Lab03 – Part I

Files and the File System
Part (b) – File System

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File Systems

- Linux
  - ReiserFs, ext2, ext3, ext4 (amongst others)
  - Since early 2010 Google use ext4 as their internal file system
  - Since late 2010 Android has used ext4, too
- Windows
  - ntfs, fat32, vfat, …
- Linux can read all
- Windows cannot (need to install open source programs to read Linux files)
- Linux is very flexible this way!

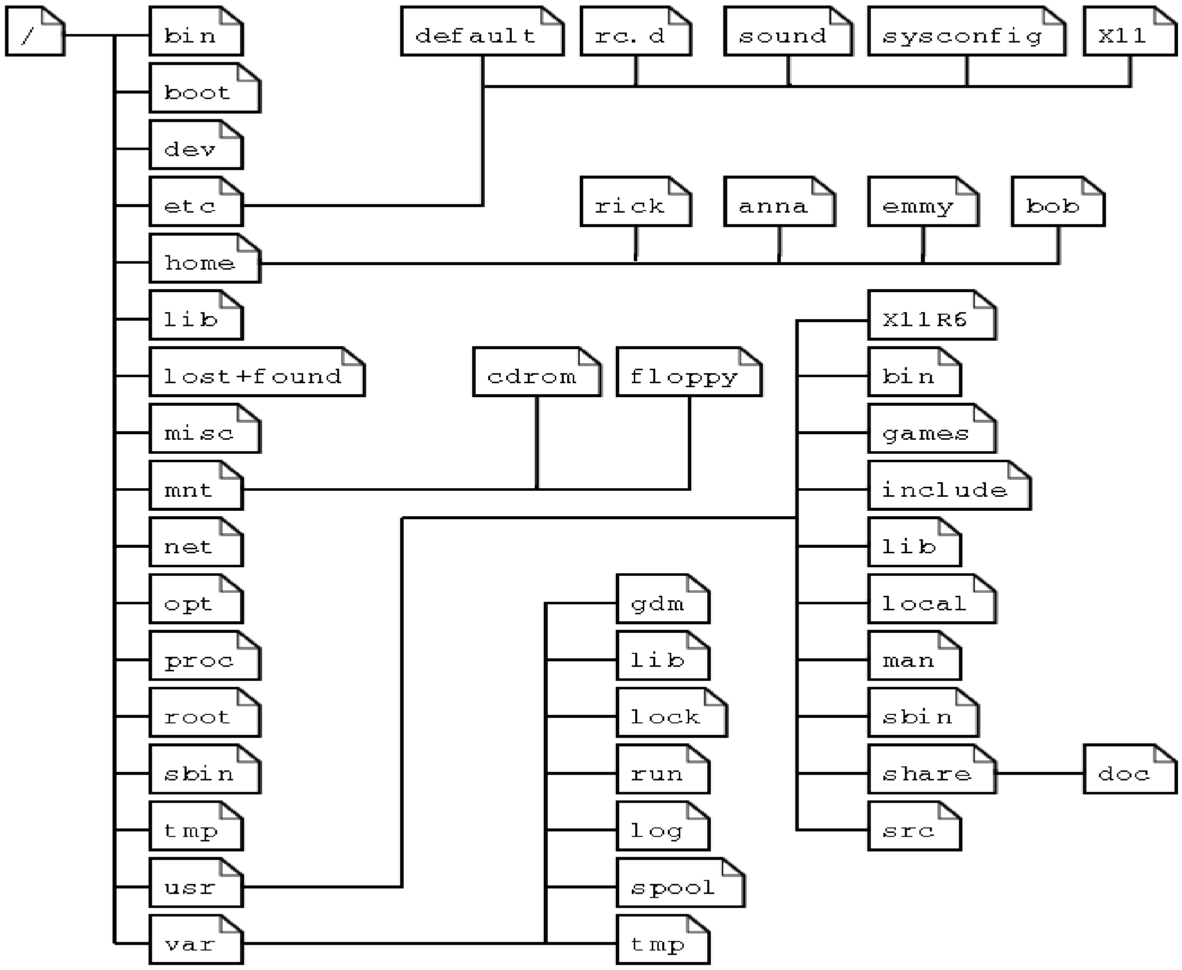
Layout of Linux File System

- Change directory to root

```
cd /
```

- List the contents
- You will see directories which are similar on all Linux systems
  - `bin` – binary executables
  - `boot` – contains the bootable Linux image
  - `etc` – configuration files
  - `dev` – contains a location for devices
  - `home` – users’ home directories
  - `media` – location where media is mounted
  - `usr` – system users’ files
  - `var` – contains log files, mail queues, print queues, etc.

