

Internet of Things (IoT)

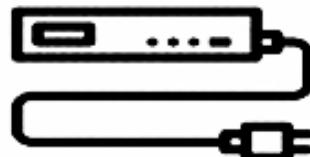
Make It Yourself Workshop



Overview

- **Introduction to Internet of Things (IoT)**
- **IoT System Components**
 - Embedded Systems
 - Hardware & Software
 - Sensors & Actuators
 - Communication Network
- **Hands-On with IoT Development Platforms**
 - Hardware - NodeMCU
 - Software - Arduino Integrated Development Environment (IDE)
 - Do It Yourself (DIY) Experiments
- **Familiarizing Cloud Platforms**
 - ThingSpeak - www.thingspeak.com
 - Ubidots - www.ubidots.com
- **IoT Projects**

Embedded Systems



Sensors



Image Source: <https://www.lanner-america.com/wp-content/uploads/2016/10/IoTsensoretech.png>

Actuators



Image Source: <https://techsee.me/wp-content/uploads/2018/10/IoT-onboarding.jpg>

Programming



Cloud

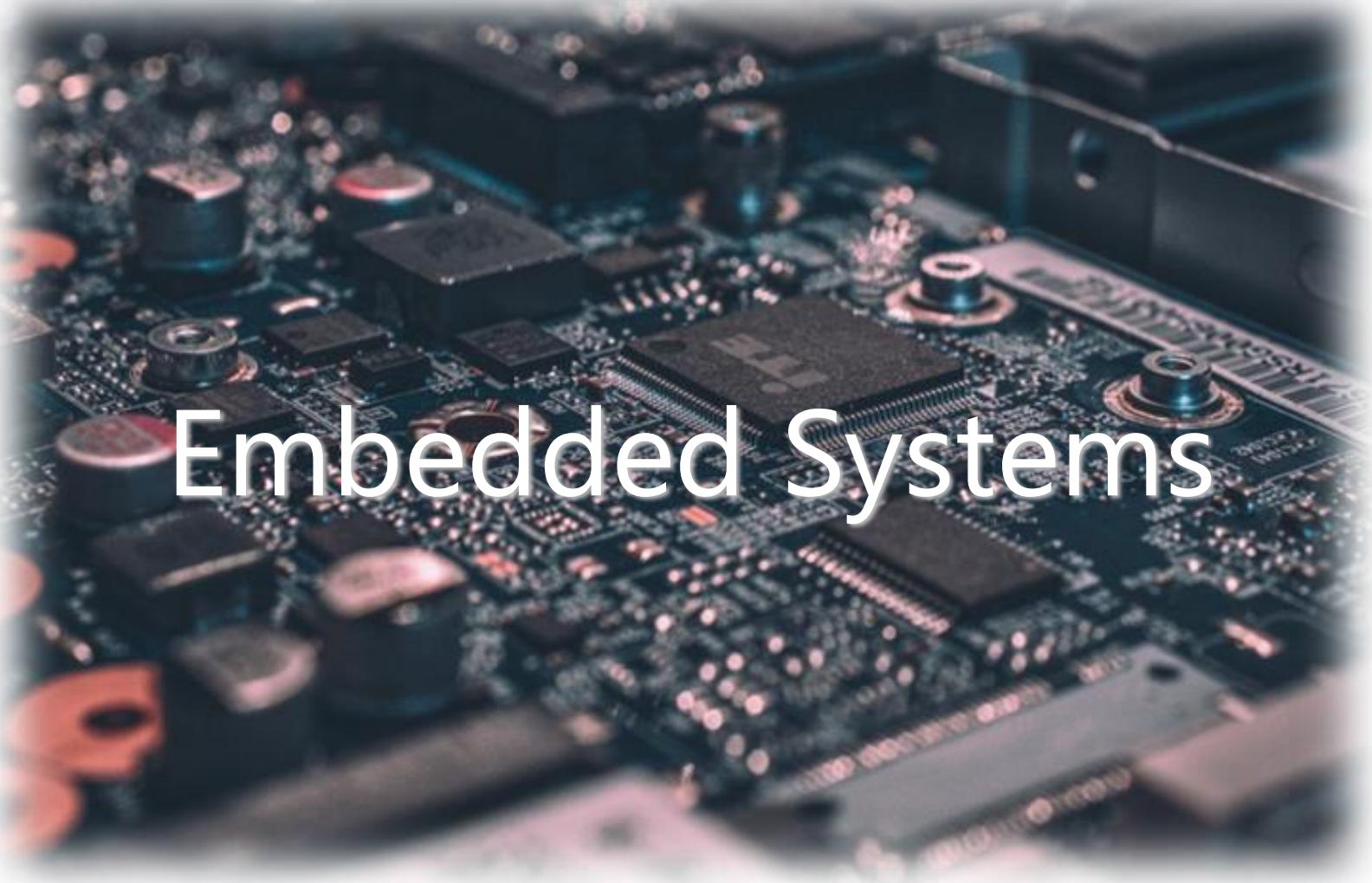


Image Source: <https://d15shllkswkct0.cloudfront.net/wp-content/blogs.dir/1/files/2011/09/cloud-computing-3.jpg>

Internet of Things (IoT)



Image Source: Wikipedia®



Embedded Systems

Image Source: Google®

Embedded Systems ...



Image Source: https://images-na.ssl-images-amazon.com/images/I/81pTG2IEL7L._SL1500_.jpg

Embedded Systems ...



Image Source: <https://ae01.alicdn.com>

Embedded System

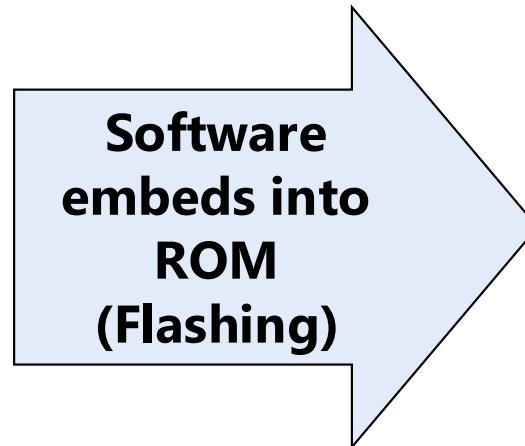
An Embedded System is one that has Computer Hardware with Software embedded inside.

Software Program

```
#include "NodeMCU.h"
#define ledPin D0

void setup()
{
    pinMode(ledPin, OUTPUT);
}

void loop()
{
    digitalWrite(ledPin, HIGH);
    delay (1000);
    digitalWrite(ledPin, LOW);
    delay (1000);
}
```



Roles of Embedded System educore **In Modern World**

**Health
Care**

Transportation

**Home
Appliances**

**Defence
Manufacturing**

Demonstration

Obstacle Range Finder

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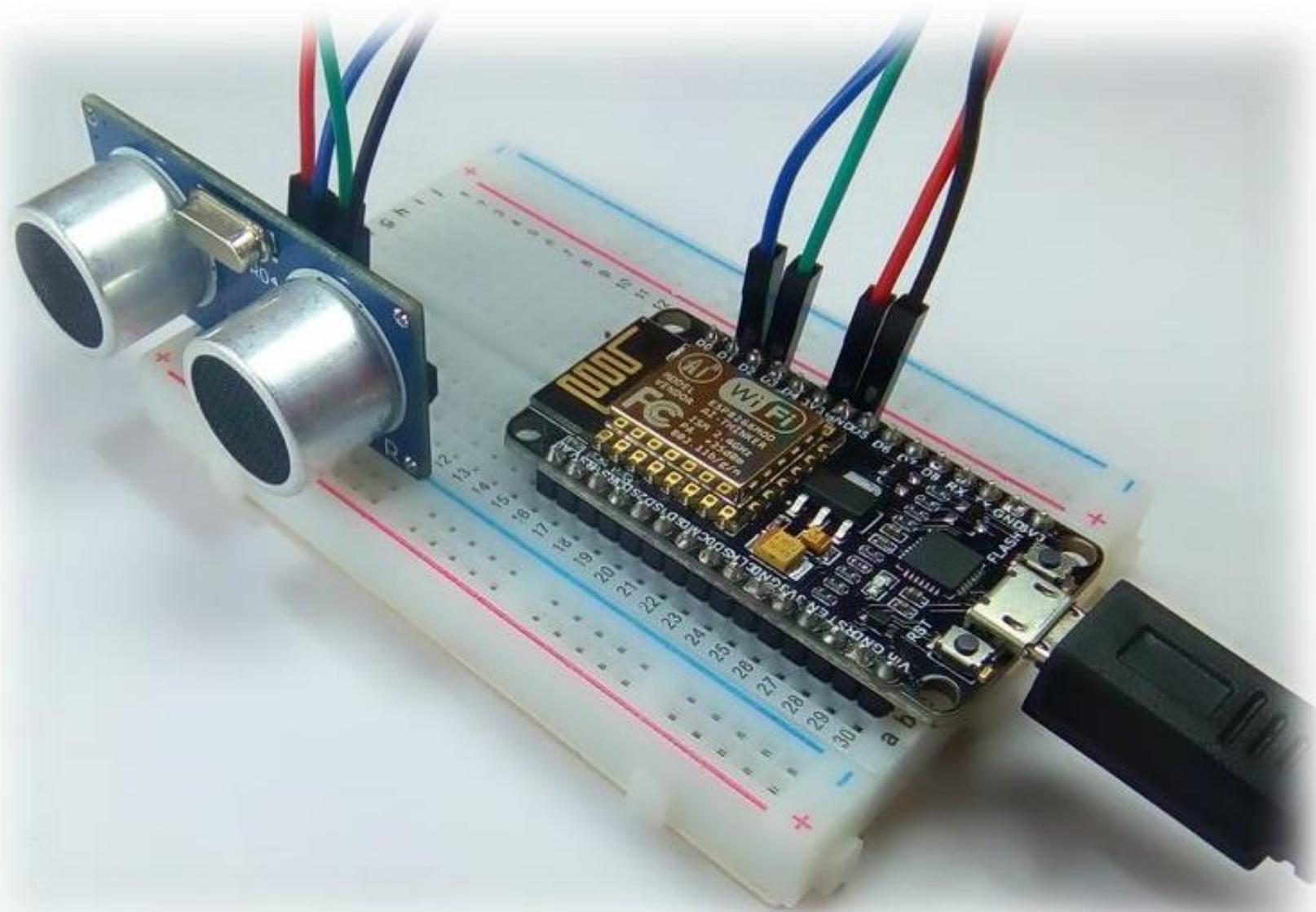


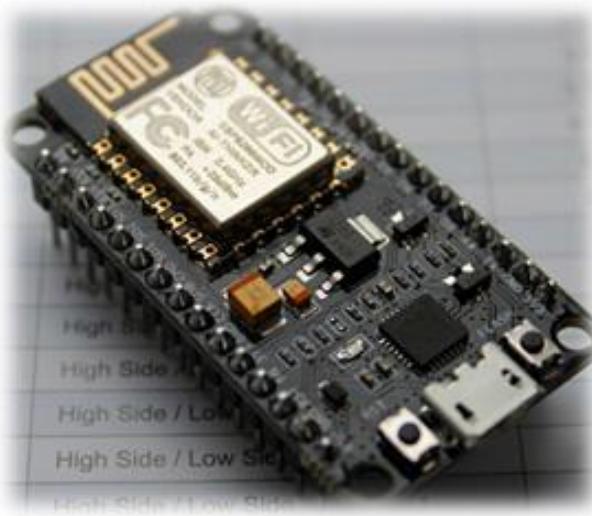
Image Source: <https://cdn.instructables.com/F9F/7UFQ/J48Q4APW/F9F7UFQJ48Q4APW.LARGE.jpg>

Demonstration

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Obstacle Range Finder - Components

Hardware



NodeMCU

ESP8266 WiFi SoC based Open Source
Hardware Development Platform



Ultrasonic Sensor

HC-SR04
5V-12V, 0.2 – 0.45m range
with 0.03m precision

Software



ARDUINO 1.8.9

The open-source Arduino Software (IDE) makes it easy to write code and upload it to the board. It runs on Windows, Mac OS X, and Linux. The environment is written in Java and based on Processing and other open-source software. This software can be used with any Arduino board. Refer to the [Getting Started](#) page for installation instructions.

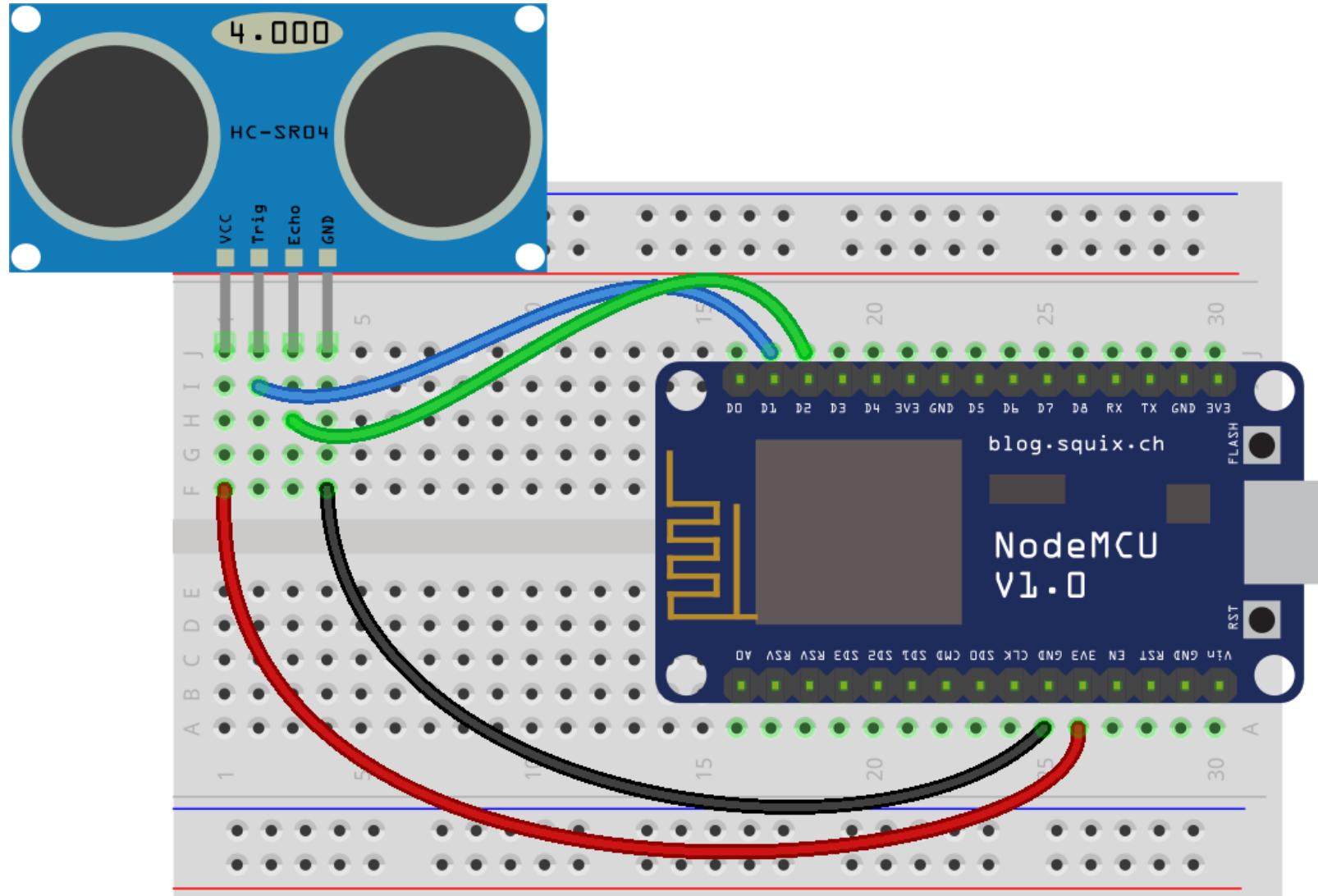
Arduino IDE

C++ based Embedded Software
Integrated Development Platform

Demonstration

Obstacle Range Finder - Wiring

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Layout designed using Fritzing® - <http://fritzing.org>

NodeMCU part Source: <https://github.com/squix78/esp8266-fritzing-parts/tree/master/nodemcu-v1.0>

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Internet of Things

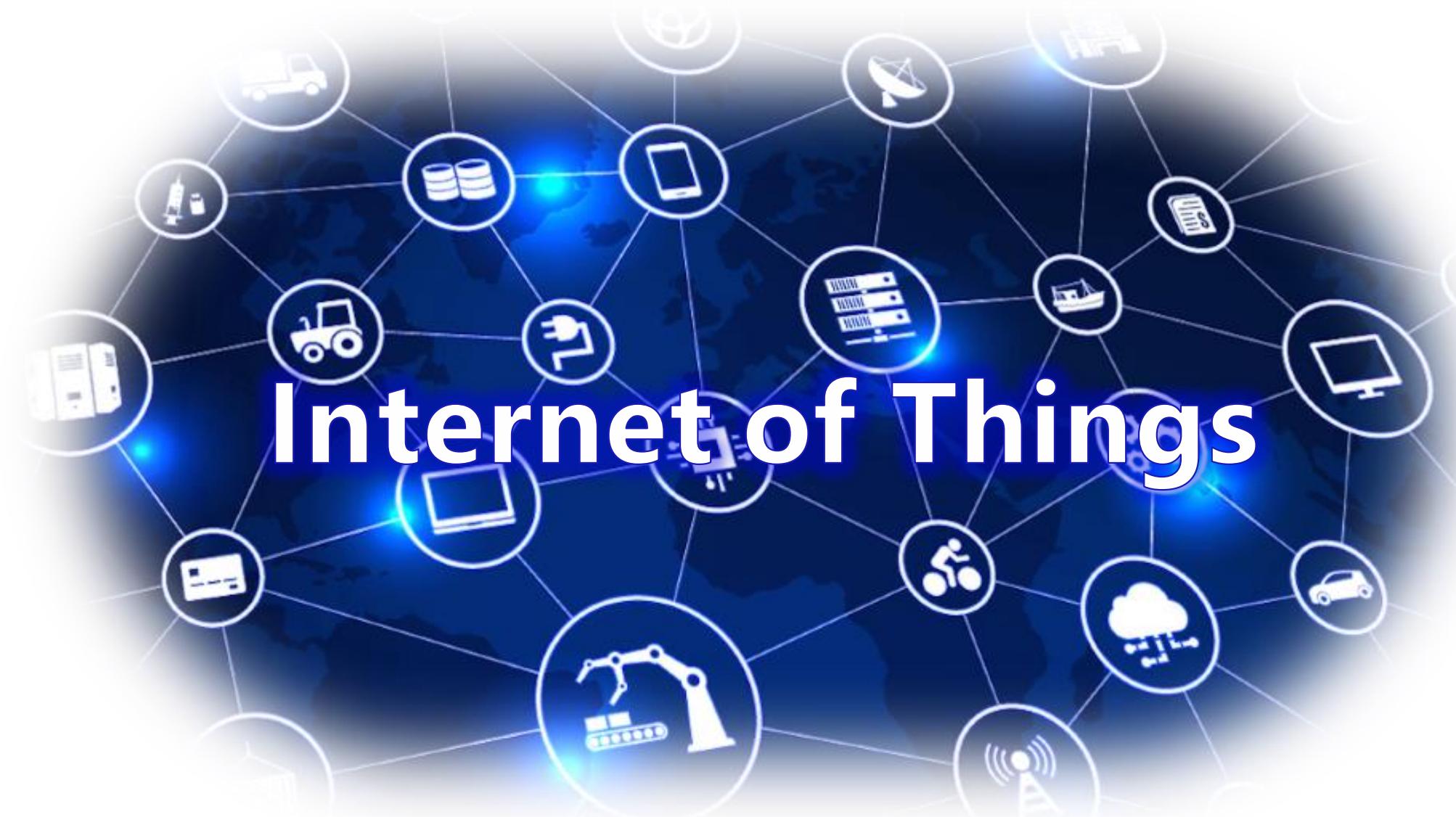


Image Source: https://martechtoday.com/wp-content/uploads/2018/08/Internet-of-Things_hvrxab.png

What is IoT ?

