

Prototype Development Platform - Arduino / Raspberry pi / Node MCU

Arduino

What is a Microcontroller?

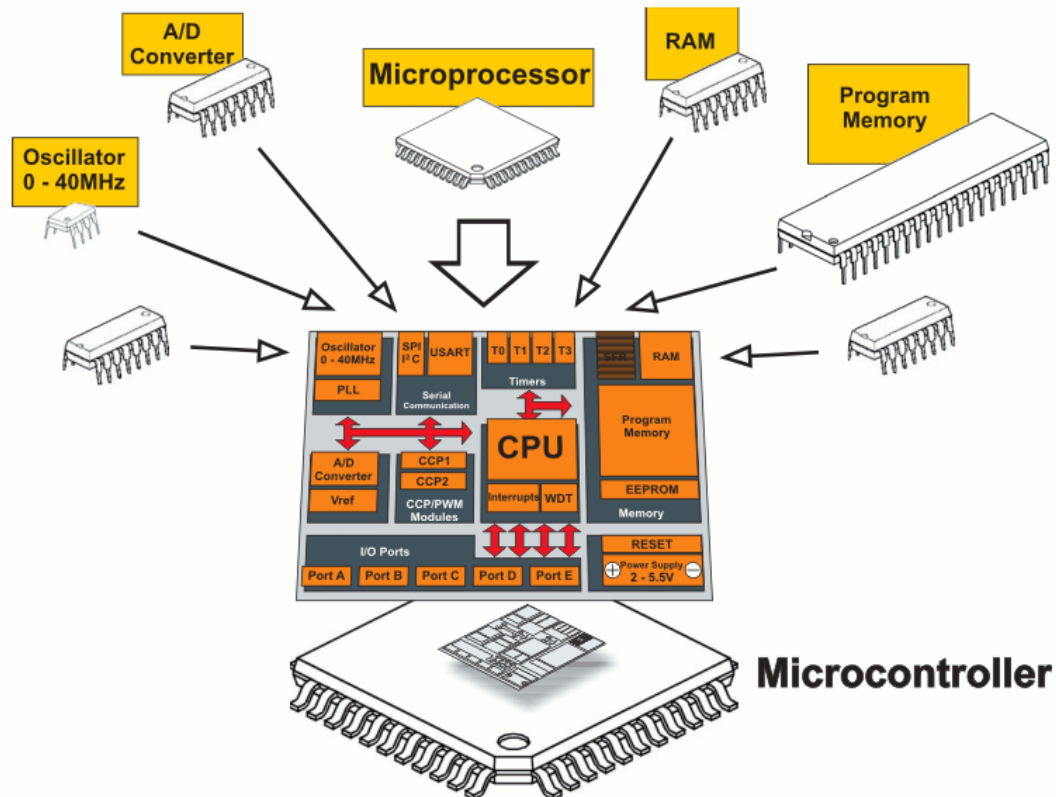
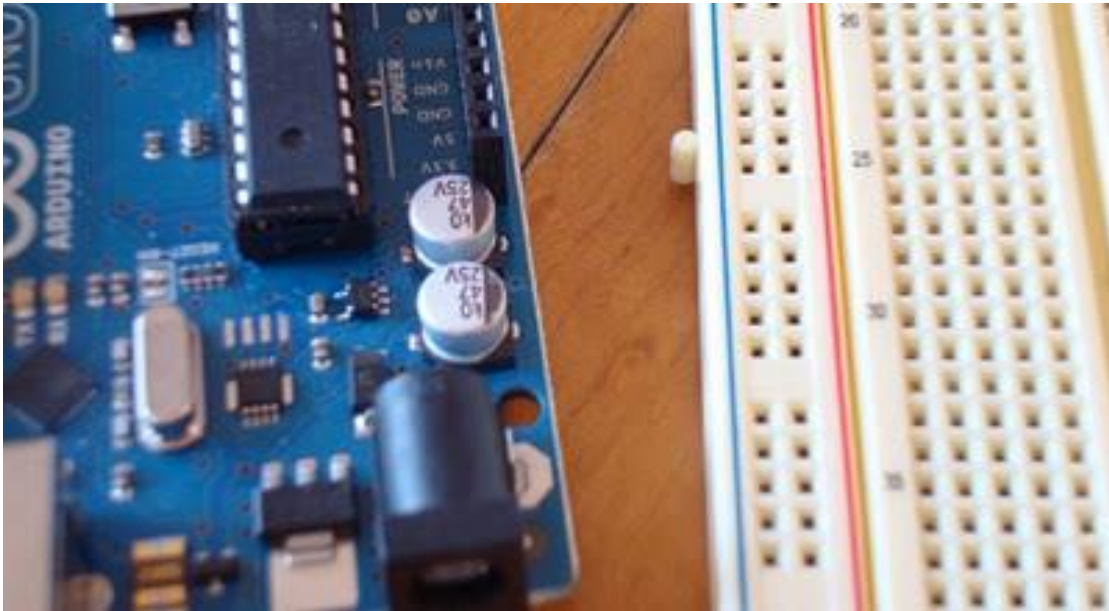


