CS 1550

Lab 2 – xv6 Introduction

Setup and exercise

Teaching Assistant

Maher Khan

(Slides credited to Henrique Potter)

Recitation TA – Office Hours

- Tuesday
  - 2:00pm - 5:00pm
- Friday
  - 1:00pm – 4:00pm

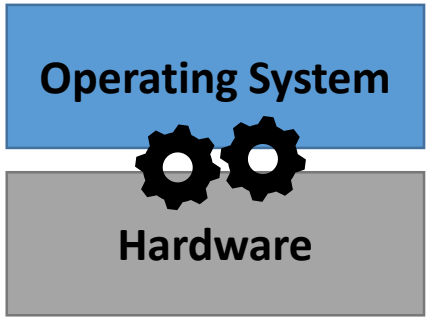
- Office: SenSq 5802

Slides on GitHub!

- https://github.com/maher460/Pitt_CS1550_recitation_materials

CS 1550 – Kernel Space vs User Space

- OS manages hardware, services and user processes
  - CPU
  - Memory (Address space)
  - I/O devices (Disk, mouse, video card, sound, network, etc.)



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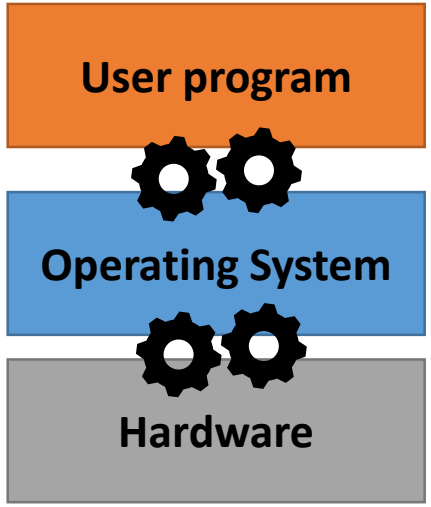
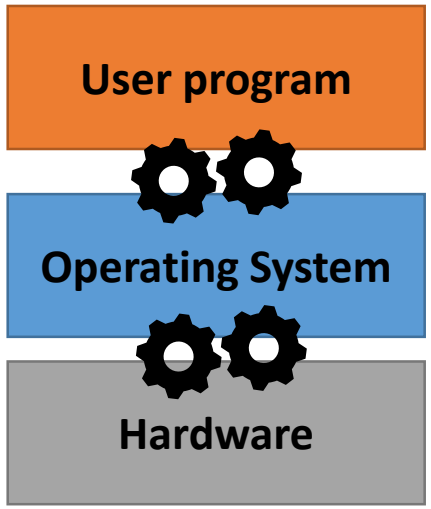


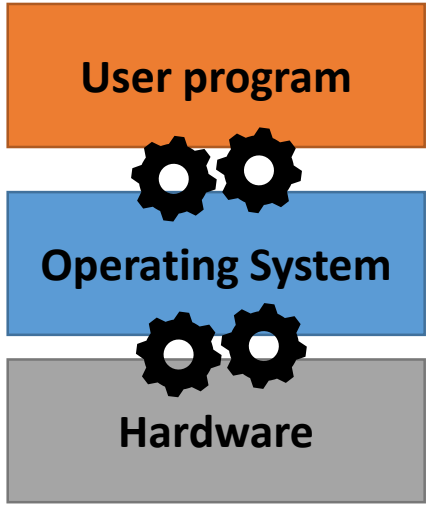
CS 1550 – Kernel Space vs User Space

- OS **is just** another **software**



CS 1550 – Kernel Space vs User Space

- OS **is just** another **software**
- User applications should not change the kernel(OS software)



CS 1550 – Kernel Space vs User Space

- User space
  - **Less privileged memory space** where user processes execute
- Kernel space
  - **Privileged memory space** where the OS main process resides
  - **No User application should be able to change**

CS 1550 – Kernel Space vs User Space

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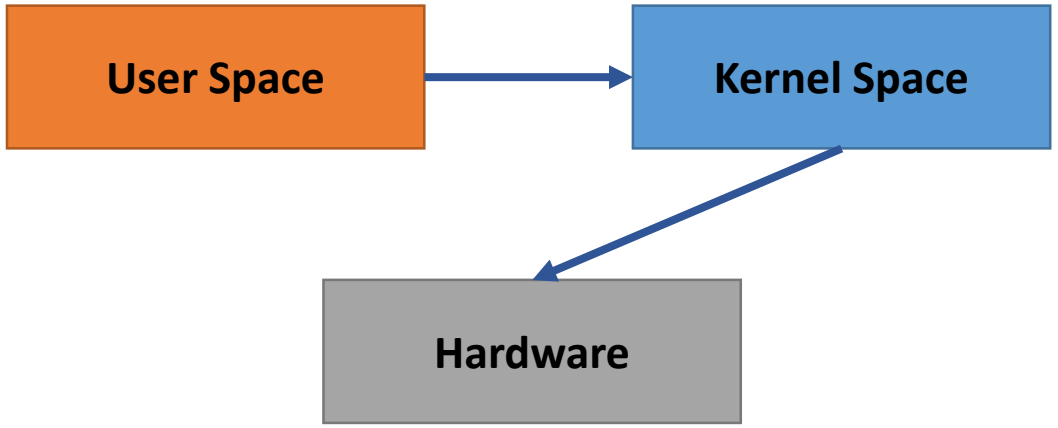
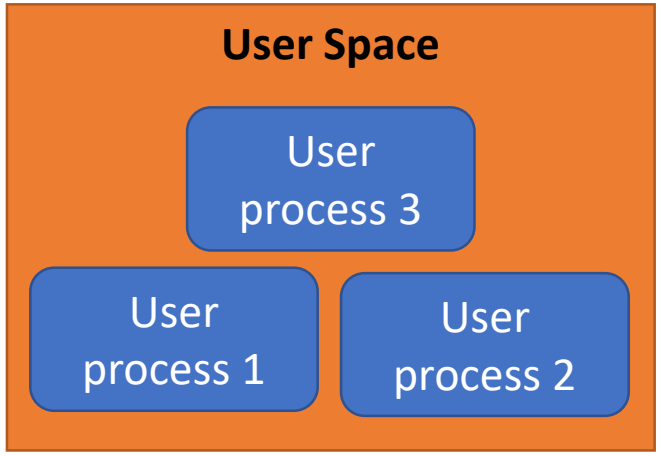


CS 1550 – Kernel Space vs User Space

- **System Call**
  - User processes have to do system calls to access the OS resources and Hardware



