OS
CASE STUDY
EXPOS

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STAGE – 1: SETTING UP THE SYSTEM

The system setup includes configuring the XSM simulator, creating necessary files, and preparing the environment. The operating system is initialized, memory is allocated, and the disk is formatted. Basic commands ensure proper interaction with the EXPOS system.

```
poojitha@IdeaPad-3:~$ cd $HOME/myexpos
poojitha@IdeaPad-3:~/myexpos$ ls
download.sh         README.md      tempfile.901244138.xsm
expl                rootfile.txt   xfs-interface
inodeusertable.txt  sample.dat     xsm
Makefile            spl
poojitha@IdeaPad-3:~/myexpos$
```

STAGE –2: UNDERSTANDING THE FILE SYSTEM

A text file is created and loaded onto the XFS file system using xfs-interface. Blocks are dynamically allocated to store the file. The system marks used blocks, tracks file metadata, and manages free space efficiently.

```
poojitha@IdeaPad-3:~/myexpos$ cd $HOME/myexpos/xfs-interface
poojitha@IdeaPad-3:~/myexpos/xfs-interface$ ./xfs-interface
Unix-XFS Interace Version 2.0.
Type "help" for getting a list of commands.
# fdisk
Formatting Complete. "disk.xfs" created.
# exit
poojitha@IdeaPad-3:~/myexpos/xfs-interface$ ls
AUTHORS         exception.h    LICENSE
constants.h     fileSystem.h   Makefile
disk.c          inode.c        memOrg.h
disk.h          inode.h        README.md
diskUtility.c   interface.c    tempfile.1546556084.xsm
diskUtility.h   interface.h    virtualDisk.c
disk.xfs        labels.c       virtualDisk.h
exception.c     labels.h       xfs-interface
poojitha@IdeaPad-3:~/myexpos/xfs-interface$ sudo ./xfs-interface
[sudo] password for poojitha:
Unix-XFS Interace Version 2.0.
Type "help" for getting a list of commands.
# fdiak
Unknown command "fdiak". See "help" for more information.
# fdisk
Formatting Complete. "disk.xfs" created.
# df
0       -       1
1       -       1
2       -       1
3       -       1
4       -       1
5       -       1
6       -       1
7       -       1
8       -       1
9       -       1
10      -       1
11      -       1
12      -       1
13      -       1
```

```
509       -       0
510       -       0
511       -       0

No of Free Blocks = 443
Total no of Blocks = 512
# exit
poojitha@IdeaPad-3:~/myexpos/xfs-interface$ cd ..
poojitha@IdeaPad-3:~/myexpos$ cat sample.dat
There is a place where the sidewalk ends
And before the street begins,
And there the grass grows soft and white,
And there the sun burns crimson bright,
And there the moon-bird rests from his flight
To cool in the peppermint wind.
poojitha@IdeaPad-3:~/myexpos$ ls
download.sh          README.md      tempfile.901244138.xsm
expl                 rootfile.txt   xfs-interface
inodeusertable.txt   sample.dat     xsm
Makefile             spl
poojitha@IdeaPad-3:~/myexpos$ cd $HOME/myexpos/xfs-interface
poojitha@IdeaPad-3:~/myexpos/xfs-interface$ ./xfs-interface
Unix-XFS Interace Version 2.0.
Type "help" for getting a list of commands.
# load --data $HOME/myexpos/sample.dat
# copy 3 4 $HOME/myexpos/inode_table.txt
# exit
poojitha@IdeaPad-3:~/myexpos/xfs-interface$ cd ..
poojitha@IdeaPad-3:~/myexpos$ cat inode_table.txt
1
root
512
0
0
-1
-1
-1
5
-1
-1
-1
-1
-1
-1
-1
2
sample.dat
18
1
poojitha@IdeaPad-3:~/myexpos$ cd xfs-interface
poojitha@IdeaPad-3:~/myexpos/xfs-interface$ ./xfs-interface
Unix-XFS Interace Version 2.0.
Type "help" for getting a list of commands.
# load --data $HOME/myexpos/sample.dat
Disk already contains the file with this name. Try again with a dif
# dump --inodeusertable
# exit
poojitha@IdeaPad-3:~/myexpos/xfs-interface$ ls
AUTHORS         fileSystem.h        Makefile
constants.h     inode.c             memOrg.h
disk.c          inode.h             README.md
disk.h          inodeusertable.txt  tempfile.1546556084.xsm
diskUtility.c   interface.c         virtualDisk.c
diskUtility.h   interface.h         virtualDisk.h
disk.xfs        labels.c            xfs-interface
exception.c     labels.h
exception.h     LICENSE
poojitha@IdeaPad-3:~/myexpos/xfs-interface$ cat inodeusertable.txt
1
root
512
0
0
-1
-1
-1
```

//69th block is marked as used

//after we load the file sample.dat

```
No of Free Blocks = 442
Total no of Blocks = 512
# exit
```

```
poojitha@IdeaPad-3:~/myexpos/xfs-interface$ ./xfs-interface
Unix-XFS Interace Version 2.0.
Type "help" for getting a list of commands.
# copy 69 69 $HOME/myexpos/data.txt
# exit
poojitha@IdeaPad-3:~/myexpos/xfs-interface$ cat data.txt
cat: data.txt: No such file or directory
poojitha@IdeaPad-3:~/myexpos/xfs-interface$ cd ..
poojitha@IdeaPad-3:~/myexpos$ cat data.txt
There is a plac
e where the sid
ewalk ends
And before the
street begins,
And there the g
rass grows soft
 and white,
And there the s
un burns crimso
n bright,
And there the m
oon-bird rests
from his flight


To cool in the
peppermint wind
```

