**Linux Booting Process**

* It is of set processes those are run when Linux boots (after powering on the machine to user login prompt).
* Detailed stages of Linux booting process:

1. System startup (Hardware initialization)
2. Boot loader stage-1 (MBR loading)
3. Boot loader stage-2 (GRUB loading)
4. Kernel
5. INIT levels
6. User prompt

* Power on
* SMPS: AC to DC
* CPU locates BIOS
* BIOS: POST and select boot device

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MBR

System Startup

Hardware Initialization

User prompt appeared for login

User Prompt

INIT Process

Kernel runs INIT process

GRUB loads Kernel into RAM

Kernel

CPU loads MBR into RAM

Contains boot loader information

MBR loads GRUB into RAM

Locates all installed OS and gives GUI to select desired OS. Also loads kernel of selected OS and into RAM

Boot loader

Initializes devices, loads initrd module and mount root file system

Runs all boot script, check file systems and starts the system on specified run level

1. **System startup (Hardware initialization):**

* Machine is power on.
* Power is supplied to SMPS (Switched Mode Power Supply). SMPS converts AC to DC and also maintains proper DC level.
* DC power is supplied to all devices/peripherals connected to machine.
* As soon as CPU gets power, it runs certain programs stored in memory. [Bootstrapping is program that tells CPU where to fetch instructions after booting up. By default, the address of this instruction is FFFF: 0000 h resides in ROM.]
* CPU first passes control to BIOS. [That instruction is to JUMP to another memory location (Location of BIOS)]

**Role of BIOS:**

* BIOS : Basic Input Output System – firmware
* It is stored in ROM.
* It performs POST (Power On Self Test).
* It retrieves information from CMOS (time & date synchronization).
* It selects first bootable device.

POST:

* It determines whether all components (hardware) are working correctly or not.
* For that, BIOS has a list of all devices present in previous boot. So BIOS will send electric pulse to each and every device from that list. If acknowledge pulse arrives, it means that device is working properly. If not then it will consider it as faulty device. The same process is performed for newly attached device. At the end, BIOS will store the new list in its memory for next boot.
* POST is of two types:

Partial POST: Timer IC, DMA, CPU, ROM.

Full POST: besides partial POST, Hard disk, motherboard, keyboard, mouse, printer, etc.

* Booting is of two types:

Warm boot: reset the running machine; partial POST performed.

Cold boot: Machine will run after powering it up; full POST performed.

Selecting 1st boot device:

* After POST, BIOS will select 1st boot device and gives back control to CPU.
* If BIOS is unable to find 1st bootable device then it looks for 2nd bootable device. If not then 3rd bootable device and so on.
* If BIOS will not found any bootable device then it will show alert as “*No boot device found*”.

1. **Boot loader stage-1 (MBR loading):**

* CPU loads MBR of boot device (say hard disk) into RAM.

MBR: Master Boot Recorder

* It is way of storing partitioning information on the disk/drive.
* It contains information regarding boot loader.
* It is of 512 bytes that resides in first sector of boot device (say hard disk).
* MBR(512 bytes) is divided into 3 parts:

1. Primary boot loader code (446 bytes): provides boot loader information and its location on boot device.
2. Partition table information (64 bytes): provides information regarding partitions. [Maximum 4 partitions are possible in MBR as each partition is of 16 bytes.]
3. Magic number/MBR validation timestamp (2 bytes): Used to retrieve MBR if it get corrupted.

**3. Boot loader stage-2 (GRUB loading):**

* MBR loads GRUB (GRand Unified Boot loader) boot loader into RAM.
* GRUB is located in 1st 30 KB of hard disk immediately following MBR.
* It locates all installed operating systems and gives GUI to select OS as per requirement.
* Once user selects OS, it passes control to the kernel of selected OS.
* If user doesn’t select any OS then it passes control to default kernel.

1. **Kernel:**

* Kernel is central part of OS.
* It acts as mediator of hardware and software component.
* It handles resource management.
* Once kernel has control, it initializes devices, loads initrd module and mount root file system.
* Kernel once loaded into RAM, it always resides on RAM until the machine is shutdown.
* Kernel starts its operation by first performing INIT process.

1. **INIT Process:**

* Once kernel is loaded, kernel finds INIT process in /sbin/init and executes it.
* INIT process runs all boot script, check file systems and starts the system on specified run level in the file /etc/inittab.
* So, INIT is the first process started in Linux.

**Run Levels:**

* Services those are started during startup.
* It is executed from run level directory.
* S: Startup process

K: Killed during shutdown process

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| **Run level** | **Description** |
| 0 | Halt |
| 1 | Single user mode(used for troubleshooting) |
| 2 | Multiuser without NFS (same as 3 if don’t have networking) |
| 3 | Full multiuser mode |
| 4 | Unused |
| 5 | X11 / GUI |
| 6 | Reboot |

1. **User Prompt:**

* Once kernel starts all programs as per desired run level, login prompt will be appeared on screen.

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| **LILO(LInux LOader)** | **GRUB(GRand Unified Boot loader)** |
| larger in size than GRUB | Smaller in size |
| Allows fast boot up when installed in MBR |  |
| no interactive command interface | It has interactive command interface |
| does not support booting from a network | support booting from a network |
| supports only Linux operating system | supports large number of OS |