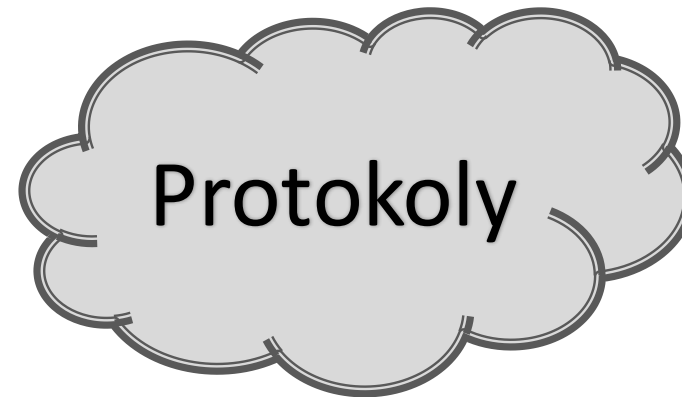
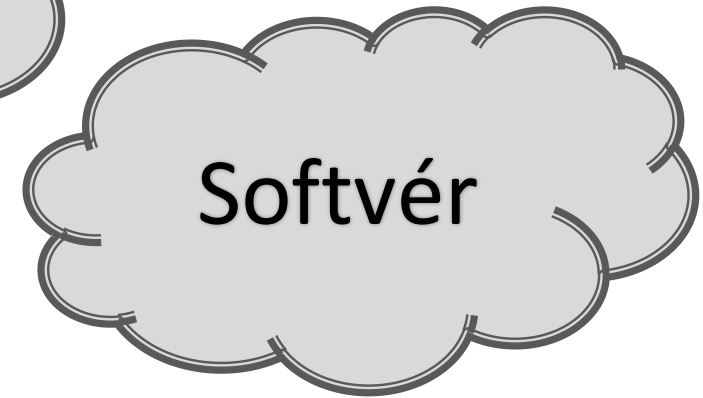
