Chapter 7

IoT Physical Devices & Endpoints

Outline

- Basic building blocks of an IoT Device
- Exemplary Device: Raspberry Pi
- Raspberry Pi interfaces
- Programming Raspberry Pi with Python
- Other IoT devices

What is an IoT Device

- A "Thing" in Internet of Things (IoT) can be any object that has a unique identifier and which can send/receive data (including user data) over a network (e.g., smart phone, smart TV, computer, refrigerator, car, etc.).

- IoT devices are connected to the Internet and send information about themselves or about their surroundings (e.g. information sensed by the connected sensors) over a network (to other devices or servers/storage) or allow actuation upon the physical entities/environment around them remotely.

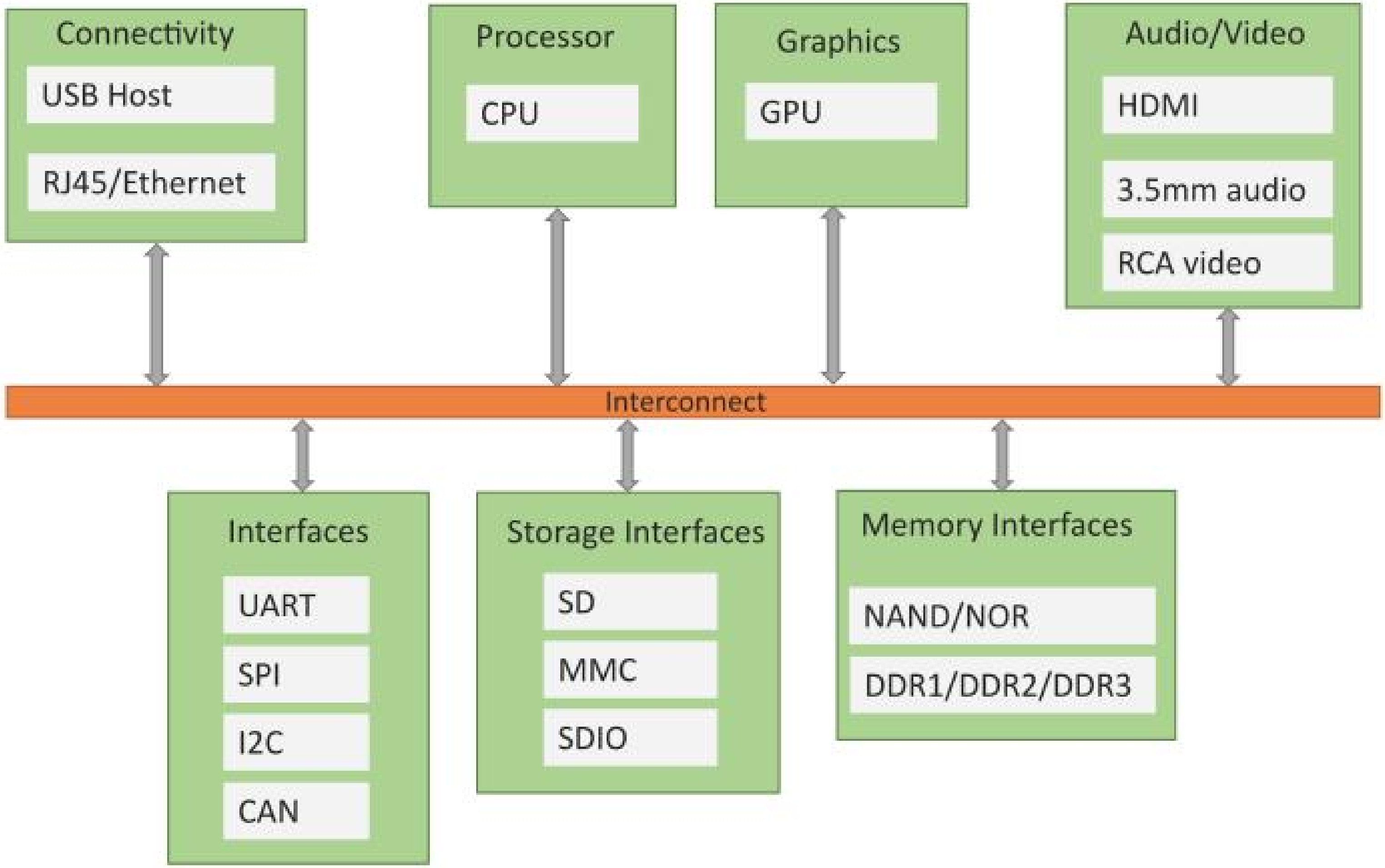
IoT Device Examples

- A home automation device that allows remotely monitoring the status of appliances and controlling the appliances.
- An industrial machine which sends information abouts its operation and health monitoring data to a server.
- A car which sends information about its location to a cloud-based service.
- A wireless-enabled wearable device that measures data about a person such as the number of steps walked and sends the data to a cloud-based service.

Basic building blocks of an IoT Device

- Sensing
  - Sensors can be either on-board the IoT device or attached to the device.
- Actuation
  - IoT devices can have various types of actuators attached that allow taking
  - actions upon the physical entities in the vicinity of the device.
- Communication
  - Communication modules are responsible for sending collected data to other devices or cloud-based servers/storage and receiving data from other devices and commands from remote applications.
- Analysis & Processing
  - Analysis and processing modules are responsible for making sense of the collected data.

Block diagram of an IoT Device



Exemplary Device: Raspberry Pi

- Raspberry Pi is a low-cost mini-computer with the physical size of a credit card.
- Raspberry Pi runs various flavors of Linux and can perform almost all tasks that a normal desktop computer can do.
- Raspberry Pi also allows interfacing sensors and actuators through the general purpose I/O pins.
- Since Raspberry Pi runs Linux operating system, it supports Python "out of the box".

