Linux Lecture – 01

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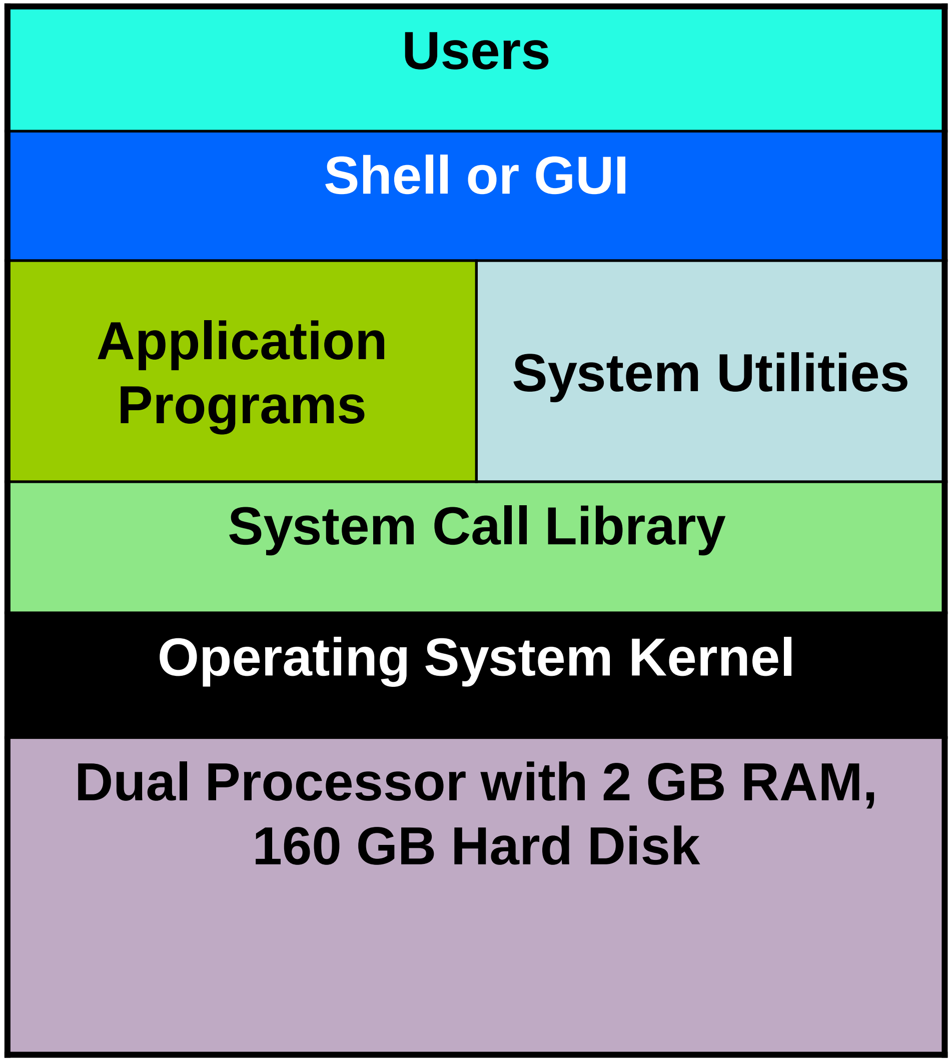
Today’s Lecture

- Operating System Concept
- Brief History of UNIX & Linux
- A Linux Distribution
- Architecture of Linux
- Basic Principals of Linux
- Linux File System
- Typical Linux Directory Structure
- How to login
- Basic Linux Commands

Operating System Concept

- An operating system (OS) is a resource manager
- It is a set of software routines:
  - that allow users and application programs to access system resources
  - in a safe, efficient and abstract way
  - CPU, memory, disks, modems, printers network cards etc.
- A general operating system architecture can be understood by the figure



Users

Shell or GUI

Application Programs

System Utilities

System Call Library

Operating System Kernel

Dual Processor with 2 GB RAM, 160 GB Hard Disk

Operating System Concept

- The **kernel** controls the hardware
- It provides functions like
  - Handling of interrupts from the devices
  - Allocation of memory to programs
  - Sharing of CPU among the programs
- Basic kernel services are exposed to higher-level programs through a library of **system calls**
- **Application Programs** and **System Utility Programs** make use of system calls
  - Launched using a **shell/GUI**
- The OS may differ from one another on the basis of:
  - System calls
  - System utilities
  - User interface they provide
  - Resource scheduling policies implemented by the kernel

History of UNIX & Linux

- In late 1960s, **MULTICS** was introduced for mainframe computers
- Joint venture of GE, MIT and Bell Labs
- Inspired Ken Thompson – who wrote simpler version called **UNICS,** which evolved into UNIX
- Ken Thompson with Dennis Ritchie in 1973 wrote the **UNIX** kernel in C
- The Fifth edition of UNIX was released to universities in 1974
- In 1978, **UNIX** development was split into two main branches:
  - **SYSV**
  - **BSD**