CS 1550 – Kernel Space vs User Space

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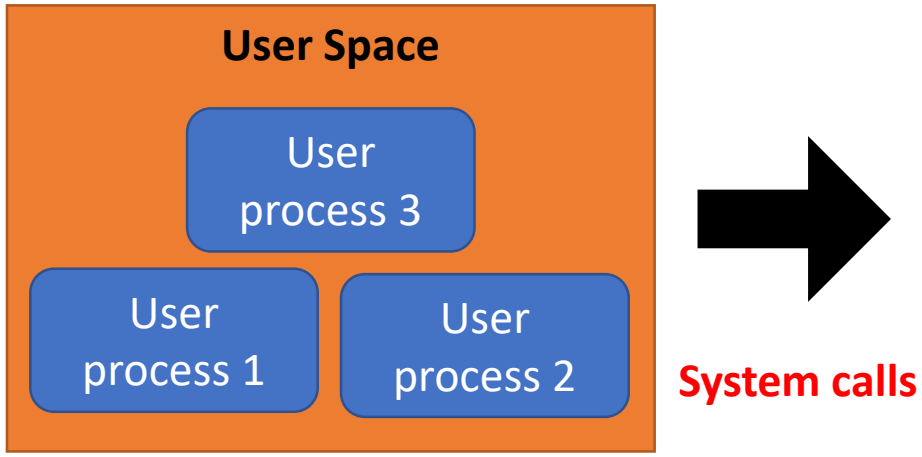

CS 1550 – Kernel Space vs User Space

- **System Call**
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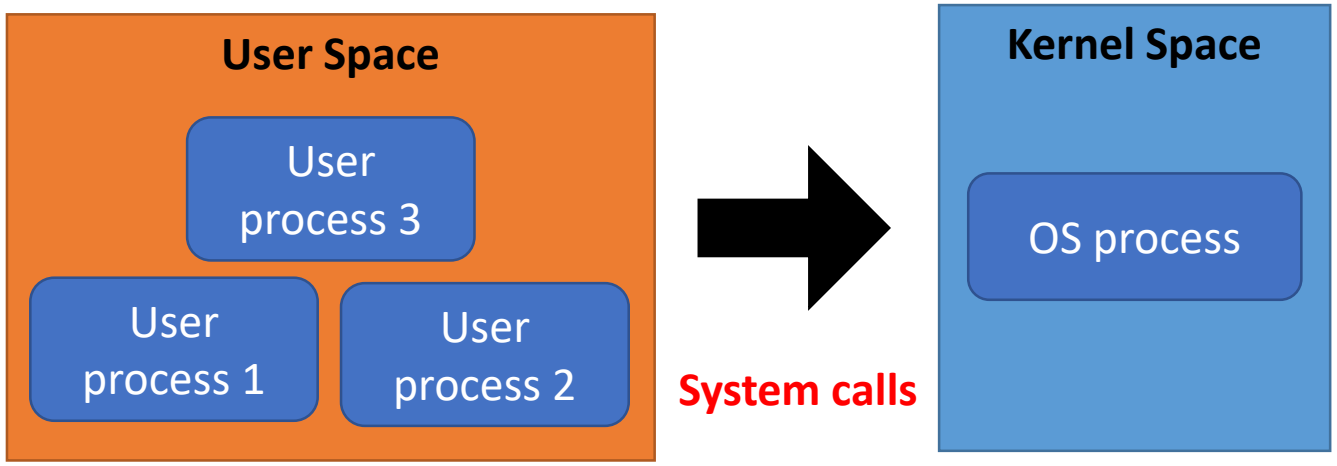
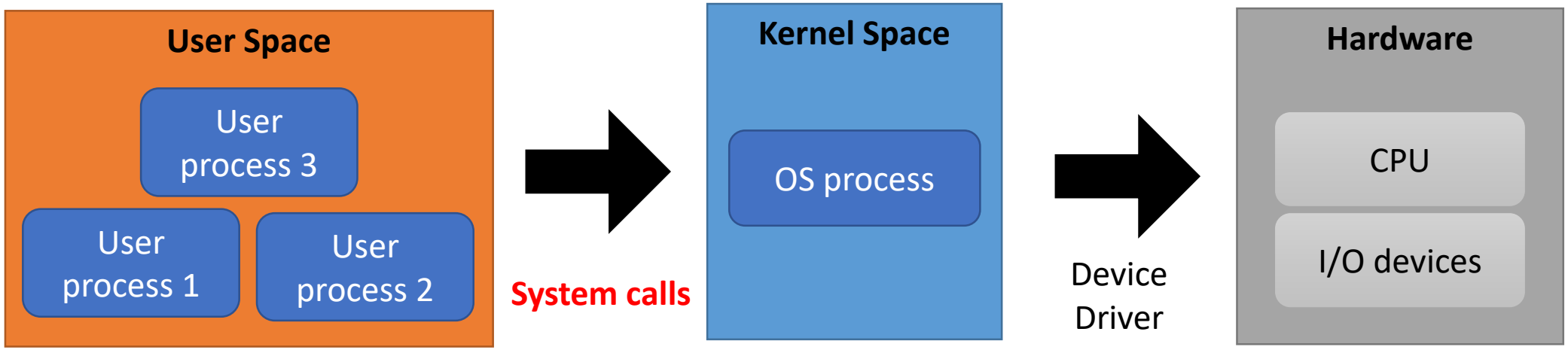


CS 1550 – Kernel Space vs User Space

- **System Call (OS function)**
  - User processes have to do system calls to access the OS resources and Hardware



System Call
-
exercise

CS 1550 – xv6

- Simple Unix-like teaching **operating system** from MIT
  - Provides basic services to running programs

CS 1550 – Unix is everywhere

- Most operating systems are based on Linux

CS 1550 – xv6

- Simple Unix-like teaching operating system from MIT
  - Has a **subset of traditional** system calls
    - **fork**() Create process
    - **exit**() Terminate current process
    - **wait**() Wait for a child process
    - **kill**(pid) Terminate process pid
    - **getpid**() Return current process's id sleep(n)
    - **Sleep** for n time units exec(filename, *argv)
    - **Load** a file and execute it sbrk(n)
    - ….

CS 1550 – xv6

- Compile and Run xv6 in a cs pitt server
  - Since it is an OS how can we run it?

