

The kernel first mounts the rootfs located in ram (ramfs) and runs the init process for this root. The rootramfs contains only the minimum necessary binaries such as mount and chroot that are required to run its init process along with minimum utilities such as ls and cat, etc.. The init process runs a bash script and requires input from the user:

1- if the user enters 1 it mounts the rootfs on partition 2 mmcblk0p2, changes its root to it and then runs the init process for that rootfs (Busy box init process)

2- if the user enters 2 it mounts the rootfs on partition 3 instead

3- if the user enters 3 it just opens a shell for the user and remains on the ramfs

The binaries for the rootramfs were statically compiled while the binaries for the rootfs on the block devices 2 and 3 were dynamically linked.

1- compiling the kernel:

```

adhamwala@adhamwala-G3-3500: ~/embedded_linux_kitchen... x adhamwala@adhamwala-G3-3500: ~/embedded_linux_kitchen... x adhamwala@adhamwala-G3-3500: ~/embedded_linux_kitchen...
adhamwala@adhamwala-G3-3500:~/embedded_linux_kitchen/linux$ export ARCH=arm
adhamwala@adhamwala-G3-3500:~/embedded_linux_kitchen/linux$ cd arch/arm/
boot/ mach-alpine/ mach-davinci/ mach-hpe/ mach-mmp/ mach-omap1/ mach-s3c/ mach-sunxi/ nwfpe/
common/ mach-artpec/ mach-digicolor/ mach-imx/ mach-moxart/ mach-omap2/ mach-s5pv210/ mach-tegra/ plat-orion/
configs/ mach-asm9260/ mach-dove/ mach-ixp4xx/ mach-mstar/ mach-orion5x/ mach-sa1100/ mach-uniphier/ probes/
crypto/ mach-aspeed/ mach-ep93xx/ mach-keystone/ mach-mv78xx0/ mach-pxa/ mach-shmobile/ mach-ux500/ tools/
include/ mach-at91/ mach-exynos/ mach-lpc18xx/ mach-mvebu/ mach-qcom/ mach-socfpga/ mach-versatile/ vdsol/
kernel/ mach-axxia/ mach-footbridge/ mach-lpc32xx/ mach-mxs/ mach-rda/ mach-spear/ mach-vt8500/ vfp/
lib/ mach-bcm/ mach-gemini/ mach-mediatek/ mach-nomadik/ mach-realtek/ mach-sti/ mach-zynq/ xen/
mach-actions/ mach-berlin/ mach-highbank/ mach-meson/ mach-npcm/ mach-rockchip/ mach-stm32/ mm/
mach-a1roha/ mach-clps711x/ mach-hisi/ mach-milbeaut/ mach-nspire/ mach-rpc/ mach-sunplus/ net/
adhamwala@adhamwala-G3-3500:~/embedded_linux_kitchen/linux$ cd arch/arm/configs/
adhamwala@adhamwala-G3-3500:~/embedded_linux_kitchen/linux/arch/arm/configs$ ls | grep vex
vexpress_defconfig
adhamwala@adhamwala-G3-3500:~/embedded_linux_kitchen/linux/arch/arm/configs$ cd ../../
adhamwala@adhamwala-G3-3500:~/embedded_linux_kitchen/linux/arch$ cd ..
adhamwala@adhamwala-G3-3500:~/embedded_linux_kitchen/linux$ make vexpress_defconfig
#
# configuration written to .config
adhamwala@adhamwala-G3-3500:~/embedded_linux_kitchen/linux$

```

```

adhamwala@adhamwala-G3-3500: ~/embedded_linux_kitchen... x adhamwala@adhamwala-G3-3500: ~/embedded_linux_kitchen... x adhamwala@adhamwala-G3-3500: ~/embedded_linux_kitchen...
adhamwala@adhamwala-G3-3500:~/embedded_linux_kitchen/linux$ export ARCH=arm
adhamwala@adhamwala-G3-3500:~/embedded_linux_kitchen/linux$ cd arch/arm/
boot/ mach-alpine/ mach-davinci/ mach-hpe/ mach-mmp/ mach-omap1/ mach-s3c/ mach-sunxi/ nwfpe/
common/ mach-artpec/ mach-digicolor/ mach-imx/ mach-moxart/ mach-omap2/ mach-s5pv210/ mach-tegra/ plat-orion/
configs/ mach-asm9260/ mach-dove/ mach-ixp4xx/ mach-mstar/ mach-orion5x/ mach-sa1100/ mach-uniphier/ probes/
crypto/ mach-aspeed/ mach-ep93xx/ mach-keystone/ mach-mv78xx0/ mach-pxa/ mach-shmobile/ mach-ux500/ tools/
include/ mach-at91/ mach-exynos/ mach-lpc18xx/ mach-mvebu/ mach-qcom/ mach-socfpga/ mach-versatile/ vdsol/
kernel/ mach-axxia/ mach-footbridge/ mach-lpc32xx/ mach-mxs/ mach-rda/ mach-spear/ mach-vt8500/ vfp/
lib/ mach-bcm/ mach-gemini/ mach-mediatek/ mach-nomadik/ mach-realtek/ mach-sti/ mach-zynq/ xen/
mach-actions/ mach-berlin/ mach-highbank/ mach-meson/ mach-npcm/ mach-rockchip/ mach-stm32/ mm/
mach-a1roha/ mach-clps711x/ mach-hisi/ mach-milbeaut/ mach-nspire/ mach-rpc/ mach-sunplus/ net/
adhamwala@adhamwala-G3-3500:~/embedded_linux_kitchen/linux$ cd arch/arm/configs/
adhamwala@adhamwala-G3-3500:~/embedded_linux_kitchen/linux/arch/arm/config$ ls | grep vex
vexpress_defconfig
adhamwala@adhamwala-G3-3500:~/embedded_linux_kitchen/linux/arch/arm/config$ cd ../../
adhamwala@adhamwala-G3-3500:~/embedded_linux_kitchen/linux/arch$ cd ..
adhamwala@adhamwala-G3-3500:~/embedded_linux_kitchen/linux$ make vexpress_defconfig
#
# configuration written to .config
adhamwala@adhamwala-G3-3500:~/embedded_linux_kitchen/linux$ make menuconfig
*** End of the configuration.
*** Execute 'make' to start the build or try 'make help'.
adhamwala@adhamwala-G3-3500:~/embedded_linux_kitchen/linux$ make -j12

