UNIT-II

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.

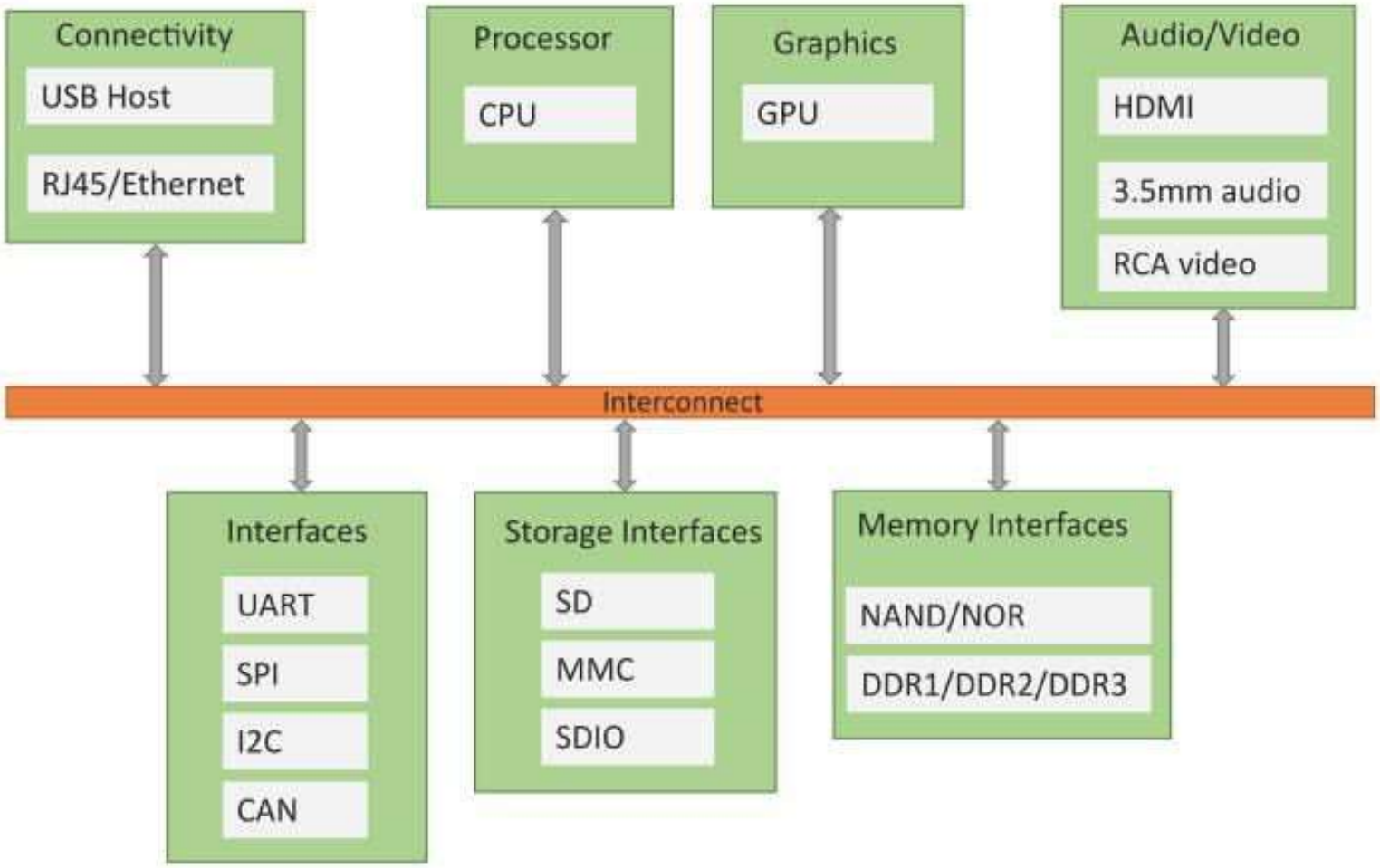
IoT Device Examples

- 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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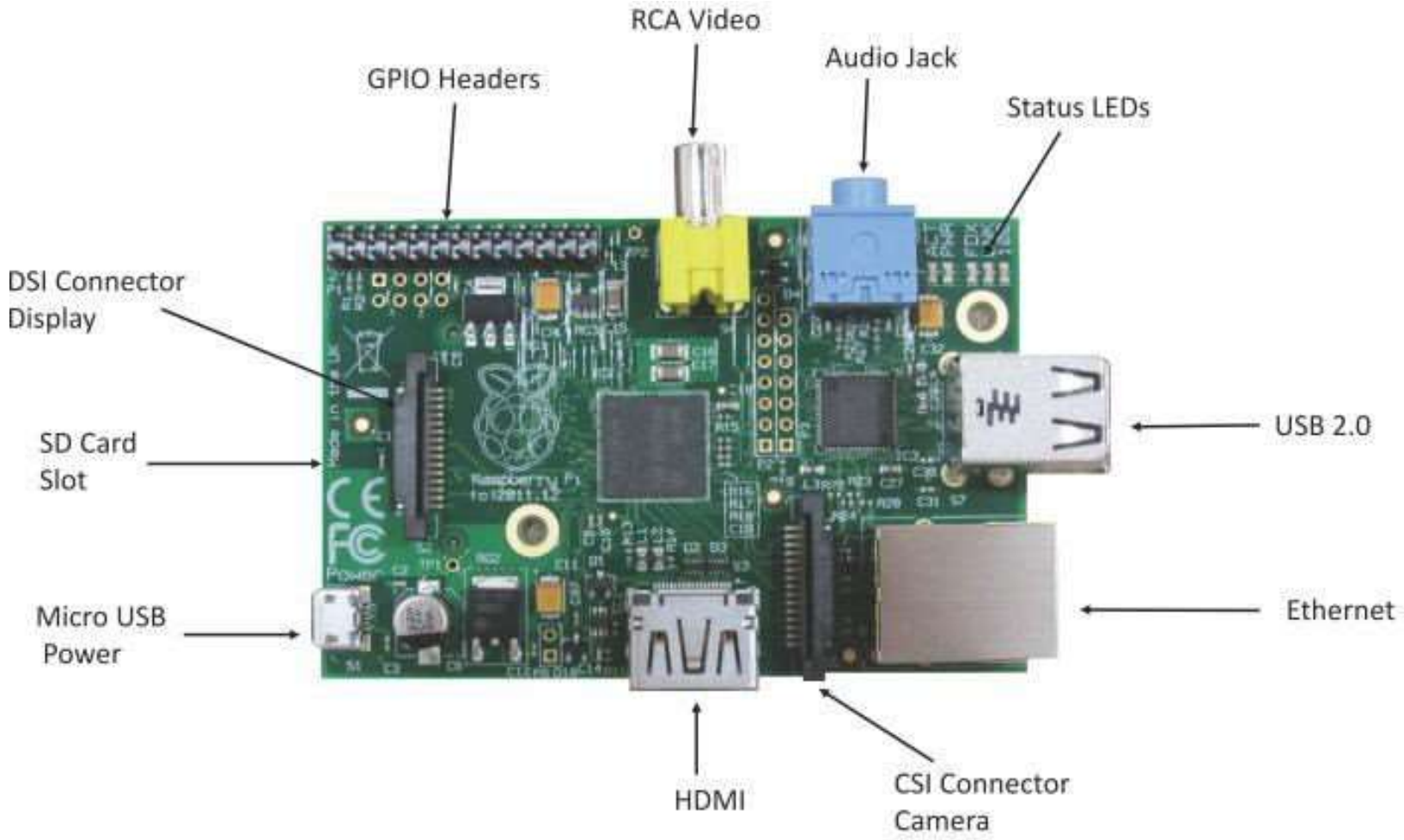
Raspberry Pi



Raspberry Pi Components

- Processor and RAM : based on ARM processor
- Latest version=model B, Revision 2
- Comes with 700 MHz lowpower
- 512 MB SDRAM
- USB ports : Two USB 2.0 ports
- It provides current up to 100mA
- For connecting devices that draw current mare than 100mA
- External USB powered hub I s required

Raspberry Pi Components

- Ethernet ports : RJ45 Ethernet port
- You can connect an Ethernet cable or a USB WiFIi adaptor to provide Internet connectivity
- HDMI Output: Provides both video and audio output
- You can connect Raspberry pi to a monitor using HDMI cable
- For monitors that have a DVI port but no HDMI port
- You can use an HDMI to DVI adaptor or cable

Raspberry Pi Components

- Composite video output : RP comes with a composite video output with RCA jack
- RCA jack supports both PAL NTSC video output
- RCA jack can be used to connect old TVs that have an RCA input only

- Audio output : RP has a 3.5 mm audio input jack
- This is used for providing audio output to old TVs along with RCA jack for video

Raspberry Pi Components

- GPIO Pins : rp COMES WITH A NO OF gpio PINS
- There are 4 types of pins
- 12c interface pins, SPI interface pins, serial Rx pins, Tx pins

- Display serial interface(DSI): used to connect an LCD pannel to RP
- Camera serial interface(CSI): used to connect a camera module to RP

