

Operating System

It is interface between user and hardware. It provides user environment in which user can execute their program efficiently

functions of Operating System

- ① Memory Allocation
- ② Device Management
- ③ Process Management
- ④ interrupt handling

System software: It provides platform to execute application Software Program.

Application software: It provides services to users.

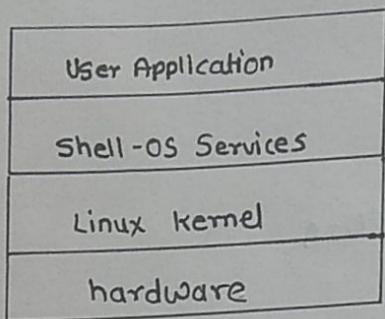


Fig. Architecture of Linux OS

GNU stands for GNU's not Unix

GNU General Public License (GPL)

The GNU General Public License (GPL)

Copyleft license used primarily for software. The GNU GPL allows users to change and share all versions of a program. GPL is provided through a foundation, a non profit organization that works to provide free software for the GNU Project.
i] Anyone can download and run software
ii] Anyone can modify it.
iii] Anyone can redistribute free copies of the software
iv] Anyone can distribute modified versions of software.

A program is free software if the program's users have the essential freedoms:

- 1] The freedom to run the program as you wish, for any purpose
- 2] The freedom to study how the program works and change it so it does your computing as you wish
- 3] The freedom to redistribute the copies so you can help others
- 4] The freedom to distribute copies of modified versions to others.

Open Source Software examples

- 1] Linux (Operating System)
- 2] KDE, GNOME
- 3] Android
- 4] Apache
- 5] MySQL
- 6] Perl, PHP, Python
- 7] Open office
- 8] GCC

A complete Linux system package is called a distribution.

Linux distributions are divided in three categories

- ① Full core Linux distributions
- ② Specialized distributions
- ③ Live CD test distribution

Core Linux distributions

A core Linux distribution contains a kernel, one or more graphical desktop environments and just about every Linux application that is available, precompiled for kernel. It provides one-stop shopping for complete Linux installation.

- i] Slackware ii] Red Hat iii] Fedora iv] Gentoo
- v] OpenSuse vi] Debian.

Linux is an operating system built by Linus Torvalds at the University of Helsinki in 1991. The name Linux comes from the Linux kernel. It is the SW on a computer which enables applications and the users to access the devices on the computer to perform some specific function.

Features of UNIX OS

- i] multi-user, multitasking OS
- ii] It can be used as the master control program in workstations and servers
- iii] Hundreds of commercial applications are available
- iv] In its heydays, UNIX was rapidly adopted and became standard OS in universities

Limitation of Linux

- i] there's no standard edition of Linux
- ii] Linux has patchier support for drivers which may result in malfunctioning of the entire system.
- iii] Linux is, for new users at least, not as easy to use as windows.
- iv] Many of the programs we are using for windows will only run on Linux only with the help of a complicated emulator.
- v] Linux is best suitable for corporate user. It's much harder to introduce in a home setting.
- ~~vi] the unfriendly, terse, inconsistent and non-mnemonic interface~~
- ~~vii] Unix OS is designed for a slow computer~~

Linux v/s UNIX

Linux

- (i) Linux is freely distributed, downloaded through magazines, books, website etc.
- (ii) Linux is open source and thousands of programmers collaborate online and continue to its development.
- (iii) Bash is Linux default shell.
- (iv) Linux provides two GUI's viz. KDE and GNOME. Though there are many alternatives such as Mate, LXDE, Xfce etc.
- (v) Linux has about 600 viruses listed.
- (vi) Threat detection and solution is very fast because Linux is mainly community driven.
- (vii) Linux OS can be installed on various types of devices like mobile, tablet, computers.
- (viii) Linux is portable and is booted from a USB stick.

UNIX

- (i) Different flavors of UNIX have different pricing depending upon type & vendor.
- (ii) Unix systems have different versions. These versions are primarily developed by AT&T as well as other commercial vendors.
- (iii) Bourne shell is UNIX default shell.
- (iv) It provides Common Desktop Environment and GNOME.
- (v) There are 80 to 120 viruses reported in Unix.
- (vi) Unix user require longer wait time to get the proper bug fixing patch.
- (vii) UNIX System is used for internet servers, workstations and PCs.
- (viii) Unix is not portable.