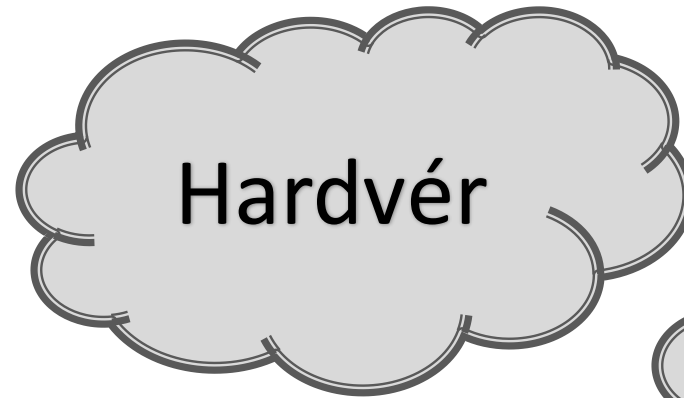
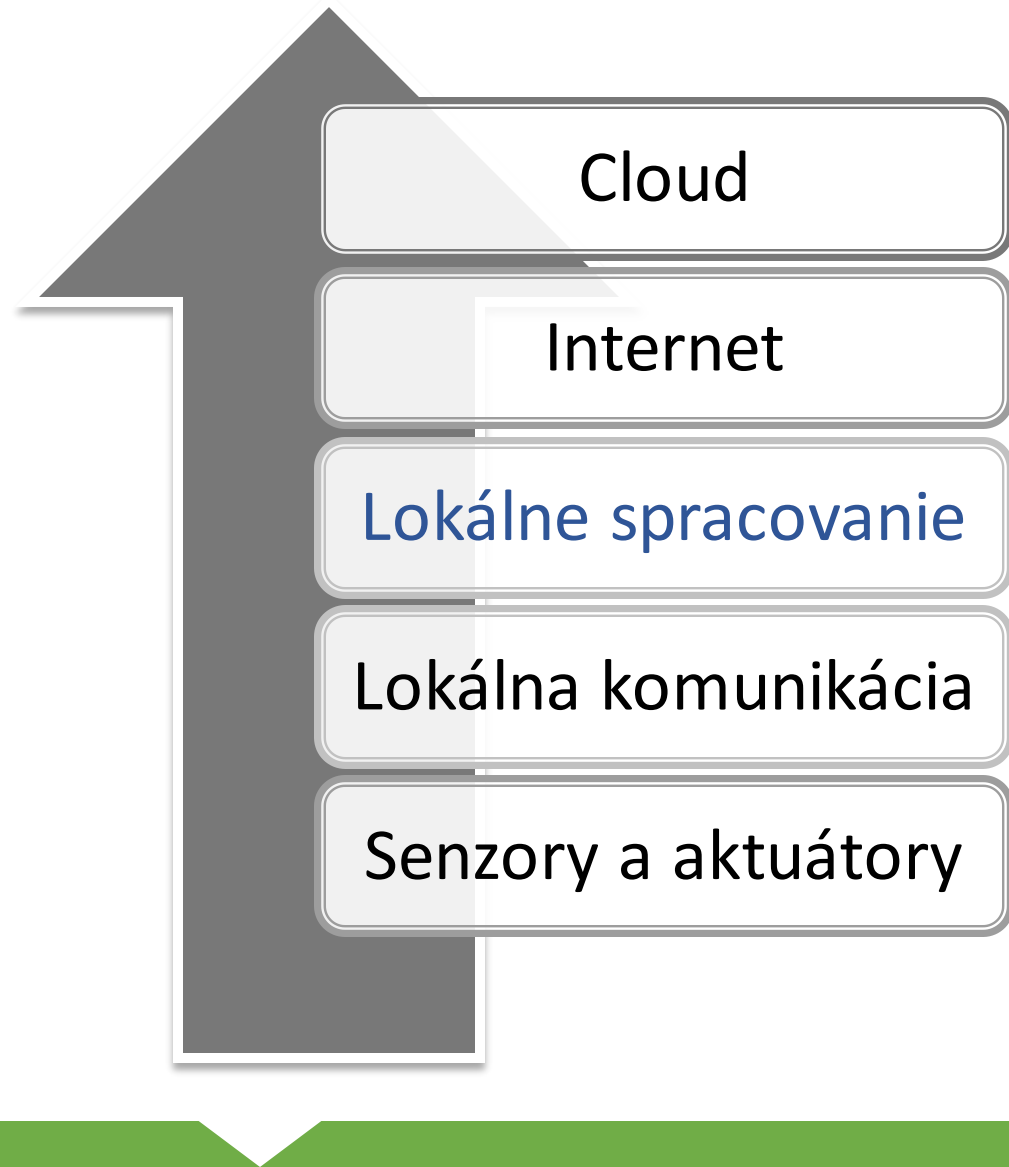


