

СБОРКА КОРНЕВОЙ ФАЙЛОВОЙ СИСТЕМЫ

```
user@debian1: ~/linux_arm
user@debian1:~/linux_arm$ arm-linux-gnueabi-gcc -static init.c -o init -Ofast
user@debian1:~/linux_arm$ ls
init  init.c  run.sh  vexpress-v2p-ca9.dtb  zImage
user@debian1:~/linux_arm$ ls --list
ls: unrecognized option '--list'
Try 'ls --help' for more information.
user@debian1:~/linux_arm$ ls -list
total 11904
402737  428 -rwxrwxr-x 1 user user  488420 Sep  8 00:06 init
393463   4 -rw-rw-r-- 1 user user    330 Sep  8 00:05 init.c
393340   4 -rwxrwxr-x 1 user user    121 Sep  7 09:34 run.sh
393338  16 -rw-rw-r-- 1 user user  14329 Sep  7 09:20 vexpress-v2p-ca9.dtb
393337 11452 -rwxrwxr-x 1 user user 11723264 Sep  7 09:04 zImage
user@debian1:~/linux_arm$ file init
init: ELF 32-bit LSB executable, ARM, EABI5 version 1 (GNU/Linux), statically linked, BuildID[sha1]=2a26d63703b78afa0ce85048fd924d44383db2ba, for GNU/Linux 3.2.0, with debug_info, not stripped
user@debian1:~/linux_arm$ ldd init
not a dynamic executable
user@debian1:~/linux_arm$ cat init.c
#include <stdio.h>
#include <unistd.h>
#include <stdlib.h>

int main(int argc, char *argv[]) {
    printf("\n-----HELLO WORLD-----\n");
    for (int i = 0; i < argc; i++) {
        printf("Argument %d: ", i);
        printf("%s\n", argv[i]);
    }
    printf("\n-----END-----\n");
    sleep(20);
    return EXIT_SUCCESS;
}
user@debian1:~/linux_arm$
```

Компилируем программу `init`.

```
user@debian1: ~/linux_arm
[ 1.326193] isp1760 4f000000.usb: new USB bus registered, assigned bus number 1
[ 1.326601] isp1760 4f000000.usb: Scratch test failed. 0x00000000
[ 1.326648] isp1760 4f000000.usb: can't setup: -19
[ 1.326907] isp1760 4f000000.usb: USB bus 1 deregistered
[ 1.331455] usbcore: registered new interface driver usb-storage
[ 1.366814] rtc-pl031 10017000.rtc: registered as rtc0
[ 1.367696] rtc-pl031 10017000.rtc: setting system clock to 2025-09-08T04:14:47 UTC (1757304887)
[ 1.369640] i2c_dev: i2c /dev entries driver
[ 1.393621] mmc-pl18x 10005000.mmc: Got CD GPIO
[ 1.393762] mmc-pl18x 10005000.mmc: Got WP GPIO
[ 1.396589] mmc-pl18x 10005000.mmc: mmc0: PL181 manf 41 rev0 at 0x10005000 irq 31,32 (pio)
[ 1.398358] sdhci: Secure Digital Host Controller Interface driver
[ 1.398371] sdhci: Copyright(c) Pierre Ossman
[ 1.399931] Synopsys Designware Multimedia Card Interface Driver
[ 1.401214] sdhci-pltfm: SDHCI platform and OF driver helper
[ 1.406108] usbcore: registered new interface driver usbhid
[ 1.406131] usbhid: USB HID core driver
[ 1.439917] hw perfevents: enabled with armv7_cortex_a9 PMU driver, 7 (8000003f) counters available
[ 1.442793] NET: Registered PF_INET6 protocol family
[ 1.450239] Segment Routing with IPv6
[ 1.450471] In-situ OAM (IOAM) with IPv6
[ 1.450796] sit: IPv6, IPv4 and MPLS over IPv4 tunneling driver
[ 1.452924] NET: Registered PF_PACKET protocol family
[ 1.452953] can: controller area network core
[ 1.453470] NET: Registered PF_CAN protocol family
[ 1.453525] can: raw protocol
[ 1.453629] can: broadcast manager protocol
[ 1.453722] can: netlink gateway - max_hops=1
[ 1.454672] Key type dns_resolver registered
[ 1.455084] ThumbEE CPU extension supported.
