



Introduction to Linux



Fall 2016
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Overview

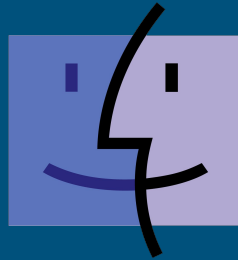
- Operating System
- History
- Motivation
- Linux
 - Overview
 - The Kernel
 - File System
 - Shell
- Working in Linux
 - Common Commands
 - Basic File Editing with VIM
 - Installing New Software
 - Secure Shell Protocol
- Reference Material

The Operating System

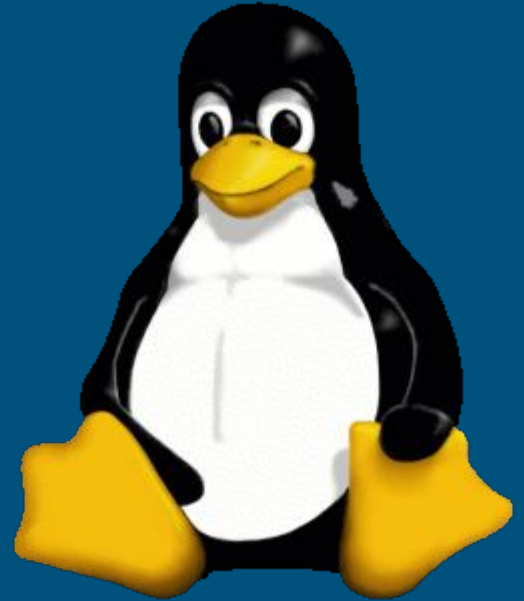
- Interconnect between applications and hardware
- Process and memory management
- Device drivers



Microsoft®
Windows98



Mac™ OS



History

1980s: Microsoft DOS, Apple OS X, and UNIX with proprietary source code

1984: GNU foundation started in order to develop an open source, UNIX like, OS

1991: Linus Torvalds' Kernel, titled Linux, chosen for the GNU Project

2016: Estimated 87 million Linux users



Motivation

Advantages of Linux:

- Fast
- Open Source
- Community development
- Well Documented and Supported
- Technical skill for coop