Raspberry Pi

Základy internetu vecí

ÚINF PF UPJŠ

IoT - komponenty



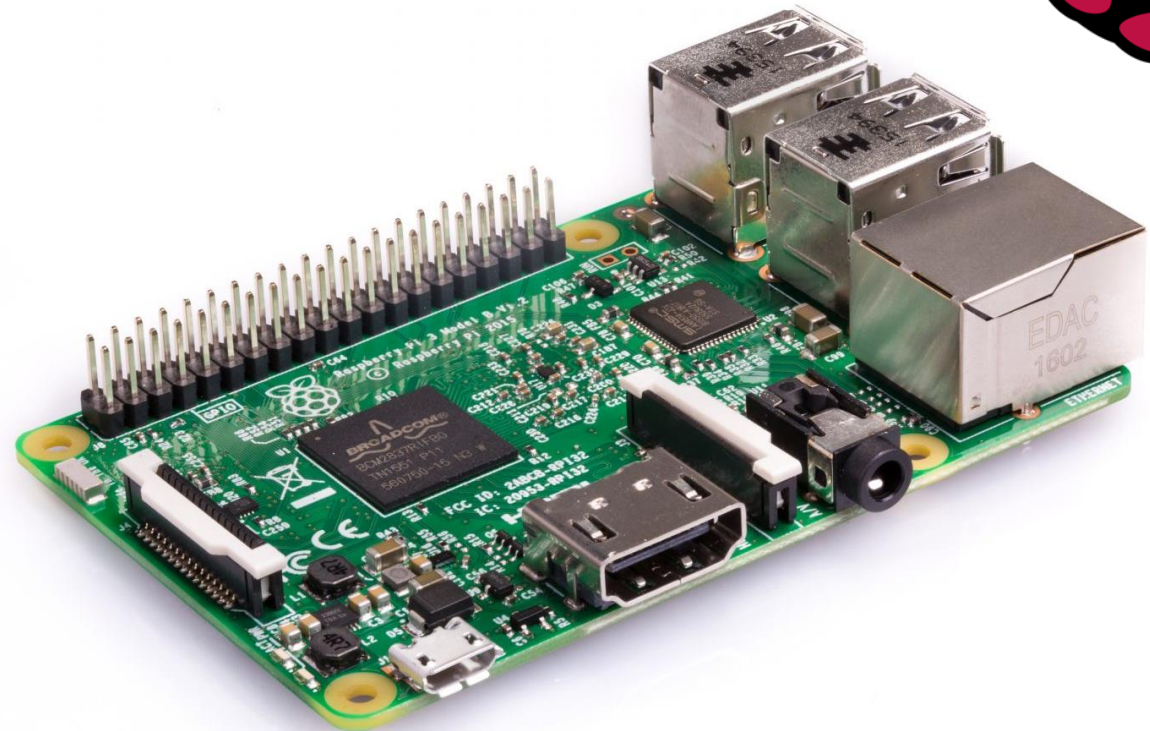
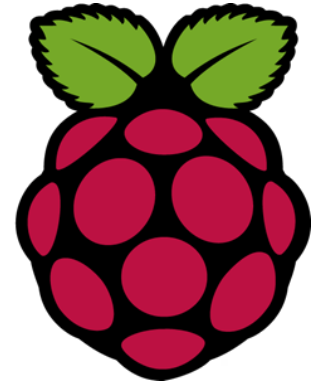
Hardvér: Jednodoskový počítač (SBC)

- **Kompletný počítač na jednej doske**
- Prvý SBC: dyna-micro (1976)



