Computer Systems and Networks

ECPE 170 – Jeff Shafer – University of the Pacific

Linux Basics

Pre-Lab

- Everyone installed Linux on their computer
- Everyone launched the command line ("terminal") and ran a few commands
- **What problems were encountered?**
  - **Virtualization support in processor not enabled (BIOS)**
  - VMWare Player (current version) only runs on Windows 64
  - 3D graphics virtualization incompatible with specific hardware
  - Old virtual machine software
  - Others?
- Tip: If you have problems maximizing your VM to full screen, or doing copy-and-paste between Linux and Windows, make sure you installed the VM tools

Person of the Day: Linus Torvalds

- Creator of **Linux Kernel**
  - Started in 1991
  - First developer – hobby project (for fun!)
  - Modern kernel is product of work by thousands of programmers
  - Currently "final authority" on what is included in the kernel
- Creator of **Git version control system**
  - Initially for Linux kernel dev

Operating System Tasks

- **What does the OS need to do?**
  - Schedule processes to run
  - Memory management
  - Interrupt handling (manage hardware in general)
  - Security (between processes)
  - Network access
  - Storage management (filesystem)
  - Graphical user interface
    - May be a **middleware** layer on top of the OS

Operating Systems – Processes

- **Process management** is a key operating system task
- OS must initially **create processes** when you run your program
- OS can allow processes to **access resources**
  - Must *schedule* access to *shared* resources (e.g., CPU)
- OS can allow processes to **communicate** with each other
- OS must **clean up** after process finishes
  - Deallocate resources (e.g. memory, network sockets, file descriptors, etc…) that were created during process execution

Operating Systems – Scheduling

- The operating system schedules process execution
  - What processes are allowed to run at all?
  - What processes are allowed to run right now?
- **Context switches** occur when the CPU is taken from one process and given to another process
  - CPU *state* (registers, current PC, etc…) is preserved during a context switch

Operating Systems – Scheduling

- **Preemptive Scheduling**
  - Each process is allocated a timeslice.
  - When the timeslice expires, a context switch occurs
    - A context switch can also occur when a higher-priority process needs the CPU

Operating Systems – Security

- Process A is forbidden from reading/modifying/writing the memory of Process B
  - **Virtual memory** is a huge help here!
  - Each process has a separate *virtual* address space that maps to different regions of *physical* memory
- Process A has other limits besides which memory pages it can access
  - **What are some other limits?**
  - Amount of memory consumed
  - Number of open files on disk
  - Which files on disk can be read/written

Operating Systems – Filesystem

- OS is responsible for managing data on persistent storage
- Job of the **filesystem!**
  - What files exist? (i.e. names)
  - How are they organized? (i.e. paths/folders)
  - Who owns and can access them? (i.e. usernames, permissions)
  - Where are individual file blocks stored on the disk?
    - *i.e. filename "database.dat" is really composed of 15823 blocks, of which block 1 is located at logical block address #... on the hard drive.*

Operating Systems – Device Management

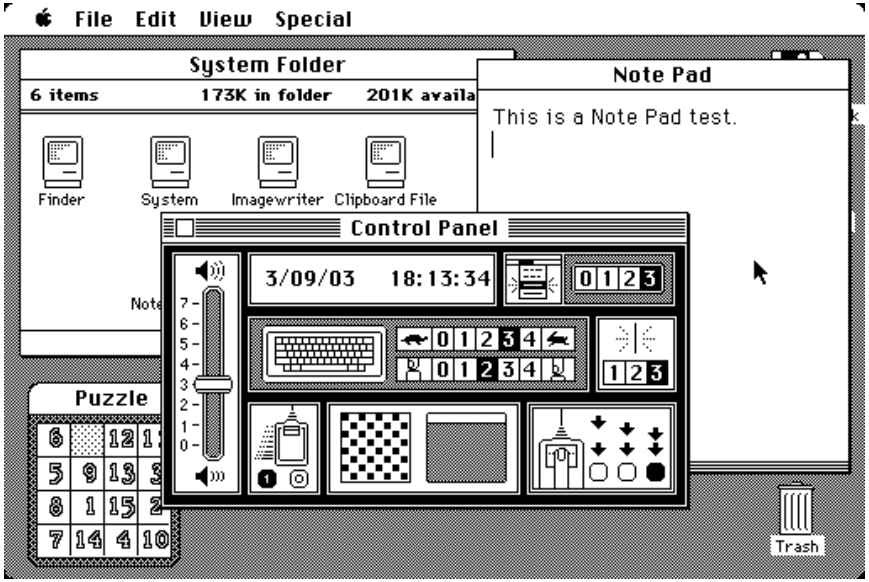
- Manage devices
  - How do we send data to the NIC for transmission?
  - How do we render an image for display on screen?
  - How do we read a block of data from our RAID disk controller?
- Operating systems can be extended through **device drivers** to manage new hardware
  - Hardware vendors write software to manage their devices
  - OS provides a fixed interface (API) that driver must follow
- Common task for a device driver is **responding to interrupts** (from that device)