CS 1550 – xv6

- Compile and Run xv6 in a cs pitt server

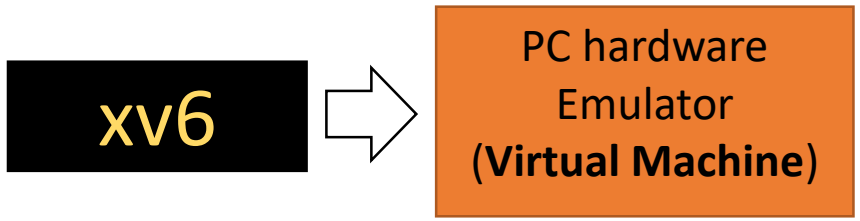
CS 1550 – xv6

- Compile and Run xv6 in a cs pitt server

xv6

CS 1550 – xv6

- Compile and Run xv6 in a cs pitt server



CS 1550 – xv6

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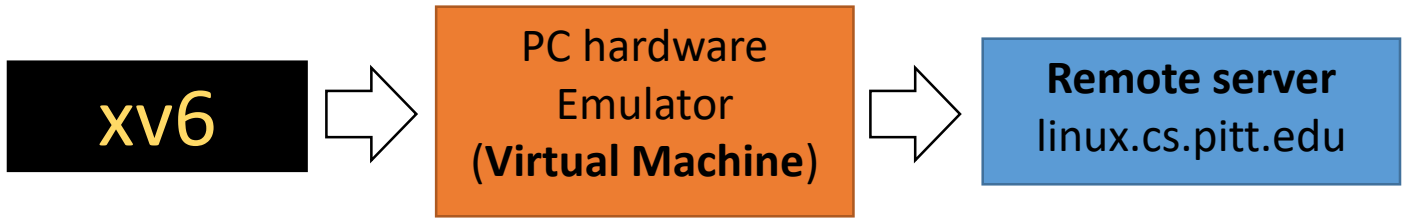

CS 1550 – xv6

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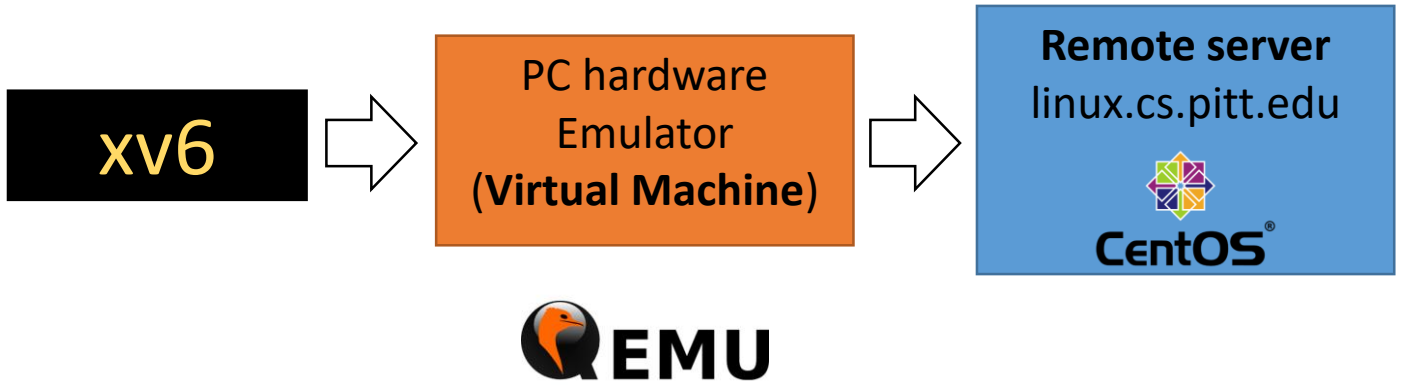
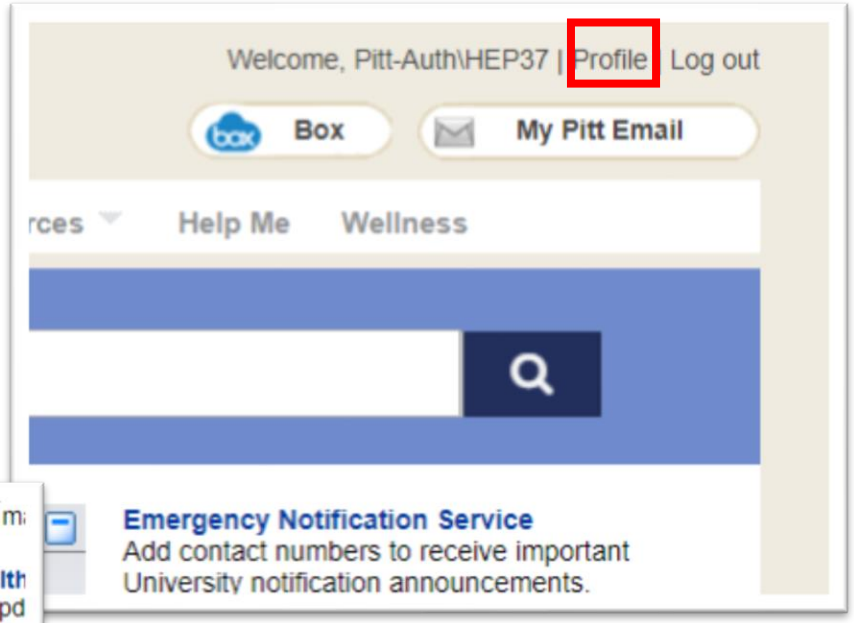
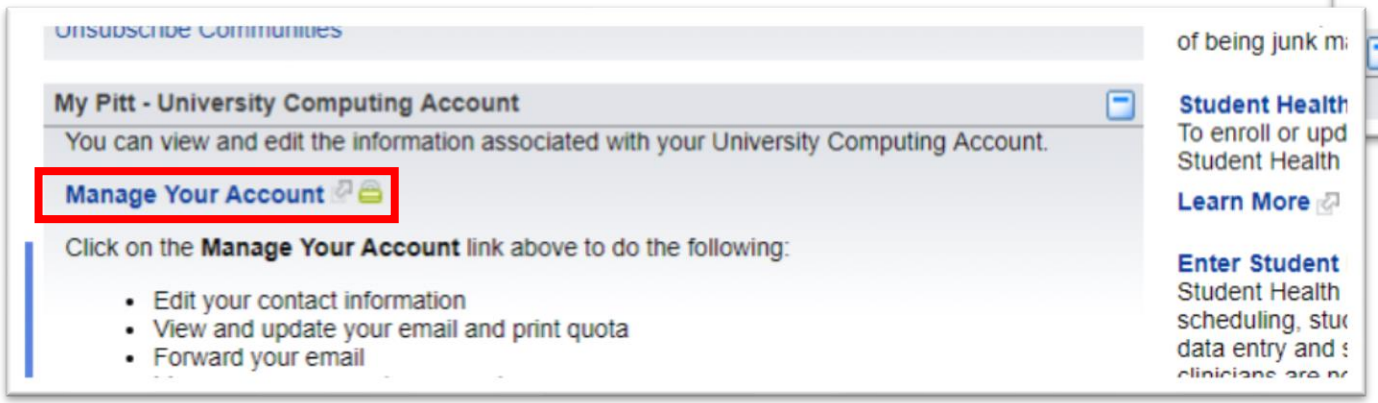


CS 1550 – Compile and Run xv6

1. Extend disk Quota, if you have less then 500mb free space
   a) Log in to https://my.pitt.edu
   b) Click on "Profile" at the top of the screen
   c) Click on "Manage Your Account"
   d) Click on "Manage Email Quota"
   e) Click on "Increase My UNIX Quota"





