Embedded Linux

Various Layers within Linux

Various layers within Linux, also showing separation between the userland and kernel space

User mode	**User applications**	*bash*, *LibreOffice*, *GIMP*, *Blender*, *0 A.D.*, *Mozilla Firefox*, ...				
	System components	**init daemon**: *OpenRC*, *runit*, *systemd*...	**System daemons**: *polkitd*, *smbd*, *sshd*, *udevd*...	**Window manager**: *X11*, *Wayland*, *SurfaceFlinger* (*Android*)	**Graphics**: *Mesa*, *AMD Catalyst*, ...	**Other libraries:** *GTK*, *Qt*, *EFL*, *SDL*, *SFML*, *FLTK*, *GNUstep*, ...
	C standard library	`fopen`, `execv`, `malloc`, `memcpy`, `localtime`, `pthread_create` ... (up to 2000 subroutines) *glibc* aims to be fast, *musl* aims to be lightweight, *uClibc* targets embedded systems, *bionic* was written for Android, etc. All aim to be POSIX/SUS-compatible.				
Kernel mode	**Linux kernel**	`stat`, `splice`, `dup`, `read`, `open`, `ioctl`, `write`, `mmap`, `close`, `exit`, etc. (about 380 system calls) The Linux kernel System Call Interface (SCI), aims to be POSIX/SUS-compatible[2]				
		Process scheduling subsystem	IPC subsystem	Memory management subsystem	Virtual files subsystem	Network subsystem
		Other components: ALSA, DRI, evdev, klibc, LVM, device mapper, Linux Network Scheduler, Netfilter Linux Security Modules: *SELinux*, *TOMOYO*, *AppArmor*, *Smack*				
Hardware (CPU, main memory, data storage devices, etc.)						

https://en.wikipedia.org/wiki/User_space_and_kernel_space

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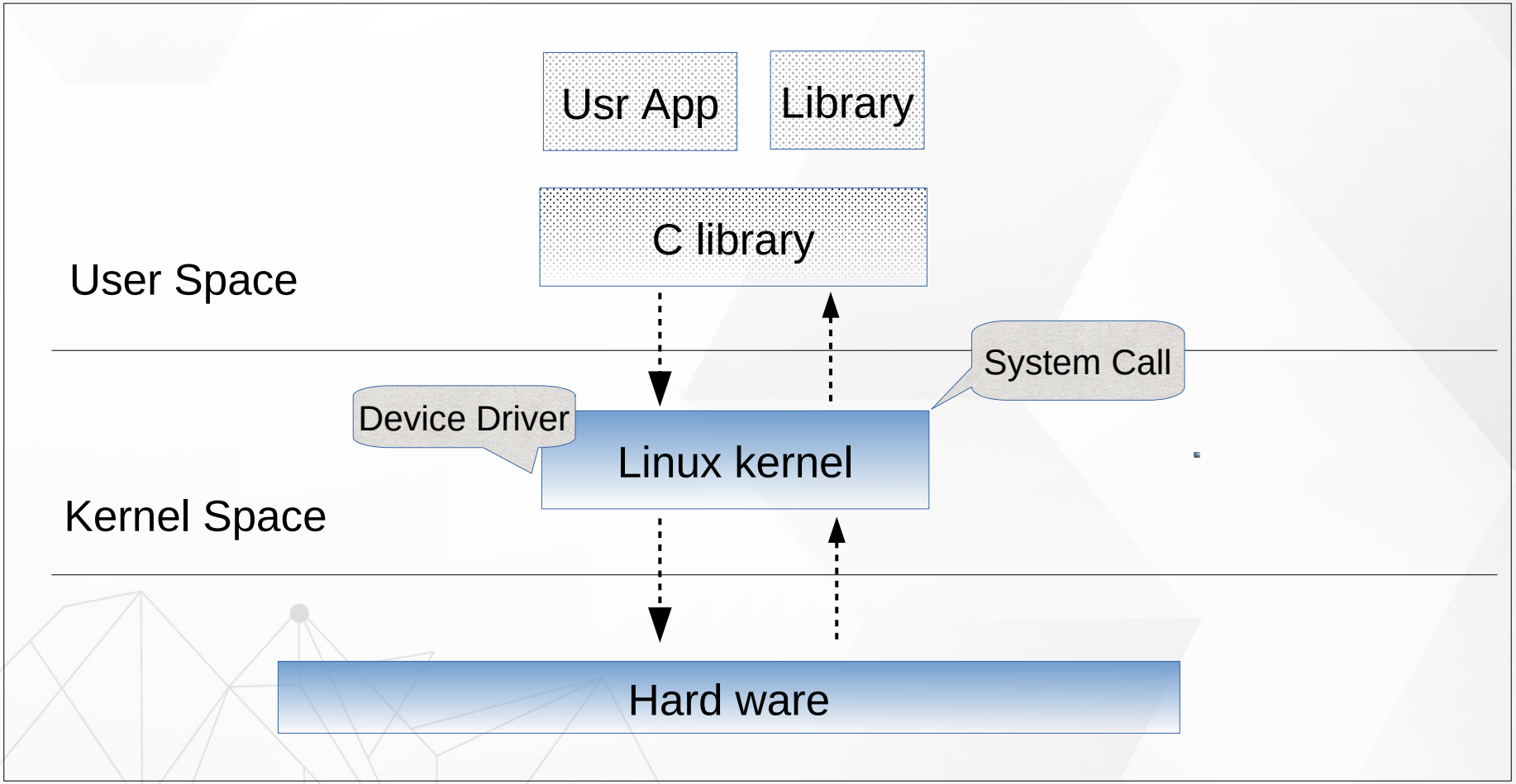
Embedded Linux System



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Linux kernel key features

- Portability and hardware support
- Scalability
- Exhaustive networking support
- Stability and reliability
- Modularity
- Easy to program.

