CSE 451 Section
Autumn 2005

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Office hours: WTh 3:30-4:20
Allen 216 (or lab)

Reminders

- Sign up for mailing list
- Read the web site
  - Work through lab information
- Start reading the book
- Do the first homework – due Monday!
- Check `forkbomb` access
- Read & start project 1

451 Projects

- 4 projects
- First one – individual, others – groups of 3
- Need basic C and UNIX skills
  - Check links if you need help with this
- Challenging
  - Don’t leave until last minute
- Learn a lot of cool stuff

First Project

- Introduces C and Unix skills you’ll need
- Teaches how to build and run Linux in VMWare
- Two main parts:
  - Write a simple shell in C
  - Add a simple system call to Linux kernel
- Due: Friday, Oct 7, before lecture (2:30)
  - Electronic turnin: code + writeup

The shell

- Print out prompt
- Accept input
- Parse input
- If built-in command
  - do it directly
- Else create new process
  - Launch specified program there
  - Wait for it to finish
- Repeat

```
CSE451Shell% /bin/date
Fri Jan 16 00:05:39 PST 2004
CSE451Shell% pwd
/root
CSE451Shell% cd /
CSE451Shell% pwd
/
CSE451Shell% exit
```

System Calls

- What's a system call?
- Examples?
- In your shell:
  - Use *fork* to create a child process
  - Use *execvp* to execute a specified program
  - Use *wait* to wait until child process terminates

Project 1: Adding a System Call

- Add *physusage* system call to Linux:
  - Purpose: count memory allocation
  - Make a histogram of allocated memory sizes (powers of 2)
- Steps:
  - Modify kernel to keep track of this information
    - We give you the kernel code
  - Add *physusage* to return the counts to the user
  - Use *physusage* in your shell to get this data from kernel and print it out.

Example of physusage

```
CSE451Shell% clear physusage
CSE451Shell% cd /
CSE451Shell% pwd
/
CSE451Shell% date
Wed Sep 29 16:52:41 PDT 2004
CSE451Shell% time
Usage: time [-apvV] [-f format] [-o file] [--append] [--
verbose]
       [--portability] [--format=format] [--output=file] [--
version]
       [--help] command [arg...]
CSE451Shell% physusage
Total requests to page_alloc: 47
Requests for order 1 pages: 23
Requests for order 2 pages: 20
Requests for order 3 pages: 4
CSE451Shell% exit
```

Programming in kernel mode

- Your shell will operate in user mode
- Your system call code will be in the Linux kernel, which operates in kernel mode
  - Be careful - different programming rules, conventions, etc.

Programming in kernel mode

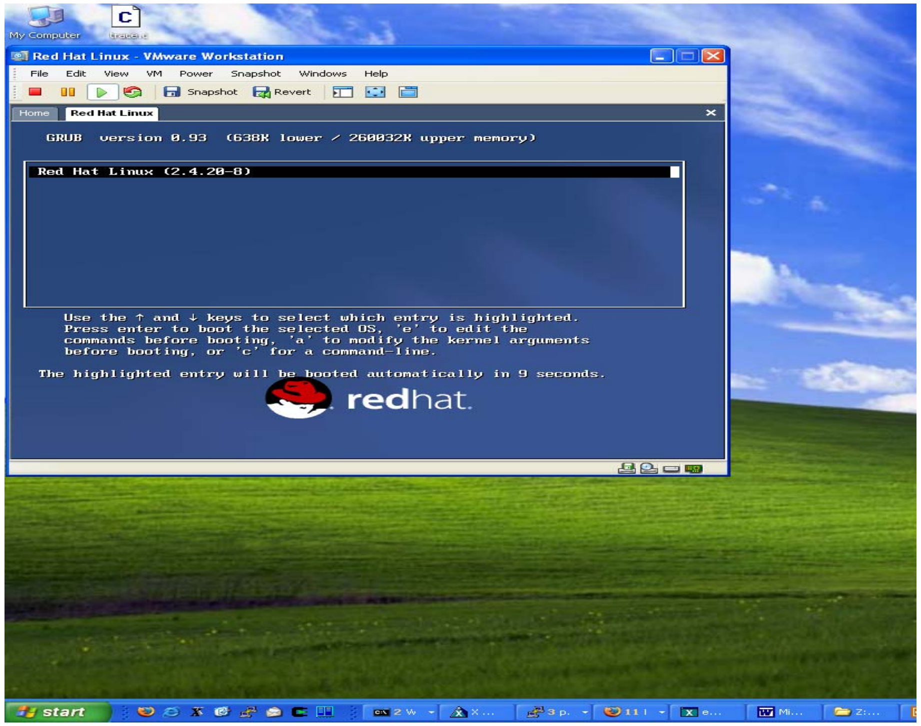
- Can’t use application libraries (e.g. libc)
  - E.g. can’t use printf
- Use only functions defined by the kernel
  - E.g. use printk instead
- Include files are different in the kernel
- Don’t forget you’re in kernel space
  - E.g. unsafe to access a pointer from user space directly, use fn’s that perform checks
- Best way to learn – look at existing code

Computing Resources

- Develop your code on dedicated 451 Linux host:
  - `forkbomb.cs.washington.edu`
- Test your code on VMWare PCs in 006

VMWare

- Software simulation of x86 architecture
- Run an OS in a sandbox
  - Easily reset to known good state

