



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?**
 - Old virtual machine software
 - 3D graphics virtualization incompatible with specific hardware
 - 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 a process is taken from the CPU and replaced by 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 pages it can access
 - **Ideas of 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)

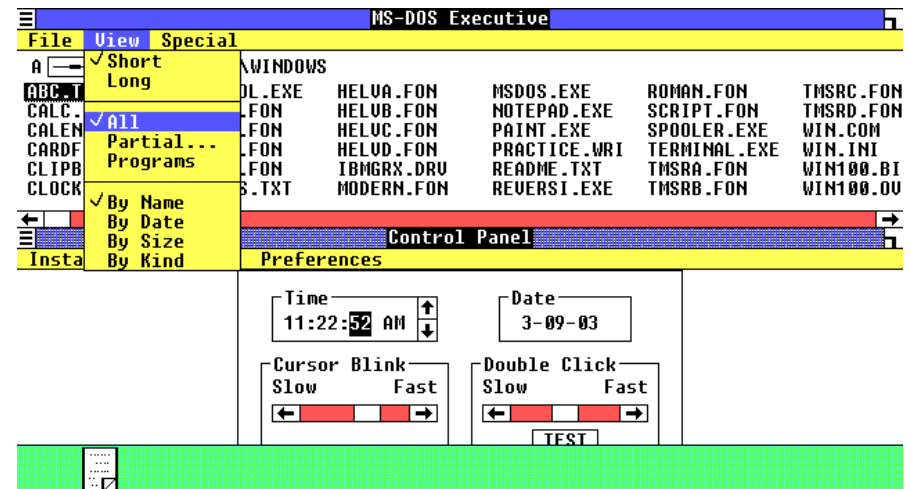
- Kernel performs:
 - **Scheduling**
 - **Synchronization**
 - **Memory management**
 - **Interrupt handling**
 - **Security and protection**

Operating Systems – GUI

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

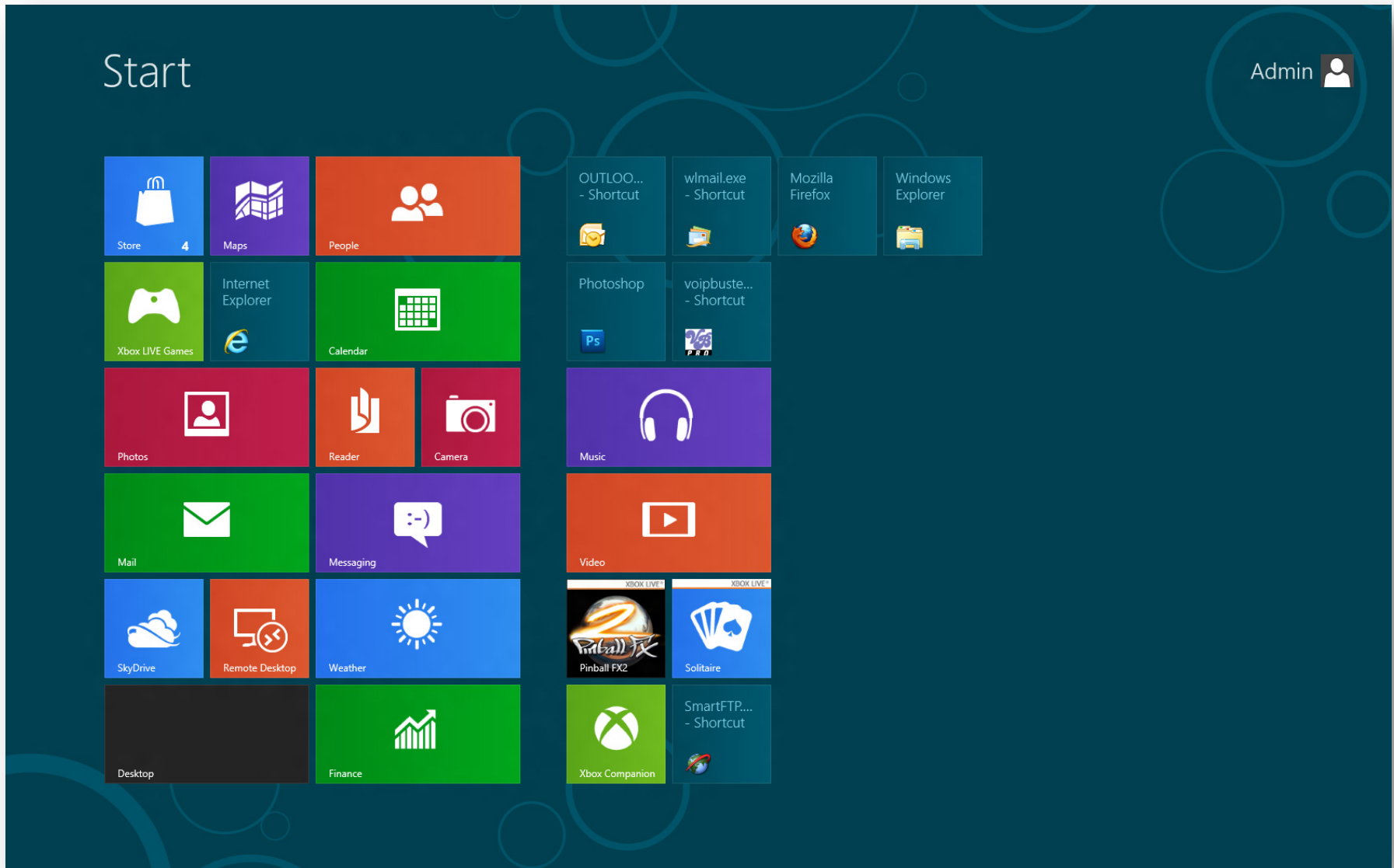


Apple Mac OS 1.0 (released 1984)



