUSPENDED as a result of the call.

Note also that local RINs are acquired for use by all processes in the process tree therefore SONPROG did not need to call the GETLOCRIN intrinsic; this had already been done by the father process.

## Using PARM and INFO

In the previous examples PARM was used to communicate a creation order to each of the sons. This value also determined which array element was displayed. The values of PARM and INFO can be used to pass 'one time only' information from a process to a son at creation time. The son need not check the values, and the information contained in PARM or INFO can be reaquired by the son as often as necessary. The intrinsic GETINFO, available with MPE version 6.02.00 (U-MIT) or later, can be used to retrieve these values. For example:

```
MOVE 80 TO INFO-LEN.
CALL INTRINSIC "GETINFO" USING INFO, INFO-LEN, PARM
     GIVING GETINFOERR.
IF GETINFOERR NOT = 0 THEN
     .
     .
     .
```

## Communication Between Processes

In addition to the 'one time only' communication available through PARM and INFO there exists the abilty for processes both inside and outside the 'process tree' to communicate. This is known as Interprocess Communication (IPC).

Interprocess Communication can be accomplished in one of two ways: through the use of MESSAGE files or by using the MAIL intrinsics. This is not to be confused with electronic mail! The most efficient and easy method is through the use of MESSAGE files.

Refer to the *MPE File System Reference Manual, Section 8* for a more complete discussion on this topic.

To demonstrate the MESSAGE file communication between processes you can try this brief example using FCOPY and two terminals.

You'll need to log on to each of the two terminals. You need not be the same user nor in the same account. The limitation is that each of the two users must have appropriate access to the message file you will need to create. That is, the reader process needs at least READ access and the writer process must have WRITE access.

To build the file issue the following BUILD command:

```
:BUILD MSGFILE;REC=-80,,,ASCII;MSG
```

At one terminal type:

```
:FCOPY FROM= ;TO=MSGFILE
```

This will be the writer process. On the other terminal type:

```
:FCOPY FROM=MSGFILE;TO=
```

This is the reader process. Whatever is typed onto the writer's terminal will be read by the reader FCOPY process, and displayed on its terminal. When you terminate the writer process either by a CONTROL Y or :EOD the reader process will also end since FCOPY will receive the EOD OF FILE.

## The MAIL Intrinsics

These intrinsics are an older form of IPC. Communication is limited between processes to those in a process tree. The intrinsics are, in general, more difficult to use than MESSAGE file IPC and require that programs be PREPARED with 'PH' capabilty. Message file IPC has no special capability requirements.

Another limitation of MAIL IPC is that communication is limited to father and son processes only. Processes in the same generation, sometimes refered to as 'brothers', may only communicate through the father. No such limitation exists for Message File IPC.

### The MAILBOX

This is a term used in MAIL IPC that defines the location used to store incoming or outgoing mail between two processes. There can be only one mailbox per pair of commumicating processes. That is, a father may have one mailbox for each of its sons, but they do not all share the same mailbox. Each son will have one mailbox for each of its sons.

A mailbox is an extra data segment. If, however, the mail is one word (2 bytes) in length an extra data segment is not created. Rather, a portion of the calling process' stack is used. Since mailboxes are extra data segments, the number and maximum size that may be created is configurable.

### Checking the MailBox

The MAIL intrinsic is used to check the mailbox. This intrinsic returns the state of the mailbox and, if incoming mail exists, will return the length in words of that mail. For example:

```
CALL INTRINSIC "MAIL" USING 0, MAIL-LENGTH
                      GIVING MAIL-STATUS.
IF MAIL-STATUS > 2 THEN
      .
      .
      .
```

Rather than the condition code, the STATUS variable is checked since it indicates the success of the call. Refer to the *MPE System Intrinsic Reference Manual* for a definition of the values returned.