History of UNIX & Linux

- Linux – open source OS for PCs
- Developed by Linus Torvalds (a Finnish graduate student), in 1991
- Neither pure SYSV nor BSD, mix of both
- Conforms to a set of standards called POSIX
- Code freely available, anyone can:
  - Modify, add features, correct deficiencies
- Different Distributions:
  - Caldera Systems Corel Debian Mandrake
  - Red Hat Slackware Strom SUSE
  - Turbo Gentoo Stampede Knoppix
  - Fedora Ubuntu College Linux White Box Linux

A Linux Distribution

- A distribution comprises of:
  - Kernel
    - 2.6.9-89.0.11.EL.cernsmp
  - System Utilities
    - File copy, hard disk repair/defragment etc.
  - GUI
    - GNOME, KDE
  - Application Programs
    - Open office, evolution, firefox, gedit, gftp. konqueror, evince, kdevelop, kview, emace, vim etc.

Architecture of Linux

- Kernel
  - Initializes the device drivers
  - Processor & memory management functions
  - Support for many different type of file systems
  - A wide range of system calls (mix of SYS V, BSD and POSIX.1)
  - Loaded into the memory at system startup
  - Location /boot/vmlinuz
  - Source files /usr/src/linux
- Shells & GUIs
  - Textual command line shells
    - bourne shell (sh), bourne again shell (bash)
    - csh and tcsh
  - GUI Environment
    - GNOME and KDE

Architecture of Linux

- System Utilities
  - – ls, grep, sed, awk, less, bc, wc, more etc.
  - – Powerful tools that perform a single task extremely well
  - – Can also chain programs together using pipes
  - – Server programs called **daemons**
- Application Programs
  - – emacs, vi, kdevelop, gcc, g++, open/star office etc.

Basic Principals of Linux

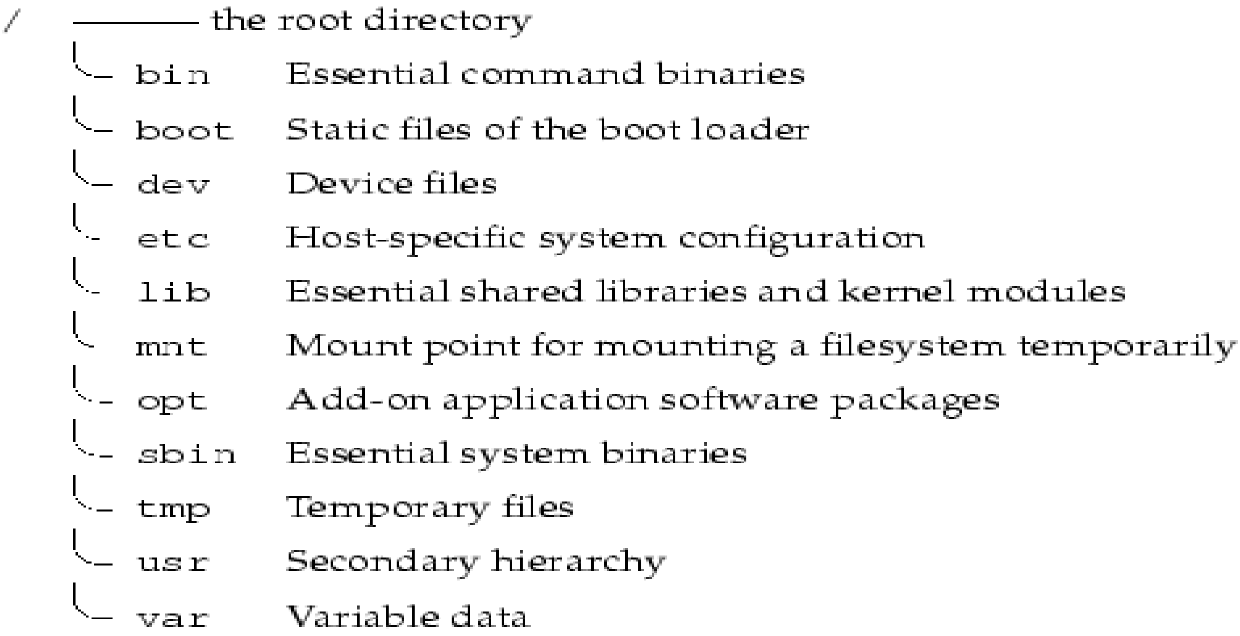
- Everything is a file
- Small, single purpose programs
- Ability to chain programs to perform complex tasks
- Avoid captive user interface
- Configuration data is stored in text
- Linux is case-sensitive

Linux File System

- Every file in Linux can be one of the following four types:
  - Ordinary File (contain data, info)
  - Directories (hold files & other directories)
  - Devices (for accessing the hardware)
  - Links (Pointer to another file)
    - Hard Link
    - Soft Link