Workstation PCs include features such as

- i] Error correcting code (ECC) memory support
- ii] Additional memory sockets for registered modules
- iii] Multiple processor sockets for more powerful CPUs
- iv] Multiple displays
- v] Reliable operating systems with advanced features
- vi] High performing graphic cards.

Performance

It's lightweight architecture. Linux runs faster than both Windows 8.1 and 10. Linux supports many efficient tools and operates them seamlessly.

Security

Linux is an open source SW. Anyone can contribute code to help enhance the users' experience with Linux. As well, anyone can add features to fix bugs, reduce security risks and more.

Software development

The terminal in Linux is a wild card. You can do almost anything with it. This includes SW installation, application and server configurations, file system management and much more. If you are a developer, the terminal is the sweet spot. There is nothing more convenient than running servers, training machine learning models, accessing remote machines and compiling and running scripts from the same terminal window. It's a huge productivity booster. By using terminal automation becomes a game changer.

Modding

With Linux, you can easily configure and access your computer, check processes and manage virtual environments. Because your server will probably Linux based. It will be easier to mimic behaviors, use similar SW packages and automate workflows.

Linux as a Server

A Linux Server is an efficient powerful variant of Linux open source operating system. Linux servers are built to address the ever increasing requirements of business applications like system and network administration, web services and database management.

Linux servers are often preferred over other server because of their reputation, security, consistency and flexibility.

Types of Servers

- i] Application Server
- ii] Cache Server
- iii] Database Server
- iv] DHCP Server
- v] DNS Server
- vi] FAX Server
- vii] File Server
- viii] Web Server
- ix] Game Server.
- x] Mail Server

Linux as a Workstation

Advantages

- i] Stability and performance
- ii] Full remote management by the network administrator
- iii] Full network backup capabilities
- iv] Lower cost of ownership in comparison with windows-based desktops.

A workstation is a computer dedicated to a user or group of users engaged in business or professional work. It includes one or more high resolution displays and faster processor than a PC. A workstation also has greater multitasking capability because of additional RAM.

For Internet

- i] Firefox
- ii] SpiderOak
- iii] Teamviewer

For security

- i] Tor
- ii] Tox
- iii] Privoxy

For image manipulation

- i] Krita
- ii] Pinta
- iii] Gimp
- iv] photo QT

For Entertainment

- i] Atrac
- ii] Micro (democracy player)
- iii] SM player

Linux, the kernel is mostly written in C and little bit of Assembly. Toolkits and frameworks used to develop the graphical interface (e.g. GTK, Qt, GNOME, KDE, Unity) are written in C and C++. UTILITIES and application (i.e. programs) that come bundled with the OS are usually written in Java, Python C, C++ and even C#.

Tools

- i] Anonymizers
- ii] Backup
- iii] Partimage
- iv] Browsers
- v] chat
- vi] Converters
- vii] AODC
- viii] Emulators

→ XOX →

UNIX

The UNIX OS was born in late 1960's. AT&T Bell Labs released an OS called Unix written in C, which allows quicker modification, acceptance and portability. It began as a one-man project under the leadership of Ken Thompson at Bell Labs. It went on to become most widely used OS. UNIX is a proprietary OS.

Specialized Linux Distributions

A new subgroup of Linux Distributions has started to appear. These are typically based on one of the main distributions but contain only a subset of applications that would make sense for a specific area of use. These distributions also attempt to help beginning Linux users by auto detecting and auto configuring common h/w devices. This makes installing Linux a much more enjoyable process.

- i] centos
- ii] Ubuntu
- iii] PCLinuxOS
- iv] Mint
- v] dyne:bolic
- vi] Puppy Linux

The Linux LiveCD

A relatively new phenomenon in Linux world is the bootable distribution. This lets you see what a Linux system is like without actually installing it. This is excellent way to test various Linux distributions without having to mess with your pc.

- i] Knoppix
- ii] PCLinuxOS
- iii] Ubuntu
- iv] slax
- v] Puppy Linux

Linux Applications

- i] Text and word processing application
- ii] Programming languages
- iii] X-windows
- iv] Internet tools
- v] Databases

vi] Dos and windows compatibility software

For web development

- i] Eclipse
- ii] Brackets
- iii] Codeblocks
- iv] LightTable

For communication

- i] Telegram
- ii] Pidgin
- iii] Jitsgi

use of Linux partitions

- ① To specify limit on disk usage
- ② It can be used as virtual memory / secondary memory
- ③ To segregate OS and user data
- ④ Increasing efficiency of backup tools
- ⑤ To install multiple OS