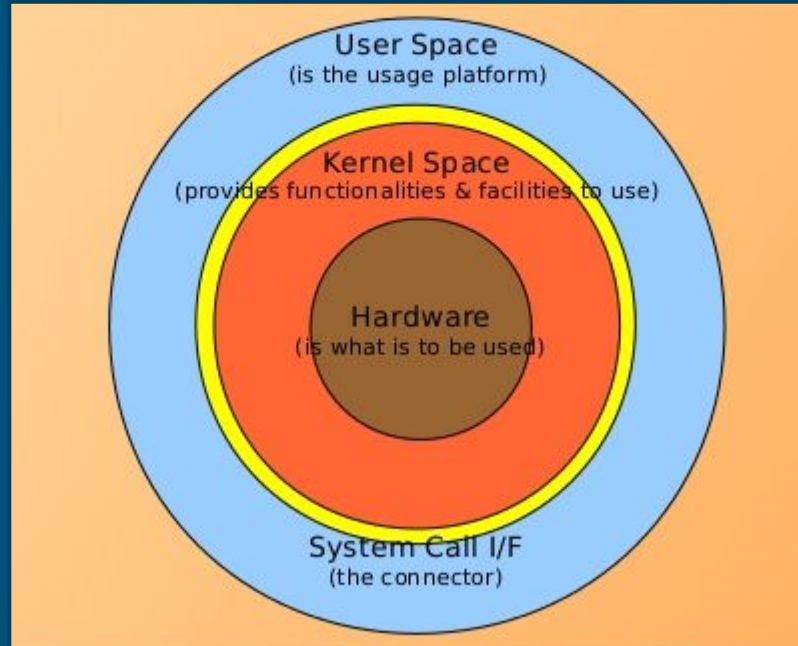
Linus Torvalds

Popularity

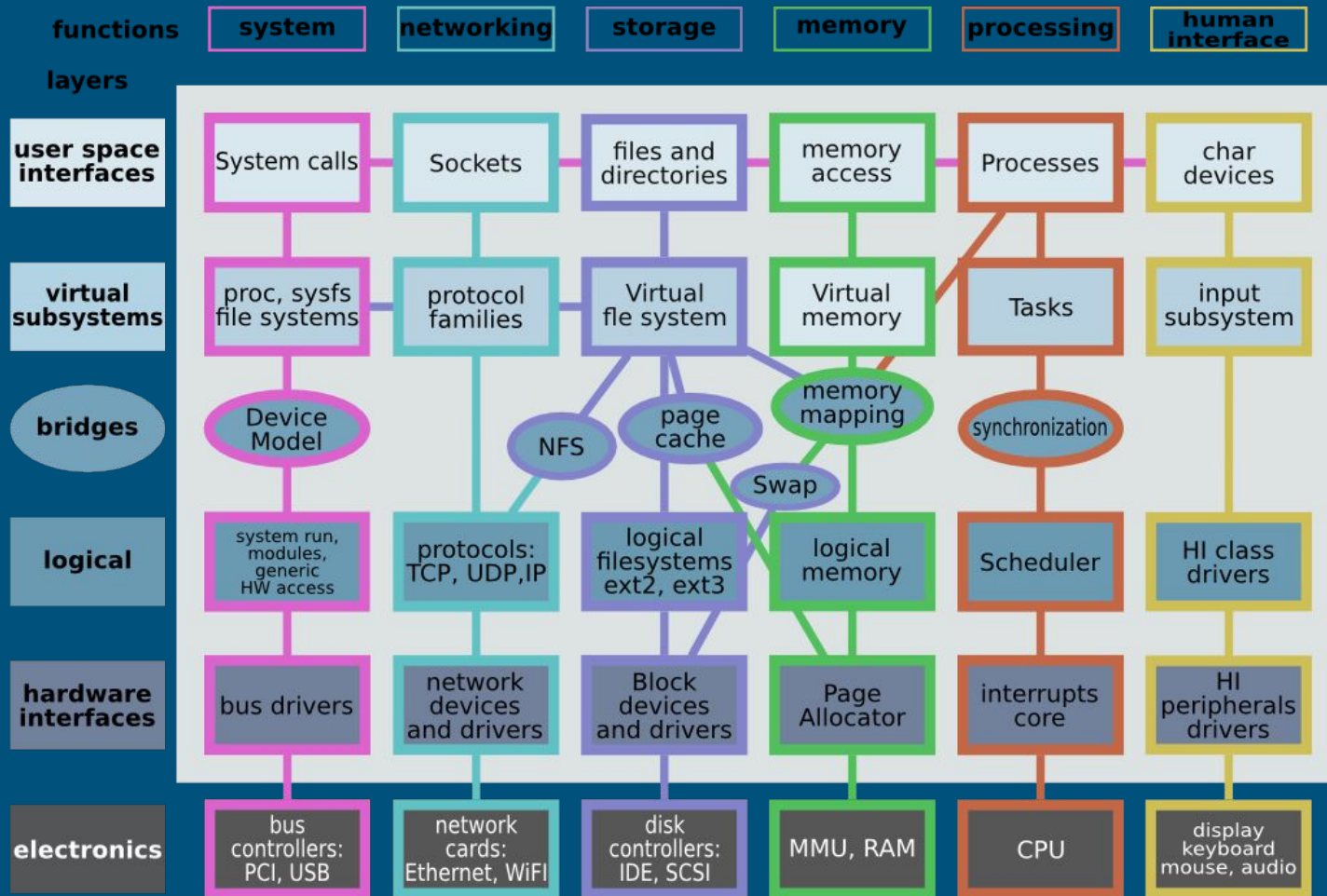
- It's free!
- Stable, reliable, and powerful
- Hardware Agnostic
 - Super Computer or Raspberry Pi
- Preloaded with development software for C, C++, including compiler
 - Easy to install new software