STAGE – 3: BOOTSTRAP LOADER

An assembly program is written to print "HELLO_WORLD". This bootloader loads the kernel into memory, initializes essential registers, and hands over control to the OS. The program sets up the minimal environment required to execute higher-level functionalities.

```
poojitha@IdeaPad-3:~/myexpos$ cd ./xfs-interface
poojitha@IdeaPad-3:~/myexpos/xfs-interface$ ./xfs-interface
Unix-XFS Interace Version 2.0.
Type "help" for getting a list of commands.
# load --os $HOME/myexpos/spl/spl_progs/hellow_world.xsm
# exit
poojitha@IdeaPad-3:~/myexpos/xfs-interface$ cd ..
poojitha@IdeaPad-3:~/myexpos$ cd xsm
poojitha@IdeaPad-3:~/myexpos/xsm$ ./xsm
HELLO_WORLD
Machine is halting.
```

STAGE –4: LEARNING THE SPL LANGUAGE

SPL (System Programming Language) is used to write low-level OS programs. Basic operations like printing odd numbers are implemented. SPL allows defining handlers, system calls, and interrupt routines, providing better control over system behavior.

//printing odd numbers

Load

```
poojitha@IdeaPad-3:~/myexpos$ cd ./xfs-interface/
poojitha@IdeaPad-3:~/myexpos/xfs-interface$ ./xfs-interface
Unix-XFS Interace Version 2.0.
Type "help" for getting a list of commands.
# load --os $HOME/myexpos/spl/spl_progs/printOdd_st4.xsm
# exit
poojitha@IdeaPad-3:~/myexpos/xfs-interface$ cd ..
poojitha@IdeaPad-3:~/myexpos$ cd xsm
poojitha@IdeaPad-3:~/myexpos/xsm$ ./xsm
1
3
5
7
9
11
13
15
17
19
Machine is halting.
```

STAGE – 5: XSM DEBUGGING

Debugging tools in XSM help trace and fix errors in kernel and user programs. Breakpoints are set, registers are inspected, and memory access is monitored. Debugging ensures correct implementation of system-level functionalities.

//DEBUGGING

```
poojitha@IdeaPad-3:~/myexpos$ cd ./xfs-interface
poojitha@IdeaPad-3:~/myexpos/xfs-interface$ ./xfs-interface
Unix-XFS Interace Version 2.0.
Type "help" for getting a list of commands.
# load --os $HOME/myexpos/spl/spl_progs/debug_test_st5.xsm
# exit
poojitha@IdeaPad-3:~/myexpos/xfs-interface$ cd ..
poojitha@IdeaPad-3:~/myexpos$ cd xsm
poojitha@IdeaPad-3:~/myexpos/xsm$ ./xsm --debug
Previous instruction at IP = 530: BRKP
Mode: KERNEL     PID: -1
Next instruction at IP = 532, Page No. = 1: JMP 534
debug> reg
R0: 1   R1:     R2:     R3:     R4:
R5:     R6:     R7:     R8:     R9:
R10:    R11:    R12:    R13:    R14:
R15:    R16: 1  R17: 0  R18:    R19:
P0:     P1:     P2:     P3:
BP:     SP:     IP: 532 PTBR:   PTLR:
EIP:    EC:     EPN:    EMA:
debug> s
Previous instruction at IP = 532: JMP 534
Mode: KERNEL     PID: -1
Next instruction at IP = 534, Page No. = 1: MOV R16,R0
debug> c
Previous instruction at IP = 530: BRKP
Mode: KERNEL     PID: -1
Next instruction at IP = 532, Page No. = 1: JMP 534
debug> exit
Killing the machine
```

STAGE -6: RUNNING A USER PROGRAM

User programs execute in user mode, interacting with the OS through system calls. The process terminates with a halt instruction. Exception handlers manage errors and unexpected behaviors, preventing crashes.

```
poojitha@IdeaPad-3:~/myexpos/xsm$ cd ..
poojitha@IdeaPad-3:~/myexpos$ cd expl/expl_progs
poojitha@IdeaPad-3:~/myexpos/expl/expl_progs$ ls
even_14.expl       init_17a.xsm          odd_17a.xsm
even_14.xsm        init_stage14.expl     oddeven.xsm
idleprog2.xsm      init_stage14.xsm      odd_nos.xsm
idleprog.expl      int10_stage14.spl     prime_14a.expl
idleprog.xsm       int10_stage14.xsm     prime_14a.xsm
idle_stage14.expl  module_5_stage14.spl  squares.xsm
idle_stage14.xsm   module_5_stage14.xsm  timer_stage14.spl
init_16.expl       module_7_stage14.spl  timer_stage14.xsm
init_16.xsm        module_7_stage14.xsm
init_17a.expl      odd_17a.expl
poojitha@IdeaPad-3:~/myexpos/expl/expl_progs$ nano squares.xsm
poojitha@IdeaPad-3:~/myexpos/expl/expl_progs$ cd ..
poojitha@IdeaPad-3:~/myexpos/expl$ cd ..
poojitha@IdeaPad-3:~/myexpos$ cd ./xfs-interface
poojitha@IdeaPad-3:~/myexpos/xfs-interface$ ./xfs-interface
Unix-XFS Interace Version 2.0.
Type "help" for getting a list of commands.
# load --init $HOME/myexpos/expl/expl_progs/squares.xsm
# exit
poojitha@IdeaPad-3:~/myexpos/xfs-interface$ cd ..
poojitha@IdeaPad-3:~/myexpos$ cd spl/spl_progs
```

