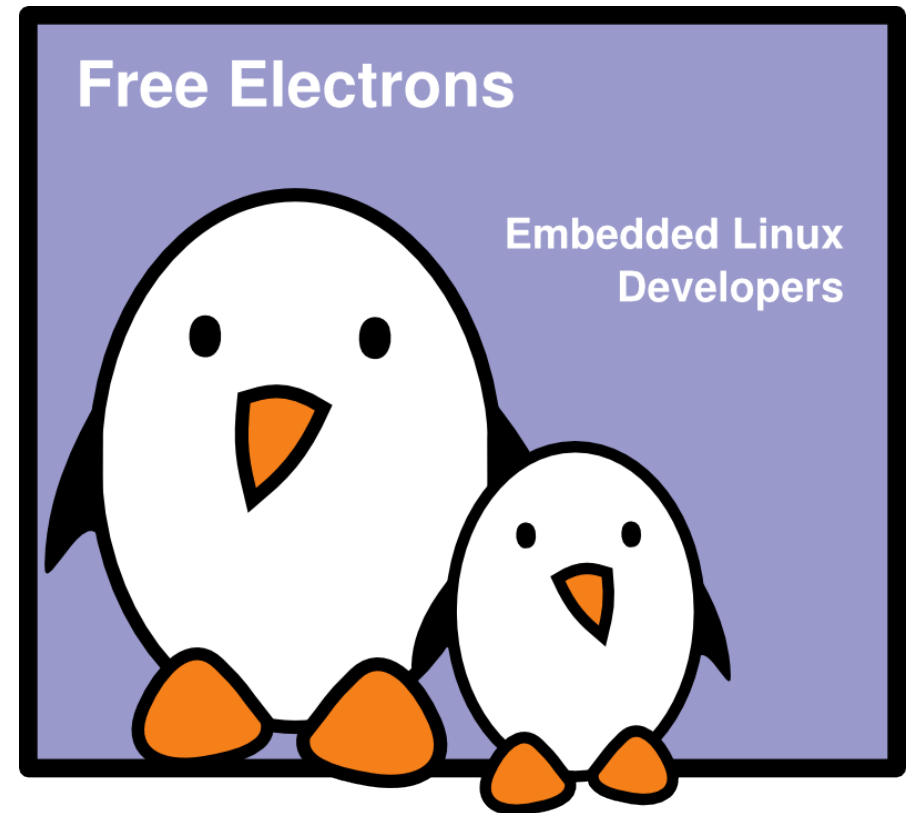




## Using USB gadget drivers

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**Free Electrons**





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# What are USB gadgets ?

- ▶ The USB controller found in most of our PCs can only act as hosts on a USB bus, they can “drive” devices, but not be “driven”
- ▶ However, the USB controller found on many embedded systems can often act either as a host, as a device, or as both.
- ▶ Having a device acting as a USB device allows to easily connect it to other systems, using the now widespread USB connection.
- ▶ This operation mode is called “USB gadget” by Linux
- ▶ Several USB gadget drivers are already available in Linux
  - ▶ Ethernet
  - ▶ Serial
  - ▶ Mass storage
  - ▶ MIDI
  - ▶ Printer



# Kernel requirements

- ▶ USB Gadget generic support  
Kernel option `CONFIG_USB_GADGET`
- ▶ USB Gadget controller support
  - ▶ The controller support for USB gadget is different from the USB host support
  - ▶ Depending on your hardware and the available Linux support, might need to be implemented
- ▶ USB Gadget driver
  - ▶ They are independent from the hardware
  - ▶ `CONFIG_USB_ETH` for Ethernet, `CONFIG_USB_FILE_STORAGE` for mass storage, `CONFIG_USB_G_SERIAL` for serial
- ▶ See <http://www.linux-usb.org/gadget/> for details



# Ethernet gadget driver on the device

- ▶ Kernel option `CONFIG_USB_ETH`
- ▶ This driver allows to establish an Ethernet connection between the embedded system (USB device) and the host system (USB master)
- ▶ When compiled as a module, the module name is `g_ether`.
- ▶ On the embedded system, a `usbX` network interface appears and can be configured as usual