Layout of Linux File System



Source: The Linux Documentation Project. http://www.tldp.org/LDP/intro-linux/html/sect_03_01.html

Layout of Linux File System

Directory	Content
/bin	Common programs, shared by the system, the system administrator and the users.
/boot	The startup files and the kernel, vmlinuz. In some recent distributions also grub data. Grub is the GRand Unified Boot loader and is an attempt to get rid of the many different boot-loaders we know today.
/dev	Contains references to all the CPU peripheral hardware, which are represented as files with special properties.
/etc	Most important system configuration files are in /etc, this directory contains data similar to those in the Control Panel in Windows
/home	Home directories of the common users.
/initrd	(on some distributions) Information for booting. Do not remove!
/lib	Library files, includes files for all kinds of programs needed by the system and the users.
/lost+found	Every partition has a lost+found in its upper directory. Files that were saved during failures are here.
/misc	For miscellaneous purposes.
/mnt	Standard mount point for external file systems, e.g. a CD-ROM or a digital camera.
/net	Standard mount point for entire remote file systems.
/opt	Typically contains extra and third party software.
/proc	A virtual file system containing information about system resources. More information about the meaning of the files in proc is obtained by entering the command man proc in a terminal window. The file proc.txt discusses the virtual file system in detail.
/root	The administrative user's home directory. Mind the difference between /, the root directory and /root, the home directory of the root user.
/sbin	Programs for use by the system and the system administrator.
/tmp	Temporary space for use by the system, cleaned upon reboot, so don't use this for saving any work!
/usr	Programs, libraries, documentation etc. for all user-related programs.
/var	Storage for all variable files and temporary files created by users, such as log files, the mail queue, the print spooler area, space for temporary storage of files downloaded from the Internet, or to keep an image of a CD before burning it.

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Everything is a File

- Everything that is not a process is treated as a file on Linux
- For example, a directory is just a file which lists the contents of the directory
- Just like system processes, files have id numbers
- You can also view programs, for example, try using `less` to see the `ls` command

```
less /bin/ls
```

Since it is an executable very little of it is readable; to see all of the “readable stuff” try

```
strings /bin/ls
```

Recovering Disks

- If you have a hard disk which has failed and Windows will not boot from it or allow you to copy your needed files

- Try using a live Linux CD to inspect the hard drive

- If your disk is recoverable, you can mount the drive from your live CD and copy them to a backup location

- It is always worth a try!

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Partitions

- The previous example of a disk failure is the main reason why we use disk partitions. The damage is minimised to the partition instead of the entire disk

- To view the partitions on your computer use the disk space usage command called **`df`**.

- **`Note:`** `The -h option may be used to print the sizes in a more human readable format, as follows:`

```
df -h
```

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Repairing Disks

- If your Linux disk is faulty or causing problems, you can use a repair program

- For example, the **`fsck`** (file system check) program will check and repair a file system

```
fsck /dev/hda1
```

- This will try to repair any broken links on hard disk number 1

- Or just type `fsck` on its own to choose from available partitions

Creating Bootable CDs

- A good local mirror of Linux distribtions and open source software is available at: ftp.esat.net
- The ISOs can be burnt on to CD or DVD and will allow you to boot and install Linux
- **K3b** is a popular CD burner program for Linux

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Exercises

1) Examine your root directory on your system and draw a tree diagram of the most important directories

2) Find a new program in the system-wide users' binary directory

3) Examine the disk partitions on your system, how big is your home directory in GB?