//halt

//exception handler code

```
poojitha@IdeaPad-3:~/myexpos/spl/spl_progs$ nano haltprog_6.spl
poojitha@IdeaPad-3:~/myexpos/spl/spl_progs$ cd ..
poojitha@IdeaPad-3:~/myexpos/spl$ ./spl $HOME/myexpos/spl/spl_progs/haltprog.spl
poojitha@IdeaPad-3:~/myexpos/spl$ ./spl $HOME/myexpos/spl/spl_progs/haltprog_6.spl
poojitha@IdeaPad-3:~/myexpos/spl$ cd ..
poojitha@IdeaPad-3:~/myexpos$ cd ./xfs-interface
poojitha@IdeaPad-3:~/myexpos/xfs-interface$ ./xfs-interface
Unix-XFS Interace Version 2.0.
Type "help" for getting a list of commands.
# load --int=10 $HOME/myexpos/spl/spl_progs/haltprog_6.xsm
# exit
poojitha@IdeaPad-3:~/myexpos/xfs-interface$ ./xfs-interface
Unix-XFS Interace Version 2.0.
Type "help" for getting a list of commands.
# load --exhandler $HOME/myexpos/spl/spl_progs/haltprog_6.xsm
# exit
poojitha@IdeaPad-3:~/myexpos/xfs-interface$ cd ..
poojitha@IdeaPad-3:~/myexpos$ cd ./xfs-interface
poojitha@IdeaPad-3:~/myexpos/xfs-interface$ ./xfs-interface
Unix-XFS Interace Version 2.0.
Type "help" for getting a list of commands.
# load --os $HOME/myexpos/spl/spl_progs/os_startup_st6.xsm
# exit
poojitha@IdeaPad-3:~/myexpos/xfs-interface$ cd ..
poojitha@IdeaPad-3:~/myexpos$ cd xsm
poojitha@IdeaPad-3:~/myexpos/xsm$ ./xsm --debug --timer 0
Previous instruction at IP = 12: BRKP
Mode: USER       PID: 0
Next instruction at IP = 14, Page No. = 0: ADD R0,1
debug> reg
R0: 1   R1: 1   R2: 1   R3:     R4:
R5:     R6:     R7:     R8:     R9:
R10:    R11:    R12:    R13:    R14:
R15:    R16: 1024       R17:    R18:    R19:
P0:     P1:     P2:     P3:
BP:     SP: 1023        IP: 14  PTBR: 29696     PTLR: 3
EIP:    EC:     EPN:    EMA:
debug> step
Previous instruction at IP = 14: ADD R0,1
Mode: USER       PID: 0
Next instruction at IP = 16, Page No. = 0: JMP 2
debug> exit
Killing the machine
```

STAGE -7: ABI AND XEXE FORMAT

The Application Binary Interface (ABI) defines rules for system interaction. XEXE format structures executable files, including header information, segment details, and entry points. Understanding these ensures proper program execution

```
poojitha@IdeaPad-3:~$ cd myexpos
poojitha@IdeaPad-3:~/myexpos$ cd spl
poojitha@IdeaPad-3:~/myexpos/spl$ cd spl_progs
poojitha@IdeaPad-3:~/myexpos/spl/spl_progs$ nano os_startup.spl
poojitha@IdeaPad-3:~/myexpos/spl$ ./spl $HOME/myexpos/spl/spl_progs/os_startup.spl
poojitha@IdeaPad-3:~/myexpos/spl$ cd ..
poojitha@IdeaPad-3:~/myexpos$ cd expl
poojitha@IdeaPad-3:~/myexpos/expl$ ls
aa.c       data.h      instr.h      ltranslate.c      README.md      userdtype.c
abstree.h  decode.lex  lex.yy.c     ltranslate.l      symboltable.c  y.tab.c
abstree.l  expl        lex.yy.o     ltranslate.lex.c  symboltable.h  y.tab.h
abstree.y  expl-bin    library.lib  ltranslate.lex.o  typecheck.c    y.tab.o
codegen.c  expl_progs  ltranslate   Makefile          typecheck.h
poojitha@IdeaPad-3:~/myexpos/expl$ cd expl_progs
poojitha@IdeaPad-3:~/myexpos/expl/expl_progs$ ls
square.xsm
poojitha@IdeaPad-3:~/myexpos/expl/expl_progs$ touch init.xsm
poojitha@IdeaPad-3:~/myexpos/expl/expl_progs$ nano init.xsm
poojitha@IdeaPad-3:~/myexpos/expl/expl_progs$ rm init.xsm
poojitha@IdeaPad-3:~/myexpos/expl/expl_progs$ cd ..
poojitha@IdeaPad-3:~/myexpos/expl$ touch init.xsm
poojitha@IdeaPad-3:~/myexpos/expl$ nano init.xsm
poojitha@IdeaPad-3:~/myexpos/expl$ cd ..
poojitha@IdeaPad-3:~/myexpos$ cd xfs-interface/
poojitha@IdeaPad-3:~/myexpos/xfs-interface$ ./xfs-interface
Unix-XFS Interace Version 2.0.
Type "help" for getting a list of commands.
# load --os $HOME/myexpos/spl/spl_progs/os_startup.xsm
# load --library ../expl/library.lib
# load --init $HOME/myexpos/expl/init.xsm
# exit
poojitha@IdeaPad-3:~/myexpos/xfs-interface$ cd ..
poojitha@IdeaPad-3:~/myexpos$ cd xsm
poojitha@IdeaPad-3:~/myexpos/xsm$ ./xsm --debug --timer 0
-----------------------------------
The simulator has encountered a NULL instruction: Entering Debug Mode.
Previous instruction at IP = 10:
Mode: KERNEL     PID: 0
Next instruction at IP = 1024, Page No. = 2:
debug> step
Machine is halting.
poojitha@IdeaPad-3:~/myexpos/xsm$
```