[ 1.455216] Registering SWP/SWPB emulation handler
[ 1.486902] input: AT Raw Set 2 keyboard as /devices/platform/bus@40000000/bus@40000000:motherboard-bus@40000000/bus@40000000:motherboard-bus@40000000:iopfpga@7,00000000/10006000.kmi/serio0/input/input0
[ 1.500673] Loading compiled-in X.509 certificates
[ 1.522064] 10009000.serial: ttyAMA0 at MMIO 0x10009000 (irq = 37, base_baud = 0) is a PL011 rev1
[ 1.535737] printk: console [ttyAMA0] enabled
[ 1.612841] 1000a000.serial: ttyAMA1 at MMIO 0x1000a000 (irq = 38, base_baud = 0) is a PL011 rev1
[ 1.615097] 1000b000.serial: ttyAMA2 at MMIO 0x1000b000 (irq = 39, base_baud = 0) is a PL011 rev1
[ 1.617034] 1000c000.serial: ttyAMA3 at MMIO 0x1000c000 (irq = 40, base_baud = 0) is a PL011 rev1
[ 1.956312] input: ImExPS/2 Generic Explorer Mouse as /devices/platform/bus@40000000/bus@40000000:motherboard-bus@40000000/bus@40000000:motherboard-bus@40000000:iopfpga@7,00000000/10007000.kmi/serio1/input/input2
[ 2.013928] clk: Disabling unused clocks
[ 2.052471] Freeing unused kernel image (initmem) memory: 2048K
[ 2.057231] Run /init as init process

-----HELLO WORLD-----
Argument 0: /init

-----END-----
[ 12.637992] amba 1000f000.wdt: deferred probe pending: (reason unknown)
[ 12.638260] amba 100e0000.memory-controller: deferred probe pending: (reason unknown)
[ 12.638310] amba 100e1000.memory-controller: deferred probe pending: (reason unknown)
[ 12.638342] amba 100e5000.watchdog: deferred probe pending: (reason unknown)
[ 22.129358] Kernel panic - not syncing: Attempted to kill init! exitcode=0x00000000
[ 22.131587] CPU: 0 UID: 0 PID: 1 Comm: init Not tainted 6.17.0-rc4 #1 NONE
[ 22.132255] Hardware name: ARM-Versatile Express
[ 22.132941] Call trace:
[ 22.134349] unwind_backtrace from show_stack+0x10/0x14
[ 22.136433] show_stack from dump_stack_lvl+0x54/0x68
[ 22.136839] dump_stack_lvl from vpanic+0xf4/0x300
[ 22.137259] vpanic from __do_trace_suspend_resume+0x0/0x4c
[ 22.138788] ---[ end Kernel panic - not syncing: Attempted to kill init! exitcode=0x00000000 ]---
```

Запускаем в QEMU.

```
user@debian1: ~/busybox-1.37.0
*** Execute 'make' to build the project or try 'make help'.

user@debian1:~/busybox-1.37.0$ ARCH=arm CROSS_COMPILE=arm-linux-gnueabihf- make menuconfig
scripts/kconfig/mconf Config.in
#
# using defaults found in .config
#

*** End of configuration.
*** Execute 'make' to build the project or try 'make help'.

*** End of configuration.
*** Execute 'make' to build the project or try 'make help'.

user@debian1:~/busybox-1.37.0$ ARCH=arm CROSS_COMPILE=arm-linux-gnueabihf- make menuconfig
scripts/kconfig/mconf Config.in
#
# using defaults found in .config
#

*** End of configuration.
*** Execute 'make' to build the project or try 'make help'.