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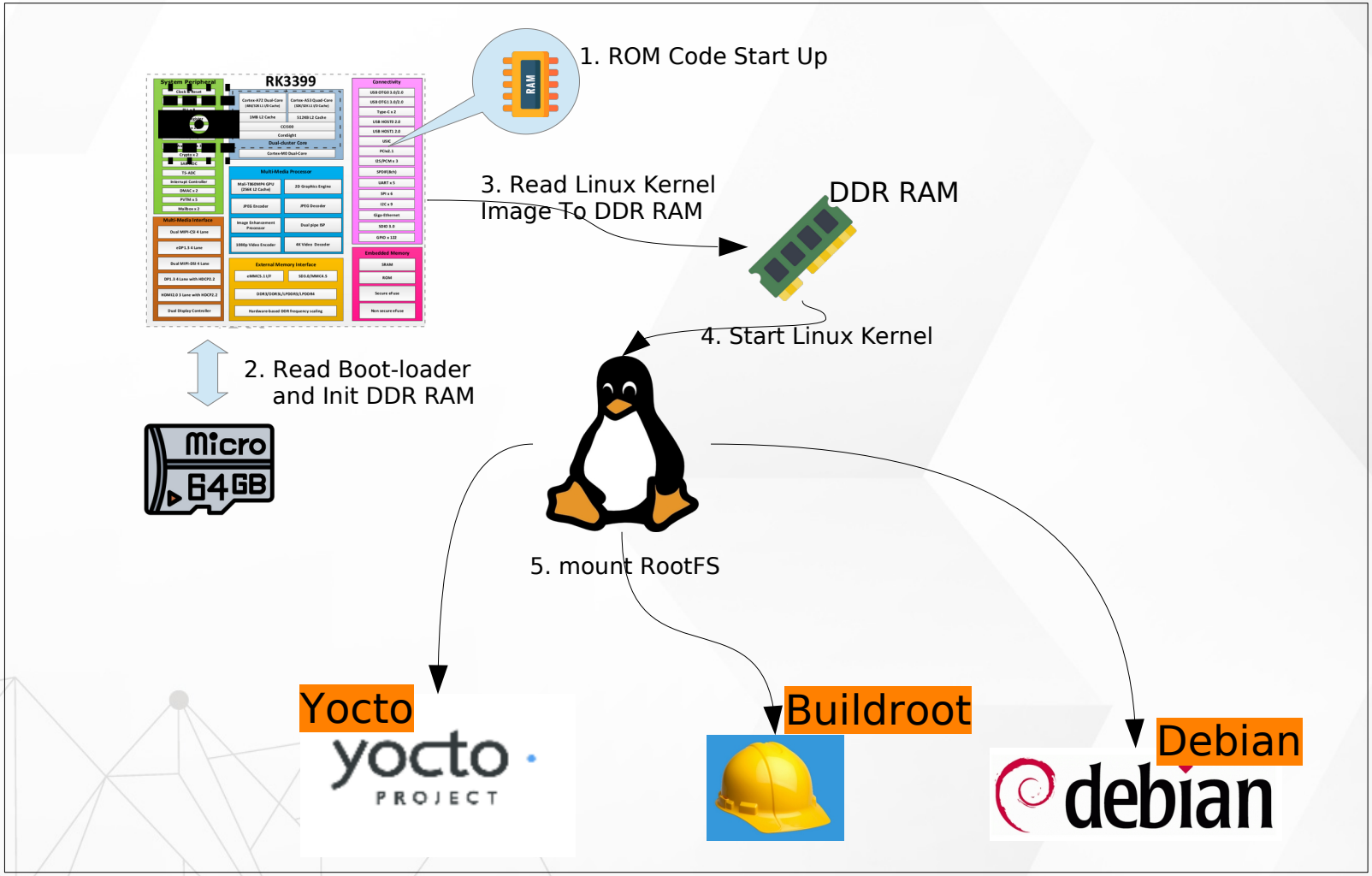
System Start Up

Linux Start Up



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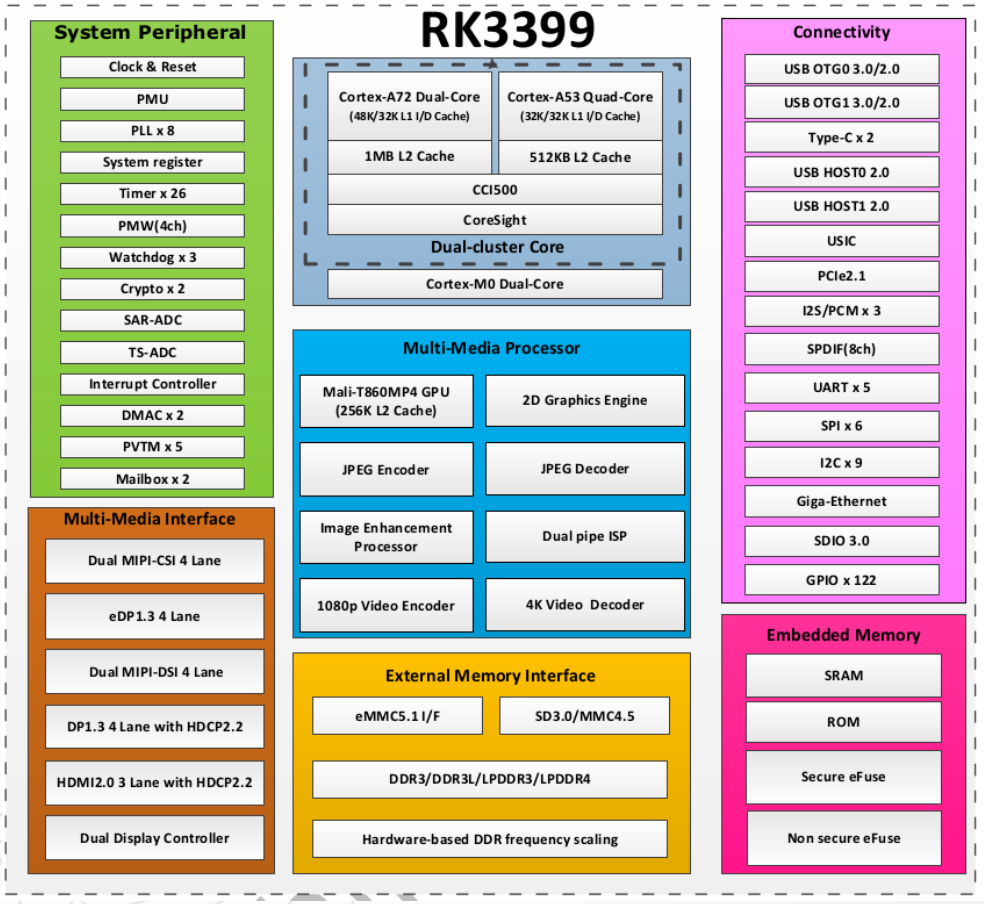
SOC RK3399



