



OS CASE STUDY

◆ EXPOS ◆

- 
- DIYA BHAT
CB.SC.U4CSE23319
 - DURGAM POOJITHA
CB.SC.U4CSE23320
 - JAI SUBIKSHA T
CB.SC.U4CSE23327
 - MAHASRI M
CB.SC.U4CSE23335



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
-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/xf-interface$ ./xf-interface
Unix-XFS Interace Version 2.0.
Type "help" for getting a list of commands.
# copy 69 69 $HOME/myexpos/data.txt
# exit
poojitha@IdeaPad-3:~/myexpos/xf-interface$ cat data.txt
cat: data.txt: No such file or directory
poojitha@IdeaPad-3:~/myexpos/xf-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 ./xf-interface
poojitha@IdeaPad-3:~/myexpos/xf-interface$ ./xf-interface
Unix-XFS Interace Version 2.0.
Type "help" for getting a list of commands.
# load --os $HOME/myexpos/spl/spl_progs/hello_world.xsm
# exit
poojitha@IdeaPad-3:~/myexpos/xf-interface$ 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 Interface 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 Interface 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 Interface 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 Interface 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 Interface 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_progs$ ./spl $HOME/myexpos/spl/spl_progs/os_startup.spl
poojitha@IdeaPad-3:~/myexpos/spl/spl_progs$ cd ..
poojitha@IdeaPad-3:~/myexpos/spl$ 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 Interface 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 Interface 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 Interface 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
5
TIMER
6
TIMER
7
TIMER
8
TIMER
9
TIMER
10
TIMER
11
TIMER
12
TIMER
13
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:~/nyexpos/spl/spl_progs$ cd ..
poojitha@IdeaPad-3:~/nyexpos/spl$ cd ..
poojitha@IdeaPad-3:~/nyexpos$ cd xfs-interface
poojitha@IdeaPad-3:~/nyexpos/xfs-interface$ ./xfs-interface
Unix-XFS Interface 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:~/nyexpos/xfs-interface$ cd ..
poojitha@IdeaPad-3:~/nyexpos$ cd xsm
poojitha@IdeaPad-3:~/nyexpos/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
96
TIMER
TIMER
TIMER
TIMER
97
TIMER
TIMER
TIMER
TIMER
98
TIMER
TIMER
TIMER
TIMER
99
TIMER
TIMER
TIMER
TIMER
100
TIMER
TIMER
Machine is halting.
poojitha@IdeaPad-3:~/nyexpos/xsm$
```

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:~/nyexpos/xfs-interface$ ./xfs-interface
Unix-XFS Interface Version 2.0.
Type "help" for getting a list of commands.
# load --init ../expl/samples/numbersito100.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:~/nyexpos/xfs-interface$ cd ..
pocjitha@IdeaPad-3:~/nyexpos$ cd xsm
pocjitha@IdeaPad-3:~/nyexpos/xsm$ ./xsm
0
101
1
102
103
2
3
104
105
4
106
5
107
6
108
7
109
8
110
111
```

```
112
113
114
115
116
117
118
119
120
121
122
123
124
125
126
127
128
129
130
131
132
133
134
135
136
137
138
139
140
141
142
143
144
145
146
147
148
149
150
151
152
153
154
155
156
157
158
159
160
161
162
163
164
165
166
167
168
169
170
171
172
173
174
175
176
177
178
179
180
181
182
183
184
185
186
187
188
189
190
191
192
193
194
195
196
197
198
199
200
201
202
203
204
205
206
207
208
209
210
211
212
213
214
215
216
217
218
219
220
221
222
223
224
225
226
227
228
229
230
231
232
233
234
235
236
237
238
239
240
241
242
243
244
245
246
247
248
249
250
251
252
253
254
255
256
257
258
259
260
261
262
263
264
265
266
267
268
269
270
271
272
273
274
275
276
277
278
279
280
281
282
283
284
285
286
287
288
289
290
291
292
293
294
295
296
297
298
299
300
301
302
303
304
305
306
307
308
309
310
311
312
313
314
315
316
317
318
319
320
321
322
323
324
325
326
327
328
329
330
331
332
333
334
335
336
337
338
339
340
341
342
343
344
345
346
347
348
349
350
351
352
353
354
355
356
357
358
359
360
361
362
363
364
365
366
367
368
369
370
371
372
373
374
375
376
377
378
379
380
381
382
383
384
385
386
387
388
389
390
391
392
393
394
395
396
397
398
399
400
401
402
403
404
405
406
407
408
409
410
411
412
413
414
415
416
417
418
419
420
421
422
423
424
425
426
427
428
429
430
431
432
433
434
435
436
437
438
439
440
441
442
443
444
445
446
447
448
449
450
451
452
453
454
455
456
457
458
459
460
461
462
463
464
465
466
467
468
469
470
471
472
473
474
475
476
477
478
479
480
481
482
483
484
485
486
487
488
489
490
491
492
493
494
495
496
497
498
499
500
501
502
503
504
505
506
507
508
509
510
511
512
513
514
515
516
517
518
519
520
521
522
523
524
525
526
527
528
529
530
531
532
533
534
535
536
537
538
539
540
541
542
543
544
545
546
547
548
549
550
551
552
553
554
555
556
557
558
559
560
561
562
563
564
565
566
567
568
569
570
571
572
573
574
575
576
577
578
579
580
581
582
583
584
585
586
587
588
589
590
591
592
593
594
595
596
597
598
599
600
601
602
603
604
605
606
607
608
609
610
611
612
613
614
615
616
617
618
619
620
621
622
623
624
625
626
627
628
629
630
631
632
633
634
635
636
637
638
639
640
641
642
643
644
645
646
647
648
649
650
651
652
653
654
655
656
657
658
659
660
661
662
663
664
665
666
667
668
669
670
671
672
673
674
675
676
677
678
679
680
681
682
683
684
685
686
687
688
689
690
691
692
693
694
695
696
697
698
699
700
701
702
703
704
705
706
707
708
709
710
711
712
713
714
715
716
717
718
719
720
721
722
723
724
725
726
727
728
729
730
731
732
733
734
735
736
737
738
739
740
741
742
743
744
745
746
747
748
749
750
751
752
753
754
755
756
757
758
759
760
761
762
763
764
765
766
767
768
769
770
771
772
773
774
775
776
777
778
779
780
781
782
783
784
785
786
787
788
789
790
791
792
793
794
795
796
797
798
799
800
801
802
803
804
805
806
807
808
809
810
811
812
813
814
815
816
817
818
819
820
821
822
823
824
825
826
827
828
829
830
831
832
833
834
835
836
837
838
839
840
841
842
843
844
845
846
847
848
849
850
851
852
853
854
855
856
857
858
859
860
861
862
863
864
865
866
867
868
869
870
871
872
873
874
875
876
877
878
879
880
881
882
883
884
885
886
887
888
889
890
891
892
893
894
895
896
897
898
899
900
901
902
903
904
905
906
907
908
909
910
911
912
913
914
915
916
917
918
919
920
921
922
923
924
925
926
927
928
929
930
931
932
933
934
935
936
937
938
939
940
941
942
943
944
945
946
947
948
949
950
951
952
953
954
955
956
957
958
959
960
961
962
963
964
965
966
967
968
969
970
971
972
973
974
975
976
977
978
979
980
981
982
983
984
985
986
987
988
989
990
991
992
993
994
995
996
997
998
999
1000
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 Interface 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
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 Interface 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
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65
66
67
68
69
70
```

```
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 Interface 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 Interface 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 $HOME/myexpos/expl/expl_progs/odd_17.xsm
# exit
^C
poojitha@IdeaPad-3:~/myexpos/xf-interface$ 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.

