

Internet of Things

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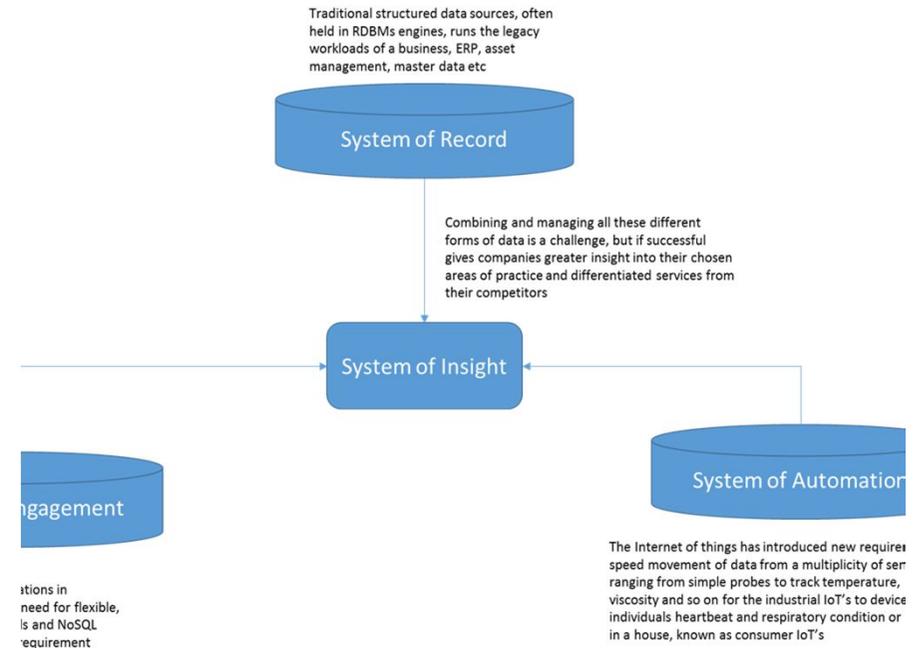
Internet-of-Things

- “Things” connected through the Internet
- The “things” may be remotely controlled
- The “things” can provide data
- New business models / smarter solutions
- Teaching philosophy:
 - Combination of theory and practical experience
 - Learning by doing

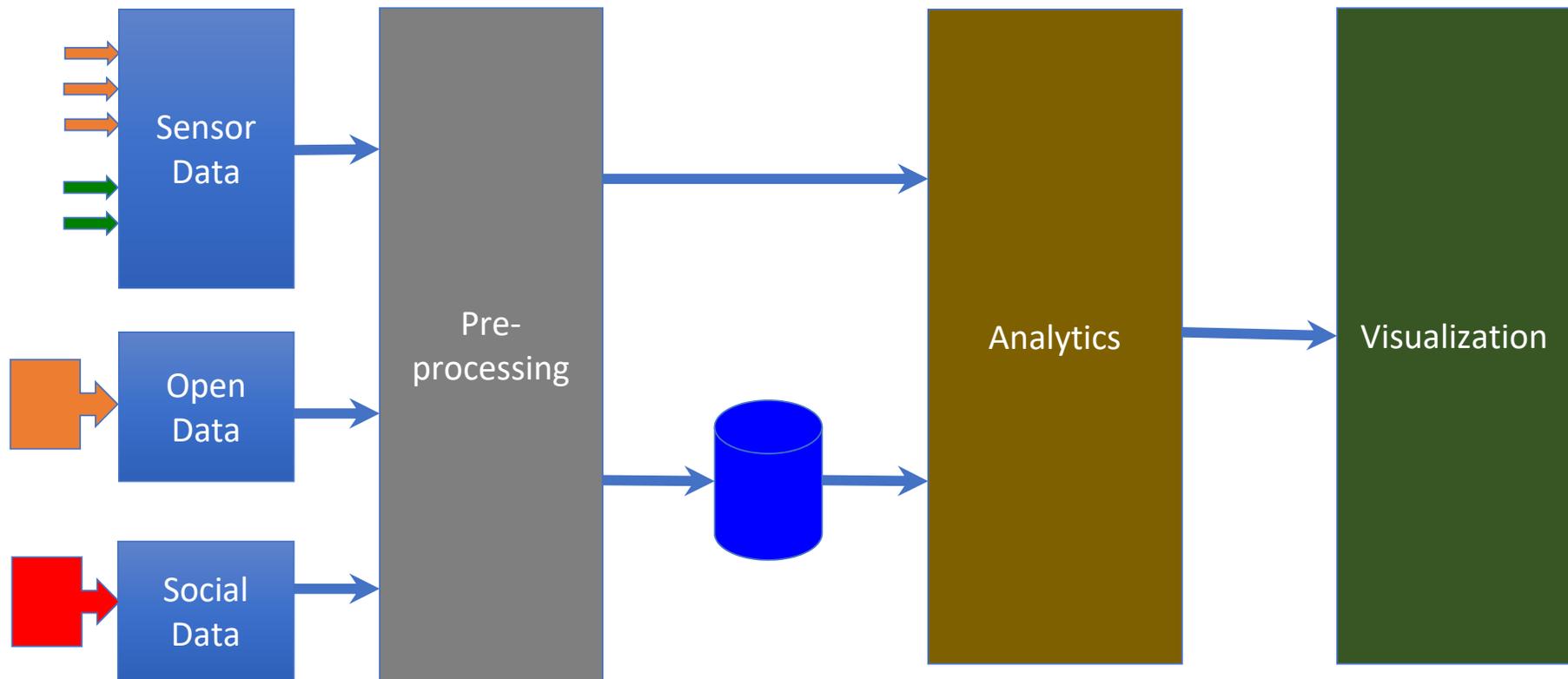
Contemporary Use of ICT Systems

System of Insight

- System of Record
 - Traditional databases, ERP, CRM
- System of Engagement
 - Social media, blogs
- System of Automation
 - Internet-of-things



