Arduino & MicroPython for Internet of Things

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Introduction

Name: Ardy Seto Priambodo, S.T., M.Eng.
Occupation: Lecturer in Electronics and Informatics Engineering Education, Engineering Faculty (UNY), Embedded System (Drone, IoT, Automatics System) Freelancer
Education: S.T. from Electrical Engineering ITS, M.Eng. from Electrical Engineering UGM
Hobby: Teaching, Aeromodelling, DIY Electronics (Robot & Microcontroller), *Ngoprek*

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Outline

> What is IoT?
> History and Development of IoT
> What is Embedded System?
> Arduino and MicroPython
> Relation between IoT and Embedded System
> Demo: ESP8266 with MicroPython / Arduino

Internet of Things

From **Wikipedia**: The Internet of things (IoT) is a system of interrelated computing devices, mechanical and digital machines provided with unique identifiers (UIDs) and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction

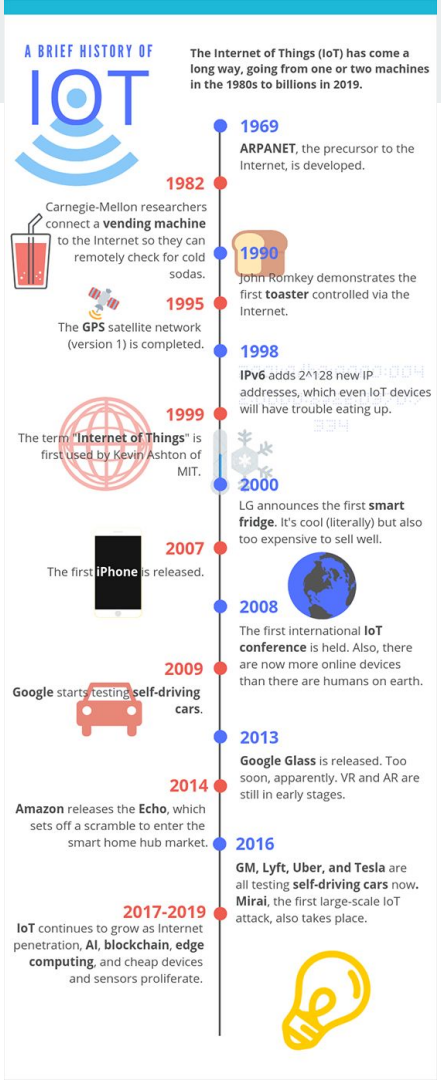
From **ZDnet**: The Internet of Things, or IoT, refers to the billions of physical devices around the world that are now connected to the internet, all collecting and sharing data.

From **RedHat**: Internet of Things (IoT) refers to an ongoing trend of connecting all kinds of physical objects to the internet, especially ones that you might not expect.

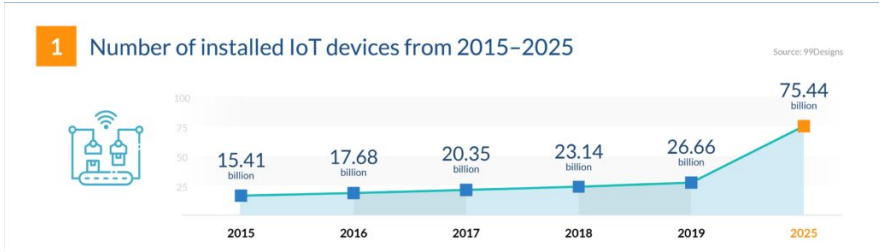
History of IoT

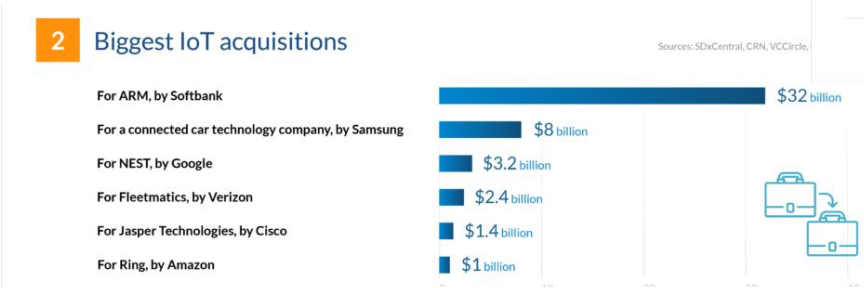
1969: Internet is developed
1982: Vending Machine connected with Internet
1995: GPS
1999: IoT terms by Kevin Ashton
2000: LG announces Smart Fridge
2007: First iPhone
2008: First International IoT Conference
2009: Google test self-driving cars
2013: Google Glass
2016: Self-driving cars
2017-2019: AI, blockchain, edge computing

Source: https://www.iottechtrends.com/history-of-iot/

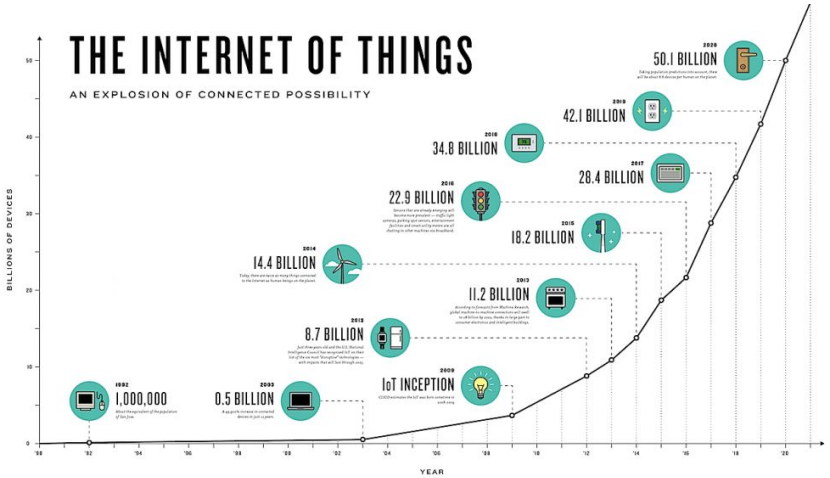


Statistics of IoT





Why IoT is Important?



