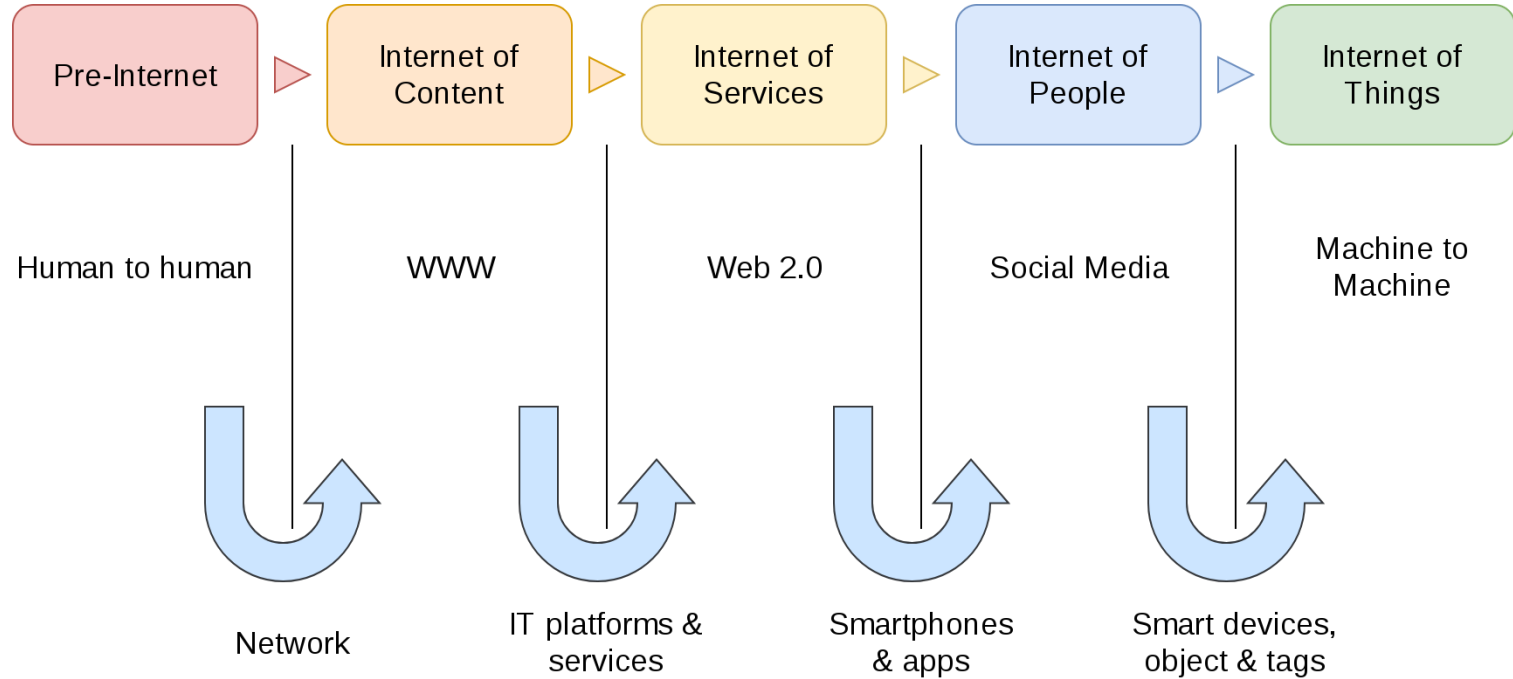# Internet - of - *cheap* Things

A Beginners Guide to the Internet, ESP and RPI

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The Internet

Pre-Internet	Internet of Content	Internet of Services	Internet of People	Internet of Things

Human to human

WWW

Web 2.0

Social Media

Machine to Machine

Network

IT platforms & services

Smartphones & apps

Smart devices, object & tags

IoT, WoT, IoE, CPS, ...