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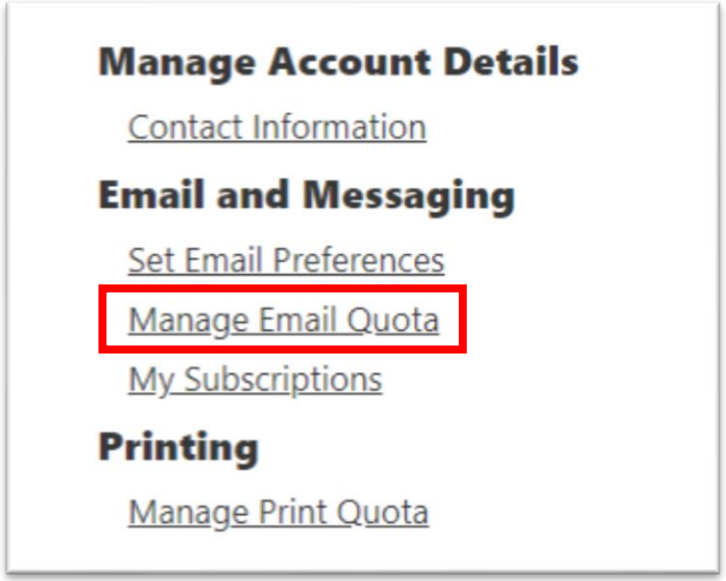
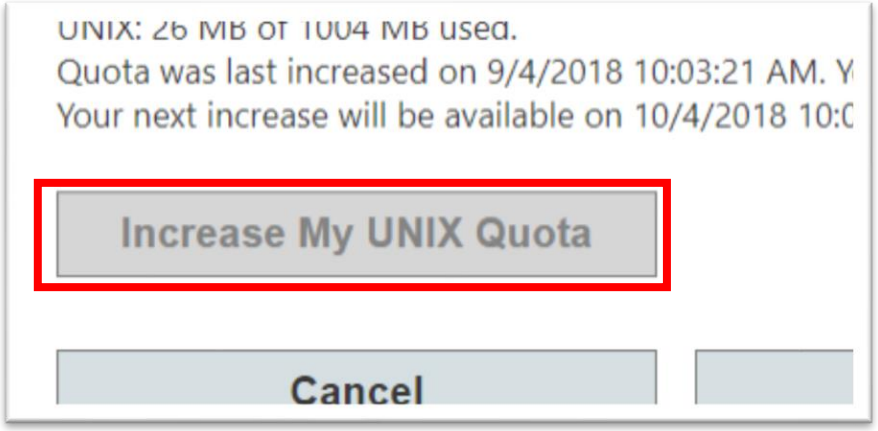




CS 1550 – xv6

- Connect to Pulse (campus VPN) first if connected to non-Pitt wifi.
- Log in to linux.cs.pitt.edu
  - **ssh** user_name**@linux.cs.pitt.edu**

- Use Terminal(MacOS/Ubunto)
- Use Putty/Powershell (Windows)

CS 1550 – xv6

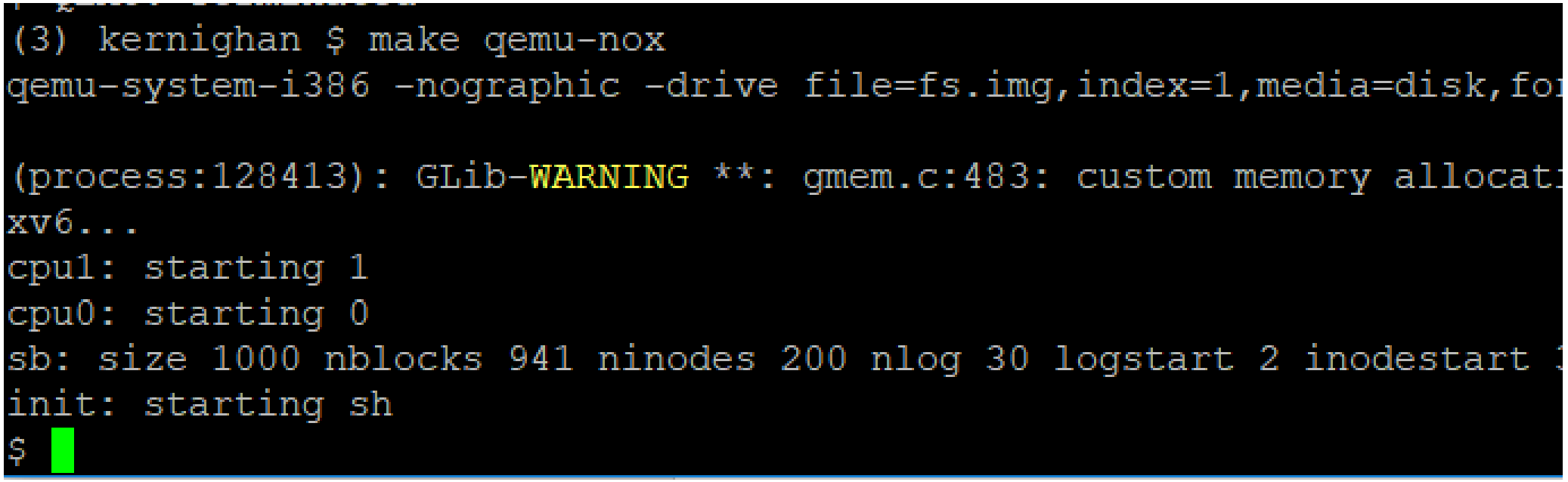
- Go into the private folder
  - **cd private**
- Download the xv6 source code from github
  - **git clone git://github.com/mit-pdos/xv6-public.git**

CS 1550 – xv6

- Go into the cloned xv6 source code folder
  - **cd xv6-public**

- Compile and run the code with
  - **make qemu-nox**

CS 1550 – xv6


(3) kernighan $ make qemu-nox
qemu-system-i386 -nographic -drive file=fs.img,index=1,media=disk,fo
(process:128413): GLib-WARNING **: gmem.c:483: custom memory allocat
xv6...
cpu1: starting 1
cpu0: starting 0
sb: size 1000 nblocks 941 ninodes 200 nlog 30 logstart 2 inodestart
init: starting sh
$