Typical Directory Structure

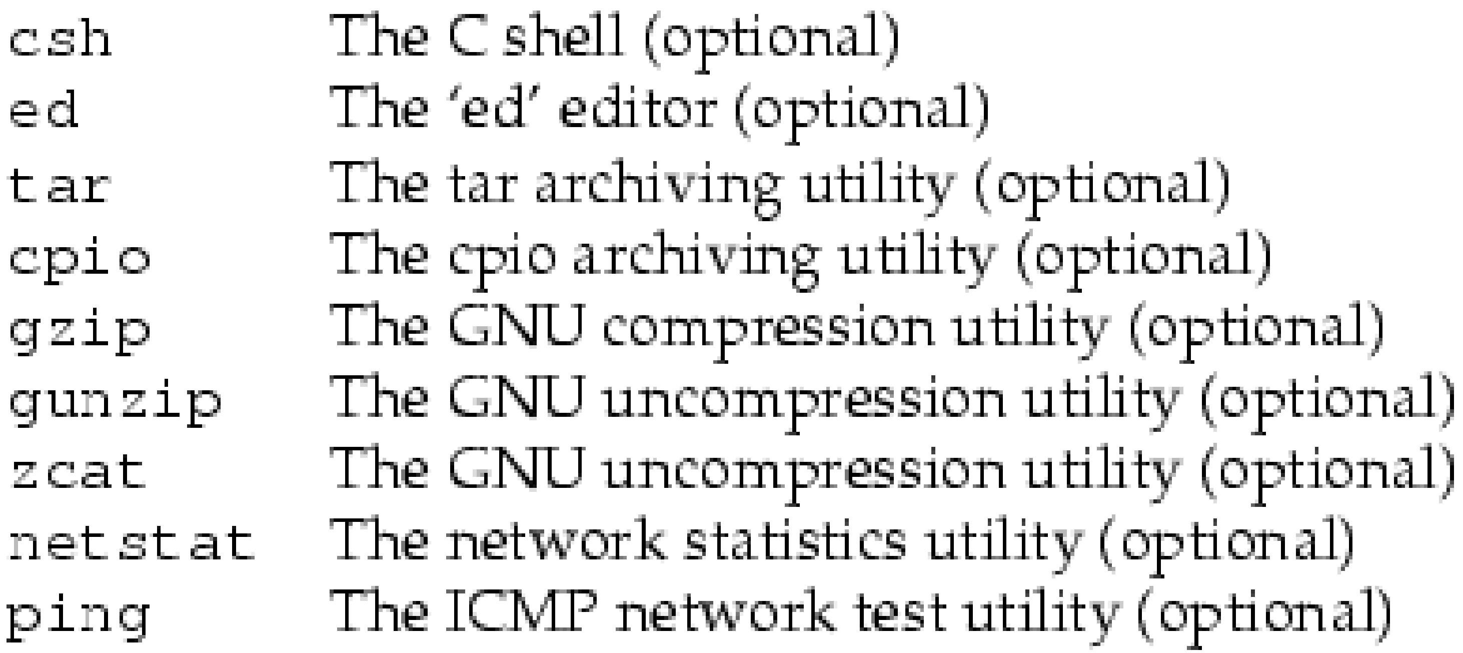
- Linux Filesystem is laid out in a hierarchical tree structure.
- Top level directory is called root "/"



```
/    ———— the root directory
  └─ bin    Essential command binaries
  └─ boot   Static files of the boot loader
  └─ dev    Device files
  └─ etc    Host-specific system configuration
  └─ lib    Essential shared libraries and kernel modules
  └─ mnt    Mount point for mounting a filesystem temporarily
  └─ opt    Add-on application software packages
  └─ sbin   Essential system binaries
  └─ tmp    Temporary files
  └─ usr    Secondary hierarchy
  └─ var    Variable data
```

