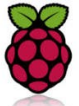
Raspberry Pi & Co



Practice and theory

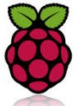
Raspberry Pi in a nutshell

Raspberry Pi hardware

Raspberry Pi Alternatives

Raspberry Pi Advice

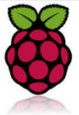
RPi in a nutshell

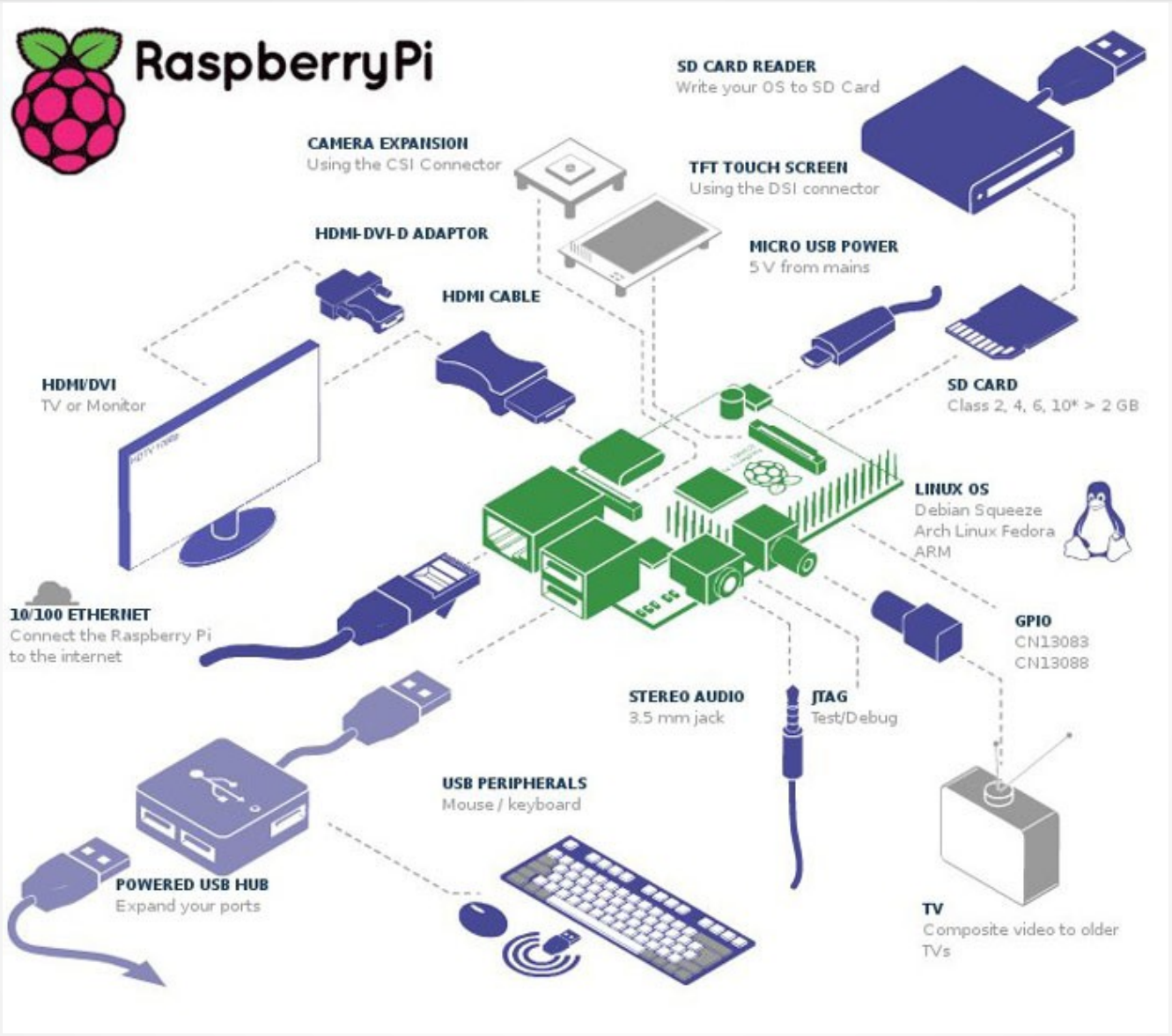


Raspberry Pi is a desktop-computer

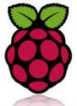
- Light-weight **credit-card**-sized
- USB 2.0, Ethernet, Audio Jack
- Powerful **graphic** capabilities and **HDMI**
- **GPIO** and support for low-level-protocols like i2c, spi, uart ...