STAGE - 8: HANDLING TIMER INTERRUPT

A timer interrupt triggers periodically to manage multitasking. The interrupt handler updates process states, schedules tasks, and ensures fair CPU allocation. This mechanism is essential for implementing time-sharing in the OS.

```
poojitha@IdeaPad-3:~/myexpos/xsm$ cd ..
poojitha@IdeaPad-3:~/myexpos$ cd spl
poojitha@IdeaPad-3:~/myexpos/spl$ cd spl_progs
poojitha@IdeaPad-3:~/myexpos/spl/spl_progs$ nano os_startup.spl
poojitha@IdeaPad-3:~/myexpos/spl/spl_progs$ ./spl $HOME/myexpos/spl/spl_progs/os_startup.spl
bash: ./spl: No such file or directory
poojitha@IdeaPad-3:~/myexpos/spl/spl_progs$ cd ..
poojitha@IdeaPad-3:~/myexpos/spl$ ./spl $HOME/myexpos/spl/spl_progs/os_startup.spl
poojitha@IdeaPad-3:~/myexpos/spl$ cd spl_progs
poojitha@IdeaPad-3:~/myexpos/spl/spl_progs$ touch sample_timer.spl
poojitha@IdeaPad-3:~/myexpos/spl/spl_progs$ nano sample_timer.spl
poojitha@IdeaPad-3:~/myexpos/spl/spl_progs$ cd ..
poojitha@IdeaPad-3:~/myexpos/spl$ ./spl $HOME/myexpos/spl/spl_progs/sample_timer.spl
poojitha@IdeaPad-3:~/myexpos/spl$ ./spl $HOME/myexpos/spl/spl_progs/os_startup.spl
poojitha@IdeaPad-3:~/myexpos/spl$ cd ..
poojitha@IdeaPad-3:~/myexpos$ ./xfs-interface
bash: ./xfs-interface: Is a directory
poojitha@IdeaPad-3:~/myexpos$ cd xfs-interface/
poojitha@IdeaPad-3:~/myexpos/xfs-interface$ ./xfs-interface
Unix-XFS Interace Version 2.0.
Type "help" for getting a list of commands.
# load --int=timer $HOME/myexpos/spl/spl_progs/sample_timer.xsm
# exit
poojitha@IdeaPad-3:~/myexpos/xfs-interface$ cd xfs-interface/
bash: cd: xfs-interface/: Not a directory
poojitha@IdeaPad-3:~/myexpos/xfs-interface$ ./xfs-interface
Unix-XFS Interace Version 2.0.
Type "help" for getting a list of commands.
# load --os $HOME/myexpos/spl/spl_progs/os_startup.xsm
# exit
poojitha@IdeaPad-3:~/myexpos/xfs-interface$ cd ..
poojitha@IdeaPad-3:~/myexpos$ cd xsm
poojitha@IdeaPad-3:~/myexpos/xsm$ ./xsm --timer 2
TIMER
TIMER
---------------------------------
The simulator has encountered a NULL instruction.
Machine is halting.
poojitha@IdeaPad-3:~/myexpos/xsm$ S
```

STAGE - 9: HANDLING KERNEL STACK

The kernel stack stores function call records, local variables, and return addresses during system execution. Stack management prevents overflow, ensures smooth function calls, and handles system interrupts efficiently.

```
poojitha@IdeaPad-3:~/myexpos/spl/spl_progs$ cd ..
poojitha@IdeaPad-3:~/myexpos/spl$ ./spl spl_progs/os_startup9.spl
Invalid input file
poojitha@IdeaPad-3:~/myexpos/spl$ ./spl spl_progs/os_startup9.spl^C
poojitha@IdeaPad-3:~/myexpos/spl$ ./spl spl_progs/os_startup.spl
poojitha@IdeaPad-3:~/myexpos/spl$ ./spl spl_progs/timer9.spl
poojitha@IdeaPad-3:~/myexpos/spl$ cd ..
poojitha@IdeaPad-3:~/myexpos$ cd xfs-interface
poojitha@IdeaPad-3:~/myexpos/xfs-interface$ ./xfs-interface
Unix-XFS Interace Version 2.0.
Type "help" for getting a list of commands.
# load --os $HOME/myexpos/spl/spl_progs/os_startup.xsm
# load --int=timer $HOME/myexpos/spl/spl_progs/timer.xsm
Can't open source file.
File ◆◆
       V◆ not found.
Error while trying to delete temporary file
# load --int=timer $HOME/myexpos/spl/spl_progs/timer9.xsm
# exit
poojitha@IdeaPad-3:~/myexpos/xfs-interface$ cd ..
poojitha@IdeaPad-3:~/myexpos$ cd xsm
poojitha@IdeaPad-3:~/myexpos/xsm$ ./xsm
First instruc
0
--------------------------------
The instruction is not available in this architecture.
Machine is halting.
```

