Linux Programming

Symbols

- . : current directory you are in
- ..: paernt directory of the current one
- ~ :
    - the logged in user's home directory
    - the user home directory will always start with /home/
    - the home directory for user user1 is /home/user1

File System

- a logical way to organize the files on the disk
- file system path
    - way to locate a file on the disk
    - address of the file on the disk
    - types
        - **absolute path**
            - always starts with root (/)
            - never changes
            - e.g.
                - /etc/hostname
        - **relative path**
            - path relative to the current directory
            - changes as you change the current directory
            - e.g.
                - c.d.: /home/sunbeam => ../../tmp
                - c.d.: /home/sunbeam/Desktop => ../../../tmp
- > **Everything in unix/linux is a file** even directory is also a type of file even device is also a type of file

Linux Shell

- program used to interact with the OS
- e.g.
    - sh: shell
    - bash: bourne again shell
    - ksh: K shell
    - csh: C shell
    - zsh: Z shell

Editor

- program with which one can edit a file
- types
    - GUI
        - gedit: GNU Editor
    - CUI
        - vi:
        - vim:
- **vim**
    - modes
        - view mode
            - does not allow editing the file
            - default mode
            - use escape to switch to view mode
            - shortcuts
                - **navigation**
                    - h: go to left
                    - j: go down the file
                    - k: go upwards
                    - l: go to right character by character
                    - w: go to the next word
                    - 3w: go to the 3rd word in forward direction
                    - b: go to the previous word
                    - 5b: go the 5th word in backward direction
                    - }: go to the next paragraph
                    - 3}: go to the 3rd paragraph in forward direction
                    - {: go to the previous paragraph
                    - 3{: go to the 3rd paragrapn in backward direction
                    - gg: go to the begining of the file
                    - G: go to the end of the file
                    - $ (shift + 4): go to the end of the line
                    - ^ (shift + 6): go to the begining of the line
                - **editing**
                    - o: to add a new blank line
                    - yy: copy current line
                    - yw: copy current word
                    - p: paste on the next line
                    - P: paste on the previous line
                    - u: undo
                    - ctr + r: redo
                    - dd: delete (copies the contents in the memory)

                - dw: delete a word (copies the word in memory)

            - **close**

                - q: to quit
                - q!: close without saving the changes
                - wq: close after the changes are saved
                - w: write the contents

        - insert mode

            - allows inserting/editing contents
            - use i to enter into insert mode

        - visual mode

            - user will get the visual feedback
            - from view mode use v to go into visual mode
            - use arrow keys to select the content
            - use y to copy or d to cut
            - use p to paste the copied contents

Linux Commands

- action user wants to perform
- types
    - internal
        - part and parcel and of shell
        - the code for these commands is implemented inside the shell
        - one may not find an executable for these commands
        - e.g. cd
    - external
        - generally, these commands are located under /usr/bin
        - one may find an executable for these commands
        - e.g. mkdir, ls

Package manager

- used to manage the packages
- e.g.
    - debian: aptitude
    - red hat: yum
    - alpine: apk

System information

- **date**: displays the current date, time and timezone
- **cal**:
    - displays the calendar for current month

    - use year as command line argument to display calendar for entire year
        - cal 2020
        - cal 2019

- **uptime**: shows the time the machine is up from last reboot
- **whoami**: displays the currently logged in user
- **who**:
    - displays the list of currently active users
    - includes all the SSH sessions
- **w**:
    - displays the currently active users along with some other information like uptime
    - includes all the SSH sessions
- **hostname**:
    - displays the host name of the machine
    - the hostname is stored in a file /etc/hostname
- **hostnamectl**:
    - displays more infromation about the hostname
    - e.g.
        - Static hostname
        - OS version
        - virtualization
- **uname**:
    - displays information about the OS (along with distribution)
    - uname: type of OS
    - uname -r: kernel version
    - uanme -a: shows all the information
- **lsb_release**:
    - displays the distribution specific information
    - includes
        - distribution ID
        - description
        - codename
        - release (version)
- **df**:
    - disk free
    - displays the disk usage
    - df -h: print the info in human readable format