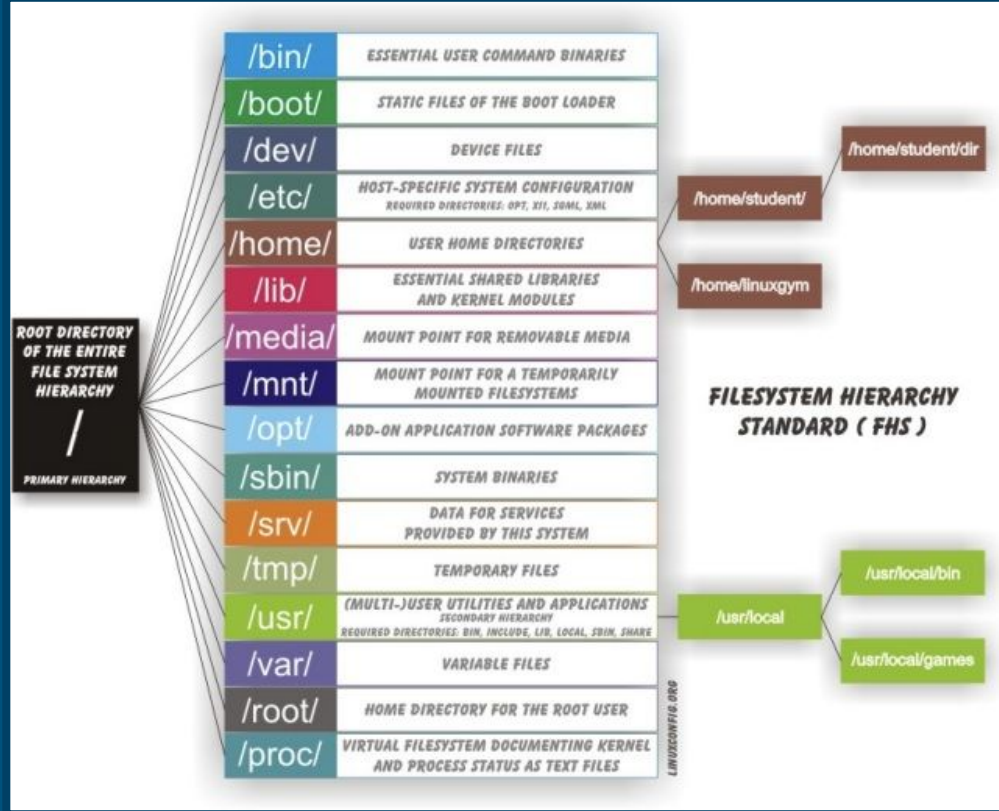
Linux: Overview



The Kernel



File System



Linux: The Shell

- Provides a user environment
- Interface between user space and the kernel
- Interprets commands, no compilation needed
- Shell *scripts* can hold multiple commands
- Shells:
 - sh
 - **bash**
 - csh
 - ksh

```
mars@marsmain ~ $ pwd
/home/mars
mars@marsmain ~ $ cd /usr/portage/app-shells/bash
mars@marsmain /usr/portage/app-shells/bash $ ls -al
total 130
drwxr-xr-x  3 portage portage 1024 Jul 25 10:06 .
drwxr-xr-x 33 portage portage 1024 Aug  7 22:39 ..
-rw-r--r--  1 root  root    35808 Jul 25 10:06 ChangeLog
-rw-r--r--  1 root  root    27002 Jul 25 10:06 Manifest
-rw-r--r--  1 portage portage 4645 Mar 23 21:37 bash-3.1_p17.ebuild
-rw-r--r--  1 portage portage 5977 Mar 23 21:37 bash-3.2_p39.ebuild
-rw-r--r--  1 portage portage 6151 Apr  5 14:37 bash-3.2_p40-r1.ebuild
-rw-r--r--  1 portage portage 5988 Mar 23 21:37 bash-3.2_p40.ebuild
-rw-r--r--  1 portage portage 5648 Apr  5 14:37 bash-4.0_p10-r1.ebuild
-rw-r--r--  1 portage portage 6230 Apr  5 14:37 bash-4.0_p10.ebuild
-rw-r--r--  1 portage portage 5648 Apr 14 05:52 bash-4.0_p17-r1.ebuild
-rw-r--r--  1 portage portage 5532 Apr  8 10:21 bash-4.0_p17.ebuild
-rw-r--r--  1 portage portage 5660 May 30 03:35 bash-4.0_p24.ebuild
-rw-r--r--  1 root  root    5660 Jul 25 09:43 bash-4.0_p28.ebuild
drwxr-xr-x  2 portage portage 2048 May 30 03:35 files
-rw-r--r--  1 portage portage 468 Feb  9 04:35 metadata.xml
mars@marsmain /usr/portage/app-shells/bash $ cat metadata.xml
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE pkgmetadata SYSTEM "http://www.gentoo.org/dtd/metadata.dtd">
<pkgmetadata>
  <herd>base-system</herd>
  <use>