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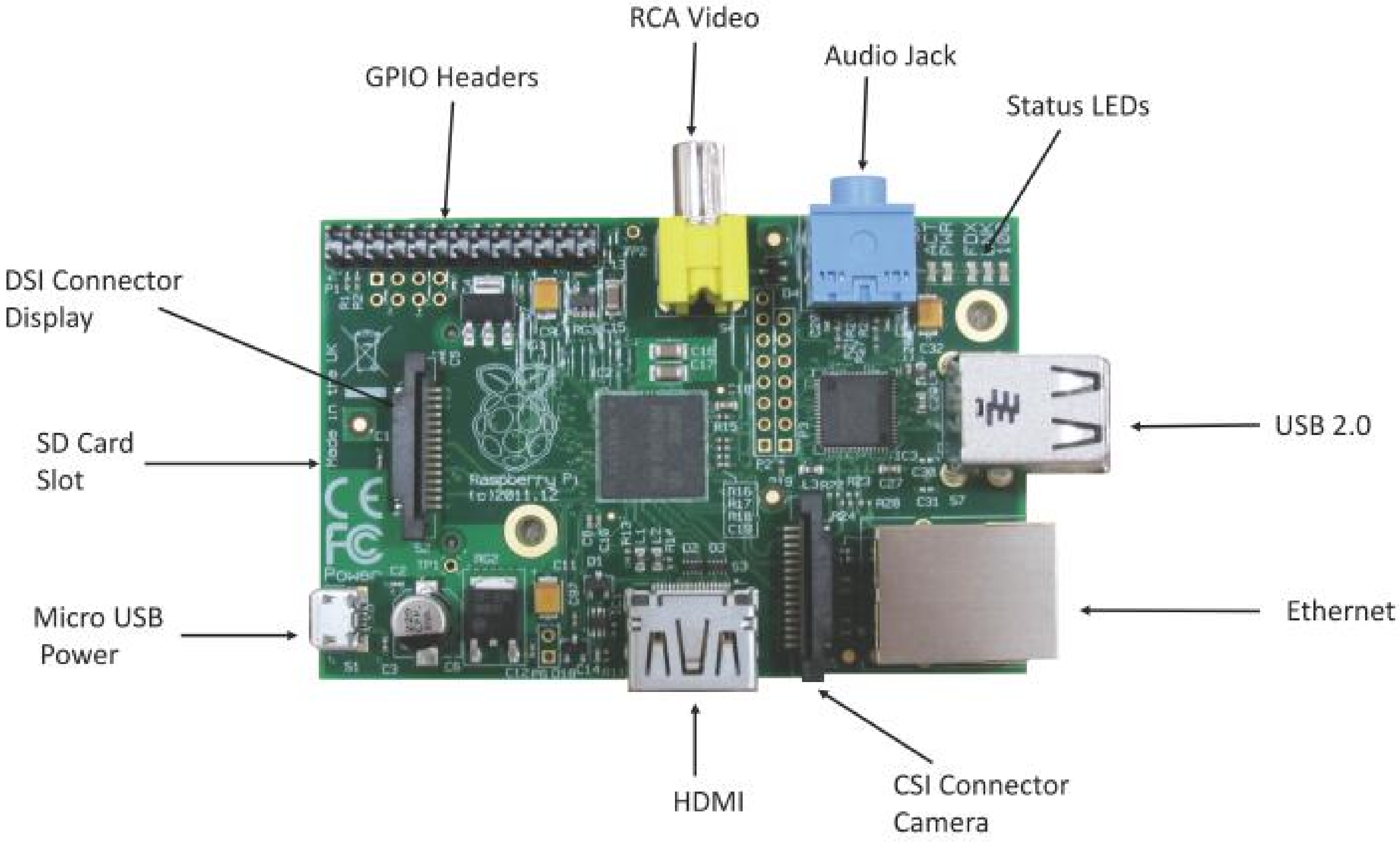