Operating Systems – The Kernel

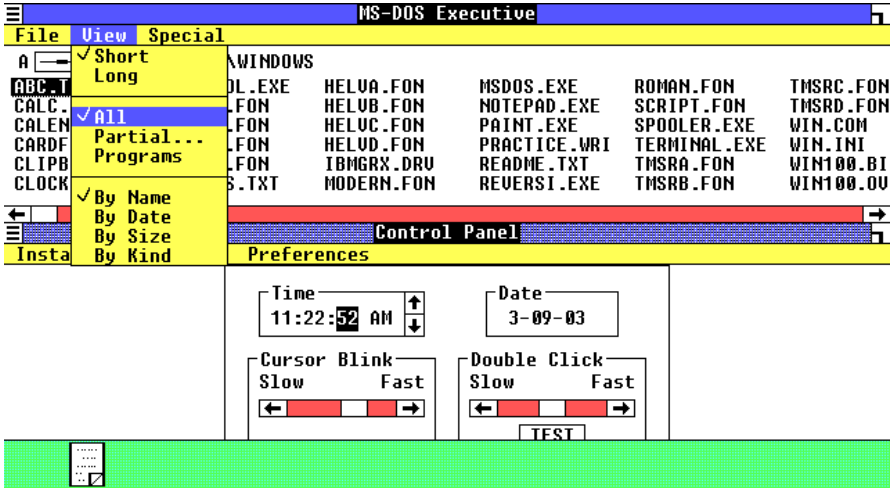
- Who does all this essential work in the operating system? (besides the GUI)
  - The **kernel** (i.e. the heart or core of the OS)
- Kernel performs:
  - Scheduling
  - Synchronization
  - Memory management
  - Interrupt handling
  - Security and protection

Operating Systems – GUI

- Operating systems with **graphical user interfaces** (GUI) were first brought to market in the 1980s



Apple Mac OS 1.0 (released 1984)



Microsoft Windows 1.0 (released 1986)

Captures from http://www.guidebookgallery.org/screenshots

Significant evolution in GUI design in subsequent decades

Operating Systems – GUI

- Technical perspective:
  - The GUI is one of the **least important parts** of the operating system
- A GUI does not even have to be part of the *true* OS at all
  - Windows 1.0 was just a **program that ran on top** of MS-DOS, the *true* operating system (of that era)
- *But to a user, the GUI is one of the most important parts of the OS!*

Command-Line

Advantages of Command Line

Advantages of Windows / GUI

Linux Command Line

Shell

- **What is the shell? (e.g. BASH, CSH, SH)**
  - Program between user and the kernel
  - Command-line interpreter
    - Parses user input and carries out commands