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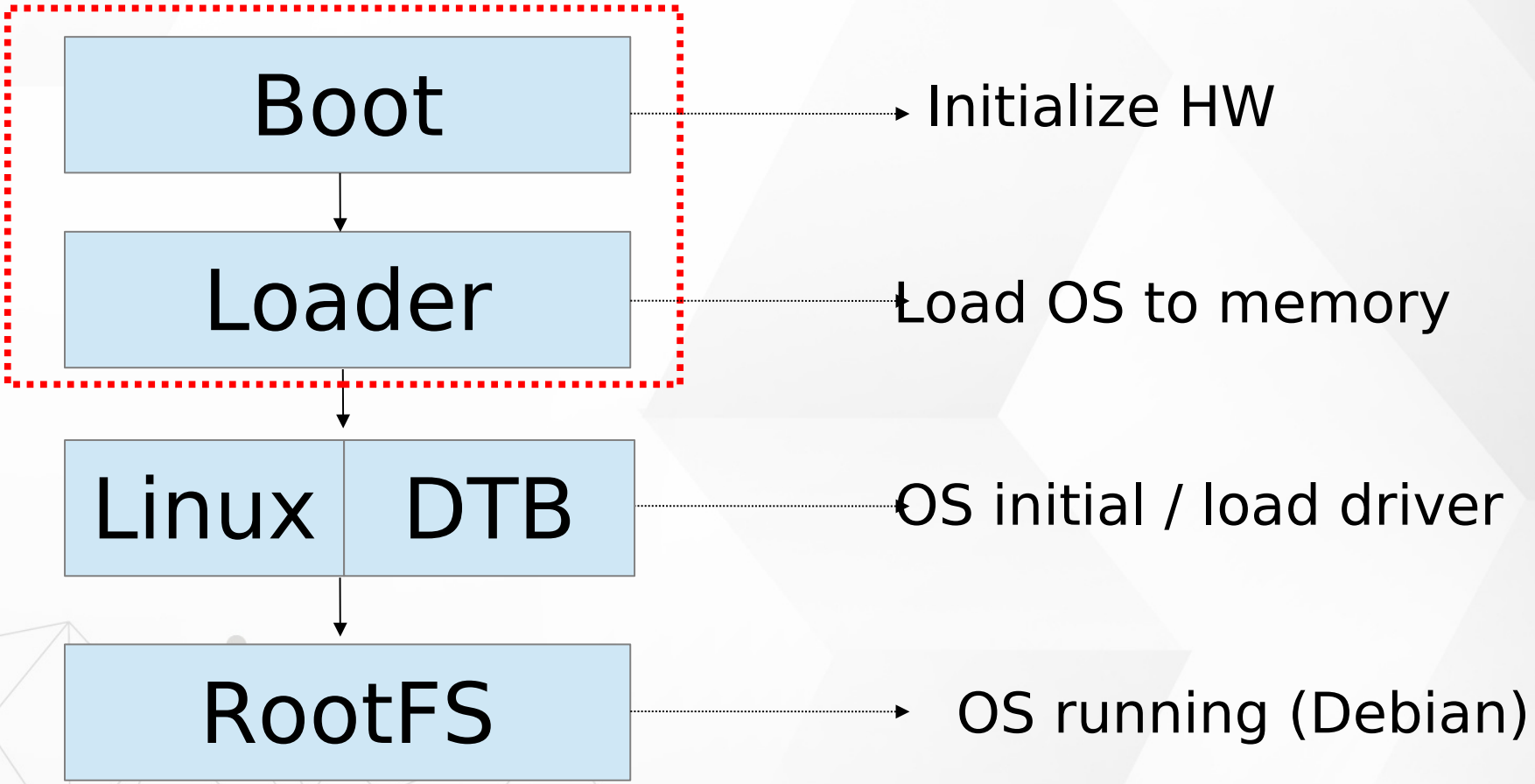
Embedded Linux System Booting



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RK3399 System Boot

Reference:

Page 30 of Rockchip_RK3399TRM_V1.3_Part1.pdf

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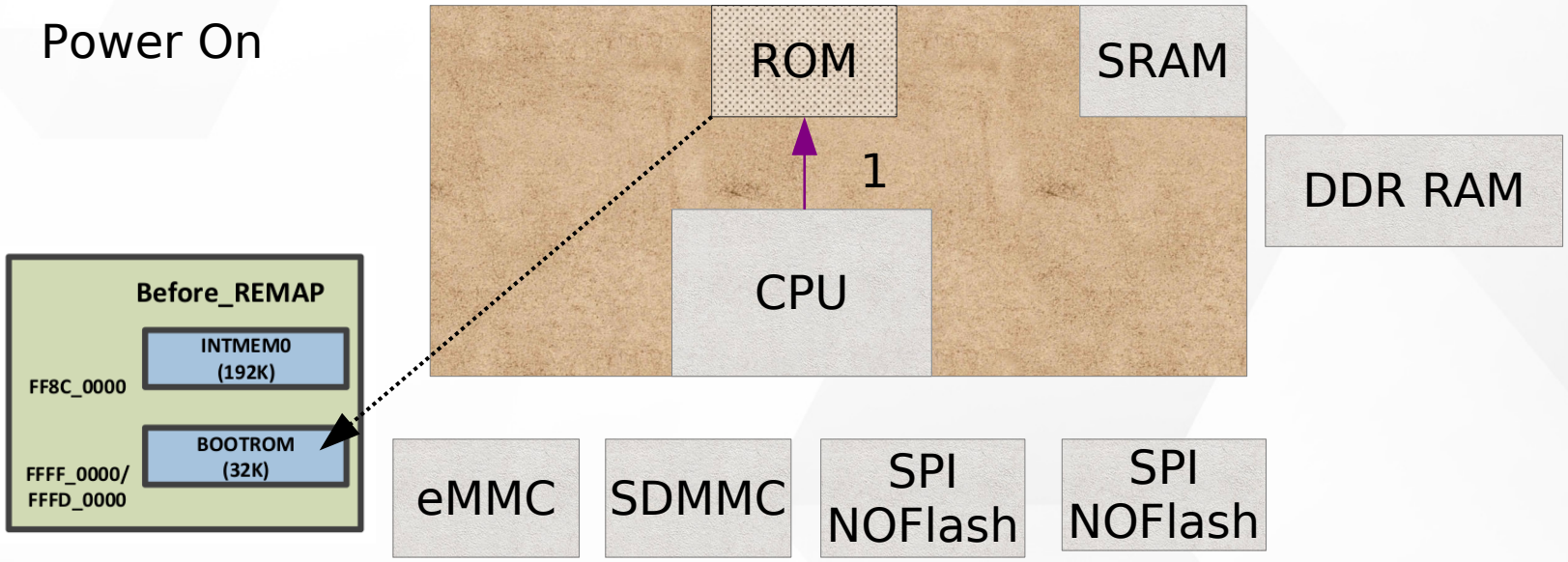
RK3399 System Boot (1)



Cortex-A53 get first instruction from address **0xffff0000 romcode** start to run

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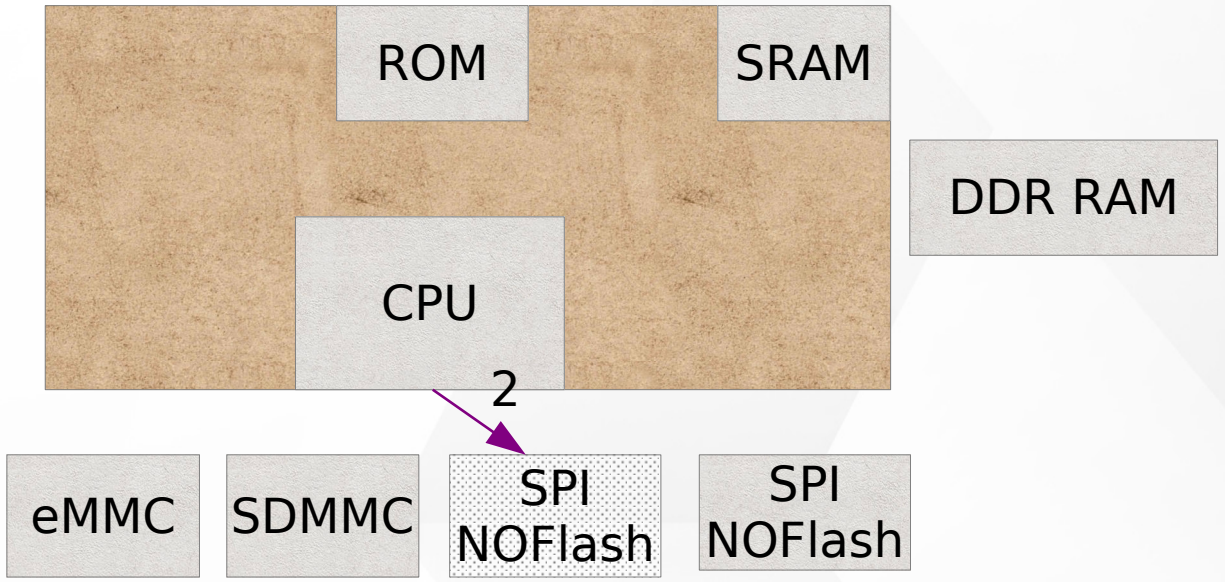
RK3399 System Boot (2)



