CSE 451 Section
Autumn 2004

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Office hours: Tue 1-2, Thu 4:30-5:30
Allen 218 (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 tomorrow!
- Check spinlock/coredump 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, Jan 14, 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 *execcounts* system call to Linux:
  - Purpose: collect statistics
  - Count number of times you call *fork*, *vfork*, *clone*, and *exec* system calls.
- Steps:
  - Modify kernel to keep track of this information
    - We give you the kernel code
  - Add *execcounts* to return the counts to the user
  - Use *execcounts* in your shell to get this data from kernel and print it out.

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Example of execcounts

```
CSE451Shell% execcounts clear
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% execcounts
Statistics:
Fork:                   3       27%
Clone:                  0       0%
VFork:                  0       0%
Exec:                   8       72%
CSE451Shell% exit
```

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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.

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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

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Computing Resources

- Develop your code on dedicated 451 Linux hosts:
  - *spinlock*, *coredump*
- Test your code on VMWare PCs in 006
- Do not use attu

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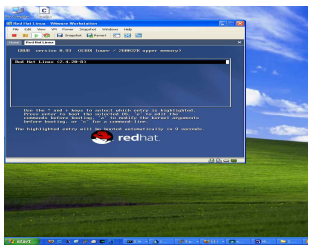
VMWare

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



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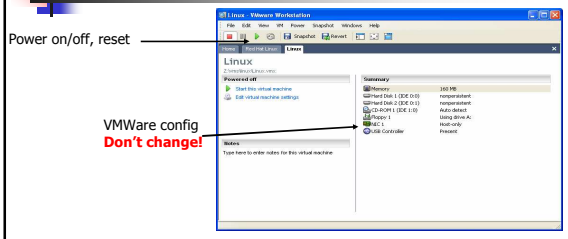
Using VMWare



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

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Linux && VMWare

- There is only one user: *root*
- The password is *rootpassword*
- You will need to:
  - Build a kernel image on *spinlock/coredump*
  - 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

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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

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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

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Refreshing C skills; code quality

- What's wrong with this:

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

- How do we fix this?

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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"));
  …
}
```

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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
```

- works for both for kernel and userspace
- To use:

```
PDEBUG("Testing two numbers: %d and %d\n", num, num2);
```

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