Fig. 0-1 Microcontroller versus Microprocessor

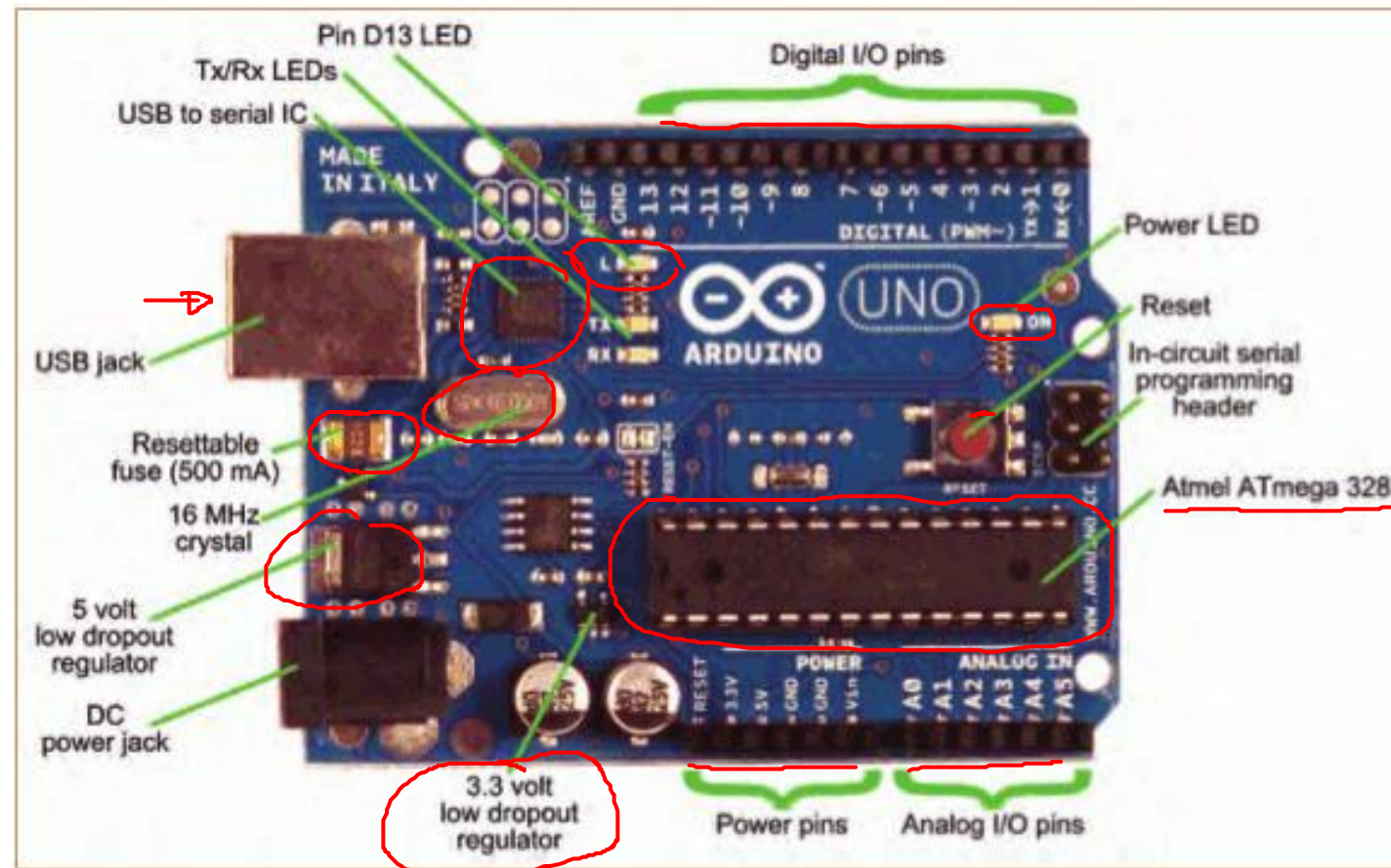
- A small computer on a single chip
 - containing a processor, memory, and input/output
- Typically "**embedded**" inside some device that they control
- A microcontroller is often small and low cost