Swap partition

It is a mechanism in which process can be swapped temporarily out of main memory to secondary memory. later on again swap back to main memory

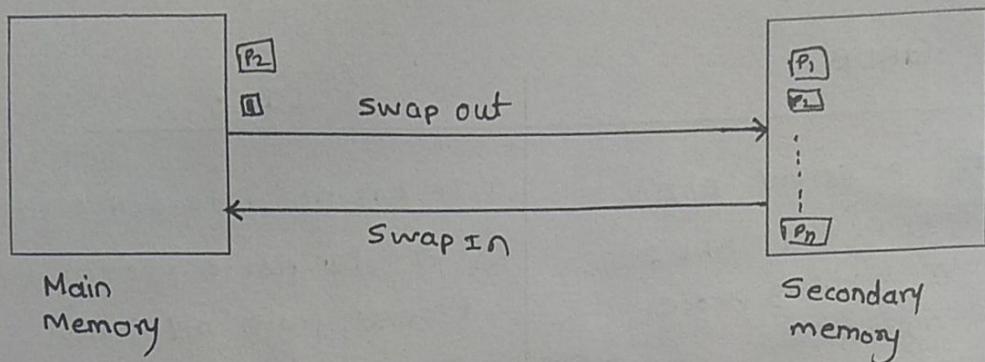


Fig. swapping

• fdisk

fdisk is powerful and popular tool user to create, edit, delete partition. It supports multiple partition table format. It provides user friendly, text based and menu-driven interface to display, create, resize, delete, modify and move partitions

Cut: It is used to extract vertical selection of column or character position or fields from one or more files.

Paste: This command is used to join files horizontally, parallel merging separated by tab as delimiter.

What is booting

Booting is the first process that is executed when Linux system started. In booting process, the processor first search for BIOS program in memory and execute it.

BIOS: BIOS is a built-in software. It is the first SW that is run by the computer when you turn on computer system. In that we have POST used to check hw devices whether they are working properly or not. It is present in your motherboard.

Bootloader: Bootloader is the program which loads the system's main memory while booting process.

GRUB

Grand Unified bootloader is used in Linux OS, DOS. By default bootloader in RHEL. It enables to select an OS from various OS which are installed on your PC, at the time of booting. It displays menu interface that lists OS installed on your system.

Difference between GRUB and LILO

GRUB

- ① It has powerful CLI
- ② It supports Linux booting process from network
- ③ For MS-DOS and Linux
- ④ It has complicated interface
- ⑤ New, by default in RHEL
- ⑥ GRUB configuration files are stored in /boot/grub menu-list

To add user : adduser
To delete user : userdel

LILO

- ① It has no interactive CLI
- ② It does not support booting process from network.
- ③ Only for Linux
- ④ It has simpler interface, it is easy for user.
- ⑤ Old, by default in many Linux distributions
- ⑥ Configurations of LILO are stored in /etc/lilo.conf.

/mnt: This stands for mount and contains filesystem mount points. Used for multiple hard drives, multiple partitions, network filesystems and CDROMs etc.

/proc: This contains virtual filesystems describing the process information as files.

/sbin: This stands for system Binaries and contains the fundamental utilities needed to start maintain and recover system.

/root: This is the home location for the system administrator root. This accounts home directory is usually the the root of first partition

/srv: This one is Server data which is data for services provided by system

/sys: This contains a sysfs virtual filesystem which holds information related to the hardware operating system

/tmp: This is a place for temporary files. tmpfs mounted on it or script on start up usually clear this at boot.

/usr: This holds the executables and shared resources that are not system critical

/var: This stands for variable and is a place for files that are in a changeable state. Such as size going up and down.

/swap: The swap partition is where you extend the system memory by dedicating part of hard drive

root (/)

The root directory is the top of the hierarchy, the point where the primary file system is mounted and from which all other filesystems stem. All files and directories appear under root directory /, even if they are stored on different physical devices.

A swap partition provides memory that can be used as virtual RAM.

Disk partitioning

Disk partitioning is the creation of one or more regions on a drive / disk or other secondary storage, so that an operating system can manage information about in each region separately.

Disadvantages of multiple partitions

- i] Reduces the total space available for user storage on disk
- ii] Reduces overall disk performance on systems
- iii] Increases disk fragmentation
- iv] May prevent using whole disk capacity, because it may break free capacities apart.

Logical partitions inside an extended partition always start at 5.