Internet of things (IoT) refers to the concept of connecting **any thing** to the Internet. It is the Idea that people can communicate with the objects and physical things

Things can be Humans, Animals, Buildings, Energy Stations, Smartphones, Tablets, Bicycle, Sensors, Cameras, Vehicles, Health monitoring devices and so on...



Image Source: <https://des.gbtcnd.com/uploads/pdm-desc-pic/Electronic/image/2017/03/21/1490059347782768.jpg>

Smart Wrist Band

Heart Rate Monitor



Sedentary Monitor

Pedometer



Calorie Monitor

Sports Monitor



Call Alert

Alarm Clock



Sleep Monitor



Image Source: <https://des.gbtcnd.com/uploads/pdm-desc-pic/Electronic/image/2017/03/21/1490059347782768.jpg>



Image Source: <https://fortunedotcom.files.wordpress.com/2014/05/google-gadgets-car.jpg>

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Internet of Things – Do It Yourself Workshop

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Driverless Cars



Image Source: <https://fortunedotcom.files.wordpress.com/2014/05/google-gadgets-car.jpg>

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Driverless Cars

GPS (global positioning system)

combined with readings from tachometers, altimeters and gyroscopes to provide the most accurate positioning

Cost: \$80-\$6,000

Lidar (light detection and ranging)

monitor the vehicle's surroundings (road, vehicles, pedestrians, etc.)

Cost: \$90-\$8,000

Ultrasonic sensors

to measure the position of objects very close to the vehicle

Cost: \$15-\$20

Video cameras

monitor the vehicle's surroundings (road, vehicles, pedestrians, etc.) and read traffic lights

Cost (Mono): \$125-\$150

Cost (Stereo): \$150-\$200

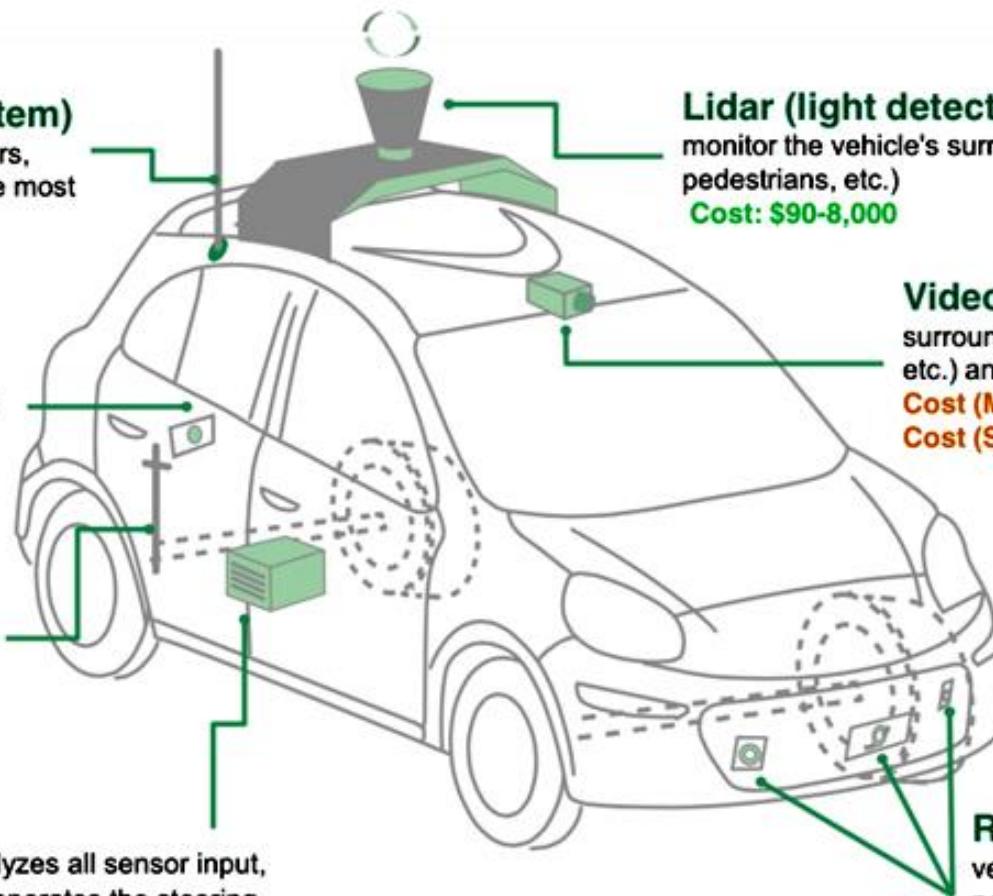
Odometry sensors

to complement and improve GPS information

Cost: \$80-\$120

Central computer analyzes all sensor input, applies rules of the road and operates the steering, accelerator and brakes

Cost: ~50-200% of sensor costs



Radar sensors monitor the vehicle's surroundings (road, vehicles, pedestrians, etc.)

Cost (Long Range): \$125-\$150

Cost (Short Range): \$50-\$100



Image Source: <https://informedmag.com/wp-content/uploads/2016/10/Best-Smart-Wifi-Outlets-1.jpg>

Smart Power Outlets



Wireless Control • Energy Monitoring & Conservation • Smart Device Integration

Image Source: <https://informedmag.com/wp-content/uploads/2016/10/Best-Smart-Wifi-Outlets-1.jpg>

Smart Key Chains & ID Cards



Image Source: Google®

Things !!!

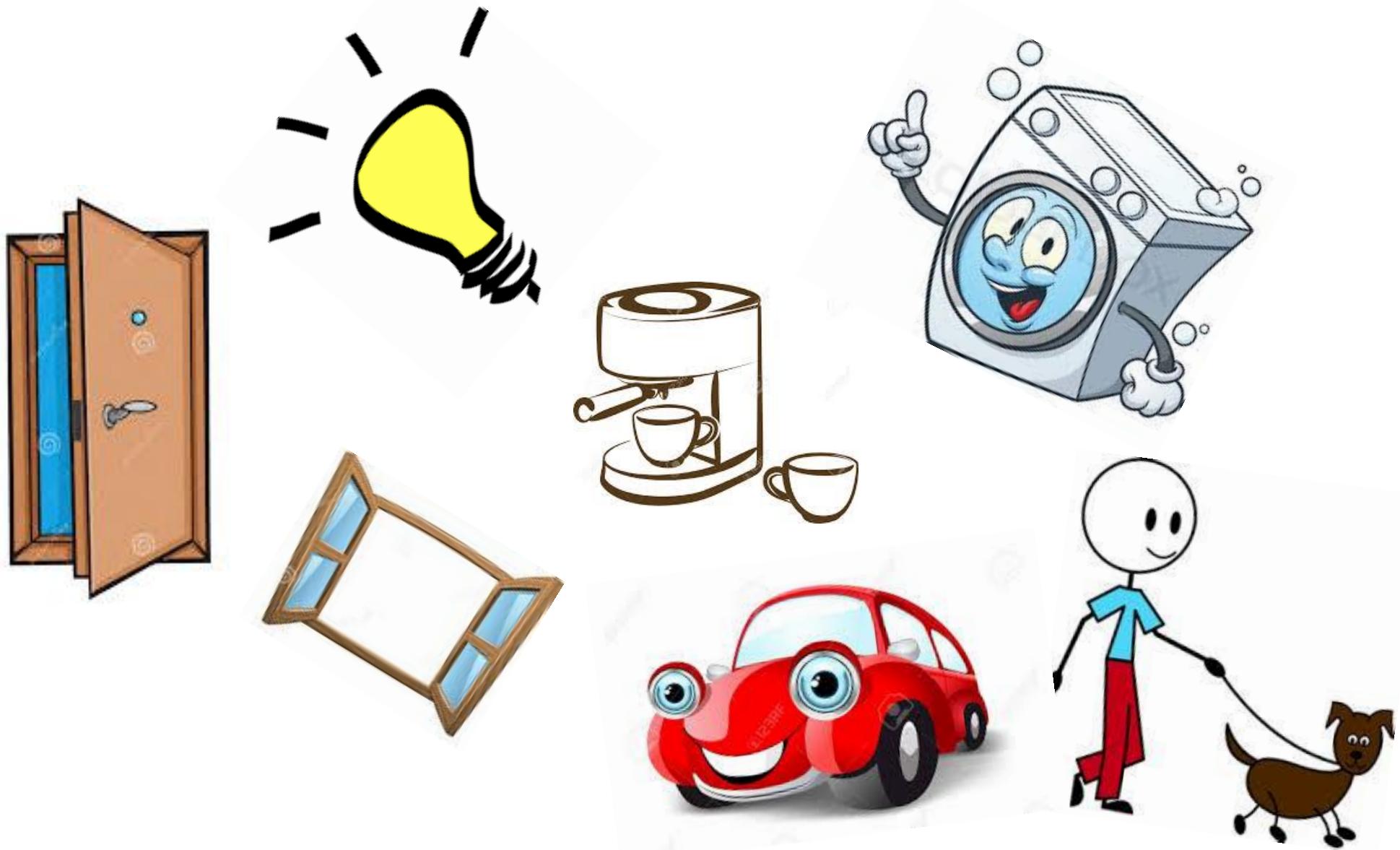


Image Source: Google®

How Things Communicate ?

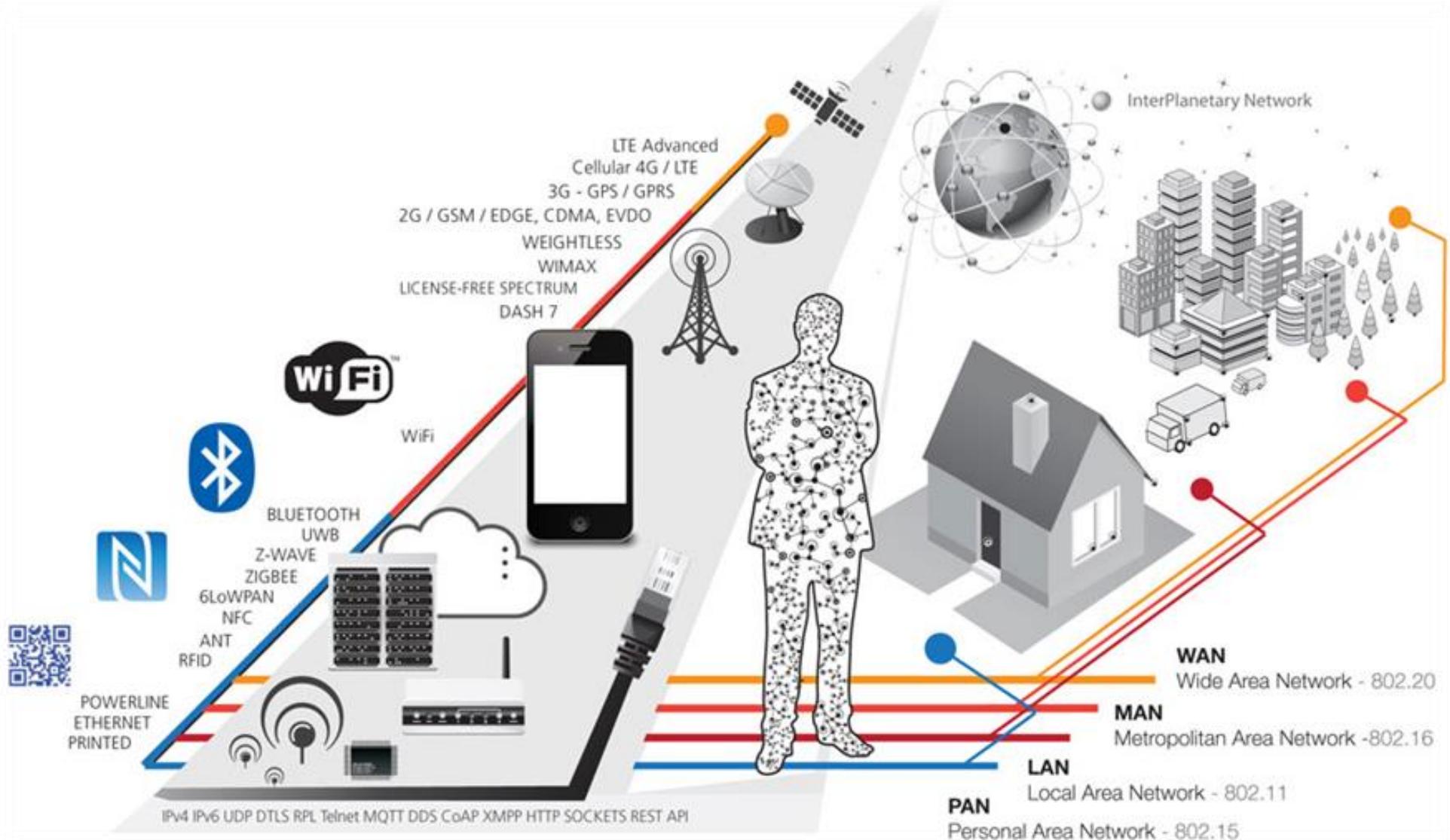


Image Source: <https://www.postscapes.com/wp-content/uploads/2018/03/connectivity-diagram.jpg>

Data Analysis & Action



Image Source: <https://www.postscapes.com/wp-content/uploads/2018/03/connectivity-diagram.jpg>

IoT Life Cycle

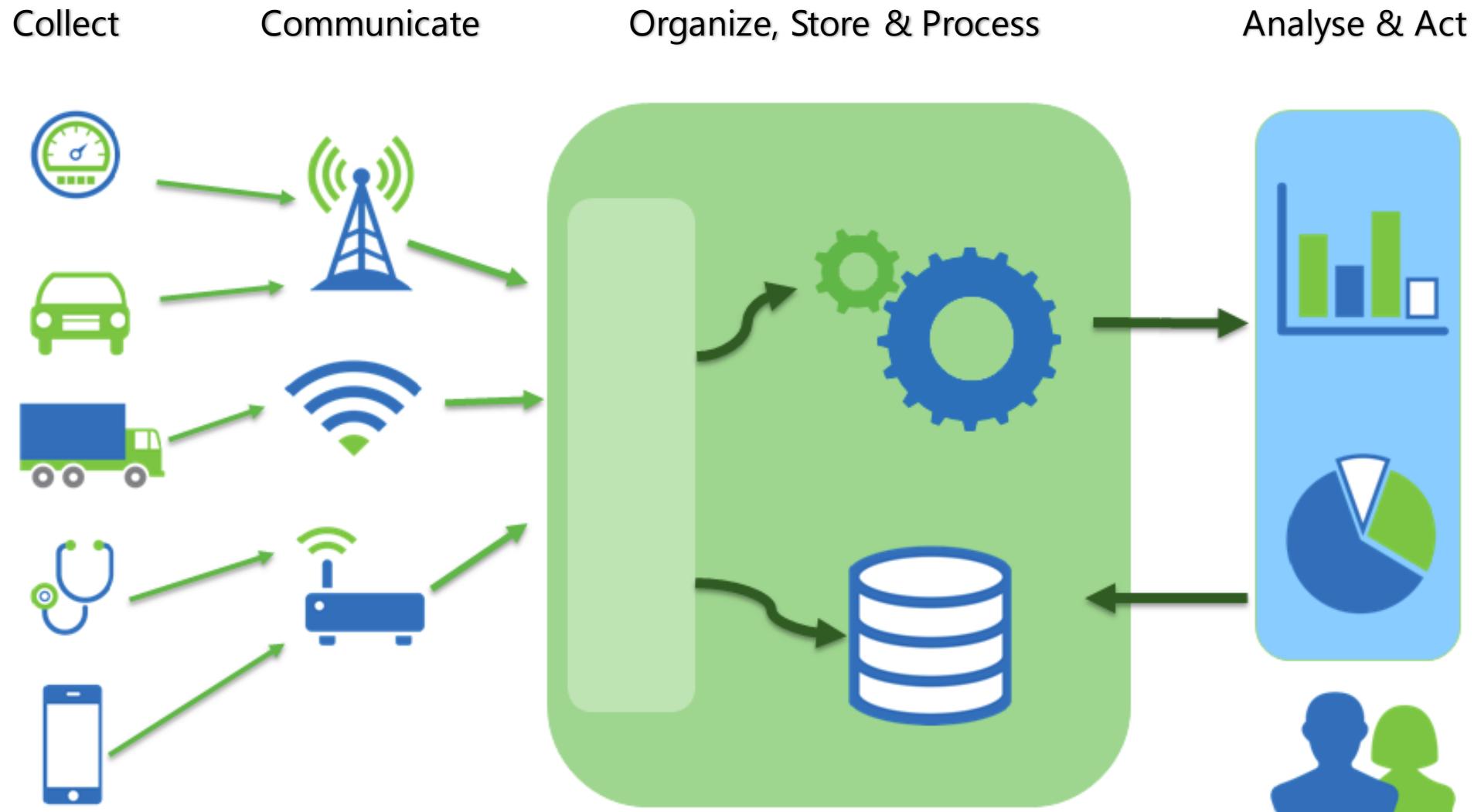


Image Source: <https://www.postscapes.com/wp-content/uploads/2018/03/connectivity-diagram.jpg>