What is a Development Board



- A printed circuit board designed to facilitate work with a particular microcontroller
- Typical components include:
 - Power circuit
 - Programming interface
 - Basic input; usually buttons and LEDs
 - I/O pins

The Arduino Development Board



What is the Arduino

The word “Arduino” can mean 3 things

A physical piece of hardware



A programming environment



A community & philosophy



Introduction to Arduino

- ▶ Arduino is a basic single board microcontroller designed to make applications, interactive controls, or environments easily adaptive.
 - ▶ The hardware consists of a board designed around an 8-bit microcontroller, or a 32-bit ARM.
 - ▶ Current models feature things like a USB interface, analog inputs, and GPIO pins which allows the user to attach additional boards.
- ▶ Introduced in 2005, the Arduino platform was designed to provide a cheaper way for students and professionals to create applications that play in the human interface world using sensors, actuators, motors, and other rudimentary products.
- ▶ It offers a simple integrated **IDE (integrated development environment)** that runs on regular personal computers and allows users to write programs for Arduino using C or C++.

Why Arduino?

► Inexpensive:

- Arduino boards are relatively inexpensive compared to other microcontroller platforms. The least expensive version of the Arduino module can be assembled by hand.

► Cross-platform:

- The Arduino software runs on Windows, Macintosh OS and Linux operating systems.

► Simple, clear programming environment:

- The Arduino programming environment is easy-to-use for beginners, yet flexible enough for advanced users to take advantage of as well.

► Open source and extensible software:

- The Arduino software is published as open source tools, available for extension by experienced programmers. The language can be expanded through C++ libraries.

► Open source and extensible hardware:

- The Arduino is based on Atmel's ATMEGA microcontrollers. Even relatively inexperienced users can build the breadboard version of the module in order to understand how it works and save money.

Which Arduino?

- ▶ Entry Level
 - ▶ Easy to use and ready to first creative projects. These boards and modules are the best to start learning and tinkering with electronics and coding.
- ▶ Enhanced Features
 - ▶ Experience the excitement of more complex projects, with advanced functionalities, or faster performances.
- ▶ Internet of Things
 - ▶ Make connected devices easily with IoT and the world wide web.
- ▶ Wearable
 - ▶ Add smartness to projects and sewing the power of electronics directly to textiles.

Which Arduino?

▶ ✓ ARDUINO UNO

- ▶ A microcontroller board based on the ATmega328P.
- ▶ It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button.
- ▶ Connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

▶ ARDUINO MEGA 2560

- ▶ A microcontroller board based on the ATmega2560.
- ▶ It has 54 digital input/output pins (of which 15 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button.
- ▶ It is the recommended board for 3D printers and robotics projects.

▶ ARDUINO MICRO

- ▶ A microcontroller board based on the ATmega32U4, featuring a built-in USB which makes the Micro recognisable as a mouse or keyboard.
- ▶ It has 20 digital input/output pins (of which 7 can be used as PWM outputs and 12 as analog inputs), a 16 MHz crystal oscillator, a micro USB connection, an ICSP header, and a reset button.

