

```
EEEEEEEEEE XX XX AAAAAA MM MM PPPPPPPP LL EEEEEEEEEE SSSSSSSS
EEEEEEEEEE XX XX AAAAAA MM MM PPPPPPPP LL EEEEEEEEEE SSSSSSSS
EEEEEEEEEE XX XX AAAAAA MM MM PPPPPPPP LL EEEEEEEEEE SSSSSSSS
EE XX XX AA AA MMMM MMMM PP PP LL EE SS
EE XX XX AA AA MMMM MMMM PP PP LL EE SS
EE XX XX AA AA MMMM MMMM PP PP LL EE SS
EE XX XX AA AA MM MM PP PP LL EE SS
EE XX XX AA AA MM MM PP PP LL EE SS
EEEEEEEEEE XX XX AA AA MM MM PPPPPPPP LL EEEEEEEEE SSSSSS
EEEEEEEEEE XX XX AA AA MM MM PPPPPPPP LL EEEEEEEEE SSSSSS
EEEEEEEEEE XX XX AA AA MM MM PPPPPPPP LL EEEEEEEEE SSSSSS
EE XX XX AAAAAAAAAA MM MM PP LL EE SS
EE XX XX AAAAAAAAAA MM MM PP LL EE SS
EE XX XX AAAAAAAAAA MM MM PP LL EE SS
EE XX XX AA AA MM MM PP LL EE SS
EE XX XX AA AA MM MM PP LL EE SS
EEEEEEEEEE XX XX AA AA MM MM PP LLLLLLLLLL EEEEEEEEE SSSSSSSS
EEEEEEEEEE XX XX AA AA MM MM PP LLLLLLLLLL EEEEEEEEE SSSSSSSS
EEEEEEEEEE XX XX AA AA MM MM PP LLLLLLLLLL EEEEEEEEE SSSSSSSS
```

```
UU      UU      SSSSSSSS  SSSSSSSS  DDDDDDDD  IIIIII  SSSSSSSS  PPPPPPPP
UU      UU      SSSSSSSS  SSSSSSSS  DDDDDDDD  IIIIII  SSSSSSSS  PPPPPPPP
UU      UU      SS        SS        DD        DD        SS        PP        PP
UU      UU      SS        SS        DD        DD        SS        PP        PP
UU      UU      SS        SS        DD        DD        SS        PP        PP
UU      UU      SS        SS        DD        DD        SS        PP        PP
UU      UU      SSSSSS    SSSSSS    DD        DD        SSSSSS  PPPPPPPP
UU      UU      SSSSSS    SSSSSS    DD        DD        SSSSSS  PPPPPPPP
UU      UU      SS        SS        DD        DD        SS        PP
UU      UU      SS        SS        DD        DD        SS        PP
UU      UU      SS        SS        DD        DD        SS        PP
UUUUUUUUUU  SSSSSSSS  SSSSSSSS  DDDDDDDD  IIIIII  SSSSSSSS  PP
UUUUUUUUUU  SSSSSSSS  SSSSSSSS  DDDDDDDD  IIIIII  SSSSSSSS  PP
                                     ....
                                     ....
                                     ....
                                     ....
```

```
MM      MM      AAAAAA  RRRRRRRR
MM      MM      AAAAAA  RRRRRRRR
MMMM     MMMM  AA        AA  RR        RR
MMMM     MMMM  AA        AA  RR        RR
MM      MM      AA        AA  RR        RR
MM      MM      AA        AA  RRRRRRRR
MM      MM      AA        AA  RRRRRRRR
MM      MM      AAAAAAAAAA  RR        RR
MM      MM      AAAAAAAAAA  RR        RR
MM      MM      AA        AA  RR        RR
MM      MM      AA        AA  RR        RR
MM      MM      AA        AA  RR        RR
MM      MM      AA        AA  RR        RR
```


.TITLE USER SYS DISP - Example of user system service dispatcher
.IDENT 'V04=001'

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Facility: Example of User Written System Services

++
Abstract:

This module contains an example dispatcher for user written system services along with several sample services and a user rundown example. It is a template intend to serve as the starting point for implementing a privileged shareable image containing your own services. When used as a template, the definitions and code for the sample services should be removed.