STAGE - 10: CONSOLE OUTPUT

Kernel modules handle console output using system calls. Functions send characters or strings to the screen buffer, allowing users to view messages, results, or debugging information directly.

```
Unix-XFS Interace Version 2.0.
Type "help" for getting a list of commands.
# load --init ../expl/expl_progs/first20.xsm
File ../expl/expl_progs/first20.xsm not found.
# load --init ../expl/samples/first20.xsm
# load --os ../spl/spl_progs/os_startup.xsm
# load --int=10 ../spl/spl_progs/haltprog.xsm
# load --exhandler ../spl/spl_progs/haltprog.xsm
# load --library ../expl/library.lib
# load --int=timer ../spl/spl_progs/sample_timer_s9.xsm
# load --int=7 ../spl/spl_progs/sample_int7.xsm
# exit
poojitha@IdeaPad-3:~/myexpos/xfs-interface$ cd ..
poojitha@IdeaPad-3:~/myexpos$ cd xsm
poojitha@IdeaPad-3:~/myexpos/xsm$ ./xsm
1
TIMER
2
TIMER
3
TIMER
4
TIMER
TIMER
5
TIMER
6
TIMER
7
TIMER
8
TIMER
9
TIMER
10
TIMER
11
TIMER
12
TIMER
13
TIMER
TIMER
14
TIMER
15
TIMER
16
TIMER
17
TIMER
18
TIMER
19
TIMER
20
TIMER
Machine is halting.
poojitha@IdeaPad-3:~/myexpos/xsm$
```

STAGE - 11: INTRODUCTION TO EXPL

EXPL (EXPOS Programming Language) is designed for writing user programs. It includes high-level constructs for memory management, process handling, and system interactions, making OS programming easier.

```
poojitha@IdeaPad-3:~/myexpos/spl/spl_progs$ cd ..
poojitha@IdeaPad-3:~/myexpos/spl$ cd ..
poojitha@IdeaPad-3:~/myexpos$ cd xfs-interface
poojitha@IdeaPad-3:~/myexpos/xfs-interface$ ./xfs-interface
Unix-XFS Interace Version 2.0.
Type "help" for getting a list of commands.
# load --init ../expl/samples/numbers1to100.xsm
# load --os ../spl/spl_progs/os_startup_s9.xsm
Can't open source file.
File ♦I♦♦♦ not found.
Error while trying to delete temporary file
# load --os ../spl/spl_progs/os_startup.xsm
# load --int=10 ../spl/spl_progs/haltprog.xsm
# load --exhandler ../spl/spl_progs/haltprog.xsm
# load --library ../expl/expl_progs/library_test.lib
# load --int=timer ../spl/spl_progs/sample_timer_s9.xsm
# load --int=7 ../spl/spl_progs/sample_int7.xsm
# exit
poojitha@IdeaPad-3:~/myexpos/xfs-interface$ cd ..
poojitha@IdeaPad-3:~/myexpos$ cd xsm
poojitha@IdeaPad-3:~/myexpos/xsm$ ./xsm
TIMER
TIMER
0
TIMER
TIMER
TIMER
TIMER
TIMER
1
TIMER
TIMER
TIMER
TIMER
2
TIMER
TIMER
TIMER
TIMER
```

STAGE - 12: INTRODUCTION TO MULTIPROGRAMMING

```
TIMER
TIMER
94
TIMER
TIMER
TIMER
TIMER
95
TIMER
TIMER
TIMER
TIMER
TIMER
96
TIMER
TIMER
TIMER
TIMER
97
TIMER
TIMER
TIMER
TIMER
98
TIMER
TIMER
TIMER
TIMER
99
TIMER
TIMER
TIMER
TIMER
TIMER
100
TIMER
TIMER
Machine is halting.
poojitha@IdeaPad-3:~/myexpos/xsm$ s
```

Multiple programs execute concurrently by switching between processes. The OS handles context switching, memory allocation, and CPU scheduling, enabling parallel execution while ensuring efficiency.

```
pocjitha@IdeaPad-3:~/myexpos/xfs-interface$ ./xfs-interface
Unix-XFS Interace Version 2.0.
Type "help" for getting a list of commands.
# load --init ../expl/samples/numbers1to100.xsm
# load --os ../spl/spl_progs/os_startup_s12.xsm
Can't open source file.
File ◆*b◆ not found.
Error while trying to delete temporary file
# load --os ../spl/spl_progs/os_startup.xsm
# load --int=10 ../spl/spl_progs/haltprog.xsm
#
# load --exhandler ../spl/spl_progs/haltprog.xsm
# load --library ../expl/library.lib
# load --int=timer ../spl/spl_progs/sample_timer_s12.xsm
# load --int=7 ../spl/spl_progs/sample_int7.xsm
# load --idle ../expl/expl_progs/idleprog2.xsm
# exit
pocjitha@IdeaPad-3:~/myexpos/xfs-interface$ cd  ..
pocjitha@IdeaPad-3:~/myexpos$ cd xsm
pocjitha@IdeaPad-3:~/myexpos/xsm$ ./xsm
0
101
1
102
103
2
3
104
105
4
106
5
107
6
108
7
109
8
110
9
111
```

```
184
82
185
83
186
84
187
85
188
86
189
87
190
88
191
89
192
90
193
91
194
92
195
93
196
94
197
198
95
96
199
200
97
201
98
202
99
203
100
Machine is halting.
```