CS 1550 – xv6

- Compile and run the code with
  - **make qemu-nox**

Compiles and **run xv6** with **qemu**

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CS 1550 – xv6

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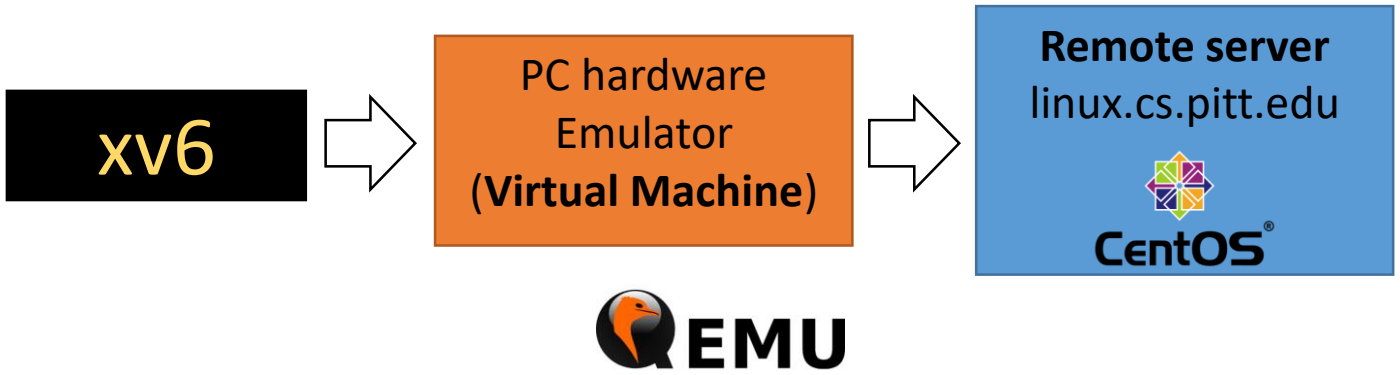

CS 1550 – xv6

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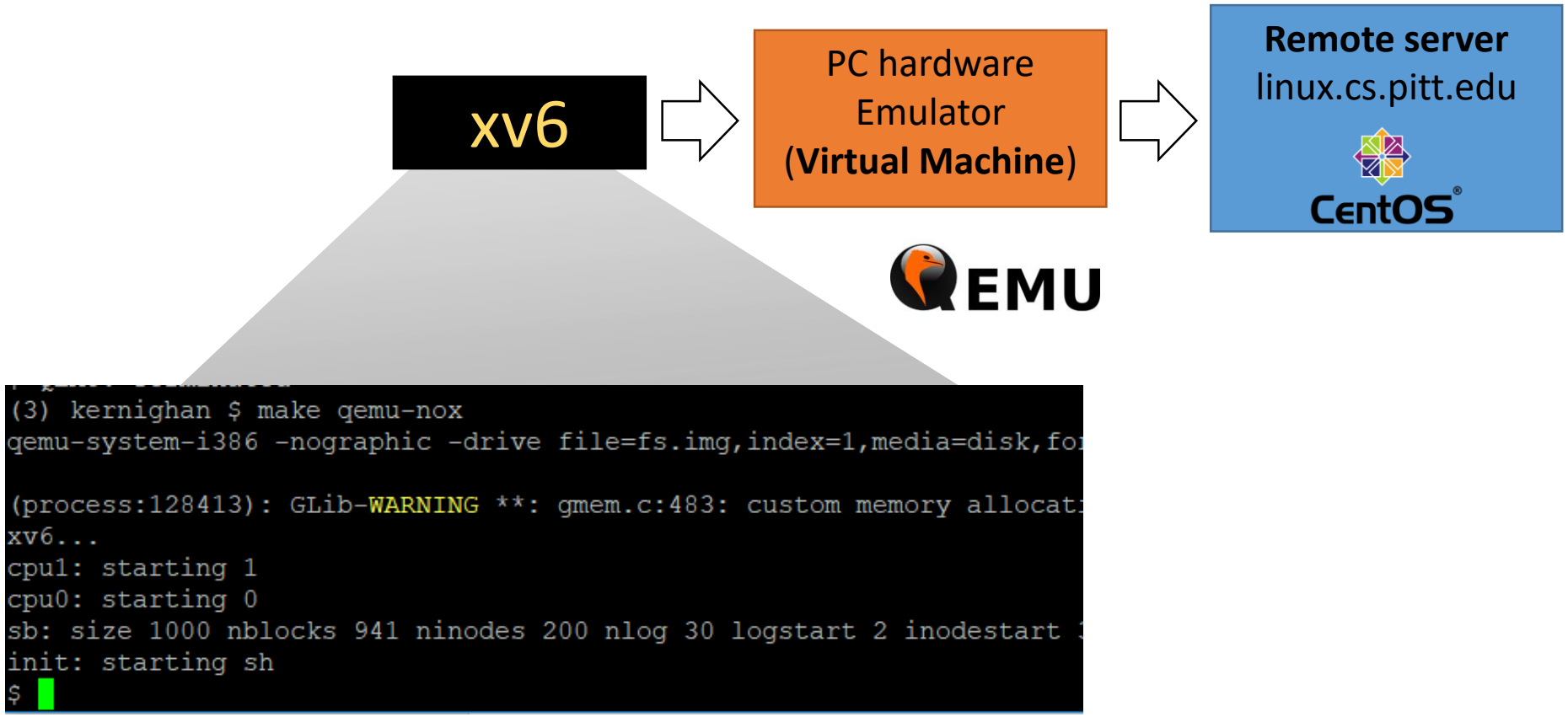
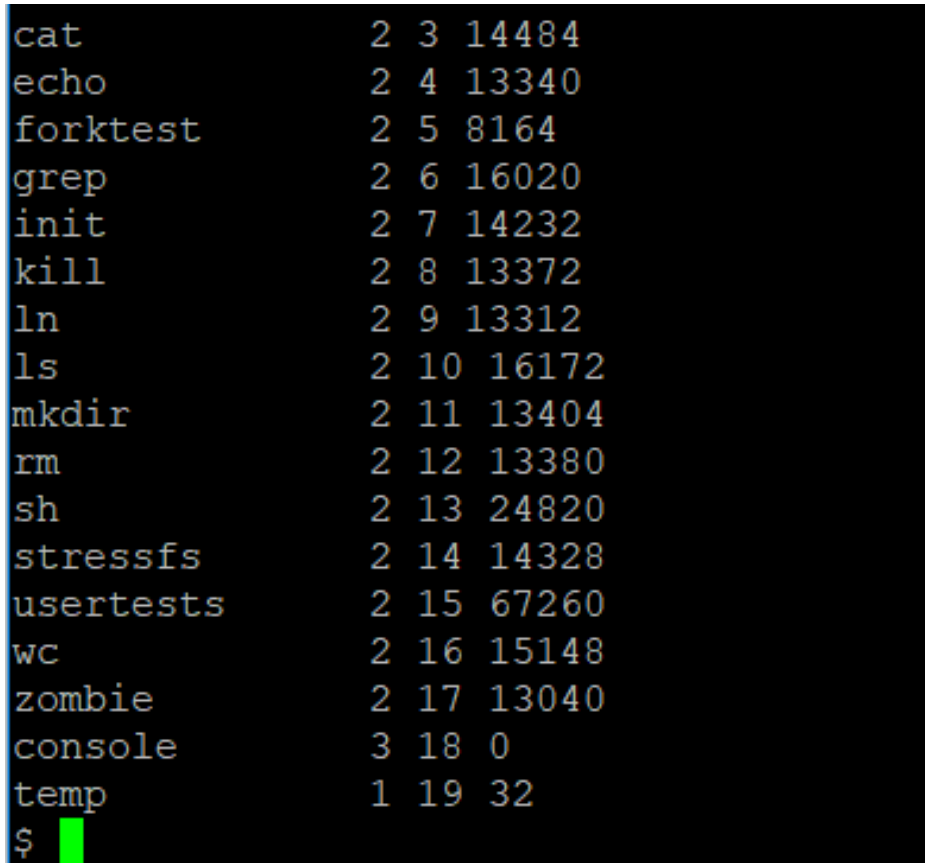