Choosing the right Hardware Platform

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Major Factors

- Processor
- Chipset
- Memory
- On-Board Peripherals
 - I²C, SPI, CAN, USB, HDMI, Parallel ports etc.
- System Clock options
- OS support
- Cost

NodeMCU Development Board



Image Source: <https://dziadainfpolx.cloudfront.net/blog/wp-content/uploads/2015/09/official-nodemcu-development-board.jpg>

NodeMCU Development Board

Specification & Pin Out

- Tensilica L106, 32-bit RISC Processor, 160 MHz
- 9 Digital I/O Pins (digital input/output pins)
- 1 Analog pin (10 Bit ADC)
- 4MB Flash (Program) memory
- 128KB Data Memory
- Inbuilt WiFi 802.11 b/g/n
- UART(2), SPI(2), I²C (1)
- USB Powered
- Operating Voltage 3.3V
- 3.3V & 5V Outputs available for external use

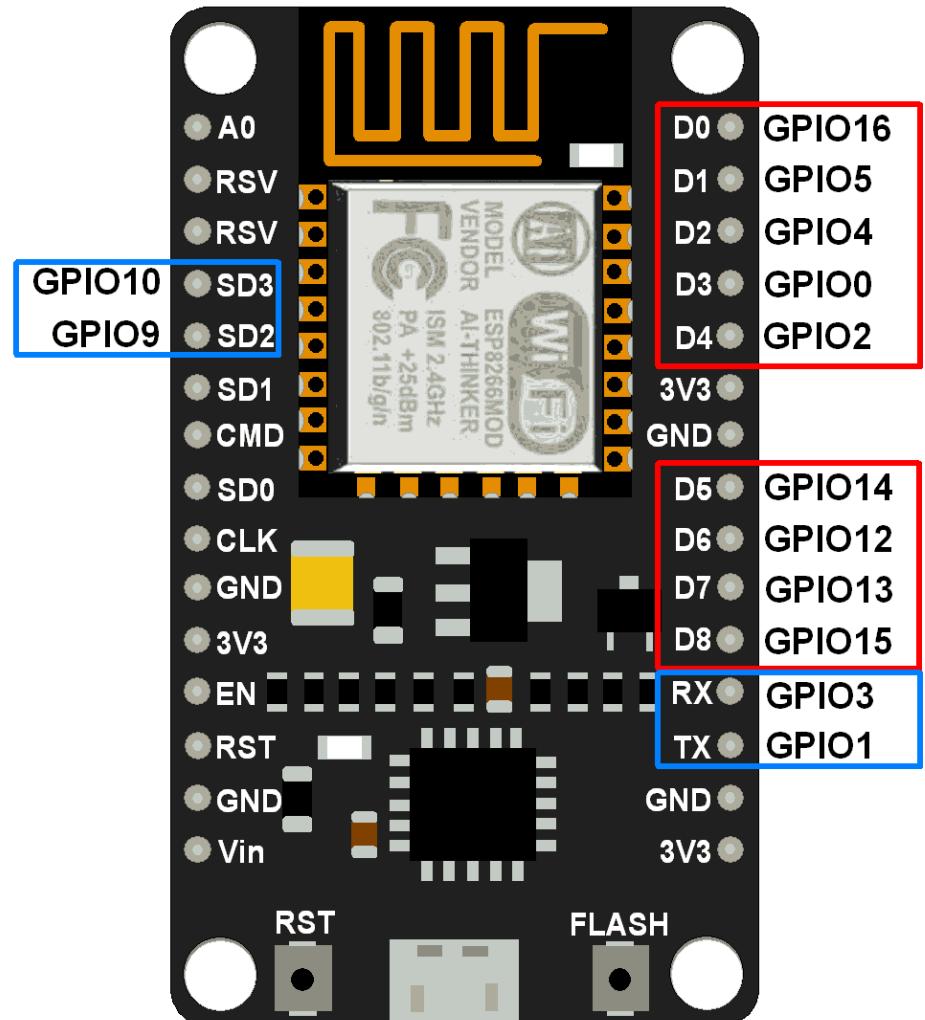


Image Source: <https://www.electronicwings.com>

NodeMCU Development Board

Pin Out

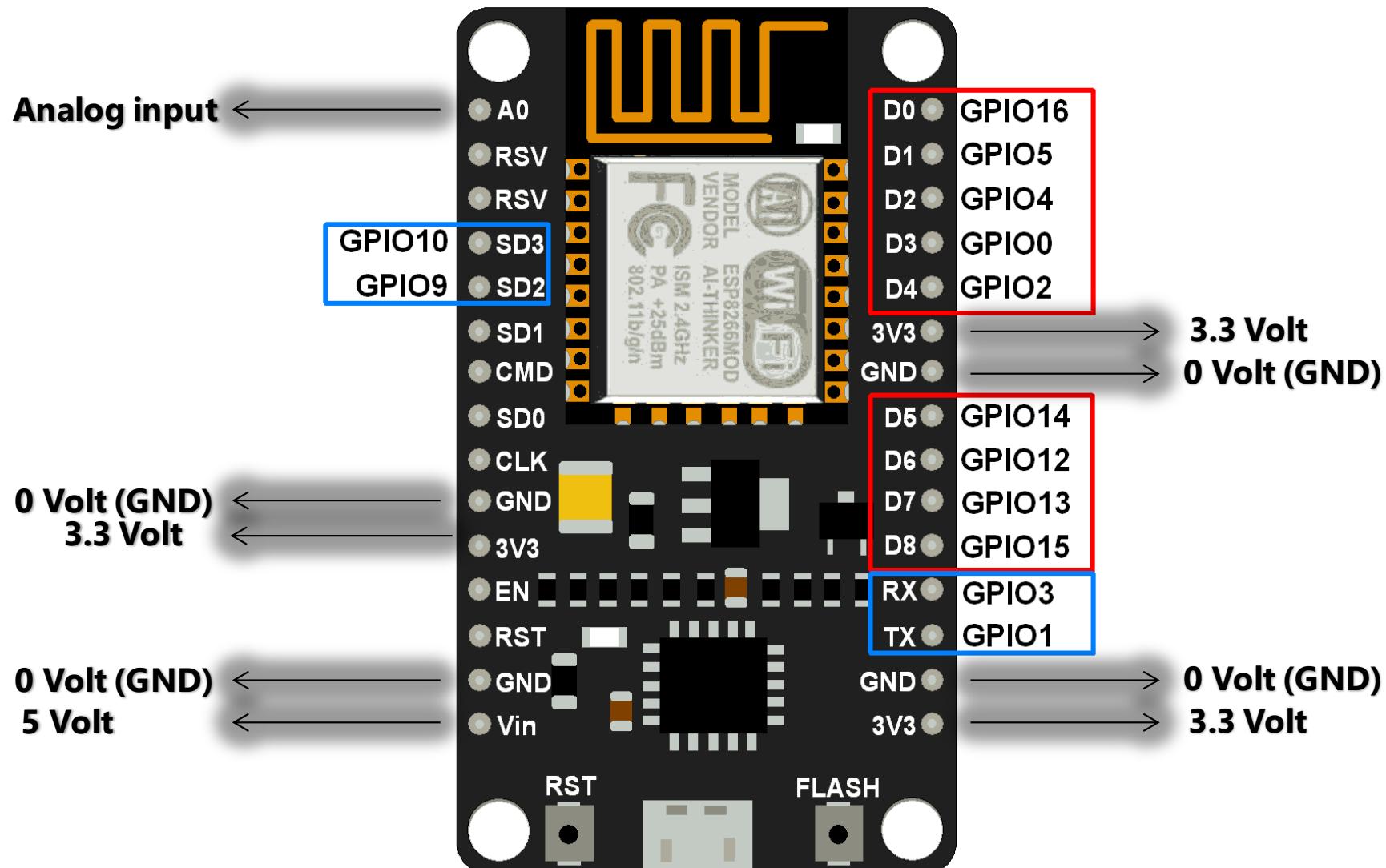


Image Source: <https://www.electronicwings.com>

Software Development Platform

Arduino® Integrated Development Environment (IDE)



ARDUINO

The open-source Arduino Software (IDE) makes it easy to write code and upload it to the board. It runs on Windows, Mac OS X, and Linux. The environment is written in Java and based on Processing and other open-source software.

This software can be used with any Arduino board. Refer to the [Getting Started](#) page for Installation instructions.

Windows Installer, for Windows XP and up
Windows ZIP file for non admin install

Windows app Requires Win 8.1 or 10
[Get](#)

Mac OS X 10.8 Mountain Lion or newer

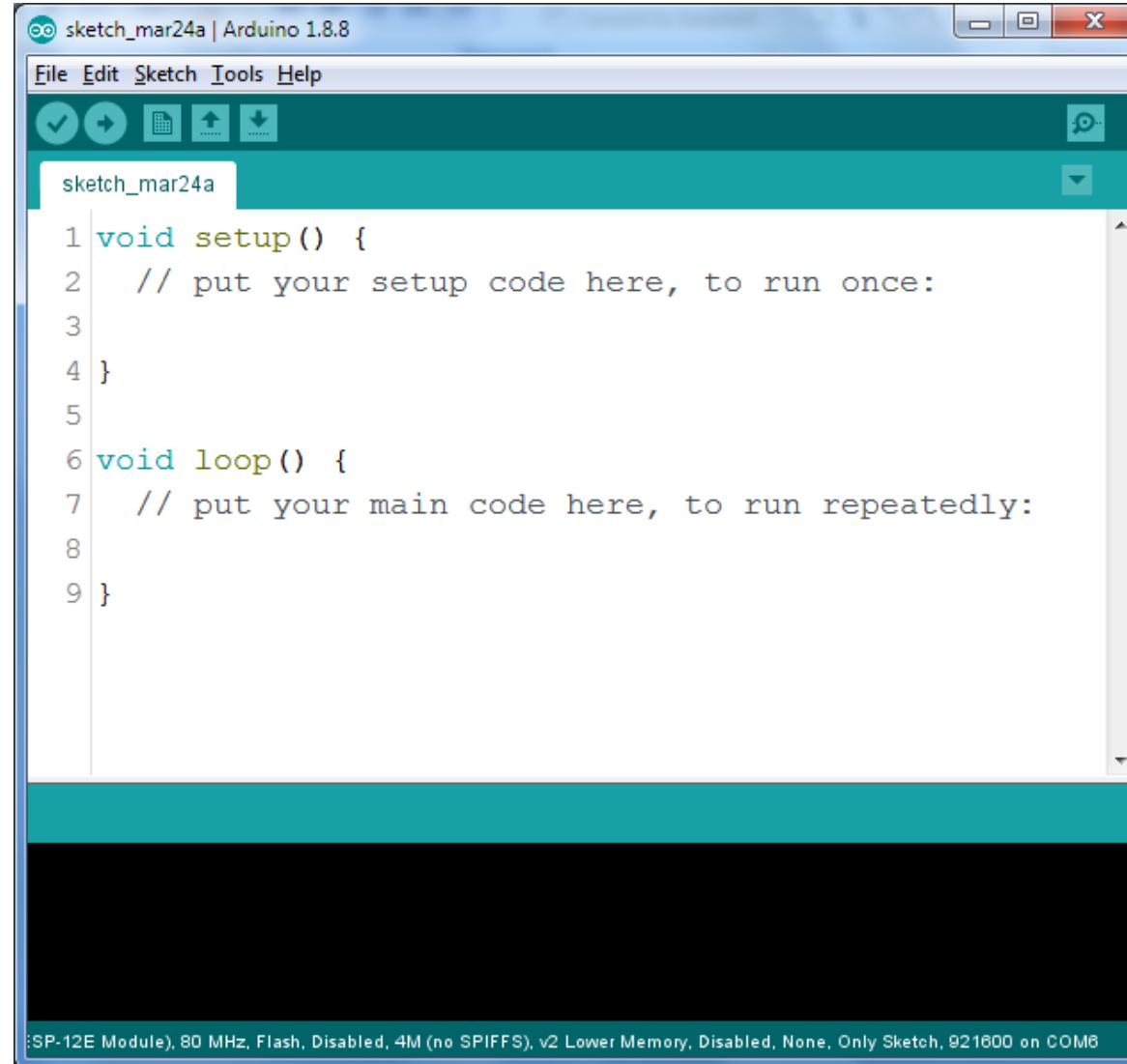
Linux 32 bits
Linux 64 bits
Linux ARM 32 bits
Linux ARM 64 bits

[Release Notes](#)
[Source Code](#)
[Checksums \(sha512\)](#)

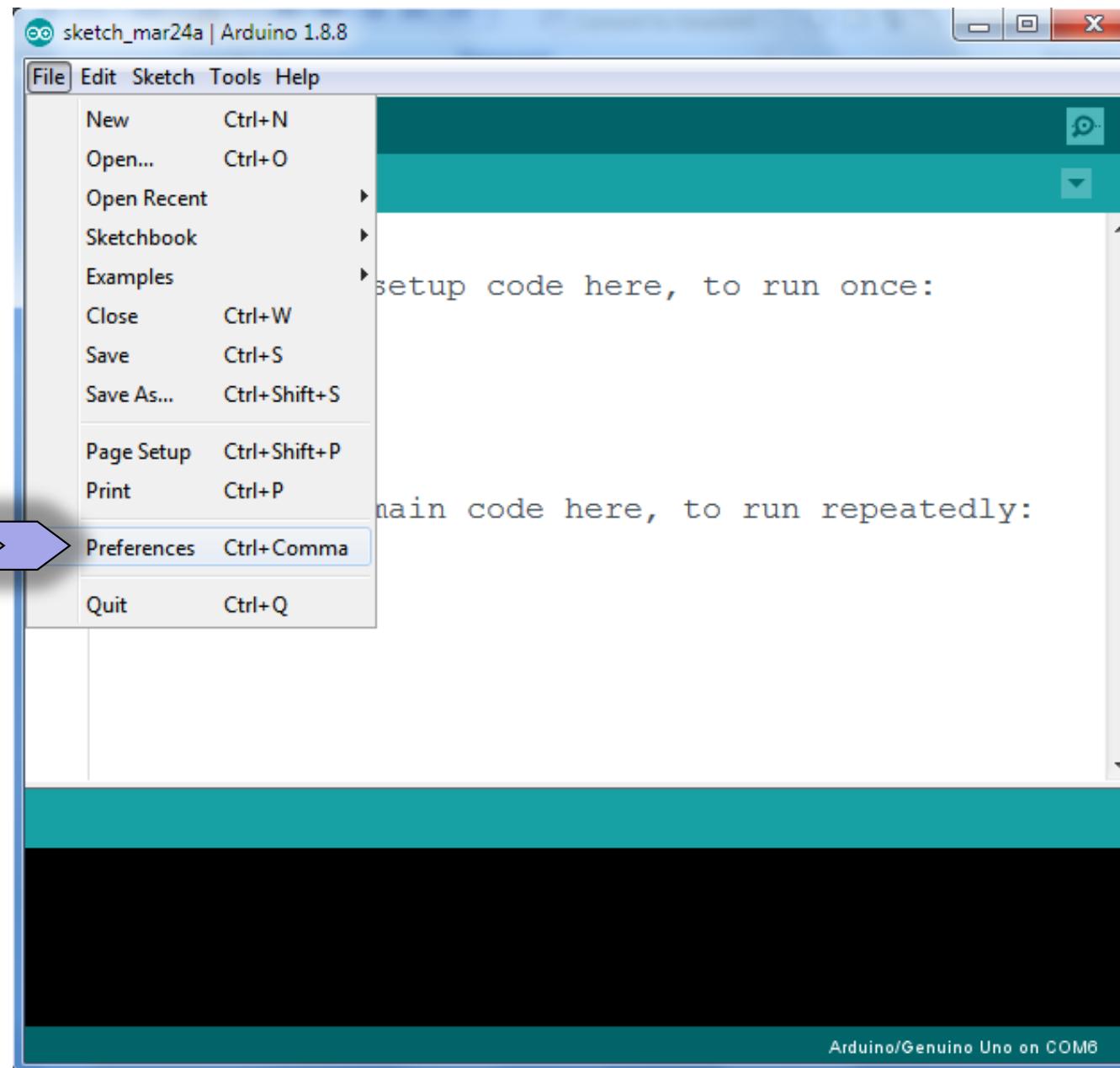
<https://www.arduino.cc>

Software Development Platform

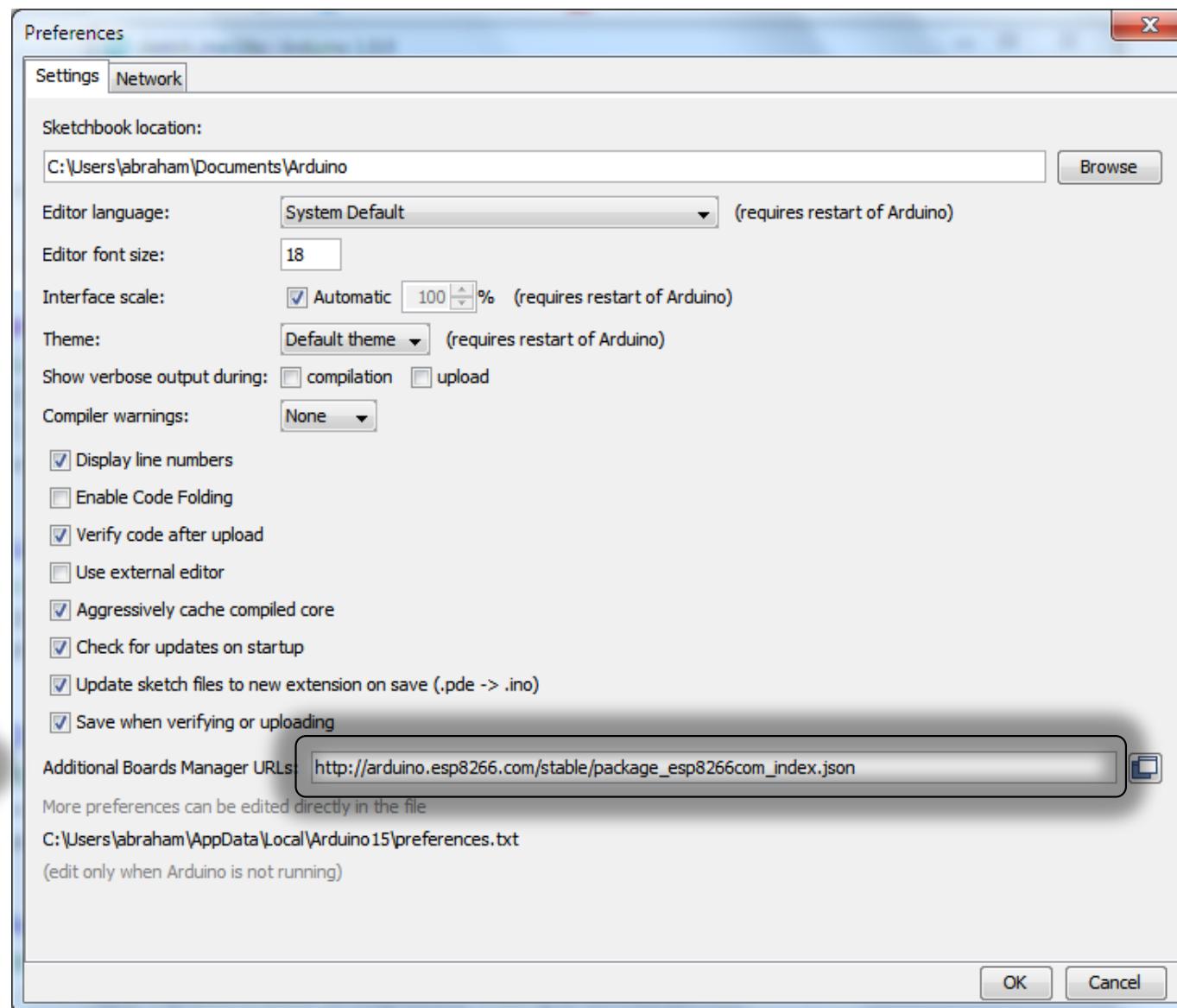
Arduino® Integrated Development Environment (IDE)