Hardware RPi





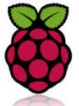
Hardware RPI



Raspberry Pi hardware

- SOC - Broadcom BCM2835
  - ARM V11 => 700 mHz
    (overclockeable to 1 gHz within guarantee)
  - GPU on SOC
  - I2c,spi,uart, GPIO controlled
  - Hardware-codecs

Hardware RPI



Raspberry Pi hardware

Disk-less

- No diskcontroller
- No SATA connector

SD-card

- OS booted from SD-card
- Data stored on SD

No NAND Flash-memory

Hardware RPi

MODEL A

-

Less memory (RAM)
One USB (need a dongle)
No Ethernet (WIFI via usb)

+

Less power-consuming
Cheaper

MODEL B

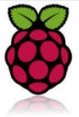
-

More memory (RAM)
Two USB
Ethernet (WIFI via usb)

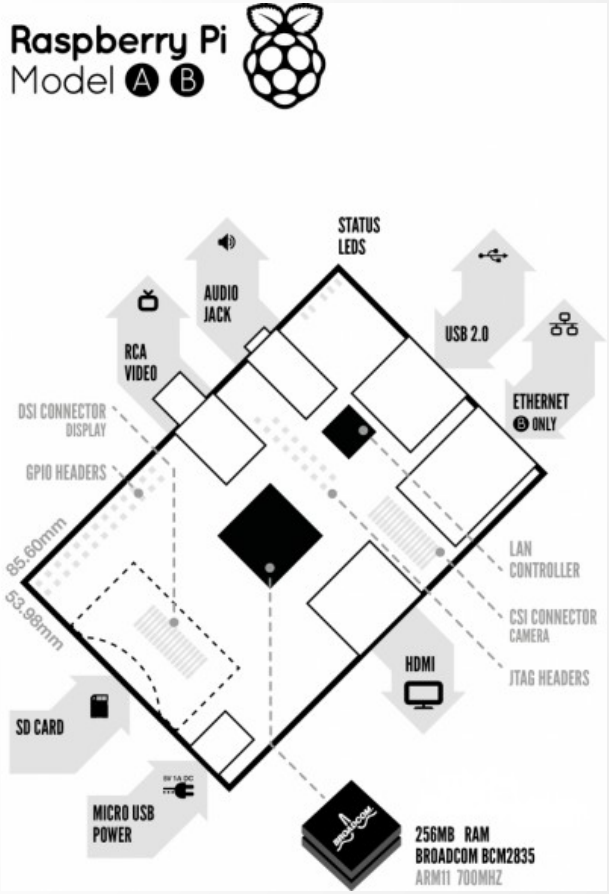
+

More power-consuming
10 $ more

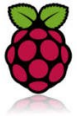
Hardware RPi



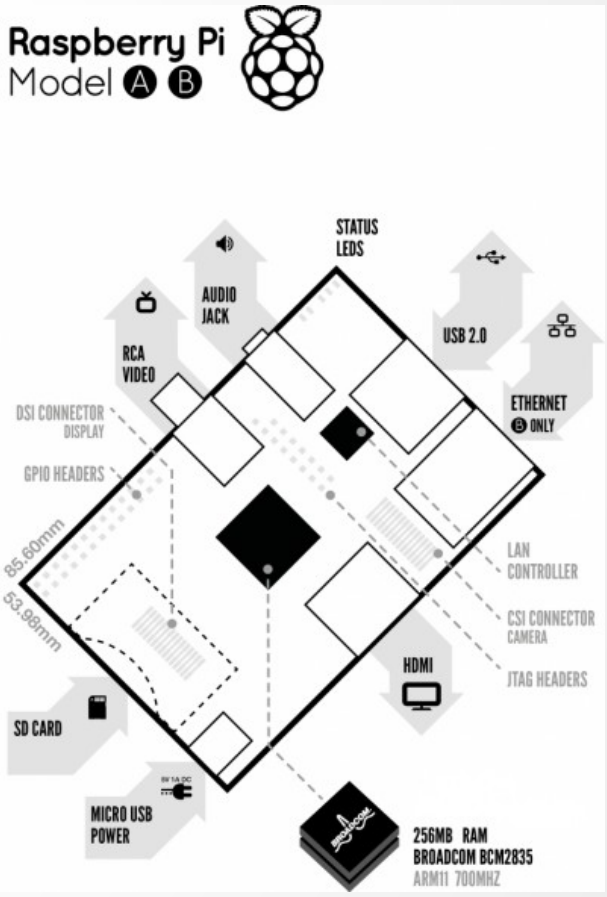
	Model A	Model B
Target price	US$25 Ext tax	US$35 Ext tax
SoC	Broadcom BCM2835 (CPU + GPU. SDRAM is a separate chip stacked on top)	
CPU	700 MHz ARM11 ARM1176JZF-S core	
Memory (SDRAM)	256 MiB (planned with 128 MiB, Upgraded to 256 MiB on 29 Feb 2012)	256 MiB (until 15 Oct 2012); 512 MiB (since 15 Oct 2012)
GPU	Broadcom VideoCore IV,OpenGL ES 2.0,OpenVG 1080p30 H.264 high-profile encode/decode	
USB 2.0 ports	1 (provided by the BCM2835)	2 (via integrated USB hub)
Video outputs	Composite video | Composite RCA, HDMI (not at the same time)	
Audio outputs	TRS connector | 3.5 mm jack, HDMI	