Internet of Things in Context



Internet-of-Things - Overview

Microcontrollers

Processes input to make output
(*Computational capacity*)

Sensors

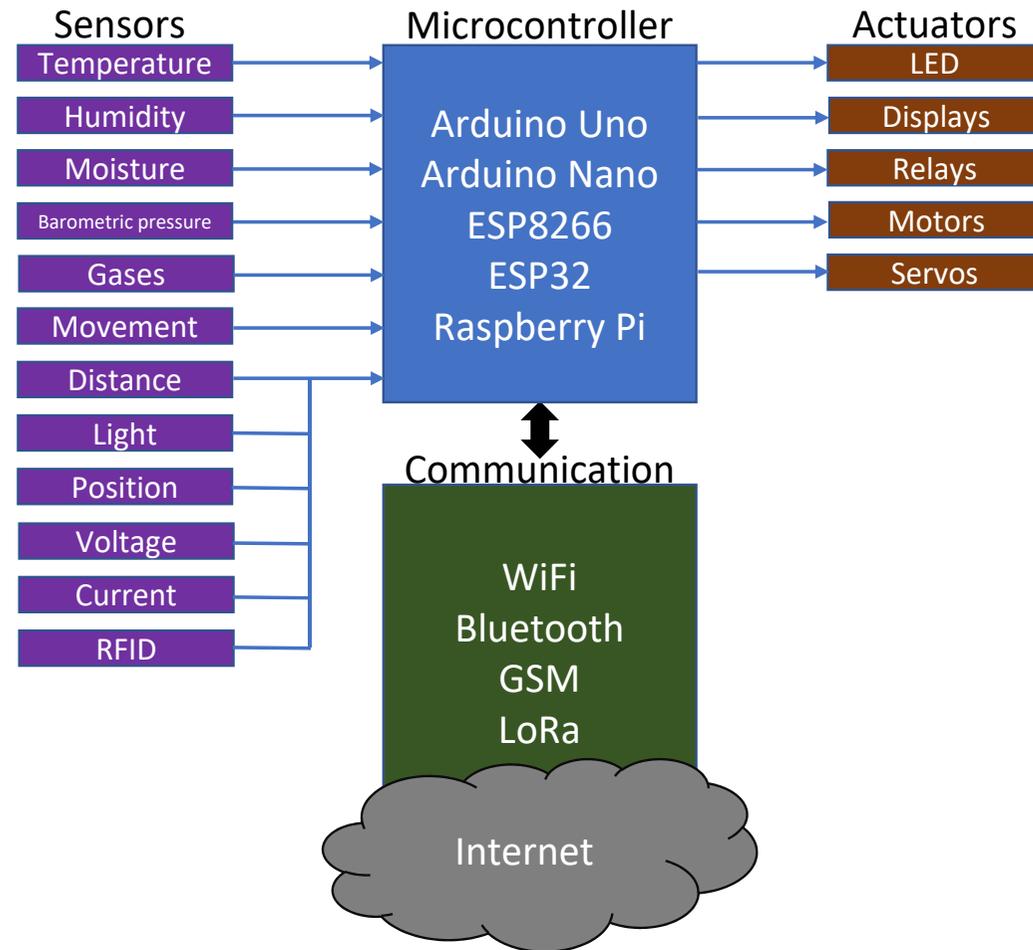
Collect input data

Actuators

Makes things happen

Communication

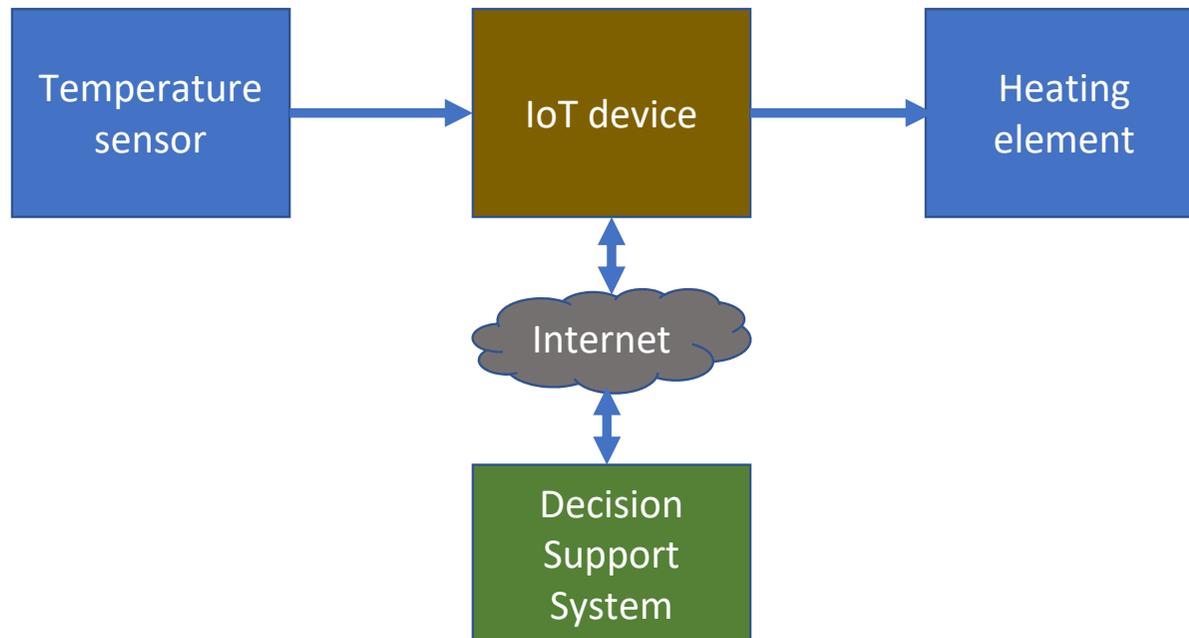
Communicates with the outside world through Internet



Laboratory assignments

- Measure temperature, humidity, distance
- Detect movement
- Store data on SD-card
- Use real-time clock
- Detect smoke
- Output data through displays (LED/LCD/OLED)
- Control the outside world through relays, motors and servo
- Read and write RFID tags
- Capture data from infrared remote controls, play back data on infrared transmitter
- Transfer wireless data through radio, WiFi and Bluetooth

Example



Components and modules

- ESP8266 (NodeMCU)
