**Complete Linux Boot Process Explained**

**1. Power ON & Firmware Initialization (BIOS/UEFI)**

When you press the power button on your laptop or computer, it sends electricity through the system to turn everything on. But just turning on the electricity isn’t enough the computer has to check that everything is working. **What is BIOS/UEFI?**

These are tiny programs built into your computer's motherboard.

* **BIOS** = Basic Input/Output System
* **UEFI** = Unified Extensible Firmware Interface (a newer version of BIOS)
* Think of BIOS/UEFI as your computer’s **babysitter** they help it **wake up**, **do a quick health check**, and **start the brain** (the operating system).

**What does BIOS/UEFI do?**

* Runs a test called **POST** (Power-On Self-Test)
* Checks if RAM, keyboard, mouse, screen, and disks are working
* Looks for a device (hard drive, SSD, USB) that can **boot an operating system**

📌 **Interview Tip:** “BIOS/UEFI initializes system hardware and locates a bootable device.”

**2. MBR/GPT & Boot Device Selection**

**What are these?**

* **MBR** = Master Boot Record
* **GPT** = GUID Partition Table
* These are like **maps** that tell the computer where to find what on your hard drive.

Older systems use **MBR**, and newer systems (with UEFI) use **GPT**. They help your computer find the **bootloader**, which is the next thing it needs.

* **MBR** is old and limited to 4 partitions and 2TB disks.
* **GPT** is modern, used with UEFI, and supports more partitions and larger disks.

**3. Bootloader (GRUB or GRUB2)**

**What is a bootloader?**

A small program that **loads your operating system** in this case, Linux.

In most Linux systems, the bootloader is called **GRUB** (GRand Unified Bootloader). The newer version is called **GRUB2**.

**What does GRUB do?**

* It might show you a menu if you have more than one OS (like Linux + Windows)
* It picks the Linux version to load
* Loads the **Linux kernel** (the core part of Linux)
* Loads a helper file called **initramfs** (used to start the system)
* GRUB is like the **conductor of a train**: it gets the right Linux train onto the tracks and says “GO!”

**GRUB config files**:

* /boot/grub2/ or /boot/efi/EFI/...
* /etc/default/grub
* /etc/grub.d/

📌 **Interview Tip:** “GRUB loads the Linux kernel and initial RAM filesystem into memory and passes control to the kernel.”  
  
  
**4. Kernel – The brain of Linux wakes up**

**What is the kernel?**

The **kernel** is the **heart and brain of Linux**. It controls everything memory, CPU, devices, etc.

**What does it do during boot?**

* Loads drivers (programs that let Linux talk to hardware)
* Prepares the computer to run programs
* Loads **initramfs** (a mini-Linux that helps it find your main system)
* Mounts (attaches) your **root file system** the main part of Linux where everything lives
* You can think of the kernel as the **manager** who makes sure the whole Linux factory runs smoothly.

📌 **Interview Tip:** “**initramfs**: A temporary RAM-based root filesystem with drivers needed to find and mount your real root partition (like /dev/sda1).”

**5. systemd – The team leader of Linux**

**What is systemd?**

systemd is the **first real program** that the Linux kernel starts. It is **process number 1** (called **PID 1**).

It takes over from the kernel and starts **everything else** services, apps, logins, etc.

**What does systemd do?**

* Starts your networking, audio, keyboard, login service, etc.
* Decides whether to boot in text mode or GUI (like Windows)
* Makes sure all services start in the right order
* Manages your login screen or terminal
* If Linux is a concert, systemd is the **stage manager** making sure all the bands come on at the right time. **Replaces old systems like SysVinit and Upstart**

**📌** **Interview Tip:** “systemd is the first user-space process. It manages services and controls boot targets.”

**6. Run Targets (Instead of Runlevels)**

In the past, Linux used **runlevels** (0 to 6). Now it uses **targets**.

| **Runlevel** | **systemd Target** | **Purpose** |
| --- | --- | --- |
| 0 | poweroff.target | Shutdown |
| 1 | rescue.target | Single-user mode |
| 3 | multi-user.target | CLI, multi-user (no GUI) |
| 5 | graphical.target | Multi-user with GUI (with mouse, icons) |
| 6 | reboot.target | Reboot |

**7. Startup Scripts and Login Screen**

Finally, once systemd finishes its job, the system shows you a **login prompt**.

* If you're using a terminal-only system: you get a text prompt.
* If you have a desktop: you get a graphical login window.

Once you log in, Linux is ready to go!

* **Command Summary: Boot Process Tools**

uname -r                               # Shows kernel version

dmesg | less                           # View boot-time system messages

systemctl list-units --type=service  # Show running services

ls /boot.                             # Lists kernel and GRUB files