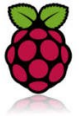
Hardware RPi



	Model A	Model B
Audio inputs	none, but a USB mic or sound-card could be added	
Onboard Storage	Secure Digital|SD / MMC / SDIO card slot	
Onboard Network	None	10/100 wired Ethernet RJ45
Low-level peripherals	General Purpose Input/Output (GPIO) pins, Serial Peripheral Interface Bus (SPI), I²C, I²S, Universal asynchronous receiver/transmitter (UART)	
Real-time clock	None	
Power ratings	300 mA, (1.5 W)	700 mA, (3.5 W)
Power source	5 V (DC) via Micro USB type B or GPIO header	
Size	85.0 x 56.0 mm x 15mm	85.0 x 56.0 mm x 17mm
Weight	31g	40g



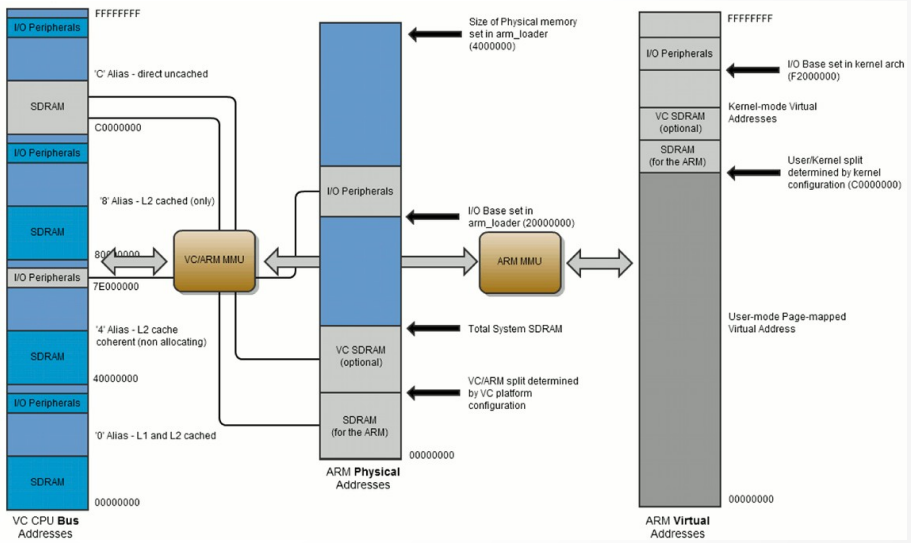
Hardware RPi



Broadcom BCM2835

Heart of the Rpi => System on a Chip

- Timers
- Interrupt controller
- GPIO
- USB-controller
- PCM / I2S
- DMA controller
- I2C master
- I2C / SPI slave
- SPI0, SPI1, SPI2
- PWM
- UART0, UART1



More detail on SOC and RTL-logic see:

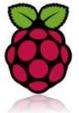
http://www.raspberrypi.org/wp-content/uploads/2012/02/BCM2835-ARM-Peripherals.pdf

Hardware RPi

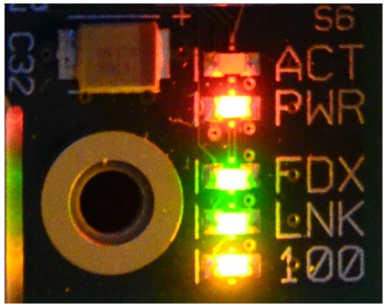
GPIO

- 26 pins
  - 8 GPIO pins
  - I²C, SPI, UART
  - +3.3 V, +5 V and GND supply lines
- GPIO voltage levels are 3.3 V
  Not 5 V tolerant, no over-voltage protection
  (use logic level translator for 5 v-logic)
- All the GPIO pins can be reconfigured
  to provide alternate functions
- i2c pull-up resistor is built in
- Do not draw more than 3mA per output
  Higher might harm the RPi