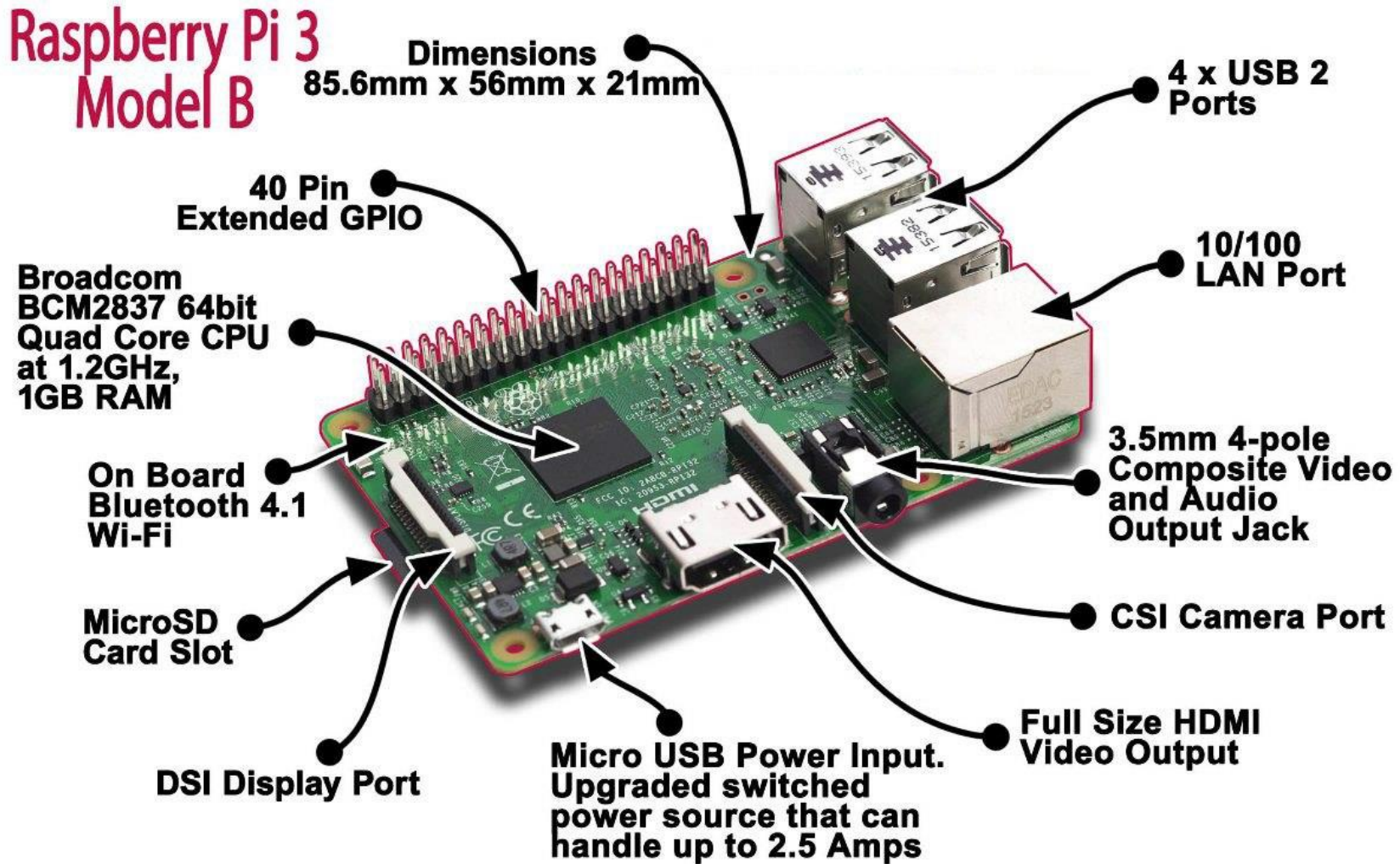
Raspberry Pi

- Jednodoskový počítač (vyvinutý pre edukačné účely):
 - CPU: 1.2 GHz 64-bit quad-core **ARM** Cortex-A53
 - SDRAM: **1 GB**
 - 5V, 300 mA (1.5 W)
 - 17× GPIO
 - MicroSDHC slot
 - 10/100 Mbit/s Ethernet,
 - 802.11n wireless
 - Bluetooth 4.1
 - HDMI, USB
 - **Linux, Windows 10 IoT Core**
 - **40 €**