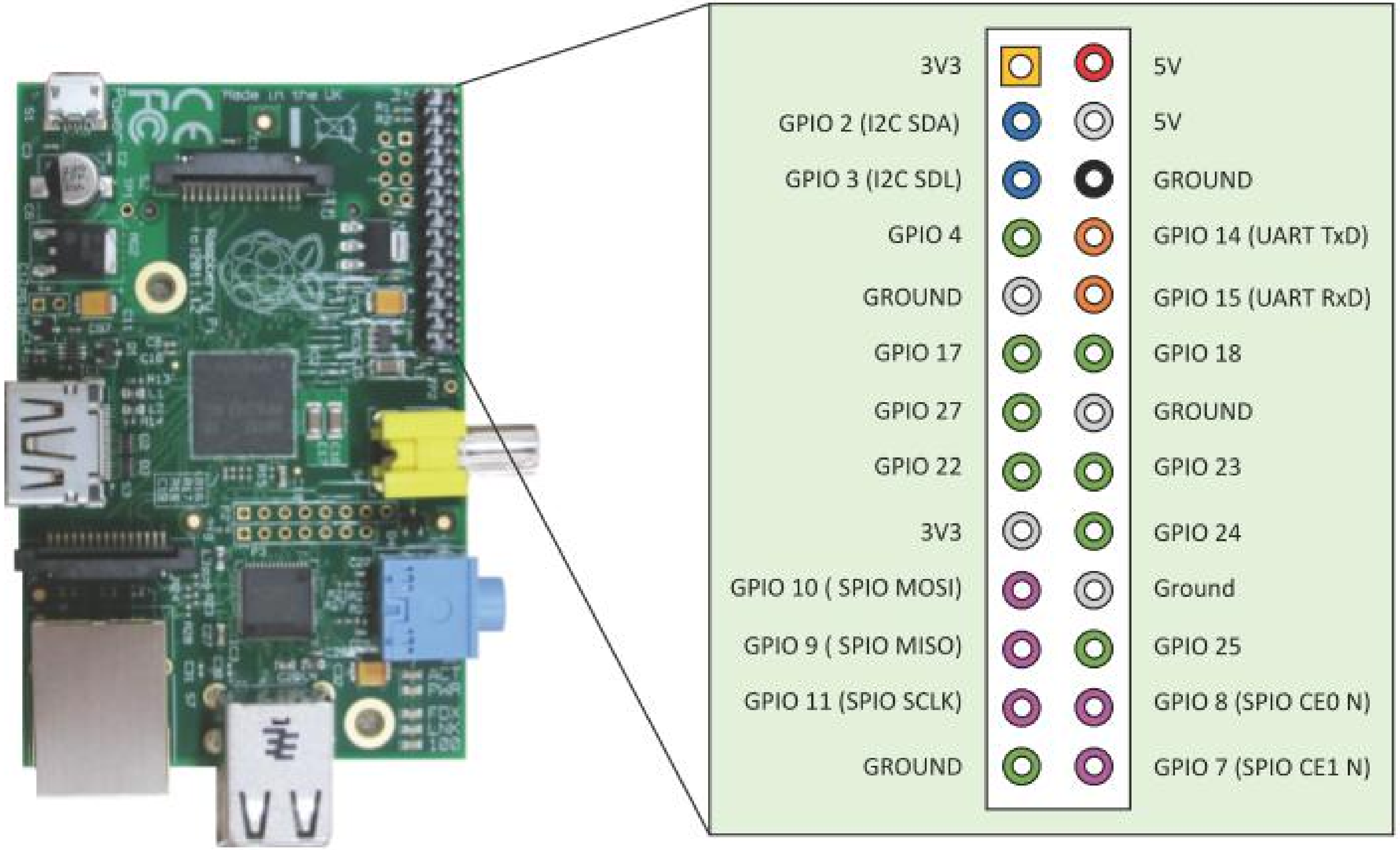
Raspberry Pi