### Sending Mail

This intrinsic transmits data from the calling process into the mailbox. Depending on the value passed as WAITFLAG the intrinsic will cause the process to wait for the mail to be read or continue without waiting.

```
MOVE 1 TO MAIL-WAIT-FLAG.
CALL INTRINSIC "SENDMAIL" USING PIN,
                                MAIL-LENGTH,
                                MAIL-MESSAGE,
                                MAIL-WAIT-FLAG
                          GIVING MAIL-STATUS.
IF C-C NOT = 0 THEN
    .
    .
    .
```

Note, this intrinsic returns a status and also sets the condition code. Please refer to the *MPE System Intrinsics Reference Manual* for an explanation of the values returned in STATUS.

In this example a MAIL-WAIT-FLAG of '1' is used to cause the calling process to wait until any prior mail is collected. A zero value would have caused any uncollected mail to be overwritten and the calling process would not have waited for the receiving process to collect the message.

## Receiving Mail

To read the contents of the mail box the RECEIVEMAIL intrinsic is used. It acts in a similar way as SENDMAIL in that it can be used to cause the calling process to wait until mail is received, for example:

```
MOVE 1 TO MAIL-WAIT-FLAG.
CALL INTRINSIC "RECEIVEMAIL" USING PIN,
                                   MAIL-MESSAGE,
                                   MAIL-WAIT-FLAG
                              GIVING MAIL-STATUS.
IF C-C NOT = 0 THEN
    IF MAIL-STATUS = 3 THEN
    .
    .
    .
```

This intrinsic does not return the length of the mail received. Before attempting to receive mail it is recommended to call MAIL to determine if mail exists and to determine the length of the message. If it is determined that an incoming message is longer than can be accomodated, there would be no way to safely transfer the mail to the callers stack without the possiblity of data corruption occuring.

## Using the Mail Intrinsics

If you have purchased TDP (Text and Document Processor) you can easily demonstrate Mail IPC. To do this alter the earlier example that created an EDITOR.PUB.SYS process so that PROG-NAME contains TDP.PUB.SYS. Then, in between the code that calls CREATE and the code that calls ACTIVATE add the following:

```
SEND-MAIL.
    MOVE
   "Q'Please enter // when thru adding, thanks';Make Demo;k;e"
         TO MAIL-MESSAGE.
    MOVE 0 TO MAIL-WAIT-FLAG.
    CALL INTRINSIC "SENDMAIL" USING PIN,
                                    40,
                                    MAIL-MESSAGE,
                                    MAIL-WAIT-FLAG
                               GIVING MAIL-STATUS.
    IF MAIL-STATUS NOT = 0 THEN
        CALL INTRINSIC "QUIT" USING MAIL-STATUS.
```

**NOTE**

Mail messages sent to TDP must be at least 72 bytes (36 words).

TDP will check the mailbox after it is activated and treat the contents as a command to be executed before prompting for the first user command from the standard input device ($STDIN). In this example four commands are sent separated by semicolons. The first displays a message on the current $STDLIST device. The second MAKEs a file which then automatically causes TDP to prompt for input to the file. The third causes the file to be kept after the user has terminated additions with the '//' command. The last command exits TDP and returns to the process that created it.

# Additional Process Handling Concepts

## The FATHER Intrinsic

If your system has TDP then it also has a program called SCRIBE in the PUB group of the SYS account. This program is the formatter used by TDP when you issue a DRAFT or FINAL command. SCRIBE is specifically written to determine how it was created and act accordingly. Your programs may be written to behave this way as well. Try running SCRIBE and see what happens.

In the *Computer Scientist's Cheer* program, for example, you might not want SONPROG to be :RUN by other users. To prevent this, add the following code as the first executable statements in the program:

```
CALL INTRINSIC "FATHER" GIVING DUMMY.
IF C-C > 0 THEN
    DISPLAY "Sorry, you may not :RUN this program."
    STOP RUN.
```

Notice there is no USING parameter since the intrinsic returns the PIN in DUMMY. This name was selected since its contents are not needed. The condition code returned indicates the type of process that created the caller. In this case CCG is checked since this indicates that the creating process is a User Main or Command Interpreter process.