Data Produced by IoT Devices

- **25 GB/hour** — A modern, fully instrumented car.
- **150,000 data points/second** — A typical wind farm.
- **51,200 GB/hour** — A fully instrumented jet engine.
- **500 million data readings/day** — A smart meter project.
- **500 GB/day** — A single turbine compressor blade.
- **40% of all data by 2020** — Produced by sensors.

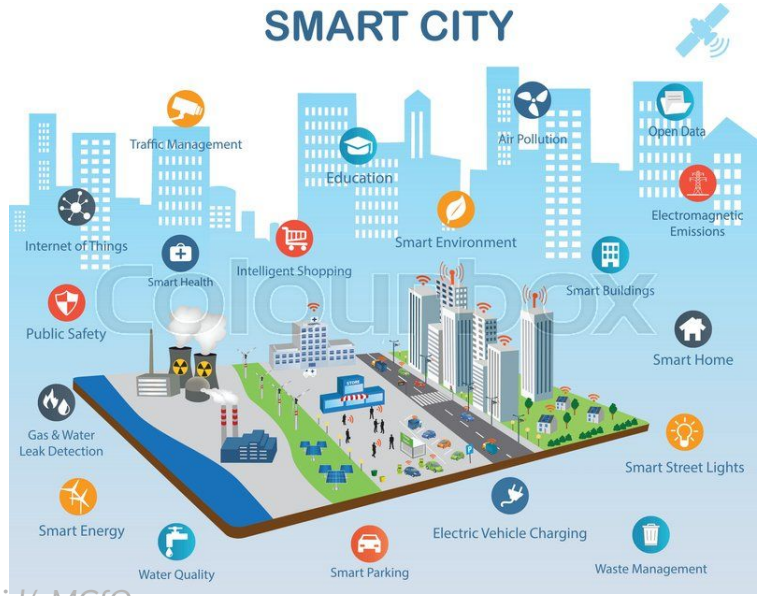
Source: Simafore, RTInsights, Cisco

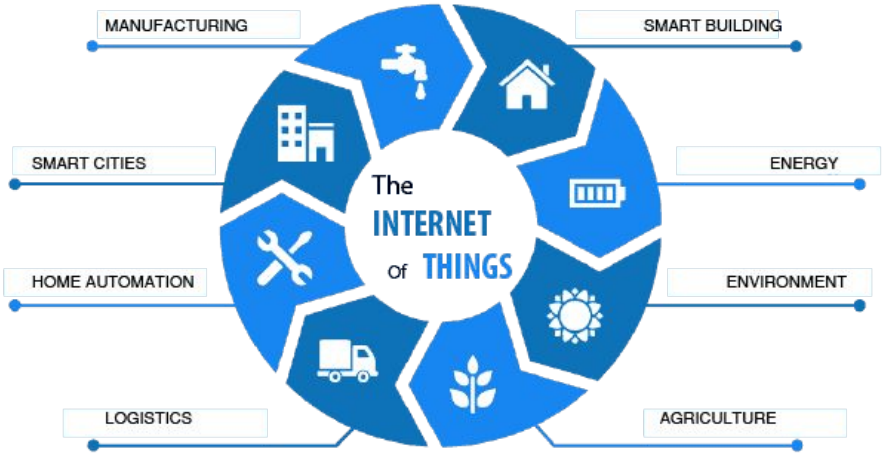
Additional Revenue from IoT Data

- **$162 billion** — Employee Productivity.
- **$55 billion** — Product Innovation.
- **$117 billion** — Operational Improvement.
- **$38 billion** — Customer Facing Activities.

Source: Microsoft

Implementation of IoT





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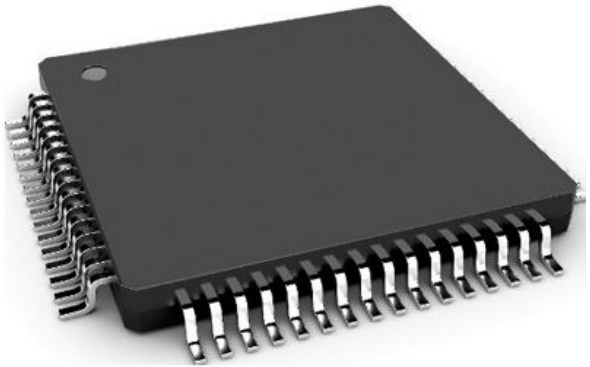
Embedded System / Microcontroller

From **Wikipedia**: a combination of a computer processor, computer memory, and input/output peripheral devices—that has a dedicated function within a larger mechanical or electrical system



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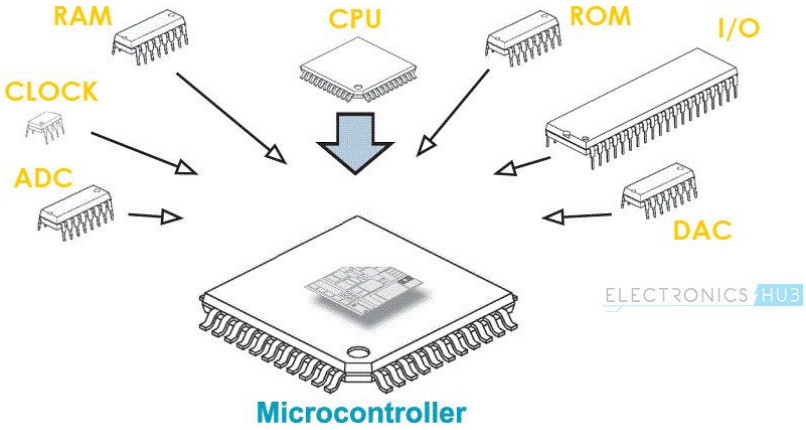
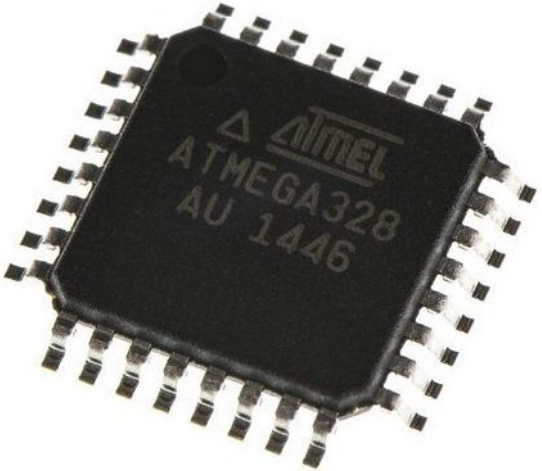
Components of uC

Basically, a Microcontroller consists of the following components.