Linux on Raspberry Pi

- Raspbian
  - Raspbian Linux is a Debian Wheezy port optimized for Raspberry Pi.
- Arch
  - Arch is an Arch Linux port for AMD devices.
- Pidora
  - Pidora Linux is a Fedora Linux optimized for Raspberry Pi.
- RaspBMC
  - RaspBMC is an XBMC media-center distribution for Raspberry Pi.
- OpenELEC
  - OpenELEC is a fast and user-friendly XBMC media-center distribution.
- RISC OS
  - RISC OS is a very fast and compact operating system.

Raspberry Pi GPIO



3V3	5V
GPIO 2 (I2C SDA)	5V
GPIO 3 (I2C SDL)	GROUND
GPIO 4	GPIO 14 (UART TxD)
GROUND	GPIO 15 (UART RxD)
GPIO 17	GPIO 18
GPIO 27	GROUND
GPIO 22	GPIO 23
3V3	GPIO 24
GPIO 10 (SPIO MOSI)	Ground
GPIO 9 (SPIO MISO)	GPIO 25
GPIO 11 (SPIO SCLK)	GPIO 8 (SPIO CE0 N)
GROUND	GPIO 7 (SPIO CE1 N)

Raspberry Pi Interfaces

- Serial
  - The serial interface on Raspberry Pi has receive (Rx) and transmit (Tx) pins for communication with serial peripherals.
- SPI
  - Serial Peripheral Interface (SPI) is a synchronous serial data protocol used for communicating with one or more peripheral devices.
- I2C
  - The I2C interface pins on Raspberry Pi allow you to connect hardware modules. I2C interface allows synchronous data transfer with just two pins - SDA (data line) and SCL (clock line).