- **du**:
    - disk usage
    - displays the size of every folder and file in the current directory
    - du -h: displays the size in human readable format
    - du -s: displays summary
- **free**:
    - displays the information about the memory
    - free -h: displays in human readable
- **whereis**:
    - displays the path and manual file (help) of the executable
- **which**:
    - displays the path
- **finger**:
    - displays full information of all active users
    - finger <username>: displays full information of the user
- **man**:
    - manual: used to get help about any command
- **Files**:
    - /proc/cpuinfo: contains h/w information about cpu
    - /proc/meminfo: contains information about memory
    - /proc/filesystems: contains the information about the FSes supported by the OS

Package management

- **apt-get**:
    - apt-get install:
        - installs a package on the machine
    - apt-get update:
        - will update the apt-cache
- **dpkg**:

File management

- **ls**:
    - used to list the contents of a directory
    - ls -l: to display in list format
    - ls -a: include hidden files as well

- **pwd**:
    - displays the absolute path of current directory
- **mkdir**:
    - used to create a new directory
    - mkdir -p: create the directories by following the path
        - e.g.
            - mdkir -p dir1/dir2
                - dir1
                    - dir2
    - mkdir d1 d2 d3: creates 3 directories named d1, d2 and d3
- **cd**:
    - used to change the directory
- **rm**:
    - used to delete a file
    - rm -r: used to delete a directory
- **tree**:
    - used to display the contents using tree like structure
    - to install tree: sudo apt-get install tree
- **touch**:
    - used to create an empty file
- **file**:
    - displays file type
- **cp**:
    - copy a file from one location to another
    - syntax:
        - cp <source> <destination>
    - cp -r: used to copy a directory from one location to another
- **mv**:
    - moves a file or directory from one location to another
        - syntax: mv <source> <destination>
    - used to rename a file
        - syntax: mv <old file name> <new file name>
- **cat**:
    - used to display the contents of a file

- **less**:
    - used to display the contents of a file using scroller
- **more**:
    - used to display the contents of a file using scroller
- **head**:
    - displays first few lines of the file
- **tail**:
    - displays last few lines of the file

Permissions

- linux is the most secure OS
- there are three permissions
    - read (r)
        - allows entity to read the contents
        - number: 4
    - write (w):
        - allows entity to write the contents
        - number: 2
    - execute (x):
        - allows entity to execute the contents
        - number: 1
- in linux the permission are given in
    - user: owner of the file
    - group: for group members
    - others: for other user who are not part of the owners group
- e.g.
    - rwx rw- ---
        - owner (user): can read, write and execute
        - group: can read and write
        - others: can not do anything with the file
- **chmod**:
    - used to change the file permissions
    - e.g.
        - chmod ugo+rw file1
        - chmod 666 file1

- **chown**:
    - used to change the ownership of a file/directory
    - **being a directory owner you can create a file inside it**
    - **being a file owner you can read/write/execute a file**
- **chroot**:

User management

- every user has an uid
    - uid is used to identify every user uniquely
- every user has a gid
    - gid is group id the user belogs to
- types
    - root: special user who is allowed to perform the administration tasks
    - users
        - allowed to perform user level tasks
        - can gain the root permissions by using sudo command
- the basic information about every user is stored in a file /etc/passwd
    - format
        - username
        - password (shifted to /etc/shadow file)
        - userid (uid)
        - groupid (gid)
        - user info (name, office number etc)
        - home directory
        - login shell
- the user's password are stored in a file /etc/shadow
    - format of the /etc/shadow
        - username
        - password
        - groupId
- **group**
    - all the groups in linux are stored in a file /etc/group
    - every user may belog to multiple groups
        - primary
        - secondary
- **to create a new user**

    - `sudo useradd ironman`
    - `sudo passwd ironman`
    - `sudo usermod -s /usr/bin/bash ironman`