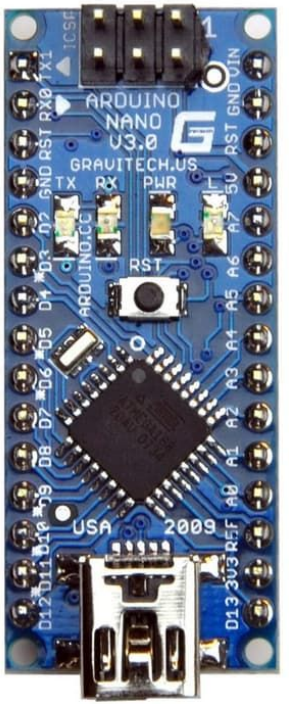
- Central Processing Unit (CPU)
- Program Memory (ROM – Read Only Memory)
- Data Memory (RAM – Random Access Memory)
- Timers and Counters
- I/O Ports (I/O – Input/Output)
- Serial Communication Interface
- Clock Circuit (Oscillator Circuit)
- Interrupt Mechanism



ATMEL ATMega328p



Parameter	Value
CPU type	8-bit AVR
Performance	20 MIPS at 20 MHz[2]
Flash memory	32 KB
SRAM	2 KB
EEPROM	1 KB
Pin count	28 or 32 pin:
Maximum operating frequency	20 MHz
Number of touch channels	16
Hardware QTouch Acquisition	No
Maximum I/O pins	23
External interrupts	2
USB Interface	No
USB Speed	–



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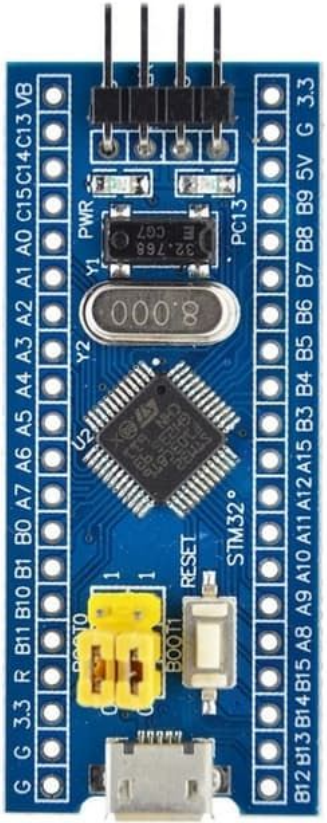
STM32F103

Features	STM32F103	ATMEGA328
Clock Frequency	72 Mhz	16 Mhz
I2C Buses	2	1
SPI Buses	2	1
CAN Bus	Yes	No
Analog Channel	10	8
PWM Channel	15	6
USART Buses	3	1
GPIO's	32	24
On Board RTC	Yes	No
Architecture	ARM Cortex M3 32 bit	AVR RISC 8 bit
ADC Resolution	12 bit	10 bit
Quantization Level	4096	1024
Flash Memory	64KB	32KB
SRAM	20KB	2KB
Debugging	Serial, JTAG	Serial
PWM Resolution	16 bit	10bit
Price	**110**	**115**



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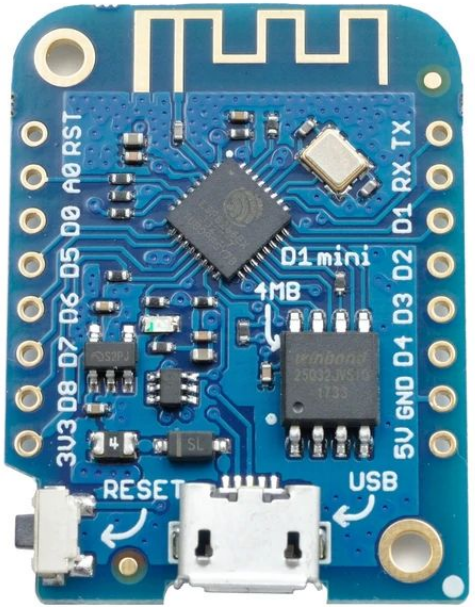
ESP8266

	ESP8266	Arduino UNO
Number of Cores	1	1
Architecture	32 Bit	8 Bit
CPU Frequency	80 MHz	16 MHz
WiFi	YES	NO
BLUETOOTH	NO	NO
RAM	160 KB	2 KB
FLASH	16 MB	32 KB
GPIO PINS	17	14
Busses	SPI, I2C, UART, I2S	SPI, I2C, UART
ADC Pins	1	6
DAC Pins	0	0



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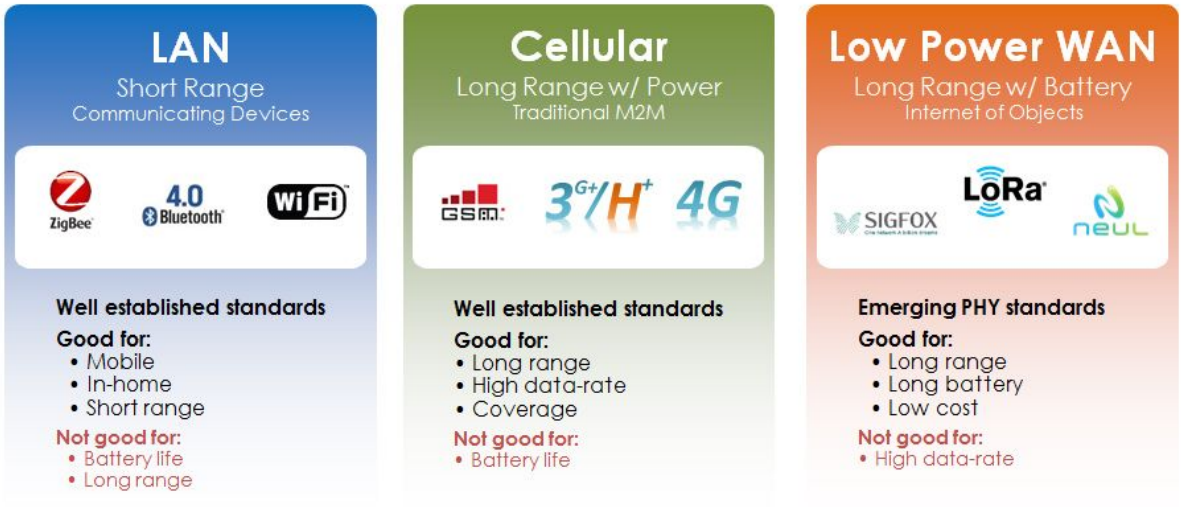
ESP32

