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U-Boot (Universal Bootloader)

What is U-Boot?

U-Boot (**Universal Bootloader**) is an open-source bootloader **commonly used in embedded Linux systems** (e.g., Raspberry Pi, BeagleBone, STM32, etc.). It's the first software that runs after the device powers on and is responsible for **loading the Linux kernel**.

🔁 U-Boot in the Booting Process (Embedded Linux)

Here's how U-Boot fits into the **Linux booting process** for embedded systems:

1. Processor Power-On / Reset

- Executes **Boot ROM Code** (built into the SoC).
- Boot ROM looks for **secondary bootloader** (often U-Boot) in flash, SD card, or other media.

2. U-Boot SPL (Secondary Program Loader) ***(if enabled)***

- **SPL** is a minimal version of U-Boot.
- Initializes basic hardware (e.g., DRAM).
- Loads the full U-Boot image into RAM.

3. Full U-Boot

- **Initializes complete hardware** (storage, Ethernet, USB).
- Provides a **boot command line interface (CLI)**.
- Loads:
    - **Linux kernel (zImage or uImage)**
    - **Device Tree Blob (DTB)**

- **Initial RAM Disk (initrd or initramfs)**

Typical U-Boot commands:

setenv bootargs console=ttyO0,115200 root=/dev/mmcblk0p2 rw

load mmc 0:1 0x80007fc0 zImage

load mmc 0:1 0x81000000 am335x-boneblack.dtb

bootz 0x80007fc0 - 0x81000000

4. Kernel Boot

- U-Boot **passes control to the kernel** along with the DTB and optional initramfs.
- From here, the **normal Linux boot** continues (init/systemd → services → login).

🔍 Key Features of U-Boot

Feature	Description
Cross-platform	Supports ARM, MIPS, x86, PowerPC, etc.
Modular	Configurable at compile-time via menuconfig.
Scripting	Environment variables and boot scripts.
Network Boot	Supports TFTP, NFS, DHCP, etc.
Flash Support	Can read/write NAND, NOR, MMC, etc.

📦 U-Boot Files in Embedded Linux

File	Purpose
MLO	SPL (first-stage bootloader for TI AM335x/OMAP)
u-boot.img	Full U-Boot image
zImage / uImage	Linux Kernel
.dtb	Device Tree Blob
initrd	Optional RAM filesystem

📌 Summary

Boot ROM → SPL (MLO) → U-Boot → Kernel + DTB + initramfs → Linux