```
Try: sudo apt install <deb name>
navadeep@navadeep:~/myexpos/xf86-interface$ ./xf86-interface
Unix-XFS Interface Version 2.0.
Type "help" for getting a list of commands.
# load --os ../spl/spl_progs/os_startup13.xsm
# load --init ../expl/sample/init18.xsm
File ../expl/sample/init18.xsm not found.
# load --init ../expl/samples/init18.xsm
# load --idle ../expl/samples/idle18.xsm
File ../expl/samples/idle18.xsm not found.
# load --idle ../expl/samples/idle14.xsm
# load --int=10 ../spl/spl_progs/int10.xsm
# load --int=9 ../spl/spl_progs/18int9.xsm
# load --exhandler ../spl/spl_progs/halt.xsm
# load --int=7 ../spl/spl_progs/int7.xsm
# load --int=6 ../spl/spl_progs/16int6.xsm
# load --int=disk ../spl/spl_progs/18int2.xsm
# load --int=console ../spl/spl_progs/console_int.xsm
# load --module 5 ../spl/spl_progs/module5.xsm
# load --module 7 ../spl/spl_progs/18module_7.xsm
# load --module 0 ../spl/spl_progs/18module_0.xsm
# load --module 1 ../spl/spl_progs/module_1.xsm
# load --module 2 ../spl/spl_progs/module_2.xsm
# load --module 4 ../spl/spl_progs/18module_4.xsm
# load --int=timer ../spl/spl_progs/timer18.xsm
# load --library $HOME/myexpos/expl/library.lib
# exit
navadeep@navadeep:~/myexpos/xf86-interface$ cd ..
navadeep@navadeep:~/myexpos/xf86-interface$ cd ../xsm
navadeep@navadeep:~/myexpos/xsm$ ./xsm
Enter :
even14.xsm
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
42
44
46
48
50
52
54
56
58
60
62
64
66
68
70
72
74
76
78
80
82
84
86
88
90
92
94
96
98
100
Machine is halting.
navadeep@navadeep:~/myexpos/xsm$
```

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.