	ESP8266	ESP32
MCU	Xtensa Single-core 32-bit L106	Xtensa Dual-Core 32-bit LX6 with 600 DMIPS
802.11 b/g/n Wi-Fi	HT20	HT40
Bluetooth	No	Bluetooth 4.2 and BLE
Typical Frequency	80 MHz	160 MHz
SRAM	No	Yes
Flash	No	Yes
GPIO	17	36
Hardware /Software PWM	None / 8 channels	None / 16 channels
SPI/I2C/I2S/UART	2/1/2/2	4/2/2/2
ADC	10-bit	12-bit
CAN	No	Yes
Ethernet MAC Interface	No	Yes
Touch Sensor	No	Yes
Temperature Sensor	No	Yes
Hall effect sensor	No	Yes
Working Temperature	-40°C to 125°C	-40°C to 125°C

Connectivity



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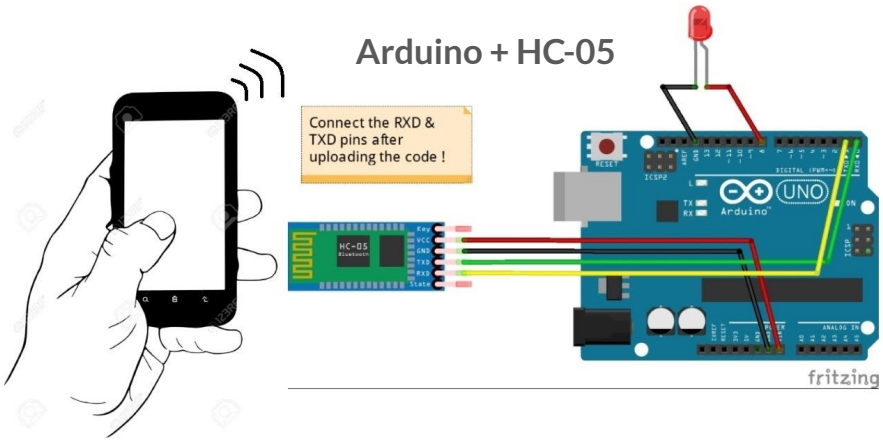
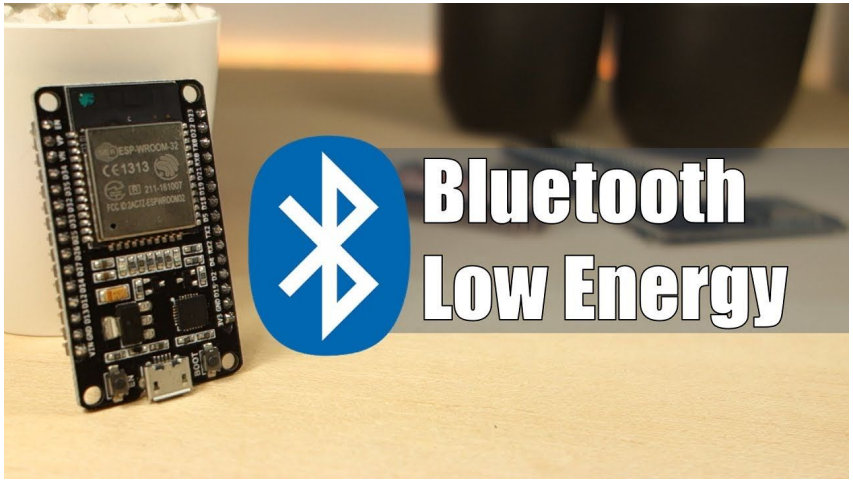
Bluetooth



ESP32



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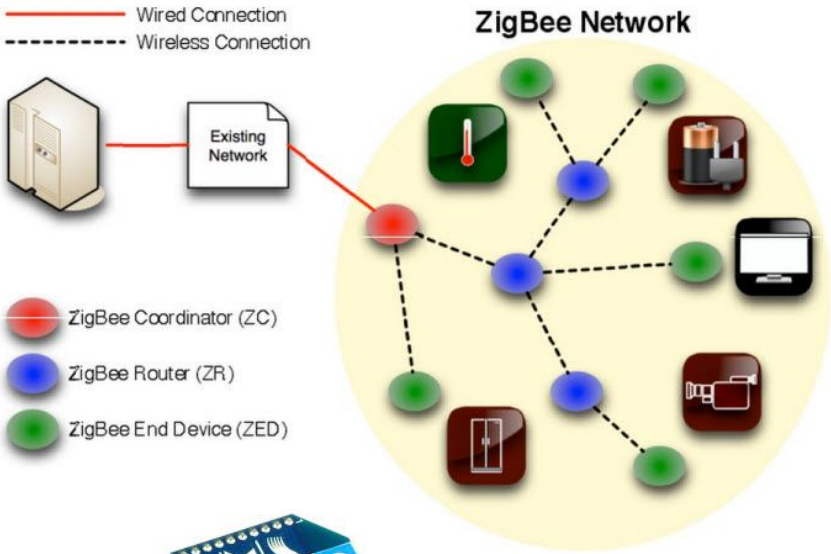
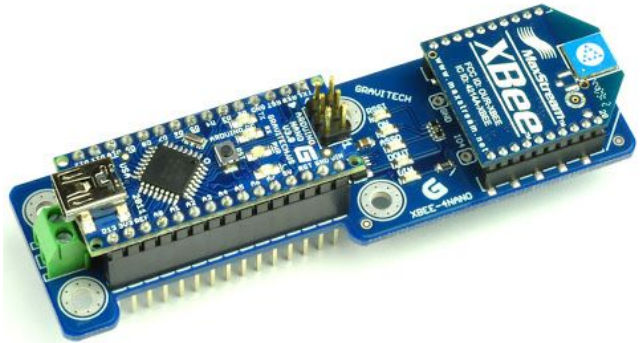
ZigBee