    <flag name='bashlogger'>Log ALL commands typed into bash; should ONLY be
      used in restricted environments such as honeypots</flag>
    <flag name='net'>Enable /dev/tcp/host/port redirection</flag>
    <flag name='plugins'>Add support for loading builtins at runtime via
      'enable'</flag>
  </use>
</pkgmetadata>
mars@marsmain /usr/portage/app-shells/bash $ sudo /etc/init.d/bluetooth status
Password:
* status: started
mars@marsmain /usr/portage/app-shells/bash $ ping -q -c 1 en.wikipedia.org
PING rr.esams.wikimedia.org (91.198.174.2) 56(84) bytes of data.

--- rr.esams.wikimedia.org ping statistics ---
1 packets transmitted, 1 received, 0% packet loss, time 2ms
rtt min/avg/max/mdev = 49.820/49.820/49.820/0.000 ms
mars@marsmain /usr/portage/app-shells/bash $ grep -i /dev/sda /etc/fstab | cut --fields=3
/dev/sda1      /boot        none
/dev/sda2      /             none
/dev/sda3      /             /

mars@marsmain /usr/portage/app-shells/bash $ date
Sat Aug  8 02:42:24 MSD 2009
mars@marsmain /usr/portage/app-shells/bash $ lsmod
Module              Size  Used by
rndis_wlan          23424  0
rndis_host           8696  1 rndis_wlan
cdc_ether            5672  1 rndis_host
usbnet              18688  3 rndis_wlan,rndis_host,cdc_ether
parport_pc          38424  0
tgirx               2388128 20
parport             39648  1 parport_pc
l100_wdt             12272  0
i2c_i801             9300  0
mars@marsmain /usr/portage/app-shells/bash $ █
```

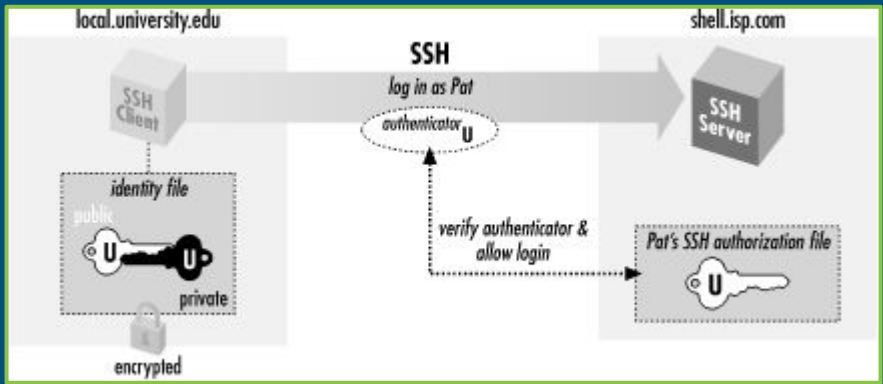
SSH

Secure SHell Protocol

Allows access to remote machines, securely!

Password, or more securely, SSH **keys**

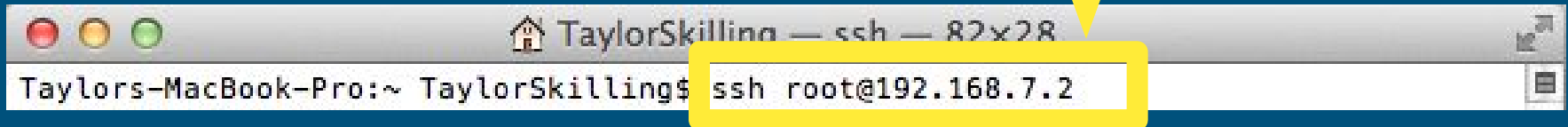
- Generate public and private keys locally
- Pass the public key to remote machine
- Login without a password!