Check ID BLOCK from external **SPI Nor Flash**

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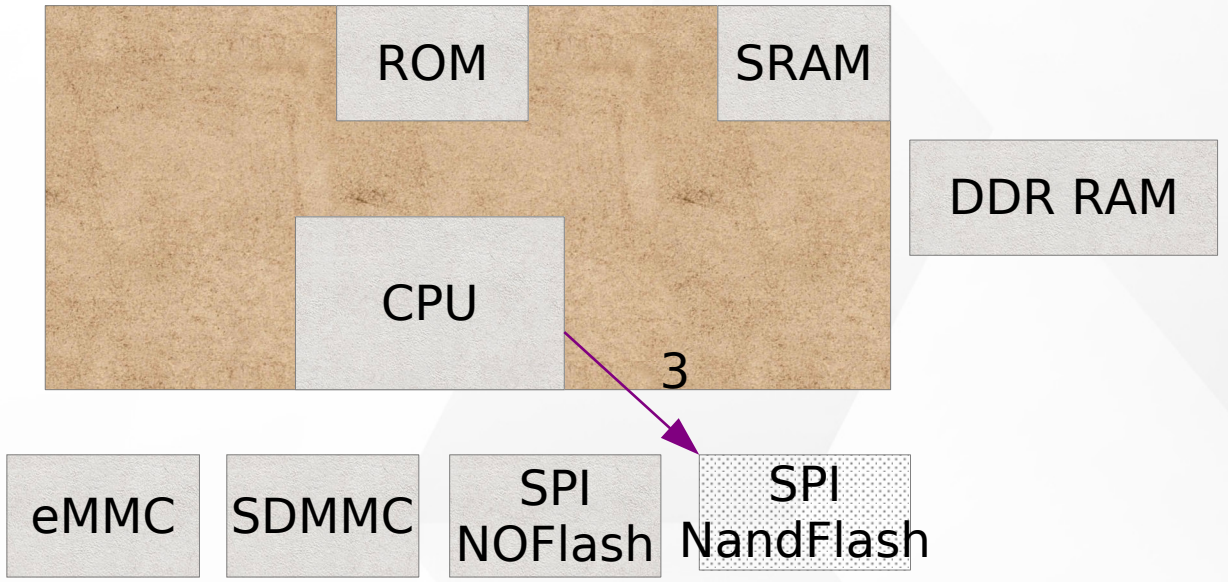
RK3399 System Boot (3)



Check ID BLOCK fromexternal **SPI Nand Flash**

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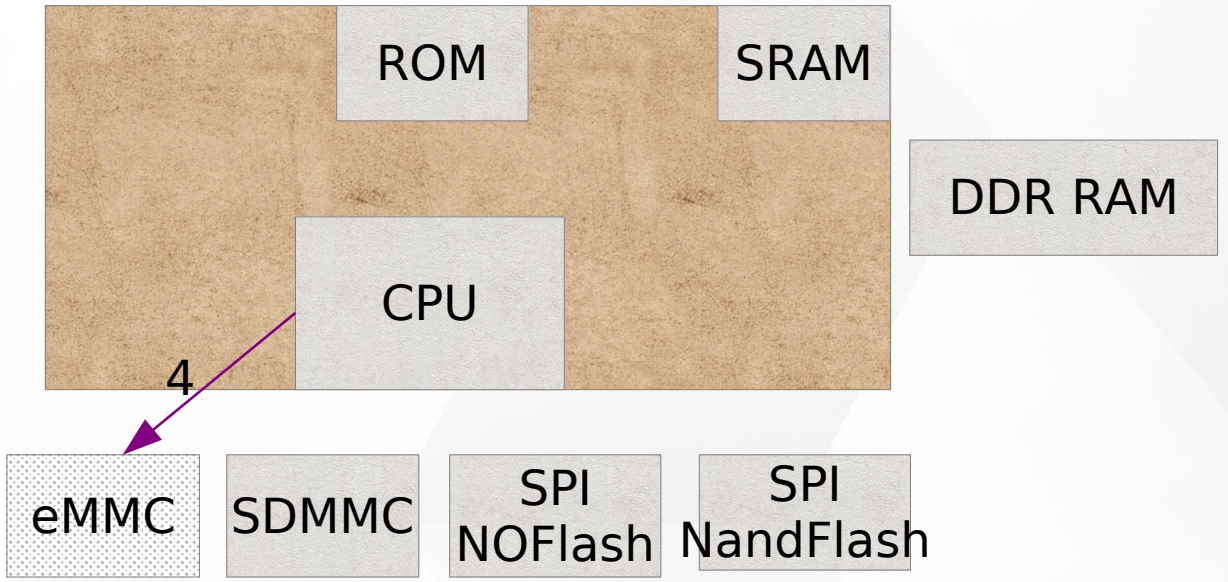
RK3399 System Boot (4)



Check ID BLOCK from external **eMMC**

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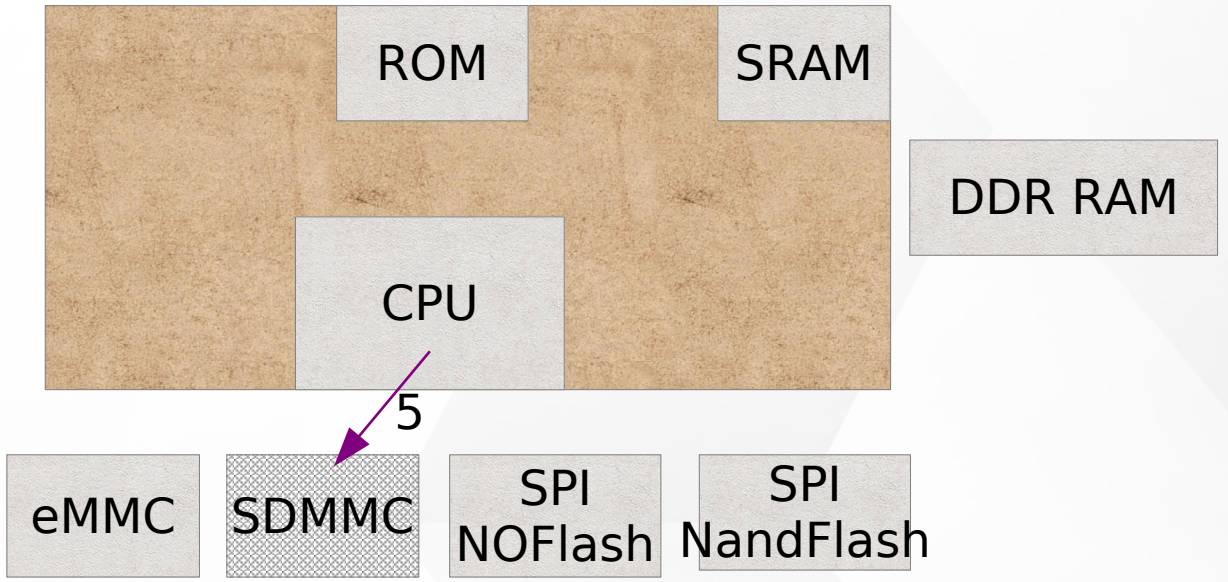
RK3399 System Boot (5)