Partition categories

i] Data partitions: These are partitions like the boot partition in that they hold directories and files or normal Linux system data. These are the files which starts and run the system.

ii] Swap partitions: These are partitions that expands the PC's physical memory by using the partition as cache.

/ : The slash / alone stands for the root of the file system.

/bin: This stands for binaries and contains the fundamental utilities that are needed by all users.

/boot: This contains all the files needed for the booting process.

/dev: This stands for devices, which contains files for peripheral devices and pseudo devices.

/etc: This contains configuration files for the system and system database.

/home: This holds all home directories for users.

/lib: This is the system libraries and has files like the kernel modules and device drivers.

/lib64: This is the system libraries and has files like the kernel modules and device drivers for 64-bit system.

/media: This is default mount point for removable devices like USB drives and media players.

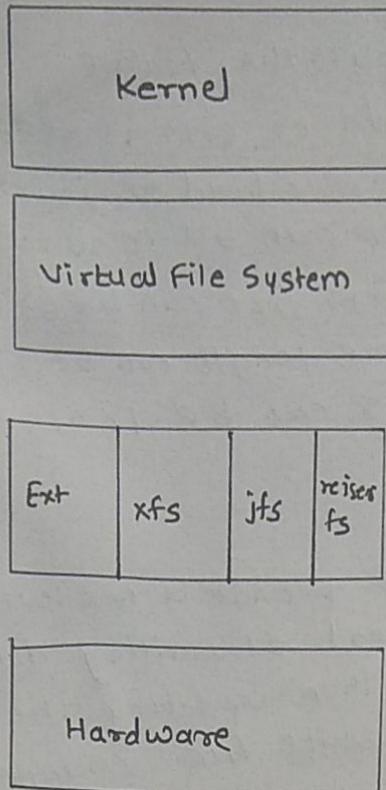


Fig. File System

- The EXT File System

The original file system introduced with the Linux operating system is called the extended file system (or just ext for short). It provides basic Unix-like file system for Linux using virtual directories to handle physical devices and storing data in fixed-length blocks on the physical devices.

The ext file system uses a system called inodes to track information about the files stored in the virtual directory. The inode system creates a separate table on each physical device called the inode table, to store the file information. Each stored file in virtual directory has an entry in inode table. The extended part of names from the additional data that it tracks on each file which consists of

- i] The file name
- ii] The file size
- iii] The owner of file
- iv] The group the file belongs to
- v] Access permissions for the file
- vi] Pointers to each disk block that contains data from the file.

Linux references each inode in the inode table using a unique no (called inode no.) assigned by the file system as data files are created. The file system uses the inode no. to identify file rather than having to use full file name and path.

Ext2: [i] known as second extended file system

[ii] Developed by Remy card

[iii] Introduced in 1993

[iv] Does not have journaling feature

[v] On flash drives, USB drives, ext2 is recommended, as it doesn't need to do overhead of journaling

[vi] Maximum file size can be 16GB to 2TB

[vii] Maximum filesystem size can be 2TB - 32TB

[viii] Maximum filename length can be 255 characters

[ix] max no. of files can be 10^{18}

Journaling File Systems

Journaling file systems provide a new level of safety to the Linux system instead of writing data directly to the storage device and then updating the inode table, journaling file systems write file changes into a temporary file (called journal) first, after data is successfully written to storage device and inode table, the journal entry is deleted.

Ext3: The third extended file system.

[i] developed by Stephen Tweedie

[ii] Introduced in 2001

[iii] Supports journaling filesystem

[iv] max file size 16GB - 2TB

[v] max filesystem size 2TB - 32TB

[vi] max filename length can be 255 characters

Ext4: The fourth Extended file system

[i] developed by Mingming Cao and others

[ii] Introduced in October 2008

[iii] Supports journaling filesystem

[iv] max file size can be 16TB

[v] max filesystem size can be 9TB

[vi] max filename length can be 255 characters

[vii] max no. of files can be 4 billion

[viii] Records file creation time

Comparison between Ext2, Ext3, Ext4

Linux12

Ext2	Ext 3	Ext4
i) Ext2 stands for second extended file system	i) Ext3 stands for third extended file system	i) Ext4 stands for fourth extended file system
ii) It was introduced in 1993. Developed by Remy Card.	ii) It was introduced in 2001. Developed by Stephen Tweedie.	ii) It was introduced in 2008.
iii) This was developed to overcome the limitation of original ext file system	iii) Starting from Linux Kernel 2.4.15 ext3 was available	iii) Available from 2008
iv) Ext2 does not have journaling feature	v) The main benefit of ext3 is that it allows journaling	iv) Supports huge individual files and overall file system size.
v) Max file size can be 16 GB - 2TB	v) Max individual file size can be 16GB to 2TB	v) Max individual file size from 16 GB to 16 TB
vi) Overall ext2 file system size can be from 2TB to 32TB	vi) Overall ext3 file system size can be from 2TB to 32TB	vi) Overall max ext4 file size is 1EB

Syntax of mount command

```
# mount device mountpoint
```

Syntax of umount command

```
# umount device-or-mountpoint
```

- You can never unmount a file system in which you are currently working.