## The GETORIGIN Intrinsic

This intrinsic is used primarily in more complex process handling environments. Specifically when a process calls SUSPEND or ACTIVATE and passes the value of '3' for SUSP. This indicates that the caller expects to be activated either by a son or by its father. If this is the case it may be advantageous to know who woke up the process. To do this you would call the GETORIGIN intrinsic. For example:

```
CALL INTRINSIC "GETORIGIN" GIVING ACTIVATE-SOURCE.
IF ACTIVATE-SOURCE = 0 THEN
    .
    .
    .
```

This intrinsic does not return a condition code so the value of ACTIVATE-SOURCE must be checked. A value of zero would indicate the caller was not activated by either a son or its father.

## The GETPRIORITY Intrinsic

This intrinsic allows a process to alter its own priority or that of one of its sons. Priority may be no larger than the MAXPRI value of the USER running the program. For example, to reschedule a son process into the ES Subqueue or 'EQ' a call to GETPRIORITY might look like this;

```
MOVE "ES" TO PRIORITY-CLASS.
MOVE 0 TO RANK.
CALL INTRINSIC "GETPRIORITY" USING PIN,
                                   PRIORITY-CLASS,
                                   RANK.
IF C-C NOT = 0 THEN
     .
     .
     .
```

## The GETPROCID Intrinsic

This intrinsic may be used to 'take inventory' of son processes. It is beneficial in process handling environments where it is natural for some sons to end while others may continue processing. The father can periodically find out who's left. To illustrate this it will be necessary to alter the *Computer Scientist's Cheer* program example so that instead of a STOP RUN each son calls the SUSPEND intrinsic. The fifth son must still ACTIVATE the father! When the father begins execution again it can find out which of its sons still remain 'alive' using the following example;

```
    MOVE 0 TO NUM-SONS.
       MOVE 5 TO SONS-CREATED.
TAKE-INVENTORY.
    ADD 1 TO NUM-SONS.
    CALL INTRINSIC "GETPROCID" USING NUM-SONS
                               GIVING SONS-PIN (NUM-SONS).
    IF SONS-PIN (NUM-SONS) NOT = 0 THEN
       IF NUM-SONS < SONS-CREATED
            GO TO TAKE-INVENTORY.
```

As long as the value in NUM-SONS does not exceed the number of sons still in existence a non-zero PIN will be returned. It should also be noted that had, for example, son number 2 expired son 3 would become son 2 and so forth, son 5 would then not exist.

## The KILL Intrinsic

This is a rather aptly named intrinsic that does precisely what its name implies, it kills a son process. To illustrate this, alter the TAKE INVENTORY example above to include a call to KILL as follows:

```
IF SONS-PIN (NUM-SONS) NOT = 0 THEN
    CALL INTRINSIC "KILL" USING SONS-PIN (NUM-SONS)
    IF C-C NOT = 0 THEN
         .
         .
         .
```

## The GETPROCINFO Intrinsic

This intrinsic returns information about the PIN passed to it. The value is returned in a double word. To make effective use of the information returned, redefine the STATINFO variable so that it could be referenced as two seperate integer variables as described in the WORKING-STORAGE example.

```
CALL INTRINSIC "GETPROCINFO" USING PIN
                             GIVING STATINFO.
IF C-C NOT = 0 THEN
     .
     .
     .
```

Please refer to *Application Note #21, CobolII and MPE Intrinsics.* Using the table at the top of page 10 of that publication as a guide here is an example of how to use the various bit settings returned in STATINFO. In this example you will extract bits 4, 5 and 6 which will define the queue characteristics of the PIN.