 - Arduino Uno
 - Prototyping board
 - Breadboard 400 pins
 - Battery holder (4xAA)
 - Photoresistor
 - DHT11 temperature/humidity
 - Passive infrared (PIR) sensor
 - MQ2 gas sensor
 - Ultrasonic sensor
 - Joystick
 - Rotary encoder
 - 12 button panel
 - Passive buzzer
 - LED display (I2C)
-
- LCD display (I2C)
 - OLED display (I2C)
 - DC Motor
 - Micro-servo
 - Step-motor with controller
 - IR transmitter
 - IR receiver
 - RFID sensor
 - Bluetooth module
 - 2 x RF module NRF24L01
 - RTC module
 - Relay
 - Sound detector module
 - SD-card module

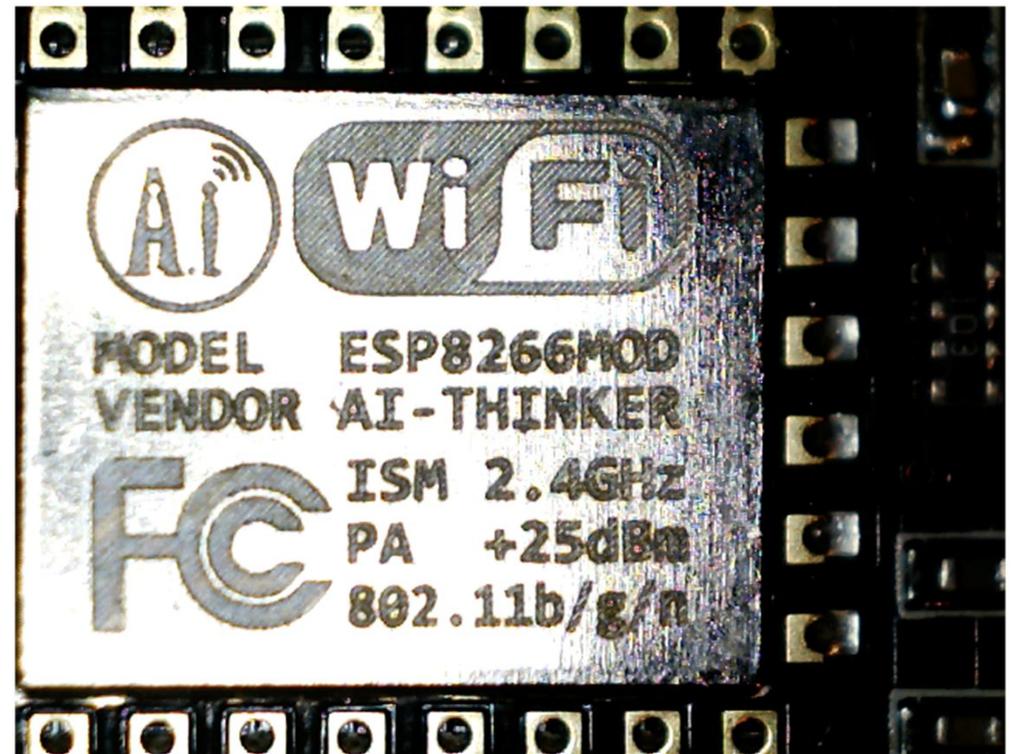
Transistors, diodes, resistors

- Transistors
 - 2x 2N2222
- Diodes
 - 1x 1N4001

- Resistors
 - 5 x 100 ohm
 - 2 x 150 ohm
 - 5 x 220 ohm
 - 2 x 300 ohm
 - 5 x 1.000 ohm (1K)
 - 2 x 2.000 ohm (2K)
 - 2 x 10.000 ohm (10K)