XOX

GRUB

GRUB is a bootloader capable of loading a variety of free and proprietary operating systems. GRUB will work well with Linux, DOS, Windows or BSD. GRUB stands for GRand Unified Bootloader

GRUB features

- i) It supports unlimited no. of boot entries
- ii) GRUB is dynamically configurable
- iii) GRUB can install and run from any device including hard drives, floppy disk, CDROM, USB drives
- iv) It can decompress OS
- v) It can load OS from various locations

Syntax of shutdown command

shutdown -h time "message"

-h : halt
-r : reboot

eg. # shutdown -h now OR shutdown -h +0
reboot | -f: forcefully -p: poweroff
See log of system shutdown

#last reboot
#last shutdown

X-Window System

X-Window System is a complete, cross platform and free client-server system for managing GUI on single computer and networks of computer.

It provides display interface between system and user. It gives graphical user interface which makes use of system easy for user.

X-Server provides following 5 types of services

- ① Input handling
- ② Window Services
- ③ Graphic Services
- ④ Text and font Services
- ⑤ Resource Manager

inode

inode have 13 fields. It is a data structure in Linux that denotes a file or directory on file system. It contains the information about file like location of file on disk, access permissions, ownership of file, type of file. Each inode has a unique no. which is used in index table. Linux or Unix Kernel uses the inode no. to access the content of inode.

inode having headers which contain some data and some fields which contains single, double, triple indirect blocks

- 0 - owners identification
- 1 - group's identification
- 2 - physical disk address
- 3 - protection bits
- 4 -
- 5 - File size
- 6 - time of creation
- 7 - time of last use of file
- 8 - Time of last modification to the file
- 9 - Time of last modification to the file
- 10 - no. of links to the file
- 11 - Type of file (Directory, character special, block-special, pipe file)

Desktop Environment

It is a collection of software running on top of operating system that makes up desktop graphical interface. i.e. KDE, GNOME, Xfce (Xforms common environment), LXDE (Lightweight X11 Desktop Environment)

KDE

Functions of KDE

- ① Optional menus
- ② Web shortcuts
- ③ K3B CD/DVD burner
- ④ Optional system setting display
- ⑤ Rotating icons and widgets
- ⑥ Multiple clipboards

Components of KDE

- ① Hall
- ② Component chooser
- ③ KDE Performance
- ④ KDE's Resource configuration
 - ⑤ Service manager
 - ⑥ Session manager
 - ⑦ Spell checker

A file system is the hierarchy of directories that is used to organize files on computer.

An inode number, which is integer that is unique within the filesystem.

Key features of inode

- i] Fixed logical block size
- ii] Ease of data location
- iii] Indirect blocks.

kernel

The kernel is the heart of Unix system and resides in the computer's memory from the time of computer is turned on and booted until the time it is shut down.

Difference between microsoft windows and x-windows

- i] flexibility of the interface
- ii] fine tuned control over the interface configuration
- iii] client-server technology

x-windows

The x-windows world works on a client-server model in which applications are clients to an X server that drives the physical display. This has made X windows well adapted to network environments, allowing applications to run on one machine on the network while displaying their output on another.

X-servers

- i] support for a variety of video cards and monitor types
- ii] resolution, refresh rate and color depth of the x-windows display.

iii] basic window management: displaying and closing windows, tracking mouse movements and keystrokes.

Multiplex servers with these basic capabilities have sprung up.

In the Linux world, there are three main choices: XFree86, Metacity and Accelerated-X.

Window Managers

Window managers fill out the niceties of the GUI not provided by X servers. Among other features, window managers include window decorations (which provide the means to resize, move, close and minimize windows) and mechanisms for launching applications (such as desktop menus, control panels and button bars).

Main window managers that are available for Linux: FVWM, fvwmcs, twm, olvwn etc. The default window manager with Red Hat Linux 7 is sawfish.