Setting up Arduino IDE for NodeMCU Board

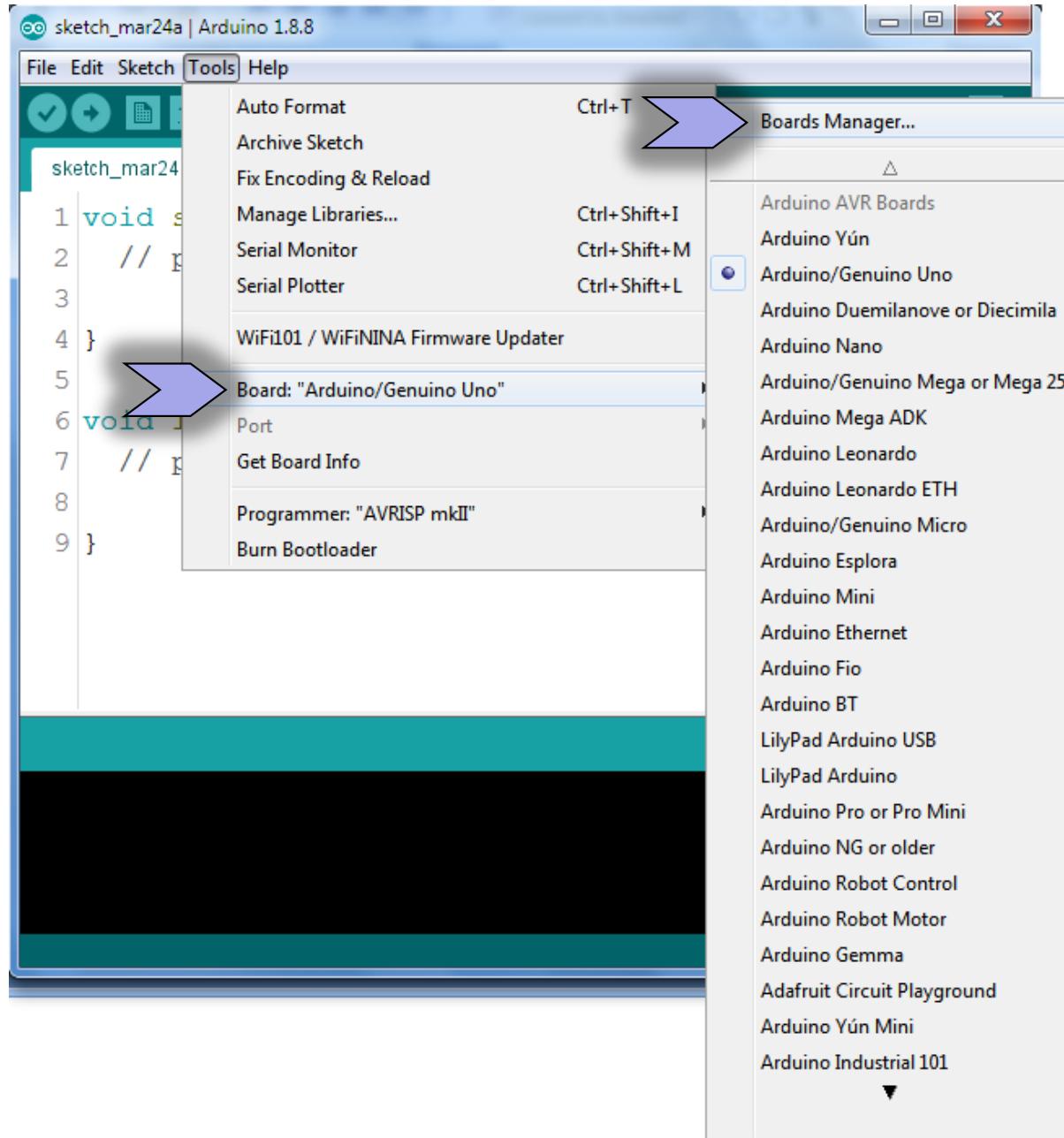


Setting up Arduino IDE for NodeMCU Board

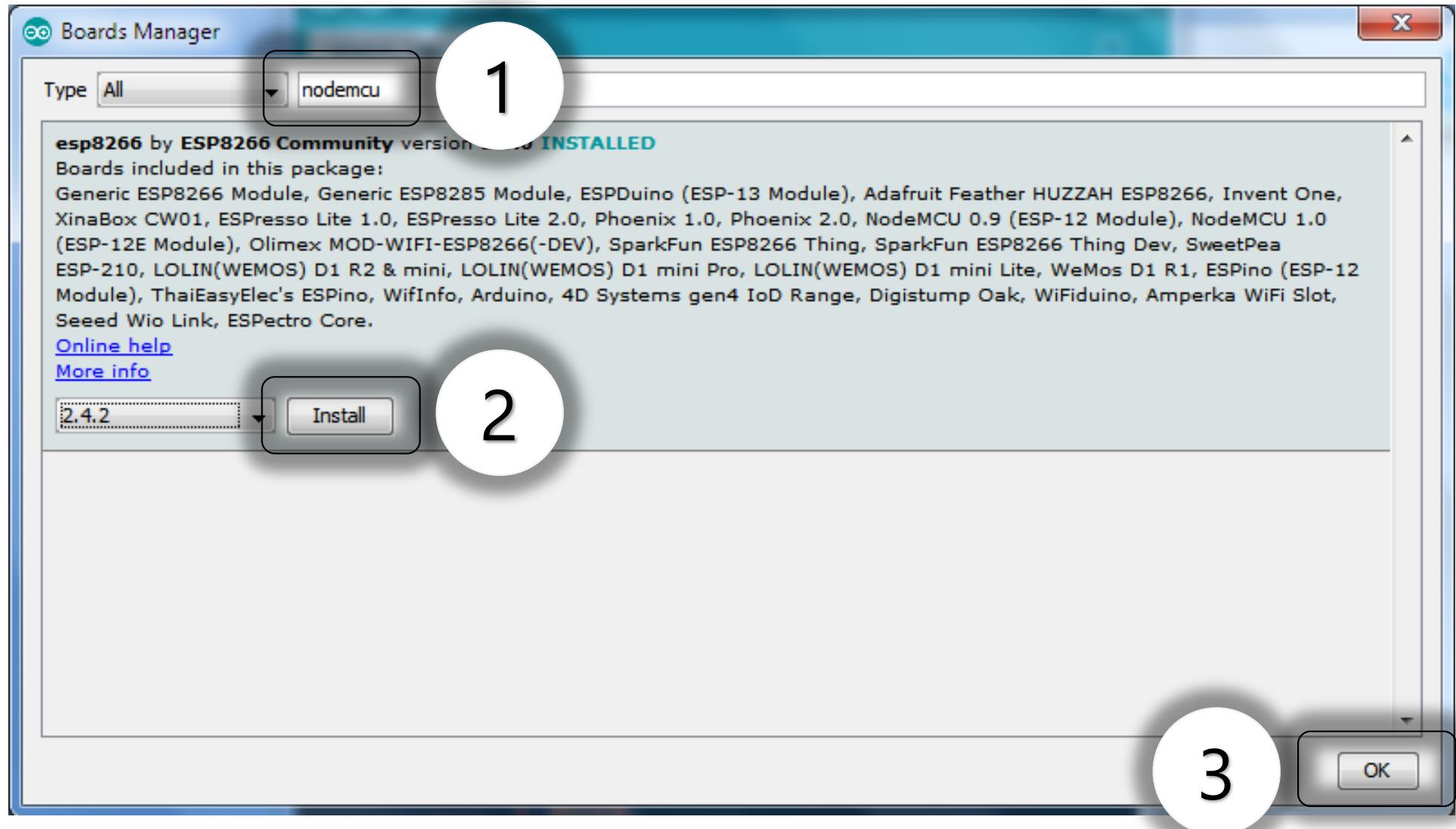


Google Search keyword: "Arduino additional Board manager URL for NodeMCU"

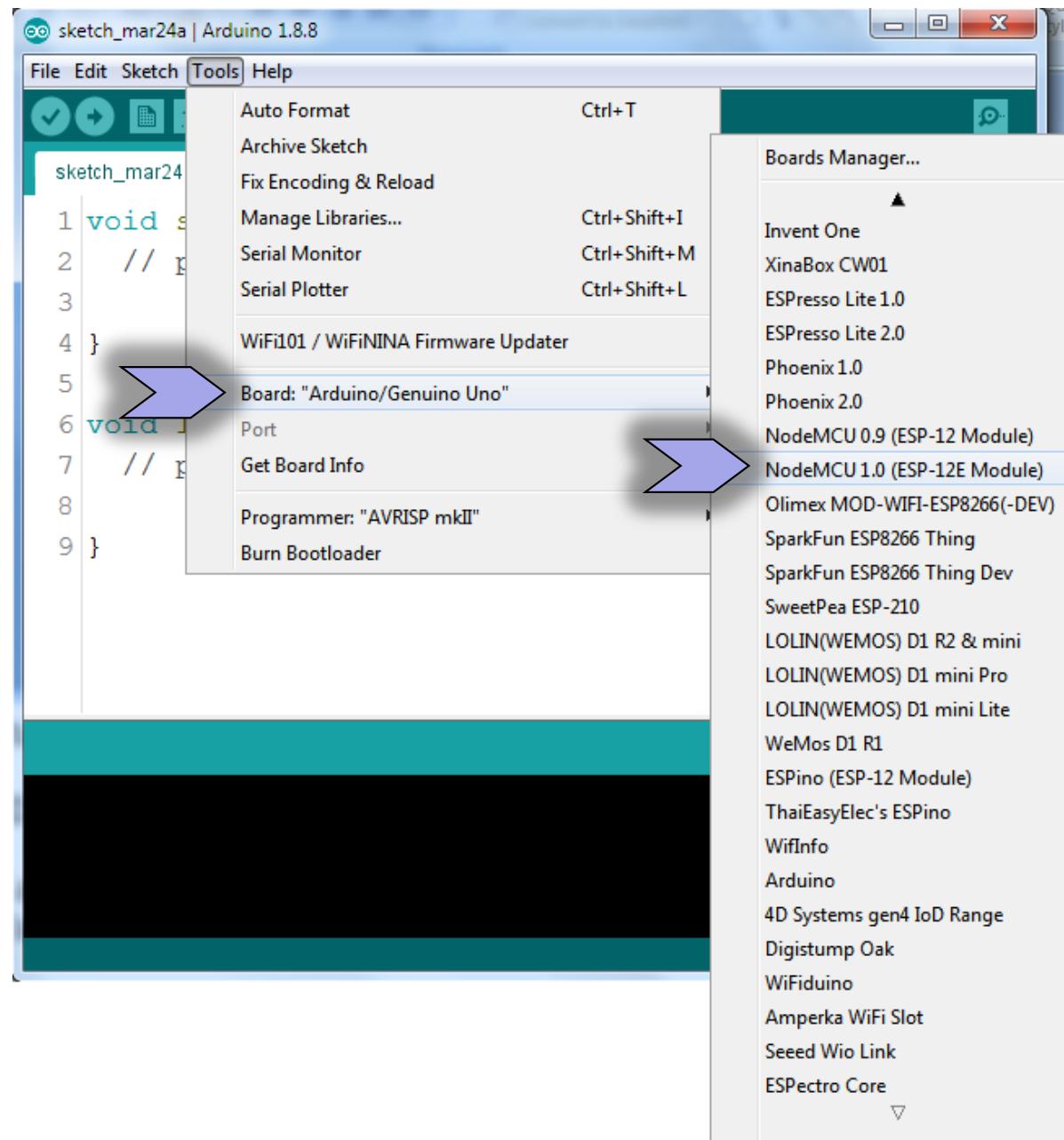
Setting up Arduino IDE for NodeMCU Board



Setting up Arduino IDE for NodeMCU Board



Setting up Arduino IDE for NodeMCU Board



Programming NodeMCU

Commonly used Arduino Functions

Function	Purpose	Example Syntax
pinMode()	Used to configure pins as input/output	pinMode(D0, INPUT);
digitalRead()	Used to read digital signals from a pin	digitalRead(D0);
digitalWrite()	Used to write digital signals on to a pin: HIGH for 5V & LOW for 0V	digitalWrite(D0, HIGH);
analogRead()	Used to read analog signals from a pin using internal A to D Conversion	analogRead(A0);
analogWrite()	Used to generate width varying digital pulses using Pulse Width Modulation (PWM) which can be used to produce low frequency Analog signals with the help of additional filters.	analogWrite(D6, 400);

Programming NodeMCU

Commonly used Arduino Functions ...

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Function	Purpose	Example Syntax
Serial.print()	Used to transmit data through serial interface for debugging / monitoring / communication purposes	Serial.print("Hello World");
Serial.begin()	Sets the data rate in bits per second (bps or baud) for serial data transmission.	Serial.begin(115200);
delay()	To delay the next command for a certain duration in milliseconds.	delay(1000);

Let's Do It Yourself Hands-On!!!