Technical Specifications

Microcontroller	ATmega328P
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limit)	6-20V
Digital I/O Pins	<u>14</u> (of which 6 provide PWM output)
PWM Digital I/O Pins	6
Analog Input Pins	6
DC Current per I/O Pin	20 mA
DC Current for 3.3V Pin	<u>50 mA</u>
Flash Memory	32 KB (ATmega328P) of which 0.5 KB used by <u>bootloader</u>
SRAM	2 KB (ATmega328P)
EEPROM	1 KB (ATmega328P)
Clock Speed	16 MHz
LED_BUILTIN	13
Length	68.6 mm
Width	53.4 mm
Weight	25 g

UNO

Getting Started

- ▶ Check out: <http://arduino.cc/en/Guide/HomePage>
- 1. Download & install the Arduino environment (IDE) ✓
- 2. Connect the board to your computer via the USB cable ✓
- 3. If needed, install the drivers ✓
- 4. Launch the Arduino IDE ✓
- 5. Select your board ✓
- 6. Select your serial port ✓
- 7. Open the blink example ✓ [Any]
- 8. Upload the program ✓

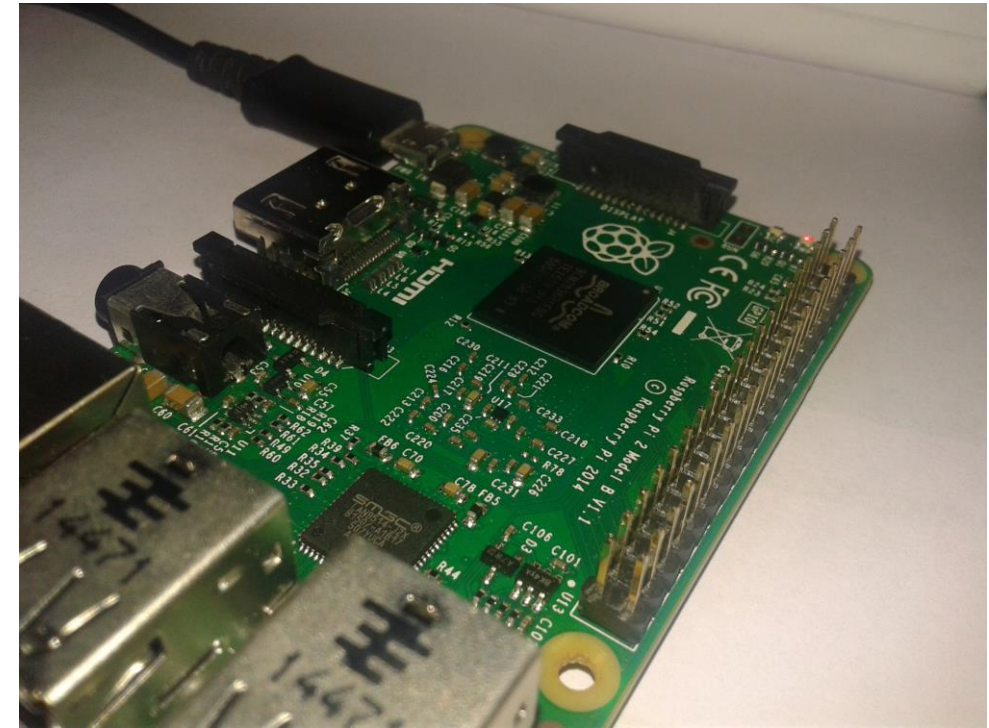
Fundamentals of Arduino Programming

- ▶ The Arduino IDE supports the languages C and C++ using special rules of code structuring.
- ▶ The Arduino IDE supplies a software library from the Wiring project, which provides many common input and output procedures.
- ▶ Sketch
 - ▶ A sketch is a program written with the Arduino IDE. Sketches are saved on the development computer as text files with the file extension .ino. Arduino Software (IDE) pre-1.0 saved sketches with the extension .pde.
 - ▶ A minimal Arduino C/C++ program consist of only two functions:
 - ▶ **setup():** This function is called once when a sketch starts after power-up or reset. It is used to initialize variables, input and output pin modes, and other libraries needed in the sketch.
 - ▶ **loop():** After setup() function exits (ends), the loop() function is executed repeatedly in the main program. It controls the board until the board is powered off or is reset.