What is ESP8266

- ESP8266 is a microcontroller with built-in WiFi
- Has an embedded TCP/IP protocol stack
- Can be used as a web server, web client and for many other applications

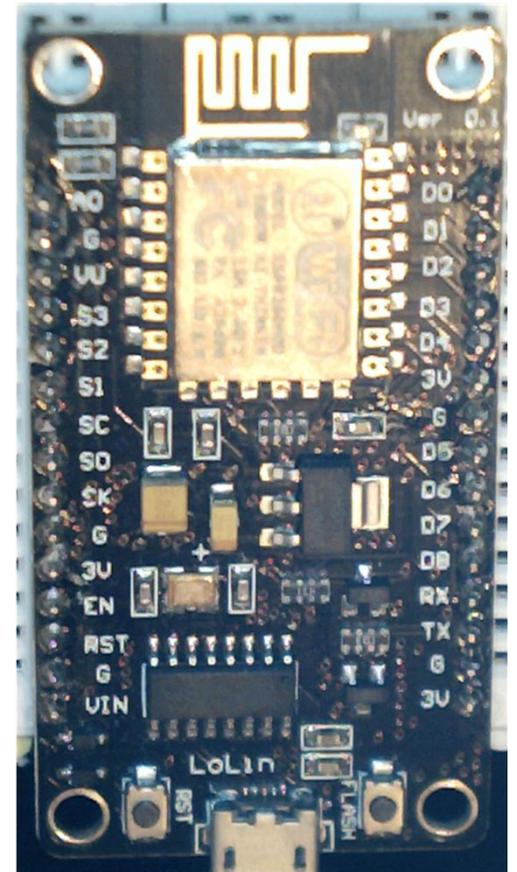


Different Versions of ESP8266

- The ESP8266 is the microcontroller with built-in WiFi
- The ESP8266 itself does not communicate through USB
- This is necessary for hooking up with a PC
- Therefore, a lot of circuit boards have been made to:
 - Host the ESP8266
 - Provide an USB adapter circuit (e.g., CH340)
 - Provide power for the ESP8266 from the USB connection

First Example

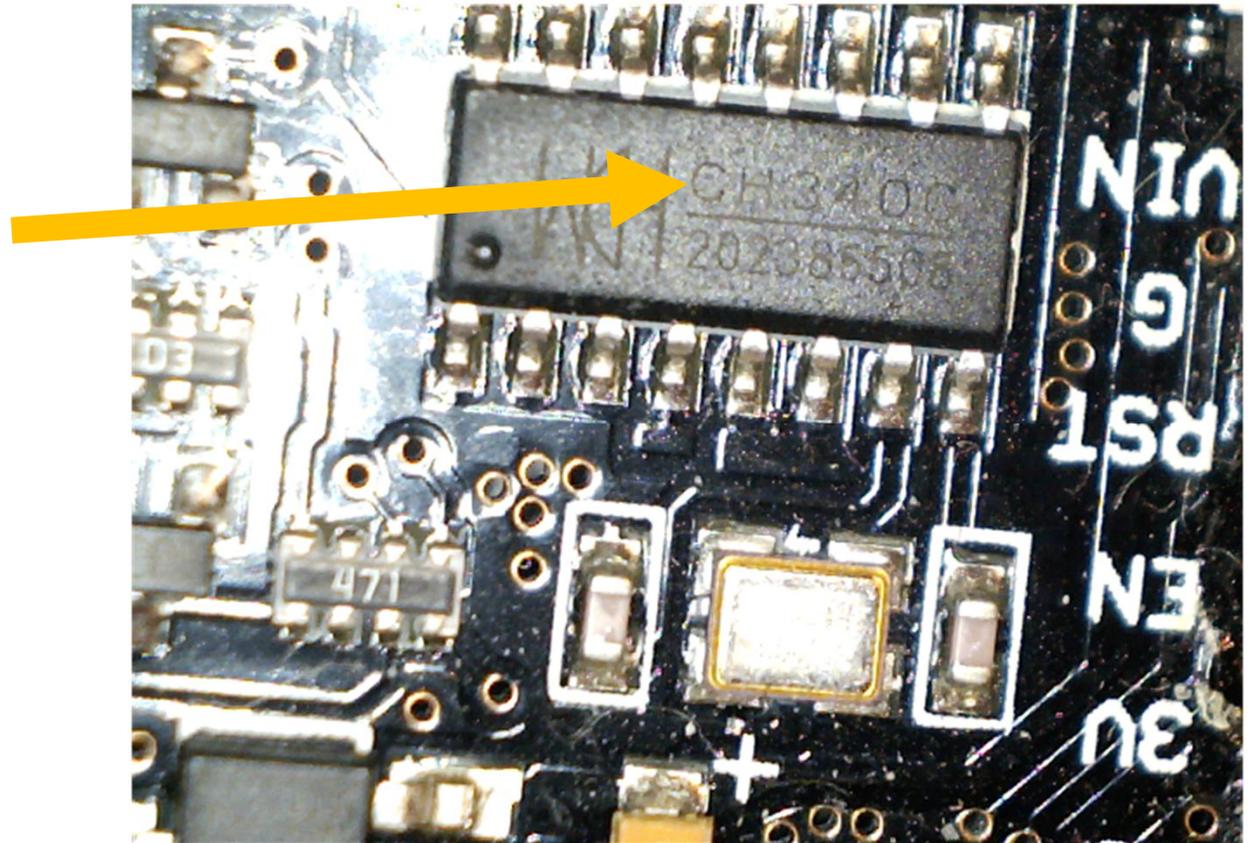
- This is a typical example of an ESP8266 card
- It has an ESP8266, a USB interface, and a few components handling power requirements



