

Устанавливаем кросс-компилятор:

```
nastya@linux:~$ sudo apt install gcc-10-arm-linux-gnueabi-hf-base
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
The following NEW packages will be installed:
  gcc-10-arm-linux-gnueabi-hf-base
0 upgraded, 1 newly installed, 0 to remove and 47 not upgraded.
Need to get 40.2 kB of archives.
After this operation, 105 kB of additional disk space will be used.
Get:1 http://ru.archive.ubuntu.com/ubuntu noble/universe amd64 gcc-10-arm-linux-gnueabi-hf-base 10.5.0-4ubuntu2cross1 [40.2 kB]
Fetched 40.2 kB in 0s (104 kB/s)
Selecting previously unselected package gcc-10-arm-linux-gnueabi-hf-base:amd64.
(Reading database ... 150069 files and directories currently installed.)
Preparing to unpack ../gcc-10-arm-linux-gnueabi-hf-base_10.5.0-4ubuntu2cross1_amd64.deb ...
Unpacking gcc-10-arm-linux-gnueabi-hf-base:amd64 (10.5.0-4ubuntu2cross1) ...
Setting up gcc-10-arm-linux-gnueabi-hf-base:amd64 (10.5.0-4ubuntu2cross1) ...
```

Создаем файл конфигураций:

```
nastya@linux:~/kernel/linux$ ARCH=arm make defconfig
YACC      scripts/kconfig/parser.tab.[ch]
HOSTCC    scripts/kconfig/lexer.lex.o
HOSTCC    scripts/kconfig/menu.o
HOSTCC    scripts/kconfig/parser.tab.o
HOSTCC    scripts/kconfig/preprocess.o
HOSTCC    scripts/kconfig/symbol.o
HOSTCC    scripts/kconfig/util.o
HOSTLD    scripts/kconfig/conf
*** Default configuration is based on 'multi_v7_defconfig'
#
# configuration written to .config
#
```

Собираем ядро:

```
nastya@linux:~/kernel/linux$ ARCH=arm CROSS_COMPILE=arm-linux-gnueabi- make -j 4 zImage
SYNC    include/config/auto.conf.cmd
UPD      include/generated/uapi/linux/version.h
SYSHDR   arch/arm/include/generated/uapi/asm/unistd-oabi.h
WRAP     arch/arm/include/generated/uapi/asm/kvm_para.h
WRAP     arch/arm/include/generated/uapi/asm/bitsperlong.h
WRAP     arch/arm/include/generated/uapi/asm/bpf_perf_event.h
WRAP     arch/arm/include/generated/uapi/asm/errno.h
WRAP     arch/arm/include/generated/uapi/asm/ioctl.h
WRAP     arch/arm/include/generated/uapi/asm/ipcbuf.h
WRAP     arch/arm/include/generated/uapi/asm/msgbuf.h
WRAP     arch/arm/include/generated/uapi/asm/param.h
WRAP     arch/arm/include/generated/uapi/asm/poll.h
WRAP     arch/arm/include/generated/uapi/asm/resource.h
```

Собираем device tree blobs:

```
nastya@linux:~/kernel/linux$ ARCH=arm make -j 4 dtbs
SYNC    include/config/auto.conf.cmd
*
* Restart config...
*
*
* Memory initialization
*
Initialize kernel stack variables at function entry
> 1. no automatic stack variable initialization (weakest) (INIT_STACK_NONE)
> 2. pattern-init everything (strongest) (INIT_STACK_ALL_PATTERN) (NEW)
> 3. zero-init everything (strongest and safest) (INIT_STACK_ALL_ZERO) (NEW)
choice[1-3]: 1
Enable heap memory zeroing on allocation by default (INIT_ON_ALLOC_DEFAULT_ON) [N/y/?] n
Enable heap memory zeroing on free by default (INIT_ON_FREE_DEFAULT_ON) [N/y/?] n
Enable register zeroing on function exit (ZERO_CALL_USED_REGS) [N/y/?] (NEW) n
*
```

Запускаем ядро в эмуляторе QEMU:

```
nastya@linux:~/arm-compile$ QEMU_AUDIO_DRV=none qemu-system-arm -M vexpress-a9 -kernel zImage -dtb vexpress-v2p-ca9.dtb
-append "console=ttyAMA0" -nographic
[ 0.000000] Booting Linux on physical CPU 0x0
[ 0.000000] Linux version 6.14.0my-g38fec10eb60d-dirty (nastya@linux) (arm-linux-gnueabi-gcc (Ubuntu 10.5.0-4ubuntu
2) 10.5.0, GNU ld (GNU Binutils for Ubuntu) 2.42) #1 SMP Sun Sep 7 19:55:53 UTC 2025
[ 0.000000] CPU: ARMv7 Processor [410fc090] revision 0 (ARMv7), cr=10c5387d
[ 0.000000] CPU: PIPT / VIPT nonaliasing data cache, VIPT nonaliasing instruction cache
[ 0.000000] OF: fdt: Machine model: V2P-CA9
[ 0.000000] Memory policy: Data cache writeback
[ 0.000000] efi: UEFI not found.
[ 0.000000] cma: Failed to reserve 64 MiB on node -1
[ 0.000000] Zone ranges:
[ 0.000000]   DMA      [mem 0x0000000060000000-0x0000000067ffffff]
[ 0.000000]   Normal  empty
[ 0.000000]   HighMem  empty
[ 0.000000] Movable zone start for each node
[ 0.000000] Early memory node ranges
[ 0.000000]   node 0: [mem 0x0000000060000000-0x0000000067ffffff]
[ 0.000000] Initmem setup node 0 [mem 0x0000000060000000-0x0000000067ffffff]
[ 0.000000] Reserved memory: created DMA memory pool at 0x4c000000, size 8 MiB
[ 0.000000] OF: reserved mem: initialized node vram@4c000000, compatible id shared-dma-pool
[ 0.000000] OF: reserved mem: 0x4c000000..0x4c7fffff (8192 KiB) nomap non-reusable vram@4c000000
[ 0.000000] CPU: All CPU(s) started in SVC mode.
[ 0.000000] percpu: Embedded 17 pages/cpu s40204 r8192 d21236 u69632
```

Получаем ошибку, т.к. нет процесса init:

```
[ 2.408935] Kernel panic - not syncing: VFS: Unable to mount root fs on unknown-block(0,0)
[ 2.409751] CPU: 0 UID: 0 PID: 1 Comm: swapper/0 Not tainted 6.14.0my-g38fec10eb60d-dirty #1
[ 2.410102] Hardware name: ARM-Versatile Express
[ 2.410349] Call trace:
[ 2.410891] unwind_backtrace from show_stack+0x10/0x14
[ 2.412754] show_stack from dump_stack_lvl+0x50/0x64
[ 2.413165] dump_stack_lvl from panic+0x10c/0x384
[ 2.413558] panic from mount_root_generic+0x1d4/0x278
[ 2.413984] mount_root_generic from prepare_namespace+0x1fc/0x258
[ 2.414555] prepare_namespace from kernel_init+0x1c/0x12c
[ 2.414954] kernel_init from ret_from_fork+0x14/0x28
[ 2.415488] Exception stack(0xc8825fb0 to 0xc8825ff8)
[ 2.416094] 5fa0: 00000000 00000000 00000000 00000000
[ 2.416650] 5fc0: 00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
[ 2.416847] 5fe0: 00000000 00000000 00000000 00000000 00000013 00000000
[ 2.418312] ---[ end Kernel panic - not syncing: VFS: Unable to mount root fs on unknown-block(0,0) ]---
```