Let's connect them together

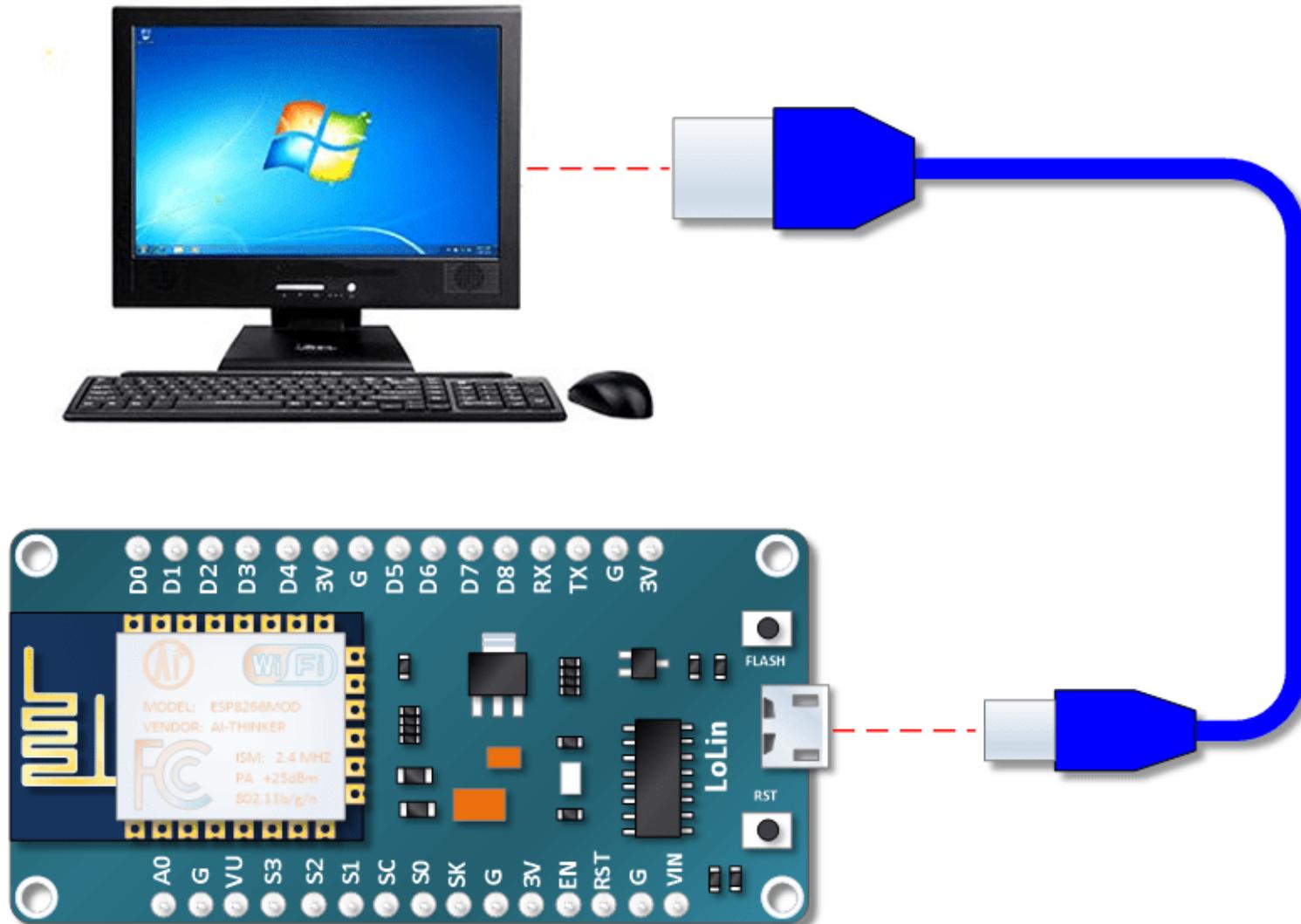
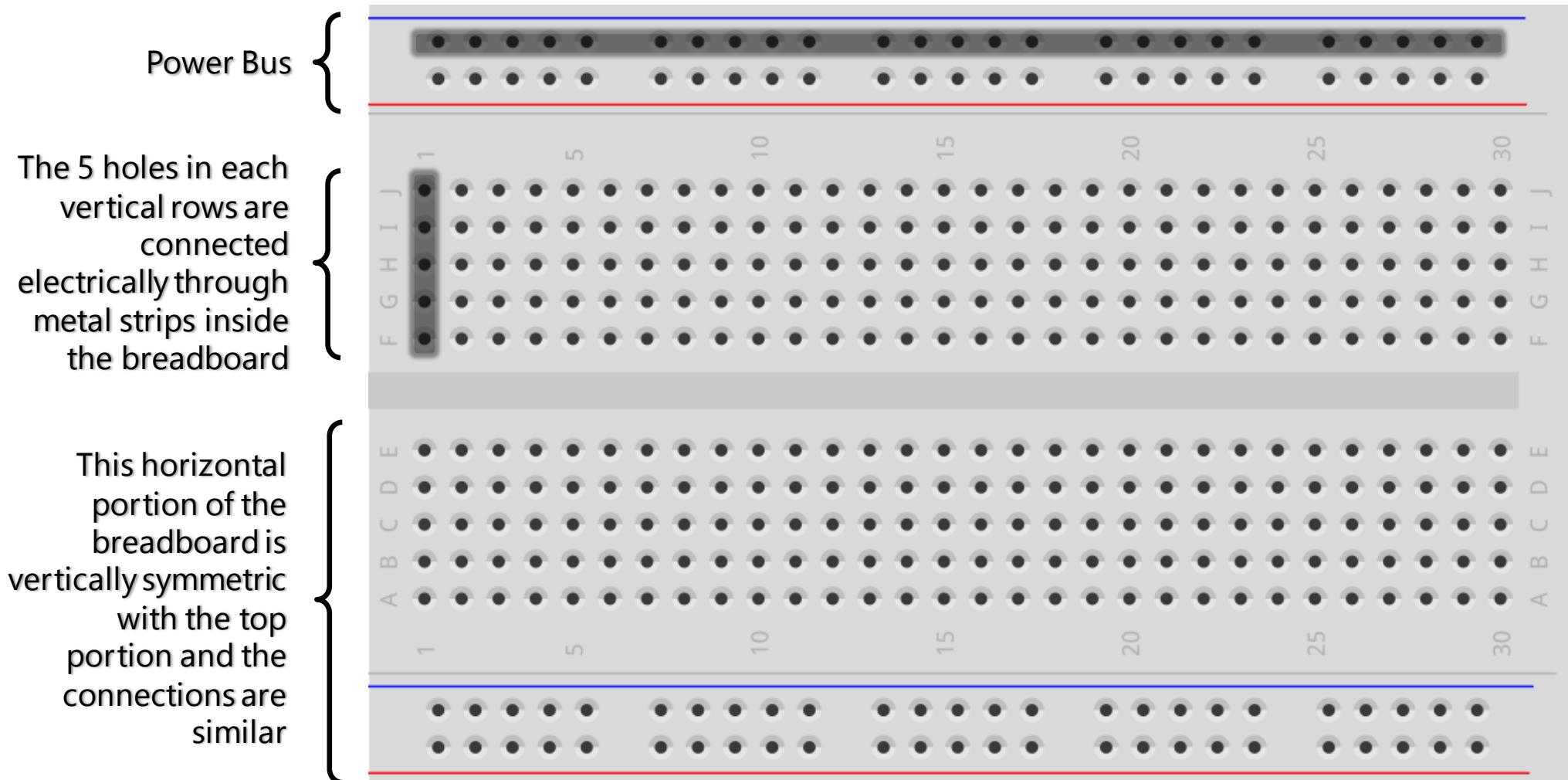


Image Source: <https://i0.wp.com/henrysbench.capnfatz.com/wp-content/uploads/2016/09/Connect-to-Computer.png>

Breadboard Connection

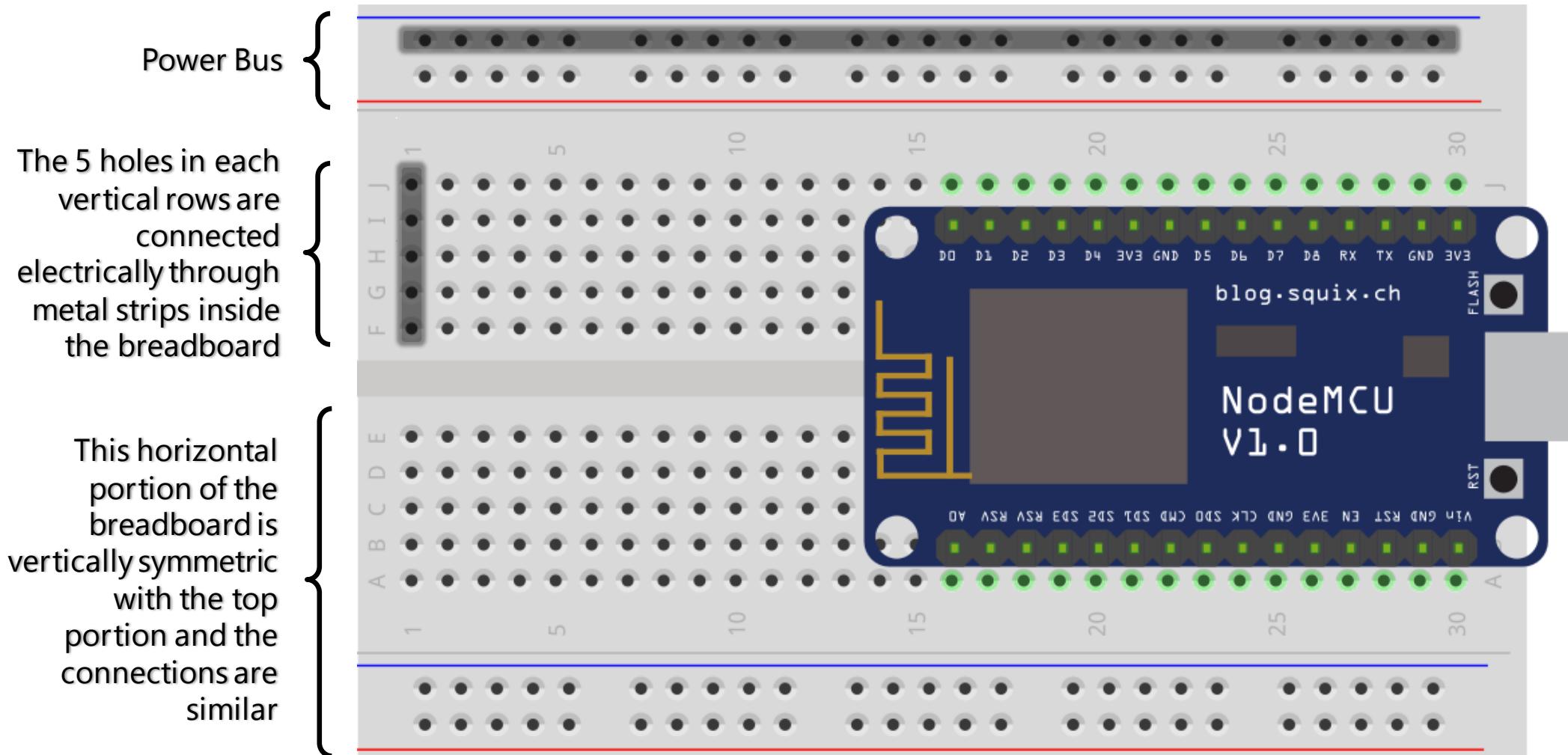
The horizontal strips that run the length of the breadboard are electrically connected inside. The strips are usually used for power and ground connections



Reference: <https://diygeeks.org/wp-content/uploads/2018/01/BreadBoard-Labelling-1012x1024.jpg>

Breadboard Connection

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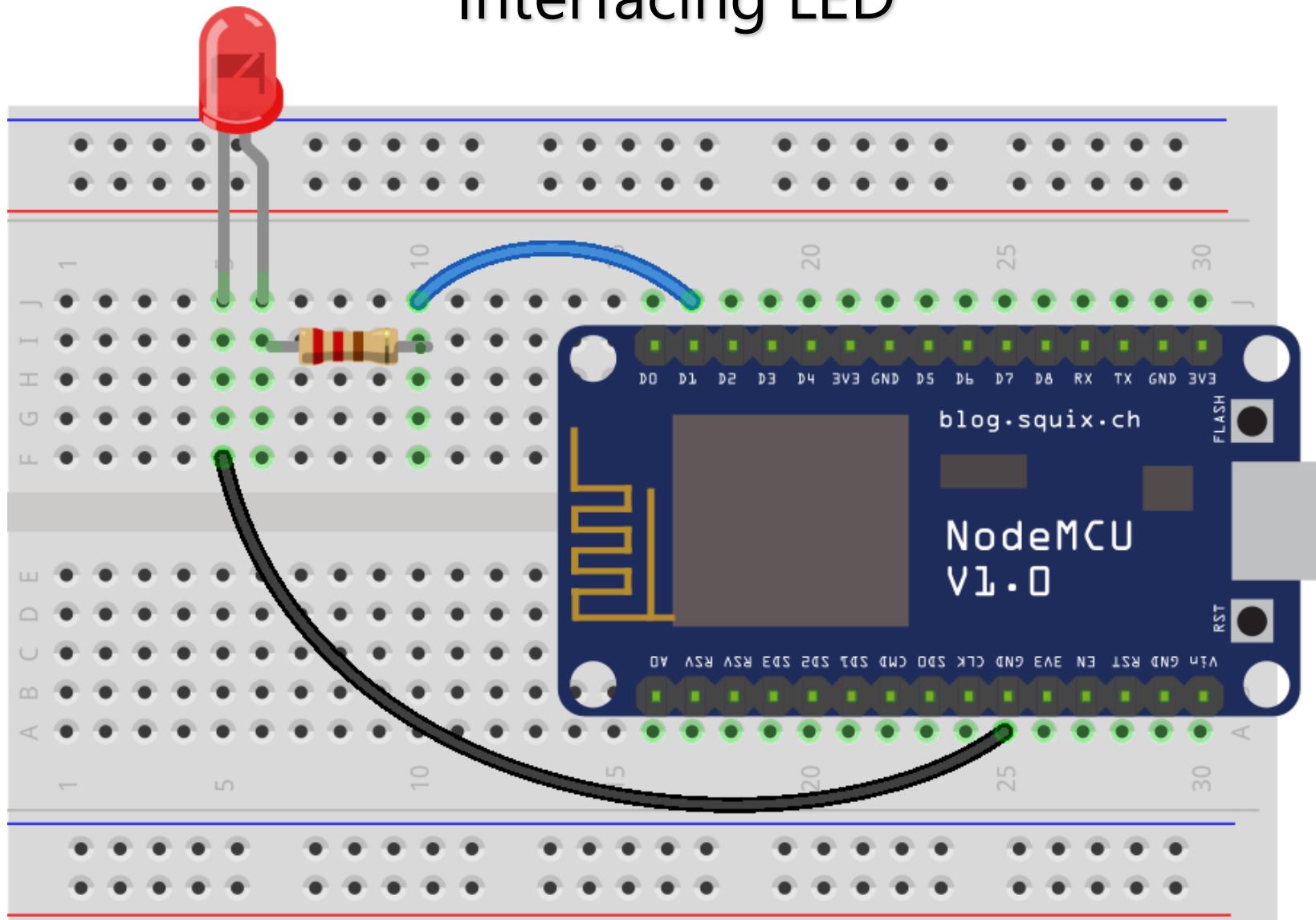
Reference: <https://diygeeks.org/wp-content/uploads/2018/01/BreadBoard-Labelling-1012x1024.jpg>

Layout designed using Fritzing® - <http://fritzing.org>, NodeMCU part Source(s):<https://github.com/squix78/esp8266-fritzing-parts/tree/master/nodemcu-v1.0>

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DIY Experiments with NodeMCU

Interfacing LED



Layout designed using Fritzing® - <http://fritzing.org>

NodeMCU part Source(s):<https://github.com/squix78/esp8266-fritzing-parts/tree/master/nodemcu-v1.0>

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Momentary Tactile Push Button / Switch

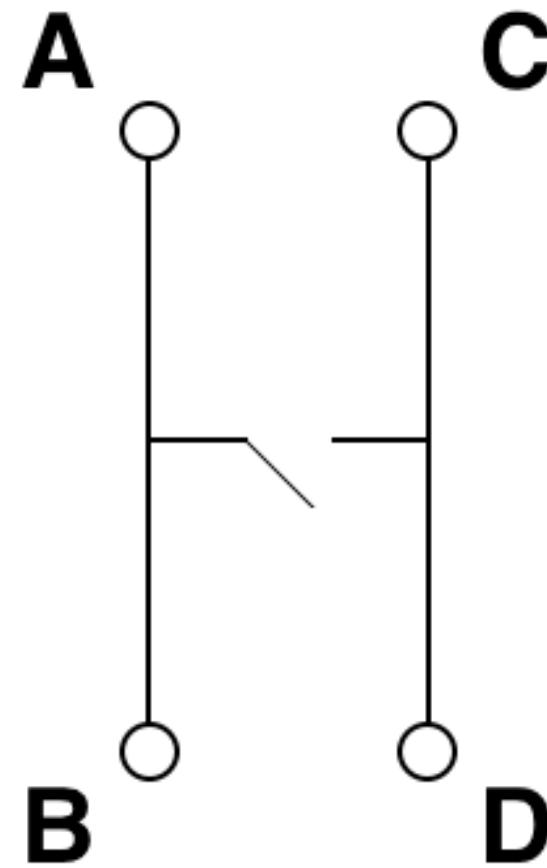
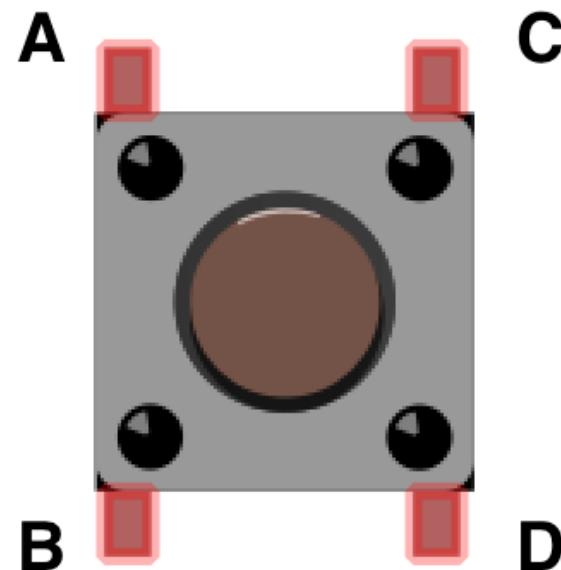


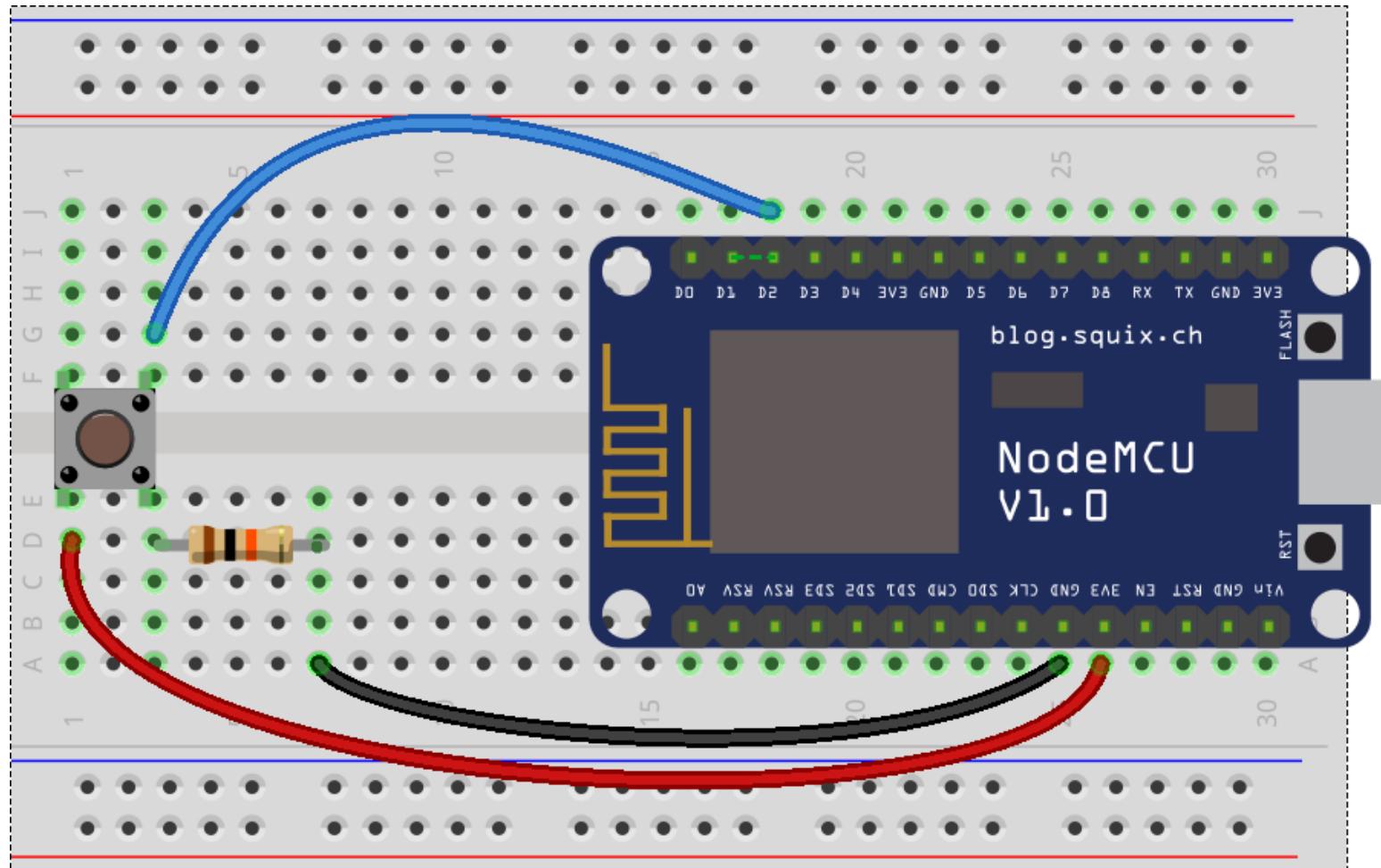
Image Source(s):

http://razzpisampler.oreilly.com/images/rpck_1102.png,

https://docs.labs.mediatek.com/resource/linkit7697-arduino/files/en/12880064/12880062/1/1498095674923/button_sch.png