Desktop Environment

There are different desktop environments for Linux that provide robust, integrated GUIs and provide target platform for application developers to build SW with a common look and feel and include integration features such as drag and drop.

KDE

KDE combines a set of applications, such as a file manager, terminal emulator and display configuration system with window manager to create a consistent look and feel for X applications.

KDE is the default desktop environment for a no. of Linux distributions, including Caldera, SUSE and Corel. It is an alternative desktop environment for most other distri

GNOME

GNOME is the result of an alternative effort to develop a comprehensive, free desktop environment for Linux. Unlike KDE, which includes a built-in-window manager, GNOME is window manager independent. It provides programming interface that allows window manager developers to integrate full support for GNOME in their window manager.

General Purpose Command

i] clear ii] man iii] sudo iv] banner v] date
 vi] cal vii] exit viii] pwd ix] echo

Communication commands

i] who ii] whoami iii] mesg iv] mail

Help commands

i] help ii] whatis iii] man iv] info

File and directory manipulation command

i] mkdir ii] rmdir iii] ls iv] rm v] cp vi] mv vii] touch
 viii] cd ix] chmod x] chown xi] head xii] tail xiii] cat
 xiv] pwd xv] file xv] stat xvii] ln

• Processes in Linux

I] Foreground process: Every process when started run in foreground by default. It receives input from keyboard/mouse it sends output to the monitor screen
 eg. pwd, ls

II] Background process: It runs in background without keyboard input and waits till keyboard input is required. So other processes can be done in parallel with the process running in background. Since they do not have to wait for previous process to be completed.

Stopping a process

kill pid

Other process control commands

① bg

It is a process control command that resumes suspended process while keeping them running in background.
 Syntax: pid

② fg

fg continues stopped process by running it in foreground

③ nice

It starts a new process and assign it priority (nice value) at same time.
 nice nicevalue.

④ renice

to change the priority of already running process

Process Life Cycle

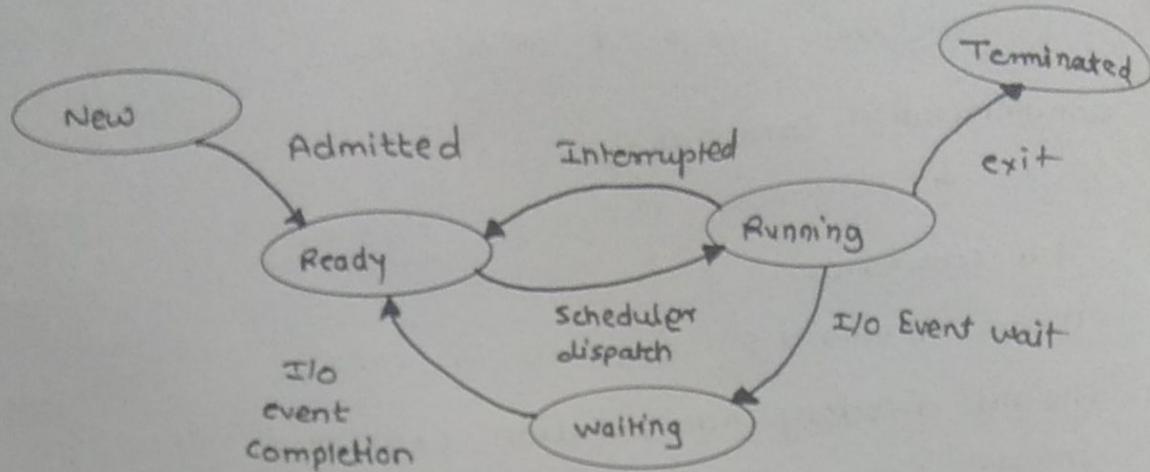


Fig. Process Life Cycle

~~Process is nothing but part of application on your mobile phone that time process is created by OS of that application.~~

Any time when you open an application on your mobile phone that time process is created by OS of that application.

Process is nothing but part of application or executing instance of that application. So this process will go through various states in its life cycle i.e. from birth to death.

Running multiple processes at a single moment of time is called multiprogramming or multitasking even though multiple process running at same time but processor only execute one process at a time. So process goes into various life cycle.

These states can be represented by process state diagram. This diagram is generalised to all OS.

1. New / Create: whenever you application need to execute, OS create a process for new application. OS will assign process id, create PCB, memory allocation etc. This state of process is called new / create state. In this state process is not going to submitted to process scheduler.