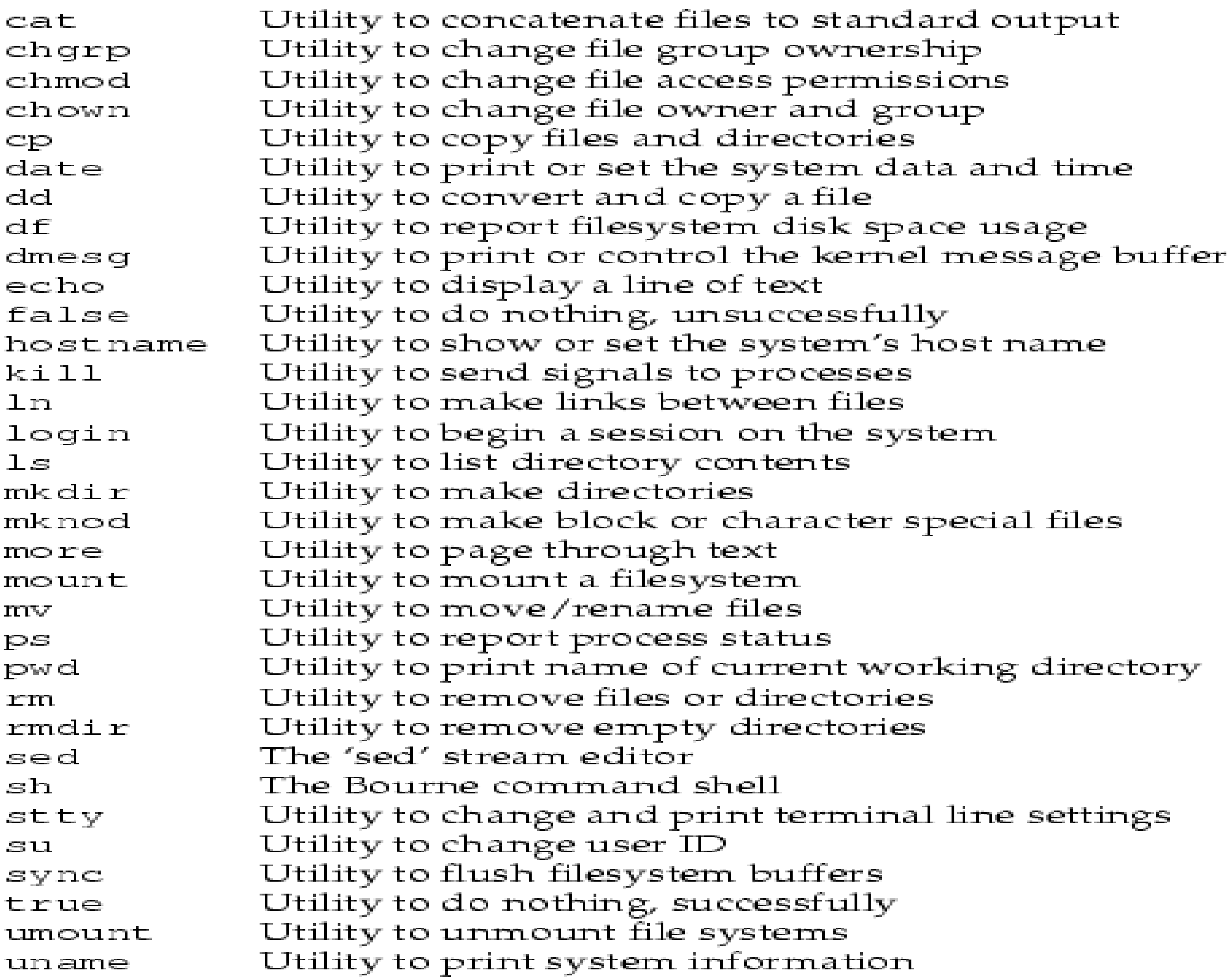
/bin: Binary files

- /bin contains commands that may be used by both the system administrator and by users



csh	The C shell (optional)
ed	The 'ed' editor (optional)
tar	The tar archiving utility (optional)
cpio	The cpio archiving utility (optional)
gzip	The GNU compression utility (optional)
gunzip	The GNU uncompression utility (optional)
zcat	The GNU uncompression utility (optional)
netstat	The network statistics utility (optional)
ping	The ICMP network test utility (optional)

/bin: Binary files



cat	Utility to concatenate files to standard output
chgrp	Utility to change file group ownership
chmod	Utility to change file access permissions
chown	Utility to change file owner and group
cp	Utility to copy files and directories
date	Utility to print or set the system data and time
dd	Utility to convert and copy a file
df	Utility to report filesystem disk space usage
dmesg	Utility to print or control the kernel message buffer
echo	Utility to display a line of text
false	Utility to do nothing, unsuccessfully
hostname	Utility to show or set the system's host name
kill	Utility to send signals to processes
ln	Utility to make links between files
login	Utility to begin a session on the system
ls	Utility to list directory contents
mkdir	Utility to make directories
mknod	Utility to make block or character special files
more	Utility to page through text
mount	Utility to mount a filesystem
mv	Utility to move/rename files
ps	Utility to report process status
pwd	Utility to print name of current working directory
rm	Utility to remove files or directories
rmdir	Utility to remove empty directories
sed	The 'sed' stream editor
sh	The Bourne command shell
stty	Utility to change and print terminal line settings
su	Utility to change user ID
sync	Utility to flush filesystem buffers
true	Utility to do nothing, successfully
umount	Utility to unmount file systems
uname	Utility to print system information

/sbin: Super-user Binaries

- This directory contains the binaries used by the root user

/boot: Boot files

- This directory contains everything required for the boot process except configuration files