DIY Experiments with NodeMCU

Interfacing Push Button Switch



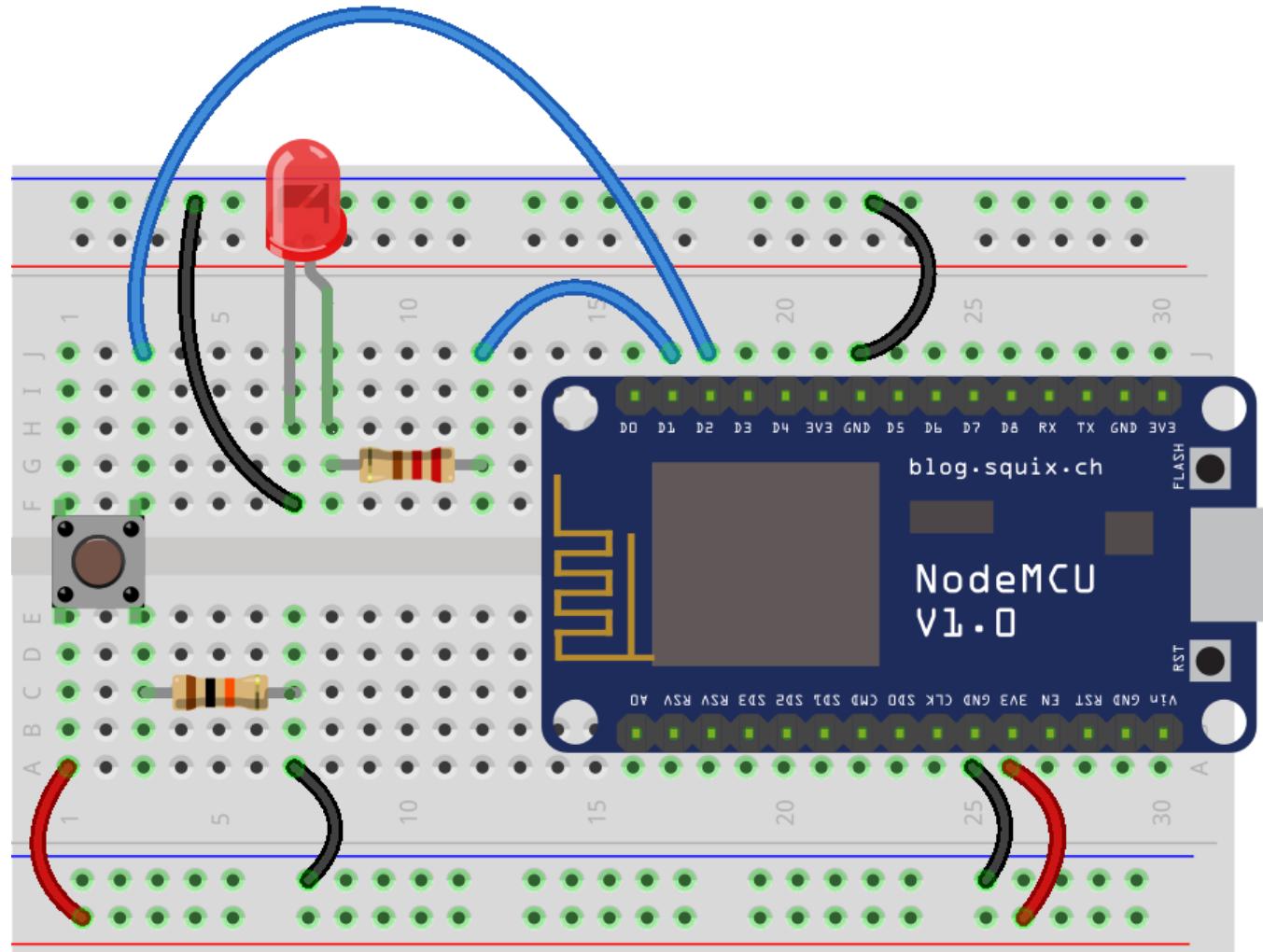
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NodeMCU part Source: <https://github.com/squix78/esp8266-fritzing-parts/tree/master/nodemcu-v1.0>

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DIY Experiments with NodeMCU

Interfacing Switch and LED



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NodeMCU part Source: <https://github.com/squix78/esp8266-fritzing-parts/tree/master/nodemcu-v1.0>

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Light Dependent Resistor (LDR)

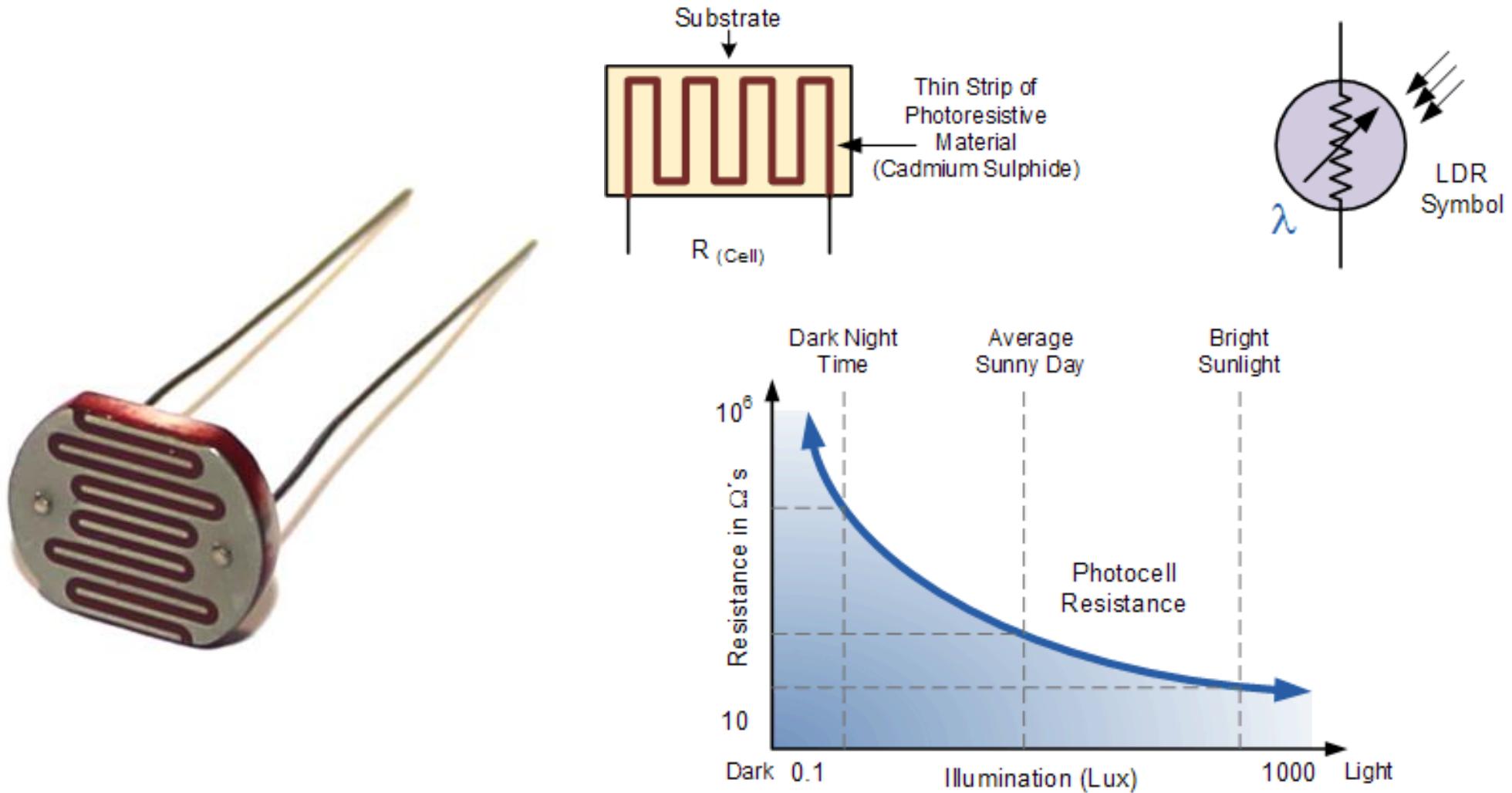


Image Source(s):

<http://www.electicalelibrary.com/wp-content/uploads/2017/08/LDR-destaque.jpg>
<https://www.electronics-tutorials.ws/io/io19.gif>

LDR application circuit diagram

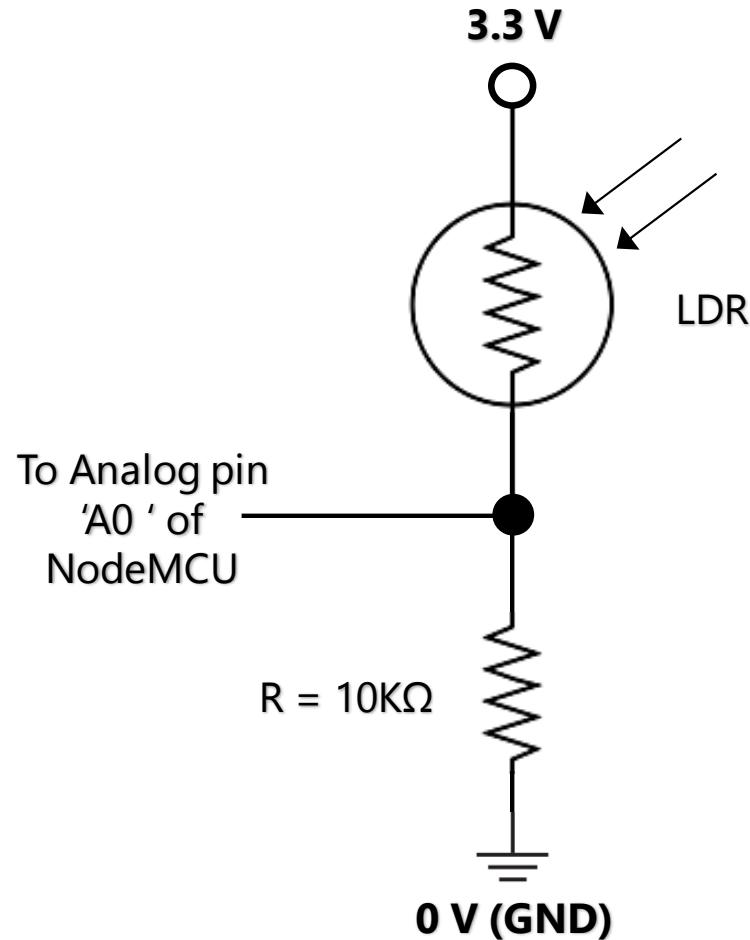
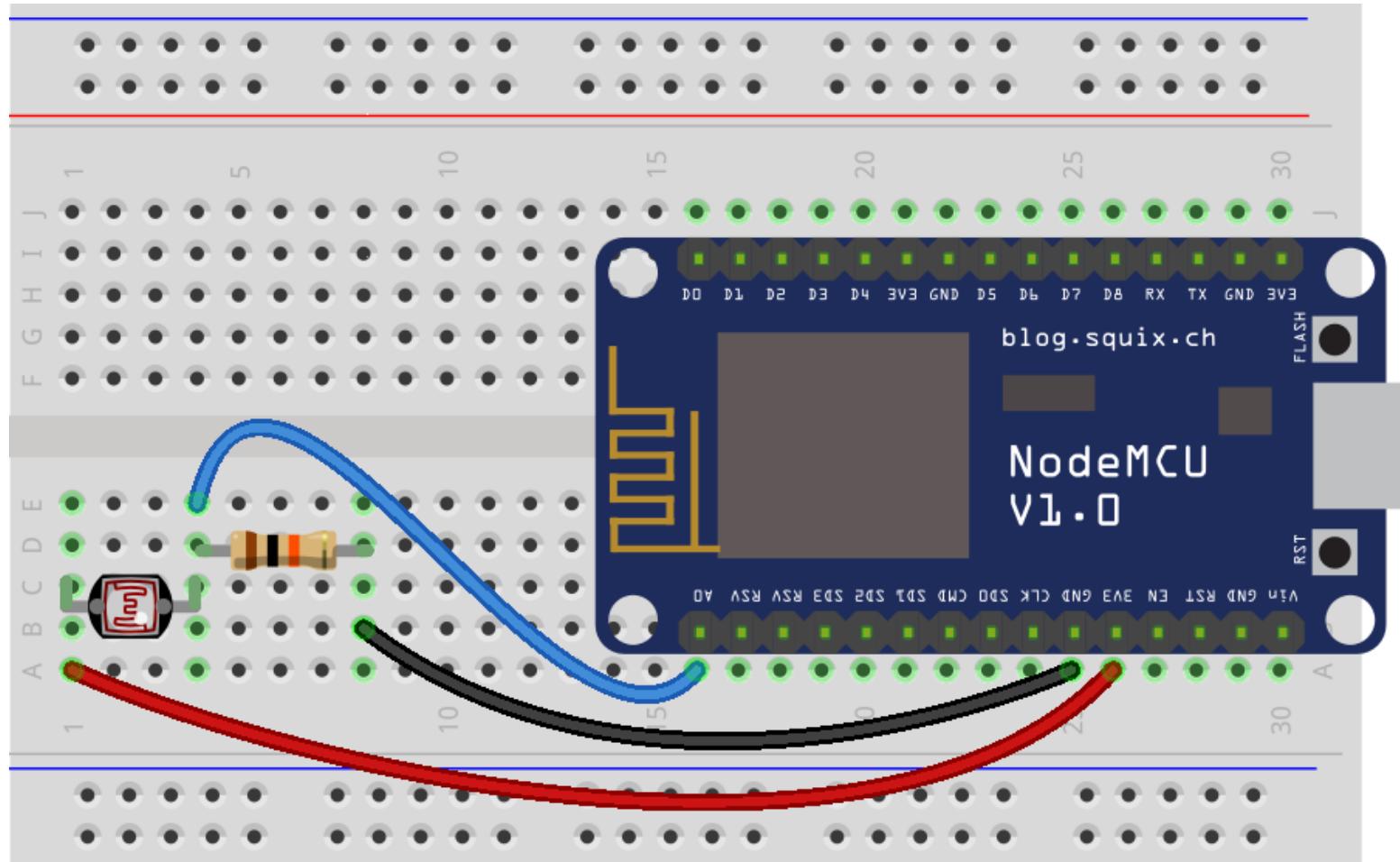


Image Source: <https://www.electronics-notes.com/images/light-dependent-resistor-photoresistor-circuit-symbol.svg>

DIY Experiments with NodeMCU

Interfacing LDR



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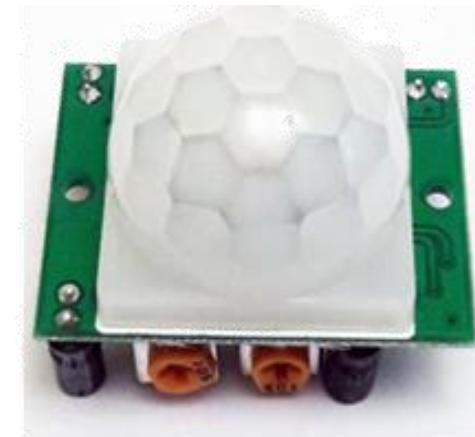
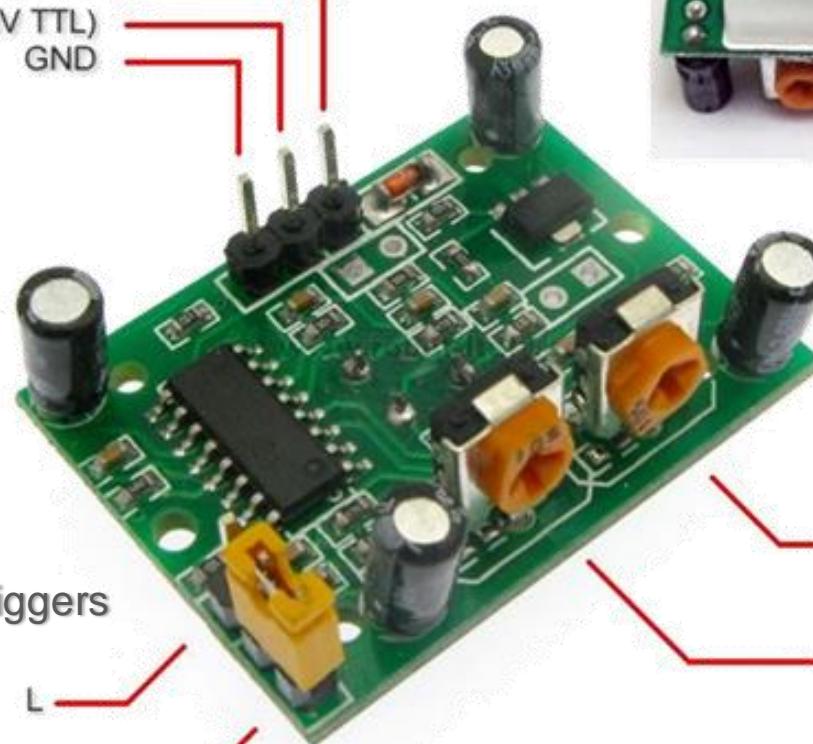
NodeMCU part Source: <https://github.com/squix78/esp8266-fritzing-parts/tree/master/nodemcu-v1.0>