BL1

work in cache

IDB_Loader



Check ID BLOCK from external **SDMMC**

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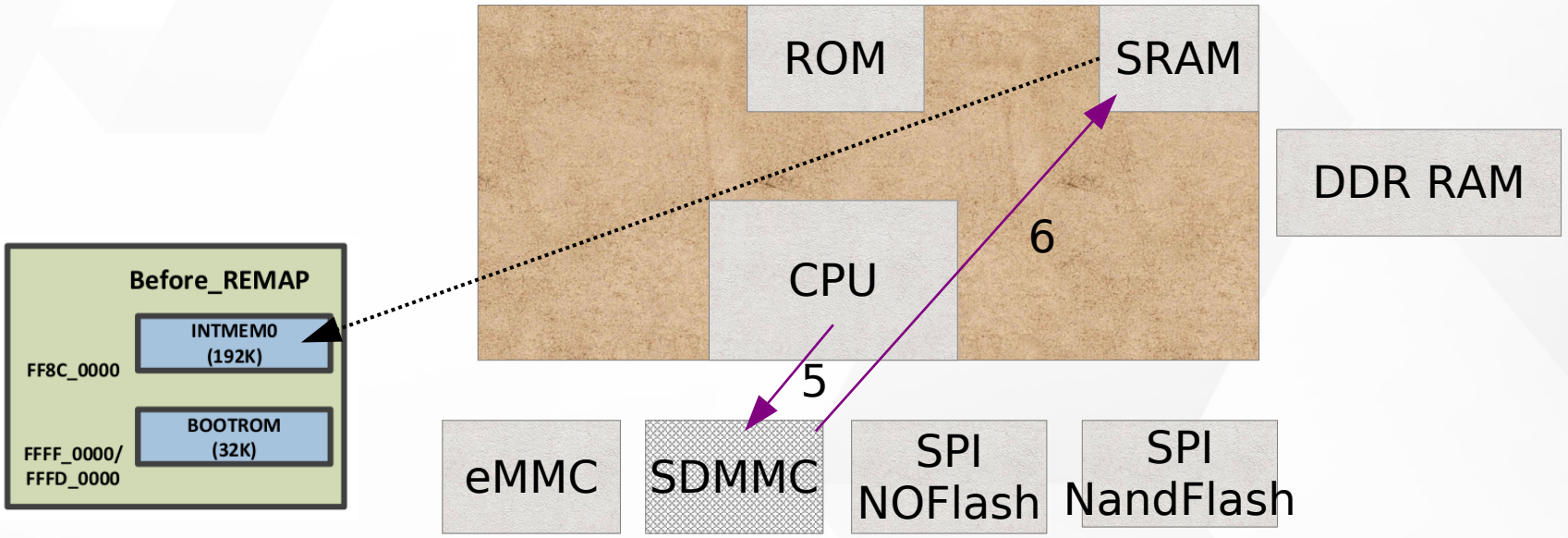
RK3399 System Boot (6)



5. Check ID BLOCK from external **SDMMC**
6. Read **2nK** SDRAM initialization image code to **internal SRAM**

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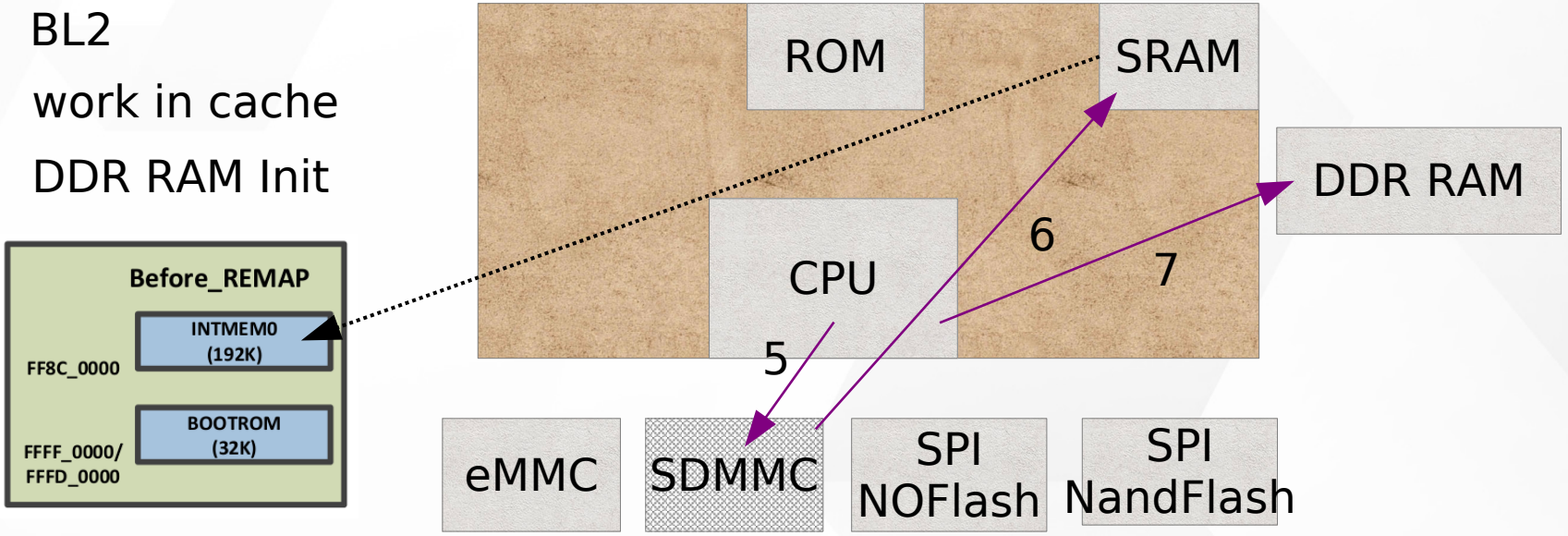
RK3399 System Boot (7)