The USB Interface

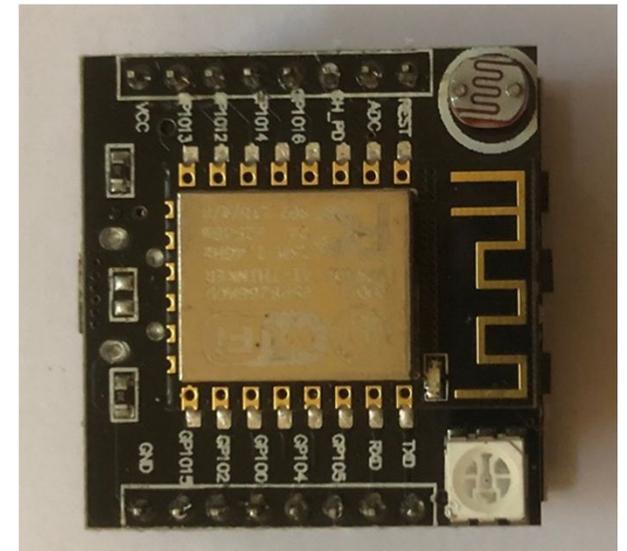
CH340 is a low cost USB interface circuit often used in Chinese produced microcontrollers

Some operating systems detect CH340, if not a driver must be installed

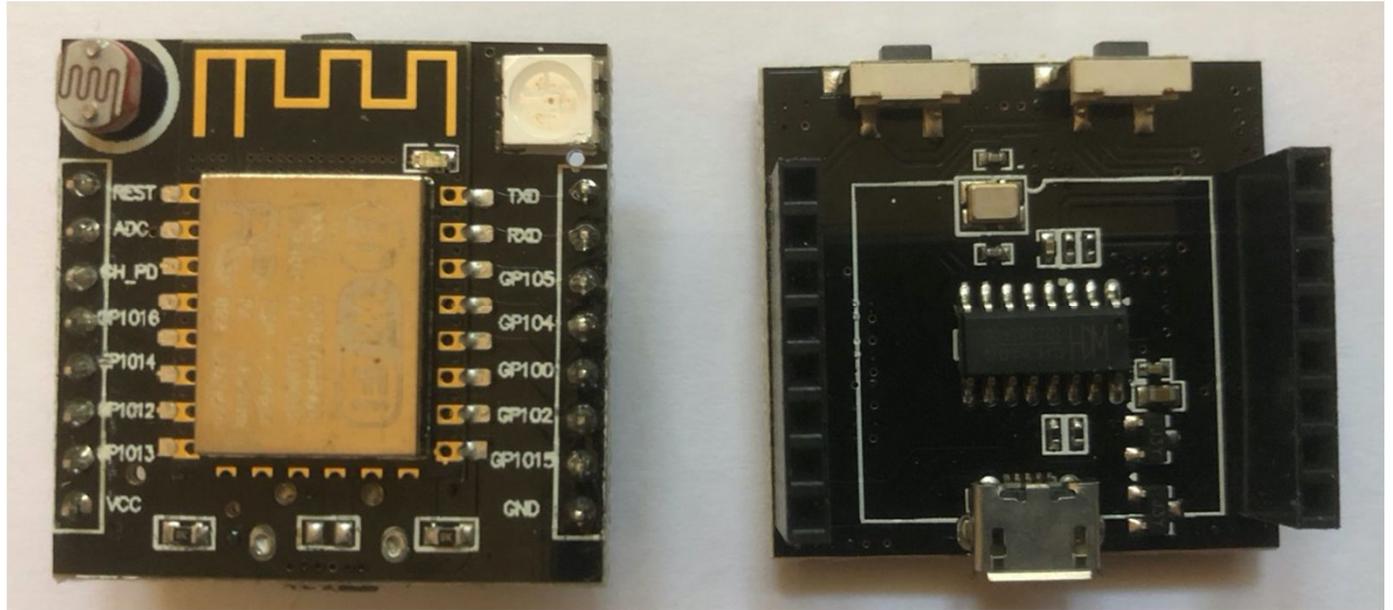
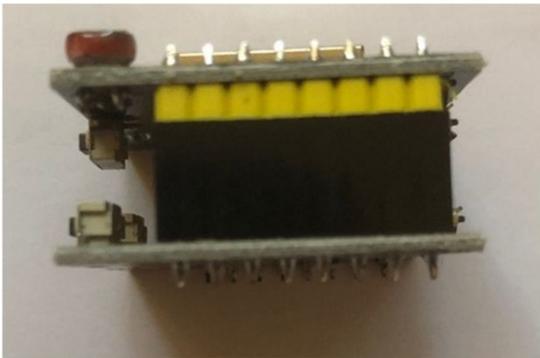