- **id**
    - displays the user information
    - userid (uid) and groupid (gid)
- **passwd**
    - used to change the current user's password
    - sudo passwd
        - allows to change the password for other user
- **su**
    - used to switch user
- **useradd**:
    - used to add a user
- **adduser**:
    - used to add a user
- **groupadd**:
    - used to create a group
- **addgroup**:
- **usermod**:
    - allows to modify the user information
    - -s: used to change the login shell
    - -a: used to append to existing groups
    - -G: adds the user to other groups
    - -g: sets the user's primary group
- **userdel**:
- **deluser**:~~~~
    - used to delete a user
    - --remove-home: used to delete the home directory
- **groupdel**
- **delgroup**
    - used to delete a group

Archiving and unarchiving

- **Archiving**
    - create a new file combining multiple files together
    - used to take a backup
- **Unarchiving**
    - extract the files added in an archived file
    - used to restore a backup
- **tar**:
    - tape archive
        - c: create archive
        - v: verbose (show the output everytime a file is added to the archived file)
        - f: file name
        - x: unarchive
        - j:
            - to compress at the time of archiving or decompress at the time of unarchiving
            - uses bzip2 for compress and decompressing the files
        - z:
            - to compress at the time of archiving or decompress at the time of unarchiving
            - uses gzip for compress and gunzip decompressing the files

Compression and decompress

- **zip**:
    - used to compress the files
- **bzip2**:
    - used to compress and decompress the files
    - -k: to keep the original file
    - -z: to compress the file
    - -d: decompress the file
- **unzip**:
    - used to decompress a file

Basic Networking

- **ifconfig**:
    - used to get the network information
        - ip address
            - ip4: 32 bit
            - ip6: 128 bit
        - mac address
        - netmask (subnet mask)
        - broadcast ip address

    - if not available install it by using

      ```
      sudo apt-get install net-tools
      ```

- **ping**:
    - used to check the connectivity between two machines
    - e.g. ping google.com
- **dig**:
    - used to get the DNS record for a domain name
    - e.g. dig google.com
- **curl**:
    - console url
    - get the html from a url
    - e.g. curl google.com
- **elinks**:
    - similar to the GUI browser
    - e.g. elinks google.com
- **wget**:
    - used to download file(s) from internet by using url
    - e.g. wget <url>
- **traceroute**:
    - used to check the hops in between the machine and the destination
    - e.g. traceroute google.com

Disk management

- **lsblk**:
    - lists the block devices connected to the machine
- **dd**:
    - used to create disk
    - used to replicate a disk/partition
    - e.g.

      ```
      dd if=/dev/zero of=mydrive bs=1024K count=100
      ```

      - where
        - if: input
        - of: output file
        - bs: block size
        - count: no of blocks created inside the file
- **mkfs**:
    - used to initialize the FS on the disk
- **mount**:
    - used to mount a drive
    - the directory used to mount a drive is called as mount point
    - e.g. sudo mount -t ext4 <drive> <mount point>
- **umount**:

    - used to unmount the mounted drive
    - e.g. sudo umount <mount point>
- **fsck**:
    - check the FS for errors
- **fdisk**:
    - used to partition the disk
    - -l: list of partitions
- **tune2fs**
    - used to tune the fsck process

Shortcuts for terminal

- **ctrl + c**:
    - to break/stop the current
- **up arrow**:
    - to go to the previous previous
- **down arrow**:
    - to go to the next previous
- **ctrl + a**:
    - jump to the begining of the line
- **ctrl + e**:
    - jump to the end of the line

Searching in file system

- **find**:

    - used to find file/directory from FS
    - e.g.
        - find . -name "<criteria>"
    - -name: search by file name
    - -group: search by group name
    - -user: search by user name

Dealing with text stream

Regular Expression

- used to search by using special symbols/characters

- types

    - \d: represents a digit (0-9)
    - ^: search from the beginging of the line
    - $: search in the end of the line
    - .: any character