Overview:

User written system services are contained in privileged shareable images that are linked into user program images in exactly the same fashion as any shareable image. The creation and installation of a privileged, shareable image is slightly different from that of an ordinary shareable image. These differences are:

1. A vector defining the entry points and providing other control information to the image activator. This vector is a the lowest address in an image section with the VEC attribute.
2. The shareable image is linked with the /PROTECT option that marks all of the image sections so that they will protected and given EXEC mode ownership by the image activator.
3. The shareable image MUST be installed /SHARE /PROTECT with the INSTALL utility in order for the image activator to connect the privileged shareable image to the change mode

dispatchers.

A privileged shareable image implementing user written system services is comprised of the following major components:

1. A transfer vector containing all of the entry points and collecting them at the lowest virtual address in the shareable image. This formalism enables revision of the shareable image without necessitating the relinking of images that use it.
2. A Privileged Library Vector in a PSECT with the VEC attribute that describes the entry points for dispatching EXEC and KERNEL mode services along with validation information.
3. A dispatcher for kernel mode services. This code will be called by the VMS change mode dispatcher when it fails to recognize a kernel mode service request.
4. A dispatcher for executive mode services. This code will be called by the VMS change mode dispatcher when it fails to recognize an executive mode service request.
5. Service routines to perform the various services.

The first four components are contained in this template and are most easily implemented in MACRO, while the service routines can be implemented in BLISS or MACRO. Other languages may be usable but are not recommended -- particularly if they require runtime support routines or are extravagant in their use of stack or are unable to generate PIC code.

This example is position-independent (PIC) and it is good practice to implement shareable images this way whenever possible.

Revision History:

V04-001	WMC0001	Wayne Cardoza	06-Sep-1984
Make system version a weak reference.			
V03-002	KDM0074	Kathleen D. Morse	23-Aug-1983
Use cpu-dependent routine to get the TODR value.			
Add \$\$\$DEF and remove \$PRDEF.			
V03-001	ACG0001	Andrew C. Goldstein	23-May-1983
Fix change-mode dispatcher to clean two extra longwords off stack before calling user system service.			

Link Command File Example:

```
$!  
$! Command file to link User System Service example.  
$!  
$ LINK/PROTECT/NOSYSSHR/SHARE=USS/MAP=USS/FULL SYS$INPUT/OPTIONS  
$!
```


Options file for the link of User System Service example.

SYSS\$SYSTEM:SYS.STB/SELECTIVE

Create a separate cluster for the transfer vector.

CLUSTER=TRANSFER_VECTOR,,,SYSS\$DISK:[]USSDISP

GSMATCH=LEQUAL,1,1

.PAGE

.SBTTL Declarations and Equates

Include Files

.LIBRARY "SYSS\$LIBRARY:LIB.MLB" ; Macro library for system structure
; definitions

Macro Definitions

DEFINE_SERVICE - A macro to make the appropriate entries in several
different PSECTs required to define an EXEC or KERNEL
mode service. These include the transfer vector,
the case table for dispatching, and a table containing
the number of required arguments.

DEFINE_SERVICE Name,Number_of_Arguments,Mode

.MACRO DEFINE_SERVICE,NAME,NARG=0,MODE=KERNEL
.PSECT \$\$\$TRANSFER_VECTOR,PAGE,NOWRT,EXE,PIC
.ALIGN QUAD ; Align entry points for speed and style
.TRANSFER NAME ; Define name as universal symbol for entry
.MASK NAME ; Use entry mask defined in main routine
.IF IDN MODE,KERNEL
CHMK #<KCODE_BASE+KERNEL_COUNTER> ; Change to kernel mode and execute
RET ; Return
KERNEL_COUNTER=KERNEL_COUNTER+1 ; Advance counter

.PSECT KERNEL_NARG,BYTE,NOWRT,EXE,PIC
.BYTE NARG ; Define number of required arguments

.PSECT USER_KERNEL_DISP1,BYTE,NOWRT,EXE,PIC
.WORD 2+NAME-KCASE_BASE ; Make entry in kernel mode CASE table

.IFF
CHME #<ECODE_BASE+EXEC_COUNTER> ; Change to executive mode and execute
RET ; Return
EXEC_COUNTER=EXEC_COUNTER+1 ; Advance counter

.PSECT EXEC_NARG,BYTE,NOWRT,EXE,PIC
.BYTE NARG ; Define number of required arguments