/dev : Device files

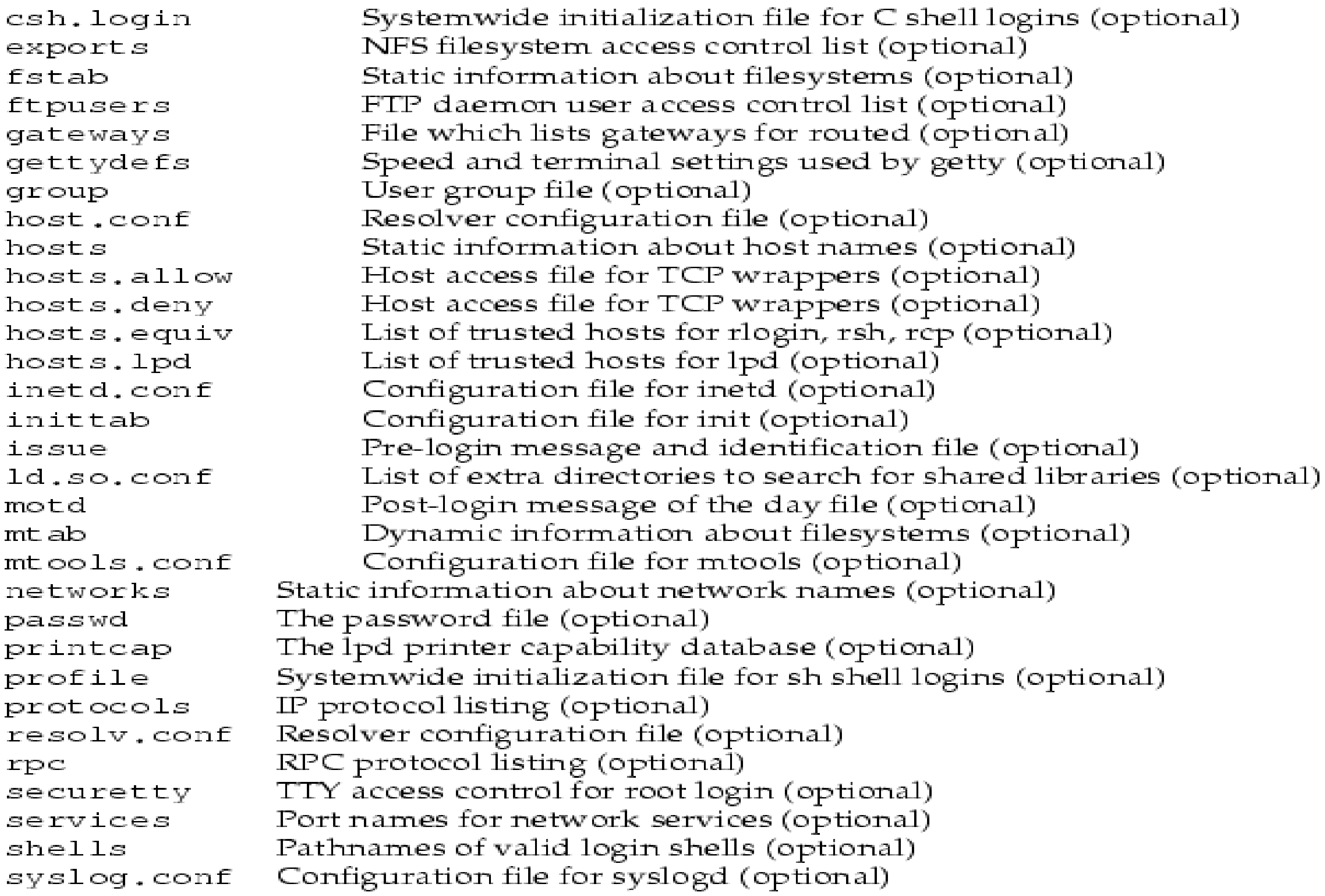
- The /dev directory is the location of special or device files

/proc : Virtual File System

- The /proc directory contains directories and files that report system information and status

/etc: Configuration files

- /etc contains configuration files and directories.



csh.login	Systemwide initialization file for C shell logins (optional)
exports	NFS filesystem access control list (optional)
fstab	Static information about filesystems (optional)
ftpusers	FTP daemon user access control list (optional)
gateways	File which lists gateways for routed (optional)
gettydefs	Speed and terminal settings used by getty (optional)
group	User group file (optional)
host.conf	Resolver configuration file (optional)
hosts	Static information about host names (optional)
hosts.allow	Host access file for TCP wrappers (optional)
hosts.deny	Host access file for TCP wrappers (optional)
hosts.equiv	List of trusted hosts for rlogin, rsh, rcp (optional)
hosts.lpd	List of trusted hosts for lpd (optional)
inetd.conf	Configuration file for inetd (optional)
inittab	Configuration file for init (optional)
issue	Pre-login message and identification file (optional)
ld.so.conf	List of extra directories to search for shared libraries (optional)
motd	Post-login message of the day file (optional)
mtab	Dynamic information about filesystems (optional)
mtools.conf	Configuration file for mtools (optional)
networks	Static information about network names (optional)
passwd	The password file (optional)
printcap	The lpd printer capability database (optional)
profile	Systemwide initialization file for sh shell logins (optional)
protocols	IP protocol listing (optional)
resolv.conf	Resolver configuration file (optional)
rpc	RPC protocol listing (optional)
securetty	TTY access control for root login (optional)
services	Port names for network services (optional)
shells	Pathnames of valid login shells (optional)
syslog.conf	Configuration file for syslogd (optional)

/home: User area

- /home contains user home directories
- Area writable by individual users
- Others users may be able to read depending upon permissions

/lib: Library files

- /lib contains essential shared libraries and kernel modules.
- The /lib directory contains those shared library images needed to boot the system and run the commands in the root filesystem, i.e., by binaries in /bin and /sbin.