"The network of devices that contain the hardware, software, firmware, and actuators which allow the devices to connect, interact, and freely exchange data and information."
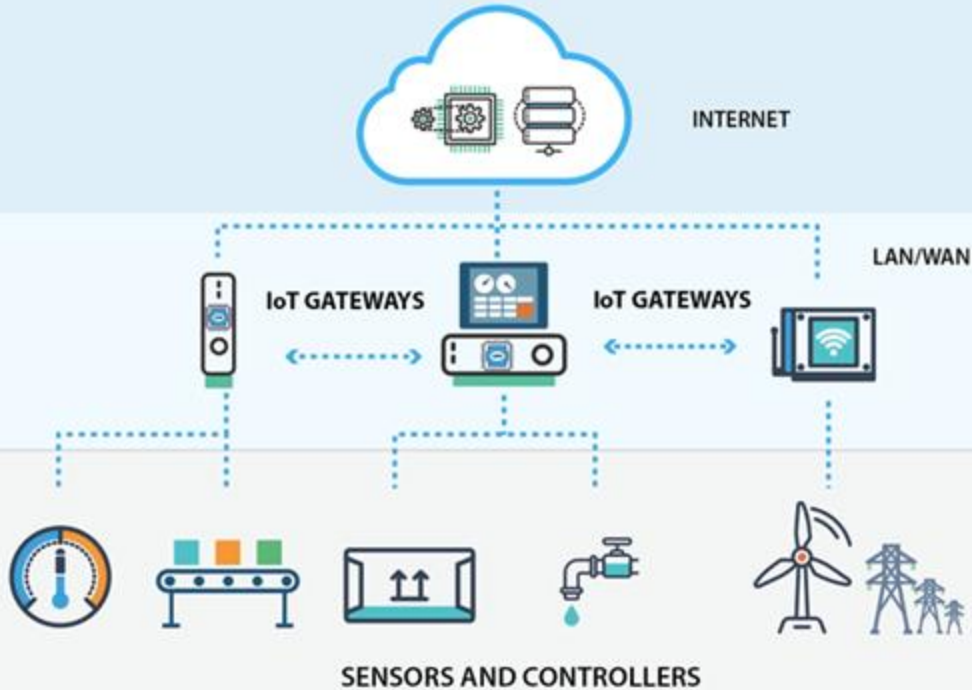
"(...) user or industrial devices that are connected to the internet. IoT devices include sensors, controllers, and household appliances."