CS 1550 – xv6

- Once in xv6 you can call **ls**



Exiting xv6

- To exit xv6:
  - **Control+a**
  - Then, **x**

My xv6 Github

- Before you start changing the code, it’s better to have the code accessible through your own private GitHub repository.
- Go to www.github.com
- Create an account if you don’t have one already, otherwise login.
- Create a new repository

Create a new repository

A repository contains all the files for your project, including the revision history.

Owner / Repository name *


maher460 / my_xv6

Great repository names are short and memorable. Need inspiration? How about **stunning-memory**.

Description (optional)

Public
Anyone can see this repository. You choose who can commit.

Private
You choose who can see and commit to this repository.

Initialize this repository with a README
This will let you immediately clone the repository to your computer. Skip this step if you're importing an existing repository.

Add .gitignore: None | Add a license: None

Create repository

My xv6 Github

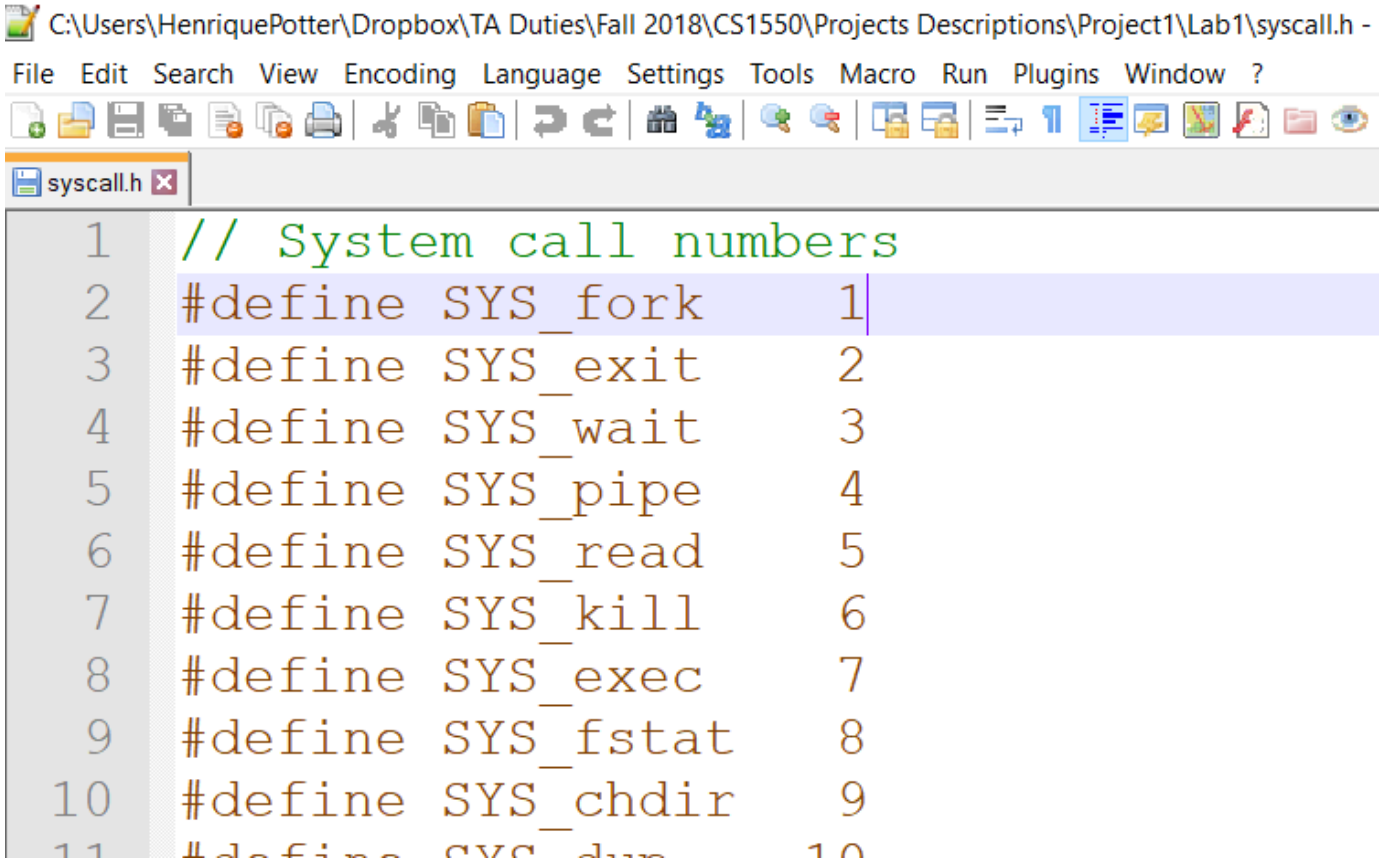
- Inside the xv6-public folder in linux.cs.pitt.edu machine:
  - Set the git remote URL to your newly created private repo
    - **git remote set-url origin https://github.com/maher460/my_xv6.git**
  - Next you will have to remove a tag from your local git in order to avoid a pointer conflict:
    - **git tag –d master**
  - Now, we are ready to push all the code to the private repo!
    - **git push –u origin master**
  - Check your private GitHub repo to make sure all the code is there.