Linux on Beaglebone Black

<https://beagleboard.org/getting-started>

Username: root



Common Commands

Full Path: ~\$ /home/path/to/whatever

Relative Path: ~\$ path/to/whatever

Special Characters

/	root
~	home
..	up one
.	current

Commands

\$ pwd	Print Working Directory: print the current working directory
\$ cd [path]	Change Directory: change current working directory to [path]
\$ ls	List: print a list of all files/directories in the cwd
\$ cp [from] [to]	Copy: copy file [from] to [to]
\$ mv [from] [to]	Move: move/rename file [from] to [to]
\$ rm [file]	Remove: delete [file]. WARNING: NO TRASH
\$ man [cmd]	Provides manual for the command chosen

```
NAME
    pwd - print name of current/working directory

SYNOPSIS
    pwd [OPTION]...

DESCRIPTION
    Print the full filename of the current working directory.

    -L, --logical
        use PWD from environment, even if it contains symlinks

    -P, --physical
        avoid all symlinks

    --help display this help and exit

    --version
        output version information and exit

    If no option is specified, -P is assumed.
```

Common Commands - PWD

Full Path: ~\$ /home/path/to/whatever

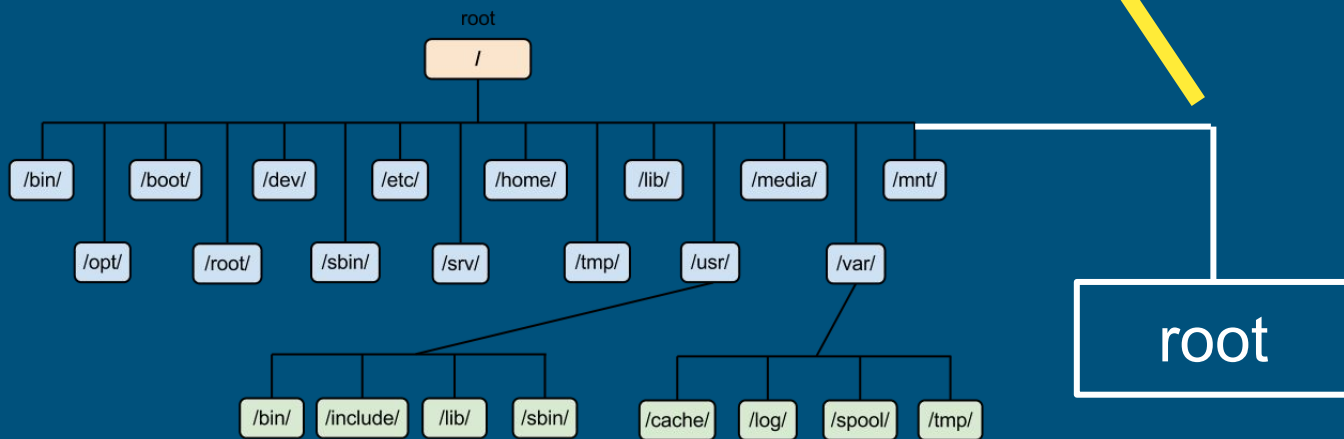
Relative Path: ~\$ path/to/whatever

Commands

\$ pwd

Print Working Directory: print the current working directory

```
root@beaglebone:~# pwd
/root
```



Common Commands - Navigation

Full Path: ~\$ /home/path/to/whatever

Relative Path: ~\$ path/to/whatever

Special Characters

- / root
- ~ home
- .. up one
- . current

Commands

- \$ pwd Print Working Directory: print the current working directory
- \$ cd [path] Change Directory: change current working directory to [path]
- \$ ls List: print a list of all files/directories in the cwd

```
kenny@kenny-CX62-6QD:~$ ls
```

AES_fullmask	CryptoTest	Downloads	Fundies1	m5out	mytest	Public	Test
CPrograms	Desktop	Encryption	gem5-stable	Music	openssl-1.0.2a	Racket	Videos
C++Programs	Documents	examples.desktop	gnome-terminal-colors-solarized	myCA	Pictures	Templates	