Internet of Things (IoT), NIST, https://csrc.nist.gov/glossary/term/internet_of_things_iot
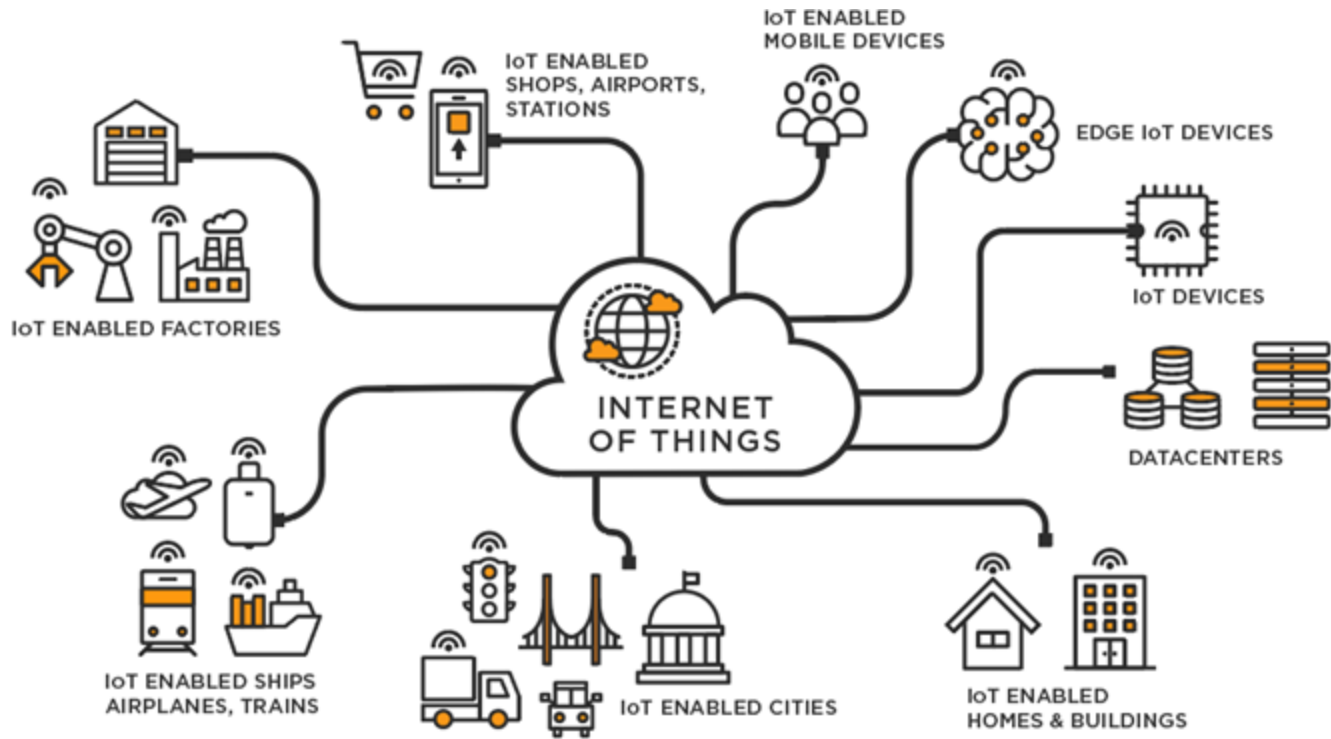
What is the Internet of Things (IoT)?, TIBCO Software, https://www.tibco.com/reference-center/what-is-the-internet-of-things-iot
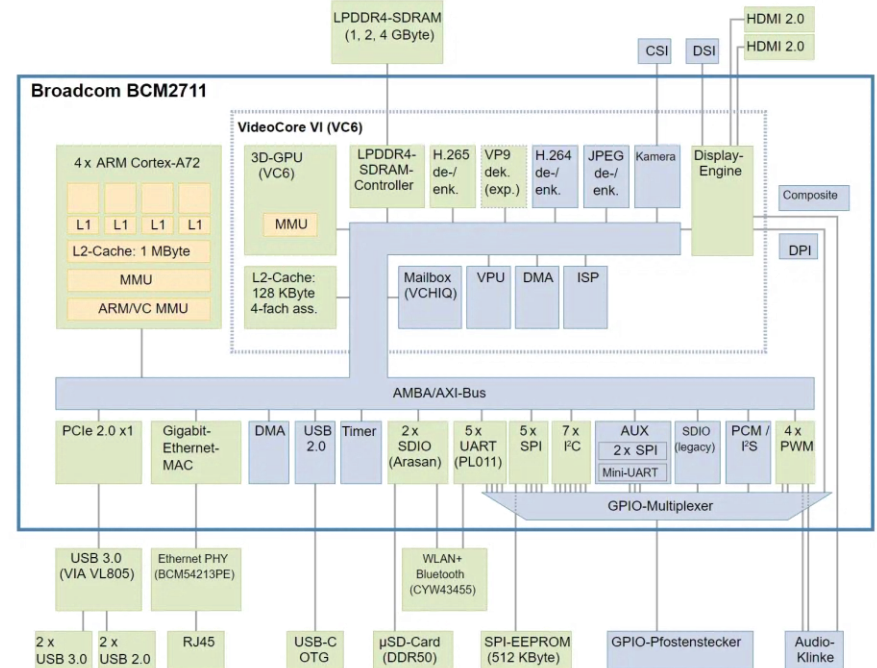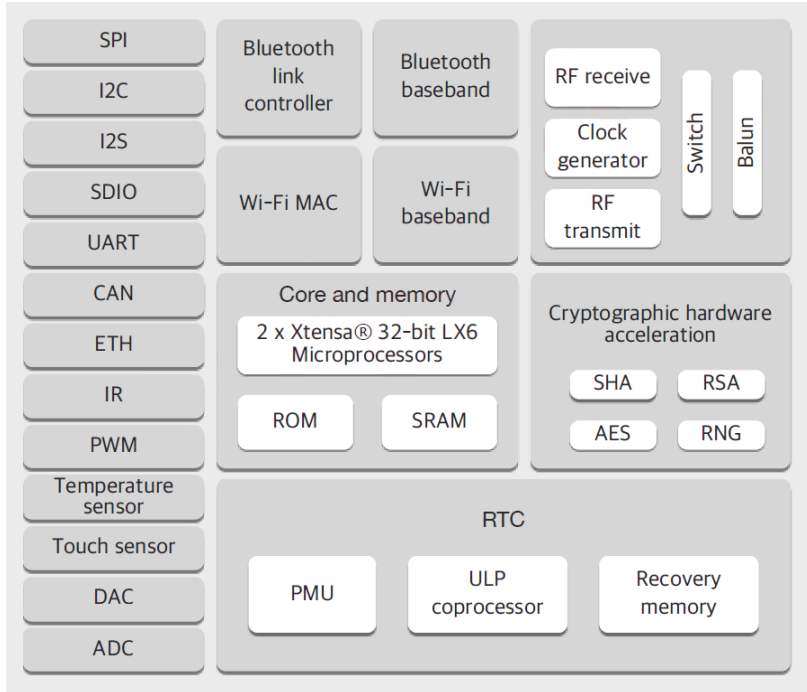
The IoT Three Tiers