*** End of configuration.
*** Execute 'make' to build the project or try 'make help'.

user@debian1:~/busybox-1.37.0$ ARCH=arm CROSS_COMPILE=arm-linux-gnueabihf- make -j4_
```

Кросс-компилируем **busybox**

```
user@debian1: ~/busybox-1.37.0

./_install//usr/sbin/readahead -> ../../bin/busybox
./_install//usr/sbin/readprofile -> ../../bin/busybox
./_install//usr/sbin/remove-shell -> ../../bin/busybox
./_install//usr/sbin/rtcwake -> ../../bin/busybox
./_install//usr/sbin/seedrng -> ../../bin/busybox
./_install//usr/sbin/sendmail -> ../../bin/busybox
./_install//usr/sbin/setfont -> ../../bin/busybox
./_install//usr/sbin/setlogcons -> ../../bin/busybox
./_install//usr/sbin/svlogd -> ../../bin/busybox
./_install//usr/sbin/telnetd -> ../../bin/busybox
./_install//usr/sbin/tftpd -> ../../bin/busybox
./_install//usr/sbin/ubiattach -> ../../bin/busybox
./_install//usr/sbin/ubidetach -> ../../bin/busybox
./_install//usr/sbin/ubimkvol -> ../../bin/busybox
./_install//usr/sbin/ubirename -> ../../bin/busybox
./_install//usr/sbin/ubirmvol -> ../../bin/busybox
./_install//usr/sbin/ubirsvol -> ../../bin/busybox
./_install//usr/sbin/ubiupdatevol -> ../../bin/busybox
./_install//usr/sbin/udhcpd -> ../../bin/busybox

-----
You will probably need to make your busybox binary
setuid root to ensure all configured applets will
work properly.
-----

user@debian1:~/busybox-1.37.0$ ls
applets          configs          _install        make_single_applets.sh  selinux
applets_sh       console-tools   INSTALL         miscutils             shell
arch             coreutils       klibc-utils     modutils              size_single_applets.sh
archival         debianutils     libbb           networking            syslogd
AUTHORS          docs            libpwdgrp       NOFORK_NOEXEC.lst    testsuite
busybox          e2fsprogs      LICENSE         NOFORK_NOEXEC.sh     TODO
busybox_ldscript.README.txt  editors         loginutils      printutils            TODO_unicode
busybox.links    examples        mailutils       procps                util-linux
busybox_unstripped  findutils      Makefile        qemu_multiarch_testing
busybox_unstripped.map  gcc_14.patch  Makefile.custom  README
busybox_unstripped.out  include        Makefile.flags   runit
Config.in         init           Makefile.help    scripts

user@debian1:~/busybox-1.37.0$ ls _install/
bin linuxrc sbin usr
user@debian1:~/busybox-1.37.0$ cat gcc_14.patch
---
libbb/hash_md5_sha.c | 2 ++
1 file changed, 2 insertions(+)

diff --git a/libbb/hash_md5_sha.c b/libbb/hash_md5_sha.c
index 57a801459..75a61c32c 100644
--- a/libbb/hash_md5_sha.c
+++ b/libbb/hash_md5_sha.c
@@ -1313,7 +1313,9 @@ unsigned FAST_FUNC sha1_end(sha1_ctx_t *ctx, void *resbuf)
     hash_size = 8;
     if (ctx->process_block == sha1_process_block64
        #if ENABLE_SHA1_HWACCEL
+    if defined(__GNUC__) && (defined(__i386__) || defined(__x86_64__))
        || ctx->process_block == sha1_process_block64_shaNI
+    endif
    #endif
    ) {
         hash_size = 5;
    }
--
user@debian1:~/busybox-1.37.0$ ARCH=arm CROSS_COMPILE=arm-linux-gnueabihf- make install
```

Просто так он не собирался, нужно было пропатчить пару файлов.