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PIR Motion Sensor – HCR501



VCC 5-12VDC
OUT (3.3V TTL)
GND



Setting for Single or Repeatable Triggers

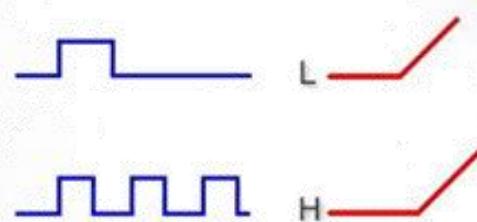


Image Source:: https://c.76.my/Malaysia/hc-sr501-motion-sensor-arduino -ir-bodypassive-infrared-sensor-module-redbean77-1711-20-F625876_1.jpg

PIR Motion Sensing

Fresnel Lens Focusing

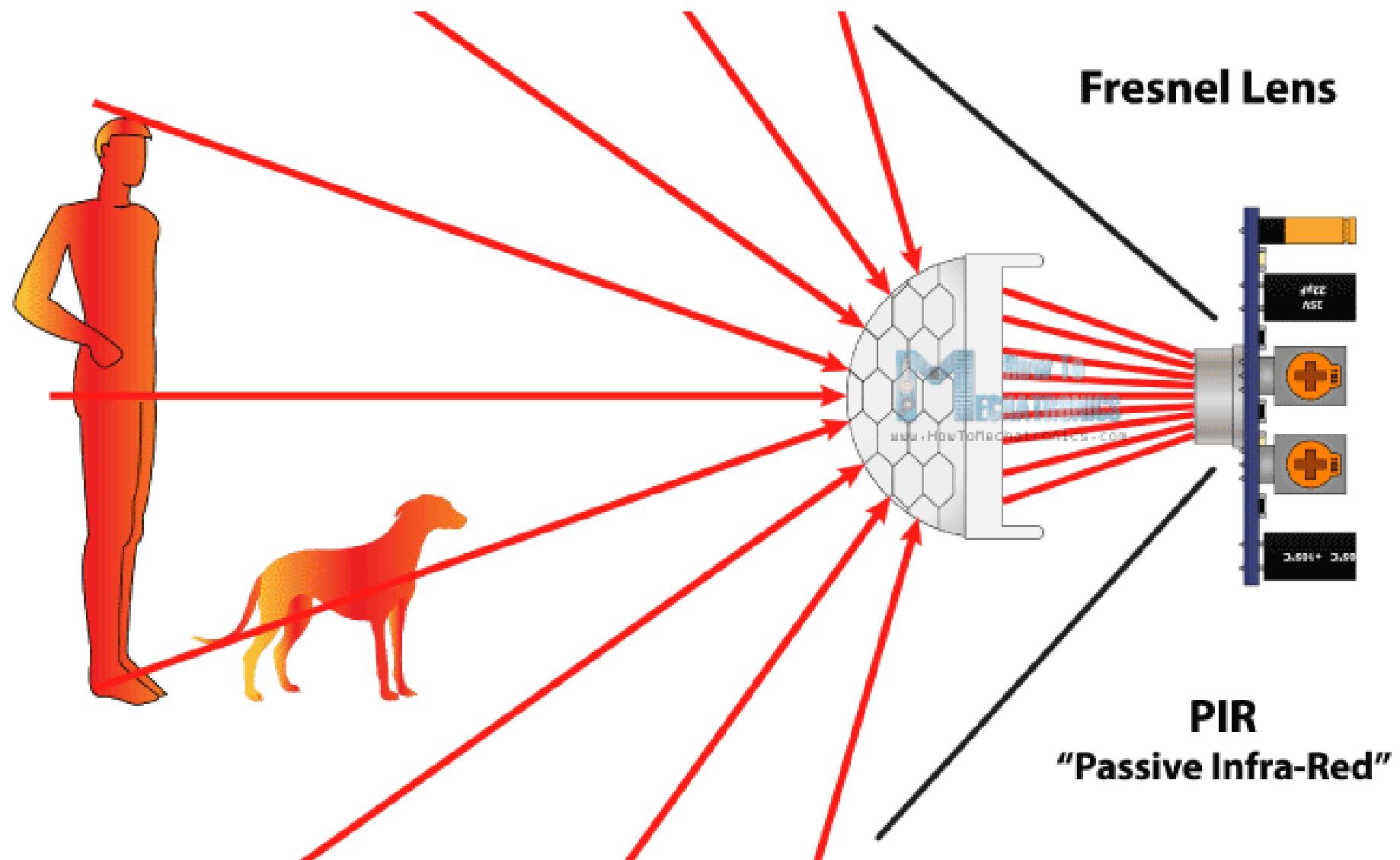


Image Source:: <https://howtomechatronics.com/wp-content/uploads/2015/09/PIR-Motion-Sensor-How-It-Works.png>

PIR Motion Sensing

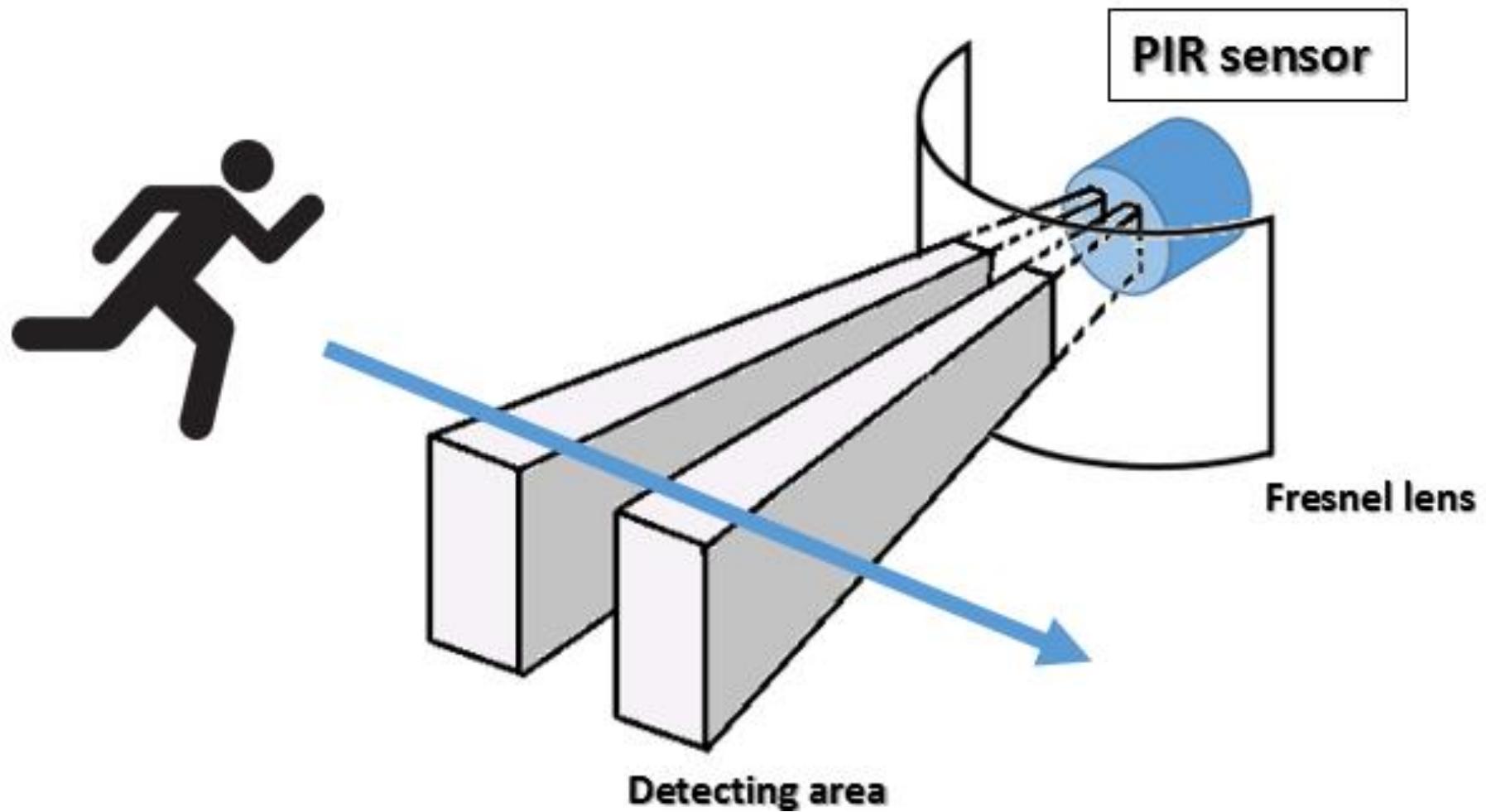


Image Source: <https://static1.squarespace.com/static/557f31e6e4b0971f7f8bcac6/t/5b04a73e352f53cc9e14f413/1527031679239/Meccanismo-Complesso-PIR-sensor-how-to.png>

DIY Experiments with NodeMCU

Interfacing PIR Motion Sensor – HCR501

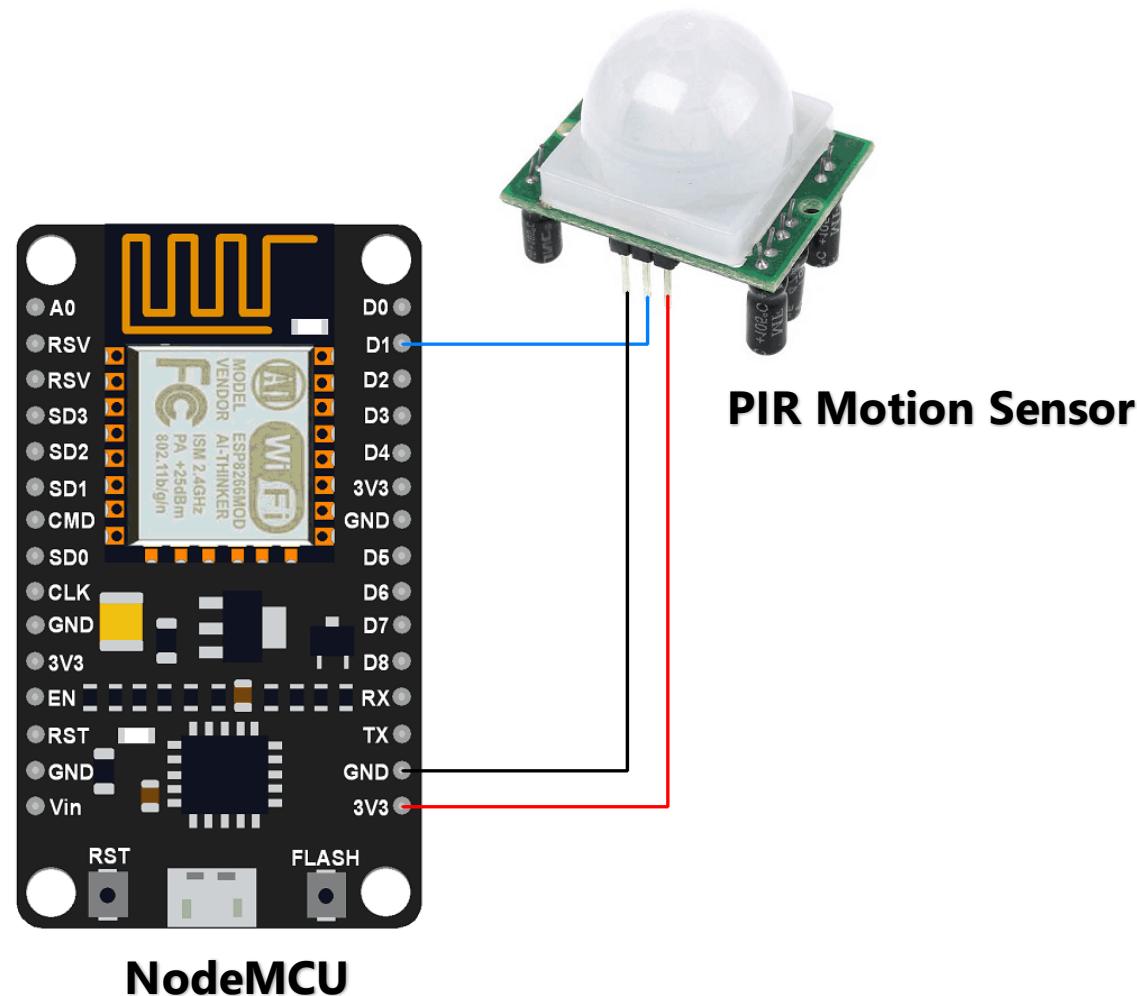


Image Source:: <http://www.electronicwings.com>

Ultrasonic Sensor – HC-SR04



HC-SR04

Working of HC-SR04

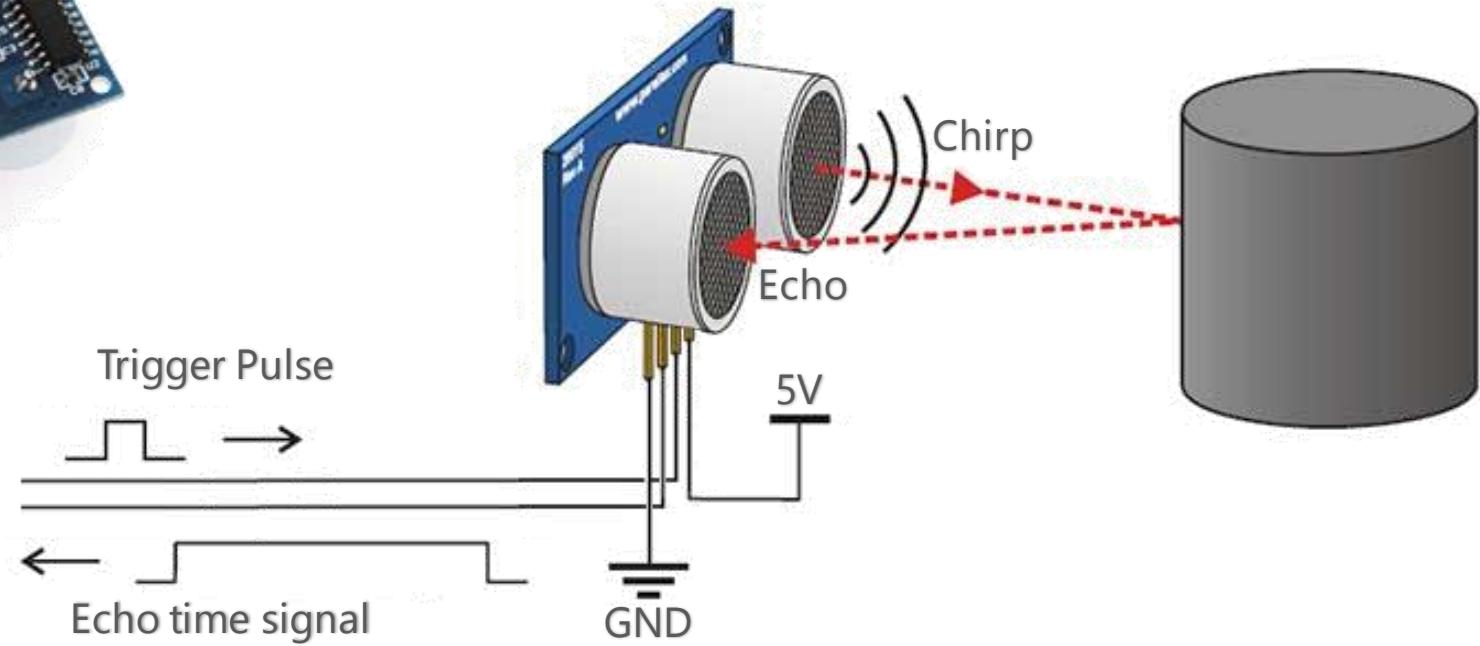


Image Source:: <https://cdn2.bjultrasonic.com/wp-content/uploads/2017/04/Ultrasonic-Sensors.jpg>