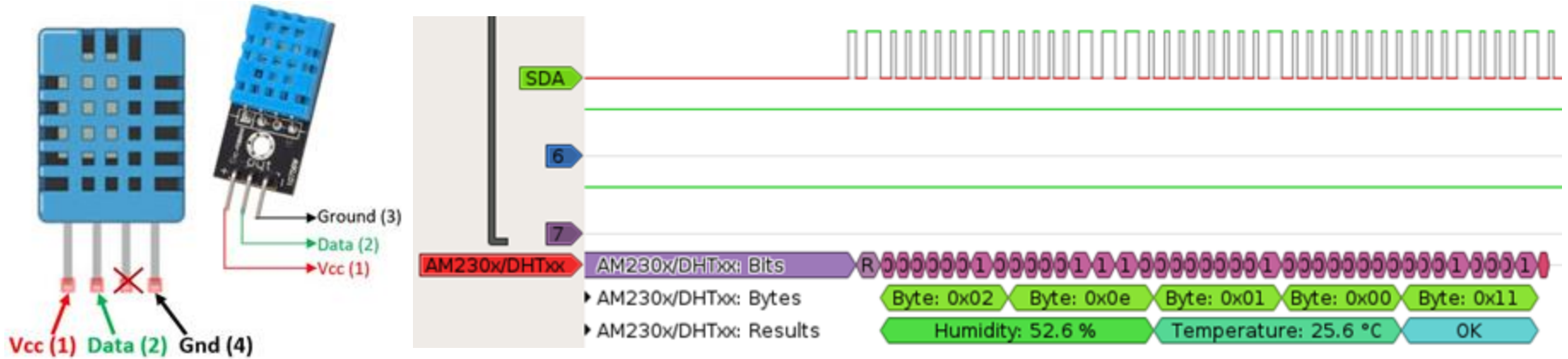Cloud Tier: (Virtualized) High-power Servers and Services

Fog Tier: Gateways, Data Aggregators, Pre-Processing, etc.

Edge Tier: Sensors, Actuators, and other Low-computational Tasks

# Micro-controller (ESP) vs SOC/SBC (RPI)

# Sensors (DHT11)

DHT11 is a **single wire digital humidity and temperature sensor**, which provides humidity and temperature values serially with **one-wire protocol**. DHT11 sensor provides relative **humidity value in percentage (20 to 90% RH)** and **temperature values in degree Celsius (0 to 50 °C)**.