2 Ready state: Processes are ready and waiting to be executed by processor. As processor can execute one process at a time. It means process is in the ready state because processor is performing some other tasks.

If processor is free then scheduler will accept the process from ready queue and move to next state called running state.

3. Running state: In this state instructions of process are executed by processor sequentially. Running state may enter in waiting state when process wants to perform some I/O operation i.e. if process want printer for execution and currently it is not available. Then process enters in waiting state. This state is also called blocked state. After the completion of I/O operation process will enter into ready state (waiting to get execute). Now when the process is running there are two possibilities:

- a) If any interrupt occurs to system e.g. You are running program and by mistake you press Esc key. It will generate signal which is given to ~~processor~~ processor to give an action such type of interrupts caused this process to again enter in ready queue.

5. Terminated state: When finished its execution then it enters in termination. This is finish state of process. Process can enter in terminated state by 2 ways.

- (i) Normal : when all instruction of process over it will end normally.
- (ii) when user kill the process that is abnormal.

Linux There are two main classes of shell

- i) those that derive their essential syntax and design from Bourne shell
- ii) those that base their model on the cshell.

Bourne shell (sh)

The Bourne shell (sh) is seen by many as the original Unix shell. In many ways it is rather limited, lacking features such as a history list and command-line editing. But as the original Unix shell, many features of the Bourne shell including its core command set, are found in many modern shells.

C Shell (csh)

The C shell (csh) was an early Unix shell that was developed to provide a command set and scripting environment derived from syntax of the popular C programming language. C shell introduced many key ideas including command aliases and command histories.

Bourne Again Shell (bash)

The Bourne Again shell (bash) is the most common shell installed with Linux distributions known as Bash, this shell is based on Bourne shell (as the name implies) but provides broad additional feature set including command line editing, a history list and filename completion.

Korn shell (ksh)

The Korn shell (ksh) is another of the family of shells that is derived from original Bourne shell. By some counts, the Korn shell is the most popular Unix shell in use; however it is generally not the default shell on most Linux systems. The Korn shell was probably the first to introduce many of the popular features you now see in Bash, including command line editing.

Other shells

- i) Adventure shell (ash)
- ii) Extensible shell (es)
- iii) ERGO shell (esh)
- iv) z shell (zsh)

• `.bashrc`: This is a simple text file that is executed by Bash whenever you launch the shell - generally when you login. The `.bashrc` file can contain any legitimate combination of commands and bash functions that you would type at normal Bash prompt, as well as sophisticated scripting commands. It is in the `.bashrc` file that you can configure the behaviour of Bash, set environment variables such as your path, and launch any programs that you may want to launch every time you run the Bash shell.

• Features of Bash shell

- i] Setting of environment variables
- ii] Command aliases
- iii] pattern expansion
- iv] Input and output redirection
- v] filename completion
- vi] full command-line editing
- vii] command-history list
- viii] Job Control
- ix] brace Expansion
- x] command Substitution

Setting Environment variables

```
$ export PATH=$PATH:/use/local/bin
```

Input and Output Redirection

i] one of the most useful concepts in the Unix world is that standard input and standard output often, non-interactive programs receive their input data through standard input - usually the keyboard. Similarly they display their results to the standard output - usually the screen.

ii] However most shells provide the ability to redirect standard input and output, which allows you to build complex command combinations out of multiple commands and data files. As you saw in the last chapter, the use of pipe (|) allows the redirection of standard output to standard input. For instance in the command

```
$ ls -l | more
```

The output of the `ls -l` command is not displayed to standard output but is instead redirected to standard input of the `more` command. The `more`

Input command processes this redirected input and then displays the results to the standard output.
There is another way to redirect standard input and output in Bash : using the < and > redirection symbols. For instance, consider a situation where you want to save a directory listing to a file for later processing. You can use > symbol to redirect the standard output.

```
$ ls -l > filelist
```

This command saves the output of the ls -l command in a file called filelist. Similarly, if you want to use the contents of a file as the standard input for a command you use the < symbol

```
$ mail user@gmail.com < filelist>
```

This command causes the contents of the file filelist to be used as the input data for the mail command, effectively causing the contents of the file to be used as the body of resulting e-mail message.

Filename completion

Sometimes called word completion, filename completion is a simple but very useful concept. It works like this : if you type enough characters to uniquely identify a file, command or directory name, Bash can complete rest of the name.

By simply pressing tab key, Bash attempts to complete the name.

When you don't provide enough information for Bash to know how to complete a name. In this situation, the shell is able to provide you with all possible alternatives to match ~~to~~ the name you are trying to complete.

