>>> Operating Systems And Applications For Embedded Systems
>>> Building the kernel

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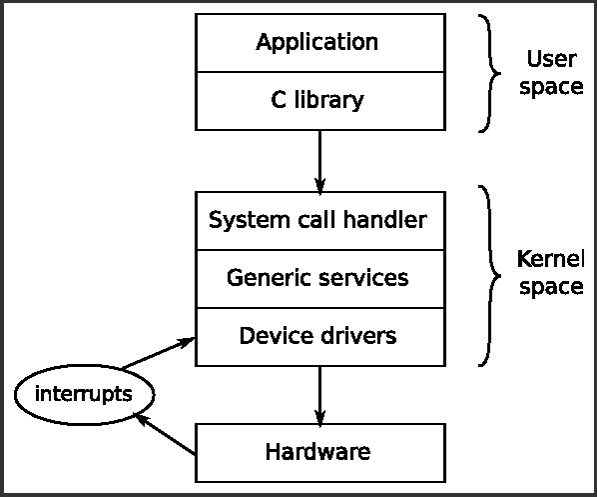
>>> Plan

>>> Main Features

The kernel has three main jobs: to manage resources, to interface with hardware, and to provide an API that offers a useful level of abstraction to user space programs.



>>> Getting the source

1. `git clone git://git.kernel.org/pub/scm/linux/kernel/git/stable/linux-stable.git linux`
2. `cd linux`

>>> Main directories

* arch: This contains architecture-specific files. There is one subdirectory per architecture.
* Documentation: This contains kernel documentation. Always look here first if you want to find more information about an aspect of Linux.
* drivers: This contains device drivers, thousands of them. There is a subdirectory for each type of driver.
* fs: This contains filesystem code.
* include: This contains kernel header files, including those required when building the toolchain.
* init: This contains the kernel start-up code.
* kernel: This contains core functions, including scheduling, locking, timers, power management, and debug/trace code.
* mm: This contains memory management.
* net: This contains network protocols.
* scripts: This contains many useful scripts including the device tree compiler, dtc, which I described in Chapter 3, All About Bootloaders.
* tools: This contains many useful tools, including the Linux performance counters tool, perf, which I will describe in Chapter 13, Profiling and Tracing.

>>> Kernel configration I

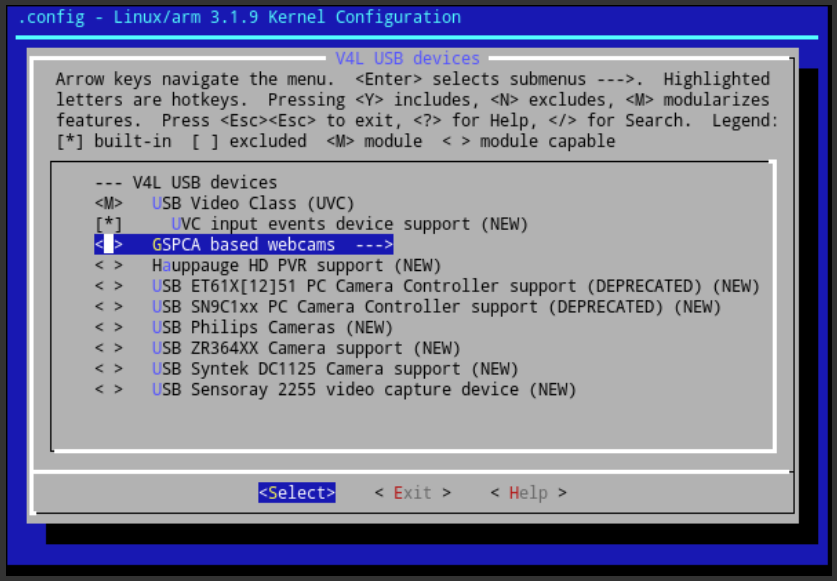
This configuration item, along with all the others, is stored in a file named .config.
The variable names stored in .config are prefixed with CONFIG_, so if DEVMEM is enabled, the line reads:
CONFIG_DEVMEM=y

* bool: This is either y or not defined.
* tristate: This is used where a feature can be built as a kernel module or built into the main kernel image. The values are m for a module, y to be built in, and not defined if the feature is not enabled.
* int: This is an integer value written using decimal notation.
* hex: This is an unsigned integer value written using hexadecimal notation.
* string: This is a string value.