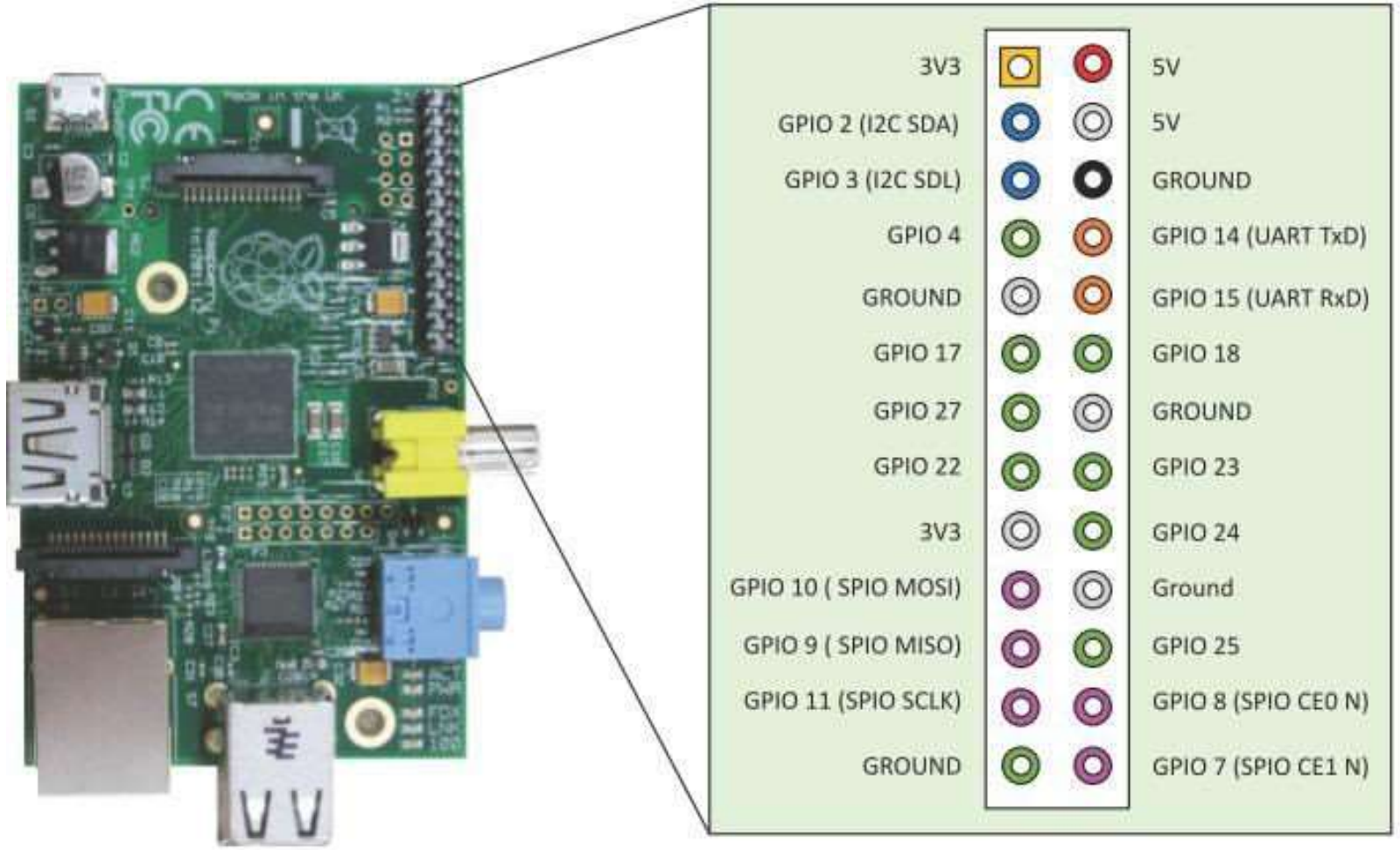
Raspberry Pi Components

- Status LEDs : It has 5 status LEDs
- ACT --- SD card access
- PWR –3.3 v power is present
- FDX--- full duplex LAN connected
- LNX--- link or n/w activity
- 100– 100 Mbits LAN connected
- SD card slot: RP do not have a built in OS and storage