My xv6 GitHub

- You want to clone the GitHub repo to your own local machine
- In your Terminal/PowerShell (in a new window/tab to keep the ssh of linux.cs.pitt.edu still running):
  - **git clone https://github.com/maher460/my_xv6.git**
- Now, you can use your favourite IDE to code and upload all the changes to your private git:
  - **git add –A**
  - **git commit –m “**comment about the changes you made**”**
  - **git push**
- Pull all the uploaded changes in the linux.cs.pitt.edu:
  - **git pull**

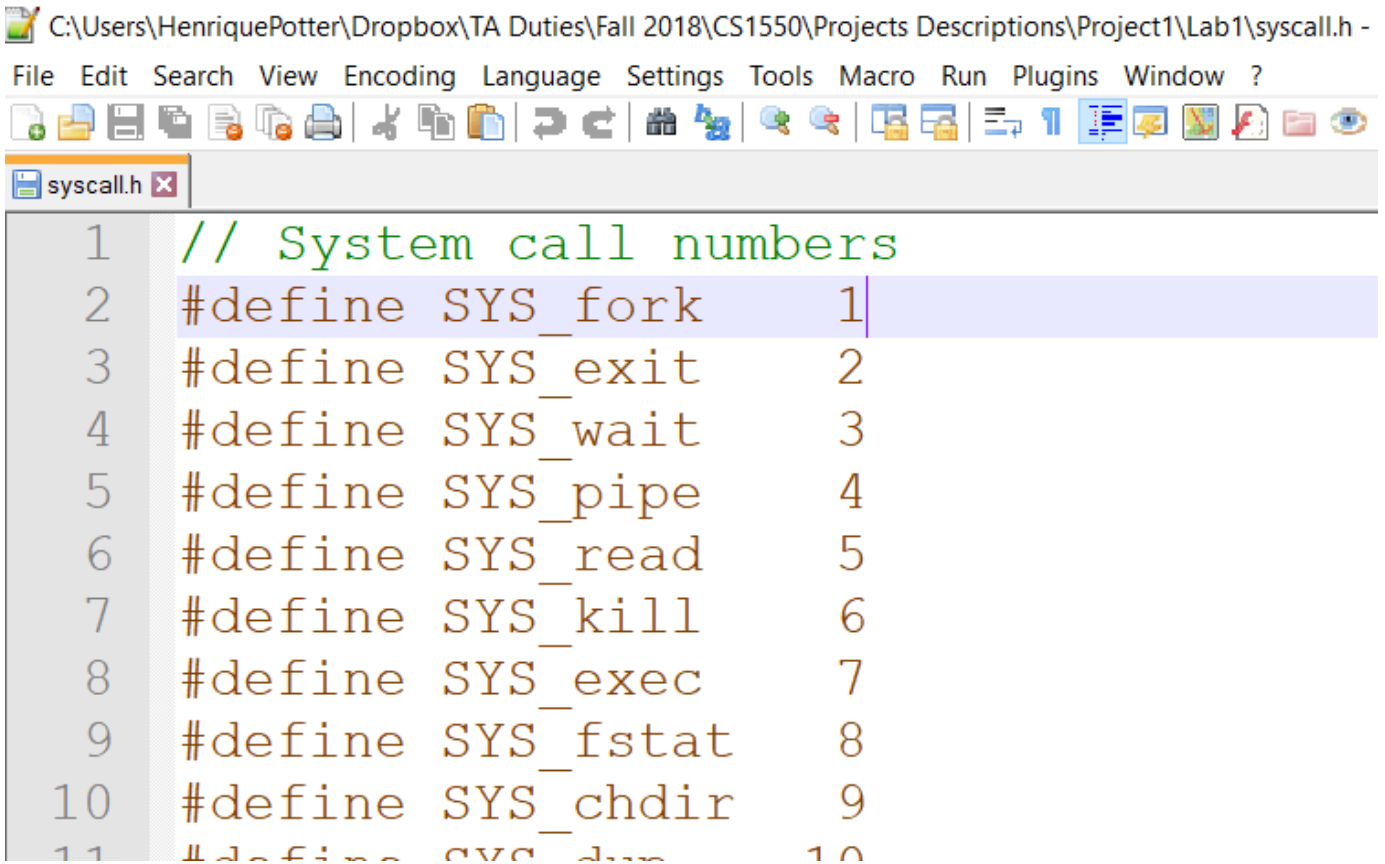
CS 1550 – xv6 – Adding a custom Syscall

- First we need to define our new call and its number at
  - **syscall.h**



CS 1550 – xv6 – Adding a custom Syscall

- First we need to define our new call and its number at
  - **syscall.h**
- Add
  - #define SYS_getday 22



CS 1550 – xv6 – Adding a custom Syscall

- Next we need to map the new call in the array pointer of system calls
  - **syscall.c**
- Add
  - [SYS_getday]   sys_getday,

```
110
111 static int (*syscalls[])(void) = {
112 [SYS_fork]    sys_fork,
113 [SYS_exit]    sys_exit,
114 [SYS_wait]    sys_wait,
115 [SYS_pipe]    sys_pipe,
116 [SYS_read]    sys_read,
117 [SYS_kill]    sys_kill,
118 [SYS_exec]    sys_exec,
119 [SYS_fstat]   sys_fstat,
120 [SYS_chdir]   sys_chdir,
121 [SYS_dup]     sys_dup,
122 [SYS_getpid]  sys_getpid,
123 [SYS_sbrk]    sys_sbrk,
124 [SYS_sleep]   sys_sleep,
125 [SYS_uptime]  sys_uptime,
126 [SYS_open]    sys_open,
127 [SYS_write]   sys_write,
```

CS 1550 – xv6 – Adding a custom Syscall

- Next we need to map the new call in the array pointer of system calls
  - **syscall.c**

- Add
  - extern int sys_getday(void);

```
96  extern int sys_mknod(void);
97  extern int sys_open(void);
98  extern int sys_pipe(void);
99  extern int sys_read(void);
00  extern int sys_sbrk(void);
01  extern int sys_sleep(void);
02  extern int sys_unlink(void);
03  extern int sys_wait(void);
04  extern int sys_write(void);
05  extern int sys_uptime(void);
06
07  static int (*syscalls[])(void) = {
08      [SYS_fork]    sys_fork,
09      [SYS_exit]    sys_exit,
10      [SYS_wait]    sys_wait,
11      [SYS_pipe]    sys_pipe,
```

CS 1550 – xv6 – Adding a custom Syscall

- Then we need to implement the actual method

- In xv6 this is organized in two files.
  - sysfile.c -> file related system calls
  - sysproc.c -> all the other syscalls

CS 1550 – xv6 – Adding a custom Syscall

- Then we need to implement the actual method

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CS 1550 – xv6 – Adding a custom Syscall

- Then we need to implement the actual method

- In xv6 this is organized in two files.
  - sysfile.c -> file related system calls
  - **sysproc.c -> all the other syscalls**

```
3  #include "defs.h"
4  #include "date.h"
5  #include "param.h"
6  #include "memlayout.h"
7  #include "mmu.h"
8  #include "proc.h"
9
10 int
11 sys_fork(void)
12 {
13   return fork();
14 }
15
16 int
17 sys_exit(void)
18 {
19   exit();
20   return 0;  // not reached
21 }
22
```

CS 1550 – xv6 – Adding a custom Syscall

- Then we need to implement the actual method

- In xv6 this is organized in two files.
  - sysfile.c -> file related system calls
  - **sysproc.c -> all the other syscalls**