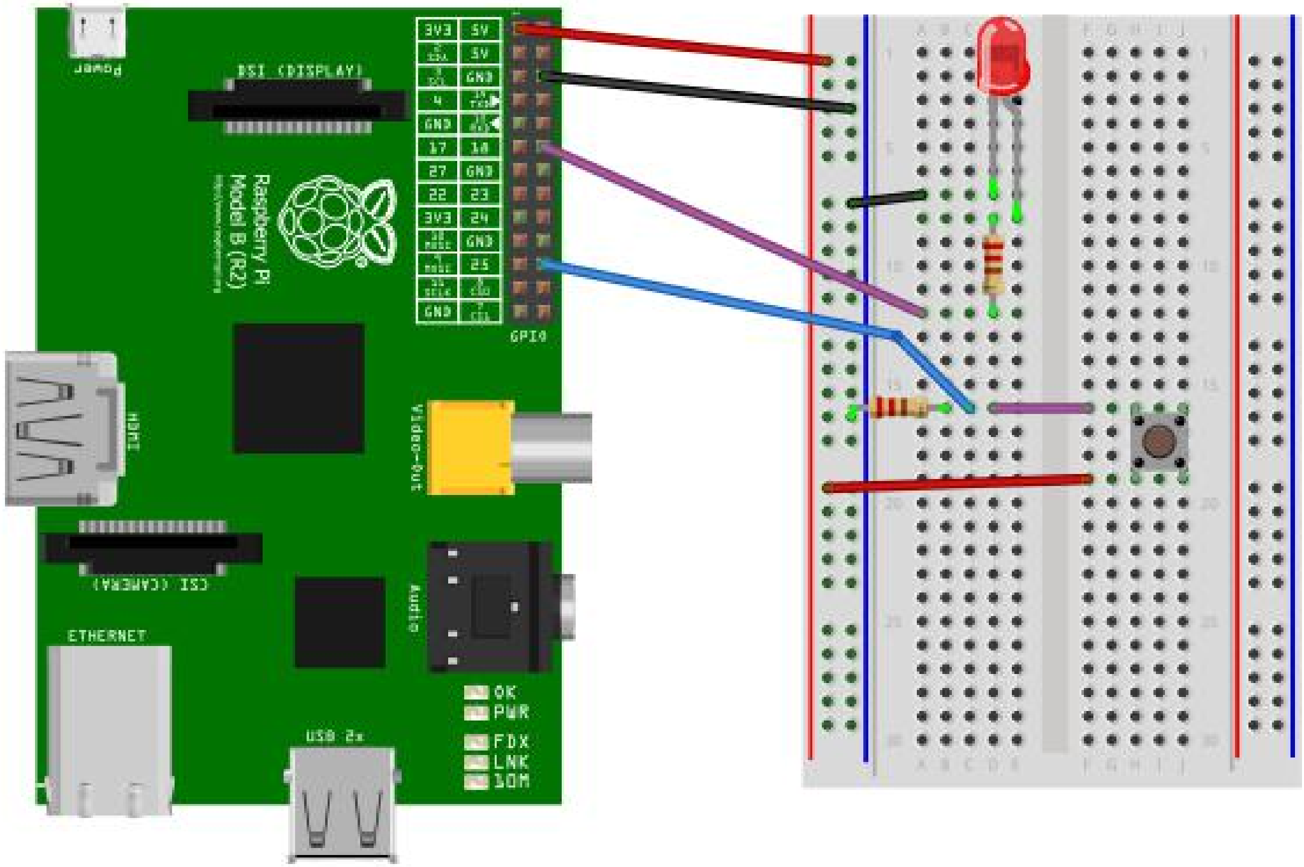
Raspberry Pi Example:
Interfacing LED and switch with Raspberry Pi

```
from time import sleep
import RPi.GPIO as GPIO
GPIO.setmode(GPIO.BCM)

#Switch Pin
GPIO.setup(25, GPIO.IN)
#LED Pin
GPIO.setup(18, GPIO.OUT)
state=false

def toggleLED(pin):
        state = not state
        GPIO.output(pin, state)

while True:
        try:
                if (GPIO.input(25) == True):
                        toggleLED(pin)
                sleep(.01)
                except KeyboardInterrupt:
                        exit()
```



Other Devices

- pcDuino
- BeagleBone Black
- Cubieboard