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



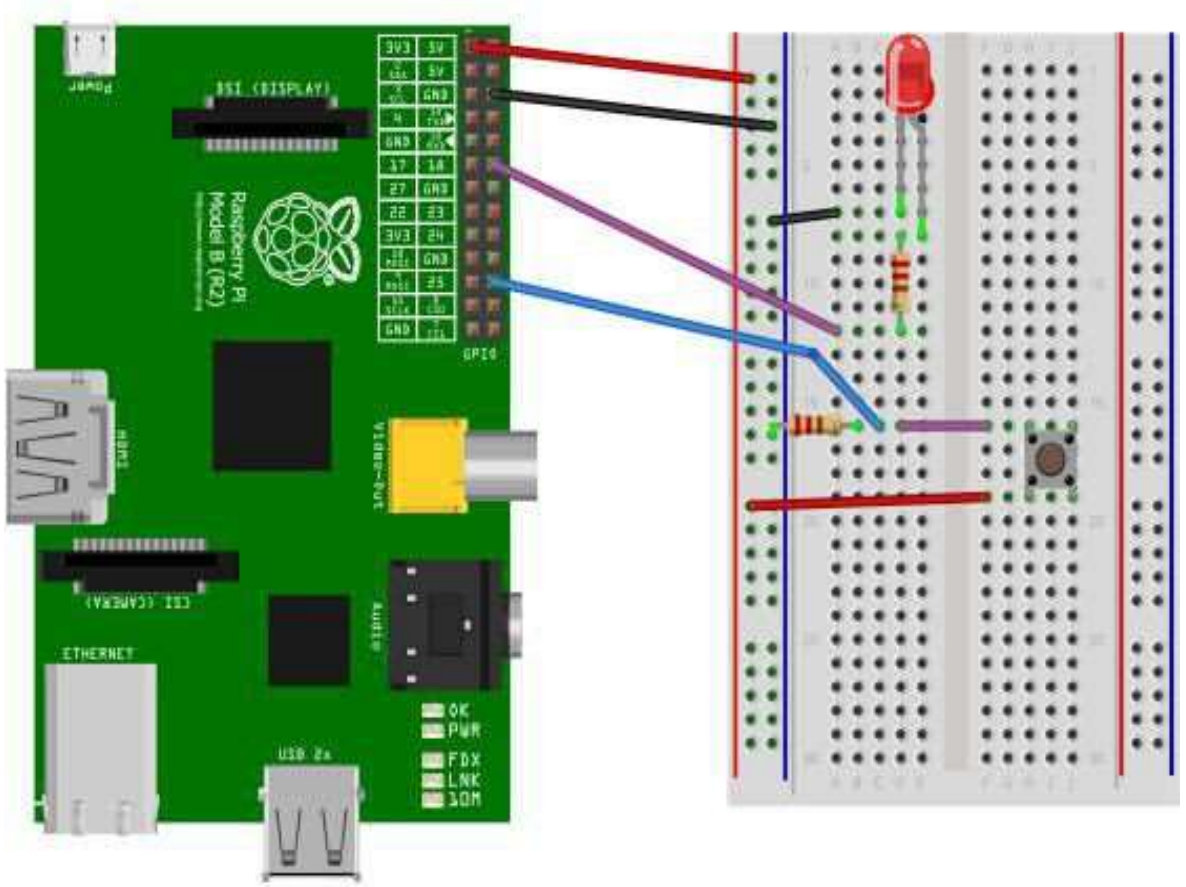
Raspberry Pi Interfaces

- 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: Controlling LED with raspberry Pi

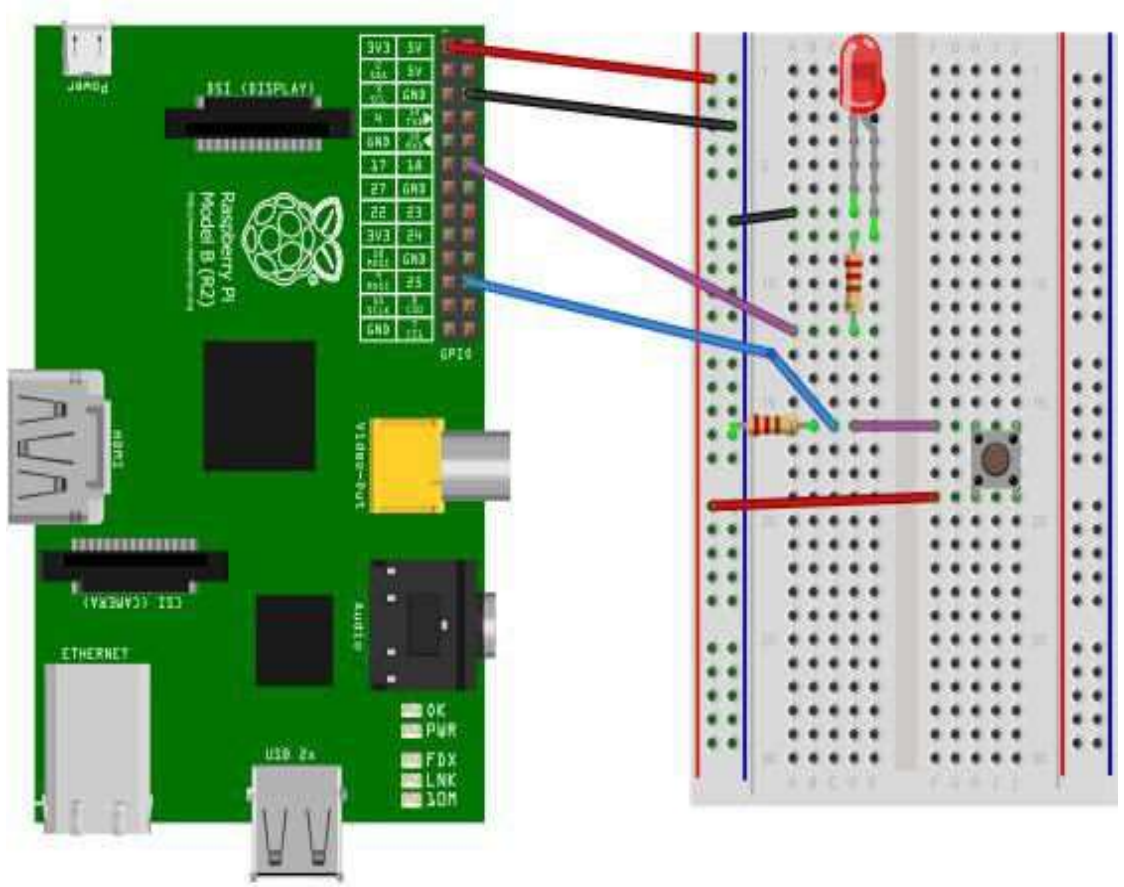
$echo 18> /sys/class/gpio/export
$cd /sys/class/gpio/gpio18
$Exho out>direction
$echo 1>value
$echo 1>value

