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Linux booting process

The **Linux booting process** involves several key stages that occur when you power on a Linux-based system. Here's a clear, step-by-step explanation:

🔧 1. BIOS / UEFI (Firmware Stage)

- **What it does:** Initializes hardware (CPU, RAM, keyboard, storage devices).
- **Role:** Looks for a **bootable device** (hard disk, USB, etc.).
- **Next step:** Loads the **bootloader** from the Master Boot Record (MBR) or EFI partition.

🚀 2. Bootloader (GRUB/LILO/SYSLINUX)

- **Popular bootloader: GRUB** (GRand Unified Bootloader).
- **What it does:**
    - Presents a boot menu (if multiple OSes).
    - Loads the **Linux kernel** and **initramfs/initrd** (temporary root file system).
- **Next step:** Transfers control to the **kernel**.

🧠 3. Kernel Initialization

- **What it does:**
    - Initializes system hardware using drivers.
    - Mounts the **initramfs** or **initrd** as a temporary root filesystem.
    - Initializes memory, CPU scheduler, device drivers, etc.

- **Next step:** Starts the **init process** (PID 1).

🔁 4. Init / System Manager (PID 1)

- **Traditional:** /sbin/init
- **Modern systems:** Use **systemd** or **upstart**
- **What it does:**
    - Reads configuration files (/etc/inittab, systemd units).
    - Brings the system to a specified **runlevel** or **target** (e.g., multi-user, graphical).
    - Starts services like networking, login prompts, cron, etc.

🧑‍🚀 5. Runlevel/Target Services

- **Systemd Targets:**
    - multi-user.target: Text mode
    - graphical.target: GUI (X server or Wayland)
- **What it does:** Activates background services (daemons), mounts filesystems, enables networking, etc.

💻 6. Login Prompt

- **Console or graphical login:** Provided by **getty**, **GDM**, **LightDM**, or other display managers.
- **User logs in**, shell starts, and you gain full access to the system.

Summary Diagram:

BIOS/UEFI → Bootloader (GRUB) → Kernel → init/systemd → Targets/Services → Login Prompt

✅ **Final Output:**

A fully functional Linux system ready for user interaction or automated tasks.