```

Building binaries using busy box

```
adhamwala@adhamwala-G3-3500: ~/embedded_linux_kitch... x adhamwala@adhamwala-G3-3500: ~/embedded_linux_kitch... x adhamwala@adhamwala-G3-3500: ~/embedded_linux_kitch...
adhamwala@adhamwala-G3-3500:~/embedded_linux_kitchen/busybox$ 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'.
adhamwala@adhamwala-G3-3500:~/embedded_linux_kitchen/busybox$ export ARCH=arm
adhamwala@adhamwala-G3-3500:~/embedded_linux_kitchen/busybox$ export CROSS_COMPILE=~/.x-tools/arm-cortexa9_neon-linux-gnueabi/bin/arm-cortexa9_neon-linux-gnueabi-
adhamwala@adhamwala-G3-3500:~/embedded_linux_kitchen/busybox$ make -j12
```

```
adhamwala@adhamwala-G3-3500: ~/embedded_linux_kitch... x adhamwala@adhamwala-G3-3500: ~/embedded_linux_kitch... x adhamwala@adhamwala-G3-3500: ~/embedded_linux_kitch...
BusyBox 1.36.0 Configuration

                                Settings
Arrow keys navigate the menu. <Enter> selects submenus --->. Highlighted letters are hotkeys. Pressing <Y> includes, <N> excludes, <M> modularizes features.
Press <Esc><Esc> to exit, <?> for Help, </> for Search. Legend: [*] built-in [ ] excluded <M> module < > module capable

( )
[*] Clean up all memory before exiting (usually not needed)
[*] Support LOG_INFO level syslog messages
--- Build Options
[*] Build static binary (no shared libs)
[ ] Force NOMMU build
( ) Cross compiler prefix
( ) Path to sysroot
( ) Additional CFLAGS
( ) Additional LDFLAGS
( ) Additional LDLIBS
[ ] Avoid using GCC-specific code constructs
[*] Use -mpreferred-stack-boundary=2 on i386 arch
[*] Use -static-libgcc
--- Installation Options ("make install" behavior)
What kind of applet links to install (as soft-links) --->
(./_install) Destination path for 'make install'
--- Debugging Options
[ ] Build with debug information
[ ] Enable runtime sanitizers (ASAN/LSAN/USAN/etc...)
[ ] Build unit tests
```

Compressing the ramfs for u-boot:

```
./bin/mktemp
./bin/resume
./bin/reformime
./bin/sync
4104 blocks
adhamwalaa@adhamwalaa-G3-3500:~/embedded_linux_kitchen/rootramfs$ cd ..
adhamwalaa@adhamwalaa-G3-3500:~/embedded_linux_kitchen$ ls
busybox  crosstool-ng  initramfs.cpio  linux  qemu  rootramfs  rpi  u-boot
adhamwalaa@adhamwalaa-G3-3500:~/embedded_linux_kitchen$ gzip initramfs.cpio
adhamwalaa@adhamwalaa-G3-3500:~/embedded_linux_kitchen$ mkimage -A arm -O linux
-T ramdisk -d initramfs.cpio.gz uRamdisk
Image Name:
Created:      Mon Feb 10 00:19:58 2025
Image Type:   ARM Linux RAMDisk Image (gzip compressed)
Data Size:    1121862 Bytes = 1095.57 KiB = 1.07 MiB
Load Address: 00000000
Entry Point:  00000000
adhamwalaa@adhamwalaa-G3-3500:~/embedded_linux_kitchen$ ls
busybox  initramfs.cpio.gz  qemu  rpi  uRamdisk
crosstool-ng  linux  rootramfs  u-boot
adhamwalaa@adhamwalaa-G3-3500:~/embedded_linux_kitchen$ sudo cp uRamdisk /media/
adhamwalaa/boot/
adhamwalaa@adhamwalaa-G3-3500:~/embedded_linux_kitchen$
```

Kernel panic after user switches to mmcblk0p2 since the new root doesn't have an init process yet:

```
initramfs> 1
Mounting new root from /dev/mmcblk0p2...
EXT4-fs (mmcblk0p2): mounted filesystem 52344936-6f28-403c-b78c-3adc8c019d7e r/w with ordered data mode. Quota mode: disabled.
Root filesystem mounted successfully!
Switching to new root...
switch_root: '/init' is not a regular file
Kernel panic - not syncing: Attempted to kill init! exitcode=0x00000100
CPU: 0 PID: 1 Comm: switch_root Not tainted 6.6.74+ #1
Hardware name: ARM-Versatile Express
unwind_backtrace from show_stack+0x10/0x14
show_stack from dump_stack_lvl+0x50/0x68
dump_stack_lvl from panic+0x108/0x31c
panic from make_task_dead+0x0/0x16c
---[ end Kernel panic - not syncing: Attempted to kill init! exitcode=0x00000100 ]---
```