ZigBee is based on IEEE (Institute of Electrical & Electronics Engineers) 802.15.4 Standard which lays down specifications for the low rate wireless personal area network. ZigBee is primarily used for two-way communication between a sensor and a control system. Like Bluetooth and Wi-Fi, it is a short-range communication and offers connectivity up to 100 meters.





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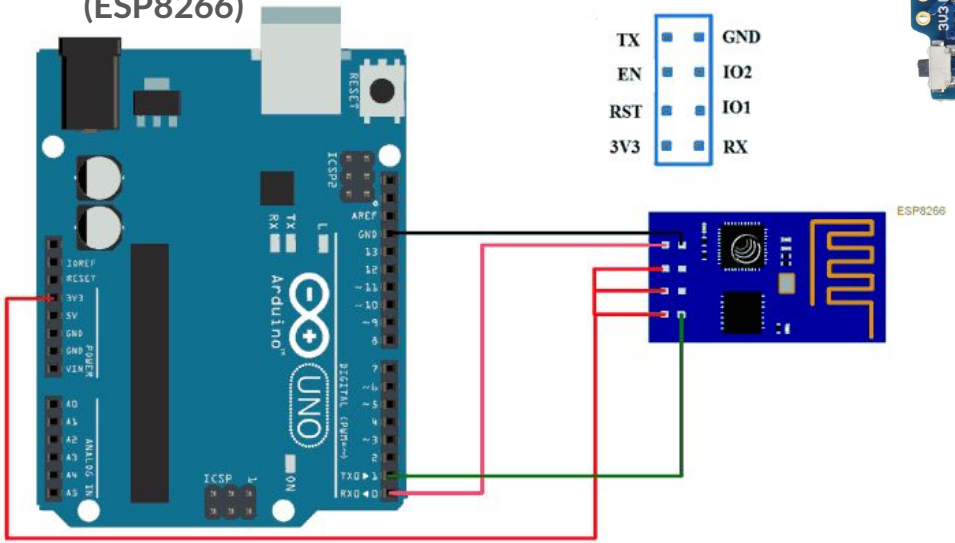
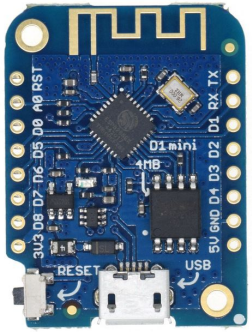
WiFi

Arduino + WiFi Module (ESP8266)



Wemos D1 Mini (ESP8266)



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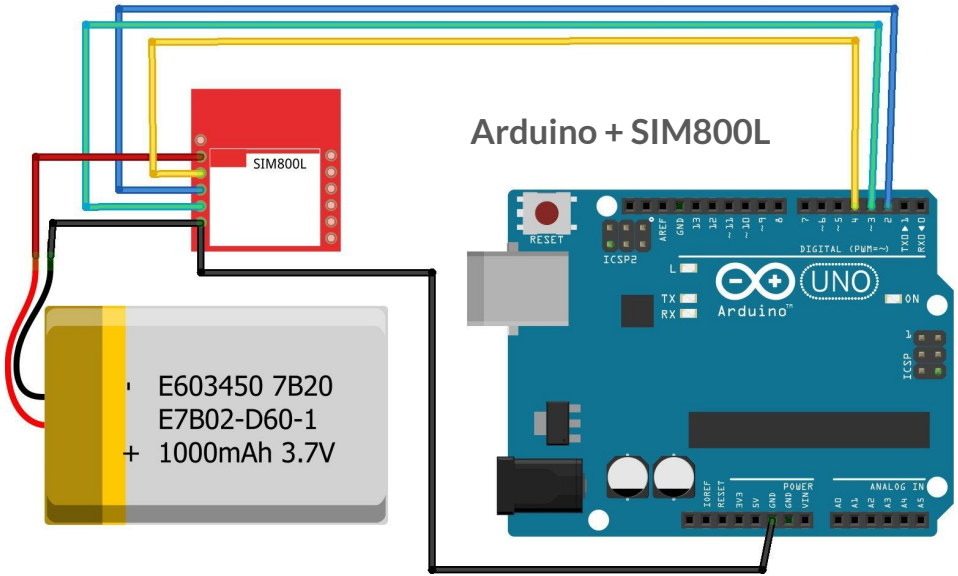
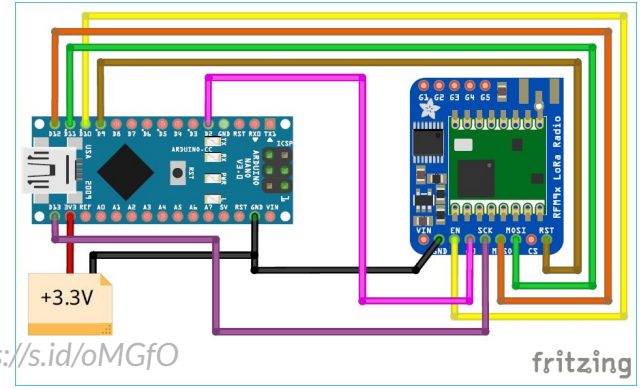
GSM / GPRS Module

