Operating System Concepts

COP4610.02

Mini Project 1

Noah Baldwin
Cody Carroll
Paul Teleweck

Participants name	Code section	Report Section	Documentation Sec	Presentation Sec
Noah Baldwin	33.33%	33.34%	33.33%	33.3%
Cody Carroll	33.33%	33.33%	33.34%	33.3%
Paul Teleweck	33.34%	33.33%	33.33%	33.3%

1. Created a user program within “user” called howmanysys.c
   - Added function to print number of system calls.

howmanysys.c
~/Desktop/xv6/user

```c
#include "types.h"
#include "stat.h"
#include "user.h"

// running system call howmanysys()
int
main(void)
{
        printf(1, "There are %d system calls.\n", howmanysys());
        exit();
}
```

2. Add #define statement in syscall.h to add howmanysys into system calls.
   - Create a system call number for howmanysy

syscall.h
~/Desktop/xv6/include

```c
#ifndef _SYSCALL_H_
#define _SYSCALL_H_

// System call numbers
#define SYS_fork    1
#define SYS_exit    2
#define SYS_wait    3
#define SYS_pipe    4
#define SYS_write   5
#define SYS_read    6
#define SYS_close   7
#define SYS_kill    8
#define SYS_exec    9
#define SYS_open   10
#define SYS_mknod  11
#define SYS_unlink 12
#define SYS_fstat  13
#define SYS_link   14
#define SYS_mkdir  15
#define SYS_chdir  16
#define SYS_dup    17
#define SYS_getpid 18
#define SYS_sbrk   19
#define SYS_sleep  20
#define SYS_uptime 21
#define SYS_howmanysys 22
```

3. Add [sys_howmanysys] sys_howmanysys, inside the file syscall.c.

syscall.c
~/Desktop/xv6/kernel

```c
// can catch definitions that don't match

// array of function pointers to handlers for all the syscalls
static int (*syscalls[])(void) = {
[SYS_chdir]   sys_chdir,
[SYS_close]   sys_close,
[SYS_dup]     sys_dup,
[SYS_exec]    sys_exec,
[SYS_exit]    sys_exit,
[SYS_fork]    sys_fork,
[SYS_fstat]   sys_fstat,
[SYS_getpid]  sys_getpid,
[SYS_kill]    sys_kill,
[SYS_link]    sys_link,
[SYS_mkdir]   sys_mkdir,
[SYS_mknod]   sys_mknod,
[SYS_open]    sys_open,
[SYS_pipe]    sys_pipe,
[SYS_read]    sys_read,
[SYS_sbrk]    sys_sbrk,
[SYS_sleep]   sys_sleep,
[SYS_unlink]  sys_unlink,
[SYS_wait]    sys_wait,
[SYS_write]   sys_write,
[SYS_uptime]  sys_uptime,
[SYS_howmanysys] sys_howmanysys,
};
```

4. Add int howmanysys(void); to the file, sysfunc.h.

sysfunc.h
~/Desktop/xv6/kernel

```c
#ifndef _SYSFUNC_H_
#define _SYSFUNC_H_

// System call handlers
int sys_chdir(void);
int sys_close(void);
int sys_dup(void);
int sys_exec(void);
int sys_exit(void);
int sys_fork(void);
int sys_fstat(void);
int sys_getpid(void);
int sys_kill(void);
int sys_link(void);
int sys_mkdir(void);
int sys_mknod(void);
int sys_open(void);
int sys_pipe(void);
int sys_read(void);
int sys_sbrk(void);
int sys_sleep(void);
int sys_unlink(void);
int sys_wait(void);
int sys_write(void);
int sys_uptime(void);
int sys_howmanysys(void);
```

5. Add sys_howmanysys function inside sysproc.c
   - Verifies syscall number is valid and calls appropriate handler. Called++ increments with every system call.

```
Open ▾   *syscall.c   ~/Desktop/xv6/kernel   Save
[SYS_unlink]  sys_unlink,
[SYS_wait]    sys_wait,
[SYS_write]   sys_write,
[SYS_uptime]  sys_uptime,
[SYS_howmanysys] sys_howmanysys,
};

// Called on a syscall trap. Checks that the syscall number
(passed via eax)
// is valid and then calls the appropriate handler for the syscall.
// Defining external int to be incremented here and pulled in
sysproc.c
extern uint called;
void
syscall(void)
{
  int num;
  called++; // increment called every time a system call is made
  num = proc->tf->eax;
  if(num > 0 && num < NELEM(syscalls) && syscalls[num] != NULL) {
    proc->tf->eax = syscalls[num]();
  } else {
    cprintf("%d %s: unknown sys call %d\n",
            proc->pid, proc->name, num);
    proc->tf->eax = -1;
  }
}
```

   - Initializes the external integer from syscall.c at 0 and returns that integer through the howmanysys() function.

```
Open ▾   sysproc.c   ~/Desktop/xv6/kernel   Save
    sleep(&ticks, &tickslock);
  }
  release(&tickslock);
  return 0;
}

// return how many clock tick interrupts have occurred
// since boot.
int
sys_uptime(void)
{
  uint xticks;

  acquire(&tickslock);
  xticks = ticks;
  release(&tickslock);
  return xticks;
}

// Initializing the external integer from syscall.c at 0 and
returning that integer through howmanysys()
uint called = 0;
int
sys_howmanysys(void)
{
  return called;
}
```