Raspberry pi

What is Raspberry Pi

- ▶ The Raspberry Pi is a low cost, credit-card sized computer that plugs into a computer monitor or TV, and uses a standard keyboard and mouse.
- ▶ Little device that enables people of all ages to explore computing, and to learn how to program in languages like Scratch and Python.
- ▶ It's capable of doing everything a desktop computer to do, from browsing the internet and playing high-definition video, to making spreadsheets, word-processing, and playing games.
- ▶ The Raspberry Pi has the ability to interact with the outside world, and has been used in a wide array of digital maker projects, from music machines and parent detectors to weather stations etc
- ▶ Raspberry Pi hails from the United Kingdom. Inventor Eben Upton and his colleagues at the University of Cambridge's Computer Laboratory. Raspberry Pi was designed to be a cheap, hackable computer for improving tinkering skills. The first shipment of Pis became available in April 2012.



Raspberry Pi Family

Raspberry Pi 3, Pi 2, B+, A+ Board Comparison Chart				
    				
<div> <div>LATEST MODEL</div> <div>✓</div> </div>				
	Raspberry Pi 3 Model B	Raspberry Pi 2 Model B	Raspberry Pi Model B+	Raspberry Pi Model A+
Ethernet Port	Yes	Yes	Yes	No
GPU	Videocore IV	Videocore IV	Videocore IV	Videocore IV
Processor Speed	QUAD Core @1.2 GHz	QUAD Core @900 MHz	Single Core @700 MHz	Single Core @700 MHz
WiFi	Built in	No	No	No
Bluetooth LE	Built in	No	No	No
Storage	MicroSD	MicroSD	MicroSD	MicroSD
Processor Chipset	Broadcom BCM2837 64Bit Quad Core Processor powered Single Board Computer running at 1.2GHz	Broadcom BCM2836 32Bit Quad Core Processor powered Single Board Computer running at 900MHz	Broadcom BCM2835 32Bit SoC full HD multimedia applications processor	Broadcom BCM2835 32Bit SoC full HD multimedia applications processor
RAM	1GB SDRAM @ 400 MHz	1GB SDRAM @ 400 MHz	512 MB SDRAM @ 400 MHz	256 MB SDRAM @ 400 MHz
GPIO	40 pin	40 pin	40 pin	40 pin
USB 2.0	4x USB Ports	4x USB Ports	4x USB Ports	1x USB Port
Max Power Draw/Voltage	2.5A @ 5V	1.8A @ 5V	1.8A @ 5V	1.8A @ 5V