Lab03 – Part II

Scheduling & Process Management

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Processes

- Linux: assumes a multi-user environment with users running many programs (processes)

- Three types of processes exist:

  - **`interactive`**: require input

  - **`automatic`**: await execution in queue

  - **`daemons`**: server processes always running

Interactive Processes

- Started through the shell by a user
- May be run in:
  - **`foreground`**: taking over terminal
  - **`background`**: using the ampersand & sign, to facilitate further terminal usage

Controlling Interactive Processes

- **`Ctrl-Z`**: Suspend (pause) a foreground process
- **`Ctrl-C`**: Interrupt (cancel/quit) a foreground process
- **`bg`**: Send a process to the background
- **`fg`**: Bring a process to the foreground

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Controlling Interactive Processes

- The shell allows us to control the jobs. The **`jobs`** command lists all background jobs in the current terminal

- Each process has an id number, When referring to the process use its id number preceded by a percent sign **`%`**

- To terminate a process, use the **`kill`** command with the id number preceded by a percent sign

```
kill %1
```

- Similarly, to return a background process to the foreground

```
fg %2
```

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Automatic Processes

- Await execution on First-In; First-Out queue (FIFO)
- Processes can also be scheduled for specific times with the **`at`** command
- For example, to run a command at 6pm today, type:

```
at 6pm today
```

- When you press enter, you will be asked which command to run
- Press **`Ctrl-D`** on a blank line to exit
- You can view queued at jobs with the **`atq`** command

Daemon Processes

- Processes that provide a service
- E.g. ftp server, web server, email server, etc.
- Therefore, they run continuously
- These processes have socket numbers which are used as connection points by client programs using their service
- To display a list of open sockets on your computer, type:

```
lsof        // used to be 'socklist'
```

Viewing Running Processes

- So far, we have learned about `jobs` which list the processes associated with

  the terminal. But what if we want to see all the processes on the system?

- For example, if we want something similar to pressing `ctl-alt-del`

  and viewing the `Task Manager` in Windows

- The `top` command will display processes in order of their CPU usage
  - It can also be customised to order by other metrics, e.g. memory usage

- The `pstree` command will display a text-based tree listing of the

  processes on the system.
  - **Note:** that the first process initialised by the Linux system is always the init process

Viewing Running Processes

- The **ps** command will report a snapshot of the current processes
- It is usually invoked with the following arguments:

```
ps -aux
```

- a: list all processes with a terminal

- u: list processes belonging to user

- x: list all processes belonging to user (not just processes with a terminal)

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Terminating Running Processes

- It is also common to output `ps` to `grep`. For example, to search for the process id number for firefox:

```
ps -aux | grep firefox
```

- If firefox is using too much CPU and you wish to terminate it, use the `kill` command:

```
kill n
```

- Where `n` = firefox PID (process id)
- Actually, `kill` works by sending a *signal* to the process

Terminating Running Processes

- The kill command controls how the process will be terminated
- For example, to kill Firefox with a `PID` of `4123`:

```
kill -15 4123
```

Signal Name	Number	Meaning
`SIGTERM`	15	Terminate process in orderly way
`SIGINT`	2	Interrupt the process, which can be ignored
`SIGKILL`	9	Interrupt the process, cannot be ignored
`SIGHUP`	1	For daemons: reread the configuration file

Terminating Running Processes in X-Windows

- For killing windows directly on your desktop, use the **`xkill`** command

- The cursor will turn into a skull and cross bones, and kill whatever process belongs to the window you click on

Dealing with Common Process Problems

- One of the real benefits of using Linux is that you rarely need to reboot, as there are many ways to recover from disaster
- If your X-Windows system crashes, you do not need to reboot
  - Instead, use `Ctrl-Alt-F1` for a new terminal
  - Kill the process causing the problem (e.g. use top and kill). If X-Windows itself is causing the problem, kill the X-Windows processes (X, KDE, Gnome), and restart the X-Window system (startx, startkde, ...)
  - Use `Ctrl-Alt-F7` to return to X-Windows

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Shutting Down Correctly

- Linux machines need to be shutdown correctly
- This gives the filesystem and processes a chance to terminate correctly and save state if needed
- On the command line, you can use the shutdown command:

```
shutdown -h now
```

  – h means halt, or use r to reboot
  – now means now, other times can also be specified

- The reboot command will reboot the system
- Note: you will need to be root to do this from the command line

Exercises

1) Start firefox. Find out what process id (`pid`) number it was assigned when run and terminate it

2) Create a job to output your shopping_list at 17:30 when you are finished work to remind you to do the shopping

3) Find out which program on your system is taking up the most amount of cpu time and which program is taking up the most amount of memory

4) Open emacs and use `xkill` to terminate it