```
user@debian1: ~/linux_arm
[ 1.553224] usbcore: registered new interface driver cdc_subset
[ 1.553281] usbcore: registered new interface driver zaurus
[ 1.553340] usbcore: registered new interface driver cdc_ncm
[ 1.680916] isp1760 4f000000.usb: isp1760 bus width: 32, oc: digital
[ 1.681464] isp1760 4f000000.usb: NXP ISP1760 USB Host Controller
[ 1.681603] isp1760 4f000000.usb: new USB bus registered, assigned bus number 1
[ 1.682036] isp1760 4f000000.usb: Scratch test failed. 0x00000000
[ 1.682075] isp1760 4f000000.usb: can't setup: -19
[ 1.682233] isp1760 4f000000.usb: USB bus 1 deregistered
[ 1.687266] usbcore: registered new interface driver usb-storage
[ 1.702062] rtc-pl031 10017000.rtc: registered as rtc0
[ 1.702786] rtc-pl031 10017000.rtc: setting system clock to 2025-09-08T18:05:55 UTC (1757354755)
[ 1.704946] i2c_dev: i2c /dev entries driver
[ 1.741097] mmci-pl18x 10005000.mmci: Got CD GPIO
[ 1.741236] mmci-pl18x 10005000.mmci: Got WP GPIO
[ 1.743995] mmci-pl18x 10005000.mmci: mmc0: PL181 manf 41 rev0 at 0x10005000 irq 31,32 (pio)
[ 1.745794] sdhci: Secure Digital Host Controller Interface driver
[ 1.745809] sdhci: Copyright(c) Pierre Ossman
[ 1.747526] Synopsys Designware Multimedia Card Interface Driver
[ 1.749351] sdhci-pltfm: SDHCI platform and OF driver helper
[ 1.754558] usbcore: registered new interface driver usbhid
[ 1.754581] usbhid: USB HID core driver
[ 1.784090] hw perfevents: enabled with armv7_cortex_a9 PMU driver, 7 (8000003f) counters available
[ 1.787201] NET: Registered PF_INET6 protocol family
[ 1.811078] Segment Routing with IPv6
[ 1.811247] In-situ OAM (IOAM) with IPv6
[ 1.811626] sit: IPv6, IPv4 and MPLS over IPv4 tunneling driver
[ 1.814477] NET: Registered PF_PACKET protocol family
[ 1.814511] can: controller area network core
[ 1.814808] NET: Registered PF_CAN protocol family
[ 1.814849] can: raw protocol
[ 1.814950] can: broadcast manager protocol
[ 1.815055] can: netlink gateway - max_hops=1
[ 1.816093] Key type dns_resolver registered
[ 1.816554] ThumbEE CPU extension supported.
[ 1.816608] Registering SWP/SWPB emulation handler
[ 1.831167] input: AT Raw Set 2 keyboard as /devices/platform/bus@40000000/bus@40000000:motherboard-bus@40000000/bus@40000000:motherboard-bus@40000000:iofpga@7,00000000/10006000.kmi/serio0/input/input0
[ 1.872979] Loading compiled-in X.509 certificates
[ 1.887428] 10009000.serial: ttyAMA0 at MMIO 0x10009000 (irq = 37, base_baud = 0) is a PL011 rev1
[ 1.890177] printk: console [ttyAMA0] enabled
[ 1.967825] 1000a000.serial: ttyAMA1 at MMIO 0x1000a000 (irq = 38, base_baud = 0) is a PL011 rev1
[ 1.970212] 1000b000.serial: ttyAMA2 at MMIO 0x1000b000 (irq = 39, base_baud = 0) is a PL011 rev1
[ 1.972307] 1000c000.serial: ttyAMA3 at MMIO 0x1000c000 (irq = 40, base_baud = 0) is a PL011 rev1
[ 2.272937] input: ImExPS/2 Generic Explorer Mouse as /devices/platform/bus@40000000/bus@40000000:motherboard-bus@40000000/bus@40000000:motherboard-bus@40000000:iofpga@7,00000000/10007000.kmi/serio1/input/input2
[ 2.308209] clk: Disabling unused clocks
[ 2.349499] Freeing unused kernel image (initmem) memory: 2048K
[ 2.352736] Run /bin/ash as init process
/bin/ash: can't access tty; job control turned off
~ # uname -a
Linux (none) 6.17.0-rc4 #1 SMP Sun Sep 7 08:57:49 EDT 2025 armv7l GNU/Linux
~ # [ 12.630627] amba 1000f000.wdt: deferred probe pending: (reason unknown)
[ 12.630727] amba 100e0000.memory-controller: deferred probe pending: (reason unknown)
[ 12.630745] amba 100e1000.memory-controller: deferred probe pending: (reason unknown)
[ 12.630758] amba 100e5000.watchdog: deferred probe pending: (reason unknown)

~ # ls
bin          initramfs.cpio.gz  sbin
dev          root               usr
~ # echo "Hello From BusyBox"
Hello From BusyBox
~ #
```

Запускаем **busybox** в QEMU.