STAGE - 13: BOOT MODULE

The boot module loads the OS into memory, initializes system components, and transfers control to the kernel. It is the first program executed when the system starts.

```
poojitha@IdeaPad-3:~/myexpos$ cd xfs-interface
poojitha@IdeaPad-3:~/myexpos/xfs-interface$ ./xfs-interface
Unix-XFS Interace Version 2.0.
Type "help" for getting a list of commands.
# load --init ../expl/expl_progs/oddeven.xsm
# load --os ../spl/spl_progs/os_startup.xsm
# load --module 7 ../spl/spl_progs/module7.xsm
# load --int=10 ../spl/spl_progs/haltprog.xsm
# load --exhandler ../spl/spl_progs/haltprog.xsm
# load --library ../expl/library.lib
# load --int=timer ../spl/spl_progs/sample_timer.xsm
# load --int=7 ../spl/spl_progs/sample_int7.xsm
# load --idle ../expl/expl_progs/idleprog2.xsm
# exit
poojitha@IdeaPad-3:~/myexpos/xfs-interface$ cd ..
poojitha@IdeaPad-3:~/myexpos$ cd xsm
poojitha@IdeaPad-3:~/myexpos/xsm$ ./xsm
101
Even
102
0
103
2
104
4
105
106
6
107
8
108
109
10
110
12
111
14
112
113
16
114
```

```
65
221
67
222
69
223
224
71
225
73
226
75
227
228
77
229
79
230
231
81
232
83
233
85
234
235
87
236
89
237
238
91
239
93
240
241
95
242
97
243
99
244
Machine is halting.
```

STAGE - 14: ROUND ROBIN SCEDULER

The Round Robin scheduler allocates CPU time to processes in fixed intervals. The timer interrupt ensures fair execution by switching between processes, maintaining system responsiveness.

```
poojitha@IdeaPad-3:~/myexpos/xfs-interface$ ./xfs-interface
Unix-XFS Interace Version 2.0.
Type "help" for getting a list of commands.
# fdisk
Formatting Complete. "disk.xfs" created.
# load --os $HOME/myexpos/spl/spl_progs/os_startup_13.xsm
# load --init $HOME/myexpos/expl/expl_progs/init_stage14.xsm
# load --idle $HOME/myexpos/expl/expl_progs/idle_stage14.xsm
# load --exec $HOME/myexpos/expl/expl_progs/even_14.xsm
# load --int=10 $HOME/myexpos/spl/spl_progs/int10_stage14.xsm
# load --int=7 $HOME/myexpos/spl/spl_progs/int7_10.xsm
# load --module 5 $HOME/myexpos/spl/spl_progs/module_5_stage14.xsm
# load --module 7 $HOME/myexpos/spl/spl_progs/module_7_stage14.xsm
# load --int=timer $HOME/myexpos/spl/spl_progs/timer_stage14.xsm
# exit
poojitha@IdeaPad-3:~/myexpos/xfs-interface$ cd ..
poojitha@IdeaPad-3:~/myexpos$ cd xsm
poojitha@IdeaPad-3:~/myexpos/xsm$ ./xsm
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
```

```
58
59
60
61
62
63
64
65
66
67
68
69
70
71
72
73
74
75
76
77
78
79
80
81
82
83
84
85
86
87
88
89
90
91
92
93
94
95
96
97
98
99
100
Machine is halting.
```

STAGE - 15: RESOURCE MANAGER MODULE

This module efficiently manages system resources, ensuring fair allocation among processes. It prints numbers from 1 to 100 as a test program to validate its functionality.

```
poojitha@IdeaPad-3:~/myexpos/xfs-interface$ ./xfs-interface
Unix-XFS Interace Version 2.0.
Type "help" for getting a list of commands.
# fdisk
Formatting Complete. "disk.xfs" created.
# load --os $HOME/myexpos/spl/spl_progs/os_startup_13.xsm
# load --init $HOME/myexpos/expl/expl_progs/init_stage14.xsm
# load --idle $HOME/myexpos/expl/expl_progs/idle_stage14.xsm
# load --exec $HOME/myexpos/expl/expl_progs/even_14.xsm
# load --int=10 $HOME/myexpos/spl/spl_progs/int10_stage14.xsm
# load --int=7 $HOME/myexpos/spl/spl_progs/int7_stage15.xsm
# load --module 5 $HOME/myexpos/spl/spl_progs/module_5_stage14.xsm
# load --module 7 $HOME/myexpos/spl/spl_progs/module_7_stage14.xsm
# load --module 0 $HOME/myexpos/spl/spl_progs/module_0_stage15.xsm
# load --module 4 $HOME/myexpos/spl/spl_progs/module_4_stage15.xsm
# load --int=timer $HOME/myexpos/spl/spl_progs/timer_stage14.xsm
# load --library $HOME/myexpos/expl/library.lib
# exit
poojitha@IdeaPad-3:~/myexpos/xfs-interface$ cd ..
poojitha@IdeaPad-3:~/myexpos$ cd xsm
```

It prints all the numbers from 1 to 100

```
58
59
60
61
62
63
64
65
66
67
68
69
70
71
72
73
74
75
76
77
78
79
80
81
82
83
84
85
86
87
88
89
90
91
92
93
94
95
96
97
98
99
100
Machine is halting.
```

