



哈爾濱工業大學 (深圳)  
HARBIN INSTITUTE OF TECHNOLOGY

# 实验报告

开课学期: 2022 春季  
课程名称: 嵌入式计算  
实验名称: 移植 Linux 内核和根文件系统  
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## 一、 回答问题

1. 在编译 Linux 内核时，为什么要指定

`CROSS_COMPILE=arm-linux-gnueabi-`（也就是使用 `arm-linux-gnueabi-gcc`

编译），可以使用本地机 ubuntu 系统自带的 gcc 编译吗？

不可以，因为编译后的 LINUX 内核要移植到 ARM 架构上运行，而本机的 Ubuntu 不是 ARM 架构，故不能使用 Ubuntu 自带的 gcc 编译，而需要使用交叉编译器 arm-linux-gnueabi-gcc 进行编译。

2. 在制作根文件系统时，使用 mknod 命令创建了一些设备节点，  
请解释这条命令（`mknod -m 666 null c 1 3`）的含义和作用。

mknod 为创建字符或块设备文件的命令，一般格式为 `mknod name type 主设备号 次设备号`。其中主设备号用来区分不同种类的设备，而次设备号用来区分同一类型的多个设备。

该命令创建了一个名为 `null` 的设备文件。其中 `-m` 参数为设置访问设备文件的权限，设置为 `666` 表示所有成员均拥有读写权限但没有操作的权限。`c` 代表创建的设备文件类型是字符设备，字符设备文件与设备传送数据的时候是以字符的形式传送，一次传送一个字符。其主设备号为 1，次设备号为 3。

## 二、实验结果截图及分析

### 1. Linux-5.15.30 版本内核的运行截图及分析

利用 BusyBox 制作好 SD 卡根系统后，编译运行 Linux-5.15.30 内核并挂载制作好的跟系统，运行成功，截图如下所示。

```

1.066150 mmcblk0: mmc0:4567 QEMU 64.0 MiB
1.070787 amba 10020000.clcd: fixing up cyclic dependency with 0-0039
1.081275 drm-clcd-pl111 10020000.clcd: DVI muxed to daughterboard 1 (core tile) CLCD
1.092962 drm-clcd-pl111 10020000.clcd: Initializing Versatile Express PL111
1.099018 sti902x 0-0039: supply cvcc12 not found, using dummy regulator
1.099679 sti902x 0-0039: supply cvcc12 not found, using dummy regulator
1.113400 l2c l2c-0: added multiplexed l2c bus 2
1.114813 drm-clcd-pl111 1001f000.clcd: assigned reserved memory node vram@4c000000
1.115140 drm-clcd-pl111 1001f000.clcd: using device-specific reserved memory
1.115744 drm-clcd-pl111 1001f000.clcd: core tile graphics present
1.116035 drm-clcd-pl111 1001f000.clcd: this device will be deactivated
1.116373 drm-clcd-pl111 1001f000.clcd: Versatile Express init failed -19
1.118592 input: AT Raw Set 2 keyboard as /devices/platform/bus@40000000/motherboard-bus@40000000/motherboard-bus@40000000:iofpga7,00000000/10007000.knl/serio0/Input/Input0
2.120866 drm-clcd-pl111 10020000.clcd: DVI muxed to daughterboard 1 (core tile) CLCD
1.141454 drm-clcd-pl111 10020000.clcd: Initializing Versatile Express PL111
1.142011 drm-clcd-pl111 10020000.clcd: found bridge on endpoint 0
1.142268 drm-clcd-pl111 10020000.clcd: using non-panel bridge
1.146224 [drm] Initialized pl111 1.0.0 20170317 for 10020000.clcd on minor 0
1.148516 Console: switching to colour frame buffer device 128x48
1.148631 drm-clcd-pl111 10020000.clcd: [drm] fb0: pl111drfb frame buffer device
1.149094 ALSA device list:
1.149454 #0: ARM AC'97 Interface PL041 rev0 at 0x10004000, irq 32
1.173250 input: InExps/2 Generic Explorer Mouse as /devices/platform/bus@40000000/motherboard-bus@40000000/motherboard-bus@40000000:iofpga7,00000000/10007000.knl/serio1/Input/Input2
1.741291 EXT4-fs (mmcblk0): mounting ext3 file system using the ext4 subsystem
1.742847 random: fast init done
1.878125 EXT4-fs (mmcblk0): recovery complete
1.880707 EXT4-fs (mmcblk0): mounted filesystem with ordered data mode. Opts: (null). Quota mode: disabled.
1.882355 ext3 filesystem being mounted at /root supports timestamps until 2038 (0x7fffffff)
1.884188 VFS: Mounted root (ext3 filesystem) on device 179:0.
1.904352 Freeing unused kernel image (initmem) memory: 1024K
1.908170 Run /sbin/init as init process
2.121868 random: crng init done
can't run '/etc/init.d/rcS': No such file or directory
Please press Enter to activate this console.
/ # uname -a
Linux (none) 5.15.30 #1 SMP Wed May 11 14:35:47 CST 2022 armv7l GNU/Linux
/ #
/ # QEMU: Terminated
root@mlinglab:/home/ftpboot#
  