Components of a Raspberry Pi3 Board

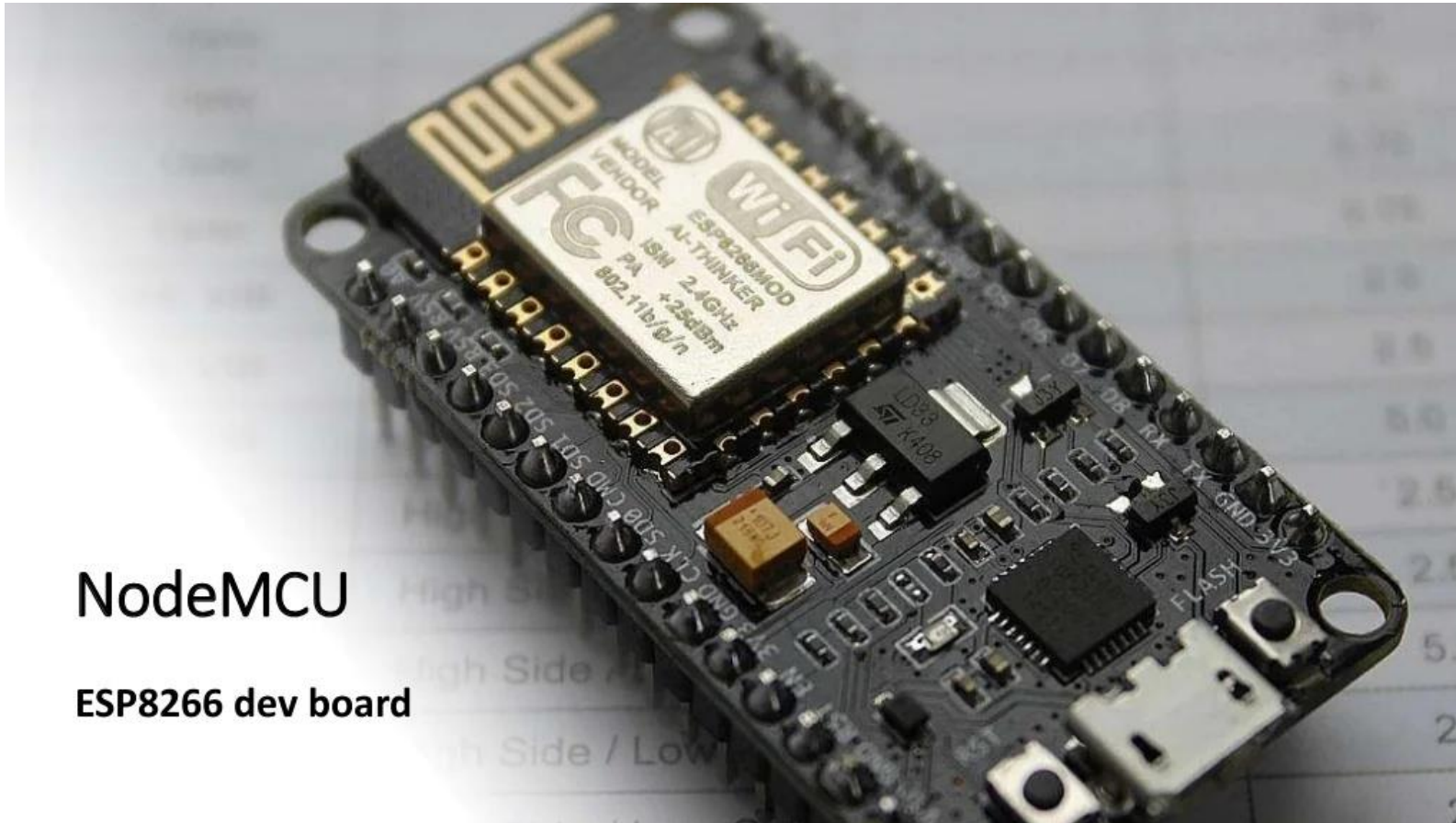
- ▶ Broadcom 64 bit Quad Core 1.2 GHz
- ▶ 1 Gb RAM
- ▶ RJ 45 Ethernet port
- ▶ 4 USB slots
- ▶ 40 GPIO pins
- ▶ HDMI connecting port
- ▶ 3.5 mm Headphone port
- ▶ Bluetooth and Wi-Fi in-built
- ▶ LCD screen can be attached
- ▶ Raspberry Camera can be attached
- ▶ Micro USB Powering port

Purpose of Raspberry Pi

- ▶ Raspberry can be used for domestic DIY projects as well as for Industrial application.
- ▶ Being an independent platform easy to integrate with other available devices like PC.
- ▶ Small and affordable for student projects.
- ▶ 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".

Node MCU

Node MCU



NodeMCU

ESP8266 dev board

Node MCU | What is it?

The NodeMCU (Node MicroController Unit) is an open source software and hardware development environment that is built around a very inexpensive System-on-a-Chip (SoC) called the ESP8266.