BL2

work in cache

DDR RAM Init



5. Check ID BLOCK from external **SDMMC**
6. Read **2nK** SDRAM initialization image code to **internal SRAM**
7. Run boot code to do DDR initialization

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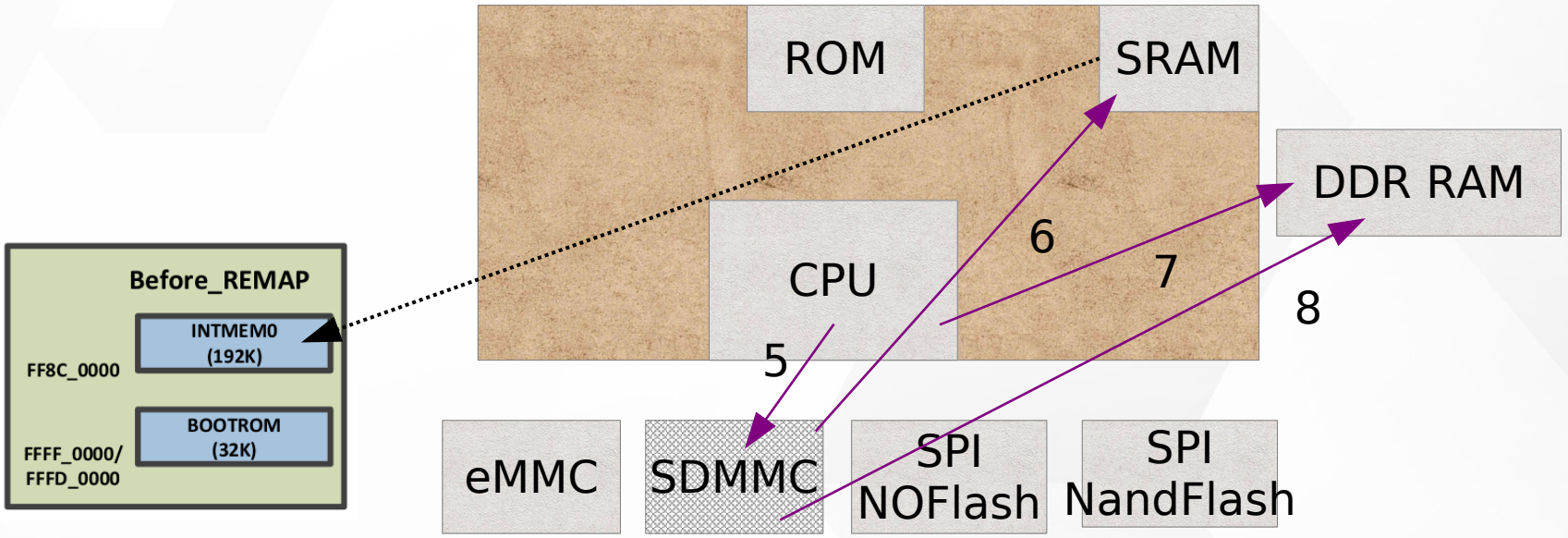
RK3399 System Boot (8)



5. Check ID BLOCK from external **SDMMC**
6. Read **2nK** SDRAM initialization image code to **internal SRAM**
7. Run boot code to do DDR initialization
8. Transfer boot code to DDR then Run boot code

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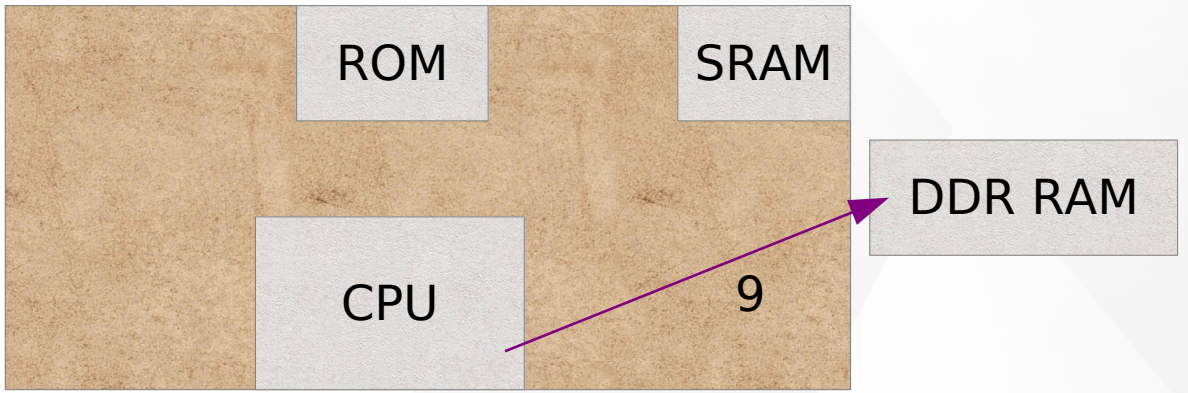
RK3399 System Boot (9)