    - [a-z]: any character between a to z
    - +: one or more
    - *: zero or more
    - ?: zero or one
    - {10}: the entity must occur 10 times consucutively
    - [.] or .: dot

- **grep**:
    - used for searching within files/text sources
    - parameters
        - -w: search for whole word
        - -i: case insensitive
        - -n: print the line number along with the searched result
        - -c: print the count of lines
- **egrep**:
- **fgrep**:
- **pgrep**:
- **cut**:
    - used to cut the lines within a source by using a delimiter
    - e.g.
        - cut -d ',' -f 1, 2, 3 <file name>

Process management

- **ps**:
    - returns the processes list
    - displays information with
        - UID: user id
        - PID: process id
        - COMMAND
        - C: cpu usage
- **kill**:
    - used to kill a process by using PID
- **killall**:
- **pkill**:
    - used to kill a process by using PID
- **top**:
    - used to find the top processes (which are consuming more CPUs/Memory)
- **htop**:
    - similar to top but its more graphical
    - install using
        - ```
          sudo apt-get update
          ```
          ```

        - sudo apt-get install htop

- **bg**:
- **fg**:

Pipe

- **|**:
    - used to pass output of one command as an input to another command
    - e.g. ps -ef | wc -l

Redirection

- a way to redirect the values
- standard file descriptor (fds)
    - stdout
        - by default it is mapped to console
    - stdin
        - by default it is mapped to keyboard
    - stderr
        - by default it is mapped to console
- **>**:
    - output redirection
    - the output of a command can be captured in a file by redirecting the standard output
    - e.g.
        - ls -l > files.txt
        - ps -ef > processes.txt
- **<**:
    - input redirection
    - used to get input from a file rather than from standard input (keyboard)
    -
- **2>**:
    - error redirection

Booting Process

POST

- Power On Self Test
- if the hardware components are working
    - cpu

    - memory
    - storage
- without RAM, a machine can **NOT** boot
- without storage, a machine can boot

BIOS

- Basic Input Output Service (System)
- provides basis device drivers
- provides basic communication with
    - input devices
        - **keyboard**
        - **mouse**
        - lightpen
        - scanner
    - output devices
        - **monitor**
        - printer
- press F2/Delete/F10 to enter and configure the BIOS settings
- finds out the first bootable device
    - bootable device: which has MBR in first 512 bytes
    - MBR
        - 2 bytes
            - magic number
            - unique number that identifies the OS uniquely
            - every executable contains this magic number so that OS can execute the native application (which contains ASM code)
        - 64 bytes
            - partition table
            - details about the partition (FS)
        - 446 bytes
            - bootloader code
            - which loads the kernel
            - bootloaders
                - Linux
                    - LiLo (Linux Loader)
                    - GRUB (Grand Unified Bootloader)
                - Android
                    - Universal bootloader (U-boot)
- Bootloader
    - stage 2:

        - loads the FS in RO mode

- **Kernel**
    - vmlinuz.x.x.x
    - unarchives itself
    - initialize the environment
    - loads the FS in RW mode
    - reserves some memory for itself
    - starts basic services
        - network
        - volume
        - FS
        - WiFi
        - Bluetooth

- **SystemD**
    - first user level process
    - starts loading the file /sbin/init
    - loads the user settings
    - by loading the rc.config files

- **Lightdm**
    - the desktop UI
    - loads the login screen

Runlevel

- which controls the booting behavior
- levels
    - **0**: halt (shutdown)
    - **1**: rescue mode (single user mode)
    - **2**: multi-user mode
    - **3**: multi-user mode + network
    - **4**: unused/reserved
    - **5**: graphical (GUI)
    - **6**: reboot
- commands
    - runlevel
        - used to display the current run level
    - systemctl
        - `sudo systemctl list-units --type target`
            - lists the targets
        - `sudo systemctl get-default`

        - shows the current target
    - update-grub
        - to update the grub settings