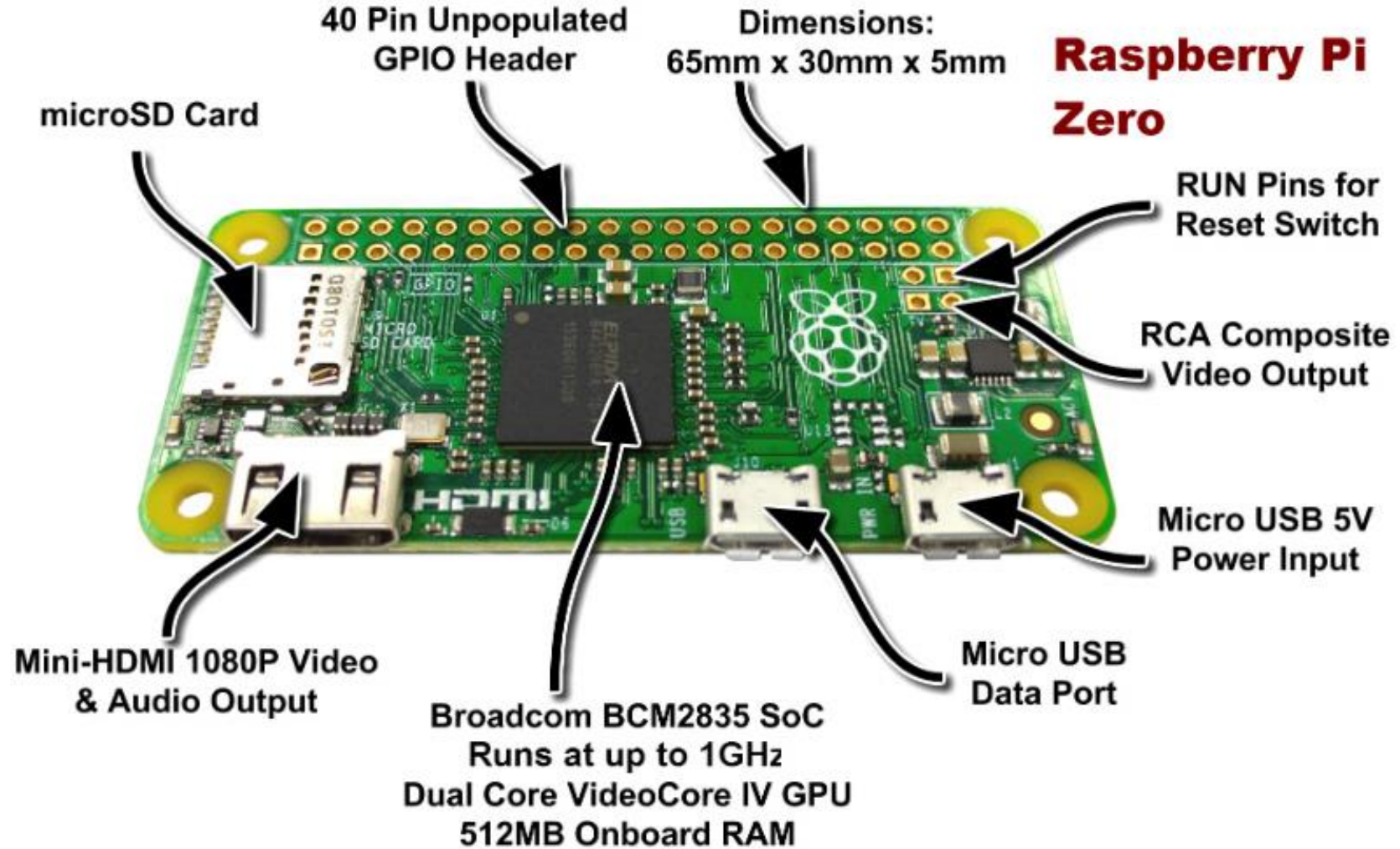


Raspberry Pi 3 (~38 EUR)

Raspberry Pi 3 Model B



Raspberry Pi Zero (~5 USD/10 USD)