Common Commands - Creating Directories

Full Path: ~\$ /home/path/to/whatever

Relative Path: ~\$ path/to/whatever

Special Characters

/	root
~	home
..	up one
.	current

Commands

\$ cp [from] [to]	Copy: copy file [from] to [to]
\$ mv [from] [to]	Move: move/rename file [from] to [to]
\$ rm [file]	Remove: delete [file]. WARNING: NO TRASH
\$ rm -r [folder]	Remove [folder] recursively. Deletes all nested files as well

```
root@beaglebone:~# pwd
/root
root@beaglebone:~# ls
BBB_Intro BBB_Intro_2 BBB_PRU_1 Workshops
root@beaglebone:~# cd Workshops/
root@beaglebone:~/Workshops# pwd
/root/Workshops
root@beaglebone:~/Workshops# ls
PRU1 scripts Workshop1
root@beaglebone:~/Workshops# cd ../
root@beaglebone:~# pwd
/root
root@beaglebone:~# ls
BBB_Intro BBB_Intro_2 BBB_PRU_1 Workshops
root@beaglebone:~#
```


VIM

Vim, Vi IMproved, is a popular configurable text editor created by Bram Moolenaar.

\$ vim [file] Opens file in vim]

Editing Modes

- Normal - For navigation and manipulation of text.
- Insert - For creating and editing text.
- Command - For inserting editor commands.

Vim starts in Normal mode, press “i” to enter insert mode, or “:” to enter command mode. Press “esc” during insert mode to enter normal mode, and press “esc” twice during command to enter normal mode.

```
VIM - Vi IMproved

version 7.4.1689
  by Bram Moolenaar et al.
Modified by pkg-vim-maintainers@lists.alioth.debian.org
Vim is open source and freely distributable

Become a registered Vim user!
type  :help register<Enter>   for information

type  :q<Enter>               to exit
type  :help<Enter>  or  <F1>   for on-line help
type  :help version7<Enter>   for version info
```

VIM

Normal Mode

Commands

:	Enter Editor Mode
i	Insert text before current cursor position.
a	Append text after current cursor position
u	Undo last change
x	Delete character
dd	Delete line cursor is currently in.
yy	Yank current line (copy)
p	Paste

```
#include <stdio.h>
#include <stdlib.h>

unsigned long long counter[16][256];
unsigned long long timing[16][256];

int main(int argc, char** argv){
    FILE* f0, *f1;

    f0 = fopen("timing.bin", "r");
    f1 = fopen("cipher.bin", "r");
    unsigned char cipher[16];
    int i, j;
    int monitor_lines = 1;
    unsigned short time[monitor_lines];

    int threshold = 70000;
    if(argc >= 2){
        threshold = atoi(argv[1]);
    }

    for(i = 0; i < 16; i++){
        for(j = 0; j < 256; j++){■
```

23,28-34

Top

VIM

Command Mode

Vim starts in normal mode, enter ":" to start command mode.

Popular Editor Commands

:help	Produces main help file.
:1, \$d	Deletes all the content of a file. \$ means the last character in the file, d means delete.
:w	Writes file (Saves contents)
:x	Only writes if there is a change
:q or q!	Quit file (! overrides last change)
:wq	Writes and quits file
esc	Tap esc twice to enter Normal mode

```
#include <stdio.h>
#include <stdlib.h>

unsigned long long counter[16][256];
unsigned long long timing[16][256];

int main(int argc, char** argv){
    FILE* f0, *f1;

    f0 = fopen("timing.bin", "r");
    f1 = fopen("cipher.bin", "r");
    unsigned char cipher[16];
    int i, j;
    int monitor_lines = 1;
    unsigned short time[monitor_lines];

    int threshold = 70000;
    if(argc >= 2){
        threshold = atoi(argv[1]);
    }

    for(i = 0; i < 16; i++){
        for(j = 0; j < 256; j++){
```

:wq

Text Processing

echo displays a line of text in the shell

```
root@beaglebone:~# x=13
root@beaglebone:~# echo The value of x is: $x
The value of x is: 13
```

cat (catenate) displays lines of text from a file into the shell

```
root@beaglebone:~/Workshops/Intro_to_Linux/files# pwd
/root/Workshops/Intro_to_Linux/files
root@beaglebone:~/Workshops/Intro_to_Linux/files# cat -n cat_me.txt
 1 Welcome to IEEE Intro to Linux Workshop!
 2
 3 As you can see, there are lines of text in this basic text file.
 4
 5 You can see some of the lines with the 'cat' command.
 6
 7 Can you see all of them with the 'cat' command?
root@beaglebone:~/Workshops/Intro_to_Linux/files#
```

