Bootloaders

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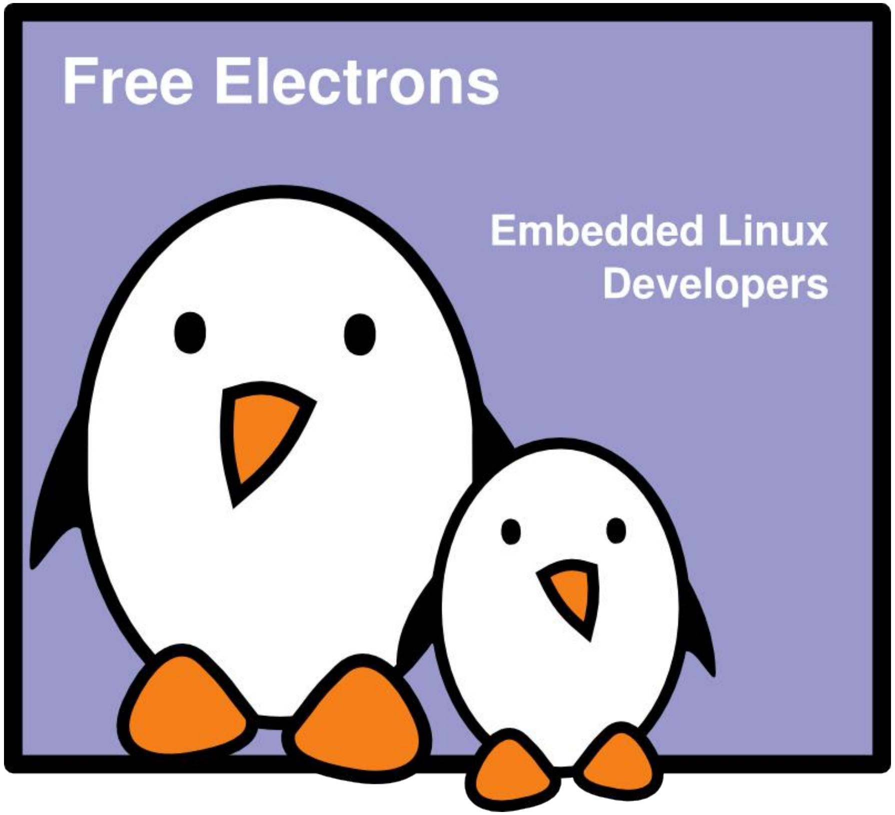


Latest update: Jan 19, 2011,
Document sources, updates and translations:
http://free-electrons.com/docs/bootloaders
Corrections, suggestions, contributions and translations are welcome!

Bootloaders

- The bootloader is a piece of code responsible for
  - Basic hardware initialization
  - Loading of an application binary, usually an operating system kernel, from flash storage, from the network, or from another type of non-volatile storage.
  - Possibly uncompression of the application binary
  - Execution of the application
- Besides these basic functions, most bootloaders provide a shell with various commands implementing different operations.
  - Loading of data from storage or network, memory inspection, hardware diagnostics and testing, etc.

Bootloaders on x86 (1)

- The x86 processors are typically bundled on a board with a non-volatile memory containing a program, the BIOS.
- This program gets executed by the CPU after reset, and is responsible for basic hardware initialization and loading of a small piece of code from non-volatile storage.
  - This piece of code is usually the first 512 bytes of an hard disk
- This piece of code is usually a 1st stage bootloader, which will load the full bootloader itself.
- The bootloader can then offer all its features. It typically understands filesystem formats so that the kernel file can be loaded directly from a normal filesystem.

Bootloaders on x86 (2)

- GRUB, Grand Unified Bootloader, the most powerful one.
  http://www.gnu.org/software/grub/
  - Can read many filesystem formats to load the kernel image and the configuration, provides a powerful shell with various commands, can load kernel images over the network, etc.
  - See our dedicated presentation for details:
    http://free-electrons.com/docs/grub/
- LILO, the original Linux Loader
  http://freshmeat.net/projects/lilo/
- Syslinux, for network and removable media booting
  http://syslinux.zytor.com

Bootloaders on embedded architectures (1)

- On embedded architectures, the low-level booting process is very CPU and board dependent
  - Some boards have a NOR flash from which the CPU starts executing instructions after reset. In that case, the bootloader must directly be flashed inside the NOR at the proper location
  - Some CPUs have an integrated bootcode in ROM that automatically loads a small portion of a DataFlash or NAND flash, usually to a static RAM. In that case, a minimal first stage bootloader is required, that will load the main bootloader (BootROM on AT91SAM CPUs, Steppingstone on S3C24xx CPUs, etc.).
- The bootloader on embedded architectures starts right after CPU reset, so it must initialize all the devices, including the memory controller in order to access the DRAM.
- As the boot process is very CPU and board dependent,
  refer to the vendor documentation.