Hardware RPi

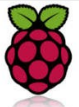


LEDS

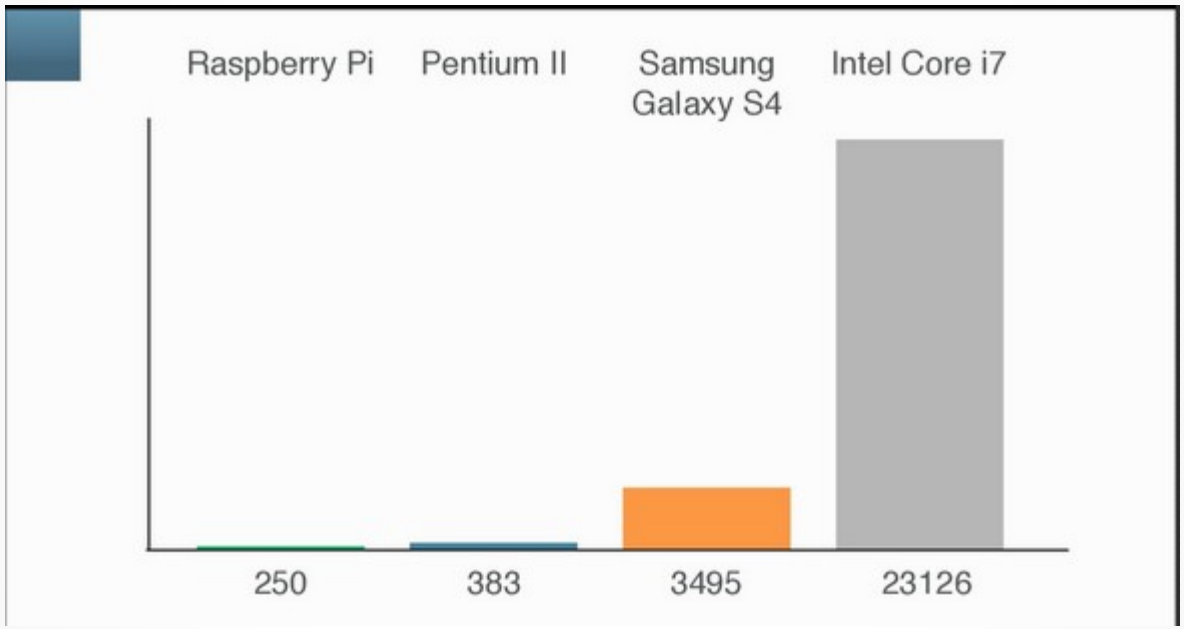


Number	Label	Color	Function
D5	OK (Rev 1.0) ACT (Rev 2.0)	Green	SD card access, connected to GPIO 16
D6	PWR	Red	3.3 V Power, connected to 3.3 V
D7	FDX	Green	Full Duplex LAN
D8	LNK	Green	Link/Activity LAN
D9	10M (Rev 1.0) 100 (Rev 2.0)	Yellow	10/100Mbit LAN

Benchmarking RPi

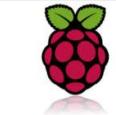


CPU-benchmark-result is not that good …



But it's not the only the CPU that counts …

Benchmarking RPi



And it's not intended to be fast

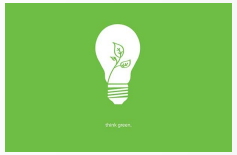
GPU 

- Can play HD-resolution
- Hardware-decoding in the GPU
  (activating codecs for low price)
- Media Center, Indie games like minecraft,

Daily computing tasks (mail, web, office, ...)

Low consumption

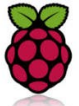
- Between 300mA and 1 A (depending on) at 5 v



SOFTWARE

- Optimized Linux kernel

Comparing RPi

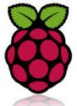


And there more

It's it the only board in it's category!!!