.PSECT USER_EXEC_DISP1,BYTE,NOWRT,EXE,PIC
.WORD 2+NAME-ECASE_BASE ; Make entry in exec mode CASE table

```

        .ENDC
        .ENDM  DEFINE_SERVICE
:
: Equated Symbols
:
$PHDDEF      : Define process header offsets
$PLVDEF      : Define PLV offsets and values
$SSDEF       : Define system status codes
:
Initialize counters for change mode dispatching codes
:
KERNEL_COUNTER=0      : Kernel code counter
EXEC_COUNTER=0        : Exec code counter
:
Own Storage
:
        .PSECT  KERNEL_NARG,BYTE,NOWRT,EXE,PIC
KERNEL_NARG:          : Base of byte table containing the
:                    : number of required arguments.
        .PSECT  EXEC_NARG,BYTE,NOWRT,EXE,PIC
EXEC_NARG:            : Base of byte table containing the
:                    : number of required arguments.
        .PAGE
        .SBTTL  Transfer Vector and Service Definitions
:++
: The use of transfer vectors to effect entry to the user written system services
: enables some updating of the shareable image containing them without necessitating
: a re-link of all programs that call them. The PSECT containing the transfer
: vector will be positioned at the lowest virtual address in the shareable image
: and so long as the transfer vector is not re-ordered, programs linked with
: one version of the shareable image will continue to work with the next.
:
: Thus as additional services are added to a privileged shareable image, their
: definitions should be added to the end of the following list to ensure that
: programs using previous versions of it will not need to be re-linked.
: To completely avoid relinking existing programs the size of the privileged
: shareable image must not change so some padding will be required to provide
: the opportunity for future growth.
:--
        DEFINE_SERVICE  USER_GET_TODR,1,KERNEL : Service to get value of time
:                                         : of day register
        DEFINE_SERVICE  USER_SET_PFC,2,KERNEL  : Service to set value of process
:                                         : default pagefault cluster
        DEFINE_SERVICE  USER_NULL,0,EXEC       : Null exec service
:
: The base values used to generate the dispatching codes should be negative for
: user services and must be chosen to avoid overlap with any other privileged
: shareable images that will be used concurrently. Their definition is
: deferred to this point in the assembly to cause their use in the preceding
: macro calls to be forward references that guarantee the size of the change
: mode instructions to be four bytes. This satisfies an assumption that is
: made by for services that have to wait and be retried. The PC for retrying
: the change mode instruction that invokes the service is assumed to be 4 bytes

```


; less than that saved in the change mode exception frame. Of course, the particular
; service routine determines whether this is possible.

KCODE_BASE=-1024 ; Base CHMK code value for these services
ECODE_BASE=-1024 ; Base CHME code value for these services

.PAGE

.SBTTL Change Mode Dispatcher Vector Block

++
; This vector is used by the image activator to connect the privileged shareable
; image to the VMS change mode dispatcher. The offsets in the vector are self-
; relative to enable the construction of position independent images. The system
; version number will be used by the image activator to verify that this shareable
; image was linked with the symbol table for the current system.

Change Mode Vector Format

Vector Type Code (PLV\$C_TYP_CM0D)	PLV\$C_TYP
System Version Number (SYSS\$K_VERSION)	PLV\$C_VERSION
Kernel Mode Dispatcher Offset	PLV\$C_KERNEL
Exec Mode Entry Offset	PLV\$C_EXEC
User Rundown Service Offset	PLV\$C_USRUNDWN
Reserved	
RMS Dispatcher Offset	PLV\$C_RMS
Address Check	PLV\$C_CHECK

The reference to SYSS\$K_VERSION will only be resolved if the image is
linked against SYS.STB. In other cases the version check is
unnecessary and will not be done.

.WEAK SYSS\$K_VERSION

.PSECT USER_SERVICES,PAGE,VEC,PIC,NOWRT,EXE

.LONG PLV\$C_TYP_CM0D ; Set type of vector to change mode dispatcher
.LONG SYSS\$K_VERSION ; Identify system version
.LONG KERNEL_DISPATCH-. ; Offset to kernel mode dispatcher
.LONG EXEC_DISPATCH-. ; Offset to executive mode dispatcher
.LONG USER_RUNDOWN-. ; Offset to user rundown service

```

      .LONG 0           ; Reserved.
      .LONG 0           ; No RMS dispatcher
      .LONG 0           ; Address check - PIC image
      .PAGE
      .SBTTL Kernel Mode Dispatcher

```

:++

Input Parameters:

```

      (SP) - Return address if bad change mode value
      R0  - Change mode argument value.
      R4  - Current PCB Address. (Therefore R4 must be specified in all
            register save masks for kernel routines.)
      AP  - Argument pointer existing when the change
            mode instruction was executed.
      FP  - Address of minimal call frame to exit
            the change mode dispatcher and return to
            the original mode.