>>> Kernel configration II

```
make ARCH=arm menuconfig
```

The star (*) to the left of an item means that it is selected (="y") or, if it is an M, that it has been selected to be built as a kernel module.


.config - Linux/arm 3.1.9 Kernel Configuration
V4L USB devices
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
--- V4L USB devices
<M> USB Video Class (UVC)
[*] UVC input events device support (NEW)
< > GSPCA based webcams --->
< > Hauppauge HD PVR support (NEW)
< > USB ET61X[12]51 PC Camera Controller support (DEPRECATED) (NEW)
< > USB SN9C1xx PC Camera Controller support (DEPRECATED) (NEW)
< > USB Philips Cameras (NEW)
< > USB ZR364XX Camera support (NEW)
< > USB Syntek DC1125 Camera support (NEW)
< > USB Sensoray 2255 video capture device (NEW)
<Select>
< Exit >
< Help >

>>> Compiling the kernel image

To build a kernel image, you need to know what your bootloader expects. This is a rough guide:

* U-Boot: Traditionally U-Boot has required a uImage, but newer versions can load a zImage file using the bootz command
* x86 targets: It requires a bzImage file
* Most other bootloaders: It requires a zImage file

```
make -j 4 ARCH=arm CROSS_COMPILE=arm-none-gnueabihf- LOADADDR=0x80008000 uImage
```

The -j 4 option tells make how many jobs to run in parallel, which reduces the time taken to build. A rough guide is to run as many jobs as you have CPU cores.

>>> Compiling device trees

```
make ARCH=arm dtbs
```

>>> Compiling modules

```
make -j4 ARCH=arm CROSS_COMPILE=arm-cortex_a8-linux-gnueabihf-
INSTALL_MOD_PATH=$HOME/rootfs modules_install
```

Kernel modules are put into the directory /lib/modules/[kernel version], relative to the root of the filesystem.

>>> Cleaning kernel sources

* clean: removes object files and most intermediates.
* mrproper: removes all intermediate files, including the .config file.
* distclean: This is the same as mrproper but also deletes editor backup files, patch leftover files, and other artifacts of software development.

>>> QEMU

```
QEMU_AUDIO_DRV=none qemu-system-arm -m 256M -nographic -M vexpress-a9 -kernel zImage
-dtb vexpress-v2p-ca9.dtb -append "console=ttyAMA0"
```

Level	Value	Meaning
KERN_EMERG	0	The system is unusable
KERN_ALERT	1	Action must be taken immediately
KERN_CRIT	2	Critical conditions
KERN_ERR	3	Error conditions
KERN_WARNING	4	Warning conditions
KERN_NOTICE	5	Normal but significant conditions
KERN_INFO	6	Informational
KERN_DEBUG	7	Debug-level messages

>>> Kernel command line I

* debug
  Sets the console log level to the highest level, eight, to ensure thatyou see all the kernel messages on the console.
* init=
  The init program to run from a mounted root filesystem, which defaults to /sbin/init.
* lpj=
  Sets the loops_per_jiffy to a given constant, see the following paragraph.
* panic=
  Behavior when the kernel panics: if it is greater than zero, it gives the number of seconds before rebooting; if it is zero, it waits forever (this is the default); or if it is less than zero, it reboots without any delay.
* quiet
  Sets the console log level to one, suppressing all but emergency messages. Since most devices have a serial console, it takes time to output all those strings. Consequently, reducing the number of messages using this option reduces boot time.

>>> Kernel command line II

* rdinit=
  The init program to run from a ramdisk, it defaults to /init.
* ro
  Mounts the root device as read-only. Has no effect on a ramdisk which is always read/write.
* root=
  Device to mount the root filesystem.
* rootdelay=
  The number of seconds to wait before trying to mount the root device, defaults to zero. Useful if the device takes time to probe the hardware, but also see rootwait.
* rootfstype=
  The filesystem type for the root device. In many cases, it is autodetected during mount, but it is required for jffs2 filesystems.
* rootwait
  Waits indefinitely for the root device to be detected. Usually necessary with mmc devices.
* rw
  Mounts the root device as read-write (default)

>>> Additional reading

* Linux Kernel Newbies, kernelnewbies.org
* Linux Weekly News, www.lwn.net

>>> References

C. Simmonds.
Mastering Embedded Linux Programming.
Packt Publishing, 2015.