```

图 1 Linux5.15.30 内核运行截图

### 2. 自选 Linux 其他版本内核的运行截图及分析

所选的是 Linux 其他版本号为 5.10.114，挂载根文件系统，内核运行成功，截图如下所示。

```

1.041660 aaci-pl041 10004000.aaci: ARM AC'97 Interface PL041 rev0 at 0x10004000, irq 32
1.041708 aaci-pl041 10004000.aaci: FIFO 512 entries
1.043726 mmc-pl18x 10005000.mmc1: Got CD GPIO
1.043838 mmc-pl18x 10005000.mmc1: Got WP GPIO
1.047284 mmc-pl18x 10005000.mmc1: mmc0: PL181 nanf 41 rev0 at 0x10005000 irq 33,34 (pio)
1.094684 10009000.uart: ttyAMA0 at MMIO 0x10009000 (irq = 37, base_baud = 0) is a PL011 rev1
1.150650 printk: console [ttyAMA0] enabled
1.152692 1000a000.uart: ttyAMA1 at MMIO 0x1000a000 (irq = 38, base_baud = 0) is a PL011 rev1
1.159146 mmc0: new SD card at address 4567
1.160875 1000b000.uart: ttyAMA2 at MMIO 0x1000b000 (irq = 39, base_baud = 0) is a PL011 rev1
1.162690 1000c000.uart: ttyAMA3 at MMIO 0x1000c000 (irq = 40, base_baud = 0) is a PL011 rev1
1.165415 mmcblk0: mmc0:4567 QEMU 64.0 MiB
1.181411 rtc-pl031 10017000.rtc: registered as rtc0
1.182422 rtc-pl031 10017000.rtc: setting system clock to 2022-05-11T07:26:39 UTC (1652253999)
1.191565 drm-clcd-pl111 1001f000.clcd: assigned reserved memory node vram@4c000000
1.192334 drm-clcd-pl111 1001f000.clcd: using device-specific reserved memory
1.193230 drm-clcd-pl111 1001f000.clcd: core tile graphics present
1.193599 drm-clcd-pl111 1001f000.clcd: this device will be deactivated
1.193999 drm-clcd-pl111 1001f000.clcd: Versatile Express init failed -19
1.197274 drm-clcd-pl111 10020000.clcd: DVI muxed to daughterboard 1 (core tile) CLCD
1.215637 input: AT Raw Set 2 keyboard as /devices/platform/bus@40000000/motherboard-bus@40000000/motherboard-bus@40000000:iofpga7,00000000/10007000.knl/serio0/Input/Input0
1.221273 drm-clcd-pl111 10020000.clcd: Initializing Versatile Express PL111
1.224622 drm-clcd-pl111 10020000.clcd: found bridge on endpoint 0
1.225100 drm-clcd-pl111 10020000.clcd: using non-panel bridge
1.236713 [drm] Initialized pl111 1.0.0 20170317 for 10020000.clcd on minor 0
1.314911 Console: switching to colour frame buffer device 128x48
1.315131 drm-clcd-pl111 10020000.clcd: [drm] fb0: pl111drfb frame buffer device
1.334283 ALSA device list:
1.334601 #0: ARM AC'97 Interface PL041 rev0 at 0x10004000, irq 32
1.835576 input: InExps/2 Generic Explorer Mouse as /devices/platform/bus@40000000/motherboard-bus@40000000/motherboard-bus@40000000:iofpga7,00000000/10007000.knl/serio1/Input/Input2
1.841489 EXT4-fs (mmcblk0): mounting ext3 file system using the ext4 subsystem
1.842574 random: fast init done
1.885154 EXT4-fs (mmcblk0): mounted filesystem with ordered data mode. Opts: (null)
1.886362 ext3 filesystem being mounted at /root supports timestamps until 2038 (0x7fffffff)
1.887444 VFS: Mounted root (ext3 filesystem) on device 179:0.
1.907989 Freeing unused kernel memory: 1024K
1.911160 Run /sbin/init as init process
2.038647 random: crng init done
can't run '/etc/init.d/rcS': No such file or directory
Please press Enter to activate this console.
/ # uname -a
Linux (none) 5.10.114 #1 SMP Wed May 11 15:10:34 CST 2022 armv7l GNU/Linux
/ #
  
```

图 2 Linux5.10.114 内核运行截图