```

user@debian1: ~/linux_arm
/usr/lib/gcc-cross/arm-linux-gnueabi/14/../../../../arm-linux-gnueabi/bin/ld: generated/obj/hostname.o: in function `hostname_main':
hostname.c:(.text.hostname_main+0x62): warning: Using 'gethostbyname' in statically linked applications requires at runtime the shared libraries from the glibc version used for linking
/usr/lib/gcc-cross/arm-linux-gnueabi/14/../../../../arm-linux-gnueabi/bin/ld: generated/obj/hostname.o: note: the message above does not take linker garbage collection into account
/usr/lib/gcc-cross/arm-linux-gnueabi/14/../../../../arm-linux-gnueabi/bin/ld: generated/obj/lib_xwrap.o: in function `xgetuid':
xwrap.c:(.text.xgetuid+0x4): warning: Using 'getpwnam' in statically linked applications requires at runtime the shared libraries from the glibc version used for linking
/usr/lib/gcc-cross/arm-linux-gnueabi/14/../../../../arm-linux-gnueabi/bin/ld: generated/obj/lib_xwrap.o: note: the message above does not take linker garbage collection into account
/usr/lib/gcc-cross/arm-linux-gnueabi/14/../../../../arm-linux-gnueabi/bin/ld: generated/obj/lib_lib.o: in function `bufgetpwnamuid':
lib.c:(.text.bufgetpwnamuid+0x48): warning: Using 'getpwnam_r' in statically linked applications requires at runtime the shared libraries from the glibc version used for linking
/usr/lib/gcc-cross/arm-linux-gnueabi/14/../../../../arm-linux-gnueabi/bin/ld: generated/obj/lib_lib.o: note: the message above does not take linker garbage collection into account
/usr/lib/gcc-cross/arm-linux-gnueabi/14/../../../../arm-linux-gnueabi/bin/ld: generated/obj/lib_xwrap.o: in function `xgetpwuid':
xwrap.c:(.text.xgetpwuid+0x4): warning: Using 'getpwuid' in statically linked applications requires at runtime the shared libraries from the glibc version used for linking
/usr/lib/gcc-cross/arm-linux-gnueabi/14/../../../../arm-linux-gnueabi/bin/ld: generated/obj/lib_xwrap.o: note: the message above does not take linker garbage collection into account
/usr/lib/gcc-cross/arm-linux-gnueabi/14/../../../../arm-linux-gnueabi/bin/ld: generated/obj/lib_lib.o: in function `bufgetpwnamuid':
lib.c:(.text.bufgetpwnamuid+0x82): warning: Using 'getpwuid_r' in statically linked applications requires at runtime the shared libraries from the glibc version used for linking
/usr/lib/gcc-cross/arm-linux-gnueabi/14/../../../../arm-linux-gnueabi/bin/ld: generated/obj/lib_lib.o: note: the message above does not take linker garbage collection into account
/usr/lib/gcc-cross/arm-linux-gnueabi/14/../../../../arm-linux-gnueabi/bin/ld: generated/obj/netstat.o: in function `addr2str':
netstat.c:(.text.addr2str+0x110): warning: Using 'getservbyport' in statically linked applications requires at runtime the shared libraries from the glibc version used for linking
/usr/lib/gcc-cross/arm-linux-gnueabi/14/../../../../arm-linux-gnueabi/bin/ld: generated/obj/netstat.o: note: the message above does not take linker garbage collection into account
..
user@debian1:~/toybox-0.8.12$ PREFIX=./_install make install
scripts/install.sh --long --symlink --force
Compile instlist...