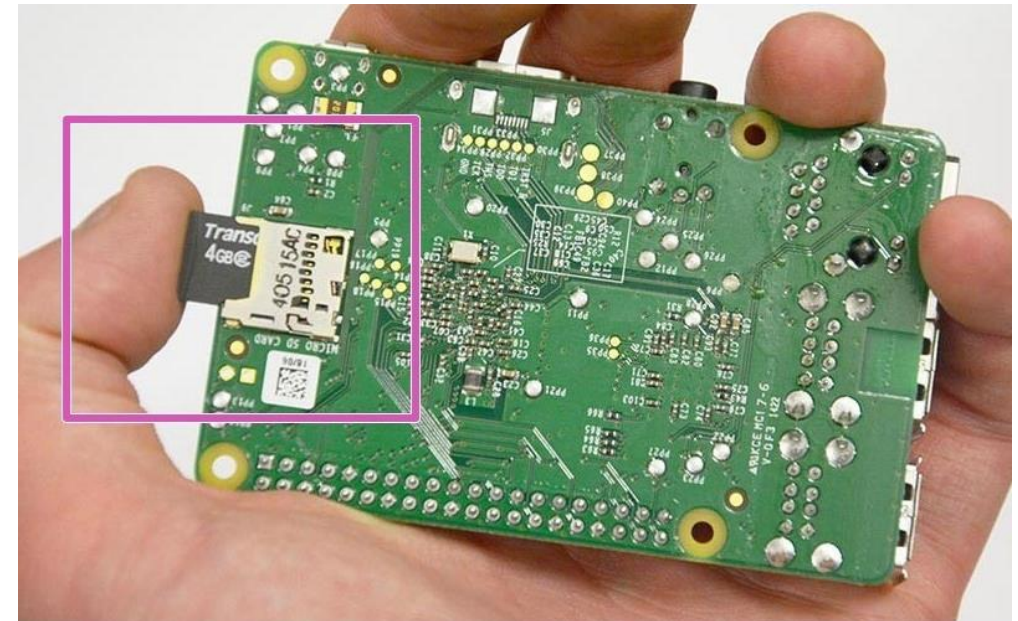
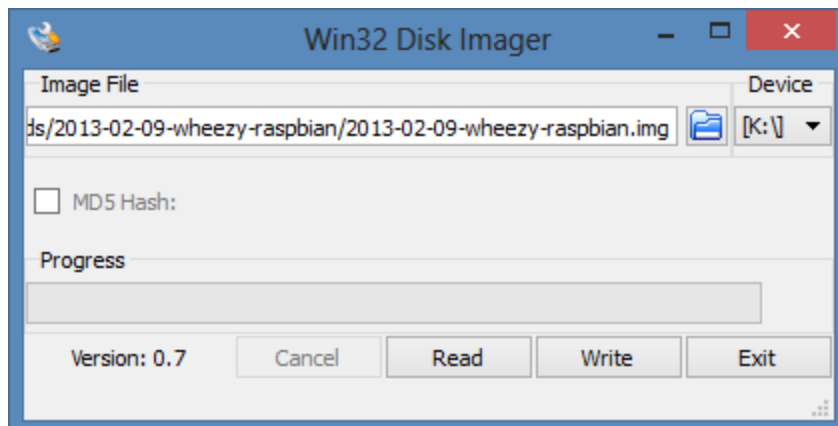
SoC – System on Chip