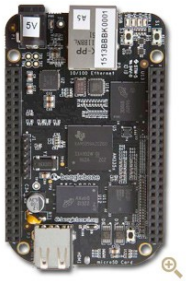
- Small Single-Board
- SOC-based
- ARM-based
- Open Source (hard and software)
- GPIO-pins
- Low level periphals-support
- Community-driven
- <= 100 €

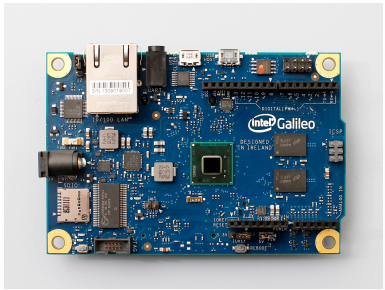
Comparing RPi



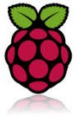
No, there's more of it

with lot of variation in their characteristics...



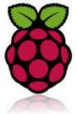


Comparing RPi



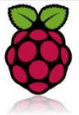
	Raspberry Pi	BeagleBone Black	pcDuino	Olinuxino Micro	Cubietruck
Memory	4 / 32 GB DDR-1600	4 / 32 GB DDR-1600 ECC	2 / 16 GB DDR-1600	2 / 16 GB DDR-1600	2 / 16 GB DDR-1600
Clockspeed	700 MHz	1 GHz	1 GHz	1 GHz	1 GHz
CPU-core(s)	ARM-11	ARM-Cortex-A8	ARM-Cortex-A8	Dual ARM-Cortex-A7	Dual ARM-Cortex-A7
GPU-core	Videocore IV	SGX530	Mali-400	Dual Mali-400	Dual Mali-400
Hardware Codecs	H264, MPEG-4 AVC (MPEG-2, VC-1 optioneel)	-	MPEG-1/2/4 AVC, JPEG, H.263, H.264, AVS, VC1, WMV7/8, VP-6	MPEG-1/2/4 AVC, JPEG, H.263, H.264, AVS, VC1, WMV7/8, VP-6	MPEG-1/2/4 AVC, JPEG, H.263, H.264, AVS, VC1, WMV7/8, VP-6
RAM	512 MB	512 MB	1 GB	1 GB	2 GB
Flash	-	2 GB	2 GB	4 GB	2 GB

Comparing RPi



	Raspberry Pi	BeagleBone Black	pcDuino	Olinuxino Micro	Cubietruck
Lithium-battery	-	-	-	Supported	Supported
Video	HDMI, Composer	Micro-HDMI	HDMI	HDMI, VGA (adapter)	HDMI, VGA
Connections	2 * USB 2.0	USB 2.0	2 * USB 2.0	3 * USB 2.0	3 * USB 2.0, Bluetooth
Audio	Audio-jack	-	-	Audio-jack, Micro	Audio-jack, SPDIF
Network	Fast Ethernet	Fast Ethernet	Fast Ethernet	Fast Ethernet	Gigabit, WIFI
Storage	SD	micro-SD	micro-SD	SD, micro-SD, SATA	SD, micro-SD, SATA
Usage	**Media Center** ++ PC + Home automation +	**Home automation** ++	PC +	Media Center + Router + NAS ++ **SERVER** ++ Home automation + **Mobile** ++	Media Center + Router ++ **NAS** +++ **SERVER** ++ Home automation + Mobile +
Price	35 €	45 €	60 €	65 €	95 €

ARM

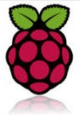


Acorn **R**ISC **M**achine
- Intel refusal to give license for 80286
- ARM1 started in BBC Micro (predecessor RPi) early 1985

Today maintained and developed by ARM Holdings
- RISC-based, efficient, default in mobile development
- Starting to get some grip on desktop and server (especially 64-bit)

Recent Evolution	1997	1998	2002	2005	2007	2009	2011		2013		
Core-name	ARM9	ARM10	ARM11	Cortex-A8	Cortex-A9	Cortex-A5	Cortex-A15	Cortex-A7	Cortex-A12	Cortex A53	Cortex-A57
Optimization					Performing	Economic	Performing	Economic	Efficient	Efficient	Performing
Architecture	ARMv5		ARMv6	ARMv7						ARMv8 (**64 bit**)	
	SINGLE-CORE			MULTI-CORE							

Advice RPi



Starters **Advice**

Buy a case

- SD-card-holder very fragile
- Solder-joints at the bottom

Availibility of an HDMI-screen

- Adapter will cost more then the RPi

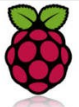
Selection of SD-card

- Defines performance
- Not all SD-cards are performed (http://elinux.org/RPi_SD_cards)

What do you need?

- Compare...

Advice RPi



Typical attributes

WiFi Dongle

Camera Module
(connector foreseen)

Cobbler

LED-screens

Shields

Jumpwires, resistors,
capacitors, ...