STAGE - 16: CONSOLE INPUT

Console input handling allows users to enter commands or data. The system reads input characters, processes them, and passes them to appropriate functions for execution.

```
poojitha@IdeaPad-3:~/myexpos/xfs-interface$ ./xfs-interface
Unix-XFS Interace Version 2.0.
Type "help" for getting a list of commands.
# fdisk
Formatting Complete. "disk.xfs" created.
# load --os $HOME/myexpos/spl/spl_progs/os_startup_13.xsm
# load --init $HOME/myexpos/expl/expl_progs/init_16.xsm
# load --idle $HOME/myexpos/expl/expl_progs/idle_stage14.xsm
# load --exhandler $HOME/myexpos/spl/spl_progs/haltprog_6.xsm
# load --int=7 $HOME/myexpos/spl/spl_progs/int7_stage15.xsm
# load --int=6 $HOME/myexpos/spl/spl_progs/int6_16.xsm
# load --int=console $HOME/myexpos/spl/spl_progs/console_int_16.xsm
# load --module 5 $HOME/myexpos/spl/spl_progs/module_5_stage14.xsm
# load --module 7 $HOME/myexpos/spl/spl_progs/module_7_16.xsm
# load --module 0 $HOME/myexpos/spl/spl_progs/module_0_stage15.xsm
# load --module 4 $HOME/myexpos/spl/spl_progs/module_4_16.xsm
# load --int=timer $HOME/myexpos/spl/spl_progs/timer_stage14.xsm
# load --library $HOME/myexpos/expl/library.lib
# exit
poojitha@IdeaPad-3:~/myexpos/xfs-interface$ cd ..
poojitha@IdeaPad-3:~/myexpos$ cd xsm
poojitha@IdeaPad-3:~/myexpos/xsm$ ./xsm
34
35
1
Machine is halting.
poojitha@IdeaPad-3:~/myexpos/xsm$ ./xsm
16
4
4
Machine is halting.
```

STAGE - 17: PROGRAM LOADER

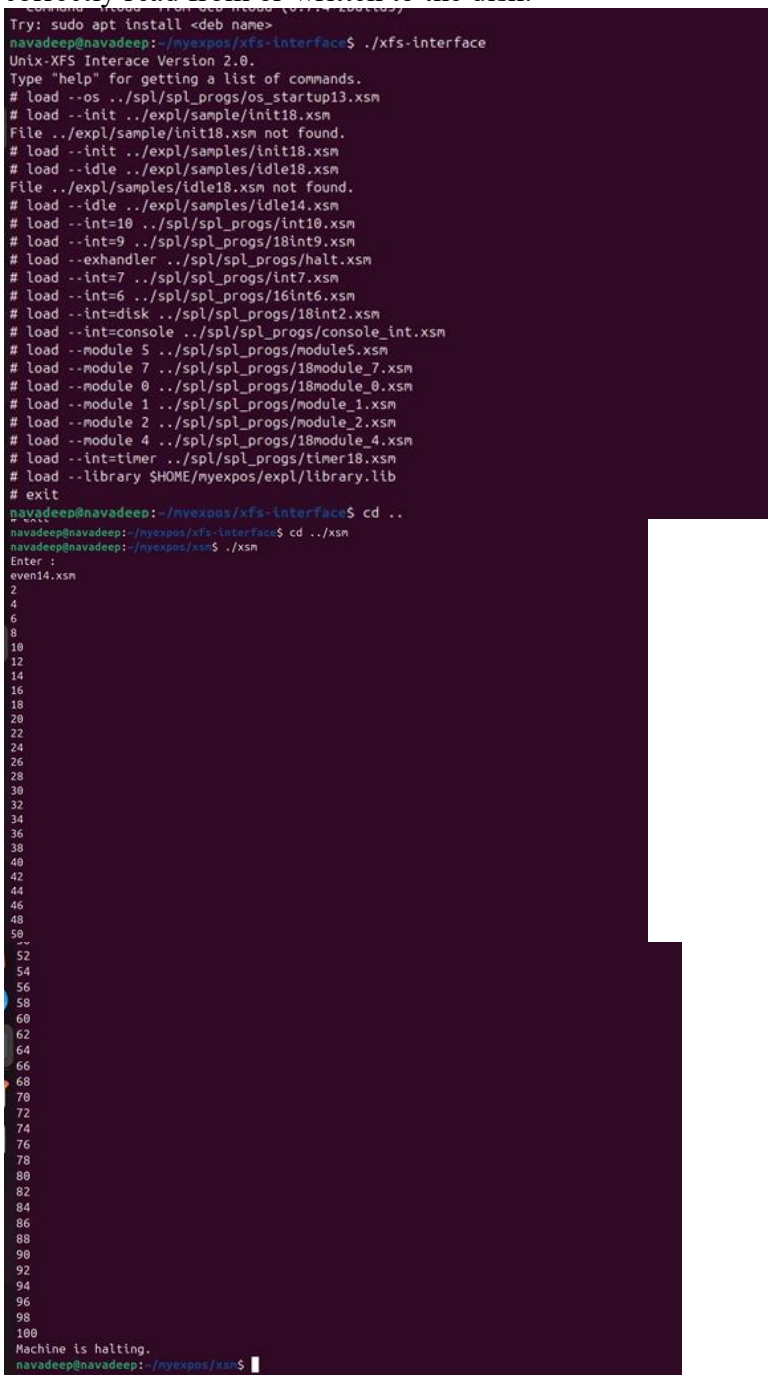
This stage focuses on developing the program loader, a critical component that loads executable programs into memory for execution. You'll learn how to read the executable file format, allocate memory, and set up the process's address space.

```
Unix-XFS Interace Version 2.0.
Type "help" for getting a list of commands.
# fdisk
Formatting Complete. "disk.xfs" created.
# load --os $HOME/myexpos/spl/spl_progs/os_startup_13.xsm
# load --init $HOME/myexpos/expl/expl_progs/init_17.xsm
# load --idle $HOME/myexpos/expl/expl_progs/idle_stage14.xsm
# load --int=10 $HOME/myexpos/spl/spl_progs/int10_stage14.xsm
# load --int=9 $HOME/myexpos/spl/spl_progs/int9_stage14.xsm
Can't open source file.
File ◆◆◆ not found.
Error while trying to delete temporary file
# load --int=9 $HOME/myexpos/spl/spl_progs/int9_17.xsm
# load --exhandler $HOME/myexpos/spl/spl_progs/haltprog_6.xsm
# load --int=7 $HOME/myexpos/spl/spl_progs/int7_stage15.xsm
# load --int=6 $HOME/myexpos/spl/spl_progs/int6_16.xsm
# load --int=console $HOME/myexpos/spl/spl_progs/console_int_16.xsm
# load --module 5 $HOME/myexpos/spl/spl_progs/module_5_stage14.xsm
# load --module 7 $HOME/myexpos/spl/spl_progs/module_7_17.xsm
# load --module 0 $HOME/myexpos/spl/spl_progs/module_0_stage15.xsm
# load --module 1 $HOME/myexpos/spl/spl_progs/module_1_17.xsm
# load --module 2 $HOME/myexpos/spl/spl_progs/module_2_17.xsm
# load --module 4 $HOME/myexpos/spl/spl_progs/module_4_16.xsm
# load --int=timer $HOME/myexpos/spl/spl_progs/timer_stage14.xsm
# load --library $HOME/myexpos/expl/library.lib
# load --exec $HOME/myexpos/expl/expl_progs/odd_17.xsm
# exit
```

```
poojitha@IdeaPad-3:~/myexpos/xfs-interface$ cd ..
poojitha@IdeaPad-3:~/myexpos$ cd xsm
poojitha@IdeaPad-3:~/myexpos/xsm$ ./xsm
34
35
1
Machine is halting.
poojitha@IdeaPad-3:~/myexpos/xsm$ ./xsm
16
4
4
Machine is halting.
```