DHT11/DHT22, www.ocfreaks.com/basics-interfacing-dht11-dht22-humidity-temperature-sensor-mcu/

Sensors (BMP280)
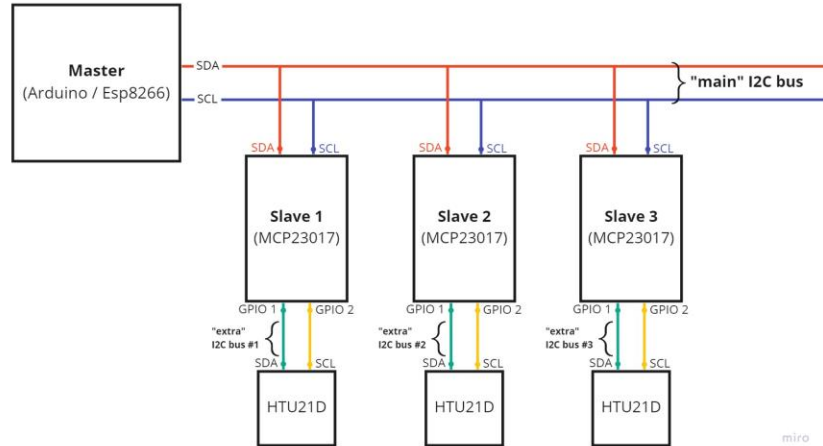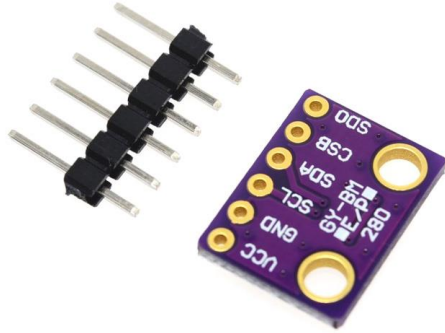
The BMP280 is an absolute barometric pressure sensor, which is especially feasible for mobile applications. I2C stands for Inter-Integrated Circuit. It is a bus interface connection protocol incorporated into devices for serial communication. It was originally designed by Philips Semiconductor in 1982. Recently, it is a widely used protocol for short-distance communication. It is also known as Two Wired Interface (TWI).

RPI4 Pinout

Raspberry Pi 4 B J8 GPIO Header

Pin#	NAME			NAME	Pin#
01	3.3v DC Power	■	●	DC Power 5v	02
03	GPIO02 (SDA1, I²C)	●	●	DC Power 5v	04
05	GPIO03 (SCL1, I²C)	●	●	Ground	06
07	GPIO04 (GPCLK0)	●	●	(TXD0, UART) GPIO14	08
09	Ground	●	●	(RXD0, UART) GPIO15	10
11	GPIO17	●	●	(PWM0) GPIO18	12
13	GPIO27	●	●	Ground	14
15	GPIO22	●	●	GPIO23	16
17	3.3v DC Power	●	●	GPIO24	18
19	GPIO10 (SPI0_MOSI)	●	●	Ground	20
21	GPIO09 (SPI0_MISO)	●	●	GPIO25	22
23	GPIO11 (SPI0_CLK)	●	●	(SPI0_CE0_N) GPIO08	24
25	Ground	●	●	(SPI0_CE1_N) GPIO07	26
27	GPIO00 (SDA0, I²C)	●	●	(SCL0, I²C) GPIO01	28
29	GPIO05	●	●	Ground	30
31	GPIO06	●	●	(PWM0) GPIO12	32
33	GPIO13 (PWM1)	●	●	Ground	34
35	GPIO19	●	●	GPIO16	36
37	GPIO26	●	●	GPIO20	38
39	Ground	●	●	GPIO21	40