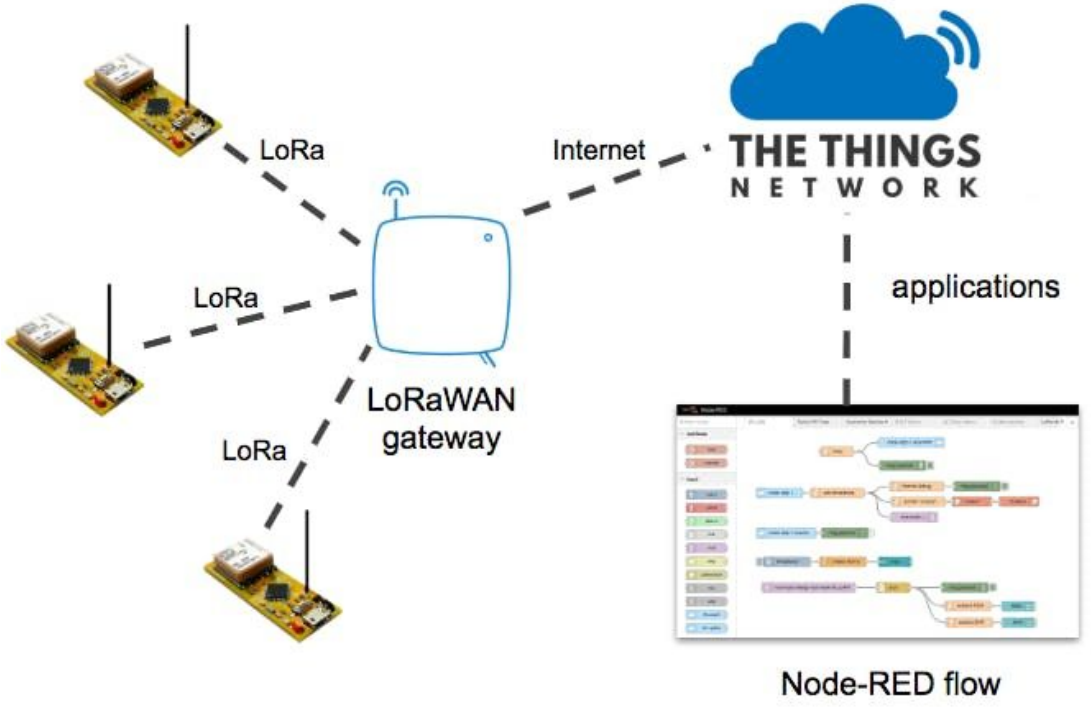


LoRa

LoRa uses license-free sub-gigahertz radio frequency bands like 433 MHz, 868 MHz (Europe), 915 MHz (Australia and North America) and 923 MHz (Asia). LoRa enables long-range transmissions (more than 10 km in rural areas) with low power consumption.



Arduino + RFM95



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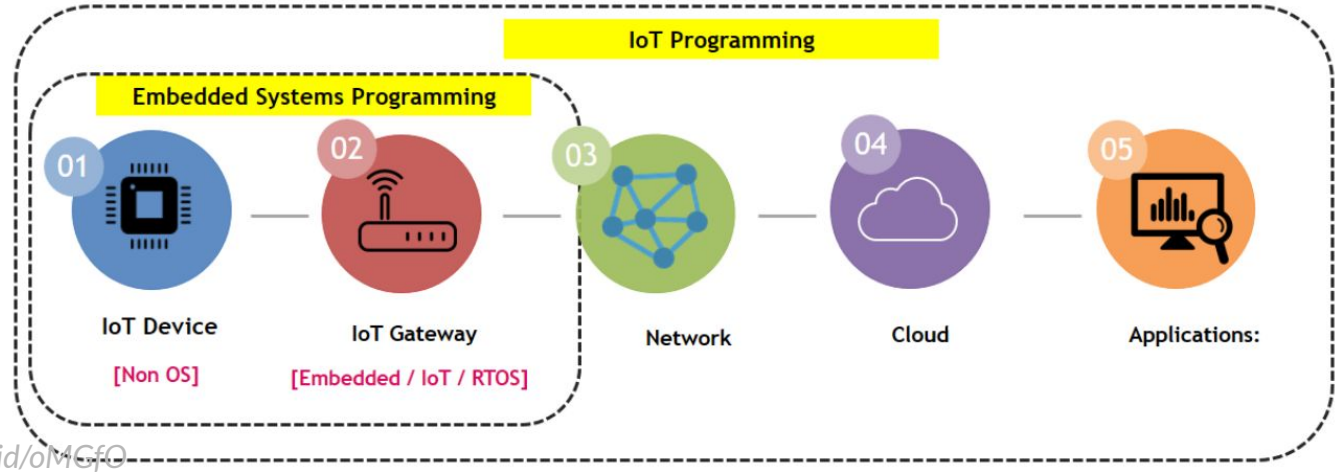
Relation IoT and Embedded System

Embedded Systems are part of the overall IoT by taking two key components in terms of IoT devices and IoT gateway.