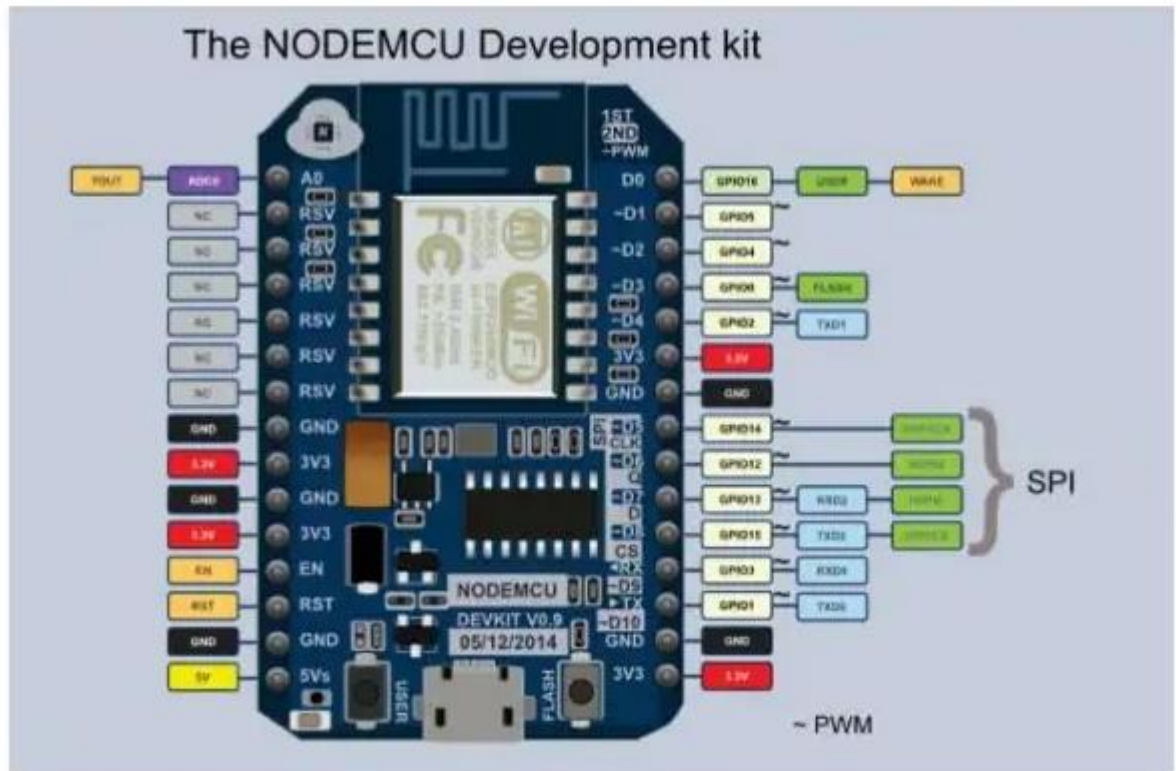
- ▶ An Arduino-like device ✓
- ▶ Main component: ESP8266
- ▶ With programmable pins
- ▶ And built-in wifi
- ▶ Power via USB
- ▶ Low cost



o with it?

Lua is a powerful, efficient, lightweight, embeddable scripting language. It supports procedural programming, object-oriented programming, functional programming, data-driven programming, and data description.

- ▶ Program it via C or LUA
- ▶ Access it via wifi (ex. HTTP)
- ▶ Connect pins to any device (in or out)



Node MCU | ESP8266

- ▶ ESP8266 is a highly integrated chip designed for the needs of a new connected world.
- ▶ It offers a complete and self-contained Wi-Fi networking solution, allowing it to either host the application or to offload all Wi-Fi networking functions from another application processor.
- ▶ ESP8266 has powerful on-board processing and storage capabilities that allow it to be integrated with the sensors specific devices through its GPIOs with minimal development up-front and minimal loading during runtime.

ESP 8266 Features

- ▶ Open-source
- ▶ Interactive
- ▶ Programmable
- ▶ Low cost
- ▶ Simple
- ▶ Smart
- ▶ WI-FI enabled

ESP 8266 Features

- ▶ **I/O Pins:**
 - ▶ Digital Pins: Pin D0 – Pin D10 Digital Pins
 - ▶ PWM Pins : 12 PWM Pins
 - ▶ Analog Pins : Pin A0
- ▶ **Power PINS**
 - ▶ Ground : 5 Pins
 - ▶ 3.3V : 3
 - ▶ Vin Pin : 1 Adding external supply of +5V (is not connected to USB)

ESP 8266 Specifications

The Development Kit based on ESP8266, integrates GPIO, PWM, IIC, 1-Wire and ADC all in one board. USB-TTL included, plug&play

- ▶ 10 GPIO, every GPIO can be PWM, I2C, 1-wire
- ▶ USB-TTL included, plug & play
- ▶ PCB antenna

Node MCU | Getting Started

- ▶ Install the Arduino IDE: <https://www.Arduino.cc/en/Main/Software>
- ▶ Install the ESP8266 Addon
- ▶ Go!

Thank you!