Install commands...
user@debian1:~/toybox-0.8.12$ cd _install/
user@debian1:~/toybox-0.8.12/_install$ ls
bin sbin usr
user@debian1:~/toybox-0.8.12/_install$ cd bin/
user@debian1:~/toybox-0.8.12/_install/bin$ ls
['      chmod  df      fgrep  ln      mountpoint  printenv  sh      true
bash      chown  dmesg  fstype  ls      mv          ps      sleep  umount
blkdiscard cksum  dnsdomainname fsync   lsattr  netcat      pwd       stat   uname
blkid     cp     dos2unix  grep   mkdir   netstat     readahead sync   unix2dos
cat       cpio  echo     help   mknod   nice        rm        touch  usleep
chattr    crc32  egrep    hostname mktemp  openvt     rmdir    toybox vmstat
chgrp     date  false    kill   mount   pidof       sed       toysh
user@debian1:~/toybox-0.8.12/_install/bin$ cd ..
user@debian1:~/toybox-0.8.12/_install$ ls
bin sbin usr
user@debian1:~/toybox-0.8.12/_install$ find . | cpio -o -H crc | gzip > initramfs.cpio.gz
2220 blocks
user@debian1:~/toybox-0.8.12/_install$ cp initramfs.cpio.gz ~/linux_arm/
user@debian1:~/toybox-0.8.12/_install$ cd ~/linux_arm/
user@debian1:~/linux_arm$ ls
FS init.c initramfs.cpio.gz run.sh vexpress-v2p-ca9.dtb zImage
user@debian1:~/linux_arm$

```

Бonus: кросс-компиляция **toybox**.

```

user@debian1: ~/linux_arm
[ 1.582741] Synopsys Designware Multimedia Card Interface Driver
[ 1.584018] sdhci-pltfm: SDHCI platform and OF driver helper
[ 1.588548] usbcore: registered new interface driver usbhid
[ 1.588570] usbhid: USB HID core driver
[ 1.592614] mmci-pl18x 10005000.mmci: mmc0: PL181 manf 41 rev0 at 0x10005000 irq 31,32 (pio)
[ 1.628344] hw perfevents: enabled with armv7_cortex_a9 PMU driver, 7 (8000003f) counters available
[ 1.632128] NET: Registered PF_INET6 protocol family
[ 1.640399] Segment Routing with IPv6
[ 1.640566] In-situ OAM (IOAM) with IPv6
[ 1.640918] sit: IPv6, IPv4 and MPLS over IPv4 tunneling driver
[ 1.643282] NET: Registered PF_PACKET protocol family
[ 1.643317] can: controller area network core
[ 1.643609] NET: Registered PF_CAN protocol family
[ 1.643651] can: raw protocol
[ 1.643760] can: broadcast manager protocol
[ 1.643862] can: netlink gateway - max_hops=1
[ 1.644844] Key type dns_resolver registered
[ 1.645276] ThumbEE CPU extension supported.
[ 1.645329] Registering SWP/SWPB emulation handler
[ 1.659691] input: AT Raw Set 2 keyboard as /devices/platform/bus@40000000/bus@40000000:motherboard-bus@40000000/bus@40000000:motherboard-bus@40000000:iofpga@7,00000000/10006000.kmi/serio0/input/input0
[ 1.700694] Loading compiled-in X.509 certificates
[ 1.715483] 10009000.serial: ttyAMA0 at MMIO 0x10009000 (irq = 37, base_baud = 0) is a PL011 rev1
[ 1.726626] printk: console [ttyAMA0] enabled
[ 1.796930] 1000a000.serial: ttyAMA1 at MMIO 0x1000a000 (irq = 38, base_baud = 0) is a PL011 rev1
[ 1.798532] 1000b000.serial: ttyAMA2 at MMIO 0x1000b000 (irq = 39, base_baud = 0) is a PL011 rev1
[ 1.800476] 1000c000.serial: ttyAMA3 at MMIO 0x1000c000 (irq = 40, base_baud = 0) is a PL011 rev1
[ 2.116346] input: ImExPS/2 Generic Explorer Mouse as /devices/platform/bus@40000000/bus@40000000:motherboard-bus@40000000/bus@40000000:motherboard-bus@40000000:iofpga@7,00000000/10007000.kmi/serio1/input/input2
[ 2.285930] clk: Disabling unused clocks
[ 2.332548] Freeing unused kernel image (initmem) memory: 2048K
[ 2.335738] Run /bin/sh as init process
$ ls
bin dev initramfs.cpio.gz root sbin usr