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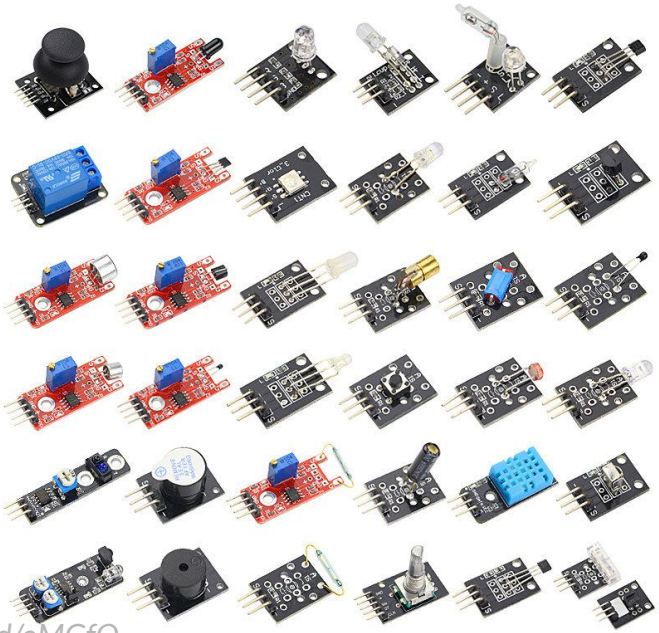
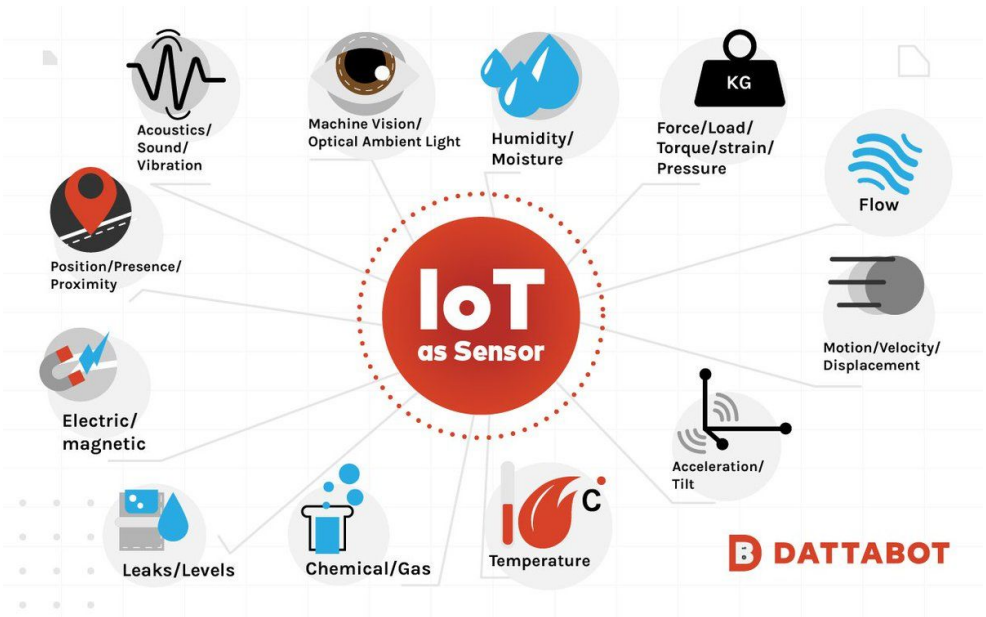
Sensor





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Actuator

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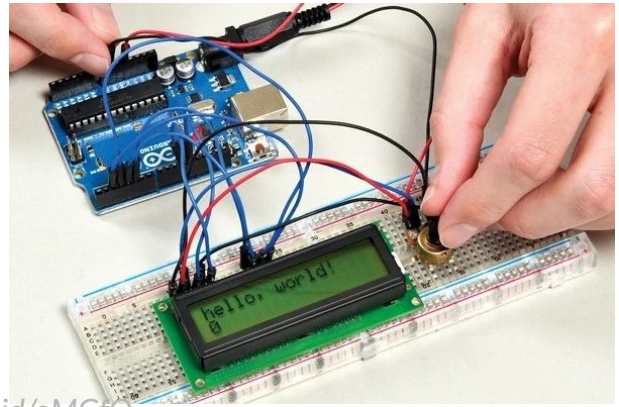
Arduino

From Wikipedia: Arduino is an open-source hardware and software company, project and user community that designs and manufactures single-board microcontrollers and microcontroller kits for building digital devices.



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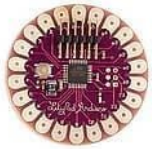
Hardware


Arduino Uno


Arduino Leonardo


Arduino Mega 2560


Arduino LilyPad


Arduino Mega ADK

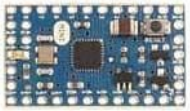

Arduino Fio


Arduino Ethernet

Arduino Pro

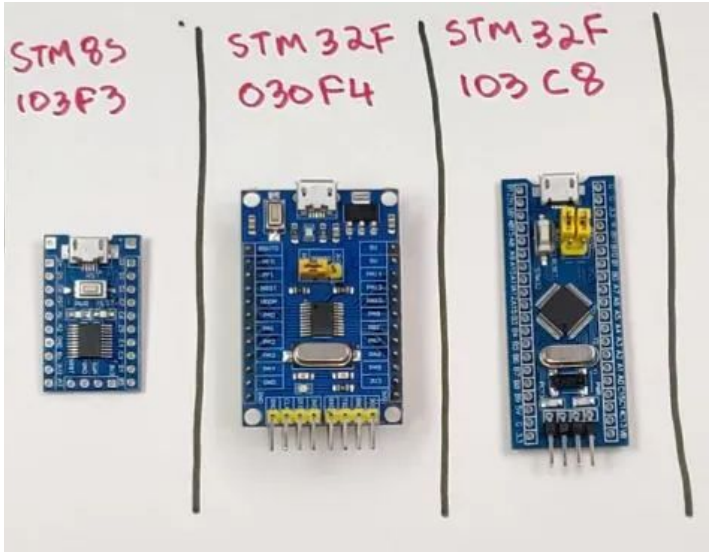

Arduino BT


Arduino Nano


Arduino Mini


Arduino Pro Mini

Hardware++



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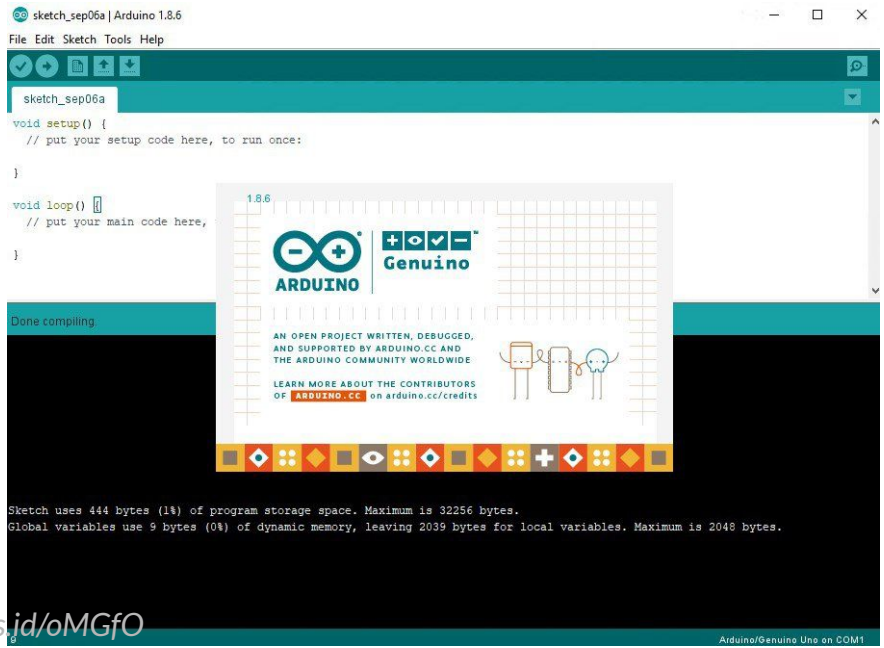
Software: Arduino IDE