- Add the following to sysproc.c:

```
int
sys_getday(void)
{
   return 6;
}
```

```
#include "defs.h"
#include "date.h"
#include "param.h"
#include "memlayout.h"
#include "mmu.h"
#include "proc.h"

int
sys_fork(void)
{
  return fork();
}

int
sys_exit(void)
{
  exit();
  return 0;  // not reached
}
```

CS 1550 – xv6 – Adding a custom Syscall

- Afterwards we define the interface for user programs to call
  - Open usys.S
- Add
  - SYSCALL(getday)

```
1  #include "syscall.h"
2  #include "traps.h"
3
4  #define SYSCALL(name) \
5    .globl name; \
6    name: \
7      movl $SYS_ ## name, %eax; \
8      int $T_SYSCALL; \
9      ret
10
11 SYSCALL(fork)
12 SYSCALL(exit)
13 SYSCALL(wait)
14 SYSCALL(pipe)
15 SYSCALL(read)
16 SYSCALL(write)
17 SYSCALL(close)
18 SYSCALL(kill)
19 SYSCALL(exec)
20 SYSCALL(open)
21 SYSCALL(mknod)
22 SYSCALL(unlink)
```

CS 1550 – xv6 – Adding a custom Syscall

- Finally we open
  - user.h
- Add
  - int getday(void);

```
1  struct stat;
2  struct rtcdate;
3
4  // system calls
5  int fork(void);
6  int exit(void) __attribute__((noreturn));
7  int wait(void);
8  int pipe(int*);
9  int write(int, void*, int);
10 int read(int, void*, int);
11 int close(int);
12 int kill(int);
13 int exec(char*, char**);
14 int open(char*, int);
15 int mknod(char*, short, short);
16 int unlink(char*);
17 int fstat(int fd, struct stat*);
18 int link(char*, char*);
19 int mkdir(char*);
20 int chdir(char*);
21 int dup(int);
22 int getpid(void);
23 char* sbrk(int);
24 int sleep(int);
```

CS 1550 – xv6 – Adding a custom Syscall

- Example user program
  - todays_date.c

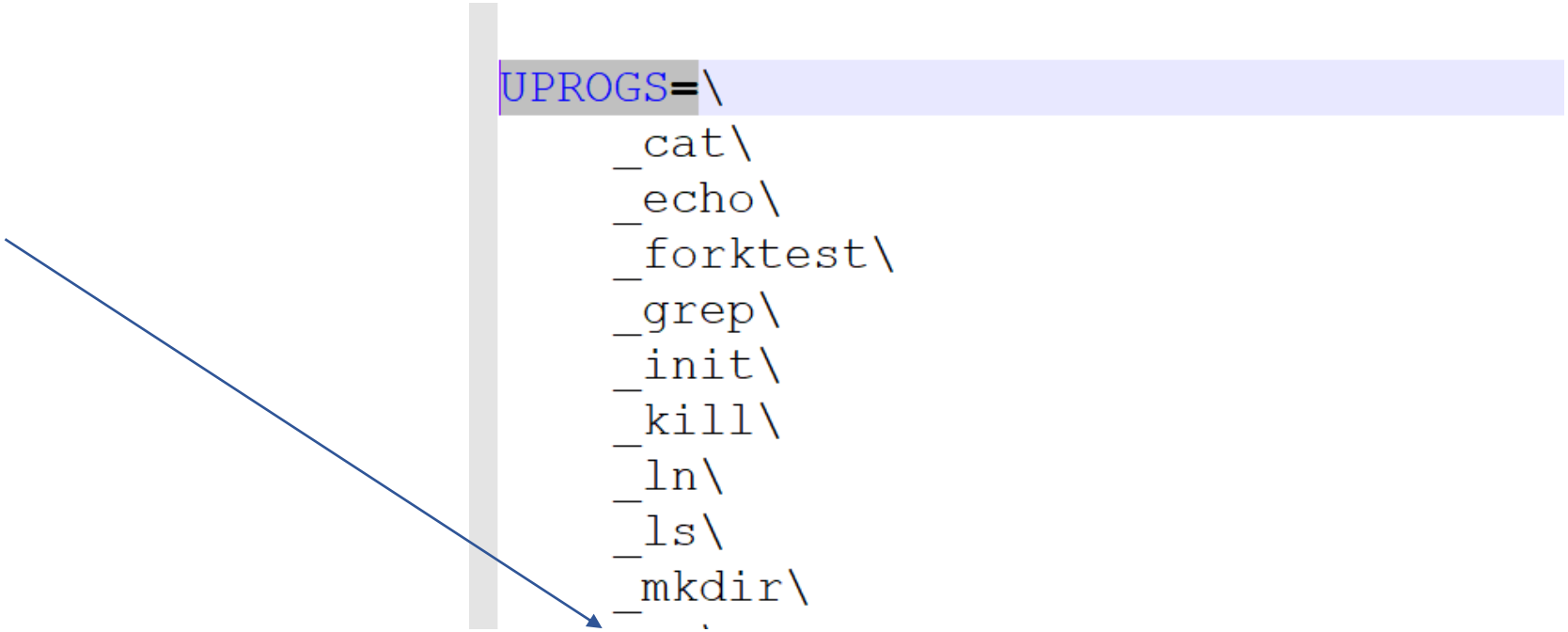
```
#include "types.h"
#include "stat.h"
#include "user.h"

int main(void) {
        printf(1, "Today is %d\n", getday());
        exit();
}
```

CS 1550 – xv6 – Adding a custom Syscall

- Adding an user program
  - Open makefile

- Add
  - _todays_date\



CS 1550 – xv6 – Adding a custom Syscall

- Adding an user program
  - Open makefile
- and also add
  - todays_date.c\

```
EXTRA=\
    mkfs.c ulib.c user.h cat.c e
    kill.c\
    ln.c ls.c mkdir.c rm.c stres
    zombie.c\
    
    printf.c umalloc.c\
    README dot-bochsrc *.pl toc.
    .gdbinit.tmpl gdbutil\

dist:
    rm -rf dist
    mkdir dist
    for i in $(FILES); \
```

CS 1550 – xv6 – Done!

Now, you can fire up your ssh to linux.cs.pitt.edu, then:

- **git pull**
- **make qemu-nox**
- **todays_date** (run this inside the xv6)

- You get this slide and code at :
  - https://github.com/maher460/Pitt_CS1550_recitation_materials

CS 1550 – Project

- **Due**: Wednesday, September 19, 2018
- **Late**: Friday, September 21, 2018
  - 10% reduction per late day

CS 1550

Lab 2 – xv6 Introduction

Setup and exercise

Teaching Assistant

Maher Khan

(Slides credited to Henrique Potter)