# Ethernet gadget on the host

## ▶ Linux

- ▶ The usbnet driver included in the kernel just works
- ▶ A usbX interface appears and can be configured as usual

## ▶ Windows

- ▶ Versions prior to Vista, no support for the Ethernet CDC model. Linux provides the `CONFIG_USB_ETH_RNDIS` option to support a protocol that Windows understands, and provides the corresponding `.inf` file.
- ▶ Versions starting at Vista, CDC support is available if the vendor provides a proper `.inf` file

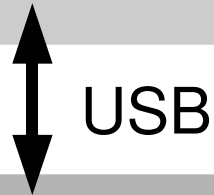


# Ethernet gadget at work

```
root@om-gta02:~# ifconfig usb0
```

```
usb0      Link encap:Ethernet  HWaddr 3E:04:A8:D5:9E:7E
          inet addr:192.168.0.202  Bcast:192.168.0.255  Mask:255.255.255.0
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          [...]
```

Target



```
thomas@surf:~$ sudo ifconfig usb0
```

```
usb0      Link encap:Ethernet  HWaddr be:26:39:84:59:80
          inet addr:192.168.0.200  Bcast:192.168.0.223  Mask:255.255.255.224
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          [...]
```

Host

```
thomas@surf:~$ ping -c 1 192.168.0.202
```

```
PING 192.168.0.202 (192.168.0.202) 56(84) bytes of data.
64 bytes from 192.168.0.202: icmp_seq=1 ttl=64 time=1.80 ms
```

```
--- 192.168.0.202 ping statistics ---
```

```
1 packets transmitted, 1 received, 0% packet loss, time 0ms
rtt min/avg/max/mdev = 1.804/1.804/1.804/0.000 ms
```



# USB storage gadget

- ▶ Kernel option `CONFIG_USB_FILE_STORAGE`
- ▶ Allows to make a file or block device available on the device through the well-known mass-storage USB protocol
- ▶ Compiled as the `g_file_storage` module
- ▶ The `file=` option allows to specify the file or the block device containing the data to export
  - ▶ Can be passed as module parameter
  - ▶ Can be passed through the `sysfs` filesystem
  - ▶ Contents of the file cannot be modified during runtime !
- ▶ Other options such as `ro` (read-only) or `removable` are also available.
- ▶ See [http://www.linux-usb.org/gadget/file\\_storage.html](http://www.linux-usb.org/gadget/file_storage.html)