•It shows how to turn the LED on/off from command line
•LED connected to GPIO pin 18
•You can connect the LED any other GPIO pin as well



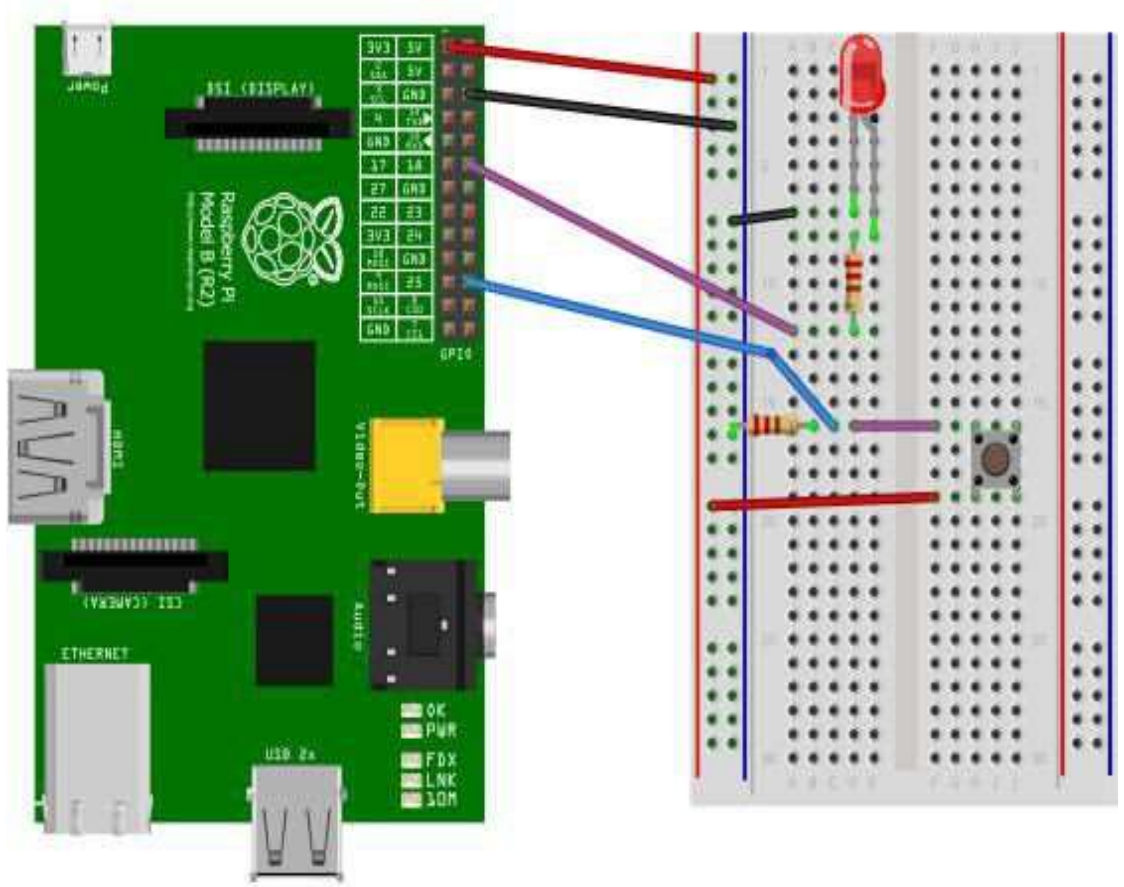
Raspberry Pi Example: Controlling LED withraspberry Pi

```
import RPi.GPIO as GPIO
import time

GPIO.setmode(GPIO.BCM)

GPIO.setup(18,   GPIO..OUT)
While True:
GPIO.output(18,   True)
Time.sleep(1)
GPIO.output(18,   False)
Time.sleep(0)
```