First you need to shift bits 4, 5 and 6 so they are in positions 13, 14 & 15. This is done by dividing STAT-WORD1 by 512 which corresponds to bit 6 in the table. Store the result in MODULO-VAR. For example:

```
COMPUTE MODULO-VAR = STAT-WORD2 / 512.
```

To extract the value of bits 13 through 15 you will need to calulate the MODULO 8 of MODULO-VAR or the remainder of MODULO-VAR divided by 8 which would be the value of these three bits. Since there is no MODULO function in COBOL it can be accomplished using the following calculation:

```
COMPUTE MODULO-VAR = MODULO-VAR - (MODULO-VAR / 8) * 8.
```

## Additional Intrinsics

The following intrinsics do not require PH capabilty but are relevant in a process handling environment.

### QUIT and QUITPROG

Both intrinsics accept an integer variable as a parameter, but the QUIT intrinsic differs from the QUITPROG intrinsic in that it will cause the caller and all of its descendants to be aborted. QUITPROG can be called by any process in the tree and will cause all processes in the tree to abort. For example:

```
CALL INTRINSIC "QUIT" USING 901.
```

might look like:

```
ABORT :DEMO.PROG.DEVEL.%0.%1
PROGRAM ERROR #18 :PROCESS QUIT .PARAM = 901

PROGRAM TERMINATED IN AN ERROR STATE.  (CIERR 976)
```

Had QUITPROG been called the message would have changed slightly to read:

```
PROGRAM ERROR #19 :PROCESS QUIT .PARAM = 901
```

The octal values %0.%1 are the code segment and offset into this segment where the call to QUIT took place. Using a PMAP and output from the VERBS compiler directive it would be possible to locate the QUIT statement using this data. It is common, however, to use the value of PARAM as an indicator of where and possibly why the call was made.

### The PROCTIME Intrinsic

As its name implies, this intrinsic returns the number of milliseconds (thousandths of seconds) of CPU time used by the caller. For example:

```
CALL INTRINSIC "PROCTIME" GIVING CPU-USAGE.
MOVE CPU-USAGE TO CPU-MASK.
DISPLAY CPU-MASK.
```

This intrinsic does not return condition codes.

### The PROCINFO Intrinsic

This intrinsic is similar in structure to the FFILEINFO and JOBINFO intrinsics. It is more difficult to use but returns some valuable information.

The intrinsic accepts up to six ITEM-NUM/ITEM pairs where the value of ITEM-NUM determines the data type of ITEM. At a minimum, the intrinsic will have five parameters and at a maximum, fifteen.

Refer to the *MPE System Intrinsic Reference Manual* for complete information on the use of this intrinsic.

With normal (non-privileged mode) capabilities this intrinsic replaces many of the intrinsics already discussed. For example, to find the PINs of all surviving son processes using a single call:

```
MOVE 10 TO SONS-PIN (1).
MOVE 0 TO PIN, ERROR-1, ERROR-2.
CALL INTRINSIC "PROCINFO" USING ERROR-1,
                                ERROR-2,
                                PIN,
                                ITEM-NUM (6),
                                SONS-PIN-ARRAY.
IF ERROR-1 NOT = 0 THEN
     .
     .
     .
```

In this example a zero is moved to PIN since the information required is for sons of the calling process. Also, a '10' is moved to the first element of SONS-PIN-ARRAY to indicate the length, including this element, of the array. Please see 'Note 1' under the PROCINFO intrinsic in the *MPE System Intrinsics Reference Manual.*

The difference between item 6 and item 7 is that item 7 will return the PINs of *all* processes both direct and indirect. That is, all decendants of the PIN specified rather than just the processes created by the PIN specified.

A feature of PROCINFO not found in any other process handling related intrinsics is the ability to return the actual name of a process. ITEM-NUM (10) returns the fully qualified name of the process identified by the PIN passed to it. This means that it is possible for a program to know its name or the name of any of of the programs currently running in the process tree.