Raspberry Pi 4 B J14 PoE Header

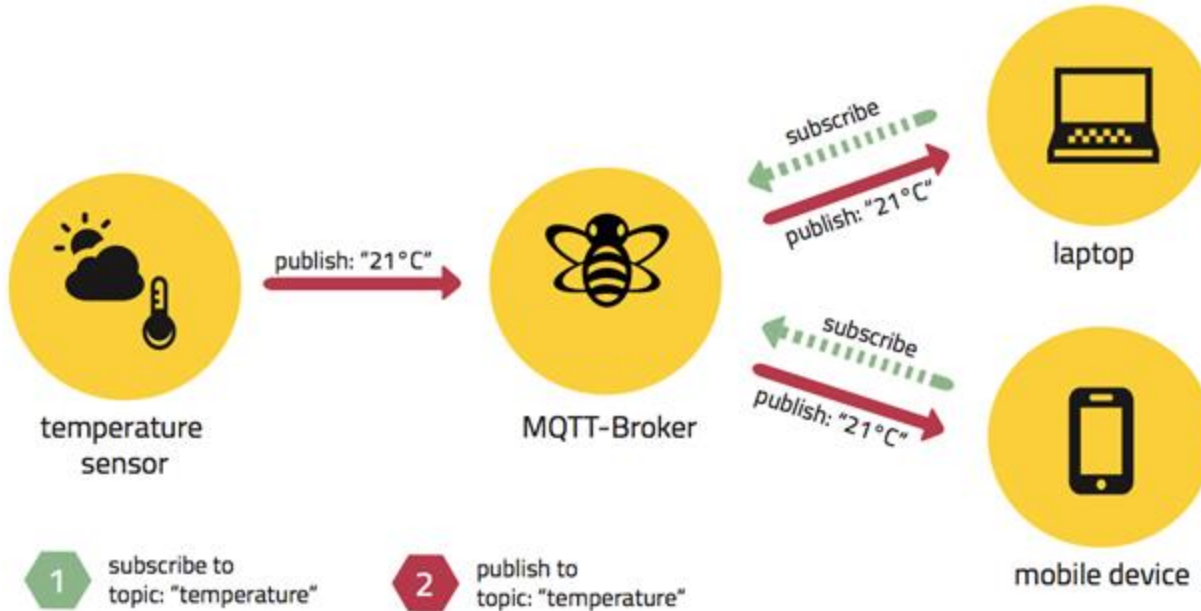|					
01	TR01	●	●	TR00	02
03	TR03	●	●	TR02	04

Pinout Grouping Legend

Inter-Integrated Circuit Serial Bus ● ● Serial Peripheral Interface Bus

Ungrouped/Un-Allocated GPIO ● ● Universal Asynchronous Receiver-Transmitter

Reserved for EEPROM ●

The *I* in *I*oT stands for ~~Security~~ Internet…

but where is it?

MQTT and the world of Pub/Sub

QoS Levels:

- *At most once (0)*
- *At least once (1)*
- *Exactly once (2)*

Birth and Last Will and Testament (LWT) messages.

Birth *is used to send a message after the service has started, and the* **LWT** *is used to notify other clients about a disconnected client.*

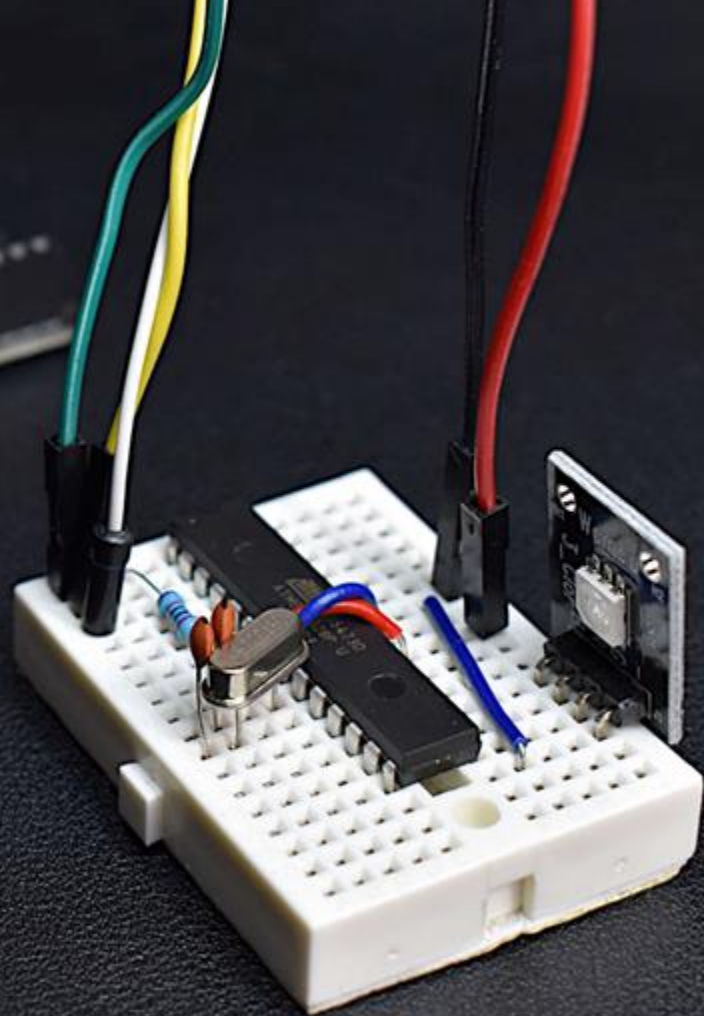TCP-based, can be used directly or with Web Sockets.

