init HELLO

Скомпилировали статически под ARM init.c, который выводит строку Hello
echo init | cpio -o -H newc | gzip > initramfs.cpio.gz
запустили в qemu
 qemu-system-arm -M vexpress-a9 -kernel ../zImage -dtb ../vexpress-v2p-ca9.dtb -initrd
initramfs.cpio.gz -append "console=ttyAMA0" -nographic

```
[    1.738222] clk: Disabling unused clocks
[    1.778784] Freeing unused kernel image (initmem) memory: 2048K
[    1.783402] Run /init as init process
Hello
[    1.949882] input: ImExPS/2 Generic Explorer Mouse as /devices/platform/b
00000/bus@40000000:motherboard-bus@40000000:iofpga@7,00000000/10007000.kmi/s
[   11.986661] amba 1000f000.wdt: deferred probe pending: (reason unknown)
[   11.986720] amba 100e0000.memory-controller: deferred probe pending: (rea
[   11.986730] amba 100e1000.memory-controller: deferred probe pending: (rea
[   11.986735] amba 100e5000.watchdog: deferred probe pending: (reason unkno
[   16.856779] Kernel panic - not syncing: Attempted to kill init! exitcode=
[   16.858452] CPU: 0 UID: 0 PID: 1 Comm: init Not tainted 6.17.0-rc5 #1 NON
[   16.859216] Hardware name: ARM-Versatile Express
[   16.859859] Call trace:
[   16.860365]  unwind_backtrace from show_stack+0x10/0x14
[   16.861700]  show_stack from dump_stack_lvl+0x54/0x68
[   16.862062]  dump_stack_lvl from vpanic+0xf4/0x304
[   16.862469]  vpanic from panic+0x2c/0x30
[   16.862849]  panic from do_exit+0x960/0x964
[   16.863171]  do_exit from do_group_exit+0x34/0x84
[   16.863465]  do_group_exit from pid_child_should_wake+0x0/0x60
[   16.864481] ---[ end Kernel panic - not syncing: Attempted to kill init!
```

Busybox

скачали busybox, собираем
ARCH=arm make defconfig
ARCH=arm make menuconfig

включили статическую сборку и указали префикс кросс-компилятора, также исключили
утилиту tc и SHA1 hwaccel флаг, потому что были ошибки

ARCH=arm make -j12
ARCH=arm make install -j12

создали initramfs

```
find . | cpio -o -H newc | gzip > initramfs.cpio.gz
```

запустили в qemu

```
QEMU_AUDIO_DRV=none qemu-system-arm -M vexpress-a9 -kernel zImage -dtb
vexpress-v2p-ca9.dtb -initrd initramfs.cpio.gz -append "console=ttyAMA0 rdinit=/bin/ash"
-nographic
```

```
[    1.709350] input: AT Raw Set 2 keyboard as /devices/platform/bus@40000000/bus@
40000000:motherboard-bus@40000000:iofpga@7,00000000/10006000.kmi/serio0/input/inpu
[    1.737663] 1000c000.serial: ttyAMA3 at MMIO 0x1000c000 (irq = 40, base_baud =
[    1.770259] clk: Disabling unused clocks
[    1.806981] Freeing unused kernel image (initmem) memory: 2048K
[    1.810595] Run /bin/ash as init process
/bin/ash: can't access tty; job control turned off
~ # [    2.167926] input: ImExPS/2 Generic Explorer Mouse as /devices/platform/bus
@40000000:bus@40000000:motherboard-bus@40000000:iofpga@7,00000000/10007000.kmi/ser
uname -a
Linux (none) 6.17.0-rc5 #1 SMP Mon Sep  8 19:53:40 +07 2025 armv7l GNU/Linux
~ #
```

скопировали libc и линкер в директорию /lib прошивки
для проверки скомпилировал hello world и скопировал в /bin
пересобрали initramfs.cpio.gz

```
[    1.965492] Freeing unused kernel image (initmem) memory: 2048K
[    1.968786] Run /bin/ash as init process
/bin/ash: can't access tty; job control turned off
~ # [    2.327170] input: ImExPS/2 Generic Explorer Mouse as /devices/platf
@40000000:bus@40000000:motherboard-bus@40000000:iofpga@7,00000000/10007000.
??
/bin/ash: ды: not found
~ # ls
bin                initramfs.cpio.gz  root                usr
dev                lib                sbin
~ # ./bin/test
Hello World
```

интересно было собрать busybox без статической линковки, поэтому сделал это

```
akenoxd@DESKTOP:~/eltex/busybox-1.37.0/_install$ cd bin/
akenoxd@DESKTOP:~/eltex/busybox-1.37.0/_install/bin$ file busybox
busybox: ELF 32-bit LSB pie executable, ARM, EABI5 version 1 (SYSV), dynamically linked, interpreter /lib/ld-linux-armhf
.so.3, BuildID[sha1]=8c3adb40623aac5ea2db4276afbe8d0d54c195dd, for GNU/Linux 3.2.0, stripped
akenoxd@DESKTOP:~/eltex/busybox-1.37.0/_install/bin$
```

чтобы узнать какие библиотеки нужны busybox для работы, используем readelf -d

```
akenoxd@DESKTOP:~/eltex/busybox-1.37.0/_install$ readelf -d bin/busybox

Dynamic section at offset 0xd4814 contains 30 entries:
  Tag        Type                         Name/Value
 0x00000001 (NEEDED)                     Shared library: [libm.so.6]
 0x00000001 (NEEDED)                     Shared library: [libresolv.so.2]
 0x00000001 (NEEDED)                     Shared library: [libc.so.6]
 0x00000001 (NEEDED)                     Shared library: [ld-linux-armhf.so.3]
 0x0000000c (INIT)                       0x6668
 0x0000000d (FINI)                       0xac40c
 0x00000019 (INIT_ARRAY)                 0xd3f30
```

и копируем эти библиотеки в прошивку
работает!

```
[      2.049766] Freeing unused kernel image (initmem) memory: 2048K
[      2.085923] Run /bin/ash as init process
/bin/ash: can't access tty; job control turned off
~ # [      2.383990] input: ImExPS/2 Generic Explorer Mouse as /devices/platform/bus@40
@40000000/bus@40000000:motherboard-bus@40000000:iofpga@7,00000000/10007000.kmi/serio1
ls
bin                initramfs.cpio.gz  root               usr
dev                lib                sbin
~ # ls lib/
ld-linux-armhf.so.3  libc.so.6              libresolv.so.2
libc.so                libm.so.6
~ #
```