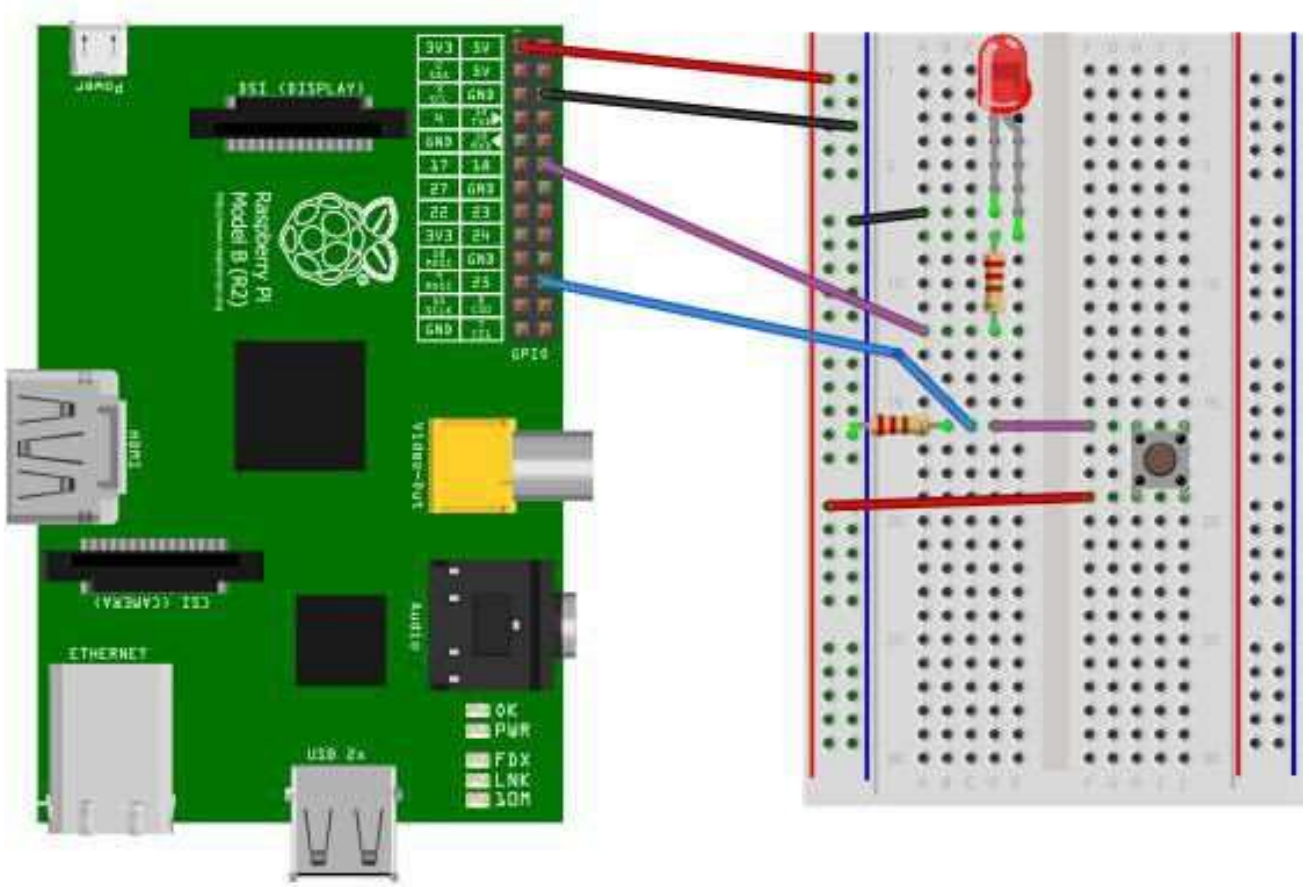
Raspberry Pi Example: Controlling LED with raspberry Pi

- the above code shows a python program for blinking an LED connected to raspbery pi
- Set pin 18 direction to output
- Then write True/False after dely of one second