A little more on MQTT...

A MQTT broker is required (local broker Mosquitto):

- Broker: **localhost**
- TCP Port: **1883**
- Websocket Port: **9001**

MQTT-Explorer (http://mqtt-explorer.com/) can be used to "debug" the communication flow

Hands-On
Starts Now!

NTP (Network Time Protocol)

- RPI does not have an RTC (Real Time Clock)
- It relies on the NTP for synchronization
- Within the university network the only NTP servers that work are:
    - time.ua.pt
    - ntp.ua.pt
- The clock is necessary for apt and the timestamp when publishing data

NTP #2

$ sudo timedatectl set-timezone Europe/Lisbon

$ sudo nano /etc/systemd/timesyncd.conf
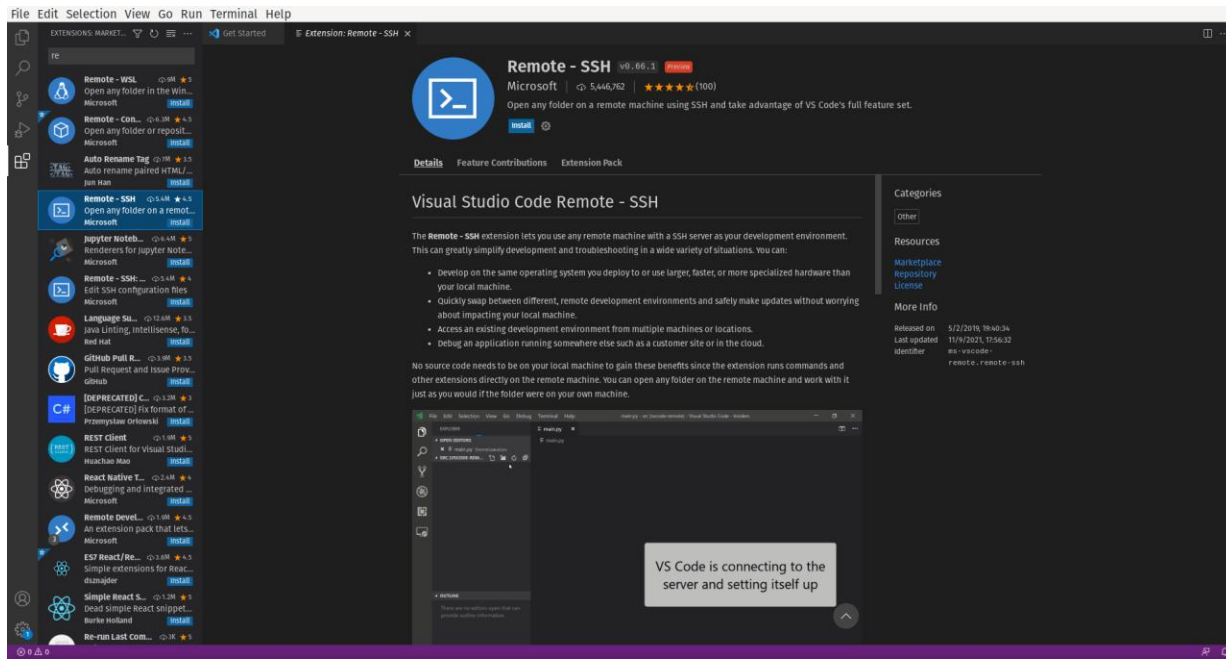
[Time]
FallbackNTP=time.ua.pt ntp.ua.pt