Ultrasonic Sensor HC-SR04

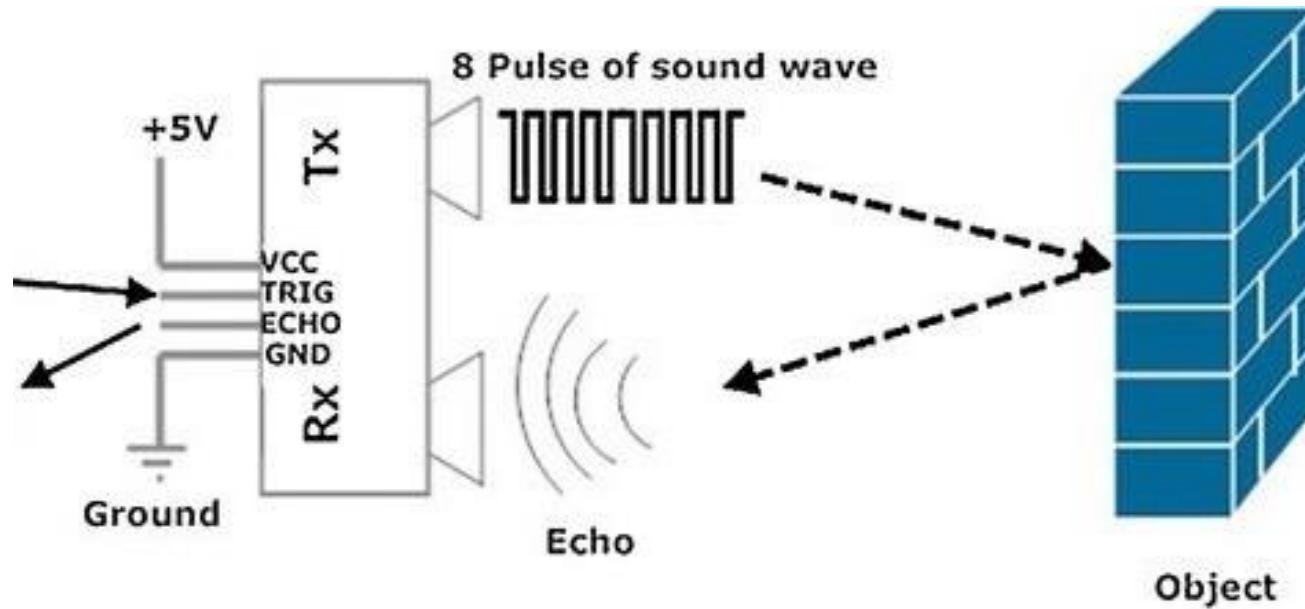
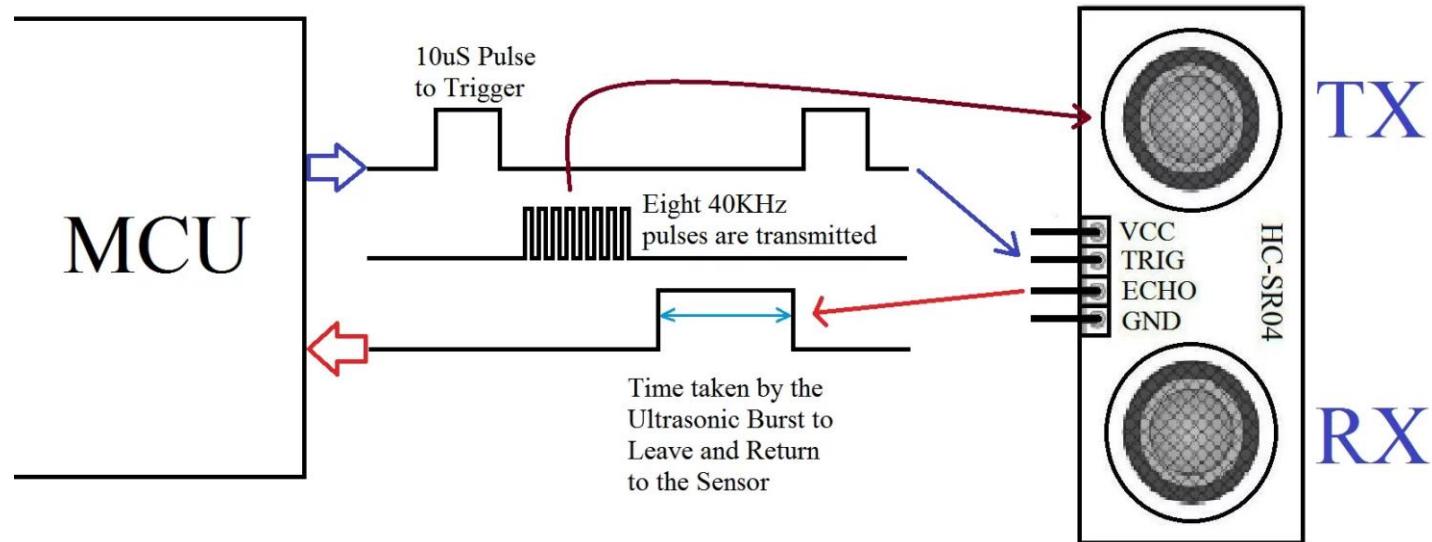


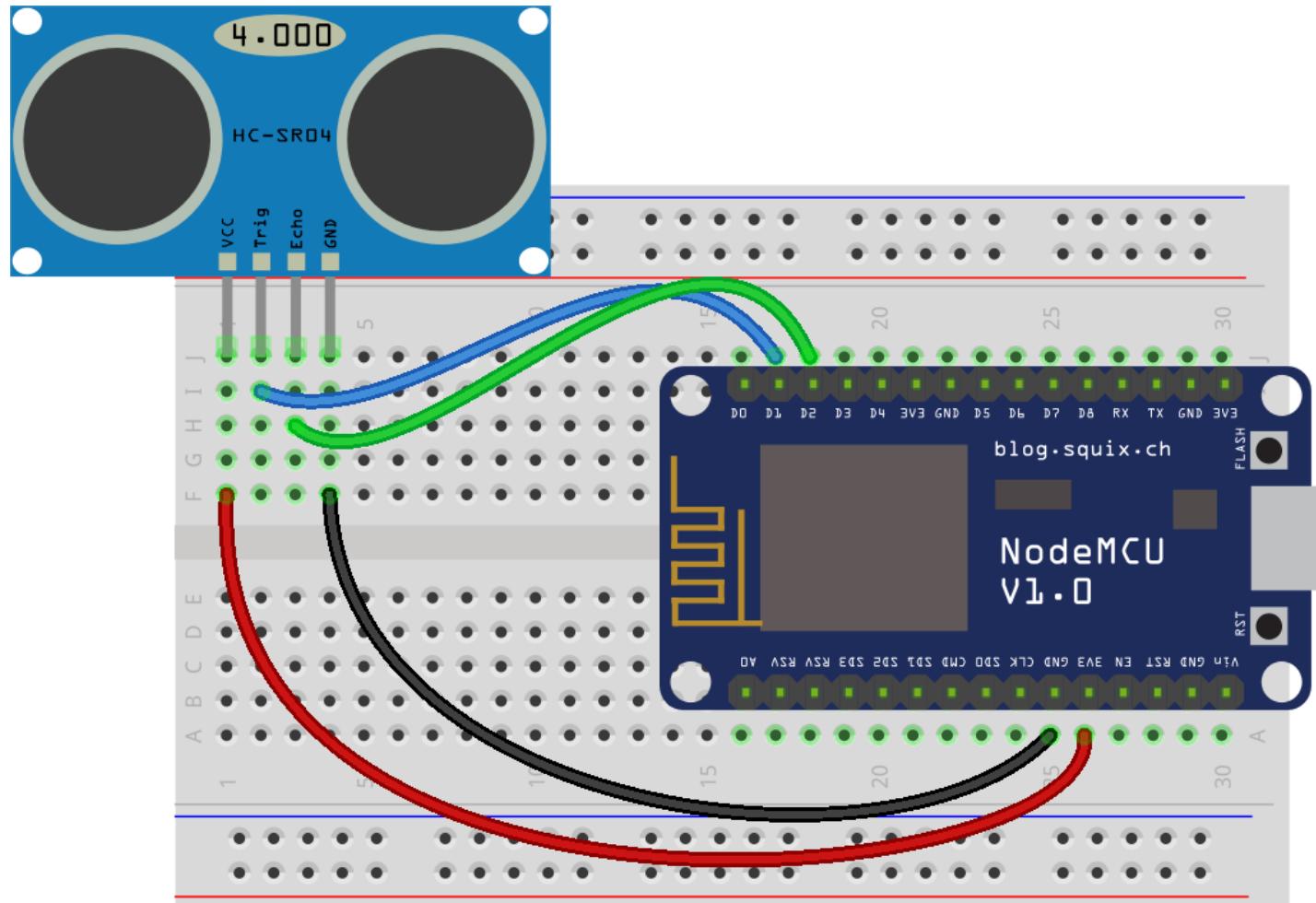
Image Source:

<https://electrosome.com/wp-content/uploads/2014/08/Working-of-HC-SR04-Ultrasonic-Sensor.jpg>

https://www.researchgate.net/figure/Working-principle-of-an-ultrasonic-sensor_fig1_304822025

DIY Experiments with NodeMCU

Interfacing Ultrasonic Sensor



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NodeMCU part Source: <https://github.com/squix78/esp8266-fritzing-parts/tree/master/nodemcu-v1.0>

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Cloud Platforms

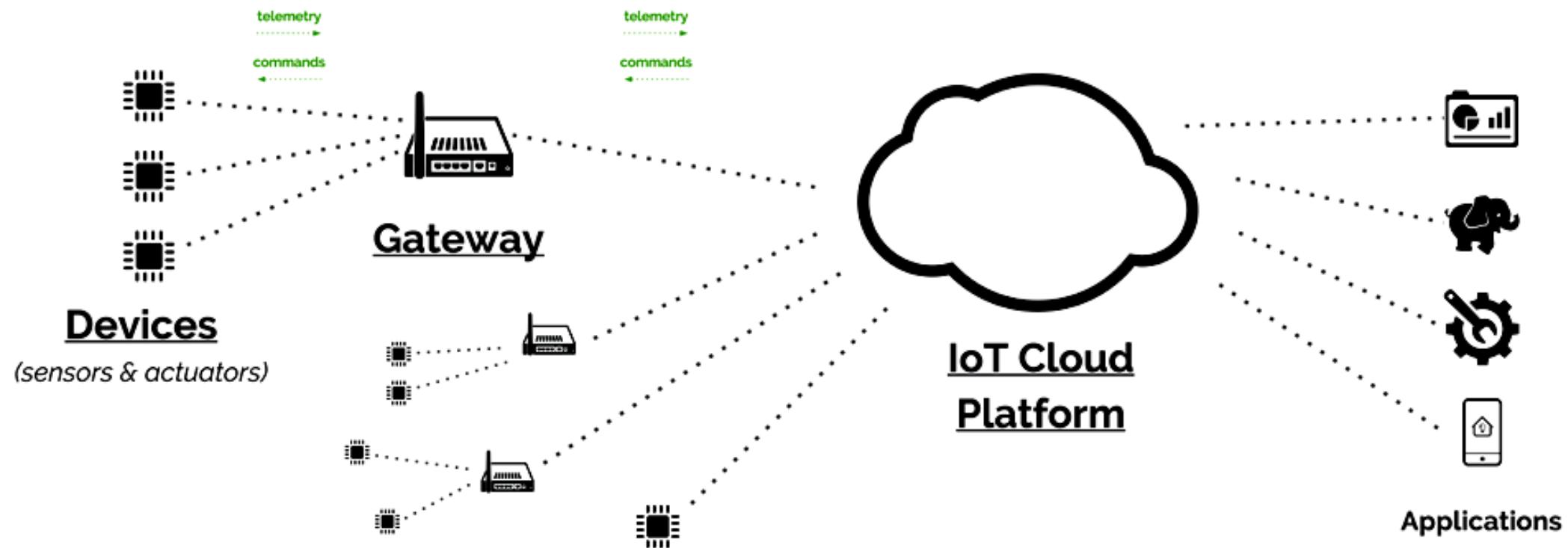


Image Source: <https://iot.eclipse.org/resources/white-papers/iot-architectures/image/IoT-arch.png>

Cloud Platforms

Thingspeak

www.thingspeak.com

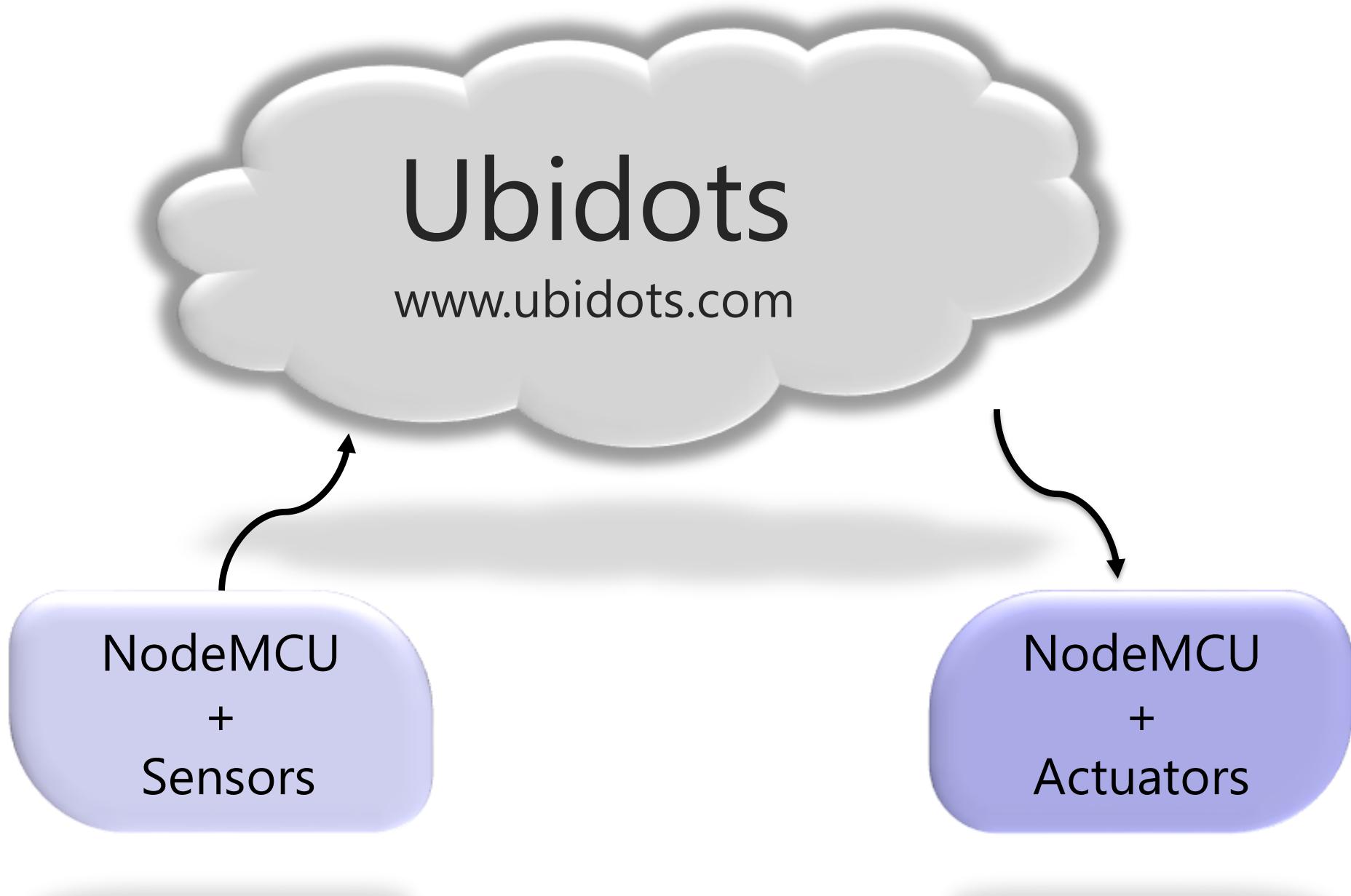
NodeMCU
+
Sensors

NodeMCU
+
Actuators

IoT Projects

**Application of IoT in Smart Cities
Use Case: Urban Waste Management**

Cloud Platforms



DIY Experiments with NodeMCU

Interfacing Temperature & Humidity Sensor

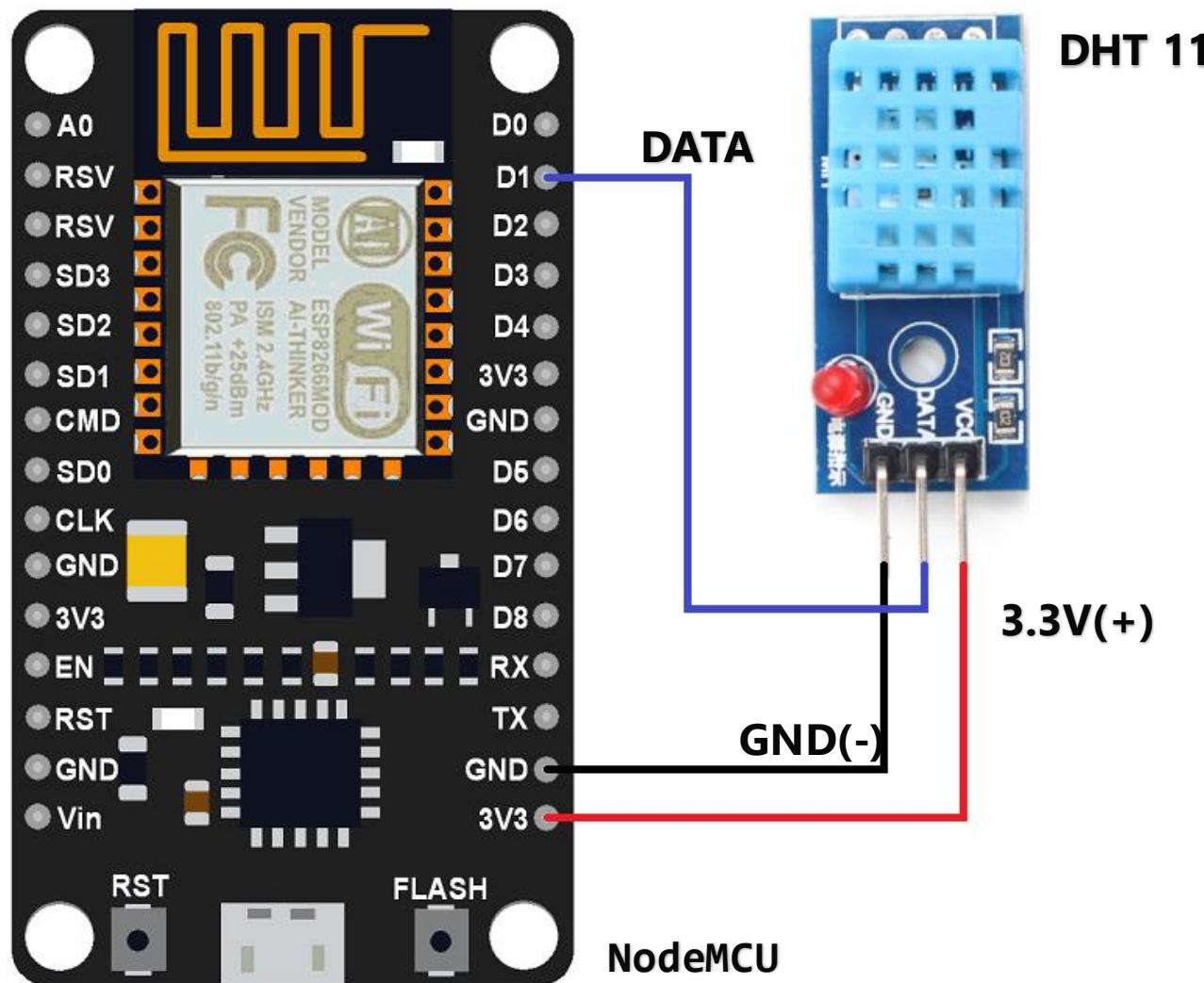


Image Source: <https://www.makerfabs.com>

IoT Projects

**Application of IoT in Home Automation
Use Case: Remote Switching of Air Conditioner**

Thank You 😊