Command Alias

Command aliasing is a powerful feature of Bash shell that allows you to define your own custom commands. For instance, if you regularly check all running process on system command is

```
$ ps -aux | more
```

```
$ alias psa = "ps -aux | more"
```

Command Line Editing

Linux

most modern shells including Bash, provide full command line editing. This allows you to see the arrow keys to move through the current line, delete and insert characters as needed and press Enter to execute the command without moving the cursor to the end of the line.

• Command history list

The history list is most often used for two purposes

i] Fixing mistakenly entered commands

ii] Repeating commands many times during a session.

Job Control

The easiest way to place a job in the background is to add an ampersand (&) to the end of the command when you run it. This character tells Bash to run the command in the background and immediately gives you a new command prompt. To put the find command in background, use following command.

```
$ find / -name '*tmp' -print > templist &
```

Once you press Enter to execute command, you are immediately presented with a new command prompt at the same time, find begins executing.

Shell

A shell is program that is interface between user and OS kernel. An OS starts a shell for each user when the user logs in or opens a terminal or console.

Tasks performed by kernel

i] Process Scheduler

ii] Memory management

iii] Virtual file system

iv] Network interface

v] Interprocess communication.

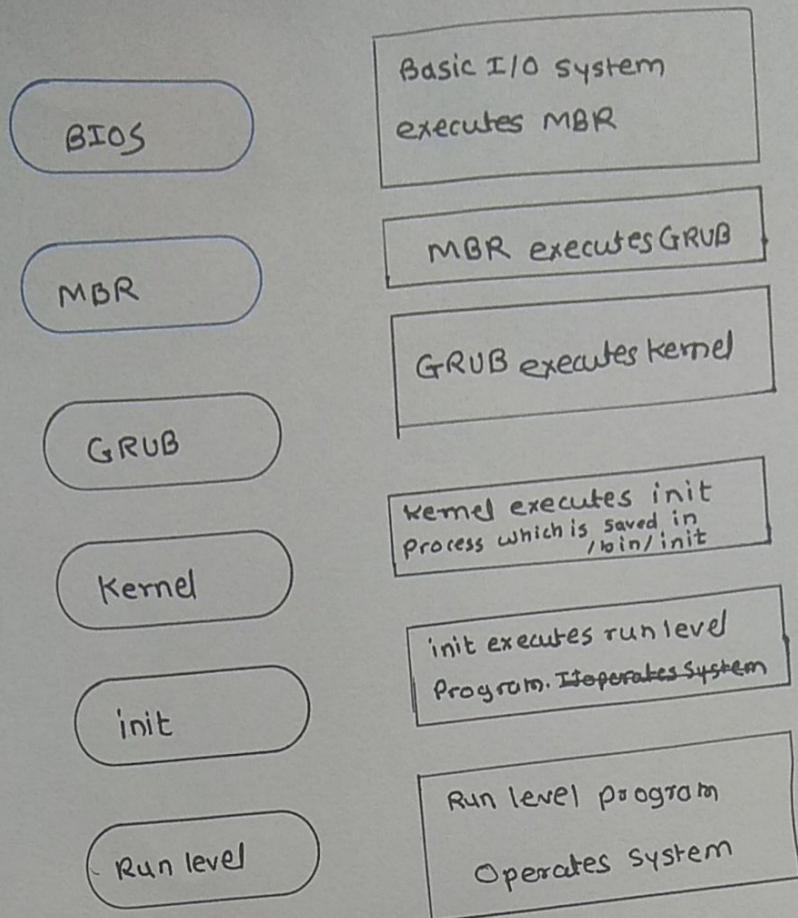


Fig. System Startup

- ① init is first process executed by kernel during booting of the System. It is called daemon process which runs till the System shutdown. That's why it is parent of all processes.
- ② init reads from the script which is stored in the file `/etc/inittab`
- ③ init command reads the initial configuration which takes care of everything that a system at the time of system initialization like setting of clock, initializing input/output devices and serial, parallel ports.
- ④ init process determines how the system should be setup in each run level.
- ⑤ Run level: It is a slow configuration of Linux system which permits only a selected group of processes to exist. It defines what services are operating on the system. Run levels
 - 0: halt the system
 - 1: single user mode
 - 2: multi user mode without networking
 - 3: multi user mode with networking
 - 4: not used

S: multiuser with networking and X-windows
6: reboot the system
NOTE: 0, 1 and 6 are reserved run levels