Operating System Concepts

- OS Concepts
- Linux commands
- Shell scripts
- Linux System call Programming

Learning OS

- step 1: End user
  - Linux commands
- step 2: Administrator
  - Install OS (Linux)
  - Configuration - Users, Networking, Storage, ...
  - Shell scripts
- step 3: Programmer
  - Linux System call programming
- step 4: Designer/Internals
  - UNIX & Linux internals

File Management

File

- File is collection of data/information on storage device.
  - File = Contents (Data) + Information (Metadata)
  - The data is stored in zero or more Data blocks (in FS), while metadata is stored in the FCB (in filesystem).
- FCB is called as "inode" on UNIX/Linux. It contains
  - type: UNIX/Linux has 7 types of files
    - -: regular, d: directory, l: symbolic link, p: pipe, s: socket, c: char device, b: block device
  - size: number of bytes
  - links: number of hard links
  - mode (permissions): (u) rwx, (g) rwx, (o) rwx
  - user & group
  - time-stamps: modification, creation, access.
  - info about data blocks
- terminal> ls -l
  - type, mode, links, user, group, size, timestamp, name.
- terminal> stat filepath

File System

- Files are stored on storage device. Arrangement of files in storage device is called as "File System".
- e.g. FAT, NTFS, EXT2/3/4, ReiserFS, XFS, HFS, etc.

- File System logically divide partition into 4 sections.
    - Boot block/Boot sector
        - Contains programs/info required for booting of OS
        - Typically contains bootstrap program and bootloader program
    - Super block/Volume control block
        - Contains information of whole partition.
        - Capacity, Label.
        - terminal> df -h
            - Total number of data blocks/inodes.
            - Number of used/free data blocks/inodes.
            - Information of free data blocks/inodes.
    - Inode List/Master file table
        - Inodes (FCB) for each file
    - Data blocks
        - Stores data of the file.
        - Each file have zero or more data blocks.
        - Size of data blocks can be configured while creating file system
- File system is created by the format utility while formatting the partition.
    - Windows: format.exe
    - Linux: mkfs
        - terminal> sudo mkfs -t ext3 /dev/sdb1
        - terminal> sudo mkfs -t vfat /dev/sdb1
        - -t fs_type e.g. ext3, ext4, vfat, ntfs, ...
        - partition e.g. /dev/sdb1

Disk/partition naming conventions

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* Windows:
    * Disks are named as disk0, disk1, ...
    * partitions are named as drives i.e. C:, D:, E:, ...
* Linux:
    * Disks are named as /dev/sda, /dev/sdb, /dev/sdc, etc.
    * Partitions per disk are named as
        * sda partitions: sda1, sda2, sda3, ...
        * sdb partitions: sdb1, ...
```

Linux File Structure

- Linux follows "/" (root) file system.
- "/" is a starting point of Linux file system.
- All your data is stored in this partition.
- / contains boot, bin, sbin, etc, root, home, dev, proc, mnt, media, opt
- In Linux everything is a file.
- Mainly there are two types of files in Linux

    - File
    - Directory (Folder)
- Linux Directories
    - boot - files related to booting
        - vmlinuz - kernel Image
        - grub - boot loader
        - config - kernel configuration
        - initrd/initramfs - initail root file system
    - bin - user commands in binary format
    - sbin - all admin/system commands in binary format
    - etc - configuration files
    - root - home directory of root user
    - home - it contains sub directories for each user with its name
        - devendra -> /home/devendra
        - sunbeam -> /home/sunbeam
        - osboxes -> /home/osboxes
    - dev - it contains all device related files
    - lib - shared program libraries required by kernel
    - mnt - it is temporary mount point
    - media - it is mount point for media eg cdrom
    - opt - stores optional files of large softwares
    - proc - virtual file system - it contains information about system or processes
    - sys - entries of each block devices, subdirectories for each physical bus type supported, every device class registered with the kernel, global device hierarchy of all devices
    - tmp - temporary files that may be lost on system shutdown
    - usr - read only directory that stores small programs and files accessible to all users

User interfacing

- UI of OS is a program (Shell) that interface between End user and Kernel.
- Shell -- Commmand interpreter
    - End user --> Command --> Shell --> Kernel
- User interfacing (Shell)
    - Graphical User Interface (GUI)
    - Command Line Interface (CLI)

Example shells

- Windows
    - GUI shell: explorer.exe
    - CLI shell: cmd.exe, powershell.exe
- DOS
    - CLI shell: command.com
- Unix/Linux
    - CLI shell: bsh, "bash", ksh, csh, zsh, ...
        - ls /bin/*sh
        - echo $SHELL

    - shell of current user can be changed using "chsh" command.
- GUI shell/standards
    - GNOME: GNU Network Object Model Environment (e.g. Ubuntu, Redhat, CentOS, ...)
    - KDE: Kommon Desktop Environment (e.g. Kubuntu, SuSE, ...)

Path

- It is a unique location of any file in the file system.
- It is represented by character strings with few delimiters (“/”, “\”, “:”)
- Types of path
    - There are two types of paths in linux
    - Absolute path
        - Path which starts with “/” is called as absolute path.
        - E.g. /home/devendra/MyData/Demos/demo01.sh
    - Relative path
        - Path with respect to current directory is called as relative path
        - E.g. MyData/Assignments/assign02.pdf

Linux commands

- cd
    - cd ~ - change working directory to home directory
    - cd - - change working directory to old working directory
    - cd .. - change working directory to parent directory
- ls
    - ls - list the contents of present working directory
    - ls path - list the contents of given path
    - ls -l - list the contents in detail format
        - type and permissions
            - Types of files
            - Permissions of files
                - r - read, w - write, x - execute
                - (rwx)user/owner, (rwx)group, (rwx)others
        - link count
        - user/owner
        - group
        - size
        - timestamp
        - name
    - ls -a - list all contents along with hidden
    - ls -A - list all contents along with hidden except . and ..
    - ls -i - list contents with indoe number

        - inode number is unique number given to every file
    - ls -s - list content with size (number of blocks)
    - ls -S - list content in descending order of their sizes

- touch
    - if file does not exist, empty file is created
    - if file exist, timestamp of that file is changed

- stat
    - stat file - display information of file
    - stat file1 file2 - display information of file1 and file2
    - stat -c "format" file - display file information in given format

- head
    - head file - display first 10 lines
    - head -5 file - display first 5 lines

- tail
    - tail file - display last 10 lines
    - tail -4 file - display last 4 lines

- sort
    - sort file - sort the content by alphabetically
    - sort -n file - sort the content by their value
        - sort command do not modify file content

- uniq
    - uniq file - display contents uniquely (truncate duplicate)
        - truncate duplicate content if it is consecutive

- rev filepath
    - Print each line reversed.
    - File contents are not modified.

- tac filepath
    - Print all lines in reverse order. The first line printed at last, while last line printed first.

- stat path
    - Display info about file or directory.

- alias
    - alias list="ls -l"
        - list will be alias/nick name to ls -l
        - list will give output same as ls -l

- unalias
    - unalias list