```

:--

```

      .PSECT USER_KERNEL_DISP0,BYTE,NOWRT,EXE,PIC
KACCVIO:      MOVZWL #SS$_ACCVIO,R0      ; Kernel access violation
              RET                        ; Set access violation status code
              ; and return
KINSFARG:     MOVZWL #SS$_INSFARG,R0      ; Kernel insufficient arguments.
              RET                        ; Set status code and
              ; return
KNOTME: RSB      ; RSB to forward request

KERNEL_DISPATCH::      ; Entry to dispatcher
      MOVAB W^KCODE_BASE(R0),R1      ; Normalize dispatch code value
      BLSS KNOTME      ; Branch if code value too low
      CMPW R1,#KERNEL_COUNTER      ; Check high limit
      BGEQU KNOTME      ; Branch if out of range

; The dispatch code has now been verified as being handled by this dispatcher,
; now the argument list will be probed and the required number of arguments
; verified.
      MOVZBL W^KERNEL_NARG[R1],R1      ; Get required argument count
      MOVAL @#4[R1],R1      ; Compute byte count including arg count
      IFNORD R1,(AP),KACCVIO      ; Branch if arglist not readable
      CMPB (AP),W^KERNEL_NARG-KCODE_BASE[R0] ; Check for required number
      BLSSU KINSFARG      ; of arguments
      MOVL FP,SP      ; Reset stack for service routine
      CASEW R0,-      ; Case on change mode
              ; argument value
              ; Base value
              #KCODE_BASE,-      ; Limit value (number of entries)
              #<KERNEL_COUNTER-1>      ; Case table base address for DEFINE_SERVICE
KCASE_BASE:

```

```

; Case table entries are made in the PSECT USER_KERNEL_DISP1 by
; invocations of the DEFINE_SERVICE macro. The three PSECTS,
; USER_KERNEL_DISP0,1,2 will be abutted in lexical order at link-time.

```



```

;
.PSECT USER_KERNEL_DISP2,BYTE,NOWRT,EXE,PIC
BUG_CHECK IVSSRVRQST,FATAL      ; Since the change mode code is validated
                                ; above, we should never get here
.PAGE
.SBTTL  Executive Mode Dispatcher
++
Input Parameters:
(SP) - Return address if bad change mode value
RO  - Change mode argument value.
AP  - Argument pointer existing when the change
      mode instruction was executed.
FP  - Address of minimal call frame to exit
      the change mode dispatcher and return to
      the original mode.
--
.PSECT USER_EXEC_DISPO,BYTE,NOWRT,EXE,PIC
EACCVIO: MOVZWL  #SS$_ACCVIO,RO      ; Exec access violation
          RET      ; Set access violation status code
          ; and return
EINSFARG: MOVZWL  #SS$_INSFARG,RO    ; Exec insufficient arguments.
          RET      ; Set status code and
          ; return
ENOTME:  RSB      ; RSB to forward request

EXEC_DISPATCH::
MOVAB    W^ECODE_BASE(RO),R1        ; Entry to dispatcher
BLSS     ENOTME                     ; Normalize dispatch code value
CMPW     R1,#EXEC_COUNTER           ; Branch if code value too low
BGEQU    ENOTME                     ; Check high limit
          ; Branch if out of range

; The dispatch code has now been verified as being handled by this dispatcher,
; now the argument list will be probed and the required number of arguments
; verified.
MOVZBL   W^EXEC_NARG[R1],R1          ; Get required argument count
MOVAL    @#4[R1],R1                 ; Compute byte count including arg count
IFNORD   R1,(AP),EACCVIO             ; Branch if arglist not readable
CMPB     (AP),W^<EXEC_NARG-ECODE_BASE>[RO] ; Check for required number
BLSSU    EINSFARG                    ; of arguments
MOVL     FP,SP                      ; Reset stack for service routine
CASEW    RO,-                       ; Case on change mode
          ; argument value
          ; Base value
          ; Limit value (number of entries)
          ; Case table base address for DEFINE_SERVICE
ECASE_BASE:
          ; Case table entries are made in the PSECT USER_EXEC_DISP1 by
          ; invocations of the DEFINE_SERVICE macro. The three PSECTS,
          ; USER_EXEC_DISPO,1,2 will be abutted in lexical order at link-time.
.PSECT USER_EXEC_DISP2,BYTE,NOWRT,EXE,PIC