/mnt: Mount area

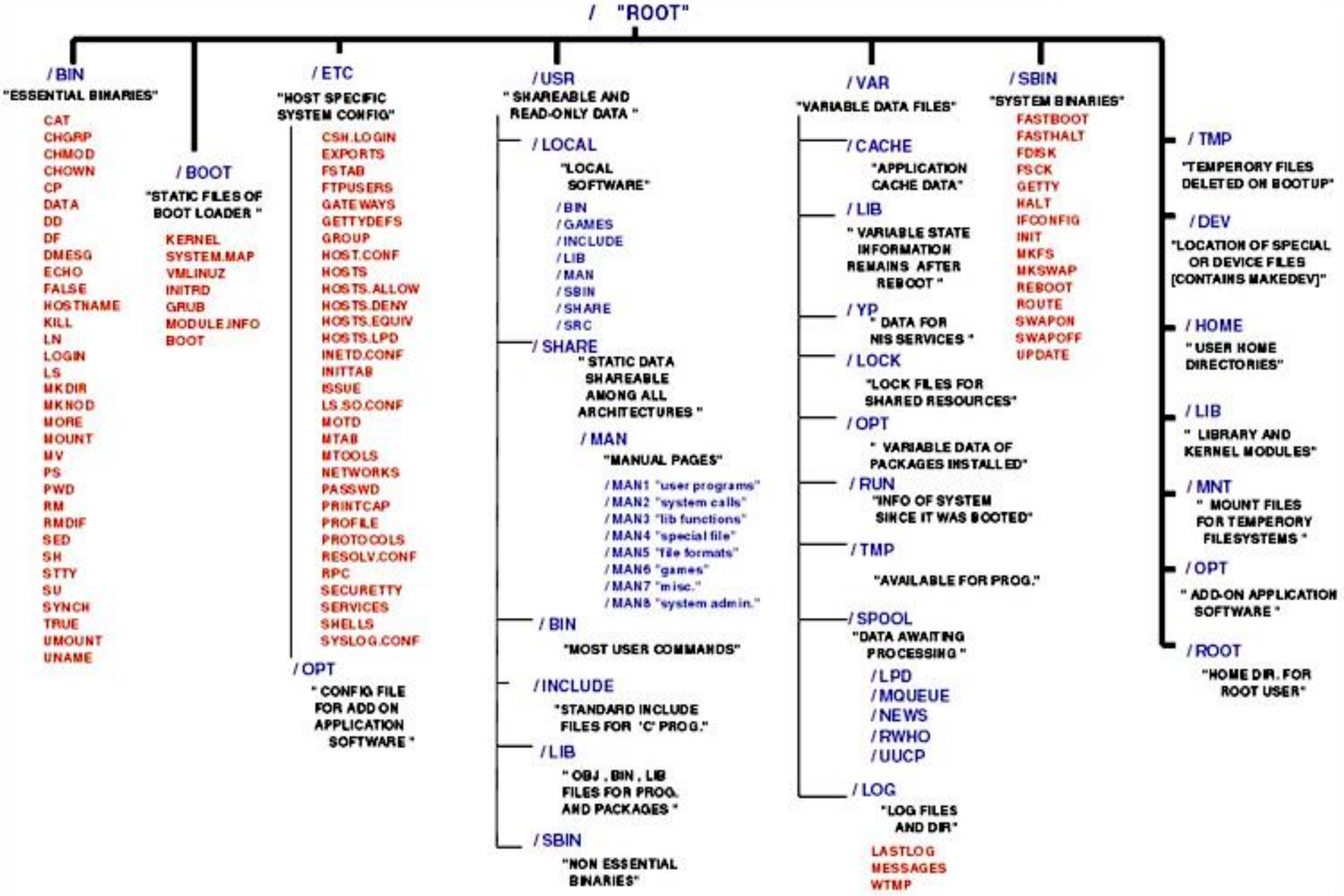
- Mount point for a temporarily mounted filesystem.
- This directory is provided so that the system administrator may temporarily mount a filesystem as needed.
- The content of this directory is a local issue and should not affect the manner in which any program is run.

/root & /tmp

- The /root is a home directory for the root user
- The /tmp directory must be made available for programs that require temporary files
- /tmp is writable by everyone i.e. world writable

/usr/lib: Library files

- Libraries for programming and packages.
- /usr/lib includes object files, libraries, and internal binaries that are not intended to be executed directly by users or shell scripts.