Witty

- A two layer ESP8266 board with the ESP8266 on the upper level, and the CH340 on the lower level.
- To program, connect USB cable to connector on the lower level
- The two levels may be separated
- In that case, the connector on the upper lever is just for power supply



Witty



The upper level with the ESP8266

The lower level with the CH340 USB interface

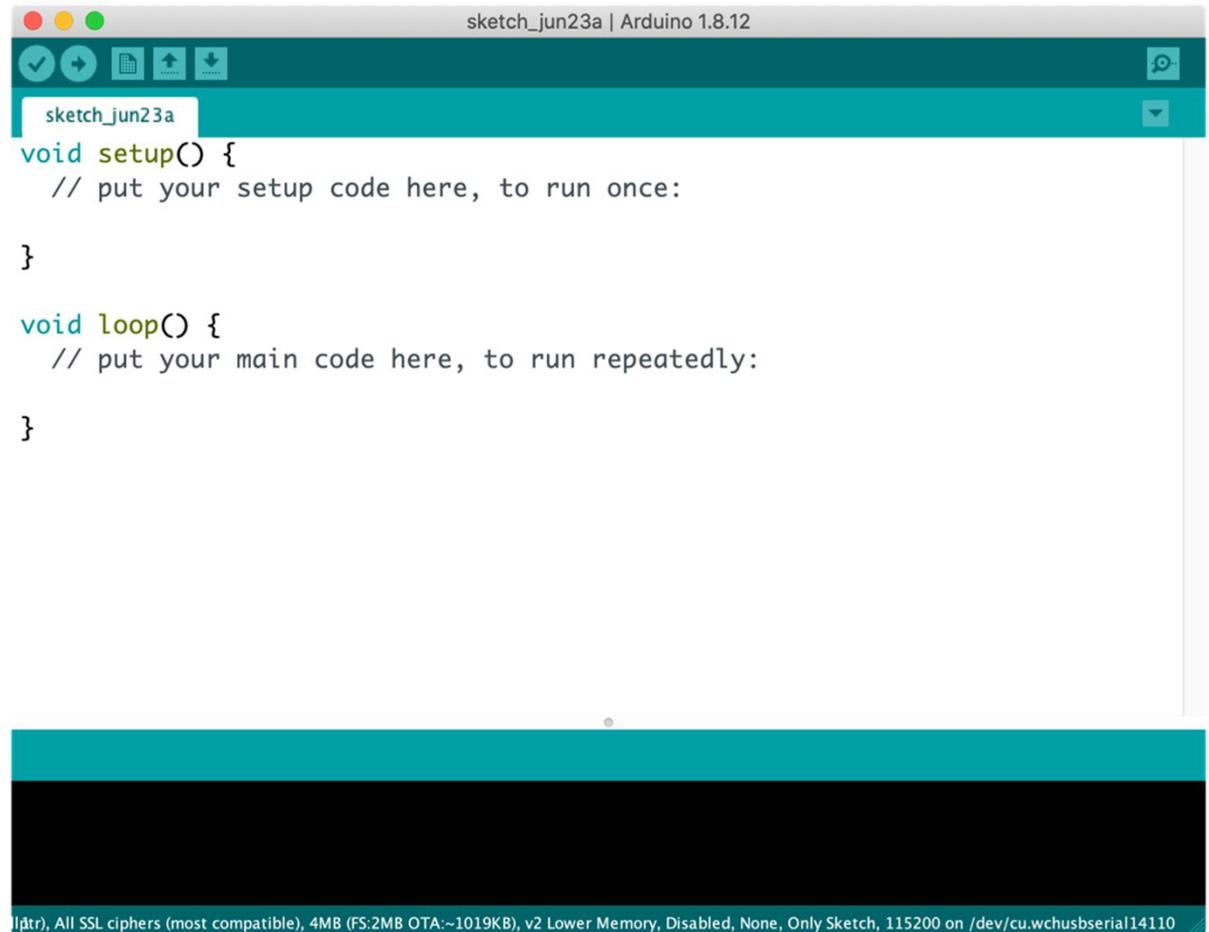
The Arduino IDE

The official Arduino site is:

<https://www.arduino.cc>

- Information about the Arduino versions
- Software downloads
- Resources, e.g. tutorials
- Forum