- **Integrovaný obvod**, ktorý obsahuje všetky **základné časti** počítača:
 - CPU, GPU, RAM, WiFi, Bluetooth, DSP (audio, video)...
 - *Broadcom BCM-2837* (na RPi3)
 - *Broadcom BCM-2836* (na RPi2)
 - **ARM** procesor



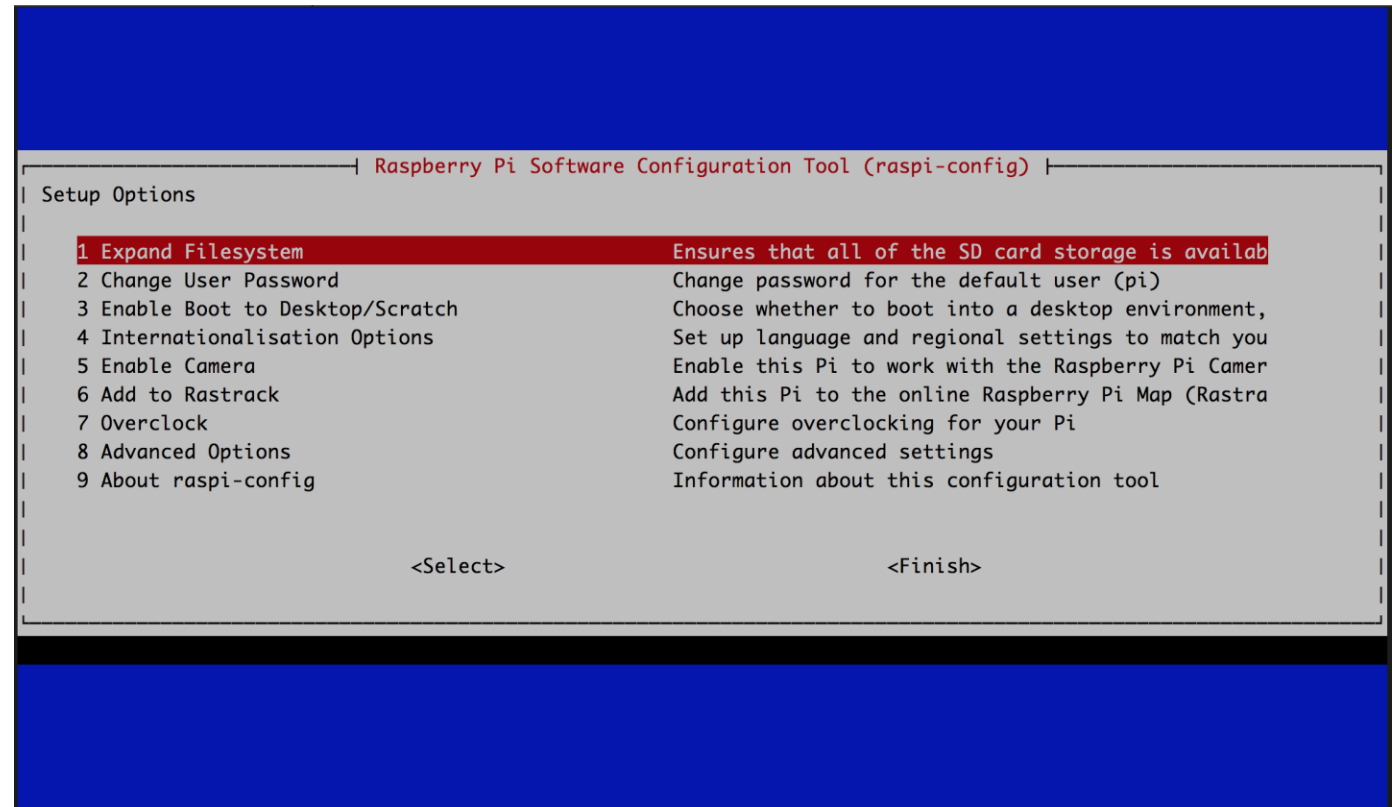
Operačný systém na RPi

- Operačný systém a súborový systém je uložený na (micro)**SD karte**
 - SSD -> obmedzený počet zápisov
 - RPi nemá hodiny reálneho času (RTC) -> strata času po vypnutí
 - default login: pi/raspberry
- 1. krok: príprava SD karty s operačným systémom



sudo raspi-config

- Nastavenie systému cez raspi-config
 - Aktivácia/deaktivácia SSH, I2C, SPI, kamery, ...
 - Bootovacie nastavenia
 - Pretaktovanie
 - ...



```
Raspberry Pi Software Configuration Tool (raspi-config)
Setup Options
1 Expand Filesystem          Ensures that all of the SD card storage is availab
2 Change User Password       Change password for the default user (pi)
3 Enable Boot to Desktop/Scratch  Choose whether to boot into a desktop environment,
4 Internationalisation Options  Set up language and regional settings to match you
5 Enable Camera               Enable this Pi to work with the Raspberry Pi Camer
6 Add to Rastrack             Add this Pi to the online Raspberry Pi Map (Rastra
7 Overclock                   Configure overclocking for your Pi
8 Advanced Options            Configure advanced settings
9 About raspi-config          Information about this configuration tool

<Select>                    <Finish>
```

Raspbian – grafické používateľské rozhranie

The image displays the Raspbian desktop environment with several windows open:

- Raspberry Pi Configuration:** A window with tabs for System, Interfaces, Performance, and Localisation. The Interfaces tab is active, showing options for enabling the desktop environment. The "To Desktop" radio button is selected, and the "Login as user 'pi'" checkbox is checked. The "Enabled" radio button is also selected.
- Terminal:** A terminal window showing the output of the `ls -l` command, listing files and directories in the current directory.
- Web Browser:** A browser window displaying the website <http://www.raspberrypi-spy.co.uk/>. The page features a Raspberry Pi logo and a section titled "Datacenter" with a button to "Try Now for Free".

A large Raspberry Pi logo is overlaid on the center of the desktop.

Raspbian = Linux

- Raspbian a ďalšie OS pre RPi sú **plnohodnotné operačné systémy** a štandardné **linuxové systémy**:
 - `ifconfig -a`
 - konfigurácia siete
 - `/etc/wpa_supplicant/wpa_supplicant.conf`
 - konfigurácia WiFi
 - `lsusb`
 - vypísanie pripojených USB zariadení
 - `/dev`
 - pripojené zariadenia
 - `udev`
 - správca zariadení pre Linux kernel
 - `/etc/udev/rules.d/` - možnosť statického mapovania zariadení