/ "ROOT"

/BIN
"ESSENTIAL BINARIES"
CAT
CHGRP
CHMOD
CHOWN
CP
DATA
DD
DF
DMESG
ECHO
FALSE
HOSTNAME
KILL
LN
LOGIN
LS
MKDIR
MKNOD
MORE
MOUNT
MV
PS
PWD
RM
RMDIF
SED
SH
STTY
SU
SYNCH
TRUE
UMOUNT
UNAME

/BOOT
"STATIC FILES OF BOOT LOADER "
KERNEL
SYSTEM.MAP
VMLINUZ
INITRD
GRUB
MODULE.INFO
BOOT

/ETC
"HOST SPECIFIC SYSTEM CONFIG"
CSH.LOGIN
EXPORTS
FSTAB
FTPUSERS
GATEWAYS
GETTYDEFS
GROUP
HOST.CONF
HOSTS
HOSTS.ALLOW
HOSTS.DENY
HOSTS.EQUIV
HOSTS.LPD
INETD.CONF
INITTAB
ISSUE
LS.SO.CONF
MOTD
MTAB
MTOOLS
NETWORKS
PASSWD
PRINTCAP
PROFILE
PROTOCOLS
RESOLV.CONF
RPC
SECURETTY
SERVICES
SHELLS
SYSLOG.CONF

/OPT
" CONFIG FILE FOR ADD ON APPLICATION SOFTWARE "

/USR
" SHAREABLE AND READ-ONLY DATA "

/LOCAL
"LOCAL SOFTWARE"
/BIN
/GAMES
/INCLUDE
/LIB
/MAN
/SBIN
/SHARE
/SRC

/SHARE
" STATIC DATA SHAREABLE AMONG ALL ARCHITECTURES "

/MAN
"MANUAL PAGES"
/MAN1 "user programs"
/MAN2 "system calls"
/MAN3 "lib functions"
/MAN4 "special file"
/MAN5 "file formats"
/MAN6 "games"
/MAN7 "misc."
/MAN8 "system admin."

/BIN
"MOST USER COMMANDS"

/INCLUDE
"STANDARD INCLUDE FILES FOR 'C' PROG."

/LIB
" OBJ , BIN , LIB FILES FOR PROG. AND PACKAGES "

/SBIN
"NON ESSENTIAL BINARIES"

/VAR
"VARIABLE DATA FILES"

/CACHE
"APPLICATION CACHE DATA"

/LIB
" VARIABLE STATE INFORMATION REMAINS AFTER REBOOT "

/YP
" DATA FOR NIS SERVICES "

/LOCK
"LOCK FILES FOR SHARED RESOURCES"

/OPT
" VARIABLE DATA OF PACKAGES INSTALLED"

/RUN
"INFO OF SYSTEM SINCE IT WAS BOOTED"

/TMP
"AVAILABLE FOR PROG."

/SPOOL
"DATA AWAITING PROCESSING "
/LPD
/MQUEUE
/NEWS
/RWHO
/UUCP

/LOG
"LOG FILES AND DIR"
LASTLOG
MESSAGES
WTMP

/SBIN
"SYSTEM BINARIES"
FASTBOOT
FASTHALT
FDISK
FSCK
GETTY
HALT
IFCONFIG
INIT
MKFS
MKSWAP
REBOOT
ROUTE
SWAPON
SWAPOFF
UPDATE

/TMP
"TEMPERORY FILES DELETED ON BOOTUP"

/DEV
"LOCATION OF SPECIAL OR DEVICE FILES [CONTAINS MAKEDEV]"

/HOME
" USER HOME DIRECTORIES"

/LIB
" LIBRARY AND KERNEL MODULES"

/MNT
" MOUNT FILES FOR TEMPERORY FILESYSTEMS "

/OPT
" ADD-ON APPLICATION SOFTWARE "

/ROOT
"HOME DIR. FOR ROOT USER"

Summary: Directory Structure

- Home Directories: /root,/home/*username*
- User Executables: /bin, /usr/bin, /usr/local/bin
- System Executables: /sbin, /usr/sbin, /usr/local/sbin
- Other Mountpoints: /media, /mnt
- Configuration: /etc
- Temporary Files: /tmp
- Kernels and Bootloader: /boot
- Server Data: /var, /srv
- System Information: /proc, /sys
- Shared Libraries: /lib, /usr/lib, /usr/local/lib

Logging into a Linux System

- Two types of login screens
  - virtual consoles (text-based)
  - graphical logins (display managers)
- Login using login name and password
- Each user has a home directory for personal file storage

Absolute & Relative Paths

- Absolute pathnames
  - Begin with a forward slash
  - Complete "road map" to file location
  - Can be used anytime you wish to specify a file name
- Relative pathnames
  - Do not begin with a slash
  - Specify location relative to your current working directory
  - Can be used as a shorter way to specify a file name

Basic Linux Commands

- **ls**, listing files and directories
  - ls –a
  - ls –l
  - ls –C
  - ls –F
  - ls --color
  - ls –d
  - ls –g
  - ls –o
  - ls –h
  - ls –lh, ls –CaF

Basic Linux Commands

- **cd**, change directory
  - cd ..
  - cd –
  - cd ~/mydir
  - cd /home/usman
  - cd
- **su**, switch user, su – (complete user environment)
- **id**, print user and group ids
- **passwd**, change password
  - **yppasswd**

Basic Linux Commands

- **man**, manual pages
  - man <command>
- **info**, information pages
  - info <command>
- **command --help**, basic help by author
  - ls --help, man --help
- **pwd**, present working directory