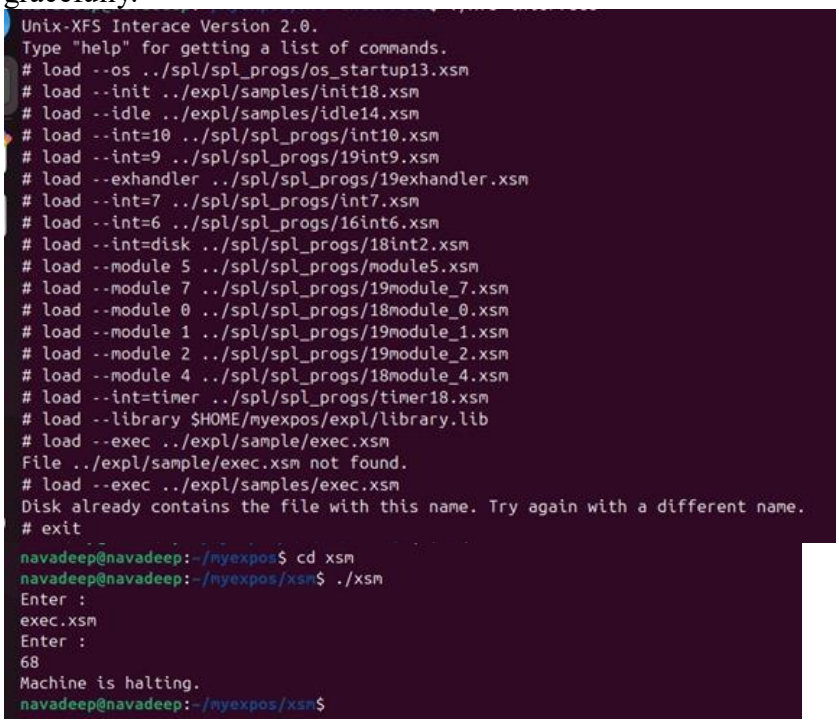
STAGE -18: DISK INTERRUPT HANDLER

In this stage, you'll implement the disk interrupt handler, which manages disk I/O operations. The handler responds to disk interruptions, processes completed I/O requests, and ensures data is correctly read from or written to the disk.



STAGE - 19: EXCEPTION HANDLER

This stage introduces exception handling in eXpOS. You'll implement handlers for exceptions such as illegal memory access, illegal instructions, arithmetic errors, and page faults. The handler will take appropriate actions, like terminating the offending process or handling the exception gracefully.



STAGE -20: PROCESS CREATION AND SYNCHRONISATION

Here, you'll implement system calls for process creation (Fork) and termination (Exit). This involves setting up new process control blocks, duplicating address spaces, and ensuring proper cleanup when processes terminate. These stages are crucial for building a functional, multitasking operating system.