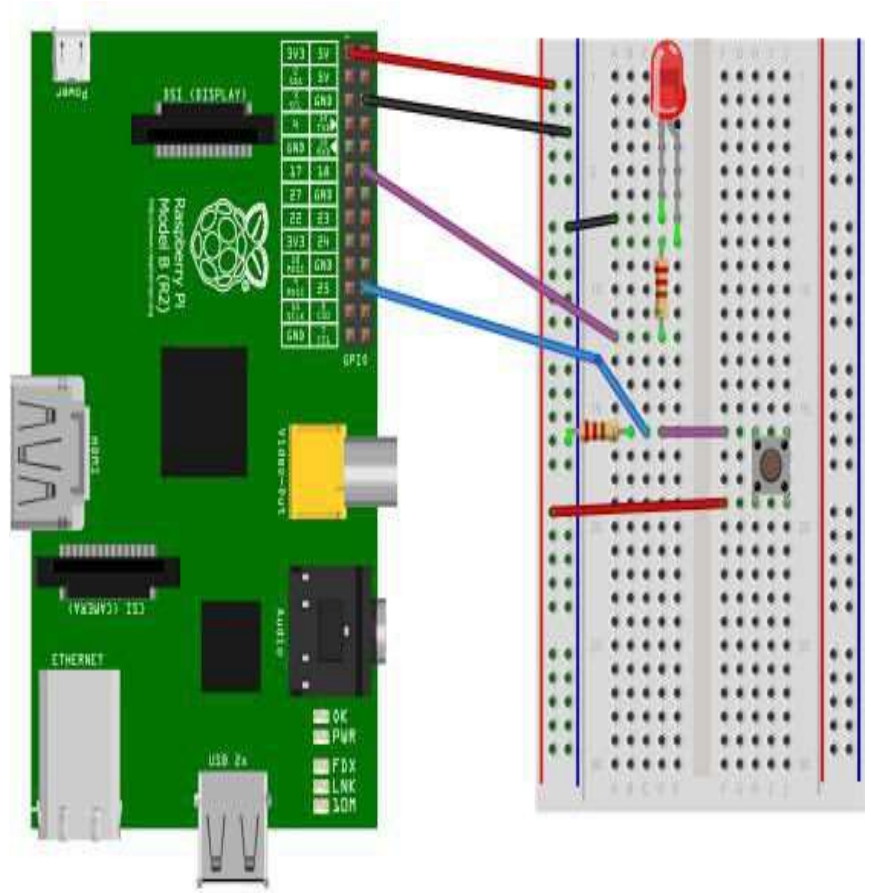
Raspberry Pi Example: Interfacing LEDand switch with Raspberry Pi

```
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()
```



Raspberry Pi Example: Interfacing LEDand switch with Raspberry Pi

- The python program for controlling an LED with switch
- The LED is connected to GPIO pin 18 and switch is connected to pin 25
- Pin 25 is checked and the state of LED is toggled if the switch is pressed



