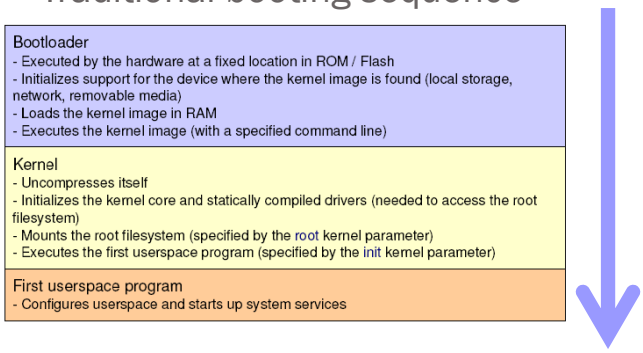
06-4 initramfs

6.4 Initial RAM Disk

- Need to mount an early root file system for certain startup-related initialization
- Two approaches
- **`initrd`**
  - Used in angstrom
- **`initramfs`**
  - Newer method

Traditional booting sequence



From Free Electrons: http://free-electrons.com/blog/beagle-labs/

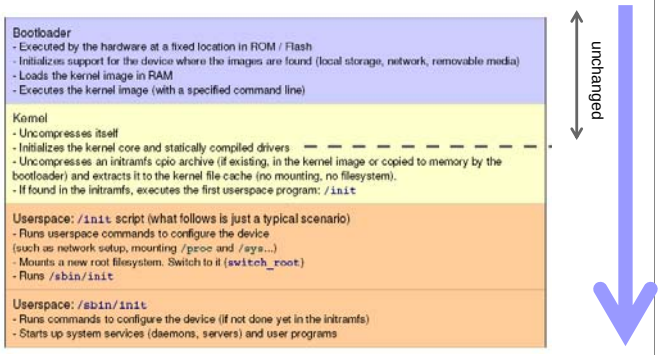
Drawbacks

- Assumption that all device drivers needed to mount the root filesystem (storage and filesystem drivers) are statically compiled inside the kernel
- Assumption can be *correct* for most embedded systems, where the hardware is known and the kernel can be fine-tuned for the system
- Assumption is mostly *wrong* for desktop and servers, since a single kernel image should support a wide range of devices and filesystems
  - More flexibility was needed
  - Modules have this flexibility, but they are not available before mounting the root filesystem
  - Need to handle complex setups (RAID, NFS, etc.)

Solution

- A solution is to include a small temporary root filesystem with modules, in the kernel itself. This small filesystem is called the *initramfs*
- This ***initramfs*** is a gzipped cpio archive of this basic root filesystem
  - A gzipped cpio archive is a kind of zip file, with a much simpler format
- The initramfs scripts will detect the hardware, load the corresponding kernel modules, and mount the real root filesystem
- Finally the initramfs scripts will run the init application in the real root filesystem and the system can boot as usual
- The initramfs technique completely replaces init ramdisks (initrds). Initrds were used in Linux 2.4, but are no longer needed

Booting sequence with initramfs



Initramfs features and advantages

- Root filesystem directly embedded in the kernel image, or copied to RAM by the bootloader, simple solution
- Just a plain compressed cpio archive extracted in the file cache. Neither needs a block nor a filesystem driver
- Simpler to mount complex filesystems from flexible userspace scripts rather than from rigid kernel code. More complexity moved out to user-space!
- Possible to add non GPL files (firmware, proprietary drivers) in the filesystem. This is not linking, just file aggregation (not considered as a derived work by the GPL)

How to populate an initramfs

Using CONFIG_INITRAMFS_SOURCE in kernel configuration (General Setup section)

- Either give an existing cpio archive (file name ending with .cpio)
- Or give a directory to be archived
- Any other regular file will be taken as a text specification file (see next page)

see .../Documentation/filesystems/ramfs-rootfs-initramfs.txt and .../Documentation/early-userspace/README in kernel sources.

See also http://www.linuxdevices.com/articles/AT4017834659.html for a nice overview of initramfs (by Rob Landley).

Initramfs specification file example

```
dir /dev 0755 0 0
nod /dev/console 0600 0 0 c 5 1
dir /root 0700 0 0
```

major minor

permissions

No need for root user access!

Initramfs specification file example

```
dir /dev 755 0 0
nod /dev/console 644 0 0 c 5 1
nod /dev/loop0 644 0 0 b 7 0
dir /bin 755 1000 1000
file /bin/busybox
/stuff/initramfs/busybox 755 0 0
slink /bin/sh busybox 777 0 0
dir /proc 755 0 0
dir /sys 755 0 0
dir /mnt 755 0 0
file /init /stuff/initramfs/init.sh 755 0 0
```

major minor

permissions

No need for root user access!

user id

group id

How to handle cpio archives

Useful when you want to build the kernel with a ready-made cpio archive, instead of letting the kernel do it for you

- Extracting:

```
host$ cpio -id < dir.cpio
```

- Creating:

```
host$ cd dir
host$ find . | cpio -H newc -o > ../dir.cpio
```

Note that the -H newc option is required to generate a cpio archive that can be used by the Linux kernel.

Summary

- For embedded systems, two interesting solutions
  - No initramfs: all needed drivers are included inside the kernel, and the final root filesystem is mounted directly
  - Everything inside the initramfs