The Arduino IDE is used for many IoT-devices, such as ESP8266



```
sketch_jun23a | Arduino 1.8.12
sketch_jun23a
void setup() {
  // put your setup code here, to run once:
}

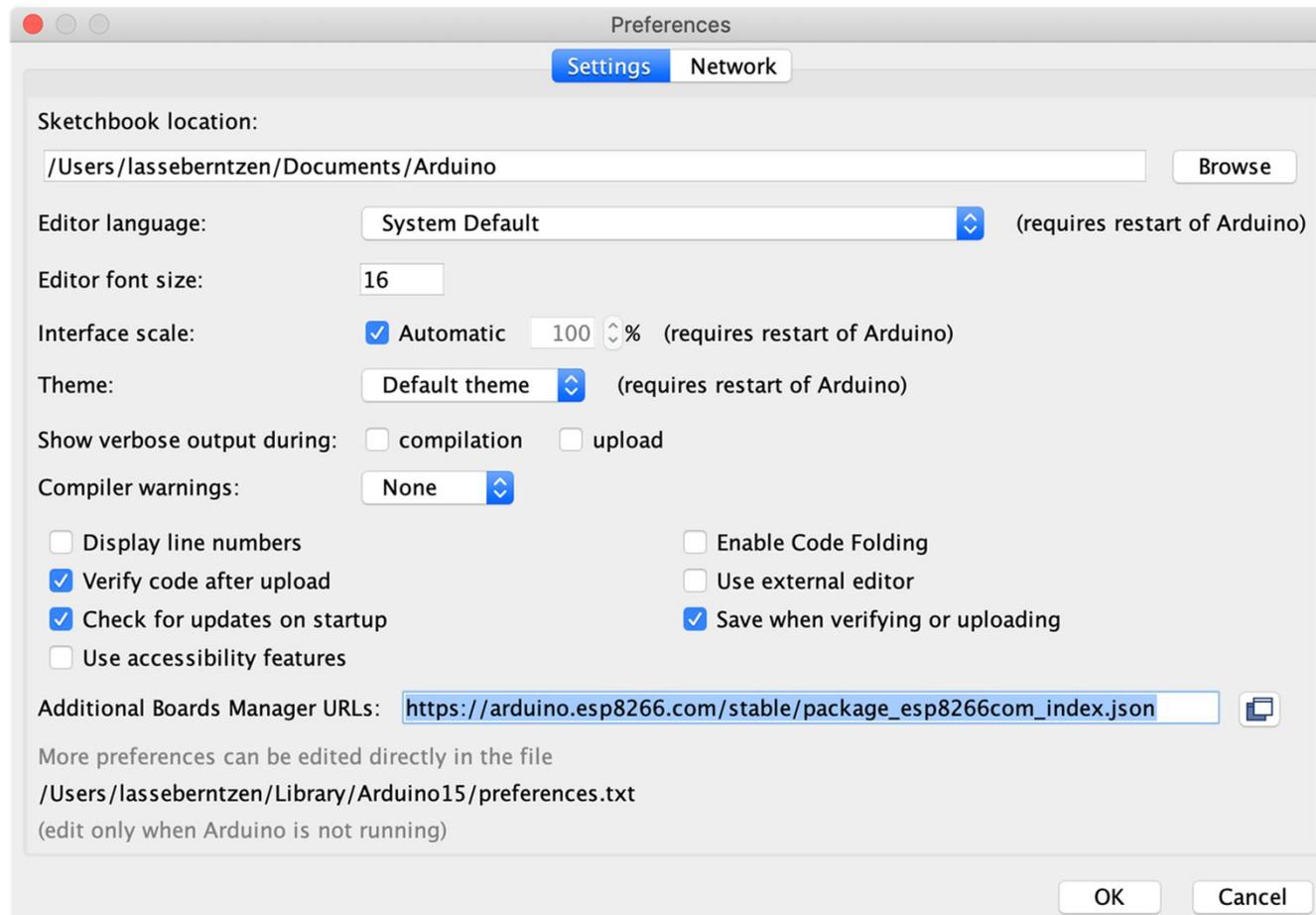
void loop() {
  // put your main code here, to run repeatedly:
}

|ptr, All SSL ciphers (most compatible), 4MB (FS:2MB OTA:~1019KB), v2 Lower Memory, Disabled, None, Only Sketch, 115200 on /dev/cu.wchusbserial14110
```

How to Add ESP8266 to the Arduino IDE

- Open **Arduino -> Preferences**
- In the field “Additional Boards Manager URLs” add the following URL:
https://arduino.esp8266.com/stable/package_esp8266com_index.json