6. In the file, usys.s, we added the system call, SYSCALL(howmanysys).

usys.S
~/Desktop/xv6/user

```
  name: \
    movl $SYS_ ## name, %eax; \
    int $T_SYSCALL; \
    ret

SYSCALL(fork)
SYSCALL(exit)
SYSCALL(wait)
SYSCALL(pipe)
SYSCALL(read)
SYSCALL(write)
SYSCALL(close)
SYSCALL(kill)
SYSCALL(exec)
SYSCALL(open)
SYSCALL(mknod)
SYSCALL(unlink)
SYSCALL(fstat)
SYSCALL(link)
SYSCALL(mkdir)
SYSCALL(chdir)
SYSCALL(dup)
SYSCALL(getpid)
SYSCALL(sbrk)
SYSCALL(sleep)
SYSCALL(uptime)
SYSCALL(howmanysys)
```

7. In the file, user.h we add the value, int howmanysys.

user.h
~/Desktop/xv6/user

```
struct stat;

// system calls
int fork(void);
int exit(void) __attribute__((noreturn));
int wait(void);
int pipe(int*);
int write(int, void*, int);
int read(int, void*, int);
int close(int);
int kill(int);
int exec(char*, char**);
int open(char*, int);
int mknod(char*, short, short);
int unlink(char*);
int fstat(int fd, struct stat*);
int link(char*, char*);
int mkdir(char*);
int chdir(char*);
int dup(int);
int getpid(void);
char* sbrk(int);
int sleep(int);
int uptime(void);
int howmanysys(void);
```

8. Add the user file howmanysys to the file, makefile.mk.

makefile.mk
~/Desktop/xv6/user

```
# user programs
USER_PROGS := \
        cat\
        echo\
        forktest\
        grep\
        init\
        kill\
        ln\
        ls\
        mkdir\
        rm\
        sh\
        stressfs\
        tester\
        usertests\
        wc\
        zombie\
        howmanysys
```

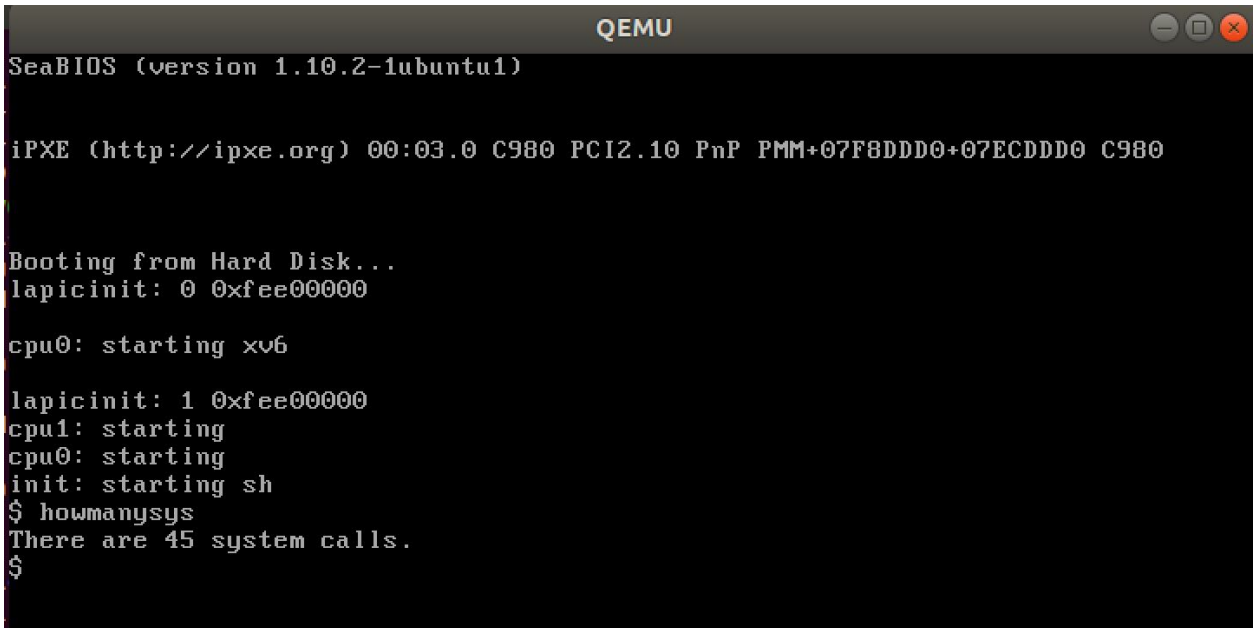
9. Makefile

Makefile
~/Desktop/xv6

```
AS := gcc
ASFLAGS += -ggdb # produce debugging information for use by gdb

# Linker options
# http://sourceware.org/binutils/docs/ld/Options.html
LD := ld

OBJCOPY := objcopy

OBJDUMP := objdump

############################################################################
# Emulator Options
############################################################################

# If the makefile can't find QEMU, specify its path here
QEMU := qemu-system-i386

# Try to infer the correct QEMU if not specified
ifndef QEMU
QEMU := $(shell if which qemu 1> /dev/null 2> /dev/null; \
        then echo qemu; exit; \
        else \
        qemu=/u/c/s/cs537-2/ta/tools/qemu; \
        if test -x $$qemu; then echo $$qemu; exit; fi; fi; \
        echo "***" 1>&2; \
        echo "*** Error: Couldn't find a working QEMU executable."
```

Makefile Tab Width: 8 Ln 66, Col 1 INS

10. Output


QEMU
SeaBIOS (version 1.10.2-1ubuntu1)
iPXE (http://ipxe.org) 00:03.0 C980 PCI2.10 PnP PMM+07F8DDD0+07ECDDD0 C980
Booting from Hard Disk...
lapicinit: 0 0xfee00000
cpu0: starting xv6
lapicinit: 1 0xfee00000
cpu1: starting
cpu0: starting
init: starting sh
$ howmanysys
There are 45 system calls.
$