Bootloaders on embedded architectures (2)

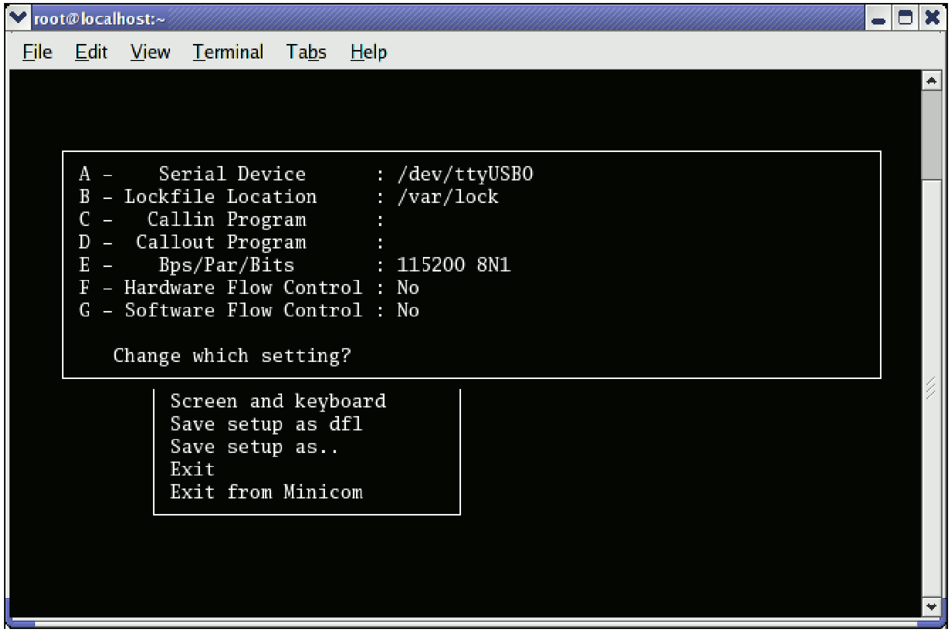
- We will focus on the generic part, the main bootloader, offering the most important features.
- There are several open-source generic bootloaders.
  Here are the most popular ones:
  - U-Boot, the universal bootloader by Denx
    The most used on ARM, also used on PPC, MIPS, x86, m68k, NIOS, etc.
    The de-facto standard nowadays. We will study it in detail.
    http://www.denx.de/wiki/U-Boot
  - Barebox, a new architecture-neutral bootloader, written as a successor of U-Boot. Better design, better code, active development, but doesn't yet have as much hardware support as U-Boot.
    http://www.barebox.org
- There are also a lot of other open-source or proprietary bootloaders, often architecture-specific
  - RedBoot, Yaboot, PMON, etc.

Accessing a serial console

Minicom (1)

- Definition: serial communication program
- Available in all GNU / Linux distributions
- Capabilities (all through a serial link):
  - Serial console to a remote Unix system
  - File transfer
  - Modem control and dial-up
  - Serial port configuration

Minicom (2)



```
A -    Serial Device      : /dev/ttyUSB0
B - Lockfile Location     : /var/lock
C -   Callin Program      :
D -  Callout Program      :
E -    Bps/Par/Bits       : 115200 8N1
F - Hardware Flow Control : No
G - Software Flow Control : No

   Change which setting?

        Screen and keyboard
        Save setup as dfl
        Save setup as..
        Exit
        Exit from Minicom
```

- Start by running `minicom -s` to setup Minicom
- A bit austere at first glance, but quickly gets friendly (see the labs for details)