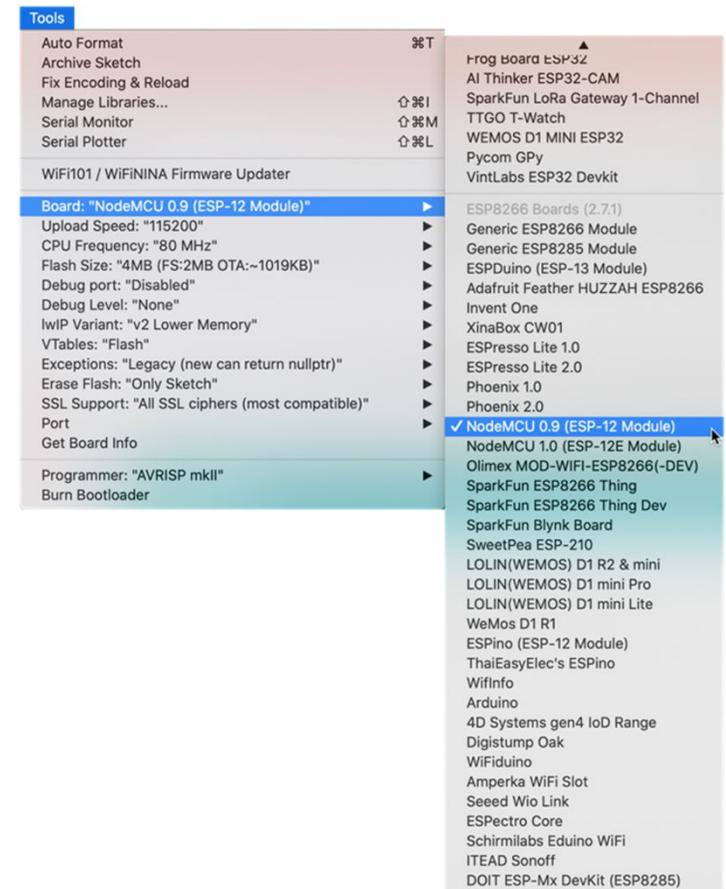
How to Add ESP8266 to the Arduino IDE



Selecting the Board

In the Tools menu select NodeMCU 0.9 (ESP12 module)
This works for both Witty and the Lolin boards

The next step is to select the port



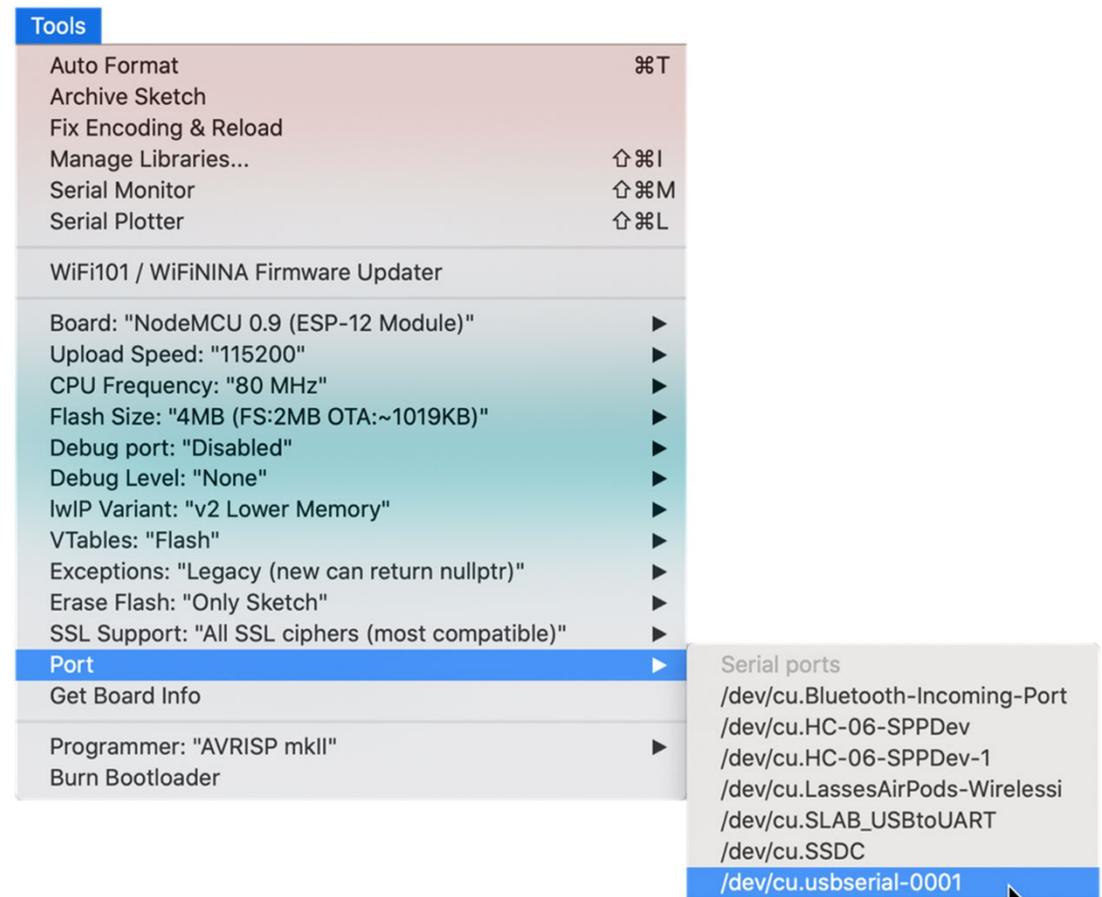
Selecting the Port

The other important thing is to select the port. Sometimes, this requires installation of a separate driver for CH340.

Make sure that the USB cable is OTG (On-The-Go). This allows devices to communicate through the cable. Some cables are just for power, and can not be used.

Common problems:

1. Missing drivers
2. Wrong cable (no OTG)



Setting Up GPIO Pins

- An ESP8266 device has a number of GPIO (General Purpose Input Output) pins
- These can read and write digital signals (zeros and ones)
- A GPIO pin can not be used for reading and writing at the same time
- The mode is selected by:
`pinMode(pin, OUTPUT)` or
`pinMode(pin, INPUT)`

Output

- Output is done by using:
digitalWrite(pin, HIGH) or
digitalWrite(pin, LOW)

Video

- Please take a look at the video named:
ESP8266_Example1_Blink_Internal.mp4
- This recording shows how to program the first ESP8266 sketch
- The sketch makes the internal LED blink at given intervals

The Result