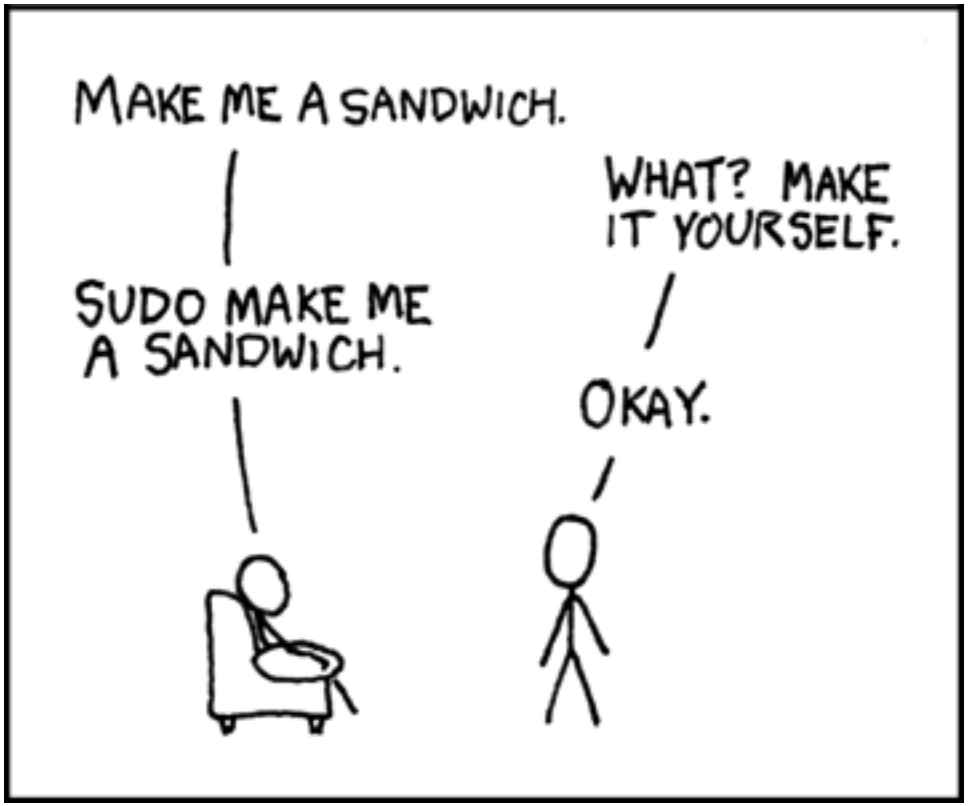
Shell Shortcuts

- <TAB> key to auto-complete commands
- <UP ARROW> key to cycle through previous commands

These two tips make your life so much easier!

Linux: Sudo Command

- `sudo <<command>>`
- Command is run as root user
- root = “Administrator”

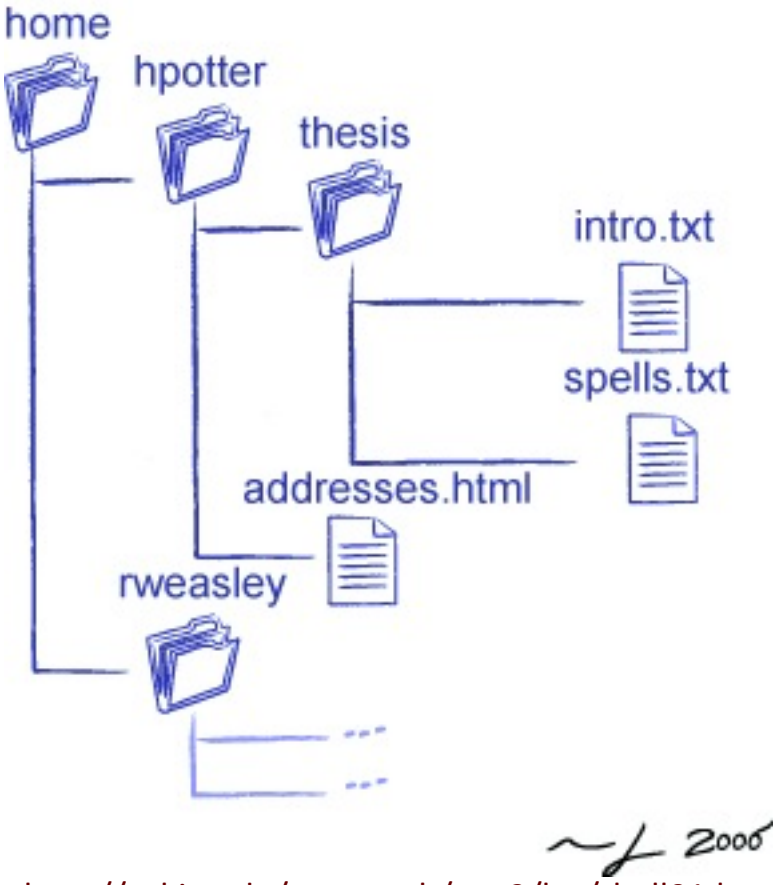


http://xkcd.com/149/

Linux: Apt-Get Command

- **What is a package manager?**
  - **Where did these apps come from?**
- `apt-get <<mode>> <<options>>`
- `apt-get install gedit`
  - Mode = install a package
  - Option = Gedit (name of package)
- **Must run as ROOT to use!**
  - `sudo apt-get …`

Linux: Directory Tree



http://osl.iu.edu/~pgottsch/swc2/lec/shell01.html

- **Absolute** path:
  - `/home/hpotter/thesis/intro.txt`
- **Relative** path:
  - If I am already in `/home/potter/`
  - `addresses.html`

Labs

Labs

- Labs have (at most) two graded elements:

1. **Pre-Lab "checkpoint"** – quick verification that pre-lab *appears* to be done
    1. Due at start of first day of lab
2. **Lab Report**
    1. Submit all source code used with lab report
    2. Due by posted date after lab

Lab Reports

- Not really “reports”, more like “worksheets”
- Create in LibreOffice (aka *OpenOffice*) using example template on website
- Export in **PDF format**
- Submit
  - Via Canvas *Assignments* section for Lab 1 only!
  - Via Version control for Lab 2 and beyond

Upcoming Schedule

- Today
  - **Lab 1 – Linux Basics**
- Thursday
  - **Lab 2 – Version Control**
- Deadlines
  - **Lab 2 pre-lab checkpoint – Start of class Thursday**
  - **Lab 1 Report – Jan 28th, 2017 by 5am**
    - Submit via Canvas
  - **Lab 2 Report – Jan 30th, 2017 by 5am**