Text Processing

grep: Command searches for specific words or patterns

grep word file.txt - will print out each line containing the word you want

It is possible to grep certain phrases:

grep 'text' file.txt

Options

- i Ignore upper/lower case distinctions
- n Number each matching line
- v Display lines that don't contain the word searched
- c Print out only the total count of matched lines

grep option word file.txt

Text Processing

pipe: Allows for interprocess communication. Pipes can connect the output of commands. By using pipes you can make the output of one command act as the input for another command.

The command **cat list list 2 | grep p | sort** will sort and print all lines with the letter p in both the list and list2 files.

Commands

\$ 	Represents pipe (or symbol)
\$ who wc -l	Who displays users on the system, wc counts the users, -l displays the numbers
\$ cat file more	Allows user to cat through a file a page at a time (press space to cycle through)

Administration

A superuser is the system user who has the permission necessary to perform administrative tasks.

```
kenny@kenny-CX62-6QD:~$ sudo apt-get upgrade
[sudo] password for kenny:
Reading package lists... Done
Building dependency tree
Reading state information... Done
Calculating upgrade... Done
The following packages were automatically installed and are no longer required:
  libpango1.0-0 libpangox-1.0-0 linux-headers-4.4.0-21
  linux-headers-4.4.0-21-generic linux-headers-4.4.0-31
  linux-headers-4.4.0-31-generic linux-headers-4.4.0-34
  linux-headers-4.4.0-34-generic linux-image-4.4.0-21-generic
  linux-image-4.4.0-31-generic linux-image-4.4.0-34-generic
  linux-image-extra-4.4.0-21-generic linux-image-extra-4.4.0-31-generic
  linux-image-extra-4.4.0-34-generic linux-signed-image-4.4.0-21-generic
  linux-signed-image-4.4.0-31-generic linux-signed-image-4.4.0-34-generic
Use 'sudo apt autoremove' to remove them.
The following packages have been kept back:
  ubuntu-core-launcher
The following packages will be upgraded:
  accountsservice apparmor bamfdaemon compiz compiz-core compiz-gnome
  compiz-plugins-default cups-browsed cups-filters cups-filters-core-drivers
  fwupd gnome-font-viewer gnome-session-bin gnome-session-common
  gnome-settings-daemon-schemas gnome-sudoku gnome-system-monitor grub-common
  grub-efi-amd64 grub-efi-amd64-bin grub-efi-amd64-signed grub2-common
  gtk2-engines-murrine language-selector-common language-selector-gnome less
  libaccountsservice0 libapparmor-perl libapparmor1 libappstream-glib8
```

Tasks such as updating and installing packages require superuser privileges.

Commands

\$ sudo	Superuser do; allows user to run commands as superuser [requires a password]
\$ passwd	Change user password
\$ reboot	Reboots the machine
\$ Shutdown	Shuts the machine off

Installing New Software

- `sudo apt-get install [package]`
- `sudo apt-get update`

```
root@beaglebone:~# sudo apt-get install python-scipy
Reading package lists... Done
Building dependency tree
Reading state information... Done
The following extra packages will be installed:
  libamd2.2.0 liblcms1 libumfpack5.4.0 python-dev python-imaging
Suggested packages:
  liblcms-utils python-imaging-doc python-imaging-dbg
The following NEW packages will be installed:
  libamd2.2.0 liblcms1 libumfpack5.4.0 python-dev python-imaging python-scipy
0 upgraded, 6 newly installed, 0 to remove and 0 not upgraded.
Need to get 10.6 MB of archives.
After this operation, 30.8 MB of additional disk space will be used.
Do you want to continue [Y/n]? █
```


Reading Material

- Google
- Beginner tutorials
 - <http://www.coe.neu.edu/computer/UNIXhelp/>
 - <http://www.ee.surrey.ac.uk/Teaching/Unix/index.html>
- Regex, Grep, Sed, AWK
 - <http://www.grymoire.com/Unix/>

Questions?

```
sudo shutdown -h now
```

Thank You