GPIO na RPi



Alternate Function						Alternate Function
	3.3V PWR	1		2	5V PWR	
I2C1 SDA	GPIO 2	3		4	5V PWR	
I2C1 SCL	GPIO 3	5		6	GND	
	GPIO 4	7		8	UART0 TX	
	GND	9		10	UART0 RX	
	GPIO 17	11		12	GPIO 18	
	GPIO 27	13		14	GND	
	GPIO 22	15		16	GPIO 23	
	3.3V PWR	17		18	GPIO 24	
SPI0 MOSI	GPIO 10	19		20	GND	
SPI0 MISO	GPIO 9	21		22	GPIO 25	
SPI0 SCLK	GPIO 11	23		24	GPIO 8	SPI0 CS0
	GND	25		26	GPIO 7	SPI0 CS1
	Reserved	27		28	Reserved	
	GPIO 5	29		30	GND	
	GPIO 6	31		32	GPIO 12	
	GPIO 13	33		34	GND	
SPI1 MISO	GPIO 19	35		36	GPIO 16	SPI1 CS0
	GPIO 26	37		38	GPIO 20	SPI1 MOSI
	GND	39		40	GPIO 21	SPI1 SCLK

GPIO: 3.3 V

vs.

Arduino 5V

- žiadny ADC
- žiadne analógové piny
- zabudované pull-up a pull-down rezistory
- 1 pin s hardvérovým PWM

WiringPi

- **WiringPi** „is a PIN based GPIO access library written in C for the BCM2835, BCM2836 and BCM2837 SoC devices used in all Raspberry Pi.“
 - C knižnica aj utilita **gpio**
- WiringPi utilita **gpio**:
 - `gpio readall`
 - `gpio [-g] mode <pin> in/out/pwm/up/down/tri`
 - prepínač -g piny v číslovaní BCM_GPIO
 - `gpio [-g] write <pin> 0/1`
 - `gpio [-g] read <pin>`
 - `gpio export <BCM_pin> in/out`
→ `/sys/class/gpio`

```
#!/bin/bash
while true
do
    cat /sys/class/gpio/gpio23/value
done
```

i2c tools

- Utility na prácu s I²C „z príkazového riadku“
 - RPi má dve I²C zbernice:
 - **0** – interné použitie
 - **1** – všeobecné použitie
 - Dostupné zbernice: `ls /dev/*i2c*`
 - SDA, SCL piny majú stále 1.8 k Ω pull-up rezistory
→ tieto piny sú nevhodné na všeobecné použitie
-
- `i2cdetect -y 1`
 - `i2cget -y 1 0x11`
 - `i2cset -y 1 0x11 0x01`

Pi4J (pi4j.com)

- Knižnica na prácu z GPIO, I²C, SPI a sériovou komunikáciou priamo z Javy
- Maven: `com.pi4j.pi4j-distribution 1.1`
- Poznámky:
 - nekompatibilná s novšími kernelmi (staticky pribuildovaná staršia verzia WiringPi)
 - riešenie: 1.2-SNAPSHOT
 - fix:

```
static {  
    System.setProperty("pi4j.linking", "dynamic");  
}
```
 - NetBeans IDE podporuje spúšťanie a debugovanie kódu na vzdialených platformách

Pi4J – práca s GPIO pinmi

```
package sk.upjs.iot;

import com.pi4j.io.gpio.*;

public class PinTest {

    static {
        System.setProperty("pi4j.Linking", "dynamic");
    }

    public static void main(String[] args) throws Exception {
        GpioController gpio = GpioFactory.getInstance();
        GpioPinDigitalInput pin = gpio.provisionDigitalInputPin(
            RaspiPin.GPIO_04, PinPullResistance.PULL_UP);
        while (true) {
            System.out.println(pin.getState());
            Thread.sleep(500);
        }
    }
}
```


Pi4J – komunikácia cez I²C

```
package sk.upjs.iot;

import com.pi4j.io.i2c.*;

public class I2CTest {

    static {
        System.setProperty("pi4j.Linking", "dynamic");
    }

    public static void main(String[] args) throws Exception {
        I2CBus i2c = I2CFactory.getInstance(I2CBus.BUS_1);
        I2CDevice device = i2c.getDevice(0x38);
        while (true) {
            System.out.println(device.read());
            Thread.sleep(500);
        }
    }
}
```

Ďakujem za pozornosť