$ uname -a
Linux (none) 6.17.0-rc4 #1 SMP Sun Sep  7 08:57:49 EDT 2025 armv7l Toybox
$ [ 12.630228] amba 1000f000.wdt: deferred probe pending: (reason unknown)
[ 12.630291] amba 100e0000.memory-controller: deferred probe pending: (reason unknown)
[ 12.630300] amba 100e1000.memory-controller: deferred probe pending: (reason unknown)
[ 12.630307] amba 100e5000.watchdog: deferred probe pending: (reason unknown)
$ ls bin
[
bash      cpio      fstype    mktemp    pwd       toysh
blkdiscard  crc32     fsync     mount     readahead true
blkid      date      grep      mountpoint rm         umount
cat        dmesg     help      mv         rmdir     uname
chatr      dnsdomainname kill      netcat    sed        unix2dos
chgrp      dos2unix  ln        nice       sleep     usleep
chmod      echo      ls        openvt    stat       vmstat
chown      egrep     lsattr    pidof     sync
cksum      false     mkdir     printenv  touch
cp         fgrep     mknod     ps        toybox
$ mkdir proc
$ mount -t proc proc proc
$ mkdir sys
$ ps
  PID TTY          TIME CMD
$ ip a
sh: ip: No such file or directory
$ echo "Hello from ToyBox"
Hello from ToyBox
$

```

Заняты **toybox** в QEMU.

```
user@debian1: ~/linux_arm
tftp
time
touch
tr
true
tsort
tty
uname
unexpand
uniq
unlink
uudecode
uuencode
wc
which
whoami
xargs
xinstall
yes
# uname -a
Linux (none) 6.17.0-rc4 #1 SMP Sun Sep  7 08:57:49 EDT 2025 armv7l
# echo "Hello from sbase + dash"
Hello from sbase + dash
```

Бонус 2: Кросс-компиляция и запуск **sbase (suckless base) + dash** в QEMU.

```
user@debian1:~/sbase$ make sbase-box-install
scripts/mkbox
arm-linux-gnueabihf-gcc -O1 -D_DEFAULT_SOURCE -D_NETBSD_SOURCE -D_BSD_SOURCE -D_XOPEN_SOURCE=700 -D_FILE_OFFSET_BITS=64 --static -o sbase-box build/*.c libutf.a libutil.a
/usr/lib/gcc-cross/arm-linux-gnueabihf/14/../../../../arm-linux-gnueabihf/bin/ld: /tmp/ccWBRIQH.o: in function
`pri_nogroup':
find.c:(.text+0xa1e): warning: Using 'getgrgid' in statically linked applications requires at runtime the shared
libraries from the glibc version used for linking
/usr/lib/gcc-cross/arm-linux-gnueabihf/14/../../../../arm-linux-gnueabihf/bin/ld: /tmp/ccMnF8Za.o: in function
`chgrp_main':
chgrp.c:(.text+0x124): warning: Using 'getgrnam' in statically linked applications requires at runtime the shared
libraries from the glibc version used for linking
/usr/lib/gcc-cross/arm-linux-gnueabihf/14/../../../../arm-linux-gnueabihf/bin/ld: /tmp/ccCOK0kF.o: in function
`tftp_main':
tftp.c:(.text+0x508): warning: Using 'getaddrinfo' in statically linked applications requires at runtime the shared
libraries from the glibc version used for linking
/usr/lib/gcc-cross/arm-linux-gnueabihf/14/../../../../arm-linux-gnueabihf/bin/ld: /tmp/ccF5ypgK.o: in function
`chown_main':
chown.c:(.text+0x358): warning: Using 'getpwnam' in statically linked applications requires at runtime the shared
libraries from the glibc version used for linking
/usr/lib/gcc-cross/arm-linux-gnueabihf/14/../../../../arm-linux-gnueabihf/bin/ld: /tmp/ccWBRIQH.o: in function
`pri_nouser':
find.c:(.text+0xa30): warning: Using 'getpwuid' in statically linked applications requires at runtime the shared
libraries from the glibc version used for linking
scripts/mkproto ./_install ./_install/share/man proto
scripts/install proto
./_install/bin/sbase-box -i ./_install/bin/
./_install/bin/sbase-box: 1: Syntax error: word unexpected (expecting ")")