Basic Linux Commands

- **ps**, process information
  - ps aux
  - pstree
  - ps fax
  - top
- **free**, memory information
  - free –m
- **cal**, calendar information
  - cal, cal 2009
- **head**, output the first part of files
  - head [-n <lines>] <filename>
- **tail**, output the last part of files
  - tail [-n <lines>] <filename>

Basic Linux Commands

- **cat**, concatenate/display files
  - cat /home/usman/myfile
- **clear**, clears the screen
- **date**, see/modify system date & time
  - date, date [MMDDhhmm[[CC]YY][.ss]]
- **df**, disk space usage
  - df –h
- **du**, file space usage
  - du –sh
- **uname**, print system info
  - uname [-a, -s, -n, -r, -v, -m]

Basic Linux Commands

- **echo**, display a line or text
  - echo “any text”, echo $HOSTNAME
- **exit**, exit the current session/shell
- **file**, determine file type
  - file <file name/path>
- **hostname**, show or set the system hostname
  - hostname [<new-name>]
- **more**, file perusal filter for CRT viewing
  - more <file name/path>
- **less**, file perusal filter
  - less <file name/path>

Basic Linux Commands

- **cp**, copy files and directories
  - cp [options] *file* *destination*
- More than one file may be copied at a time if the destination is a directory:
  - cp [options] *file1* *file2* *destination*
- If the destination is a directory, the copy is placed there
- If the destination is a file, the copy overwrites the destination
- If the destination does not exist, the copy is renamed

Basic Linux Commands

- **mv**, move and/or rename files and directories
  - mv [options] *file*   *destination*
- More than one file may be moved at a time if the destination is a directory:
  - mv [options] *file1*   *file2*   *destination*
- In **mv** also, the destination works like **cp**
- **mkdir**, creates directories
  - mkdir <directory name/path>
- **rmdir**, removes empty directories
  - rmdir < directory name/path>

Basic Linux Commands

- **touch**, create empty files or update file timestamps
  - touch <file name/path>
- **rm**, remove files
  - rm [options] <file name/path>
  - **rm -i *file*** (interactive)
  - **rm -r *directory*** (recursive)
  - **rm -f *file*** (force)
- **rm –r**, recursively removes directory trees
  - rm –rf <directory name/path>

Basic Linux Commands

- **chsh**, change your login shell
- **alias**, setting command aliases
  - alias ll=‘ls –l’
- **whoami**, print user id
- find, finding files and directories
  - find <path> –iname <file name>
  - find <path> -size +100
  - find <path> -user usman –o –group it
  - find <path> -perm 755

File Permissions in Linux

Octal	Binary	Permissions
0	000	_ _ _
1	001	_ _ x
2	010	_ w _
3	011	_ w x
4	100	r _ _
5	101	r _ x
6	110	r w _
7	111	r w x

Basic Linux Commands

- **chmod**, changing permissions of files/directories
  - Octal mode
    - chmod 644 <file name/path>
    - chmod 755 <file name/path>
    - chmod 6 <file name/path>
  - Symbolic mode
    - chmod u+x, g-r, o+x <file name/path>
    - chmod a+x <file name/path>
    - chmod =x <file name/path>
- **chown,** changing ownership of files/directories
- **chgrp**, changing group ownership of files/directories
  - chown usman <file name>
  - chgrp it <file name>
  - chown usman.it <file name>

Basic Linux Commands

- **stat**, display the file status
  - stat <file name/path>
- ssh, Open SSH client for remote login
  - ssh <username>@<hostname>
  - ssh –l <username> <hostname>
  - ssh <hostname>
- **scp**, secure copy (remote file copy)
  - scp <file name> <username>@<hostname>:<path>
  - scp <username>@<hostname>:<path> <local path>

Basic Linux Commands

- **env/setenv**, adding or changing a variable
- Setting variable values
  - MYVAR=“something”
  - echo $MYVAR
  - **bash** shell
    - export MYVAR=“something”
  - **tcsh** shell
    - setenv MYVAR “soemthing”
- Sourcing files
  - source /home/env/my_env.csh
  - . /home/env/my_env.sh

Basic Linux Commands

- ln, creating links
  - ln <source file name/path> <link name>
  - ln –s <source file name/path> <link name>
- .bashrc (bash shell)
  - For setting local variables and aliases
- .tcshrc (tcsh shell)
  - For setting local variables and aliases
- .chsrc (csh shell)
  - For setting local variables and aliases

Shell Scripting Basics

```
#!/bin/sh
echo “Welcome to Linux -- ” $USER
echo “Today is : ” $(date)
echo “You are working in : ” `pwd`
echo “Enter your last name: ”
read LNAME
echo "Hello  --  $LNAME”
read X
read Y
echo “The product is : $X*$Y “
echo “Bye Bye…”
```

Shell Scripting Basics

-
  ```
  #!/bin/sh
  MSG=“Assignments due today…”
  for i in $(cat ~/users) ; do
      NAME=$i
      EMAIL_ADD=$NAME@ncp.edu.pk
      echo $MSG | mail –s “Warning” EMAIL_ADD
  done
  ```

Thank you

Q & A