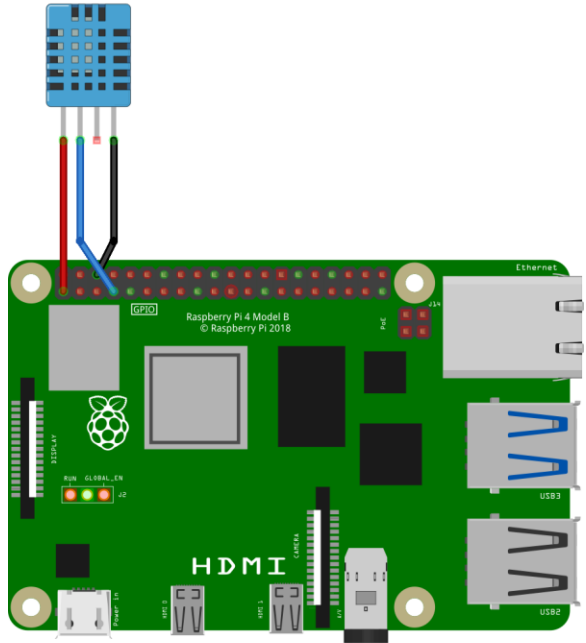**$** sudo timedatectl set-ntp false

$ sudo timedatectl set-ntp true

$ sudo reboot

VSCode Remote SSH

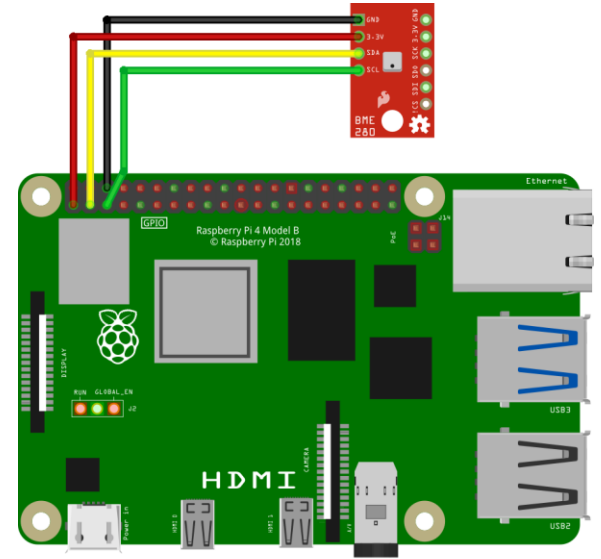- Visual Studio Code is a source-code editor made by Microsoft
- It allows the code on remote sources using SSH

DHT11 & BMP280

The Code (GitHub)

The code for a simple sensor (written in Python) can be found here:

https://github.com/mariolpantunes/rpi_iot

Read More

- IoT for Beginners - A Curriculum, https://github.com/microsoft/IoT-For-Beginners
- OWASP Internet of Things (Top 10), https://owasp.org/www-project-internet-of-things/
- Build Computer from Scratch, https://eater.net/
- Adafruit Learning System, https://learn.adafruit.com/
- Pimoroni Learning, https://learn.pimoroni.com/
- Awesome IoT List, https://github.com/phodal/awesome-iot
- https://twitter.com/internetofshit
- Andreas Spiess, https://www.youtube.com/channel/UCu7_D0o48KbfhpEohoP7YSQ

Project ideas:

- https://hackster.io
- https://hackaday.com/
- https://create.arduino.cc/projecthub

I want to spend *some* money...

⚜ AliExpress, all the components, cheap (pick 10-day delivery to ensure delivery)
⚜ PCBWay, https://www.pcbway.com/ (making PCB, 5 for 5$ + ports)

⚜⚜ Mauser.pt, https://mauser.pt/
⚜⚜ PTRobotics, https://ptrobotics.com/
⚜⚜ Mouser.com, https://pt.mouser.com/ (all the things, free ports +50€)
⚜⚜ Farnell.com, https://pt.farnell.com/ (all the things)

⚜⚜⚜ Pimoroni, https://shop.pimoroni.com/
⚜⚜⚜ Adafruit, https://www.adafruit.com/

It's a Wrap!

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