For example, a program could determine its own name by calling PROCINFO as follows:

```
MOVE 0 TO PIN, ERROR-1, ERROR-2.
CALL INTRINSIC "PROCINFO" USING ERROR-1,
                                ERROR-2,
                                PIN,
                                ITEM-NUM (10),
                                PROGRAMS-NAME.
IF ERROR-1 NOT = 0 THEN
    .
    .
    .
```

This can be valuable when process handling is implemented in a menu driven application. If the application has been designed so that all programs in the process tree reside in the same group and account, then it is not necessary for programs needing to create sons to know any more than their names. The group name (and optionally the account name) can be extracted from the string returned by PROCINFO.

For example, using the COBOLII STRING and UNSTRING verbs the callers name can be disassembled and then reassembled to be the name of program to be passed to the CREATE intrinsic. For example:

```
UNSTRING PROGRAMS-NAME DELIMITED BY "." INTO
     DPN-PROGRAM-NAME, DPN-GROUP-NAME, DPN-ACCOUNT-NAME.
MOVE "SONPROG" TO DPN-PROGRAM-NAME.
MOVE SPACES TO PROG-NAME.
STRING DPN-PROGRAM-NAME   DELIMITED BY SPACE
       "."                DELIMITED BY SIZE
       DPN-GROUP-NAME     DELIMITED BY SPACE
       "."                DELIMITED BY SIZE
       DPN-ACCOUNT-NAME   DELIMITED BY SPACE
    INTO PROG-NAME.
```

## Configuration Considerations

If you plan to make extensive use of process handling or are contemplating the purchase of a software product that uses Process Handling you should consider the following system configuration values.

Please refer to the *MPE System Operation and Resource Management Reference Manual, Section 7*, for additional information.

### The Process Control Block Table

This table contains a 21 word entry (16 words on MPE IV systems) for each process running on the system. This includes *system* processes as well as user processes. The number associated with the process' entry in this table is refered to as its *PIN*. If this table is underconfigured system failures will result.

## The CST Block Table

This table limits the number of concurrently running programs on the system. Since executable code is shared on MPE this refers to different *programs* rather than differnt processes.

## The Swap Table

This table is used to keep track of a process' *locality* or the code and data segments it needs in memory in order to run. When possible a process' entire locality is tracked through this table however it must be able to hold the *minimum locality* of each process running. If this table is underconfigured a system failure will result.

## Additional Considerations

If your programs intend to make extensive use of MAIL IPC you will need to consider the following configuration values:

- The Maximum Extra Data Segment Size
- The number of Extra Data Segments per Process
- The amount of Virtual Memory configured on your system

Remember that VIRTUAL MEMORY (VM) may be changed on Logical Device One **ONLY** during a RELOAD. VM allocations to other disc devices may be made using a COOL or COLD Start.

Virtual Memory needs to be considered if MAIL IPC is used because it creates Extra Data Segments if needed. Any time new data segments are created space is also allocated in Virtual Memory. This space is used to hold them when they no longer need to be resident in main memory.

# BACK ISSUE INFORMATION

Following is a list of the Application Notes published to date. If you would like to order single copies of back issues please use the *Reader Comment Sheet* attached and indicate the number(s) of the note(s) you need.

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| 2 | 10/15/85 | *Terminal types for HP 3000 HPIB Computers (superseded by note #13)* |
| 3 | 4/01/86 | *Plotter Configuration Guide* |
| 4 | 4/15/86 | *Printer Configuration Guide - Revised* |
| 5 | 5/01/86 | *MPE System Logfile Record Formats* |
| 6 | 5/15/86 | *Stack Operation* |
| 7 | 6/01/86 | *COBOL II/3000 Programs: Tracing Illegal Data* |
| 8 | 6/15/86 | *KSAM Topics: COBOL's Index I/O: File Data Integrity* |
| 9 | 7/01/86 | *Port Failures, Terminal Hangs, TERMDSM* |
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