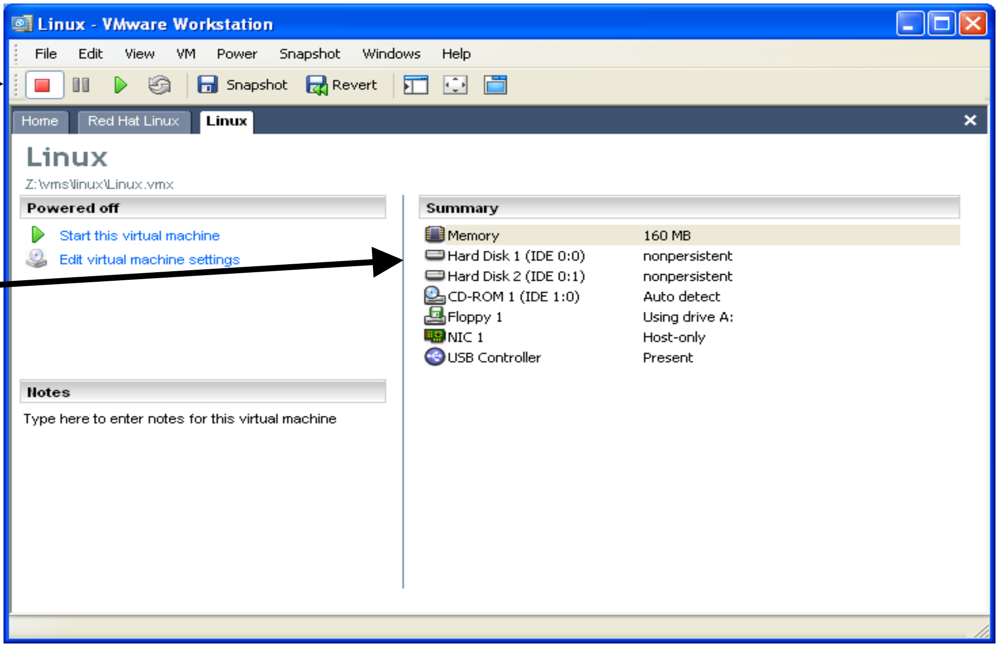


```
    GRUB  version 0.93  (638K lower / 260032K upper memory)

 Red Hat Linux (2.4.20-8)

     Use the ↑ and ↓ keys to select which entry is highlighted.
     Press enter to boot the selected OS, 'e' to edit the
     commands before booting, 'a' to modify the kernel arguments
     before booting, or 'c' for a command-line.

  The highlighted entry will be booted automatically in 9 seconds.
```

Using VMWare

Power on/off, reset

VMWare config
Don't change!


Linux - VMware Workstation
File Edit View VM Power Snapshot Windows Help
Snapshot Revert
Home Red Hat Linux Linux
Linux
Z:\vms\linux\Linux.vmx
Powered off
Start this virtual machine
Edit virtual machine settings
Notes
Type here to enter notes for this virtual machine
Summary

Memory	160 MB
Hard Disk 1 (IDE 0:0)	nonpersistent
Hard Disk 2 (IDE 0:1)	nonpersistent
CD-ROM 1 (IDE 1:0)	Auto detect
Floppy 1	Using drive A:
NIC 1	Host-only
USB Controller	Present

- All disks are nonpersistent
  - *Powering off loses your changes!* Use "shutdown –r now" instead
- Network adapter is host-only

Linux & VMWare

- There is only one user: *root*
- The password is *rootpassword*
- You will need to:
  - Build a kernel image on `forkbomb`
  - Transfer it to Linux running inside VMWare
  - Boot your new Linux kernel in VMWare
- Use ftp to get your files into VMWare
  - FTP to 192.168.93.2 from the host running VMWare.
    - E.g. using IE, go to ftp://root:rootpassword@192.168.93.2

UNIX & C help

- Unix & C tutorial links on 451 projects page
- What if my shell crashes?
  - Use gdb to debug
  - gdb tutorials linked on web site
- What do I use to compile my shell?
  - gcc. For example, `gcc –o shell shell.c –Wall -g`
- What do I use to type up my code?
  - I recommend Emacs (look for Emacs tutorials)
  - VS.NET works too

UNIX & C help - 2

- How do I find stuff in the kernel source?
  - Use grep –r *search_string* *
  - Use LXR (Linux Cross Reference): *http://lxr.linux.no/*
- Which library functions does C have to simplify my shell code?
  - man strncmp, gets, fgets, strtok, strchr, perror

Refreshing C skills; code quality

- What’s wrong with this:

```
char *buffer;
buffer = malloc(100);
strcpy(buffer, param);
```

- How do we fix this?

C Debugging hint

```
#define MYDEBUG // comment out to disable debugging

#ifdef MYDEBUG
  #define DEBUG(x) x
#else
  #define DEBUG(x)
#endif

…
int main() {
  …
  printf("normal output");
  DEBUG(printf("debug output"));
  …
}
```

More debugging

- Just for printing:

```
#ifdef MYDEBUG
#  ifdef __KERNEL__
     /* This one if debugging is on, and kernel space */
#    define PDEBUG(fmt, args...) printk("myprg: " fmt, ##
  args)
#  else
     /* This one for user space */
#    define PDEBUG(fmt, args...) fprintf(stderr, fmt, ##
  args)
#  endif
#else
#  define PDEBUG(fmt, args...) /* not debugging: nothing */
#endif
```