Other terminal emulators

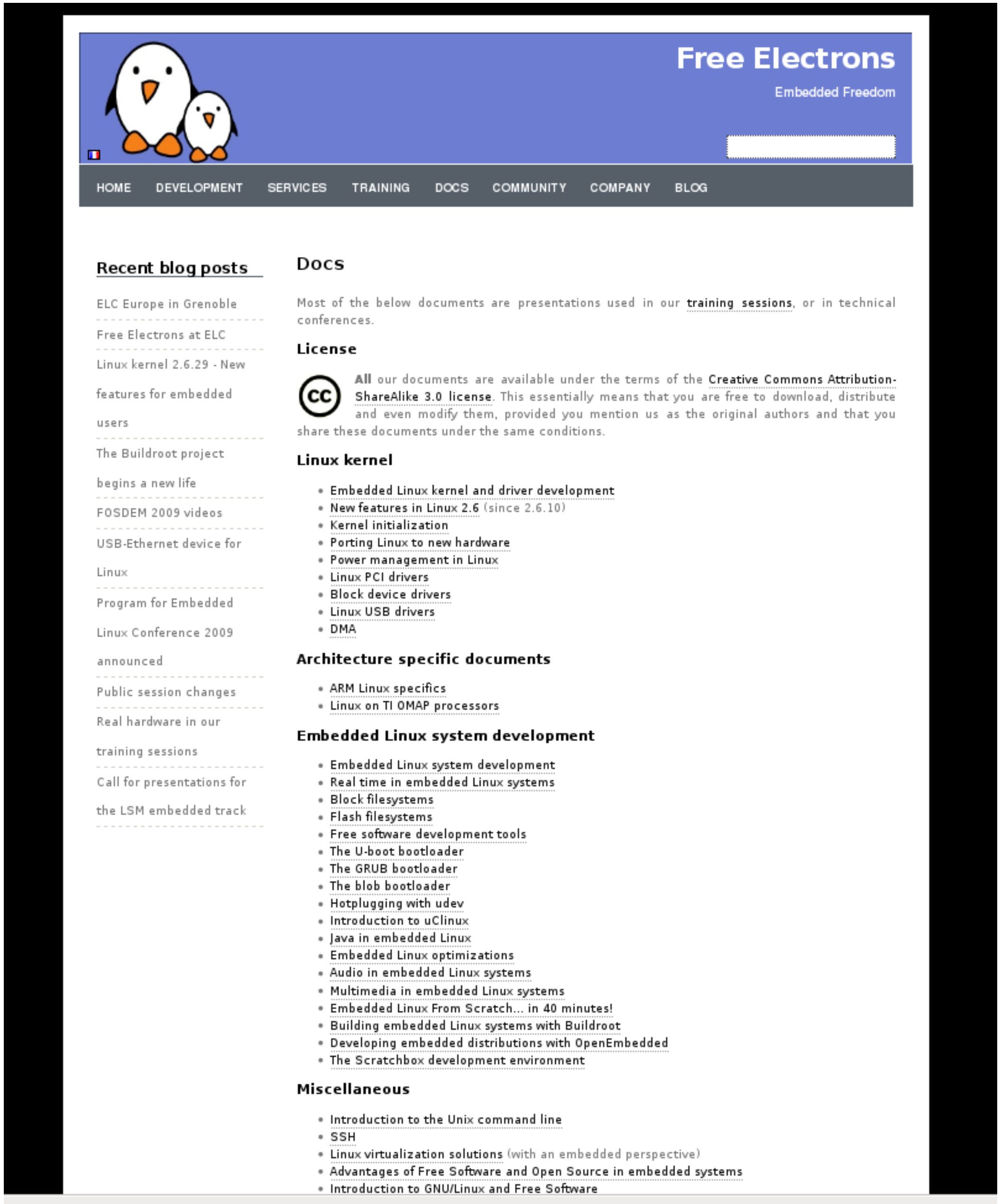
- GTKTerm: http://www.jls-info.com/julien/linux/
  Graphical. Less powerful than Minicom, but with a simpler and more attractive interface. Available in recent distros.
- CuteCom: http://cutecom.sourceforge.net/
  Another graphical and user-friendly terminal emulator. Available in recent distros.
- picocom: http://freshmeat.net/projects/picocom/
  Tiny terminal emulator (20K), can be used in embedded systems.
- GNU Screen: can also be used on a serial console:

  ```
  screen <device> <baudrate>
  ```

  Example:

  ```
  screen /dev/ttyS0 115200
  ```

Related documents



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- ELC Europe in Grenoble
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- Linux kernel 2.6.29 - New features for embedded users
- The Buildroot project begins a new life
- FOSDEM 2009 videos
- USB-Ethernet device for Linux
- Program for Embedded Linux Conference 2009 announced
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- Embedded Linux kernel and driver development
- New features in Linux 2.6 (since 2.6.10)
- Kernel initialization
- Porting Linux to new hardware
- Power management in Linux
- Linux PCI drivers
- Block device drivers
- Linux USB drivers
- DMA

Architecture specific documents

- ARM Linux specifics
- Linux on TI OMAP processors

Embedded Linux system development

- Embedded Linux system development
- Real time in embedded Linux systems
- Block filesystems
- Flash filesystems
- Free software development tools
- The U-boot bootloader
- The GRUB bootloader
- The blob bootloader
- Hotplugging with udev
- Introduction to uClinux
- Java in embedded Linux
- Embedded Linux optimizations
- Audio in embedded Linux systems
- Multimedia in embedded Linux systems
- Embedded Linux From Scratch... in 40 minutes!
- Building embedded Linux systems with Buildroot
- Developing embedded distributions with OpenEmbedded
- The Scratchbox development environment

Miscellaneous

- Introduction to the Unix command line
- SSH
- Linux virtualization solutions (with an embedded perspective)
- Advantages of Free Software and Open Source in embedded systems
- Introduction to GNU/Linux and Free Software

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on http://free-electrons.com/docs

- Linux kernel
- Device drivers
- Architecture specifics
- Embedded Linux system development

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Linux kernel

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