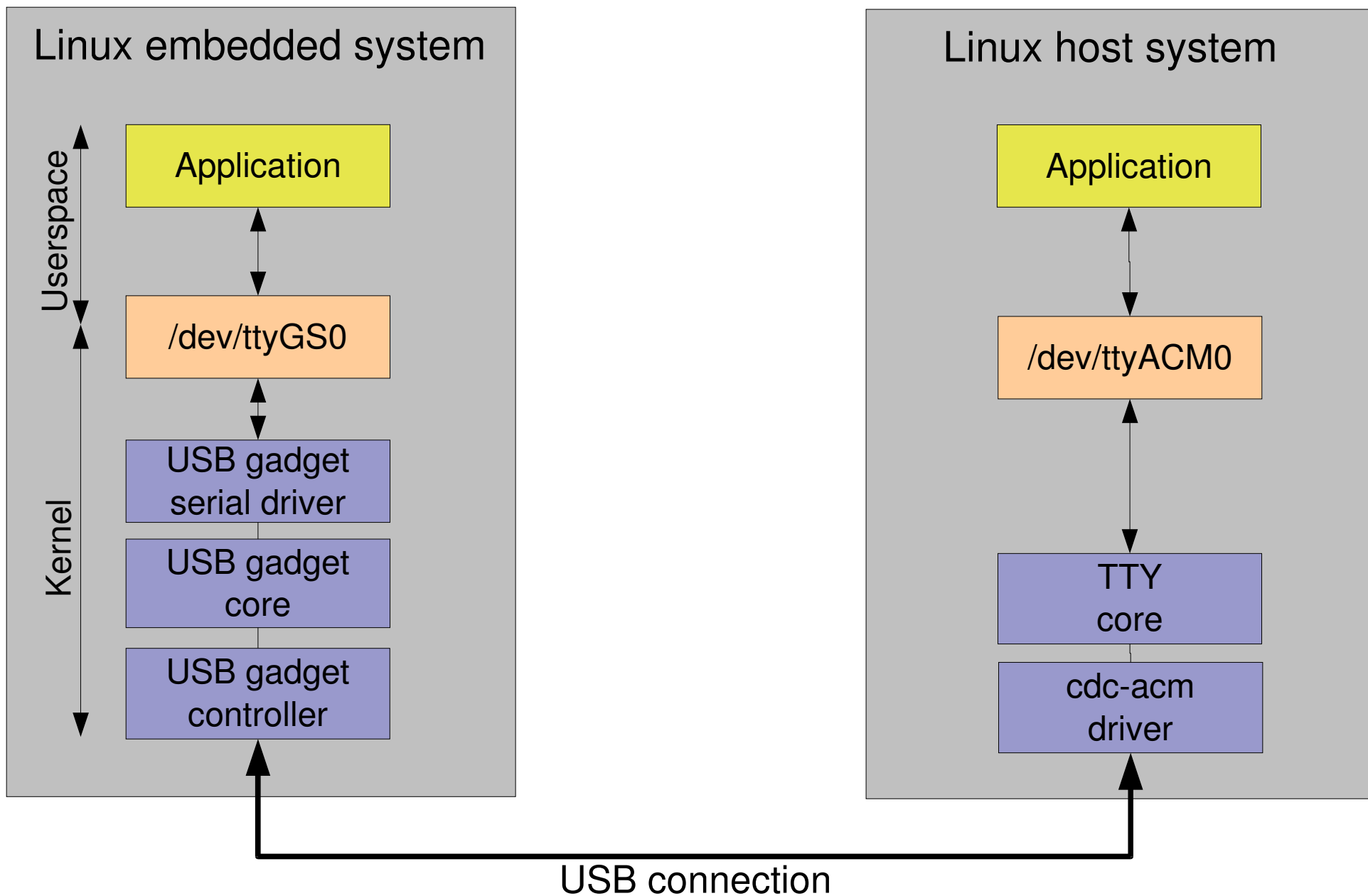


# USB serial gadget

- ▶ Kernel option `USB_G_SERIAL`
- ▶ Supports the standard CDC-ACM protocol
- ▶ On the device
  - ▶ The kernel module is `g_serial`
  - ▶ After loading, it will create a `/dev/ttyGS0` file which is one end of the serial communication.
  - ▶ If `udev/mdev` is not used, look at `/sys/class/tty/ttyGS0/dev` to know the major and minor
- ▶ On the host
  - ▶ Linux `cdc-acm` driver is included in the kernel. A `/dev/ttyACM0` device will appear, it is the other end of the serial communication.
  - ▶ For Windows, see `Documentation/usb/gadget_serial.txt`. A `.inf` file and a `.sys` file are needed.



# USB serial gadget architecture





# Practical lab – USB gadget drivers



- ▶ Configure and compile a kernel with USB gadget support
- ▶ Set up USB gadget drivers on the Calao ARM board



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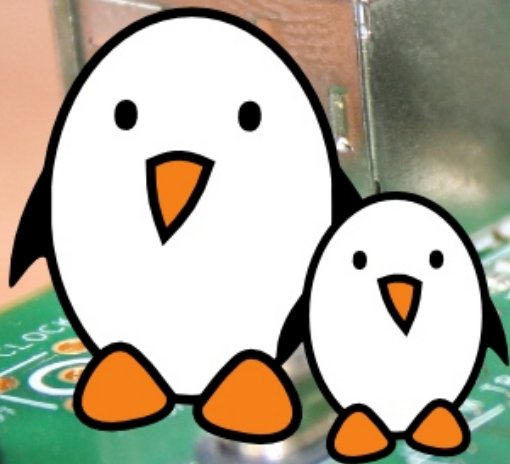
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