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 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

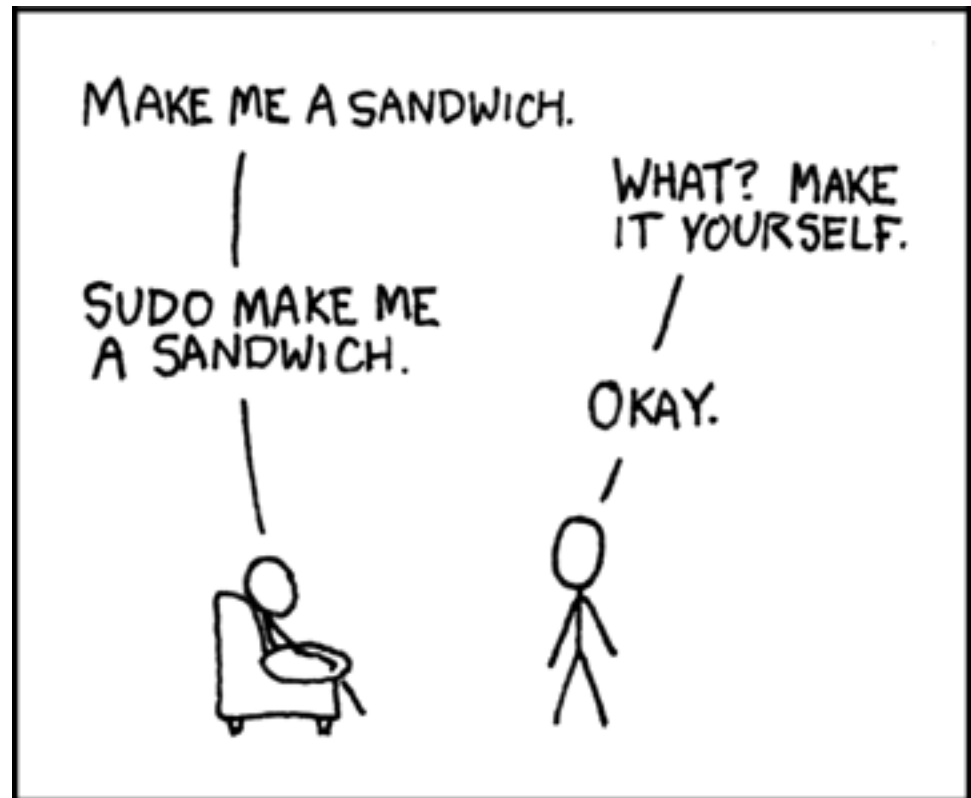
Shell Shortcuts

- <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"

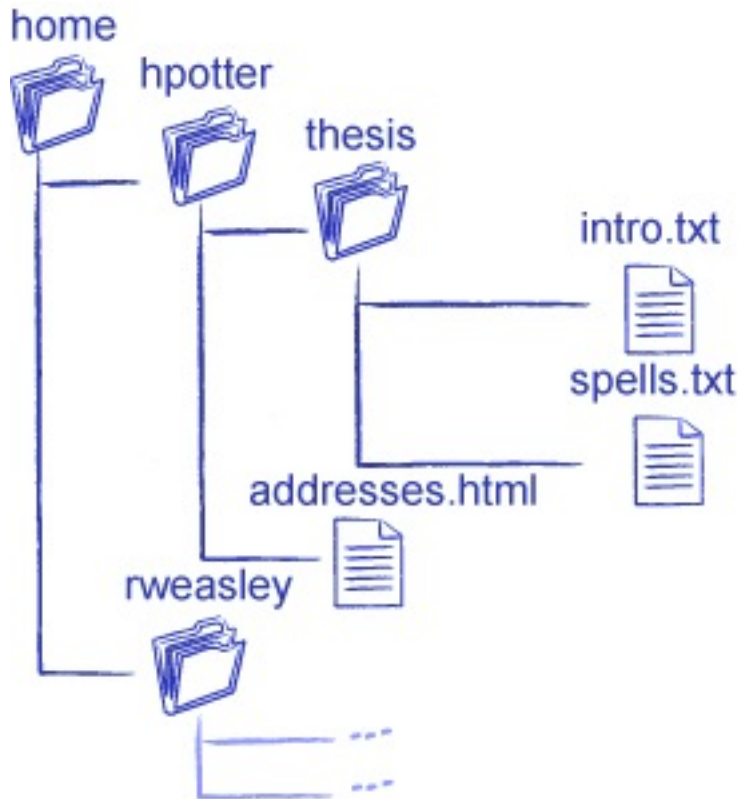


<http://xkcd.com/149/>

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



➤ Absolute path:

➤ `/home/hpotter/thesis/intro.txt`

➤ Relative path:

➤ If I am already in `/home/potter/`

➤ `addresses.html`

~f 2006

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

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 OpenOffice (aka *LibreOffice*) using example template on website
- Export in **PDF format**
- Submit
 - Via Sakai *Assignments* section for Lab 1 only!
 - Via Version control for Lab 2 and beyond

Upcoming Schedule

- Today / Monday
 - **Lab 1 – Linux Basics**

- Next Wednesday / Friday
 - **Lab 2 – Version Control**
 - *Note that Lab 2 has a pre-lab checkpoint*