make: *** [Makefile:232: sbase-box-install] Error 2
user@debian1:~/sbase$ ls _install/
bin share
user@debian1:~/sbase$ ls _install/bin/
basename  cols      echo      getconf   logname   nl         renice    sha224sum  sponge    touch     uudecode
cal        comm      ed         grep      ls         nohup     rev        sha256sum  strings   tr         uuencode
cat        cp        env         head      md5sum    od         rm         sha384sum  sync      true      wc
chgrp      cron      expand      hostname  mkdir     paste     rmdir     sha512-224sum  tail     tsort     which
chmod      cut       expr       join      mkfifo    pathchk   sbase-box  sha512-256sum  tar      tty       whoami
chown      date      false      kill      mknod     printenv  sed        sha512sum    tee      uname     xargs
chroot     dd        find       link      mktemp    printf    seq        sleep       test     unexpand  xinstall
cksum      dirname   flock      ln         mv         pwd       setuid     sort       tftp     uniq      yes
cmp        du        fold       logger    nice      readlink  sha1sum    split      time     unlink

user@debian1:~/sbase$ file _install/bin/sbase-box
_install/bin/sbase-box: ELF 32-bit LSB executable, ARM, EABI5 version 1 (GNU/Linux), statically linked, BuildID[sha1]=c94a64b092abf7d81b196ddb18a878df4b94235, for GNU/Linux 3.2.0, not stripped
user@debian1:~/sbase$ cd
user@debian1:~/dash-0.5.12$ PREFIX=~/.sbasedash/_install/bin/ CC=arm-linux-gnueabihf-gcc LDFLAGS="--static" ./configure --host=arm-linux-gnueabihf
```



```

user@debian1:~/dash-0.5.12$ ls
aclocal.m4  config.h      config.status  COPYING      install-sh    Makefile.in  stamp-h1
ChangeLog  config.h.in  configure      depcomp     Makefile      missing
compile    config.log   configure.ac   INSTALL     Makefile.am   src
user@debian1:~/dash-0.5.12$ ls src/
alias.c      cd.c      expand.c    machdep.h   miscbltin.h  mystring.h   parser.h     system.c
alias.h      cd.h      expand.h    mail.c      miscbltin.o  mystring.o   parser.o     system.h
alias.o      cd.o      expand.o    mail.h      mkbuiltins   nodes.c      redir.c      system.o
arith_yacc.c dash      histedit.c mail.o      mkinit       nodes.c.pat  redir.h      token.h
arith_yacc.h dash.1    histedit.o main.c      mkinit.c     nodes.h      redir.o      token_vars.h
arith_yacc.o error.c   init.c     main.h      mknodes      nodes.o      shell.h      trap.c
arith_yylex.c error.h   init.h     main.o      mknodes.c    nodetypes    show.c       trap.h
arith_yylex.o error.o   init.o     Makefile    mksignames   options.c    show.h       trap.o
bltin        eval.c   input.c    Makefile.am mksignames.c options.h     show.o       var.c
builtins.c   eval.h   input.h    Makefile.in mksyntax     options.o    signames.c   var.h
builtins.def eval.o   input.o    memalloc.c  mksyntax.c   output.c     signames.o   var.o
builtins.def.in exec.c   jobs.c     memalloc.h  mktokens     output.h     syntax.c
builtins.h   exec.h   jobs.h     memalloc.o  myhistedit.h output.o      syntax.h
builtins.o   exec.o   jobs.o     miscbltin.c mystring.c    parser.c     syntax.o
user@debian1:~/dash-0.5.12$ file src/dash
src/dash: ELF 32-bit LSB executable, ARM, EABI5 version 1 (GNU/Linux), statically linked, BuildID[sha1]=bd6d4e7cf77c2dd6d741c10bae3e229a13db61b7, for GNU/Linux 3.2.0, with debug info, not stripped

```