```
Unix-XFS Interface Version 2.0.
Type "help" for getting a list of commands.
# load --os ../spl/spl_progs/os_startup13.xsm
# load --init ../expl/samples/init18.xsm
# load --idle ../expl/samples/idle14.xsm
# load --int=10 ../spl/spl_progs/int10.xsm
# load --int=9 ../spl/spl_progs/19int9.xsm
# load --exhandler ../spl/spl_progs/19exhandler.xsm
# load --int=7 ../spl/spl_progs/int7.xsm
# load --int=6 ../spl/spl_progs/16int6.xsm
# load --int=disk ../spl/spl_progs/18int2.xsm
# load --module 5 ../spl/spl_progs/module5.xsm
# load --module 7 ../spl/spl_progs/19module_7.xsm
# load --module 0 ../spl/spl_progs/18module_0.xsm
# load --module 1 ../spl/spl_progs/19module_1.xsm
# load --module 2 ../spl/spl_progs/19module_2.xsm
# load --module 4 ../spl/spl_progs/18module_4.xsm
# load --int=timer ../spl/spl_progs/timer18.xsm
# load --library $HOME/myexpos/expl/library.lib
# load --exec ../expl/sample/exec.xsm
File ../expl/sample/exec.xsm not found.
# load --exec ../expl/samples/exec.xsm
Disk already contains the file with this name. Try again with a different name.
# exit
navadeep@navadeep:~/myexpos$ cd xsm
navadeep@navadeep:~/myexpos/xsm$ ./xsm
Enter :
exec.xsm
Enter :
68
Machine is halting.
navadeep@navadeep:~/myexpos/xsm$
```

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.

```
navadeep@navadeep:~/myexpos/xfs-interface$ ./xfs-interface
Unix-XFS Interface Version 2.0.
Type "help" for getting a list of commands.
# load --os ../spl/spl_progs/os_startup13.xsm
# load --init ../expl/samples/init18.xsm
# load --idle ../expl/samples/idle14.xsm
# load --int=10 ../spl/spl_progs/20exit.xsm
# load --int=9 ../spl/spl_progs/19int9.xsm
# load --int=8 ../spl/spl_progs/20fork.xsm
# load --exhandler ../spl/spl_progs/19exhandler.xsm
# load --int=7 ../spl/spl_progs/int7.xsm
# load --int=6 ../spl/spl_progs/16int6.xsm
# load --int=disk ../spl/spl_progs/18int2.xsm
# load --int=console ../spl/spl_progs/console_int.xsm
# load --module 5 ../spl/spl_progs/module5.xsm
# load --module 5 ../spl/spl_progs/20scheduler.xsm
# load --module 7 ../spl/spl_progs/20mod7.xsm
# load --module 0 ../spl/spl_progs/18module_0.xsm
# load --module 1 ../spl/spl_progs/20mod1.xsm
# load --module 2 ../spl/spl_progs/19module_2.xsm
# load --module 4 ../spl/spl_progs/18module_4.xsm
# load --int=timer ../spl/spl_progs/timer18.xsm
# load --library $HOME/myexpos/expl/library.lib
# rm exec.xsm
# load --exec ../expl/sample/exec.xsm
File ../expl/sample/exec.xsm not found.
# load --exec ../expl/samples/exec.xsm
# exit
navadeep@navadeep:~/myexpos$ cd xsm
navadeep@navadeep:~/myexpos/xsm$ ./xsm
Enter :
exec.xsm
Enter :
68
```