BL3

work in DDR RAM

UBoot



eMMC | SDMMC | SPI NOFlash | SPI NandFlash

Run UBoot

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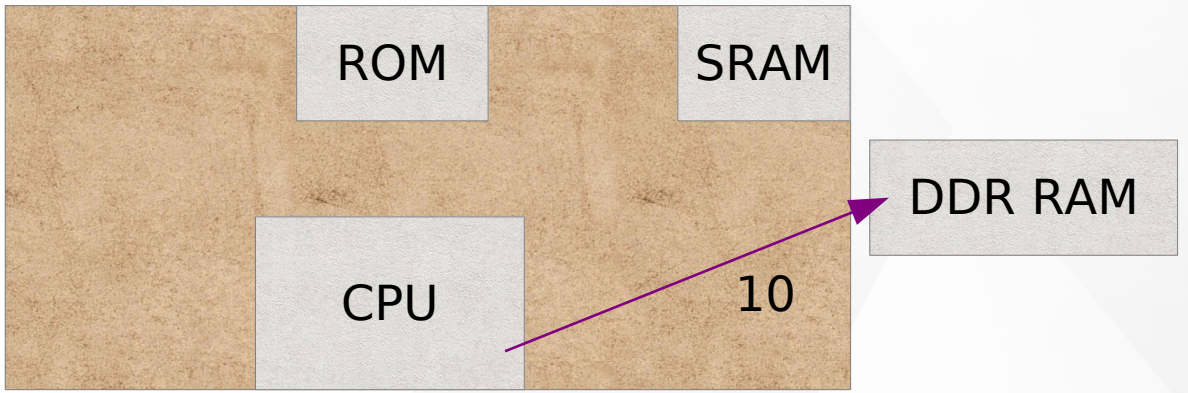
RK3399 System Boot (10)

work in DDR RAM

Linux



eMMC | SDMMC | SPI NOFlash | SPI NandFlash

Run Linux

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Boot

- Power On BootROM code (work in **cache**)
  - Load BL1
- BL1 (work in **cache** - IDB_Loader)
  - **Initial simple exception vectors, PLL** (clock)
  - **Initial Multi-CPU**
  - Load BL2
- BL2 (work in **cache**)
  - **Initial DDR memory**
  - **Initial C environment** (stack, heap,)
  - Load BL31

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Boot

- BL31 (**work in DDR**)
  - Initial exception vectors
  - Load BL32 (u-boot)

BL32 U-boot (**work in DDR**)

- **Initial storage device**
- **Load Linux Kernel**

Kernel (**work in DDR**)

- kernel/Documentation/arm64/booting.txt
- **Load RootFS**

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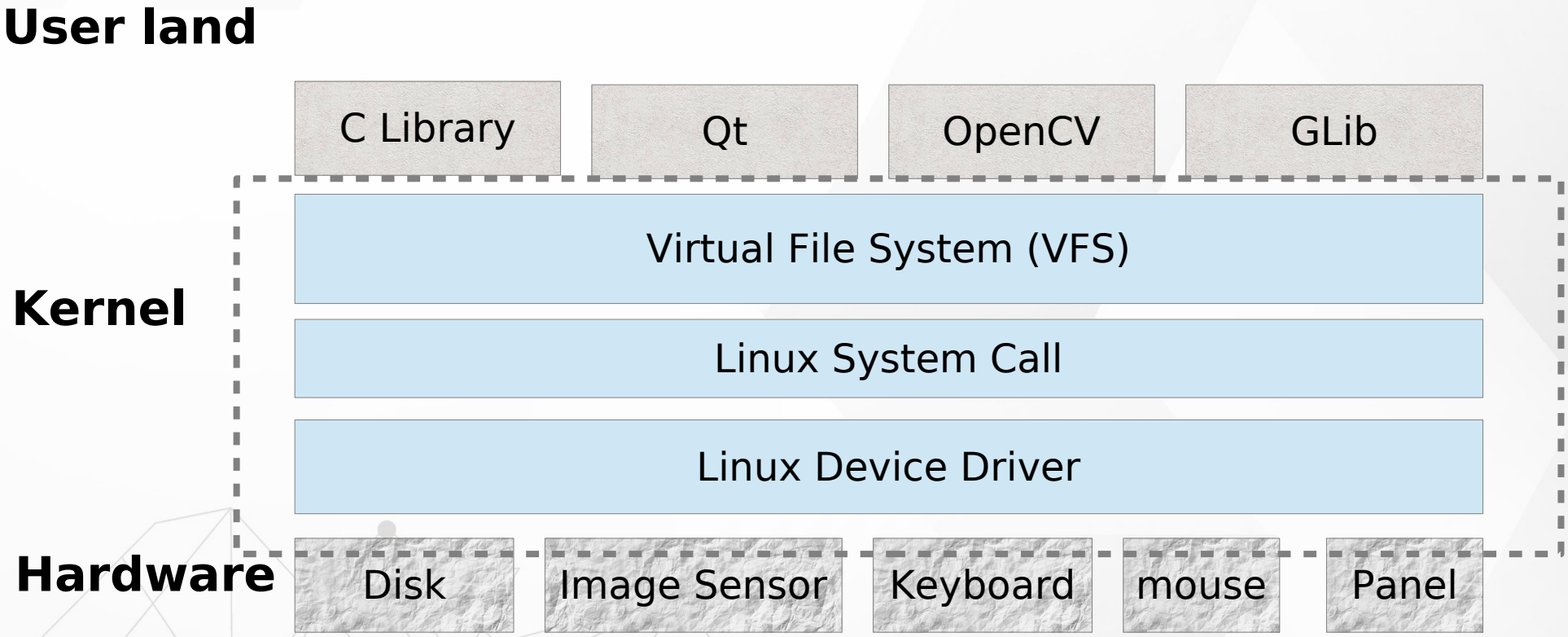
Embedded Linux System



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