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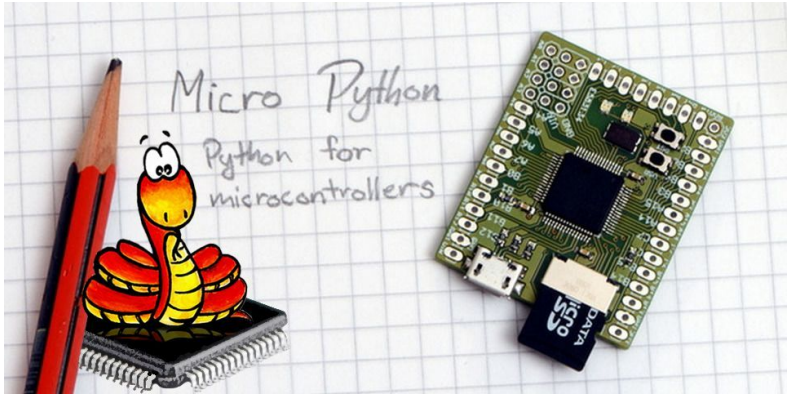
Advantages of Arduino

> Tons of Library / Module can be used
> Open Source
> There are many example in internet
> Almost every device (sensor) supported with Arduino
> Large Community

MicroPython

From Wikipedia: MicroPython is a software implementation of a programming language largely compatible with Python 3, written in C, that is optimized to run on a microcontroller. MicroPython is a full Python compiler and runtime that runs on the micro-controller hardware.



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Hardware

Pyboard v1 and D-series

pyboard v1

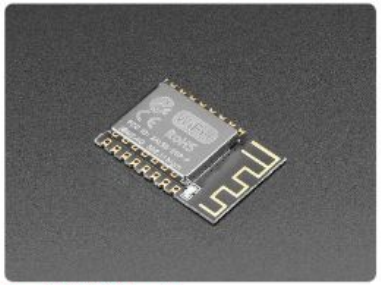
pyboard D-series

STM32 boards

STM32 Nucleo and Discovery boards

Espruino Pico

Espressif ESP-based boards

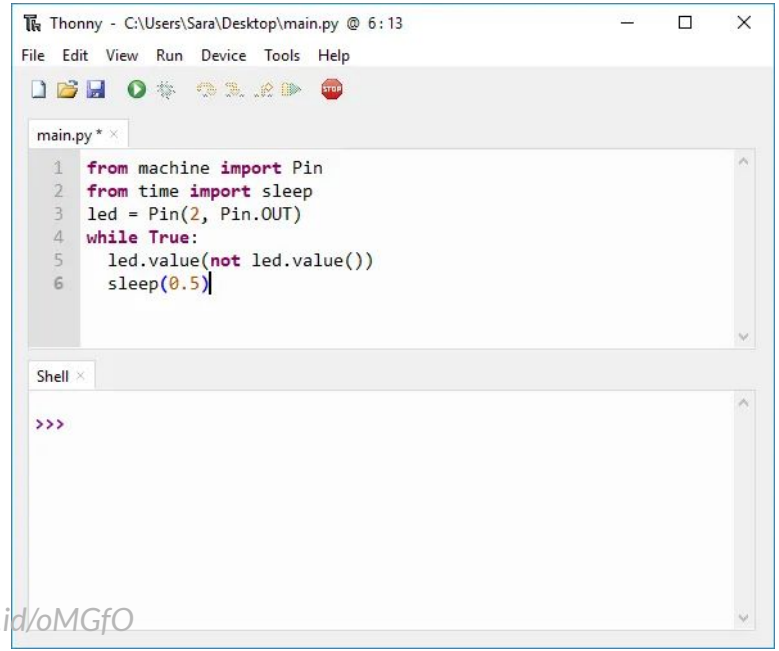


Generic ESP8266 module

Generic ESP32 module

TinyPICO

Software: Thonny



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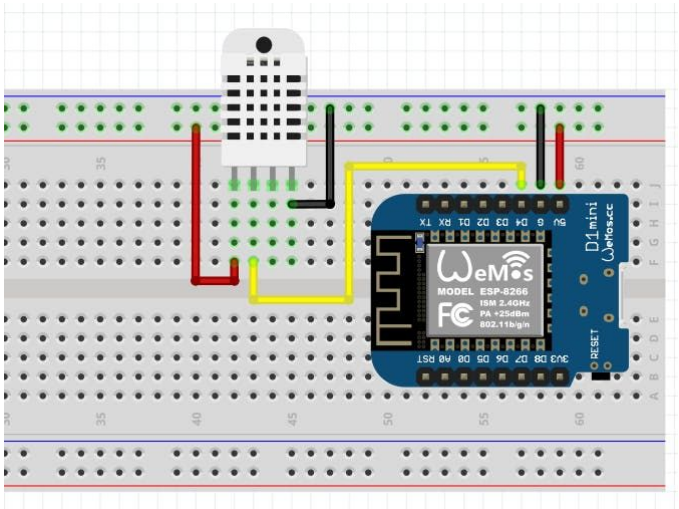
Advantages of MicroPython

> It’s like English Language
> Nice for newbie
> Open Source
> Good developer for maintain this project
> REPL : Read Eval Print Loop
> Built-in Exception and Error-Handling

DEMO :)



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Thanks

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