```



```
BUG_CHECK IVSSRVQST,FATAL      : Since the change mode code is validated
                                : above, we should never get here
```

```
.PAGE
.SBTTL  User Rundown Service
```

```
++
: Functional description:
: This service is invoked from within the kernel mode system service
: that performs image rundown. It is invoked before any system
: rundown functions (i.e. deassign channels, release memory) are
: performed. User code should not invoke any RMS services or RTL
: routines, must not signal any exceptions. User code can invoke
: most system services except those that use RMS (e.g. $PUTMSG).
```

Calling sequence:

```
JSB      USER_RUNDOWN
Entered at IPL=0 and must leave at IPL=0.
```

Input Parameters:

```
R4  - Current PCB Address. (Therefore R4 must be specified in all
      register save masks for kernel routines.)

R7  - Access mode parameter to $RUNDWN maximized with previous mode

AP  - Argument pointer existing when the $RUNDWN system
      service was invoked.

4(AP) - Access mode parameter to $RUNDWN
```

```
--
.PSECT  USER_CODE,BYTE,NOWRT,EXE,PIC
```

```
USER_RUNDOWN::      : Entry point for service
PUSHL  R2            : Save a register
PUSHAB B^SYSOUT      : Set up address of descriptor
PUSHL  S^#SYS_LEN    : Set up length
MOVAL  -(SP),R2      : Grab some temporary storage
$ASSIGN S 4(R2), (R2) : Assign a channel to operator console
BLBC   R0, 10$       : Error
$OUTPUT (R2), S^#MSG_LEN, B^MSG : Print the message on operator console
$DASSGN S (R2)       : Get rid of the channel
10$:  ADDL2 #12, SP    : Clean up
      MOVL  (SP)+, R2  : Restore register
      RSB
```

```
:
: SYSOUT: .ASCII  /_OPA0:/
: SYS_LEN=-SYSOUT
: MSG: .ASCII  /*** Image exiting ***/
: MSG_LEN=-MSG
: .PAGE
: .SBTTL  Get Time of Day Register Value
```

```
++
: Functional Description:
: This routine reads the content of the hardware time of day
: processor register and stores the resulting value at the
: specified address.
```



```

; Input Parameters:
; 04(AP) - Address to return time of day value
; R4 - Address of current PCB

```

```

; Output Parameters:
; R0 - Completion Status Code

```

```

--
;ENTRY USER_GET_TODR,^M<R2,R3,R4>
MOVL 4(AP),R1 ; Get address to store time of day register
IFNOWRT #4,(R1),10$ ; Branch if not writable
JSB G^EXES$READ_TODR ; Call cpu-dependent routine
MOVL R0,(R1) ; Return current time of day register
MOVL #SS$_NORMAL,R0 ; Set normal completion status
RET ; and return

10$: MOVZWL #SS$_ACCVIO,R0 ; Indicate access violation
RET
;
;PAGE
;SBTTL Set Page Fault Cluster Factor

```

```

; Functional Description:
; This routine sets the page fault cluster to the specified value
; and returns the previous value.

```

```

; Input Parameters:
; 04(AP) - New value for Page Fault Cluster factor
; 08(AP) - Address to return previous value
; (0 means none)
; R4 - PCB address of current process

```

```

; Output Parameters:
; R0 - Completion Status code

```

```

--
;ENTRY USER_SET_PFC,^M<R4,R5>
MOVL @#CTC$GL_PHD,R5 ; Get address of process header
MOVL 8(AP),R1 ; Get address to store previous value
BEQL 10$ ; Branch if none
IFNOWRT #4,(R1),30$ ; Branch if not writable
MOVZBL PHD$B_DFPFC(R5),(R1) ; Return current value
10$: MOVB 4(AP),R0 ; Get new value for PFC
CMPB R0,#127 ; Check for legal value
BLEQU 20$ ; Branch if legal
; Set to maximum value
20$: MOVB R0,PHD$B_DFPFC(R5) ; Set new value into PHD
MOVL #SS$_NORMAL,R0 ; Set normal completion status
RET ; and return

30$: MOVZWL #SS$_ACCVIO,R0 ; Indicate access violation
RET
;
;PAGE
;SBTTL Null Service

```

```

; Functional Description:

```

```

; Input Parameters:

```

:
: Output Parameters:
:--

```
.ENTRY  USER_NULL,^M<>      : Entry definition
MOVZWL  #SS$_NORMAL,RO      : Set normal completion status
RET                                           : and return

.END
```


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