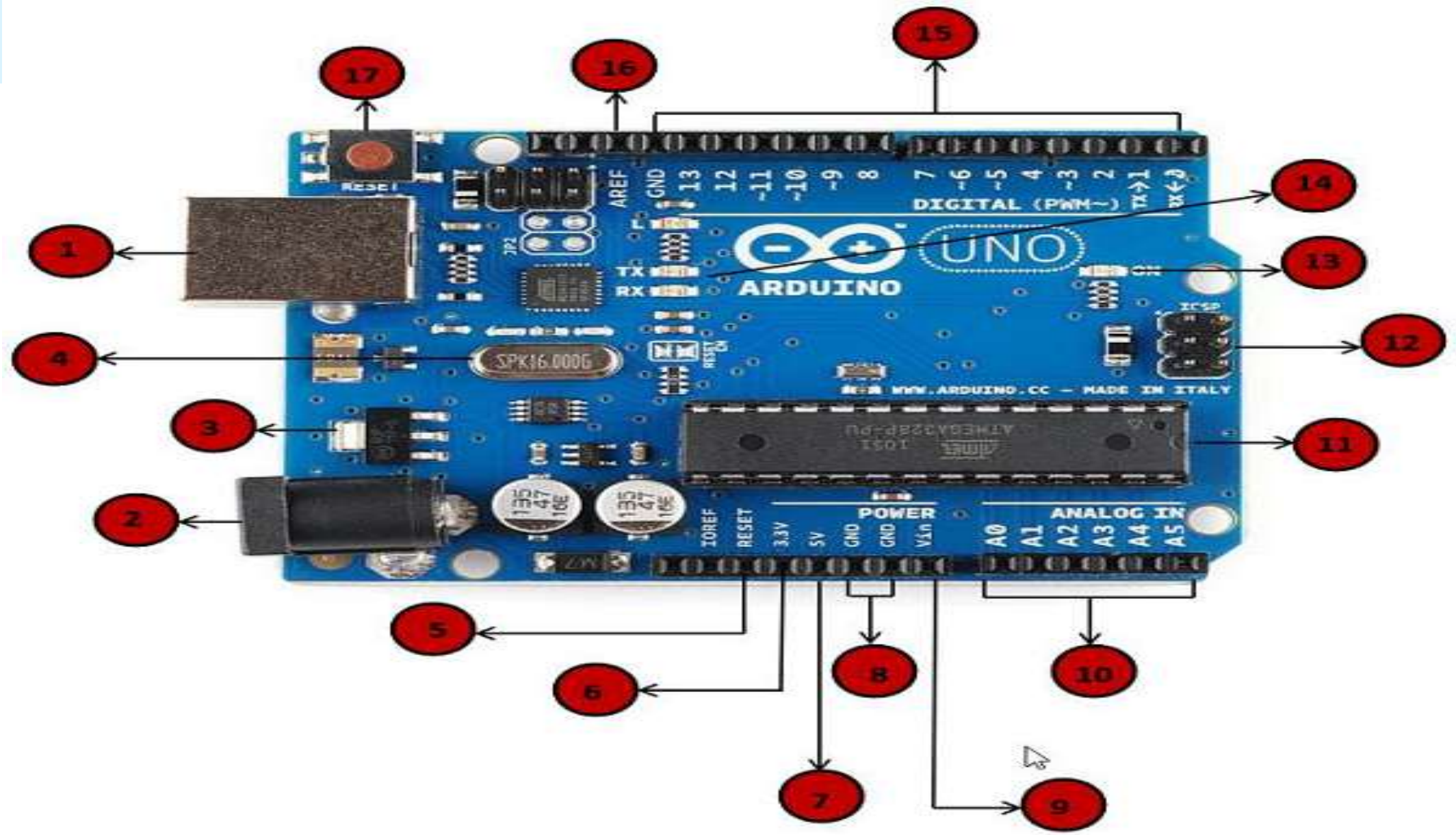
Other Devices

- pcDuino
- BeagleBone Black
- Cubieboard

Arduino

- Arduino is a prototype platform (open-source) based on an easy-to-use hardware and software.
- It consists of a circuit board, which can be programed (referred to as a microcontroller) and
- a ready-made software called Arduino IDE (Integrated Development Environment), which is used to write and upload the computer code to the physical board.

Arduino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Arduino

1.Power USB

Arduino board can be powered by using the USB cable from your computer. All you need to do is connect the USB cable to the USB connection (1).

2. Power (Barrel Jack)

Arduino boards can be powered directly from the AC mains power supply by connecting it to the Barrel Jack (2).

3.Voltage Regulator

The function of the voltage regulator is to control the voltage given to the Arduino board and stabilize the DC voltages used by the processor and other elements.

Arduino

4.Crystal Oscillator

The crystal oscillator helps Arduino in dealing with time issues. How does Arduino calculate time? The answer is, by using the crystal oscillator. The number printed on top of the Arduino crystal is 16.000H9H. It tells us that the frequency is 16,000,000 Hertz or 16 MHz.

5,17 Arduino Reset

You can reset your Arduino board, i.e., start your program from the beginning. You can reset the UNO board in two ways. First, by using the reset button (17) on the board. Second, you can connect an external reset button to the Arduino pin labelled RESET (5).

Arduino

6-9)Pins (3.3, 5, GND, Vin)

- 3.3V (6) – Supply 3.3 output volt
- 5V (7) – Supply 5 output volt
- Most of the components used with Arduino board works fine with 3.3 volt and 5 volt.
- GND (8)(Ground) – There are several GND pins on the Arduino, any of which can be used to ground your circuit.
- Vin (9) – This pin also can be used to power the Arduino board from an external power source, like AC mains power supply.

Arduino

10.Analog pins

The Arduino UNO board has six analog input pins A0 through A5. These pins can read the signal from an analog sensor like the humidity sensor or temperature sensor and convert it into a digital value that can be read by the microprocessor.

11.Main microcontroller

Each Arduino board has its own microcontroller (11). You can assume it as the brain of your board. The main IC (integrated circuit) on the Arduino is slightly different from board to board. The microcontrollers are usually of the ATMEL Company. You must know what IC your board has before loading up a new program from the Arduino IDE. This information is available on the top of the IC. For more details about the IC construction and functions, you can refer to the data sheet.

Arduino

12. ICSP pin

Mostly, ICSP (12) is an AVR, a tiny programming header for the Arduino consisting of MOSI, MISO, SCK, RESET, VCC, and GND. It is often referred to as an SPI (Serial Peripheral Interface), which could be considered as an "expansion" of the output. Actually, you are slaving the output device to the master of the SPI bus.

13.Power LED indicator

This LED should light up when you plug your Arduino into a power source to indicate that your board is powered up correctly. If this light does not turn on, then there is something wrong with the connection.

Arduino

14.TX and RX LEDs

On your board, you will find two labels: TX (transmit) and RX (receive). They appear in two places on the Arduino UNO board. First, at the digital pins 0 and 1, to indicate the pins responsible for serial communication. Second, the TX and RX led (13). The TX led flashes with different speed while sending the serial data. The speed of flashing depends on the baud rate used by the board. RX flashes during the receiving process.

15. Digital I/O

The Arduino UNO board has 14 digital I/O pins (15) (of which 6 provide PWM (Pulse Width Modulation) output. These pins can be configured to work as input digital pins to read logic values (0 or 1) or as digital output pins to drive different modules like LEDs, relays, etc. The pins labeled “~” can be used to generate PWM.

Arduino

16.AREF

AREF stands for Analog Reference. It is sometimes, used to set an external reference voltage (between 0 and 5 Volts) as the upper limit for the analog input pins.

Domain specific IoTs